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miniature battery operated sound synthesiser

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- 10 Transistors
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- 41 yards of wire
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NEW ROAMER NINE
WITH V.H.F. INCLUDING AIRCRAFT

- Nine Transistors
- 9 Tunable wavebands as Radio Ten
- Built-in ferrite rod aerial for MW/LW and SW. Push Pull output using 600 mw transistors
- Transistors and diodes, tuning condenser, volume control, and now with 3' speaker, attractive case with red speaker grille.
- Size 9 in x 2 in x 211/2 in approx. P. & P. £1.85)

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POCKET FIVE
NOW WITH 4-
LOUDSPEAKER

- 1 Tunable wavebands.
- MW/LW and Trawler Band.
- 7 stages.
- Transistors and diodes, super-sensitive ferrite rod aerial, attractive Black and Gold Case.
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- Plans and parts price list 15p (FREE with parts).

TOTAL BUILDING COSTS
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P. & INS. 15p
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- Wavebands, transistors and speaker as Pocket Five.
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P. & INS. 47p
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NOW WITH VARIABLE TONE CONTROL

- 7 TUNABLE WAVEBANDS: MW1, MW2, LW, SW1, SW2, SW3 and Trawler Band.
- Built-in ferrite rod aerial for MW and LW. Chrome plated telescopic aerial can be used above or below the deck. Push Pull output using 600 mw transistors.
- Car aerial and telescopic aerial can be angled and rotated for Peak short wave listening. Transistor Pre-Amp.
- 10 Transistors plus 3 diodes. Transistor type Amplifier.
- Plans and parts price list 25p (FREE with parts).

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(GB cash/ 1 post 15p per item)

<table>
<thead>
<tr>
<th>Price</th>
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<tr>
<td>£1.50</td>
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<td>£10.00</td>
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Practical Electronics November 1974

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50k 1% 100-150µF 63V 10, 15, 22, 33, 47, 68, 100, 150, 220, 330, 470, 680, 820, 1000, 1500, 2200, 3300, 4700, 10000, 47000
100k 1% 100-150µF 63V 10, 15, 22, 33, 47, 68, 100, 150, 220, 330, 470, 680, 820, 1000, 1500, 2200, 3300, 4700, 10000, 47000
500k 1% 100-150µF 63V 10, 15, 22, 33, 47, 68, 100, 150, 220, 330, 470, 680, 820, 1000, 1500, 2200, 3300, 4700, 10000, 47000
1M 1% 100-150µF 63V 10, 15, 22, 33, 47, 68, 100, 150, 220, 330, 470, 680, 820, 1000, 1500, 2200, 3300, 4700, 10000, 47000
10M 1% 100-150µF 63V 10, 15, 22, 33, 47, 68, 100, 150, 220, 330, 470, 680, 820, 1000, 1500, 2200, 3300, 4700, 10000, 47000

B. H. COMPONENT FACTORS LTD.


definitions, tables, and illustrations that can help in understanding the material. It is designed to be a comprehensive resource for anyone looking to learn about capacitors and their uses in electronic circuits.
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2) P.V.C. cut to size for frame and back, plus false front and back timbers, white front piping and speaker cloth
3) Recessed handles with fixing screws, jack socket, all fixing screws, corner plates, glue, and full instructions!

<table>
<thead>
<tr>
<th>Type</th>
<th>Size</th>
<th>Price manufactured</th>
<th>Kit price</th>
</tr>
</thead>
<tbody>
<tr>
<td>2' x 12&quot; Cabinet</td>
<td>36&quot; x 18&quot; x 13&quot; x 1/2</td>
<td>£19.50</td>
<td>£12.50</td>
</tr>
<tr>
<td>4' x 12&quot; Cabinet</td>
<td>31&quot; x 31&quot; x 13&quot; x 1/2</td>
<td>£24.50</td>
<td>£17.50</td>
</tr>
<tr>
<td>4' x 12&quot; P.A. Column</td>
<td>31&quot; x 27&quot; x 13&quot; x 1/2</td>
<td>£30.00</td>
<td>£21.50</td>
</tr>
<tr>
<td>1' x 15&quot;</td>
<td>36&quot; x 20&quot; x 13&quot; x 1/2</td>
<td>£21.00</td>
<td>£13.50</td>
</tr>
<tr>
<td>Mini Disco (state deck cutout BSR, GARRARD etc.)</td>
<td>33&quot; x 20&quot; x 8&quot; x 1/2</td>
<td>£20.00</td>
<td>£13.00</td>
</tr>
<tr>
<td>Maxi Disco (illustrated) (state deck cutout BSR, GARRARD etc.)</td>
<td>42&quot; x 20&quot; x 10&quot; x 1/2</td>
<td>£25.00</td>
<td>£18.50</td>
</tr>
</tbody>
</table>

