PRACTICAL ELECTRONICS
SEPTEMBER 1980

DISCO DESK
Part 1
SPECIAL OFFER
Autoranging DMM

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**EUROPE'S FASTEST SELLING ONE BOARD COMPUTER**

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  - Power supply included.

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- **Low Cost Video Monitor**
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- **COBOL**
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- (Part of the Compshop Ltd. Group)
CONSTRUCTIONAL PROJECTS

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An almost unlimited range of sound effects for your Compukit

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OUR OCTOBER ISSUE WILL BE ON SALE FRIDAY, 12 SEPTEMBER 1980
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The Kit contains all parts needed to construct the multimeter plus assembly instructions, battery and test leads.

We also offer a calibration service (£5.00 + VAT) and a trouble-shooting and service calibration (£7.50 + VAT). Various other component parts are also available as listed.

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Lascar Electronics Ltd., Unit 1, Thomasin Road, Basildon, Essex. Telephone No: Basildon (0268) 727383.
## Enter the 80’s with Saxon

### Stereo Disco Systems

**With Light Show & Display**

<table>
<thead>
<tr>
<th>System Type</th>
<th>Description</th>
<th>Price incl. VAT</th>
<th>Deposits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Standard Centaur 100W</strong></td>
<td>All systems complete with loudspeakers, leads, &amp; 2 years warranty</td>
<td>£299</td>
<td>£60</td>
</tr>
<tr>
<td><strong>Super Centaur 200W</strong></td>
<td></td>
<td>£399</td>
<td>£80</td>
</tr>
<tr>
<td><strong>GXL 200W with PDF Bins (ideal)</strong></td>
<td></td>
<td>£489</td>
<td>£99</td>
</tr>
<tr>
<td><strong>Custom Centaur 400/600W</strong></td>
<td>with four PDF 100A Bins</td>
<td>£899</td>
<td>£167</td>
</tr>
<tr>
<td><strong>Mini Disco 100W Mono</strong></td>
<td></td>
<td>£349 inc carr. &amp; VAT</td>
<td>£50</td>
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### Just Plug In And Go!!

<table>
<thead>
<tr>
<th>System Type</th>
<th>Description</th>
<th>Price incl. VAT</th>
<th>Deposits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>P.A. Systems C/W Loudspeakers</strong></td>
<td></td>
<td>£229 inc. VAT</td>
<td>£50</td>
</tr>
<tr>
<td><strong>Minidisco 100W</strong></td>
<td></td>
<td>£249 inc. carr. &amp; VAT</td>
<td>£60</td>
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</table>

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**Of the World’s Finest Cored Solder to Do a Professional Job at Home**

Ersin Multicore Solder contains 5 cores of non-corrosive flux that instantly cleans heavily oxidised surfaces and makes fast, reliable soldering easy. No extra flux is required.

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<table>
<thead>
<tr>
<th>Ref.</th>
<th>Alloy</th>
<th>Diam. mm.</th>
<th>Length metres approx.</th>
<th>Use</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size 3</td>
<td>40/60</td>
<td>1.6</td>
<td>10.0</td>
<td>For economical general purpose repairs and electrical joints. For aluminium repairs. Also solders aluminium to copper, brass etc. For fine wires, small components and printed circuits. For radio, TV and similar work. Increases copper-bit life tenfold.</td>
<td>£3.91</td>
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<tr>
<td>Size 4</td>
<td>ALU-SOL</td>
<td>1.6</td>
<td>8.5</td>
<td></td>
<td>£6.00</td>
</tr>
<tr>
<td>Size 10</td>
<td>60/40</td>
<td>0.7</td>
<td>39.6</td>
<td></td>
<td>£3.91</td>
</tr>
<tr>
<td>Size 12</td>
<td>SAVBIT</td>
<td>1.2</td>
<td>13.7</td>
<td></td>
<td>£3.91</td>
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</tbody>
</table>

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Absorbs solder instantly from tags, printed circuits etc. Only needs 40-50 Watts soldering iron. Quick and easy to use. Non-corrosive.

<table>
<thead>
<tr>
<th>Size</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>AB10</td>
<td>£1.38</td>
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A simple and effective substitute for a rotary cabinet. The output of an internal generator is phase-shifted and modulated by both.

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A simple converter that modifies the Miniscus sawtooth waveform into triangle and square waveforms. Ideally one should be used with each Miniscus VCO.

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Automatically gives Wah or Swell sounds with each note played.

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A very sophisticated synthesizer for the advanced constructor who wishes to experiment with waveform synthesis.
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PHOTOGRAPHS in this advertisement show details of units containing some of the P.E. projects built from our kits and PCBs. The kits were built by ourselves and are not for sale, though a small selection of other cases is available.

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A voltage controlled filter extracted from P.E. Minilistic project.
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P.E. VOICE OPERATED FADER
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Basic components, PCB & chart KIT 30-1 £4.37
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Very effective stereo circuit for reducing the hiss or flicker due to blanking.
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Transistor ignition (80084). A system which combines the most significant advantages of other systems, including the conventional system! £20.45

A dip-stick probe (80102). There are all kinds of indicators and warning lights in modern cars, but an oil temperature indicator is rarely included. The easiest way to add this type of indicator to an existing car is to mount a temperature sensor in the dip-stick. Project without dip-stick £3.65 dip-stick with indicator (short) £11.00 dip-stick with indicator (long) £11.45

Intelligent wiper delay (80086). This wiper delay only needs to be told once what is required of it. It will then carry out your orders until you change them, which you can do at any time, instantly. £15.85

Active car aerial (80118-1-2). If there is one place to use a good aerial it is in a car. £13.85

Stop thief! (80097). There are all sorts of systems for protecting cars, but this one is unusual: it is deception, rather than protection. £4.20

Battery voltage indicator (80101). Only a few components are needed to obtain an optional indication of the battery condition: a single lamp that changes colour as the battery goes into the danger area. £6.85

To: Heath Electronics (U.K.) Limited, Dept (PE 9), Bristol Road, Gloucester, GL2 6EE. Please send me a copy of the Heathkit catalogue. I enclose 25p in stamps. Name... Address... Keep up to date with the world’s finest electronic kits—with the Heathkit catalogue. 48 product packed pages contain photographs and specifications of the widest possible range of kits. Everything from doorbells to digital clocks, multimeters to microcomputers. Heathkit make it easy to build, easy on your pocket, and, as with 13 million Heathkit builders over 34 years, your success is guaranteed. Make sure of your copy of the Heathkit catalogue. Send the coupon today, plus 25p in stamps and beat the demand.
PRIME COMPONENTS

LOW PRICES

All our micro chips are at micro prices. Don’t be fooled by low prices. We do not offer for sale sub-spec or rebranded devices. All our parts are guaranteed to be genuine, specific devices. We go to great lengths to ensure that you are aware of the best of new devices that become available and these are featured regularly in our price lists and VAT. Just stay abreast of “Offers and Information” before ordering. Official orders from Schools, Colleges, Universities and Authorities accepted.

NEW

SPECIAL OFFER!

4K CMOS RAM (1K x 4) 450 NS ONLY £7.95 (8 for £50)

The TC 5149P from Toshiba, CMOS equivalent of the 2114 family. Supplies low power dissipation means it can be used in battery-operated portable equipment, as a sub-spec or rebranded device, or as a non-reliable micro with battery back-up. Operates from a single 5V power supply with static operation, and therefore period and a much simplified power supply circuit. Design from three states output simply memory mapping, for minimum data retention voltage 2V, the battery back-up system needs only simple circuit. Toshiba’s original CMOS technology also means wide operating and noise margins. The TC 5149P is available in a dual-inline 18 pin plastic package 0.3 inch in width.

NEW X-RATED CLOCK!

ONLY £19.99

ZULU II CLOCK KIT WITH CALENDAR AND Daylight Savings Time display

- X-TIA VALUE: All the components and high quality widescreen PAL format display provided.
- X-TIA CARE IN DESIGN: No wires between readout board and clock back. Large operational display.
- X-EXCELLENCE IN IDEAS: 5 years of designed products for the amateur radio market.
- X-EFFICIENCY IN CIRCUIT: Design and assembly time saving, the ZULU II kit is fully illustrated. The assembly manual is not a read-between-the-lines afterthought!
- X-TRA FEATURES: Guaranteed to be a clock kit with so many features – at any price.

Unit operates on either 12VAC or 12VDC.

- On board QUARTZ TIMEBASE.
- Fully comprehensive instruction manual is included with these power failures against.
- Reads true 24 HOUR TIME AND 31 DAY CALENDAR.
- Unique 100mhz CIRCUIT activates readouts with a handcuff or they can be turned on with a flick of the wrist.

When used mobile readouts blank instantly; is off.

- Specialist NOISE SUPPRESSION and battery reversal circuits.
- Bright LEDs show hours, minutes and seconds.

Just clasp your hands and the time appears for 5 seconds followed by the date for 4 seconds. A low cost 1V output is available to power the units in a number of applications, or for use on the time.

With a low cost 12V 300w transistor, the unit will work on AC.

ULTRASONIC SENDER RECEIVER KIT

TOTAL SECURITY! Completely invisible ultrasonic (23KHz). Sound beam works like a photoelectric device; simple installation, no filtering, no components used from 6 inches to 26 feet! A solid object breaking the beam causes an output to go low that will operate a variety of different types of devices. Easily installed in 15 minutes and is available with AC or 12VDC (unregulated) and draws less than 100mA. Use it for burglar alarms, object counters, automatic operators, automatic, door bells, electronic rat trap 1/2 and more.

ONLY £19.95 £67p + VAT.

NEW

SOUND ALARM KIT

A 6-pin EASY kit to assemble that emits an ear piercing sound repeated for 10 seconds. Great for alarms or toys. Operates from 6V to 12V DC (battery or AC). Use to make alarm, speaker directly, or the unit can be connected to a complete system. Over five thousand have been sold. All parts included, with instructions.

ONLY £4.99 £67p + VAT.

PROGRAMMABLE DUO P-TRANSMITTER TRANSISTOR AMPLIFIER

New from National Semiconductor, the LM 1872 is an ultra low-cost, dual output, precision, transistor amplifier. It can be used as a functional building block in current controlled operational amplifiers. It is suitable for斩 furnishes, audio, stereo, power, and sample and hold circuits. It is also useful in adding amazing effects to a wide range of audio signals. Eighty new transistors. It can also be used in many other circuits.

Price: £3.99 £67 + VAT.

LED BAR GRAPH AND ANALOGUE GRAYSCALE TRANSISTOR AMPLIFIER

New from National Semiconductor, the LM1871A is a 12 LED display amplifier. It is a dual, differential, 12 LED, light emitting diode, multi-channel, digital output amplifier. It can also be used in many other circuits.

Price: £2.99 £67 + VAT.

THE INCREDBLE NEW MUSIC MACHINE KIT!

Just £6.95 plus £1 postage and VAT. As featured in Byte, July 1979.

Based on the new 45 pin TUNES SYNTHESIZER chip, the LM 1871, with 25 different popular and classical tunes, it is a unique kit for use in an electronic organ, music box, or even as a toy. It is available as a kit, tunes included or as a complete music machine. Use the kit as a toy or as a complete music machine. It is also available as a kit.

Price: £9.95 £67 + VAT.

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Price: £9.95 £67 + VAT.
GENTS QUARTZ LCD. 5-function. Hours, minutes, secs, month, date, backlight. ONLY £4.95

We don't believe you can find better value combined with quality, than these – our special introductory prices. Compare the savings we offer and order now.

CREDIT CARD CALCULATOR. Very slim with standard 4 functions plus memory, percentage and square root. Complete with a mock leather wallet with credit card pocket. ONLY £6.95

BELTIME 29F. Alarm/Chrono. Advanced and accurate, this watch has 8 time functions, 4 alarm functions and 17 chronograph functions. Complete with backlight and stainless steel bracelet. ONLY £19.95

GENTS ANALOGUE QUARTZ. Conventional display, accuracy normally associated with digital watches. Automatic calendar, elegant and robust. ONLY £19.95

LADIES QUARTZ LCD SAME AS 10. Alternative "Round" shape. Available in gold or silver colour. ONLY £8.95

All watches have fully adjustable, matching stainless steel straps, and demonstration battery fitted (this battery is not guaranteed for use, and 60p for each spare battery required. All products carry a Full 12-Month Guarantee. Prices include VAT.

Send stamped addressed envelope for Colour Brochure of 120 other bargains.
Britain's first computer kit.

The Sinclair ZX80.

£79.95

Price breakdown:
ZX80 and manual: £69.52
VAT: £10.43
Post and packing FREE

Please note: many kit makers quote VAT-exclusive prices.

You've seen the reviews... you've heard the excitement... now make the kit!

This is the ZX80. 'Personal Computer World' gave it 5 stars for 'excellent value.' Benchmark tests say it's faster than all previous personal computers. And the response from kit enthusiasts has been tremendous.

To help you appreciate its value, the price is shown above with and without VAT. This is so you can compare the ZX80 with competitive kits that don't appear with inclusive prices.

'Excellent value' indeed!

For just £79.95 (including VAT and p&p) you get everything you need to build a personal computer at home... PCB, with IC sockets for all ICs; case, leads for direct connection to a cassette recorder and television (black and white or colour); everything!

Yet the ZX80 really is a complete, powerful, full-facility computer, matching or surpassing other personal computers at several times the price.

The ZX80 is programmed in BASIC, and you can use it to do quite literally anything from playing chess to managing a business.

The ZX80 is pleasantly straightforward to assemble, using a fine-tipped soldering iron. It immediately proves what a good job you've done; connect it to your TV...link it to an optional computer adapater. Available from Sinclair if desired (see coupon).

Please note: many kit makers quote VAT-exclusive prices.

'Use a 600 mA at 9 V DC nominal unregulated mains power supply.

The unique and valuable components of the Sinclair ZX80.

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

The unique Sinclair BASIC interpreter offers remarkable programming advantages:

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

The Sinclair ZX80.

ZX80 and manual: £69.52
VAT: £10.43
Post and packing FREE

Fewer chips, compact design, volume production - more power per pound!

The ZX80 owes its remarkable low price to its remarkable design: the whole system is packed on to fewer, newer, more powerful and advanced LSI chips. A single SUPER ROM, for instance, contains the BASIC interpreter, the character set, operating system, and monitor. And the ZX80's 1K byte RAM is roughly equivalent to 4K bytes in a conventional computer - typically storing 100 lines of BASIC. (Key words occupy only a single byte.)

The display shows 32 characters by 24 lines. And Benchmark tests show that the ZX80 is faster than all other personal computers.

No other personal computer offers this unique combination of high capability and low price.

Your ZX80 kit contains...

- Printed circuit board, with IC sockets for all ICs.
- Complete components set, including all ICs—all manufactured by selected world-leading suppliers.
- New rugged Sinclair keyboard, touch-sensitive, wipe-clean.
- Ready-moulded case.
- Leads and plugs for connection to domestic TV and cassette recorder. (Programs can be SAVEd and LOADED on to a portable cassette recorder)
- FREE course in BASIC programming and user manual
- Optional extras
  - Mains adapater of 600 mA at 9 V DC nominal unregulated (available separately—see coupon)
  - Additional memory expansion boards allowing up to 16K bytes RAM. (Extra RAM chips also available—see coupon)

*Use a 600 mA at 9 V DC nominal unregulated mains adapater. Available from Sinclair if desired (see coupon).
The Sinclair teach-yourself BASIC manual.
If the specifications of the Sinclair ZX80 mean little to you—don’t worry. They’re all explained in the specially-written 128-page book free with every kit! The book makes learning easy, exciting and enjoyable, and represents a complete course in BASIC programming—from first principles to complex programs. (Available separately—purchase price refunded if you buy a ZX80 later.) A hardware manual is also included with every kit.
The ZX80 kit costs a mere £79.95. Can’t wait to have a ZX80 up and running? No problem! It’s also available, ready assembled and complete with mains adaptor, for only £99.95.
Demand for the ZX80 is very high: use the coupon to order today for the earliest possible delivery. All orders will be despatched in strict rotation. We’ll acknowledge each order by return, and tell you exactly when your ZX80 will be delivered. If you choose not to wait, you can cancel your order immediately, and your money will be refunded at once. Again, of course, you may return your ZX80 as received within 14 days for a full refund. We want you to be satisfied beyond all doubt—and we have no doubt that you will be.

ZX80 software—now available!

See advertisements in Personal Computer World, Electronics Today International, and other journals.

New dedicated software—developed independently of Science of Cambridge—reflects the enormous interest in the ZX80. More software available soon—from leading consultancies and software houses.

ORDER FORM

To: Science of Cambridge Ltd, 6 Kings Parade, Cambridge, Cambs., CB2 1SN.

Remember: all prices shown include VAT, postage and packing. No hidden extras.

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<table>
<thead>
<tr>
<th>Item</th>
<th>Item price £</th>
<th>Total £</th>
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<tr>
<td>Sinclair ZX80 Personal Computer kit(s). Price includes ZX80 BASIC manual, excludes mains adaptor.</td>
<td>£79.95</td>
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<tr>
<td>Ready-assembled Sinclair ZX80 Personal Computer(s). Price includes ZX80 BASIC manual and mains adaptor.</td>
<td>£99.95</td>
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<tr>
<td>Mains Adaptor(s) (600 mA at 9 V DC nominal unregulated)</td>
<td>6.95</td>
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<tr>
<td>Memory Expansion Board(s) (each one takes up to 3K bytes)</td>
<td>12.00</td>
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<tr>
<td>RAM Memory chips—standard 1K bytes capacity</td>
<td>16.00</td>
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<tr>
<td>Sinclair ZX80 Manual(s) (manual free with every ZX80 kit or ready-made computer)</td>
<td>5.00</td>
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NB. Your Sinclair ZX80 may qualify as a business expense. TOTAL £

I enclose a cheque/postal order payable to Science of Cambridge Ltd for £

Please print
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Practical Electronics September 1980
CONSTRUCTORS PACK 7
ALL THE PARTS TO BUILD THE PRACTICAL ELECTRONICS TRAVELLER CAR RADIO

£10.50 p&p £1.75

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 £1.00.
Pack 7A may only be purchased at the same time as Pack 7.
NOTE: Constructor's pack 7A sold complete with radio kit £15.20 including p&p.