Please ask for quotation on any other type or size of cabinet you may require.

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* Electrolytic capacitors and second generation I.G.
* Fully protected against short or open circuit
* Less than 0.1% distortion at all powers
* Rise time 4μS-stability - Unconditional
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* Price £120.00

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* Broadcasting quality
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unbeatable price £19.75
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Normally £24 - £27.50
UNBEATABLE NOW ONLY £18.00

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**AL10/AL20/AL30 AUDIO AMPLIFIER MODULES**

The AL10, AL20 and AL30 units are similar in their appearance and in their general specification. However, careful selection of the plastic power jacks has resulted in a range of output powers from 1 to 10 watts RMS.

The versatility of their design makes them ideal for use in record players, tape recorders, stereo amplifiers and cassette and cartridge tape players in the car and home.

- **Parameter**
  - **HARMONIC DISTORTION**
  - **LOAD IMPEDANCE**
  - **INPUT IMPEDANCE**
  - **FREQUENCY RESPONSE**
  - **SENSITIVITY for RATED O/P**
  - **DIMENSIONS**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Po = 3 WATTS f = 1KHz</td>
<td>0.25%</td>
<td></td>
</tr>
<tr>
<td>f = 1KHz</td>
<td>8-15Ω</td>
<td></td>
</tr>
<tr>
<td>Po = 2 WATTS</td>
<td>50 Hz - 25KHz</td>
<td>75mV RMS</td>
</tr>
<tr>
<td>Vrms</td>
<td>±3 V</td>
<td>2&quot; x 3 7/8&quot;</td>
</tr>
</tbody>
</table>

The table above relates to the AL10, AL20 and AL30 modules. The following table outlines the differences in their working conditions.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>AL10</th>
<th>AL20</th>
<th>AL30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Supply Voltage</td>
<td>25</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Power out for 2% T.H.D.</td>
<td>3 watts</td>
<td>5 watts</td>
<td>10 watts</td>
</tr>
<tr>
<td>(RL = 8Ω) f = 1KHz</td>
<td>RMB Min.</td>
<td>RMB Min.</td>
<td>RMB Min.</td>
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</tbody>
</table>

**STABILISED POWER MODULE SPM80**

SPM80 is especially designed to power the AL60 Amplifiers, up to 1.5 watts (R.M.S.) per channel simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Main Transformer BMT80, the unit will provide outputs of up to 0.5 amperes at 30 volts RMS. 63mm x 105mm x 30mm.

These units enable you to build Audio Systems of the highest quality at a competitive unobtainable price. Also ideal for many other applications including: Security Systems, Public Address, Intercom Units, etc. Handbook available 1 Shilling.

**STEREO PRE-AMPLIFIER TYPE PA100**

Built to a specification and NOT a price, and yet still the greatest value on the market. The PA100 stereo pre-amplifier has been conceived from the latest circuit techniques. Designed for use with the AL60 power amplifier system, this quality made unit incorporates no less than eight silicon planar transistors, two of these are specially selected low noise NPN devices for use in the input stages.

The pre-amplifier has two stereo inputs, and r.m.s. and scratch filters are features of the PA100, which also has a STEREO/MONO switch, volume, balance and continuously variable bass and treble control.

**MK 60 AUDIO KIT**

Comprising 2 x AL60, 1 x BMT80, 1 x SPM80, 1 x PA100, 1 front panel, 1 kit of parts to include on/off switch, neon indicator, stereo headphone sockets plus instructions. Complete Price: £9.75 plus 30p postage.

**TEAK 60 AUDIO KIT**

Comprising: Teak veneered cabinet size 16" x 11 1/2" x 21", other parts include aluminium chassis, headband and front panel bracket, plus back panel and appropriate sockets, etc. Kit price: £9.65 plus 30p postage.

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50w PEAK (25w R.M.S.)

**PLUS THERMAL PROTECTION!**

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(Dual gear case) 240 V. 2800 rpm NEW HIGH TORQUE, approx overall size 3 x 3 x 4 1.2, spindle 3 dia. as illustrated £2.70. P & P 30p

Similar to above 10rpm (2.70. P & P 30p)

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A magnetically activated switch, vacuum sealed in a glass envelope. Silver contacts, normally closed. Rated 5amp at 120v, 1amp at 240v. Size(approx) : long x 1 x 3 inch. Ideal for burglar alarm, security systems etc. and wherever non-mechanical-switching is required.

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The HY5 is a complete mono hybrid preamplifier, ideally suited for both mono and stereo applications. Internally the device consists of two high quality amplifiers—the first contains frequency equalisation and gain correction, while the second caters for tone control and balance.

**Technical Specification**
- **Inputs:** Magnetic Pick-up 3mV RIAV, Ceramic Pick-up 30mV, Microphone 10mV, Tuner 100mV, Auxiliary 3-100mV. Input impedance 47kΩ at 1kHz.
- **Outputs:** Tape 100mV, Main output 80dB (0.775V RMS).
- **Active Tone Controls:** Treble ±12dB at 1kHz, Bass ±12dB at 100Hz. Distortion: 0.5% at 1kHz. Signal/Noise Ratio: 80dB. Overload Capability: 40dB on most sensitive input. Supply Voltage: ±15-25V.

**Price:** £4.50

---

The HY50 is a complete solid state hybrid Hi-Fi amplifier incorporating its own high conductivity heatsink hermetically sealed in black epoxy resin. Only five connections are provided: input, output, power lines and earth.

**Technical Specification**
- **Output Power:** 25W RMS into 8Ω. Load Impedance: 4-16Ω.
- **Input Impedance:** 47kΩ. Input Sensitivity: 80dB (0.775V RMS).
- **Input Impedance:** 47kΩ. Distortion: Less than 0.1% at 1kHz.
- **Frequency Response:** 10Hz-50kHz ±3dB. Supply Voltage: ±25V. Size: 105 x 50 x 25mm.

**Price:** £5.98

---

The PSU50 can be used for either mono or stereo systems.

**Technical Specification**
- **Output Voltage:** ±25V. Input Voltage: 210-240V. Size: L 70, W 12, H 50mm.

**Price:** £5

---

**Two Years' Guarantee on all Our Products**
PUSH BUTTON CAR RADIO KIT

The Tourist II

NOW BUILD YOUR OWN PUSH BUTTON CAR RADIO
Easy to assemble construction kit comprising fully completed and tested printed circuit board on which no soldering is required. All connections are simple push fit type making for easy assembly. Fine tuning push button mechanism is fully built and tested to mate with printed circuit board.

Car Radio Kit £7.70 + 55p p & p

The Tourist I Kit For the experienced constructor
If you can solder on a printed circuit board you can build this model.
Same technical specification as Tourist II

Technical specification:
(1) Output 4 watts R.M.S. output. For 12 volt operation on negative or positive earth.
(2) Integrated circuit output stage, pre-built three stage IF Module.
Controls volume manual tuning and five push buttons for station selection, illuminated tuning scale covering full, medium and long wave bands.
Size chassis 7" wide, 2" high and 4 5/8" deep approx

Speaker including baffle and fixing strip £1.65+23p.p&p.
Car Aerial Recommended — fully retractable and locking £1.37+20p. postage & packing

STEREO 21 QUALITY SOUND FOR LESS THAN £20.00

Stereo 21, easy to assemble audio system kit. No soldering required.
Includes: — BSR 3 speed deck, automatic, manual facilities together with ceramic cartridge.
Two speakers with cabinets.
Amplifier module: Ready built with control panel, speaker leads and full, easy to follow assembly instructions.
Specifications: For the technically minded: —
Input sensitivity 600mV. Aux. input sensitivity 120mV. Power output 2.7 watts per channel.
Output impedance 8-15 ohms. Stereo headphone socket with automatic speaker cutout. Provision for auxiliary inputs — radio, tape, etc., and outputs for taping discs. Overall Dimensions. Speakers approx. 15 3/4" x 8" x 4 3/4" Complete deck and cover in closed position approx. 15 1/2" x 12" x 6 1/2".
Complete only £19.95 + £1.68 p & p. Extras if required. Optional Diamond Styli £1.37.
Specially selected pair of stereo headphones with individual level controls and padded earpieces to give optimum performance, £3.85.