NEW 12+12 AMPLIFIER KIT
An opportunity to build your own 12 watts per channel stereo amplifier with up to the minute features. To compete you just supply screw, connecting wire and solder. Features include 61 stage tubes for full stereo sound, volume and balance. Easy to assemble and perfect for your home. £3.95

50WATT MONO DISCO AMP £30.60 p&p £3.20
Size approx 13" x 5" x 8" x 6". 50 watts rms. 100 watts peak output. Big features include two disc inputs, both for ceramic cartridges, tape input and microphone input. Level mixing controls with integral push pull switches. Independent bass and treble controls and master volume. £18.25

EMI SPEAKER BARGAIN
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 £1.00.
Pack 7A may only be purchased at the same time as Pack 7.
NOTE: Constructor's pack 7A sold complete with radio kit £15.20 including p&p.

Mullard AUDIO MODULES IN BARGAIN PACKS

PACK 1 2 x LP1173 10w RMS output power audio amp modules, + 1 LP1182/2 Stereo pre amp for ceramic and auxiliary inputs
OUR PRICE £7.60 p&p £1.00

PACK 2 2 x LP1184/2 Stereo pre amp for magnetic, ceramic and auxiliary inputs + 1 LP1173 10w RMS output power audio amp modules
HUS, OUR PRICE £7.65 p&p £1.15

ACCESSORIES Suitable mains power supply parts, consisting of mains transformer, bridge rectifier, smoothing capacitor and set of rotary volume and balance £3.00 p&p £1.30

Two Way Speaker Kit. Consists of two woofers and two 3½" speakers with two crossover capacitors. £6.05 p&p £1.70

BARGAIN OFFER
Ariston pick-up arm manufactured in Japan. Complete with headshell. Listed price over £30.00. Our Price per £2.50

BSR P200 Belt drive chassis complete with GP401 magnetic cartridge. £25.50

PHILLIPS RECORD PLAYER DECK GC037 Hi-fidelity record player deck. Belt drive complete with GP461 magnetic cartridge. £76.00 p&p £14.00

CONSTRUCTORS PACK 7
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 £1.00.
Pack 7A may only be purchased at the same time as Pack 7.
NOTE: Constructor's pack 7A sold complete with radio kit £15.20 including p&p.

A FEATURED PROJECT IN PRACTICAL ELECTRONICS

323 EDGWARE ROAD, LONDON W2. For Personal Shoppers Only. 218 HIGH STREET, ACTON W3 6NG. Mail Order Only. No Callers.

Mon-Sat 9.30am-5.30pm Closed Thursday

October 1980
VALUE

EXT month your copy of PE will cost 65p. Value for money? We think so, but we are operating in one of the few areas of technology which has been characterised by falling prices over the years.

Back in November 1964 (Vol. 1 No. 1) PE was 2/6d or 12½p in modern terms. Next month PE will cost more than five times that price. An Armstrong AM-FM Tuner Amplifier advertised in that first issue cost just £37.10.0 and 37 feet of solder was 5/-; no VAT to add on in those days! So, although the price of technology has fallen, a five times increase on the cover price does not seem wildly out.

Add to that the fact that the issues were then a smaller size and yes, we do still think PE is good value.

Fortunately, it would appear that many of you concur with our views as PE has been privileged to boast the highest total sales of any British electronic constructors’ magazine for the past three years; we still hold that position. This boast is based on Audit Bureau of Circulation figures of total copies sold.

OFFERS

As we have pointed out in the past, we believe our special offers give excellent value for money; this issue carries a double autoranging multimeter offer (page 57) and a corrected re-run of our Casio watch offer. There were some errors in the original Casio offer so we have published corrections and re-run it. If you took advantage of the previous offer, or if you are interested in a Casio watch at discount, turn to page 65.

FREE

Next month you will also get a free Transistor Identichart (see page 63) with your issue and November will carry another free chart. We have plenty of exciting projects planned for future issues and are anticipating other special giveaways and offers.

As we have said, PE is number one and we intend to stay there.

RECESSION

The country may be in a period of recession but we believe that this will only increase activity in the hobby electronics field. If you can build a project for half the cost of a commercial unit, it could make all the difference. To those that read more than do, perhaps being forced into something by economics will prove to be very enjoyable.

Even in these dark days when we are regularly fed on the alarming jobless figures and listen with dismay to reports of school leavers without jobs, the electronics industry in general continues to thrive. It is interesting to note that recent issues of such publications as Computer Weekly continue to be fat with job advertisements. There is much to encourage youngsters to take up electronics!

Mike Kenward
Market Place

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

by David Shortland

FABULOUS FRED
A new electronic entertainments centre which looks as if it will be fun for adults as well as children is now available from Optim Toys.

Fabulous Fred incorporates ten different electronic games which use a sound generator as well as a visual display. The nine-note keyboard can be used as a simple organ, and the memory allows tunes of up to 50-note length to be keyed in and played back.

Other games include 'Space Attack', 'Submarine Hunt', and 'Catch the Comet'. 'Baseball' and 'Roulette' are more complicated and involve the use of a board and betting chips.

Fabulous Fred should be available from many toy shops at around £25.

and Jasper Scott

DIRECT TO WIRE
A new Direct to Wire Kit which offers 1,000 connections has been introduced by Verospeed.

Based on the GTH contact patented by BICC-Burndy, the kit includes eight types of connector interlinked with M100 10 way ribbon cable, supplied on two reels, and a selection of pre-stripped ribbon cable in various lengths. Gas tight connections are achieved by direct insertion of tinned, stranded or solid conductors into the contact assemblies, thus precluding the use of noble metals and making considerable cost savings.

The kit offers the Research and Development Engineer the ability to incorporate the same products that are used in production and eliminates the need for value engineering.

Verospeed stock all replacement parts, which are also available individually. The kit is priced at £39.95, and is available direct from: Verospeed Ltd., Stansted Road, Boyatt Wood, Eastleigh, Hants. SO5 42Y (0703 618525).

COILY JUMPERS
The range of EZ test hooks, with their 'hypodermic' finger action, has been further extended by coil jumper leads.

To allow greater flexibility of movement, when making test connections, EZ Hooks are being introduced joined by a p.v.c. coil cord—gauge 22SWG 2 x 36—which will expand from closed position of 180 to 900mm. The various size Hooks (44, 57 and 127mm) are all available in ten colour-coded colours connected by self-coloured cord. Further information on the entire range of EZ Hooks is available from: British Central Electrical Co. Ltd. (International Division), Unit 10, Carvers Industrial Estate, Southampton Road, Ringwood, Hants. BH24 1JS (04254 4617).

COMPUTER ACCESSORIES
A new microcomputer case which is suitable for the UK 101, Superboard and Nascom 2 has just been introduced by Microtype. Known as the Model 3, it succeeds Microtype's previous model and is considerably larger than other cases on the market, with space for expansion boards, fan ventilation or other additions. Made in black ABS plastic, the Model 3 can be sprayed with cellulose based car paints if a different colour is required. A pre-cut keyboard panel is available for UK 101, Superboard and Nascom 2 and a blank panel is available for those with 'homebrew' computers.

The kit offers the Research and Development Engineer the ability to incorporate the same products that are used in production and eliminates the need for value engineering.

Verospeed stock all replacement parts, which are also available individually. The kit is priced at £39.95, and is available direct from: Verospeed Ltd., Stansted Road, Boyatt Wood, Eastleigh, Hants. SO5 42Y (0703 618525).

The price for the Model 3 is £29.90 including VAT and postage.

Also available from Microtype is their Stak Pak, a very neat cassette filing and storage system which should solve your program storage problems. The Stak-Pak consists of drawer sections in black plastic which lock together to form miniature cabinets of almost any height. Each drawer holds two cassettes and comes complete with index cards as well as two cassettes each loaded with 12 minutes of Agfa tape.

The price for five Stak-Pak drawer sections is £6-60 including VAT & postage.

Microtype, PO Box 104, Hemel Hempstead, Herts. HP2 7QZ.
RECHARGEABLE BATTERIES
If you're fed up with constantly having to replace the batteries in your portable radio or electric shaver, you may be interested to know that a range of rechargeable cells from the Furukawa Battery Co. is now available from Marshalls, together with a range of constant current chargers made by Friemann & Wolf.

The Nickel-Cadmium cells which are of the sealed sintered-plated type come in three different sizes, equivalent to HP7, HP11, and HP2 dry batteries. In normal use, a life of roughly 500 charge/discharge cycles may be expected.

The Friemann & Wolf (FRIWO) chargers are available in two basic types, both being double insulated and meeting SEMCO, NEMCO and DEMCO standards. The smaller of the two, the Penlight 4, accommodates up to four HP7 size cells, and maintains a charge rate of 50mA nominal. All three sizes of cell can be charged using the larger Combibox FW611, and the charge current can be switched from 50mA to 120mA to give overnight recharging for each size.

Prices for the cells and chargers are as follows: S10 a. (HP7) — £0.98; sub C (HP11) — £1.75; sub D (HP2) — £1.95; Penlight 4— £5.50; Combibox FW611— £13.25. Further information is available from:
A. Marshall (London) Ltd., Kingsgate House, Kingsgate Place, London NW6 4TA.

MACLIN ZAND
Two new kits from Maclin Zand feature an electronic music generator and a sound effects unit. The music generator which can be used as a doorbell, toy or music box is pre-programmed to play 25 songs and three chime sequences. The song memory is an integral part of the chip and therefore cannot be re-programmed.

The sound effects board has been designed around the SN76477 sound generator and includes a noise generator, VCO, noise filter, mixer, attack/decay circuit, audio amplifier and control circuitry. A prototype area is provided on the p.c.b. for experiments and among the many sounds available are one-shot controls for gun shots, explosions etc., bird sounds, sirens, race car crashes, steam trains, etc.

The music generator is priced at £9.95 and the sound effects board is £14.95. Both prices exclude VAT and p+p.

Maclin Zand Ltd., 38 Mount Pleasant, London WC1X OAP.

DOUBLE POLE TESTER
A range of pocket sized double pole testers is now available from Branco Tools Ltd.

The cheapest of the range is the Volt Check, which indicates a.c. and d.c. voltages between 4 - 5V and 415V and indicates polarity. In the middle of the range is the Multi Check which checks continuity between 0 and 20kΩ and the direction of semiconductors, as well as indicating voltages within the same range as that of the Volt Check.

Pictured above is the Master Check, which measures d.c. and a.c. voltages in seven steps from 6V to 415V and indicates polarity. Prices range from £4.30 for the Volt Check to £14.24 for the Master Check. Further information on the whole range of testers is available from:
Branco Tools Ltd., 7 Birchway, Prestbury, Cheshire SK10 4BD (0625 828476).

FUEL METERS
Two new petrol consumption meters are now available from Enviro-Systems in kit form. The FSX20 provides a system which will give an instantaneous digital readout of MPG, with a choice of two update frequencies to suit individual driving conditions, automatic clear-down under idling and simple owner calibration facility, which means the system is suitable for most vehicles with carburettor fuel systems and cable driven speedometer. A petrol injection option is available to compensate for fuel returned to the tank.

The real time clock has a dead battery back up, the capacity is sufficient to power the CMOS clock chip for approximately 12 months in the absence of system power.

The price of the complete board is £750 excluding VAT and p+p.

Microdata Computers Limited, Belvedere Works, Bilton Way, Pump Lane, Hayes, Middlesex.

SUPERPET
Commodore's new '8000 Series' system which has been nick-named the SUPERPET, consists of an 80-column version of the popular 32K PET. Text editing and report formatting are faster and easier with the new wide screen display and the 8032 provides a resident operating system with expanded commands and functions for arithmetic, editing and disk management. For data input/output applications, an 8-bit parallel Port and an IEEE-488 instrumentation bus are provided. The 8032 includes a 73-key full business style keyboard and is priced at £895 plus VAT.

Also available is the new 8050 dual drive floppy disk which has been designed to complement the 8032. The 8050 incorporates all the existing features of the current disk unit, but provides more powerful software capabilities and a one megabyte capacity.

The 8050 which is priced at £895 plus VAT utilises five 4½" diskettes and Micropolis drives.

Commodore Business Machines Limited, Information Centre, 360 Euston Road, London (01-388 5702).
COMPATIBLE MICRO (NSC 800)

All you microprocessor fans who have plumbed for the Intel 8080 family as your "pin-up" chip, need not worry about the obsolescence of all that hardware and software knowledge you have amassed. Many of you may have already upgraded to the Z80 processor from Zilog, and gained those by now well-known benefits of a more powerful instruction set, more CPU registers, and on-chip refresh for dynamic memories. Going from the 8080 to the Z80 is easy because the 8080 instructions are a sub-set of the Z80 codes and most 8080 programs will run immediately on the Z80 with no alterations, an important advantage while system software is costing more than system hardware in many situations.

Intel's own improved 8080, the 8085, takes a different line by keeping an almost identical instruction set with only limited enhancements while reducing system hardware complexity and the need for peripheral devices by providing more "on-chip" functions such as clock oscillator, bus controller, serial I/O, and several levels of direct-vector interrupt inputs. The 8085 also runs from a single 5 volt supply, like the Z80 but unlike the 8080, and it runs faster than both the 8080 and the Z80. The extra on-chip functions provided by the 8085 need extra pins which are not normally available within the limitations of a 40 pin package. Intel solved this problem by multiplexing the 8 data bus lines so that they also carry the 8 low order address bits during certain sections of an instruction cycle, as flagged by the ALE (Address Latch Enable) output. The L in ALE means, of course, that the availability of address information on the bus for only a limited period has to be overcome by catching this information externally. This need is normally satisfied by the use of special 8085 peripheral chips such as the 8155 RAM/IO/TIMER chip, and the 8355 ROM/IO chip which have internal address latches.

In short, you have a choice for 8080 upgrade. Choose either the big system power of the Z80 or the compact simplicity of the 8085 and its multiplexed bus.

Well, anyway, you did have to choose until recently, before National introduced the NSC800, a chip which must make all '80 fans drool with anticipation! Taking compatibility one stage further, National have made their new processor emulate both the 8085 and the Z80 by combining the power of Z80 instruction set with the simplicity of the 8085 bus. As if that in itself were not sufficient, National have also made other improvements to rectify some of the deficiencies of it's ancestors.

The most fundamental change is in the semiconductor technology used, NMOS for the 8085 and 8086 and a new CMOS process called P2CMOS for the NSC800. The advantage here is the wide supply voltage range possible (3 to 12 volts) and the very low power consumption which makes battery operation a real possibility. Despite its low power consumption the new chip will run as fast as the Z80 even to the extent of having a 4MHZ high speed version, the NSC800A which equates to the Z80A.

One problem with the Z80 is that the useful on-chip refresh for dynamic memories has only a 7-bit counter, and this makes it difficult for applications requiring generation of 64K RAMs which need 8 bits. The NSC800 overcomes this shortcoming by providing the eighth bit.

So far as I know, this device is not widely available yet, but when it is, it must surely become the eighth bit standard for future designs.

MAP CHIP

Still on the subject of microprocessors, it seems that the 64K address space of most micros, which has always seemed so huge, that one could never imagine having the funds to fill it, is about to become too small!

The reason is that memory is getting cheaper and cheaper, and soon it will take just eight 16 pin chips to give a system all the memory it can address, thanks to the 64K dynamic RAM devices now becoming available from Motorola, Texas Instruments and others. The effects this plentiful memory will have on system software and programming in general will be far-reaching, but down at the hardware level there will be the problem of how to address more than that restrictive 64K.

One possible solution is now available from Texas instruments in the form of a family of "Memory-mapper" devices which can be used to increase the memory space of, say, a 6800 or 8080 microprocessor to an incredible 16 megabytes! Now even if 64K RAM chips drop in price to £10 each, a quick sum reveals that to fill that space you would need to raise over £20,000 for memory alone, so it seems likely that the problem has been solved for all time!

The new devices, part of the Low Power Shottky TTL family and coded 74LS610 to 74LS613, provide an extra eight bits of addressing to give a total of 24 for most micros. Address expansion is achieved by using the top four bits of the standard address bus to select one of sixteen twelve bit registers within the map chip. The contents of the selected register provide twelve further address bits to give the total of twenty-four required, effectively splitting the memory map up into 4096 pages each of 4096 words. The registers within the mapper have to be loaded under software control of course, and this makes the expansion scheme less "transparent" to the programmer than a conventional twenty-four bit address counter. Since most programmers interact with their system via system software, however, this need not be a problem in day to day usage. A likely technique would be to load the address space with the addresses of consecutive 4K blocks to provide a single 64K 'Environment'. When more memory is needed, for a second user for example, system software would reload the registers to access further 64K blocks. A total of 256 blocks are available, although it is most unlikely that all this space would be needed in any practical system.

The attraction of these devices is really that they will allow the upgrading of an "old fashioned" eight bit system to suit future system software. Whether it will be better to throw the old eight bit chips away and go for one of the new sixteen bit devices such as the Z8000 or the 8086 which can already access more memory via an expanded address counter, remains to be seen.

The new devices run from standard TTL supplies and are housed in forty pin packages.

BIG IMAGE (MA537)

I realize that my offerings so far this month are not the sort of devices which the average reader is likely to be able to (or want to) rush out and buy just yet. My final offering is even more exotic I am afraid, but nevertheless it does provide a fascinating glimpse of the capabilities of a British electronics firm, and a hint of what the future holds for us. After all, today's exotic device is tomorrow's 'jelly-bean' part!

The device in question is made by GEC and coded the MA537, and it is a complete solid state TV image sensor in a very tiny package. On the face of it, it appears that this device opens the door to tiny video...
cameras no bigger than, say, an instantmatic, with full 625 line capability and a performance approaching that of conventional camera tubes. Combine a device such as the LED and LCD image displays currently under development, and it seems likely that the whole concept of television will be revolutionised within the next decade.

The MA537 is a CCD or 'Charge Coupled Device' image sensor which has an 8.5mm by 6.4mm sensor surface covered with an array of 576 by 385 photo detectors, all on one chip of silicon. The chip is split into two roughly equal sections, one being used for image sensing and the other half for storage. The image sensor provides a basic 268 line picture, with each line resolvable into 385 'pixels' or picture points, but by means of an ingenious trick with the clocking of the CCD image registers the number of lines is effectively doubled to provide compatibility with the interlaced 575 line system. (The other lines are never displayed and form part of the field blanking interval.) The store half of the array is also photo sensitive but is normally shielded from any illumination and used as a buffer to aid the transfer of data out of the device. Left unshielded, however, it can be used to provide a full-frame mode for enhanced resolution in special applications. In the normal mode, line image information is shifted out via a 400 element CCD analogue shift register, the extra 15 elements being available to provide a blank reference level for each line. The MA537 is packaged in a 30 pin flat-pack and would probably cost an arm and a leg at present, but come the revolution...

Nice try G.E.C., but now about a colour version?

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**Countdown**

Personal Computer World Show Sept. 4–6 Cunard Hotel, Hammersmith, London. M
Laboratory Sept. 9–11. Grosvenor Ho., Park Lane, London. E
Intron 80 Sept. 9–11. RDS, Simmonscourt Pavilion, Dublin. V
West of England Electronics Exhibition Sept. 9–11. Bristol Exhibition Centre. Q
Electrolux (Lucas battery vehicle race) Sept. 13, 1980. Fashioned on last year's event, this "whispering Grand Prix" is a contest for home made electric vehicles. It will again be held at Donington Park Race Circuit, nr. Derby. Details: f 021-554 5252. Avionics (symposium) Sept. University of Surrey. S1
Emis Oct. 7–8. Centre Hotel, Newcastle. I
Engineering Ireland Oct. 15–18. Leopardstown Exhibition Centre. V
Compee Nov. 4–6. Olympia. Z1
BEX Nov. 5–6. Sophie Gardens, Cardiff. K
Semiconductor International 80 Nov. 25–27. Metropole Convention Centre. T1
Breadboard Nov. 26–30. Royal Horticultural Halls, Westminster. T
Entertainment 81 May 9–17 (weekly mornings trade only). Nec Birmingham. B2
Components 81 (Electronic Components Industry Fair) June 9–12, 1981. Earls Court, London. This show will alternate yearly with Components now that the IEA/Electrex amalgamation has ceased. I

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**Points Arising**

**ACORN REVIEW (August 1980)**
Acorn Computers Limited are the suppliers of the Acorn modular system, peripherals and software reviewed last month. Science of Cambridge are not connected with this product and were incorrectly referred to. We apologise for any inconvenience caused.

**COMPUKIT UPDATE (June 1980)**
There is an error in Fig. 1 showing the software Baud rate circuit around IC57. RTS from IC14, pin 5, should go to IC57 pin 5 and not pin 4. On IC57, pins 3, 4 and 6 go to C7.

P.E. DMM (July 80)
In Fig. 5 the component overlay shows R6, 7, 8 (lower left) incorrectly numbered. They should be R9, 10, 11 respectively.

**MICROPROMPT (July 1980)**
Line 40 in Le Pass-Temps should read: DIMS (44), etc., Line 830 should read: T(1) = T(1) + etc.,

**CONSTANT CURRENT SOURCES (August 1980)**
There are some omissions in Fig. 4. D9 and D13 are BZY 88s, D10 is a BZY 88 6V1. TR2 is a 2N3055 and C4 is 100n.

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Practical Electronics September 1980
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Climatic Change

After more than a year of Conservative government led by Mrs Thatcher there is still plenty of opportunity and, indeed, reason for vigorous debate in her economic policy and where it is leading. And not least in industry in general and the electronics industry in particular.

Electronics companies are having mixed results. Some are doing well, some less well. But this has always been the case whatever government has been in power. Of course trading conditions are tough and, indeed, have been a lot worse at some times and in some areas. But this has always been the case. The only constant has been change.

So the long delays start, fatal in a fast-moving industry like electronics. First the debate on the amount, then the allocation of funds (too little, too late is always the industry response), the formation of committees, further debate, the start of the programme, the work put in hand, by which time the market has been missed.

This is not to say that private venture, putting your money where your mouth is, is universally successful. There is the sad story of Martello, the privately developed long range three-dimensional defence radar from Marconi Radar Systems. This was a contender for the NATO installations in Scotland. The NATO nations in this case were paymasters and, looking for the best buy, chose a US General Electric system as meeting all the technical requirements at the lowest cost. Marconi investment in Martello has been reported as being £10 million and, as Martello sales prospects are now bleak, it looks as if Marconi Radar will lose money as well as prestige on the project.

The reaction was predictable. Cries of 'foul' from Marconi Radar. Hidden subsidies were suggested from the US Government who had largely or totally paid for the radar development and had already ordered similar models to equip a US Air Force radar chain in Alaska.

And yet within the same GEC-Marconi Electronics group of companies there is brisk overseas trade with, for example, the Clansman military radio funded entirely in its development and early production phases by the British taxpayer through the Ministry of Defence. There are plenty of other Ministry-funded projects in the Group which will be offered at attractive prices to overseas buyers. Even a version of the new air interception radar now in an advanced development stage for the Royal Air Force to be for sale to overseas customers. Of course these exports, funded from public money, are not considered subsidies in the same way. It is a case of 'Who said that?'

One of the attitudes which the Government is attempting to change is that of the begging bowl. It has long been my conviction that the practice of direct government hand-outs has done more harm than good to the electronics industry. It has always encouraged sloth. Why spend your own time and money on developing a new product when a government has promised to support it?

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Subsidies

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**DISCO DESK**

**Part 1**

**BEN DUNCAN**

This series describes a discotheque control desk intended for use with high power, high fidelity sound systems. Whilst it is primarily intended for mobile work, it is also eminently suited to permanent installation in clubs, and can be readily modified for recording and broadcasting, e.g.: Hospital radio.

**BLOCK DIAGRAM**

Referring to Fig. 1, the disc signal is equalised in two stages in order to achieve an excellent overload margin, good noise performance and low distortion. The disc input stage provides moderate gain and RIAA cut. VR1 doubles as an output attenuator and as a preset balance control. After the mode selection switch and crossfader, RIAA bass boost is applied to the signal. The line signal does not require this boost and it would normally be necessary to operate an 'RIAA equalisation cancel' switch whilst crossfading from a disc to a line source. This can be an awkward operation under the pressure of a live performance, therefore the line input features RIAA bass cut, which eliminates the need for such a switch. The line input is buffered and applied to the mode switch via a fader and a passive equalisation network, which closely matches the bass portion of the RIAA record characteristic. The use of two stage disc equalisation and preamplification ensures that the op-amps always have plenty of loop gain, hence ensuring low distortion.
In a design of this nature, the tone control characteristics can be emphatic without embarrassing consequences. For instance, the very low hum level makes possible a bass boost characteristic which approximately compensates for typical loudspeaker deficiencies. This permits the reproduction of low bass at lifelike levels, assuming that suitable loudspeakers and low rumble turntables are available. The plentiful bass boost is also helpful when 'thin' recordings are encountered; EP singles are often lacking in the lowest bass notes. The bass boost curve rolls off sharply below the audio band in order to minimise the amplification of rumble. Further rumble filtering is provided in the preceding stage. The treble control provides moderate boost and cut over a wide band of frequencies, without excessive midrange or high treble boost. The commonly encountered 20dB boost at 18kHz is simply not required in a good sound system, and readily causes amplifier or horn overload and 'tinny' treble; deficiencies above 10kHz usually indicate worn discs or stylii, or an inadequate loudspeaker system. Most of the distortion in the disc and line channels is generated in this stage.

The tone control stage feeds the send-return socket via the volume control. In its normal position, the send-return switch allows the signal to pass directly to the mono output, via the mixer, and also out of the 'send' pins on the socket. Thus both mono and stereo outputs are provided simultaneously. Depressing the send-return switch forces the signal to pass via auxiliary equipment and allows the signal to return by closing the switch in series with the 'return' pins on the send-return socket. Finally, the stereo music lines are mixed down to mono, together with the microphone signal, by a unity gain mixer.

(Left) Mic bass boost curve
(Right) Disc treble boost curve

Response Curves

(Left) Disc bass boost curve
(Right) Mic treble boost curve
**SPECIFICATIONS**

### Disc
- Input impedance: 47k
- Sensitivity $\pm \frac{1}{2}$dB: $-43$dBm at 1kHz ref. 0dBm out (5-5mV)
- Hum: $-80$dB, unweighted
- Noise: $-70$dB, unweighted, 20Hz to 20kHz
- Frequency response: 12Hz-25kHz at $-3$dB points
- Input overload margin: 41dB
- Distortion, harmonic at +10dBm, 30Hz--0.06%: 1kHz--0.01%, 10kHz--0.03%

### Line inputs
- Input impedance: 100k
- Sensitivity $\pm \frac{1}{2}$dB: $-18$dBm at 1kHz ref. 0dBm out (100mV)
- Hum: $-105$dB unweighted
- Noise: $-76$dB, unweighted, 20Hz to 20kHz, 600 ohm input load
- Frequency response: 30Hz-50kHz at $-3$dB points
- Input overload margin: 38dB
- Distortion, harmonic at +10dBm, 30Hz--0.06%: 1kHz--0.008%, 10kHz--0.03%

### Microphone
- Input impedance: 600 ohms
- Sensitivity $\pm \frac{1}{2}$dB: $-30$dBm at 1kHz ref. 0dBm out (25mV)
- Hum: $-93$dB, unweighted
- Noise: $-80$dB (unweighted), 20Hz-20kHz, 200 ohm input load
- Frequency response: 32Hz-22kHz at $-3$dB points
- Input overload margin: 40dB
- Distortion, Harmonic at +10dBm, 30Hz--0.01%: 1kHz--0.02%, 10kHz--0.1%

### General
- Slew rate, all stages: $\geq5$-5V/μs
- Distortion, any input, $\leq0.1\%$ at 10dBm, 30Hz-18kHz
- Output clip level: +20dBm
- Mono and mic outputs provide 0dBm at 100 ohm source impedance and will drive 600 ohm lines at +20dBm
- Stereo lines provide 0dBm at 350 ohm source impedance
- Tone controls & RIAA equalisation matched to within $\frac{1}{2}$dB
- 0dBm = 776mV into an unspecified impedance

### Music
- Two stereo disc inputs from internal turntables A & B (1-2)
- A & B line and disc inputs selected by rotary switches (A & B)
- Two stereo line inputs from female XLR’s A & B (3-4)
- Internal preset disc balance controls
- Line input level controls (6-8)
- Line input earth-isolation switches (7-8)
- Slide crossfading between line & disc in any of 4 combinations (9)
- Bass, treble and volume controls (10-12)
- Music send-return socket provides stereo lines at 0dBm (13)
- Music send-return switch activates stereo return for insertion of graphic equalisers, limiters, expanders, etc. (14)
- Music ‘cancal switch for audience participation and emergency announcements (15)

### Microphone
- Capacitor microphone input (readily modified for moving coil microphones) from female XLR (16)
- Bass and treble controls specially contoured for vocal applications (17-18)
- Microphone gain control and on-off switch (19-20)
- XLR send-return socket providing (mono) microphone output at 0dBm for routing to vocals amplifier (21)
- Microphone send-return switch activates return for insertion of graphic equaliser, special effects, etc (22)

### Facilities and functions (see numbered photo)
- A & B cueing indicators (yellow panel i.e.d.$$: illuminate when disc operation.
- 4 watts into 4 ohms monitor amplifier, for phones or monitor speaker, with short circuit and thermal protection (27)
- A & B cueing indicators (yellow panel i.e.d.s) illuminate when disc modulation begins or line input exceeds an equivalent threshold (28-29)
- Left and Right peak indicators (Red panel top) are set to illuminate at the nominal r.m.s. input level of the systems power (30-31), e.g: 500mV, whilst VU meters provide the desk 0dB reference across the stereo lines (32-33)
- Output XLR mono output from stereo lines and microphone line via a unity gain mixer. This output can be exclusively microphone or music if required, by depressing appropriate send-return switch. Also XLR stereo music output (23)

### AUXILIARY
- Output and PFL monitoring, the latter switchable to all music inputs (24-25)
- Monitor level control (26)
- Monitor level control (26)
- 4 watts into 4 ohms monitor amplifier, for phones or monitor speaker, with short circuit and thermal protection (27)
- A & B cueing indicators (yellow panel i.e.d.s) illuminate when disc modulation begins or line input exceeds an equivalent threshold (28-29)
- Left and Right peak indicators (Red panel top) are set to illuminate at the nominal r.m.s. input level of the systems power (30-31), e.g: 500mV, whilst VU meters provide the desk 0dB reference across the stereo lines (32-33)
- Remote push button turntable start switches and turntable lamp switches. Jack socket sound-to-light modulator output (38-42)
- High reliability remote power supply with comprehensive protection.

---

**COMPONENTS**

### Card 1

#### Resistors
- R1-4: 47k
- R5-8: 7k5
- R9-12: 470R
- R13-16: 560R
- R17-20: 100k

#### Capacitors
- VR1-4: 22k enclosed cermet (RS components type 186-198)
- VR5-8: 1k dual log (Rivolo CS60 type, Maplin order code HB OQA)

#### Potentiometers
- C1-4: 1µ polycarbonate
- C5-8: 22p ceramic
- C9-12: 10p polycarbonate
- C13-16: 6n8 polycarbonate
- C17-20: 880n polycarbonate
- C21-24: 22u 25V PC mounting electrolytic
- C25-28: 470n polyester, C280AE series
- C29-32: 22p ceramic
- C33-36: 18p polycarbonate
- C37-38: 100µ, 40V axial electrolytic
- C39-40: 100p polyester, C280AE series

#### Semiconductors
-SK1, 2—XLR 3 pin female sockets (Maplin BW90X)
-SW1, 2—Miniature toggles (RS components type 316-973)

#### Miscellaneous
-“Copper clad single-sided epoxy-glass p.c.b. board incorporating 0.1” pitch edge connector (RS type 434-150) 8 x 8 pin d.i.l. sockets
-185 x 90mm aluminium screen, 22 s.w.g.
MICROPHONE CHANNEL

The microphone input is designed for the Calrec CM654 capacitor microphone but input stage modifications are given to cover the majority of moving coil and capacitor microphones, including those which are balanced or phantom powered. A good vocals microphone is essential for discotheque applications, where ‘close miking’ is the rule. All cardiod microphones provide strongly accentuated low bass under these conditions. Windshields help, but microphones intended for vocal applications often incorporate compensation for ‘close miking’. This virtually eliminates ‘pop’ and other explosive breath sounds and minimises the input transformer’s overload margin requirements. A discotheque microphone may also be required to handle SPLs in excess of 100dB if the operator shouts; capacitor microphones are particularly suited to handling high SPLs with low distortion.

Most of the distortion in the microphone channel is generated by the input transformer, but it is predominantly 2nd harmonic and quite inaudible under normal conditions. The input stage has unity gain in order to avoid overloading the tone control stage, bearing in mind the high outputs produced by close miking. The tone controls have been contoured as far as possible to suit vocals requirements, ie: for frequencies between 100Hz and 10kHz. The fundamentals of male and female speech lie around 130Hz and 200Hz respectively. These low frequencies provide the voice with body and character whilst the harmonics, particularly those around 1kHz–3kHz are essential for intelligibility.

With this in mind, the treble boost curve has been contoured to give relatively large amounts of boost around these latter frequencies, thus allowing vocals to ‘cut through’ if desired. It is difficult using the Baxandall network to bring the maximum boost up to the fundamental frequencies of the human voice. Maximum boost occurs, therefore around 50Hz but in practice the characteristic is satisfactory provided a vocally compensated microphone is used.

The microphone signal passes to a line driver, capable of providing some +20dBm into a 600 ohm load, via a gain control and the on-off switch. The microphone send-return switch is wired in the same manner as that previously described, and finally the microphone line feeds the mono mixer.

ANCILLARY FUNCTIONS

The auxiliary functions are shown in Fig. 2. The autofader drives an f.e.t. which shunts the music lines; attenuator VR_A controls the fade depth. VR_C and VR_B adjust the sensitivity (i.e. microphone level required to trigger) and the fade-up rate of the circuit respectively. SA disconnects the f.e.t. when the autofader is not required. A four way switch selects the right hand disc and line inputs for PFL (pre-fader listen) monitoring. In turn, a two way switch selects either PFL or output monitoring. A 4 watt amplifier is provided to drive either headphones or a monitor loudspeaker.

The cue l.e.d.s allow discs to be lined up rapidly and without the use of headphones. VR_D is set to discriminate between rumble and music modulations on typical discs. The VU meter driver preset is normally set such that 776mV on the stereo lines gives an 0 VU reading, though this is not conventional practice in broadcast sound equipment. The peak indicator switches on its associated l.e.d. for a few hundred milliseconds whenever a signal peak exceeds the nominal input sensitivity of the power amplifiers, eg: 500mV...
(-3½Bm). In this way, they warn that the power amplifiers are being driven close to clipping.

The 'sound-to-light mixer' provides a +10dBm output for lighting effects. The microphone level in the mix is adjusted to match the level of the music signals under normal 'miking' conditions by means of preset VRf.

**CONSTRUCTION**

Apart from the monitor amplifier, all the circuitry is contained on four pluggable cards; this greatly simplifies construction and debugging. Fig. 3 will be found helpful as construction progresses, as it shows how the circuitry on each card is interconnected. The power supply, whilst sophisticated, is simple to construct and is unlikely to require debugging. For this reason it will be presented later. For initial tests, ±15V and +12V supplies are required. To test individual cards, very little current is required (<100mA) and batteries are quite adequate if a good bench power supply is not available.

All the audio circuitry is built around the Signetics NE5534 op amp. This was introduced to Britain some 18 months ago and is truly described as 'high performance' in that it is the first op amp to approach the performance of the best discrete circuits. As a result, it has found wide acceptance in professional audio equipment. It has pin compatibility with the 741C and features internal compensation for gains in excess of 10dB. However, the addition of a small compensation capacitor ensures stability without compromising performance in the audio band. The low noise version, designated 'NE5534AN' is expensive but may be used to advantage in the disc input stage if desired.

The NE5534N, like the 741 is a hardy bi-polar device and does not require special handling precautions. However, it is not as cheap as the 741 and when the cards are initially tested it is wise to substitute the latter.

**CARD 1**

This card contains the disc and line input stages. With reference to Fig. 4, R1 provides the input bias current for IC1 and also the standard load for a magnetic cartridge. At high frequencies, the gain of IC1 falls to unity, therefore external compensation (C5) is required. R5 and R9 provide a gain of 24dB and together with C9 also furnish RIAA treble cut. However, in the series feedback configuration used here, the gain of IC1 cannot fall below unity. Thus R13 and C13 are required to maintain treble cut at high frequencies. The electrolytic capacitor C21 has significant reactance above 1kHz and therefore C17 is added to ensure good treble response. Wherever possible throughout the audio circuitry non-electrolytic coupling capacitors have been specified for this reason. VR1 doubles as a preset balance control and output attenuator as previously described.

IC5 provides unity gain and C33 with the crossfinder provides bass cut which closely complements the RIAA bass boost characteristic. For optimum screening and RF1 suppression all the disc inputs have independent OV connections and are quasi-balanced. This procedure is not so important at line input levels, and the OV connection for each stereo line input is commoned at the XLR input connector in any case. Panel mounted earth isolation switches are provided on these inputs to facilitate the control of hum loops. The supply rails adjacent to each op amp are

---

**Fig. 2. Block diagram of auxiliary functions**
Fig. 3. Simplified block diagram of complete desk showing only right hand channel

Fig. 4. Disc and line input stages (Card 1), socket detail and line decoupling
Fig. 5. P.c.b. and layout
Card 1  Edge Wiring

There are two line and disc (T and D) inputs, named A+B, and each has a left (L) and a right channel (R).

For turntable "A", the inputs are DRA + DLA
For turntable "B", the inputs are DRA + DLB
For line input "A", the inputs are TLA + TRA
For line input "B", the inputs are TLB + TRB
Disc input earth connections are designated OV together with the appropriate code.

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>OV, DRA</td>
</tr>
<tr>
<td>2</td>
<td>Live, DRA</td>
</tr>
<tr>
<td>3</td>
<td>OV, DLA</td>
</tr>
<tr>
<td>4</td>
<td>Live, DLA</td>
</tr>
<tr>
<td>5</td>
<td>OV, DBB</td>
</tr>
<tr>
<td>6</td>
<td>Live, DBB</td>
</tr>
<tr>
<td>7</td>
<td>OV, DLB</td>
</tr>
<tr>
<td>8</td>
<td>Live, DLB</td>
</tr>
<tr>
<td>9</td>
<td>OV, Summing point</td>
</tr>
<tr>
<td>10</td>
<td>DRA</td>
</tr>
<tr>
<td>11</td>
<td>DLA</td>
</tr>
<tr>
<td>12</td>
<td>DRB</td>
</tr>
<tr>
<td>13</td>
<td>DLB</td>
</tr>
<tr>
<td>14</td>
<td>TRA</td>
</tr>
<tr>
<td>15</td>
<td>TLA</td>
</tr>
<tr>
<td>16</td>
<td>TRB</td>
</tr>
<tr>
<td>17</td>
<td>TLB</td>
</tr>
<tr>
<td>18</td>
<td>TRA</td>
</tr>
<tr>
<td>19</td>
<td>TLA</td>
</tr>
<tr>
<td>20</td>
<td>TRB</td>
</tr>
<tr>
<td>21</td>
<td>TLB</td>
</tr>
<tr>
<td>22</td>
<td>-ve, 15V</td>
</tr>
<tr>
<td>23</td>
<td>OV</td>
</tr>
<tr>
<td>24</td>
<td>+ve, 15V</td>
</tr>
</tbody>
</table>

Disc inputs from magnetic cartridge

Card 1 LAYOUT

The physical layout of Card 1 is shown in Fig. 5. The copper clad board specified in the components list must be cut to size. Note that the card aperture is not symmetrical and marking out and cutting should be done from the copper side of the board if the aperture position is to correspond to Fig. 4. Accurate cutting is facilitated by using a jigsaw fitted with a very fine blade, together with an \( \frac{1}{8} \) inch strip of straight aluminium as a guide along the inside of the cutting line.

The 24 edge connector strips should be covered with enamel paint to protect it during etching; paint is more consistent than etch resistant ink over such large areas. The p.c.b. pins are wired direct to the edge connector pins by 7/0.2 cable, except for pins 1–8 which require screened cable, and pins 9 and 23, which should be brought to the edge connector with 16/0.2 cable to ensure a low impedance connection. Because the edge connector pins are cramped, all the leadout wires should be sleeved. Apart from allowing a high component density, 'hard wiring' in this fashion permits control over stray capacitance which cannot be achieved first go with 24 parallel p.c.b. tracks!

When the board is completed, scrape away excess flux, using methylated spirits as a solvent, together with a stiff brush where necessary.

Check carefully for errors, then load the 8 sockets, preferably with 741s. Note that the op amps belonging to the line inputs face in the opposite direction to those handling the disc inputs. Short all the inputs to OV and apply \( \pm 12V \) or \( \pm 15V \) via 100R current limiting resistors in each supply rail. If the supply current exceeds 30mA (741s) or 70mA (NE5534s), disconnect the supply and look for errors. If all is well, load the card with NE5534s and reconnect the supply. Then check the offset voltages at pin 6 on the i.c.s; note that a carelessly placed probe may prove fatal to the devices here. If the offset voltage is greatly in excess of 300mV, disconnect and check again for errors, or for floating inputs. Finally, reconnect the supply and check the polarity of the offset at pin 6 on I.Cs 1–4. Then reorientate C21–24 if necessary. The screen can then be added (Fig. 5) and Card 1 is now completed. The same constructional and setting up procedure applies to the remainder of the cards; remember to allow for notably lower power consumption however on Card 2, and to short all inputs to the OV rail.

Next Month—more circuits.
THE GENERAL INSTRUMENT AY-3-8912 Programmable Sound Generator was designed to produce a variety of complex sounds under software control. By using a register stack the processor can load values into the sound chip and then carry on with other tasks while the sound is being generated.

It is easy to interface the i.c. with the UK101 and to add sound to your BASIC programs by means of the POKE command.

BLOCK DIAGRAM

Fig. 1 is a block diagram of the 8912 i.c. There are three tone generators and a noise generator. The three tones can be fed out to outputs A, B and C. The noise can be added to any or all of the tones, or it can be output instead of a tone. The amplitudes of the noise and tones can be set to one of sixteen fixed values, or they can be varied by means of an envelope generator. The envelope generator amplitude modulates the outputs and can be set for various options of fast or slow attack and decay, single shot or repeat, etc. allowing a wide variation of sounds. The three outputs are logarithmic.

PSG REGISTER ARRAY

Fig. 2 shows the register array in detail. Register 0 and register 1 are cascaded to give a 12-bit word which sets the period of tone A, the top 4 bits of register 1 not being used and the bottom 4 bits forming bits 8, 9, 10 and 11 of the 12-bit word. The register can be set to any value between 1 and 4095 decimal. As the clock is divided by 16 before being fed to the tone generator, the output frequency is:

\[ f = \frac{f_{\text{clock}}}{16 \times R} \]

where \( R \) lies between 1 and 4095. Registers 2, 3 and 4, 5 similarly control tone generators B and C. Register 6 is used to control a pseudo random noise generator. Only the bottom 5 bits are used, and again, the clock is divided by 16 before being fed to the noise generator.

Register 7 is the output control register. Bits 6 and 7 should always be set to one as we are outputting data to the PSG (Programmable Sound Generator). Setting bit 0 low will enable tone A to be output to channel A. If at the same time bit 3 is set low the noise generator will be mixed with tone A. If bit 0 is now set high only noise will be output on channel A. Likewise bits 1 and 4 control tone B and noise to channel B, and bits 2 and 5 control tone C and noise to channel C. Remember it requires a low or 0 to select a tone or noise, for example, writing 254 decimal to register 7 selects tone A.

Register 8 is used to set the amplitude of channel A in the fixed output level mode. Bits 5, 6 and 7 are not used. If bit 4 is set to 0 then the output amplitude is set at one of sixteen fixed levels by means of bits 0 to 3. If bit 4 is set to a '1', however, bits 0 to 3 have no effect and the output amplitude is set by the envelope generator. Registers 9 and 10 are used similarly for channels B and C. Registers 11 and 12 are cascaded to give a 16-bit word to set the envelope period. The clock is divided by 256 before being fed to the envelope control, so with a 2MHz clock we can get a period range of about 0.1Hz to 7800Hz.

Register 13 determines the shape/cycle of the output as follows.

The envelope generator further counts down the envelope frequency by 16, producing a 16-state per cycle envelope pattern as defined by its 4-bit counter output, E3, E2, E1, E0. The particular shape and cycle pattern of any desired envelope is accomplished by controlling the count pattern (count up/count down) of the 4-bit counter and by defining a single-cycle or repeat-cycle pattern.

This envelope shape/cycle control is contained in the lower 4 bits (B3–B0) of register 13. Each of these 4 bits controls a function in the envelope generator, as illustrated in the following:

Envelope Shape/Cycle Control Register (R13)

<table>
<thead>
<tr>
<th>Bit</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>B7</td>
<td>Hold</td>
</tr>
<tr>
<td>B6</td>
<td>Not Used</td>
</tr>
<tr>
<td>B5</td>
<td>Alternate</td>
</tr>
<tr>
<td>B4</td>
<td>Attack</td>
</tr>
<tr>
<td>B3</td>
<td>Continue</td>
</tr>
</tbody>
</table>

A 40-way jump lead interfaces the Sound Generator to the UK101 (J1) on a pin-to-pin basis.
The definition of each function is as follows:

**Hold** When set to logic 1, limits the envelope to one cycle, holding the last count of the envelope counter (E3–E0 = 0000 or 1111, depending on whether the envelope counter was in a count-down or count-up mode, respectively).

**Alternate** When set to logic 1, the envelope counter reverses count direction (up-down) after each cycle.

**NOTE:** When both the Hold bit and the Alternate bit are ones, the envelope counter is reset to its initial count before holding.

**Attack** When set to logic 1, the envelope counter will count up (attack) from E3, E2, E1, E0 = 0000 to E3, E2, E1, E0 = 1111: when set to logic 0, the envelope counter will count down (decay) from 1111 to 0000.

**Continue** When set to logic 1, the cycle pattern will be as defined by the Hold bit. When set to logic 0, the envelope generator will reset to 0000 after one cycle and hold at that count.

To further describe the above functions could be accomplished by numerous charts of the binary count sequence of E3, E2, E1, E0 for each combination of Hold, Alternate, Attack and Continue. However, since these outputs are used (when selected by the Amplitude Control registers) to amplitude modulate the output of the Mixers, a better understanding of their effect can be accomplished via a graphic representation of their value for each condition selected, as illustrated in Fig. 3.

---

**Register array of AY-3-8912**

<table>
<thead>
<tr>
<th>Register</th>
<th>BIT</th>
<th>B7</th>
<th>B6</th>
<th>B5</th>
<th>B4</th>
<th>B3</th>
<th>B2</th>
<th>B1</th>
<th>B0</th>
</tr>
</thead>
<tbody>
<tr>
<td>R0</td>
<td>Channel A Tone Period</td>
<td>8-BIT Fine Tune A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R1</td>
<td>Channel B Tone Period</td>
<td>4-BIT Coarse Tune A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R2</td>
<td>Channel C Tone Period</td>
<td>8-BIT Fine Tune B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R3</td>
<td>Noise Period</td>
<td>4-BIT Coarse Tune B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R4</td>
<td>Noise Period</td>
<td>8-BIT Fine Tune C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R5</td>
<td>Noise Period</td>
<td>4-BIT Coarse Tune C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R6</td>
<td>Noise Period</td>
<td>5-BIT Period Control</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R7</td>
<td>Enable</td>
<td>IN/OUT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B8</td>
<td>Channel A Amplitude</td>
<td>Noise</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R9</td>
<td>Channel B Amplitude</td>
<td>Tone</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R10</td>
<td>Channel C Amplitude</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R11</td>
<td>Envelope Period</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R12</td>
<td>Envelope Period</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R13</td>
<td>Envelope Shape/Cycle</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R14</td>
<td>I/O Port A Data Store</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

10 \( R = 61680 : V = 61681 \)
20 \( FORT = 0 \) TO 14 : \( X = \) INT \( \{RND(5)*255\} + 1 \)
25 IF \( RND(9) < 0.5 \) THEN NEXT
26 \( R = 255 \) TO 1 \ STEP —
30 \( POKER \) = 0
40 \( GOSUB \) 1000
50 \( FORT = 1 \) TO 5000 : NEXT

**Practical Electronics** September 1980

Let the Sound Generator create its own sounds with this random program. Push it through a power amplifier for maximum effect.
Register 14 is the output port. Writing data to this register outputs it on pins 7 to 14 of the AY-3-8912.

CIRCUIT DIAGRAM

Fig. 5 shows the circuit diagram of the unit. IC3a and b provide a 1 to 2 MHz clock to the PSG. IC3c and IC4a provide a reset to the chip, R2 and C3 providing power on reset. The three output channels of the 8912 are mixed together and are amplified by IC6. The UK101 data lines D0 to D7 are fed to pins 28 to 21 of IC5. Pins 7 to 14 of IC5 are the output port lines from register 14.

Two addresses are used to load the PSG, FOFOH and F0F1H. IC1 decodes when address bits 21 to 215 are high. IC2 decodes when address bits 21 to 27 and 28 to 211 are low and R/V is low. Address bit 20 goes to IC4C.

When you write to address FOFOH pins 18 and 20 of IC5 go high and the data on the data lines is written into an address latch in the PSG, i.e., if you write 0 to FOFOH the address latch in the PSG points to register 0. If you now write to address F0F1H then the data on the data lines will be written into the register pointed to by the address latch, i.e., if you write 128 to F0F1H then 128 will be written into the register pointed to by the address latch, in this case register zero.

CONSTRUCTION

Construction is straightforward using the circuit diagram, Fig. 5 and component layout, Fig. 7. Fit the wire links followed by the sockets (it is advisable to use sockets with CMOS and MOS devices). Fit the resistors and capacitors then fit the coil former L1 and wind on 60 turns of 30 SWG enamelled wire. fit two cores into L1. A Molex plug can be fitted to the output port if it is needed. Fit wires for reset switch S1 and for the speaker. Add wires for OV and +5 volts. If preferred the +5 volts could be brought in from the UK101 via the spare pin on J1 (pin 11). The p.c.b. is connected to the UK101 via a 40-to-40 pin jumper cable.

If IC6 and IC7 are not fitted in the UK101 it will be necessary to fit two dil plugs in place of them, wired as shown in Fig. 8.

TESTING THE UNIT

Check the p.c.b. very carefully for any solder splashes causing shorts. Fit the i.c.s, connect the unit to the UK101 via a 40-way jumper cable and power up.

As stated previously, writing a number between 0 and 14 to address FOFOH (DECIMAL 61680) will set up an address latch in the i.c. to point to one of the registers R0 to R14. If you then write to address F0F1H (61681 DECIMAL) you can write data into the appropriate register.

Load the following program:

```
10 POKE 61680, 0  (POINT TO REGISTER 0)
20 POKE 61681, 255  (LOAD 255 INTO REG. 0)
   (TONE)
30 POKE 61680, 7  (POINT TO REG. 7)
40 POKE 61681, 254  (SELECT REG. 0 TO O/P)
50 POKE 61680, 8  (POINT TO REG. 8)
60 POKE 61681, 15  (SELECT O/P AMPLITUDE)
100 END
```

and run.

This outputs a single tone. To add noise change line 40 and ADD 70 and 80:

```
40 POKE 61681, 246  (SELECTS TONE AND
   NOISE ON A)
70 POKE 61680, 6  (SELECTS REG. 6)
90 POKE 61681, 1  (ENTER NOISE VALUE)
```

and run.

---

Fig. 3. Envelope shape control

Fig. 4. AY-3-8912 pin-outs

Fig. 5. Circuit diagram of the unit.
Fig. 5. Circuit diagram of Programmable Sound Generator
Fig. 6. Printed Circuit layout (actual size)

Fig. 7. Component layout
### COMPONENTS

#### Resistors
- R1, R2: 100k (2 off)
- R3: 1k
- R4: 4k7
- R5: 470
- R6: 10
- R7, R8: 10k (2 off)
- R9: 2k2

#### Capacitors
- C1, C2, C5: 470p (3 off)
- C3: 10µf tant., 10V
- C4, C9: 100n (2 off)
- C6: 4µ7 tant. 10V
- C7: 47n
- C8, C10: 100µf tant. 10V (2 off)

#### Integrated Circuits
- IC1: 74LS38
- IC2: 74LS33
- IC3: 4011
- IC4: 4025
- IC5: AY-3-8912
- IC6: LM386

#### Miscellaneous
- L1: RS coil former: 228-090 + 2 cores: 228-107
- S1: SPST push button
- Speaker: 8Ω

---

**To check envelope shapes clear above program by typing NEW.**

Enter the following:

<table>
<thead>
<tr>
<th>Line</th>
<th>POKE</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>61680</td>
<td>1</td>
</tr>
<tr>
<td>20</td>
<td>61681</td>
<td>2</td>
</tr>
<tr>
<td>30</td>
<td>61680</td>
<td>7</td>
</tr>
<tr>
<td>40</td>
<td>61681</td>
<td>254</td>
</tr>
<tr>
<td>50</td>
<td>61680</td>
<td>8</td>
</tr>
<tr>
<td>60</td>
<td>61681</td>
<td>31</td>
</tr>
<tr>
<td>70</td>
<td>61680</td>
<td>12</td>
</tr>
<tr>
<td>80</td>
<td>61681</td>
<td>64</td>
</tr>
<tr>
<td>90</td>
<td>61680</td>
<td>13</td>
</tr>
<tr>
<td>100</td>
<td>61681</td>
<td>0</td>
</tr>
</tbody>
</table>

**110 END**

and run.

Change line 100

**100 POKE 61681, 4**

and run.

Change line 100

**100 POKE 61681, 8**

and run.

By referring to Fig. 3 you can check out all the waveforms by altering line 100.

**Sweep frequency effects. Enter the following program:**

```plaintext
10 LET A = 100   (INITIALISE A)
20 POKE 61680, 2
30 POKE 61681, A   (LOAD A INTO REG. 2)
40 POKE 61680, 7
50 POKE 61681, 253   (SELECT CHAN. B O/P)
60 POKE 61680, 9
70 POKE 61681, 15   (SELECT FULL AMP. O/P)
80 LET A = A+2
90 IF A < 200 GO TO 20
100 GOTO 10
```

and run. You get a decreasing sweep frequency.

**Change the following lines:**

```plaintext
10 LET A = 200   \(\text{INITIALISE A}\)
80 LET A = A-2
90 IF A > 100 GOTO 20
```

and run. You get an increasing sweep frequency.

That checks out the unit. As you can see there is plenty of scope to add sound effects to your program. Short bursts of noise sound like gun shots, larger bursts sound like explosions. Tones can be played and the 3 channels allow chords to be output. All it takes is practice.

The unit may be fitted in a small case on its own or it may be mounted inside the computer case, as it is quite small.

---

**Fig. 8. Blanking plugs for IC6 and IC7 sockets on the 101**
**UK101—TELEPRINTER INTERFACE**

By J. J. Trevillion

This interface allows the use of a surplus teleprinter with the UK101 or similar 6502 microprocessor based machine. To constructors on a restricted budget, this is a practical alternative to an expensive line-printer, accepting such disadvantages as the low rate of print, the restricted character set and the noisy mechanism.

A simple hardware addition is used, connected directly to the UK101 bus expansion socket, whilst the software has been designed for ease of use. Description centres on the use of a CREED Type 54 teleprinter, which the author purchased relatively cheaply from a local surplus equipment dealer, although there is no reason why the interface could not be used with other 50 baud, solenoid operated teleprinters, with a minimum of modification.

**Hardware**

The author's teleprinter is fitted with a 240 volt synchronous motor which is to be preferred since it requires no setting up of speed. The teleprinter is operated by a solenoid which requires a drive of ±35 mA for MARK/SPACE. This is obtained in the circuit of Fig. 1 by switching the polarity of 24 volts across the solenoid using a relay. This voltage is high to allow the inclusion of a series resistor, R2, to maintain the switching speed of the solenoid, due to its relatively high inductance. The relay is driven by direct memory-mapped software control, such that writing to an address will send a MARK, and F101, a SPACE.

For the additional logic can just be derived from the UK101 five volt supply, since only an additional 20 mA will be drawn by the low-power solenoid devices.

No constructional details, or circuits of the ±12 volt supply, are given since these are not critical.

**Software**

A disassembled listing of the program (produced via the described interface) with a hexadecimal dump of the look-up tables used by the program, is shown in Fig. 2, whilst the flow-chart of Fig. 3 makes the listing understandable.

The program is located in the last 512 bytes of RAM of a UK101 containing 8 K of RAM, and uses RAM between addresses 0222 and 0266 for temporary storage. The program can

---

**Fig. 1. Circuit diagram**

**Fig. 2. Operating software**
Fig. 3. Flow chart

Fig. 4. Improvised characters

Table 1. Memory map.

<table>
<thead>
<tr>
<th>ADDRESS</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0222</td>
<td>Accumulator Temporary Store.</td>
</tr>
<tr>
<td>0223</td>
<td>Character Count.</td>
</tr>
<tr>
<td>0224</td>
<td>Overprint Character Count.</td>
</tr>
<tr>
<td>0225</td>
<td>Delay Counter.</td>
</tr>
<tr>
<td>0226</td>
<td>Figures Case Flag.</td>
</tr>
<tr>
<td>0227</td>
<td>Array Of Overprint BAUDOT Character Codes.</td>
</tr>
<tr>
<td></td>
<td>(64 Locations.)</td>
</tr>
<tr>
<td>1F96</td>
<td>Start of Main Look-Up Table.</td>
</tr>
<tr>
<td></td>
<td>(Terminated by 00.)</td>
</tr>
<tr>
<td>1FDC</td>
<td>Start of Overprint Table.</td>
</tr>
<tr>
<td></td>
<td>(Terminated by 00.)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ADDRESS</th>
<th>SUBROUTINE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1E00</td>
<td>Initialisation Routine.</td>
</tr>
<tr>
<td>1E1D</td>
<td>Main Printing Routine.</td>
</tr>
<tr>
<td>1F46</td>
<td>Send FIGURES Case &amp; Set Figures Flag.</td>
</tr>
<tr>
<td>1F4B</td>
<td>Output BAUDOT Code In Accumulator.</td>
</tr>
<tr>
<td>1F5F</td>
<td>2 millisecond Delay.</td>
</tr>
<tr>
<td>1F71</td>
<td>Send LETTERS Case &amp; Clear Figures Flag.</td>
</tr>
<tr>
<td>1F7B</td>
<td>Output Space.</td>
</tr>
<tr>
<td>1F7F</td>
<td>Output Carriage Return.</td>
</tr>
<tr>
<td>1F8D</td>
<td>Output Line Feed.</td>
</tr>
</tbody>
</table>

Easily be relocated for machines with less memory, and it is worth considering storing the routines in EPROM for convenience.

The routines provide the required ASCII to BAUDOT conversion by the use of a look-up table. A second table is used to increase the limited BAUDOT character set by overprinting BAUDOT characters. The characters so produced are demonstrated in Fig. 4, the overprinting being achieved by storing the BAUDOT codes to be overprinted in an array (0227 to 0266) and copying them at the end of a line of text.

Other features of the software include automatic lower case to upper case conversion, and the simulation of the TAB function (CONTROL I) to aid formatting.

A memory map of the program, including the entry points for useful subroutines, is shown in Table 1.

Fig. 3. Flow chart

Fig. 4. Improvised characters
EXPANDING GROUP

We have received the first newsletter proper from the UK101 User Group, which is accumulating members in the British Isles and overseas.

The group is doing some important work now, such as investigating the "sticking" FRE function, which Adrian Waters, the club organizer points out, is the tip of a serious iceberg concerning string data storage. A complex sound board is nearing completion, whilst behind the scenes the program library is swelling with games and educational software, and new languages such as PILOT.

The Newsletter, ROM, carries useful articles (eg. "SHIFTY CHARACTERS"), software (eg. "GET KEY FOR UK101"), news, hardware modifications, useful ROM and RAM locations, routine entry points, and a problem page. Equipment reviews are to become a regular feature.

After much difficulty I also obtained part 2 of the 6502 chip by the B output pin of IC29. The conversion can be implemented by cutting the track of the p.c.b. as shown in Fig. 1 and substituting "ADD THIS WIRE LINK TO PIN 3 OF IC29"

2MHz conversion

In the normal machine, the clock frequency of 1MHz is presented at pin 37 of the 6502 chip by the B output pin of IC29. The conversion can be implemented by cutting the track of the p.c.b. as shown in Fig. 1 and substituting the new link. Many members have included a changeover switch, although this cannot be used whilst the machine is working, without getting "hung up".

MODEM TO TANDY?

Sir—Firstly, thank you for an excellent magazine, it rivals any we have in the States.

Secondly, I picked up a copy of your February 1980 issue and am very interested in the Modem article by K. Amor. After much difficulty I also obtained part 2 in the March issue—expecting to learn how to connect this System to my Tandy TRS-80 16K Level II—only to be very disappointed. I would be very interested in any information you or your readers might have to offer. I would also be interested in exchanging hardware and software with any of your readers. Thank you.

From the desk of Bryan McPhee, Capt., USAF, 2742 Virginia Trail, Brown Mills, N.J. 08015, U.S.A.

SHIFTY CHARACTERS

Sir—The following useful feature of the UK101 is not mentioned in your series of articles or the instruction manual:

With Shift Lock up, the keyboard returns lower case letters. To input a few upper case letters or figures, press L.H. Shift and the key for the character required (ie. L.H. Shift cancels the effect of Shift Lock being up).

To obtain the normally shifted characters (eg. "1" then press R.H. Shift and the appropriate key.

Please continue to publish the very useful articles in Micro Prompt on this excellent machine.


Sorry, we thought people knew—Ed.

GET KEY FOR UK101

To get a key from the keyboard without stopping the program, as in the input statement, run the following program, then each time you require a "Get Key" statement write:

(Line number) A$ = "Space" : POKE 11, 0

After this line A$ will be a space unless a key was pressed, in which case A$ will be equal the character of the key which was pressed.

Any S variable can be used, including array's. This can be used to replace the 'GET A$' statement as used on the PET. To set up the subroutine:

10 FOR A = 540 to 597
20 READ B : POKE A, B : NEXT

30 DATA 169, 2, 32, 190, 252, 32
40 DATA 198, 252, 208, 7, 10, 208
50 DATA 245, 169, 32, 208, 28, 74
60 DATA 32, 200, 253, 152, 133, 252
70 DATA 10, 10, 10, 56, 229, 252
80 DATA 133, 252, 138, 74, 32, 200
90 DATA 253, 24, 152, 101, 252, 168
100 DATA 185, 207, 253, 160, 0, 41
110 DATA 127, 145, 105, 96, 0

Once run this program can be erased if required.

J. L. Brice, Ashford, Kent.

ERROR MESSAGE ERROR

Sir—I am a UK101 user who has, like many, been frustrated by the rather graphic error messages. The result of this has been the following short program to produce "standard" Microsoft BASIC error messages:

Enter monitor

MODEM TO TANDY?

Type: .0221/29 (carriage return)

7A "AC " 2D " BF "

Reset and enter BASIC.

Type: POKE 538, 34 : POKE 539, 2

All error messages will then be standard.

The program works by masking off the most significant bit of all characters printed. The BASIC stored messages all have the MSB set on the last character, and it is the omission of an instruction to clear this bit which caused the original error messages. Considering the complexity of the BASIC, such an omission in the error routine is understandable, but I hope this will be corrected.

New error messages

Syntax error

Double dimension

Division by zero

Undefined statement

Undefined function

Bad subscript

Long string

Out of memory

Overflow

Continue error

String tempories

Type mismatch

Next without FOR

Function call error

Illegal direct

Out of string space

Out of data


MAP READING

Sir—You may wish to pass on to your readers an error discovered in the memory map of the UK101, found whilst implementing an 6821 I/O port, at a dedicated address.

The ACIA which resides at F000—F001 is due to page select decoding repeated at a further 127 locations through Hex page F0. The memory map should thus be amended to show that ACIA resides from F000—FF0F.

Readers might also like to note that an unbuffered data bus, terminates in a patch pad with 0.1 inch pitch spacing, to the left of the ACIA chip i.e. 14. This can only be used with selectable tristate logic, but as most 6502 compatible support devices have this facility, the cost of the AT28's may be saved.

M. C. Mannering, Walthamstow.
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PART 2... TUNER & DECODER

In common with all teletext decoders, the Mullard module requires a high quality video signal from which the information is extracted. Since most readers will have little or no experience of working at TV i.f. frequencies (around 40MHz) and insufficient test equipment, the use of a pre-aligned signal section becomes almost mandatory. The solution chosen is shown in block diagram form in Fig. 2.1.

The tuner is the Mullard U321 which is specifically designed for use in the UK. It features a PIN diode attenuator to provide very good signal handling when the signal from the aerial is too large and the a.g.c. system comes into operation. It is used by several TV setmakers and is thus readily available.

The i.f. section is that used in the Philips G11 TV chassis and comprises two modules which are soldered directly onto the p.c.b. The i.f. output from the tuner is applied to pin 1 of the vision selectivity module (VSM). This, as its name implies, carries out the required bandshaping to produce the correct response as determined by the specification of the broadcast signal in the UK. The output from this module is applied to pin 1 of the vision detector module (VDM). This detects the signal to produce a video output; generates an automatic frequency control (a.f.c.) signal which is externally added via R31 to the tuning voltage to counteract any tuning drift; generates an a.g.c. current which is applied to both the vision selectivity module and to the tuner; filters to the 6MHz intercarrier sound signal which is added to the modulator since the video signal is stripped off this inside the module. Other filtering which is performed by this module is not of interest to us.

Turning our attention to the circuit diagram shown in Fig.2.2, it can be seen that the way the tuner and two modules are interconnected forms an extremely simple i.f. section with very few peripheral components. It runs from the stabilised +12V rail which is decoupled at r.f. and i.f. by R29, C11 and C13. The a.g.c. signal to the tuner is decoupled by C14 and C12 and current limited by R32. As mentioned earlier, a.g.c. is applied to both the i.f. pre-amplifier and to the tuner. The latter control signal is delayed, i.e., a.g.c. is gradually applied to the i.f. section first and when this reaches a certain point it is then also applied to the tuner. This point is called the a.g.c. takeover point and is determined by the setting of VR1 in conjunction with D1.

The a.f.c. signal from pin 7 of the VDM is added to the tuning voltage via R31. Resistors R33 and R34 determine the quiescent voltage (around 5.7V).

Turning our attention to IC1, this is a b.c.d. to 1 or 10 decoder/varicap driver which is operated from the stabilised 33V rail. Only four of the available channels are used in our design. The i.c. decodes the four-bit word according to the table below:

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>O/P</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>10</td>
</tr>
</tbody>
</table>

When a channel is decoded, the output of the SL470 goes high and connects the appropriate tuning potentiometer to the +33V stabilised supply. The tuning voltage is applied to the varicap diodes in the U321 tuner via R30.

The SL470 is driven by the buffer IC3 (4050).

SETTING UP

It is imperative that no attempt is made to adjust any of the coils in the tuner or modules. In fact the only adjustment to be made is the a.g.c. crossover point. This is done by tuning into a station and adjusting VR1 until the picture becomes slightly noisy (snow). The control is then backed off until the noise disappears and then backed off a little more from that point.
**CONSTRUCTION**

The p.c.b. design for the tuner is shown in Fig. 2.3 with the component layout in Fig. 2.4. The smaller components should be mounted first and the tuner, VSM and VDM mounted last. There is a wire link which should be fitted near one end of IC4.

The eleven connections from the tuner can be wired using ribbon cable. After soldering check the board carefully for any solder splashes and if everything is alright insert the two i.c.s.

**DECODER**

The circuit diagram of the decoder unit is shown in Fig. 2.5. The decoder has been designed around four dedicated LS1 integrated circuits. The main functions of the four i.c.'s are:
- SAA 5020 (TIC) Timing chain
- SAA 5030 (VIP) Video input processor
- SAA 5040 (TAC) Teletext data acquisition and control
- SAA 5050 (TROM) Teletext ROM, character generator
Fig. 2.5. Circuit diagram of the Decoder Board. Note that the decoupling capacitors C37 to C46 are not shown in the diagram.
Fig. 2.3. P.c.b. design of the Tuner

Fig. 2.4. Component layout

Practical Electronics September 1980
Fig. 2.6. Component layout of the Decoder Board. Note C32 is not used on the supplied board.

Fig. 2.7. Circuit diagram of the Daughter Board.

Fig. 2.8. P.c.b. design for the Daughter Board.

Fig. 2.9. Component layout of the Daughter Board.

**COMPONENTS . . . DAUGHTER BOARD**

**Resistors**
- R54, R55, R56
- 5k6 (3 off)
- R57
- 4k7

**Diodes**
- D14 to D19
- BAW 62 (6 off)

**Sockets**
- SK2
- 21-way socket
- P.c.b.
**COMPONENTS...**

### TUNER

<table>
<thead>
<tr>
<th>Resistors</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>R25, R26, R27, R28</td>
<td>4k7 (4 off)</td>
</tr>
<tr>
<td>R29</td>
<td>4Ω7</td>
</tr>
<tr>
<td>R30</td>
<td>47k</td>
</tr>
<tr>
<td>R31</td>
<td>2M2</td>
</tr>
<tr>
<td>R32</td>
<td>120</td>
</tr>
<tr>
<td>R33</td>
<td>56k</td>
</tr>
<tr>
<td>R34</td>
<td>270k</td>
</tr>
<tr>
<td>R35</td>
<td>5k6 0.5W</td>
</tr>
<tr>
<td>R36</td>
<td>470k</td>
</tr>
</tbody>
</table>

All resistors 1/2W 5% carbon except where otherwise stated.

<table>
<thead>
<tr>
<th>Capacitors</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>C10, C11</td>
<td>100n (2 off)</td>
</tr>
<tr>
<td>C12</td>
<td>220n</td>
</tr>
<tr>
<td>C13, C14</td>
<td>220µ 16V (2 off)</td>
</tr>
<tr>
<td>C15</td>
<td>2n2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semiconductors</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>D8</td>
<td>BZX 83 C3V9</td>
</tr>
<tr>
<td>D9</td>
<td>TAA 550</td>
</tr>
<tr>
<td>D10 to D13</td>
<td>IN4148 (4 off)</td>
</tr>
<tr>
<td>IC3</td>
<td>4050</td>
</tr>
<tr>
<td>IC4</td>
<td>SL470</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Potentiometer</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>VR1</td>
<td>2k2 preset</td>
</tr>
<tr>
<td>VR2 to VR5</td>
<td>100k tuning pots (4 off)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Miscellaneous</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuner 3113 108 6246</td>
<td></td>
</tr>
<tr>
<td>VSM 3113 108 25350</td>
<td></td>
</tr>
<tr>
<td>VDM 3113 108 25330</td>
<td></td>
</tr>
<tr>
<td>P.c.b.</td>
<td></td>
</tr>
</tbody>
</table>

### DECODER

<table>
<thead>
<tr>
<th>Resistors</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>R37, R41, R50</td>
<td>1k5 (3 off)</td>
</tr>
<tr>
<td>R38</td>
<td>100k</td>
</tr>
<tr>
<td>R39</td>
<td>880</td>
</tr>
<tr>
<td>R40, R49</td>
<td>1k (2 off)</td>
</tr>
<tr>
<td>R42, R43, R48</td>
<td>6k8 (3 off)</td>
</tr>
<tr>
<td>R44</td>
<td>33k</td>
</tr>
<tr>
<td>R45, R46, R47</td>
<td>1k2 (3 off)</td>
</tr>
<tr>
<td>R51, R52, R53</td>
<td>470 (3 off)</td>
</tr>
</tbody>
</table>

All resistors 1/2W 5% carbon except where otherwise stated.

<table>
<thead>
<tr>
<th>Capacitors</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>C16, C29, C31</td>
<td>1µ 25V (3 off)</td>
</tr>
<tr>
<td>C17, C34, C35, C36</td>
<td>1n (4 off)</td>
</tr>
<tr>
<td>C18, C27</td>
<td>10µ 25V (2 off)</td>
</tr>
<tr>
<td>C19, C28</td>
<td>330p (2 off)</td>
</tr>
<tr>
<td>C20, C32</td>
<td>100n (2 off)</td>
</tr>
<tr>
<td>C21</td>
<td>47p</td>
</tr>
<tr>
<td>C22, C24</td>
<td>5-65p (2 off)</td>
</tr>
<tr>
<td>C23, C25</td>
<td>10n (2 off)</td>
</tr>
<tr>
<td>C26</td>
<td>68p</td>
</tr>
<tr>
<td>C30</td>
<td>3n3</td>
</tr>
<tr>
<td>C33</td>
<td>68µ 25V</td>
</tr>
<tr>
<td>C37 to C46</td>
<td>100n (10 off)</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>Semiconductors</th>
<th>Value</th>
</tr>
</thead>
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<tr>
<td>IC5</td>
<td>SAA 5030</td>
</tr>
<tr>
<td>IC6</td>
<td>SAA 5040</td>
</tr>
<tr>
<td>IC7</td>
<td>SAA 5020</td>
</tr>
<tr>
<td>IC8</td>
<td>74LS02</td>
</tr>
<tr>
<td>IC9</td>
<td>74LS83A</td>
</tr>
<tr>
<td>IC10, IC11</td>
<td>74LS161 (2 off)</td>
</tr>
<tr>
<td>IC12, IC13</td>
<td>2614 (2 off)</td>
</tr>
<tr>
<td>IC14</td>
<td>SAA 5050</td>
</tr>
</tbody>
</table>

The TIC, TAC and TROM i.e.'s are MOS N-channel devices whereas the VIP is a monolithic bipolar type.

The decoder has two main functions: to extract the teletext data from the incoming video signal and to process it, writing the page data into memory. This function uses the VIP and TAC chips. The second function is to convert the information in the memory into a video signal to display the text on the screen. The generation of characters is carried out by the TROM and the TIC provides all the timing signals from the TIC which are synchronised to the incoming video signal so that the text and television picture may be displayed together.

The video signal from the Tuner board is fed to pin 16 of the VIP via a coupling capacitor (C16). The VIP has two separate sections: a data retrieval section and a display clock generator.

The incoming video signal contains picture, sync and teletext data which is sliced and then the teletext information extracted. A clock signal is generated from the sliced data using the tuned circuit connected to pin 21. This signal (F7) is used to clock the data into the TAC chip. The 6MHz clock oscillator (pins 8, 9) has its output (pin 6) taken to the TIC chip where it is used to provide a clock pulse every 64µs. This pulse is then passed back to the VIP where it is compared with the incoming line sync signals. This enables the timing system of the teletext display to be phase-locked with the incoming television picture signal.

### TAC SAA5040

The principle function of the data acquisition section of the TAC is to process the teletext data so that it can be written into the memory. The control section of the TAC receives information from the remote control (pins 5, 6). This information is processed and then used to operate the various display functions of the decoder (i.e. time, page selection, status etc.)

The data acquisition section checks the incoming data from the VIP and any words having a single bit error are corrected. Address words having two bits wrong are rejected.

The input (pin 2) receives a serial data stream of teletext data from the 5030 at a data rate of 6.9375 MHz. The information is clocked into the TAC (pin 3) by the clock output from the 5030.

The memory block which consists of two 1K x 4 static RAMs receives character data from pins 16 to 22 of the TAC. Whenever a character is written into memory, WOK (write OK) pin 15 is activated. After each character a clock signal WACK (write address clock) pin 28 is supplied to the address counters to address the next memory location.

The DEW (data entry window) signal from pin 14 of the TIC enables the TAC to operate in the data entry mode by enabling the data and row address outputs. The data acquisition circuits of the TAC are reset at the end of every line by a GLR (general line reset) pulse from pin 7 of the TIC.
The PO (picture on) output to the 5012A, 5030 and 5050 from the TAC is used to switch the television video on or off (a 'high' for picture on and a 'low' for picture off).

A 'high' DE (display enable) output to the TROM enables the teletext display whilst in its 'low' state the display is disabled.

The BCS (big character select) output to the 5020 and the 5050 is used to select the double height characters. A 'high' output is used for normal characters and a 'low' for double height characters.

The T/B (top/bottom) output to the 5020 (pin 18) selects whether a top or bottom half page is selected (a 'high' for top, and a 'low' for bottom).

The three state outputs for the memory addresses (pin 23 to 27) AO to A4 specify in which of the 24 screen rows the teletext data is to be written.

TIC SAA 5020
The 6MHz clock signal (F6), which is used to derive the basic timings from the teletext display, is fed to pin 2 of the TIC from pin 6 of the 5030. This signal is sub-divided by the TIC down to 25Hz, the frame rate of the television to generate all the timing signals for the teletext display.

The F1 output (pin 4) is a 1MHz clock signal for the TROM and the TAC chips. The television display is synchronised by the internally generated sync signal AHS (after hours sync) output from pin 5. The CRS (character rounding select) output signal is required for correct character rounding of the small characters within the character generator.

The internal data processing and sync circuits of the VIP are reset using the CBB (colour burst blanking). The internal control character flip-flops of the TROM chip are reset at the start of each display line by the LOSE (load output shift register enable) output from pin 13.

TROM SAA 5050
The basic input to the TROM is character data from the teletext page memory. This is in the form of a 7-bit code which is fed to pins 4 to 10. The TROM converts the data into a dot matrix pattern. The character generator ROM (4.3K bits) generates 96 alphanumeric and 64 graphic characters.

The video output signals consist of a monochrome output (pin 21) and red, green and blue signals (pins 24, 23, 22) which contain both character and background colour information. A blanking output signal is provided to blank out the television video when a newsflash or subtitle is displayed.

CONSTRUCTION
The decoder board is supplied ready built, tested and aligned. Before the board is installed the three wire links shown in Fig. 2.6. should be soldered. Check these wires carefully. The wiring for the decoder is also shown in Fig. 2.6. but it is recommended that constructors leave the wiring of the system until all the boards have been assembled.

DAUGHTER BOARD
The decoder board is interfaced to the video summer board via the interface circuit shown in Fig. 2.7. The RGB outputs from the TROM have pull-up resistors to 12V with catching diodes to prevent the outputs rising above 5V. These outputs are then diode ORed together and produce a current via R57 which is then added to the luminance channel at the delay line input on the summer board.

The daughter board is mounted on the p.c.b. shown in Fig. 2.8. with the component layout shown in Fig. 2.9.

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COBALT MAGNET ALTERNATIVES

There is now a serious world shortage of cobalt metal. This is largely due to the fact that cobalt is produced as a by-product of copper mining and most of the cobalt-copper ore mines are in Central Africa where the political situation is very unstable. The military and aerospace have first call on cobalt because it is an essential ingredient of high temperature alloys, as used for instance in jet engines. Loudspeaker manufacturers have for years used cobalt alloy magnets, for instance Alnico (aluminium-nickel-cobalt), because it offers high flux density. In turn this facilitates low leakage design by potting a compact magnet in a shield. In a colour TV set flux leakage sours the picture colours and hence potted cobalt magnets have been used almost exclusively in colour TV production. But the rising cost of cobalt has stimulated research into alternative approaches.

Two recent patents reflect this research and the worldwide trend away from cobalt as a magnetic material. UK patent application 2 031 247, filed under the New Laws by Hokuto Onkyo Co. Ltd. of Tokyo and dating from 3rd October 1978, contains a legally very broad claim to the basic concept of potting ferrite instead of cobalt. Figures 1 and 2 show known, but supposedly unsatisfactory, designs in which a ferrite magnet 10 is shielded by a pot or cup. Figure 3 shows the Onkyo design. Yoke 1 houses ferrite magnet 2. Pole 3 extends through a gap in the yoke 1 which also houses voice coil 5. The pole 3 has a cylindrical part 3a which merges into a tapered or frusto-conical part 3b. According to the rather vague wording of the patent this construction, along with the gap formed between pole cylinder 3a and yoke 1, decreases permeance between the pole and yoke. The greater the sectional area of the magnet the easier it is to keep the permeance low. The inventor claims that this decreased permeance reduces flux leakage, making the magnets suitable for use in a colour TV loudspeaker.

A similar claim is made by a Danish inventor in UK patent application 2 034 154, which was filed under the New Laws and dates back to October 1978. Although the aim is the same the approach is different. Figure 4 shows a known Alnico design. Central rod 4 is a permanent Alnico magnet inside a cylindrical pot 6. The Alnico rod backs onto base disc 2 and pole disc 18. As the inventor points out, such a compact fully shielded design has been possible because the Alnico rod 4 can be small due to the high magnetic efficiency of cobalt-based materials. But ferrite is less efficient and this makes similarly compact designs of inadequate magnetic strength. The new design is shown in Figure 5. A large ring 4 of ferrite is housed in a pot 6 which is integrated with rear pole disc 2. Front pole piece 18 is slightly larger than the ring magnet 4 and the whole combination is mounted in a cup 22. An alternative design, based on a solid disc magnet 4 is shown in Figure 6. The point of the invention is that the voice coil 12 is of much larger diameter than usual. This enables the large ferrite magnet to be used inside a pot rather than around the voice coil as an annular magnet. Again the claim is to a loudspeaker with insignificant flux leakage.
LAST month the general principles of the GEB detector were explained, and construction of a machine began with a p.c.b. comprising power supply, auto-tuning and output stages. This month the remainder of the construction will be covered.

SEARCH COILS
It's best to begin by winding the search coils, which will be required for testing the front-end circuit board at various stages. The Magnum uses a pinpoint coil, for reasons explained last month; these are slightly harder to make than widescans but the results obtainable are well worth the effort. The coil assembly is based on a 10in dia. 'Melaware' plate, made from a very rigid plastic, obtainable from most stores selling picnic tableware.

The inside of the plate is thoroughly roughened with glasspaper to enable glassfibre resin to stick to it, and two 'L'-shaped plastic brackets are bolted to the top as in Fig. 6. These were cut from a thick, strong square-shaped clip intended for mounting square section plastic drain pipes to exterior walls, obtained from a local builders' merchants. They are bolted to the plate with 2BA countersunk screws with the heads inside, so nothing protrudes to foul the coils. A hole is drilled just behind one of the brackets to allow a 4-core screened cable to pass through.

The two coils are wound on pins pushed into a suitable board. The larger transmitting coil is made with just five pins positioned as shown in Fig. 7a, on which 60 turns of 32 s.w.g. enamelled copper wire is wound. It can be tied temporarily with a few twists of wire and removed from the s.w.g. enamelled copper wire is wound. It can be tied temporarily with a few twists of wire and removed from the coil assembly based on a 10in dia. 'Melaware' plate, made from a very rigid plastic, obtainable from most stores selling picnic tableware.

The inside of the plate is thoroughly roughened with glasspaper to enable glassfibre resin to stick to it, and two 'L'-shaped plastic brackets are bolted to the top as in Fig. 6. These were cut from a thick, strong square-shaped clip intended for mounting square section plastic drain pipes to exterior walls, obtained from a local builders' merchants. They are bolted to the plate with 2BA countersunk screws with the heads inside, so nothing protrudes to foul the coils. A hole is drilled just behind one of the brackets to allow a 4-core screened cable to pass through.

The two coils are wound on pins pushed into a suitable board. The larger transmitting coil is made with just five pins positioned as shown in Fig. 7a, on which 60 turns of 32 s.w.g. enamelled copper wire is wound. It can be tied temporarily with a few twists of wire and removed from the pins—this is fiddly but not too difficult—bent to the shape of Fig. 7b, and bound tightly with a spiral of thin bare wire such as 5 amp fusewire, leaving a loop near the lead wires for use as a connection. Remove the temporary ties as the binding proceeds. A strip of aluminium cooking foil is then wrapped over the bare wire to form a Faraday shield, and this is held in place with another tight binding of the bare wire. Note that both wire bindings and the foil must have a gap—this is most important, as if the Faraday shield were allowed to form a complete 'turn' around the circumference of the coil it would render it useless.

PICKUP COIL
The pickup coil is made in the same manner, consisting of 200 turns of 36 s.w.g. enamelled copper wire wound around 16 pins placed in a 4in diameter circle. Faraday shielding is fitted as on the transmitting coil, again with the all-important gap.

The transmitting coil can now be fixed in place on the former using a small quantity of fibreglass resin. A Holts' 'Fibreglass Repair Kit', obtainable from motoring accessory shops, was used in making the prototype. The coil is best fixed in stages, using clothes pegs and weights to keep it in place as necessary. Apply the resin with a soft brush and have a jar of cellulose thinners handy to dunk the brush into the moment it starts to 'gel'. Push the 4-core screened lead through the hole in the plate, connect the coil leads to two of the cores, and the Faraday shield to the screens. It can be difficult to keep the lead in place whilst the resin sets; one way of doing this is to drill two tiny holes on each side of it and secure it flat against the plate with a couple of twists of thin wire. The pickup coil is not fitted at this stage.

FRONT-END PCB
Start building the 'front-end' circuit board by fitting all the links. Then fit R1 to 3, C1, 2, and 28, D1, and TR1. Hook up the transmitting coil and apply power from the supply board. Continue using a resistor in series with the 18 volt battery in case any faults arise during tests, as described last month. The transmit oscillator should now be running, at between 15 and 16kHz. This can be checked by placing a radio tuned to a weak longwave station very close to the coil-faint whistles due to harmonics of the transmitted signal beating with station carries should be present. Faint is the word, however, as the Magnum's oscillator produces a very clean signal. This and other parts of the circuit can be more easily checked with a 'scope of course, but if you have one you'll probably have realised this anyway.

Next fit R4 to 13, C3 to 8 and IC1. Apply power and check that IC1's d.c. output voltage (at pin 6) is equal to 5-6V. Fit IC2, apply power and check IC2's d.c. output is 5-6V. Fit IC3, hook up VR1 across points I and J, VR2 across points G and H, and fit some lengths of wire so that point M may be shorted to points K or L, and short one of these. It doesn't matter which at this stage. Apply power and check that IC3's d.c. output (pin 6) is 5-6V. The output of IC2 should actually be switching from rail to rail at the oscillator's frequency but the average value of output should be 5-6V. A fault will usually result in its being fully driven to one of the supply rails, so this is a useful test. Check that settings of VR1 (M shorted to L) and VR2 (M to K) makes little or no difference to IC3's output voltage.

It might be of interest to explain that in the original design, the pots were connected directly as they are in this test, and a 2-way switch was fitted to M, K and L. This provides 'Ground Reject' (VR2) and 'Discriminate' (VR1). However, on the first beach outing it was found that the 'Beach Effect' could only be rejected with the 'Discriminate' control: a predictable effect since beaches are usually conductive. This prevented the discrimination from being used to reject foil, of which large amounts are to be found on most beaches. To overcome this problem the switching was...
rearranged to provide a third 'Beach' position, in which VR2 is effectively switched into the discriminate circuit instead of the ground one. Thus VR2 can then be used to reject false signals from wet beaches in the same way as from ground, whilst VR1 can once again be used to check finds as intended.

Continue the construction by fitting R14 to 21, C9 to 12 and TR2. Connect the pickup coil temporarily, apply power and check that the emitter voltage of TR2 is approximately 0.6 volts above the negative rail. Fit IC4, apply power and check IC4's output voltage (pin 6) is 5.6V. Fit IC5, apply power and check that the output of IC5 is also V/2.

Fit R22 to 28 and C13 to 15. Fit IC6, observing the usual CMOS handling precautions for this chip. Place the pickup coil in approximate position over the transmitting coil, apply power and monitor the top end of R22 with a meter. The voltage present should be somewhere between 2 and 8 volts and should alter if VR1 or VR2 (whichever is selected by shorting M to K or L) is moved. Adjust the pickup coil position to obtain 5.6V at the top end of R22. Note that the Faraday shields of the coils shouldn't touch even though both sides they can form a 'shorted turn' in the middle of the assembly. Small pieces of card should be placed between them to prevent this from happening.

Fit IC7, check it's output is the same as that at the top of R22, i.e. 5.6V. Fit IC8. Check 5.6V is still present at IC7 pin 6—if not adjust coil position. Then check that 5.6V is also present at the output of IC8. This completes the construction of the front-end p.c.b.

**HARDWARE ASSEMBLY**

The rest of the hardware can be constructed next. This is made mainly from 1/2" diameter plastic plumbing pipe and fittings, assembled as shown in Fig. 8. It's simply glued and pushed together, making a very presentable handle and stem in a surprisingly short time. Wood dowelling is inserted at strategic points of the stem to prevent it from flattening when bolts are passed through it and tightened. The search coil is fixed by a length of studding passing through the two brackets and the end of the stem, with a wingnut at each end. Also that it's tilted may be easily adjusted by the user. The control box base is secured to the shaft with two bolts, and the tuning button is fitted into the end of a bicycle handlebar.
grip which is then pushed onto the plastic pipe, threading the wires through the pipe to emerge through a small hole close to the control box.

**CONTROL BOX ASSEMBLY**

The electronics now have to be assembled into the control box. The top should be cut to accept meter, pots and switch in the layout shown in Fig. 9. Note that the top only fits the base one way round before starting this! A pattern of holes can be cut in one of the aluminium side panels to act as a speaker fret, the speaker being glued into place. A clip to hold the three PP3 batteries is fashioned from sheet aluminium and wood and bolted to the same panel, and to the ends of the bolts a piece of Veroboard is attached to act as a connecting block for the leads from the batteries and tuning button. Four 4BA bolts passing up through the base of the box act as stand-off pillars on which the two p.c. boards are mounted one above the other, the front-end board being uppermost.

The best way to make all the connections to the boards is with ribbon cable, soldering this to them before fitting them into the case and noting the poit to which each coloured wire goes. A headphone socket is optional; if required it may be connected as shown in Fig. 5. ‘R’ will have to be selected for the phones to be used, in the prototype a value of 100 ohms was found to be suitable. A 5-pin DIN plug and socket was used for the coil lead, whilst not strictly necessary this does allow for experimenting with different coils at a later date.

The box specified is supplied with feet which were discarded, the securing bolts being shortened a little to compensate.

**SETTING UP THE SEARCH COILS**

When all the components have been wired up the final tricky part has been reached; the setting up of the search coils. This must be done with metal parts such as the securing bolt and wing nuts in place, though there is no need to have the coil assembled to the stem. There should be no large metal objects close to the coil during this stage. This might also be a good time to mention that the machine can be affected by line timebase radiation from 625-line TV sets, so if you get a ‘mushy’ sound or a pulsed audio effect from it, check this first. Coil adjustment is actually not as critical as it is for a normal IB machine, but there is a best point and for a GEB machine it is the position where absolute minimum residual amplitude output (and maximum phase shift effect) is obtained from the pickup coil. (Conventional IBs usually work best with a slight ‘offset’ from absolute null.) This cannot be monitored with the phase sensitive detector in the machine itself, so the circuit of Fig. 10. should be lashed up and connected to IC4 output (top end of R19) and used with...
100mm LENGTH OF PIPE

135° BEND

TUNE HOLD
SWITCH

CYCLE HANDLEBAR
GRIP

125mm LENGTH OF PIPE

125mm LENGTH OF PIPE

10.3991

1E1.40fl

WOODEN DOWEL
INSERTED HERE

WOODEN DOWEL
INSERTED HERE

Fig. 8. Hardware assembly details

the 1 volt range of a testmeter to facilitate setting up minimum amplitude.

Set VR1, VR2 and VR3 to mid-point. Switch to 'Discriminate' and switch on. The meter monitoring amplitude will probably indicate full scale. Carefully adjust the pickup coil position until the reading falls—this may take some patience as it's easy to push the coil right past the null position without noticing it if you're too hasty. Remember to keep those Faraday shields apart! Once you have the coils somewhere near the null, try presenting metal objects to the coil whilst watching the centre-zero meter. A non-ferrous object such as a copper coin should cause it to rise, whilst a ferrous object such as a nail should cause a fall. If the opposite happens the phase of the pickup coil must be reversed, either by turning it over or by reversing its lead connections.

Once correct coil phase has been established setting up consists of adjusting the pickup coil position for absolute minimum output from the amplitude monitoring test circuit, use resin to stick it down in stages, rechecking the adjustment at each stage. Final fine trimming can be done with only a small section of the pickup coil still moveable.

After the positioning of the coils has been completed the coils can be given a coat of resin, followed by a layer of chopped strand glassfibre mat and more resin, which produces a search head assembly that is neat, tough and totally waterproof. One word of caution; don't use more resin than you have to or the finished head may be heavier than necessary.

FINAL ASSEMBLY AND TESTS

All the test components can now be removed and the machine finally assembled and tested. If you've never used a GEB machine before, you're in for some pleasant surprises.

On switching on, the meter should self-zero within a couple of seconds and the tuning control should then be set just below the threshold of the audio tone. The sensitivity of this machine is quite incredible; on most inland sites you'll probably need to keep the sensitivity control set to around mid-point. With the switch in 'Ground' position, a point can be found on the 'Ground' control where moving the head to and from the ground has no effect whatever—on one side of this point there will be positive ground effect, on the other negative, so it's not difficult to find. Adjusting this control for wet beaches is the same, except that the switch should be set to 'Beach'.

Once an object has been located, the machine should be switched to 'Discriminate' and the nature of the object determined. A certain amount of ground effect will be apparent in this mode, depending upon the actual terrain being searched. Ferrous objects produce a negative response at all settings of the discriminate control, but as this control is advanced so the machine will begin to reject small pieces of silver paper, then larger pieces, thick foil, and finally pull rings. It should be noted that in the pull-ring reject setting, however, it will also reject silver coins up to about 10p size. All discriminators suffer from this problem; but the ability to reject scrap iron and foil without difficulty is an absolute boon. Some practice with assorted objects—coins, nails and scraps of foil etc., is recommended before setting forth with this machine.

The tuning 'Hold' button will be found necessary for discriminating and for pinpointing the exact position of finds. So, Good Hunting! Don't forget you need a licence for your detector; application forms for this can be obtained from: The Home Office, Radio Regulatory Dept., Waterloo Bridge House, London SE1.
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Practical Electronics  September 1980
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PE is pleased to have been able to arrange this very special offer for readers on KAISE digital multimeters. The meters employ dual slope integration, 3½ digits, 10mm high I.C.D. with unit and sign indications, autoranging on volt and ohm ranges and autopolarity. Battery life is approximately 200 hours and battery low indication, overrange indication, and push button zero adjustment on the lowest range are provided. Both meters measure approximately 155 x 85 x 28mm and weigh approximately 250g.

Unfortunately we do not have the space to give a full specification, which would take up the whole page. However, a condensed version for both instruments is given below:

**DC Voltage** 200mV, 2V, 20V, 200V, 1000V, accuracy ±0.5% (6110) and ±0.8% (6200), impedance approx: 10MΩ on all ranges except 200mV which is 100MΩ.

**AC Voltage** (frequency 40Hz to 500Hz) 2V, 20V, 200V, 600V, accuracy ±1%, impedance approx 10MΩ.

**DC Current** 20mA (6110 only), 200mA, 10A (6110 only) accuracy 6110 ±1%, 6200 ±1.2%, impedance 20mA—1Ω, 200mA—10Ω, 10A—0.01Ω.

**AC Current**, as DC Current but ±1.3% (6110), ±1.4% (6200).

**Resistance** 200Ω, 2kΩ, 20kΩ, 200kΩ, 2MΩ, accuracy ±0.5% and ±1.8% (2MΩ range) for 6110, ±0.8% and ±2% (2MΩ range) for 6200.

**Low Power Resistance**, as resistance but without 200Ω range, accuracy ±1% and ±2% (2MΩ range) for 6110, ±1.2% and ±2% (2MΩ range) for 6200. Maximum open circuit voltage on this range is 0.4V.

The 6110 also has a buzzer for continuity test and additional audible warning of overrange.

To: Maclin-Zand Electronics Ltd. (PE Offer), 38 Mount Pleasant, London WC1X 0AP. Tel. 01-837 1165.

Mail order only

Please send me

<table>
<thead>
<tr>
<th>Multimeter/s at £59.95 (6110) or £34.95 (6200) each</th>
</tr>
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<tbody>
<tr>
<td>Name ..................................................................</td>
</tr>
<tr>
<td>Address ................................................................</td>
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</tbody>
</table>

Please allow 28 days for delivery

OFFER CLOSES FRIDAY, OCTOBER 24, 1980
THIS type of amplifier which was designed whilst looking for a suitable unit to use in a theatre has been developed with two particular requirements in mind: reliability and short circuit protection of the output.

**DESIGN CONSIDERATIONS**

Class A was attractive for two reasons, which can be illustrated by reference to the conventional R.C. coupled stage shown in Fig. 1. The circuit is asymmetrical, there being only one transistor, which gives a low component count. Also the quiescent current through the stage is defined by the resistors and hence is not temperature sensitive. There is a bonus also from this type of circuit, as the output transistor is never turned off, there is no crossover distortion.

There is, of course, one serious drawback with Class A, it's poor electrical efficiency. Sometimes referred to as conversion efficiency; the ratio between actual power into the load and power supplied from the d.c. supply. The best that can be achieved is about 17 per cent and that ignores the emitter resistor. Which would mean that a 50 watt amplifier consumed at least 294 watts and getting rid of 244 watts of heat (294-50) can be something of a problem.

If we look at a simplified Class A circuit without the complications of biasing and coupling as in Fig. 2 and consider the two limiting conditions. Firstly with TR1 just about cut off, i.e. the maximum positive excursion of the output. The current through the load $R_L$ is $E/R + R_L$, but this current also flows through the collector resistor $R$; hence if $W$ watts appears in the load, then $WR/R_L$ watts appear in this resistor, which is wasted power. If $R$ could be made very small this wasted power would also be small.

The other limiting condition appears when TR1 is just about saturated (ignoring the small collector-emitter voltage), the current through $R_L$ is zero and hence the power is zero whilst the current through the collector resistor $R$ is $E/R$ and the power $E^2/R$, all the power is wasted. If $R$ could be made large then this wasted power would be reduced.

This shows the two conditions have conflicting requirements. When the output is positive going $R$ must be small, when the output is negative going $R$ must be large.

An emitter follower, Fig. 3, has the property of impedance reduction. The impedance $Z$ measured between emitter and OV (ground or signal earth) will be considerably less than the value of the base resistor $R$. Very roughly, it will be reduced in proportion to the current gain of the transistor, e.g. if the current gain is $A$ then

$$Z = \frac{R}{A} \text{ approx.}$$

Returning to Fig. 2. If an arrangement having the characteristics of an emitter follower could be associated with $R$ the collector resistor; and in addition, if this arrangement could be switched on whilst the output signal was positive going (made low resistance) and inhibited (high resistance) whilst the signal was negative going, then this would solve the conflicting requirements.
The requirement is to reduce the value of R whilst the output is positive going, i.e. supplying current (conventional flow) not during positive half cycles, the two are quite different. The same point must be made about the converse situation. The value of R must be increased whilst the output is negative going, i.e. demanding current, not the same thing as during negative half cycles.

Fig. 4. Basic Class A stage with an emitter follower

Fig. 4 shows a basic combination of a Class A stage (Fig. 2) and emitter follower (Fig. 3). This combination is called Composite Collector Load Class A. The emitter follower being switched in or out of use by the diode D1.

Considering first the positive going situation where current is being supplied to the output. The collector potential of TR1 will rise in an attempt to supply current to the output or load. This situation will reverse bias diode D1 and forward bias the base emitter junction of TR2 which then behaves as an emitter follower supplying current to the load. The current through R will be only a small proportion of the load current, or looking at it another way the combined effect will be that of a collector resistor considerably smaller than R actually is.

Now consider the opposite situation when TR1 collector is negative going attempting to draw current from the output. The diode D1 will be forward biased and the base emitter junction of TR2 reverse biased. TR2 is thus out of action and the effective collector resistance is R only. TR1 thus absorbs the current from the load plus a small current via the resistor R.

CIRCUIT DESCRIPTION

The basic circuit shown in Fig. 4 illustrates the principle involved. To convert this to a practical design requires the addition of components to provide d.c. bias, the necessary a.c. drive to the base of TR1 and negative feedback to improve the performance. As shown in Fig. 5.

Resistors R1 and R2 establish the overall gain between input and output, which is equal to R2/R1. R2 also establishes the quiescent output voltage as equal to 0V as the other input of the op-amp IC1 is referenced to 0V.

Resistors R3 and R5 provide local negative feedback over the discrete components TR1, TR2 and TR3. This provides for a much more stable amplifier and greatly improves the distortion figures.

Resistor R4 serves two purposes. It reduces the power dissipated in TR3 enabling a TO5 assembly to be used and it also prevents any avalanche condition in the event of failure. For example, if TR2 failed in the short circuit mode the output would be driven fully positive. The negative feedback via R2 would cause TR3 to be turned hard on in an attempt to restore the output voltage and, of course, TR3 would break down. However, the presence of R4 will limit the current through TR3 to a safe value under these fault conditions.

The split collector resistor R6 and R7, together with C4, provides for bootstrapping to ensure that the base of TR2 never runs out of current, even as the output approaches the positive rail voltage. As the output voltage becomes more positive C4 causes the junction of R6 and R7 to also become more positive. This maintains a substantially constant current through R7 and hence the current handling capability of the output is reasonably constant also.

Capacitor C1 provides phase correction to the feedback loop. This may or may not be necessary and depends on component types used. The action of the switching diode D1 generates small transients and these are suppressed by C2 and C3.

Fig. 5. Improved Class A circuit

Fig. 8. Circuit diagram of one channel of the Class A amplifier. (Connections for R.H. channel shown in brackets.)
Having discussed the theory behind the Class A design we can now look at a practical implementation of the idea.

PRACTICAL AMPLIFIER

The construction of a practical amplifier, as opposed to the discussion of a theoretical one, inevitably involves compromise, and the most important compromise is between power output and readily available components.

The complete circuit diagram of the amplifier is shown in Fig. 6 (the left channel). This design is quite capable of delivering 30W into an 8 ohm load. Full drive (30 watts) is obtained with 350mV peak input. However, it was felt that it would be desirable to have a higher transient capability, hence the power supply design shown in Fig. 7 provides for ±30 volts as the quiescent supply voltages giving a transient capability approaching 60 watts. (The amplifier couldn't sustain this level for long as such a load rapidly reduces the supply voltages.)

![Power supply circuit](image)

**Components...**

<table>
<thead>
<tr>
<th>Resistors</th>
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<tr>
<td>R1</td>
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</tr>
<tr>
<td>R2</td>
<td>220k</td>
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<td>100 3W</td>
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<tr>
<td>R11, R12</td>
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<td>R13</td>
<td>560</td>
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<tr>
<td>R14</td>
<td>3k3</td>
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All resistors 1/4 W except where otherwise stated.

<table>
<thead>
<tr>
<th>Capacitors</th>
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<td>C1</td>
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<tr>
<td>C3</td>
<td>3300p</td>
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<tr>
<td>C4</td>
<td>1n</td>
</tr>
<tr>
<td>C5</td>
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<td>C6, C7</td>
<td>10µ 25V (2 off)</td>
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<td>C8, C9</td>
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<td>D1</td>
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<td>D5</td>
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<td>TR1</td>
<td>BC303</td>
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<tr>
<td>TR2, TR3</td>
<td>MJE 3055 (2 off)</td>
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<tr>
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<td>Bridge rectifier WQ2 (2 off)</td>
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<tr>
<td>IC1, IC2</td>
<td>741 (2 off)</td>
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<td>Fuse holders</td>
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<td>(slow blow)</td>
</tr>
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<td>1.5A fuse</td>
<td>(quick blow)</td>
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<td><em>P.c.b.</em></td>
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<td>Banana sockets</td>
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<tr>
<td>6-way DIN socket</td>
<td></td>
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<tr>
<td>Mains toggle switch</td>
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<tr>
<td>Suitable case</td>
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<td>Veroboard</td>
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<tr>
<td>Transformer Douglas</td>
<td>MT 79 FT (2 off)</td>
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</table>

* Two required for stereo design

CONSTRUCTION

The p.c.b. design for one channel of the amplifier is shown in Fig. 8 with the component layout in Fig. 9. All the components except TR2 and TR3 can be mounted on the board. The two resistors R9 and R10 should be set at least 10mm from the p.c.b.

The mounting details of the p.c.b.s, thermal switches and output transistors are shown in Fig. 10. The transistors TR2 and TR3 should be mounted onto the heatsink using mica washers.

The Veroboard layout for the power supply unit is shown in Fig. 11. The prototype was fitted into a case 250 x 180 x 60mm. The wiring diagram for the rear panel is shown in Fig. 12. The mains switch and the i.e.d. should be mounted onto the front panel.
Fig. 8. P.c.b. design for one channel of the amplifier.

Fig. 9. Component layout

Fig. 10. Mounting details for the heatsink

TEST PROCEDURE
a. With the mains input fuse FS1 fitted and FS2 and FS3 removed, connect a 6k ohm 10 watt resistor in series with mains live and apply power. The power rails should run up to approximately their correct voltage (+30V). Switch off and discharge the rails using a convenient resistor.
b. Fit FS2 and FS3 and with no speakers connected apply power again via the 6k resistor. A small voltage should appear at each rail, about half a volt or so.
c. If the two previous checks are good. Switch off, remove the 6k resistor and apply full power. Check across each pair of speaker sockets in turn that there is no more than a few millivolts of d.c. present.
d. If check c fails, check first the voltages supplying IC1 and IC2. ±10V.
e. Check there is no a.c. voltage at the speaker terminals.
f. With speakers (8 ohm) connected but no input connection there should be a noticeable, but not loud, 100Hz buzz.
g. Check that this buzz disappears completely when the input pins are connected to OV. Pins a and e connected to pin f on socket 1. Under these conditions there should be no sound from the speakers.
h. Check that there is +20V at pin d of socket 1.

OPERATION
The amplifier is now ready to accept a nominal input of 350mV peak output from a preamplifier. For inputs other than this the values of R1 and R2 should be changed, the
relationship being a direct one, i.e. for a peak input of 175mV the gain must be doubled which will be achieved by halving the value of R1. For a peak input of 700mV the gain must be halved, achieved by halving the value of R2. The limitations are that R2 should not be made larger than 220k.

On the other hand, the 3dB point of C1, R1 is 18Hz, halving R1 without altering C1 will raise this to 36Hz by which point the loss of bass will be noticeable. Halving R1 and doubling C2 will maintain the status quo but values of C2 (which is not polarised) much more than 2µF start to give an uncomfortably large component.

For those who would like to experiment with the circuit rather than build a Hi-Fi system there are a number of comments which may be helpful. If higher continuous outputs are required the power supply must be uprated and the output stage fitted with cooling fins.

The circuit in Fig. 6 is deliberately bandwidth limited. It will be seen that the circuit is d.c. coupled with the exception of the input C1 and the bootstrapping C5. For d.c. coupling omit C1 and C5. The op-amp IC1 will require offset compensation and the output voltage/current capability will be limited by the current available in R9 and R10.

The high frequency capability is limited to avoid undue emphasis on system noise and to enable readily available components to be used, in particular the MJE3055 and 741 op-amp. To increase the high frequency capability these components would have to be replaced. The 741s with op-amps with a better bandwidth and the MJE3055s with a superior high frequency device. The switching time of D1 at high currents and high frequencies will start to become noticeable and it will have to be replaced with a high speed device. Experiment with the values of C2, C3 and C4 if the type of op-amp or output transistor is changed.

COMPUTING CLUB

A COMPUTING Club has been formed in the Falkirk area, to be known as the “Central Scotland Computing Club”.

A Committee has been formed and it is planned to hold monthly meetings in Falkirk College of Technology, Grangemouth Road, Falkirk.

The Secretary is: James G. Lyon, 78 Slamannan Road, Falkirk, FK1 5NF, Tel: Falkirk 22430.
An accurate three digit frame counter which should prove a valuable aid in the production of fades and single frame sequences.

Pin data on nearly 900 popular transistors including f.e.t.s and u.j.t.s, also comparable types.

Many of the problems that occur in mobile PA systems are the direct result of lead failure. This unit provides a complete test sequence for the rigorous analyses of mono jack and cannon connectors to obviate this.
**RE-RUN FOR RUSSIA**

The success of Salyut-6 will influence Russia's thinking in the immediate future. Six new unmanned spacecraft have flown since June this year. The new thinking will involve considerable changes for they see this as an opportunity to catch up in the development of world space matters. To this end the new design will see a change in the interior layout of spacecraft. For example, in the past the instruments have been placed along the sides of the vehicles. In the future it is intended that the equipment shall be placed along the central axis of the station to facilitate man-machine interface.

Recently an official said that 'a considerable duration increase of time spent in space has shown us that this is economic and that we are now able to more reasonably assess the feasibility of long manned flights, particularly manned flights to Venus and Mars.' That the thoughts of Soviet scientists were turned in this direction by saying 'in the not too distant future', seems to show that they have hopes of catching up with the United States. Certainly the launch of Salyut-6 has paved the way to such activities.

Already the Russians have plans for a station some 25 tons heavier than Skylab. The reports are that such a station will have a weight of 220,000lb and be manned on a permanent basis with a constant complement of 12 cosmonauts. This is planned for the 1980s with a new launcher capable of 10-14 million pound thrust. This is more powerful than Saturn-5. This of course can easily manage manned flights to the Moon and Mars.

The cosmonauts at present on Salyut-6 Valery Ryumin and Leonid Popov are, at the time of writing this page, in the eleventh week of the present mission. It is expected that they will stay for 6 months. The tasks that have currently been carried out successfully included materials processing of which one was concerned with germanium. The team also replaced an outdated module in the stabilisation system and in the medical field carried out a special examination of each other's physical condition including an electrocardiogram after performing certain prescribed exercises.

A special simultaneous experiment was carried by the cosmonauts from the space craft and another group operating a Soviet launched balloon within the Earth's upper atmosphere. This was to monitor charged particles from above and below, as it were. It is intended to fly medical doctors on future space missions as do the United States. No significant problems have arisen during the Salyut-6 manned missions. There was an occasion when cosmonaut Romanenko had bad toothache. This was dealt with by medicine from the spacecraft's medical kit with instructions from the ground medical team. Dental equipment was sent up to the space station in case the patient should become worse. Medical opinion in the Russian ranks was that appendectomy could be successful in zero gravity. This being the case there was little to be feared on long missions.

In June Russia announced more details of the Soyus-T. Both the standard Soyus and the first Soyus-T will continue to be used in service while the new Soyus-T is improved and possibly this situation will continue until the Soviet winged recovery vehicle is ready for service. Work continues on this vehicle. The Soyus-T is more efficient in the use of fuel and one way in which fuel is conserved is by separating the orbital module before the re-entry burn. This saves 10% in fuel. For the first time since the flight of the first Soyus in 1971 it was possible to fly round the Salyut and examine it visually and also with a camera.

New windows have been fitted to the Soyus because the previous design resulted in the windows becoming black during re-entry. The new design has layered windows, the blackened layer is to be jettisoned after re-entry and allow the crew full visibility. There are new spacesuits also for the Soyus-T crews. These are lighter and more efficient being free and manoeuvrable.

**THE SATELLITE POWER SYSTEM**

In the last issue of Spacewatch I gave some notes which covered the general idea of the Satellite Power System and answered some questions. In this issue more details will be given about the system.

**THE SATELLITE**

The Satellite will be a rectangular construction 10 kilometres in one direction and 5 kilometres at right angles to it. This will support the arrays of photo voltaic cells. The cells may be of gallium arsenide or silicon. Such a structure will be of considerable weight and of the order of 36,000 metric tons. As a great deal of it will be constructed in space the weight is only involved in the initial transportation first into a low earth orbit and then raised to synchronous orbit. The transmitting antenna with the conversion units on which are mounted the DC/RF converters will form the individual sub-assemblies of the transmitting antenna. This will have a diameter of 1 kilometre. Thus it will appear as an assembly of waveguides with a high density beam direct to the Earth. The transmitting antenna will be so arranged that the profile as presented to the ground antenna, the RECTENNA, has a high power centre to the beam and taper off at the edges. This has been necessary because of the possible effects to the environment over a long period and short term effects due to local conditions (weather, accidental intrusion from other causes) and safety in general. To appreciate these necessities a description of the rectenna is needed.

**THE RECTENNA**

The Rectenna is a vast array of collecting dipoles and covers an area of 130 Km². It is expected to be in the form of 10 kilometres east to west and 13 kilometres north and south. By any standards this is a large area and involves the effect on the ground beneath it and the vagaries of meteorological conditions which may at one and the same time vary widely, differing from side to side or from end to end. Indeed considerations such as the number of lightning strikes, which are quite considerable in the latitude of 35° north, the position contemplated for the rectennas across America.

The centre of the microwave beam at a frequency of 2.45 GHz will at the rectenna have a power density of 23mW/cm². The density will fall off towards the edges in such a way that at the site safety boundary will have reached the low level of 0.1mW/cm². At the overspill edge the beam will have a density of 1.0mW/cm². From the point of view of safety to human life the density of the beam will be well below possible ill effects. The hazards are more likely to effect other mechanical considerations and as suggested freak weather conditions. These considerations will all come under the scrutiny of observers and research teams. This aspect will be dealt with in later issues of Spacewatch.

**CONVERSION OF THE MICROWAVE POWER**

The Conversion of the Microwave Power is likely to take the form of sub-units of RF-LF converters arranged in such a way that around the periphery of the rectenna site feed lines will link with normal grid system in operations. It will take different forms as to the distribution voltages depending on local medium and long distance transmission networks to be fed. The order of the thinking is divided into the existing power grid. Cost and convenience will determine this for it might call for local decisions as to which is the more economical. The first of the considerations is the effect on the environment as related to the public but also the possible long term effects on the flora and fauna of America and indeed its possible effect through modification of near space in terms of communications and meteorology. Of these matters more will appear in future issues of Spacewatch.
**CORRECTION**

Unfortunately there were some errors in our Casio Watch Offer published in the July issue. Since our offers are arranged for the benefit of readers, we would like to bring these errors to your attention.

1. We indicated that the front cover illustration was of an older watch, this is not the case.
2. The watch is stainless steel encased.
3. The watch on offer is 9.65mm thick and not "less than 9mm" as originally stated.
4. The alarm sounds for 30 seconds unless cancelled, not 60 seconds as originally stated.

These mistakes were due to our late decision to change to a watch with a constant time and date display. Since we have unintentionally misled readers on these points, we will be pleased to refund their money and postage if they so wish. We would like to make it quite clear that the guarantee will be honoured by Metac.

We have published a corrected special offer page here for those that wish to take advantage of it.

**THE OFFER**

For some time PE has been trying to arrange a special offer on one of the very popular range of Casio watches. Until now this has not been possible due to the control of supply by Casio. However, Metac have now been able to purchase Casio outside the UK and this offer is the result.

We do not expect readers to be able to find this Casio watch advertised at less than the Metac price.

**THE WATCH**

**CASIO ALARM CHRONO TYPE 83 QS 41B**

Stainless steel, less than 10mm thick, mineral glass, water resistant to 2 atmospheres (66 feet), Lithium battery giving approximately four years' life, four year calendar, accurate to within 15 seconds a month, full one year's guarantee.

**THE FACILITIES**

- Hour, minute, second, am/pm, date.
- Hour, minute, am/pm, day, date.
- Stopwatch to 12 hours measuring in 1/10 second giving net time, lap time and 1st-2nd place times. Indicator shows chronograph is running when normal time is displayed.
- Alarm setting, hour, minute, am/pm. Alarm sounds for 30 seconds unless cancelled. Indicator shows alarm is set.
- User optional hourly chime (two bleeps).
- Back-light.

---

To: METAC Electronics and Time Centre (P.E. Offer)
67 High Street, Daventry, Northants. Tel. 032 72 76545.

Mail order only

Please send me watch/es at £21.95 each
I enclose P.O./Cheque No. Value
Name
Address

Please allow 21 days (maximum) for delivery (more for overseas orders)

OFFER EXTENDED TO OCTOBER 3, 1980

From: METAC Electronics and Time Centre (P.E. Offer), 67 High Street, Daventry, Northants.
One result of the pressures of modern living is the alarm clock. However, the type which must be set each night in a habit of being forgotten and the type which sound unless turned off to awaken their owners when they want a lie-in on Saturday morning. This circuit enables the user to selectively inhibit the alarm of his clock for either of the following two days—normally this would be operated on a Friday to stop the alarm for the weekend.

The complete circuit diagram is shown at right. The input on the left is a CMOS input which comes from the clock circuitry or mechanism. When the alarm of the clock is on, this output is high but when it is not on, or has been cancelled, it is low.

The two halves of IC1 are connected as a two-stage shift register. Every time the clock input is taken high, the data in the register is shifted one place to the right. Since the input of the register is low, zeros are shifted in from the left.

The complementary output of IC1b (Q2) is “ANDed” with input signal in IC2b and IC2c. Normally the shift register is full of zeros so that Q2 is high. This means that the output of the unit is the same as the input.

Suppose that IC1b is in the one state. Q2 would then be low and the output of the unit would remain low for the duration of any input pulse. However at the end of the pulse, the output of IC2a would go high and the shift register would be clocked. This would mean that another zero would be clocked into IC1a but the one in IC1b would be replaced by the zero in IC1a. Q2 would go high and a further pulse would be passed without interruption. The action of the circuit has been to suppress one pulse applied to its input. It can be seen that the state of IC1b determines whether the next pulse will be inhibited and the state of IC1a does the same thing for the next pulse but one. Since the input is an alarm signal, the circuit will selectively inhibit this signal for the following two days.

To set the state of the flip-flops, three touch switches are used. Two of these set IC1a and IC1b respectively whilst the third resets both. Normally, the set and reset inputs are held low by R1–R3 but skin resistance across the touch contacts is much lower than these resistors so the input is pulled high, setting or resetting the desired flip-flops.

To indicate the state of the flip-flops, i.e. to tell the user which inhibits he has selected, two I.E.D.s are used. These are connected to Q1 and to Q2; since these signals are of opposite logical polarity, D1 is returned via a current limiting resistor to the positive supply line whereas D2 is returned to the ground rail. This means that either I.E.D. is on when the corresponding flip-flop is in the one state.

Both the input and output of the unit are at CMOS levels and it is up to the user to interface these to his clock and alarm circuitry: this should normally present no problem. The power supply can be anywhere between 5V and 15V and can often be borrowed from the clock. C1 is necessary to prevent noise on the power line from triggering the flip-flops.

The number of flip-flops could of course be made greater than two but this was thought to be the maximum needed since it corresponds nicely with a weekend.

Construction is not at all critical and can take any desired form. The touch switches and I.E.D. can then be mounted in a convenient position on the clock.

Why not submit your idea? Any idea published will be awarded payment according to its merits. Articles submitted for publication should conform to the usual practices of this journal, e.g. with regard to abbreviations and circuit symbols. Diagrams should be on separate sheets not inserted in the text.

Each idea submitted must be accompanied by a declaration to the effect that it is the original work of the undersigned, and that it has not been offered or accepted for publication elsewhere.
**FOUR DIGIT TO SIX DIGIT CLOCKS**

There are plenty of digital clocks in the market today. Most of them are four digit types with few of six digits available. These don't have functions like alarm, radio on and off etc. I have a design which might benefit those who own a four digit clock but would like to have a six digits displaying hours, minutes and seconds. A simple straightforward multiplexing method was used with a minimum number of components to reduce cost and complexity.

A MM5387 clock chip was used. This is the same as a MM5316 except it can drive displays directly. The circuit is for a common cathode i.e.d. display clock only.

The connections are as follows—The tens of hours and hours segment outputs from the i.c. are connected normally. The tens of seconds and seconds segments were connected parallel to tens of minutes and minutes segments respectively. Two gates of a 7400 quad NAND gate form an oscillator and switch IC1c and TR3. They also switch TR1 and TR2. These control the display and blanking of seconds and minutes displays. TR3 switches the seconds display option of the clock.

The oscillator provides a square wave that switches IC1c/d, TR3. TR1 is n.p.n. and TR2 is p.n.p. Therefore when one conducts the other will be cut off. When TR1 is conducting, the seconds display enable of the clock i.e. will go negative and the clock will be programmed to display hours and minutes. At the same time TR1 will also be conducting which enables displays C and D.

When TR2 is not conducting, the seconds displays enable of the clock i.e. will go positive. This will program the clock to display seconds. At this time TR2 will be conducting enabling displays E and F.

As the oscillator functions at about 200 hertz the displaying of hours, minutes and seconds will be displayed continuously.

The circuit works well, the only problem being that there are problems in setting the time so SI was included which will cut off the six digit function. The time should be set with this in the off position.

P. Ratnam,
Penang,
Malaysia.

**QUIZ WIN INDICATOR**

If S1 is shorted, the one shot will be triggered and LP2 will light for about 3 seconds assuming that the other stage is not already in a triggered state. While lamp one is alight any closure of S2 will not cause LP1 to light as the one shot is inhibited by a logical 0 at pin 2. The same applies if the order is reversed.

Two contestants are positioned either side of the unit with fingers on the buttons. A question is asked and the first to answer presses his button and his lamp lights. The other lamp is inhibited and the win lamp resets itself after about 3 seconds ready for the next question.

J. Sarns,
West Mersea,
Essex.
THE circuit shown was designed to program a VCO in a synthesiser. Two waveforms are available; A sawtooth output from the wiper of VR3 and a squarewave from VR4. Both signals have a level of about 2 volts (peak to peak) about earth.

The novelty lies in the fact that the shape of both waveforms is continuously variable via VR1 which provides base bias to both transistors. This in turn alters the ratio of the currents in each. Because the current flowing out of the transistors is passed into an integrator, then the voltage at pin 6 of IC1 is a function of the control. The remaining circuitry is of the standard integrator—Schmitt trigger loop, the output of IC2 deciding which transistor is turned on by forward biasing. VR2 will vary the current available to the transistors and hence the frequency of oscillation.

M. Rodgers.
Maltby,
S. Yorkshire.

FUNCTION GENERATOR

SLAVE FLASH CONTROLLER

THIS 555 circuit is used to control the operation of a slave flash unit. Here the phototransistor responds to ambient light levels. The 470k variable resistor is used to set the LED to the 'just off' condition. When the master flash unit operates the CSR conducts operating the slave unit. S1 allows the slave unit to be set without discharging the flash.

R. C. MacKay,
Grangemouth.

WHEN carrying out battery capacity checks, it is extremely useful to have a load that does not need constant adjustment to maintain a steady current as the voltage falls.

This circuit fulfills the requirement that once the load is set the load current remains constant throughout the discharge time of the battery. In practice the 2N3055, and the 1 ohm resistor are mounted on a suitable heatsink. The circuit was used to test 12V batteries and the load is variable between 0 and 3 amps.

D. Halliday,
Tewkesbury,
Glos.

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sistors LP transformers. All brand new. May include
several types. 55p for 10. CLOCK CHIP HM7516 I.C.
This alarm outputs. Brackets are £4.50 each.
POLARISING filter, plastic, 0.008" thick. Any size cut
from 1 sq. in. to max. size 15"x25". £3 per sq. in.
MOUMENTARY (push to make) switch. Red cap.
50p each. SLIDE switch, 2, 3, 4 or 6 pin each. Two
calculator keypads (not compatible with 42024 calc.
chip). £0.65 each. MULTITIMER CHIP, HM7530
I.C. to build 44 digit d.m.s. (needs additional circuitry).
With data £3.55 each. KNOBS in a variety of shapes.
Incl. 6 & 8mm shafts. Various colour £1.85 each.
Rotary control knobs, black (18mm diam) with coloured
caps. £0.20 each. Skilled rotary knob, same as rotary
control knob above but has "Fixed" skirt around base.
Base cap colour required. 27p each.
Code colours available, black, red, green, blue, yellow, grey,
white. 8 DIGIT common cathode calculator display.
".1" multiplexed, with data, 95p each. LED
WRISTWATCH CHIP with data. £5.95 each.
LED WRISTWATCH DISPLAY matches above
with chip. With data, 99p each. NOTE the wristwatch
display and are housed in "lightproof" style and
requires a fairly good ultra violet LIGHTING jack
sockets, mono 25p each. stereo 50p each. LMS55
timer I.C. with applications brochure. £25 each.
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<table>
<thead>
<tr>
<th>TYPE</th>
<th>YA</th>
<th>SECONDARY RMS VOLTS</th>
<th>SECONDARY RMS CURRENT</th>
<th>DIMENSIONS</th>
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NOTE: For 220V please insert 1 in place of X in type number.
For 240V please insert 2 in place of X in type number.

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500 mfd. 750V. A.C.
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250V. A.C.
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250V. A.C.
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250V. A.C.
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