BUILD YOUR OWN STEREO AMPLIFIER

For the man who wants to design his own stereo — here's your chance to start, with Unisound — pre-amplifier, power amplifier and control panel. No soldering — just simply screw together. 4 watts per channel into 8 ohms. Inputs: 120mV (for ceramic cartridge). The heart of Unisound is high efficiency I.C. monolithic power chips which ensure very low distortion over the audio spectrum.
240V. AC only.
£7.64 + 55p p & p

8 TRACK CARTRIDGE PLAYER

Elegant self selector push button player for use with your stereo system.
Compatible with Viscount III system, Unisound module and the Stereo 21.
Technical specification Mains input, 240V. Output sensitivity 125mV
Comparative unit sold elsewhere at £24.00 approx. Yours for only £11.95 + 90p p & p.
**COMPLETE STEREO SYSTEM**

**System 1. £51.00**

40 Watt Amplifier. Viscount III - R102 new 20 watts per channel.

System I includes:
- Viscount III amplifier - volume, bass, treble and balance controls, plus switches for mono/stereo on/off function and bass and treble filters. Plus headphone socket.
- Specifications:
  - 20 watts per channel into 8 ohms. Total distortion @ 10W @ 1kHz 0.1%. P.U.T. (for ceramic cartridges) 150mV into 3 Meg, P.U.T.2 (for magnetic cartridges) 4mV @ 1kHz into 47K. equalised within ±10%. Radio 150mV into 22K. (Sensitivities given at full power). Tape out facilities: headphone socket, power out 250mW per channel. Tone controls and filter characteristics:
    - Bass: 12db to -12db @ 60Hz. Bass filter: 6db per octave cut. Treble control:
    - treble: 12db to -12db @ 15kHz. Treble filter: 12db per octave. Signal to noise ratio:
      - (all controls at max.) - 58db.
      - Crosstalk better than 26db on all inputs. Overload characteristics better than 26db on all inputs. Size approx. 13" x 8" x 3 ½"
      - Garrard SP 25 Mk III deck with magnetic cartridge, de luxe plinth and hinged cover.
- Two Duo Type II matched speakers - Enclosure size approx. 17½" x 10 ½" x 6" in simulated teak. Drive unit 13" x 8" with parasitic tweeter. 10 watts handling.

**Complete System £51.00**

**System 2. £69.00**

Viscount III amplifier (As System I)
- Garrard SP 25 Mk III deck (As System I)
- Two Duo Type III matched speakers - Enclosure size approx. 27" x 13" x 11 ½"

Finished in teak veneer. Drive units 13" x 8" bass driver, and two 3" (approx.) tweeters.
- 20 watts R.M.S., 8 ohms frequency range - 20 Hz to 18,000 Hz.

**Complete System £69.00**

**PRICES: SYSTEM 1**

- Viscount III R102 amplifier £24.20 + £1.50 postage and packing
- 2 Duo Type II speakers £14.00 + £2.20 postage and packing
- Garrard SP 25 with Mag. cartridge £21.00 + £1.75 postage and packing

**total: £59.20**

Available complete for only: £51.00 + £3.50 postage and packing

**PRICES: SYSTEM 2**

- Viscount III R102 amplifier £24.20 + £1.50 postage and packing
- 2 Duo Type III speakers £39.00 + £4.00 postage and packing
- Garrard SP 25 with Mag. cartridge £21.00 + £1.75 postage and packing

**total: £84.20**

Available complete for only: £69.00 + £4.00 postage and packing

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**EMI SPEAKERS AT FANTASTIC REDUCTIONS**

**20 WATT SPEAKER SYSTEM**

System consists of a 13" x 8" (approx) elliptical woofers unit with a 8" x 5" (approx.) mid range unit incorporating parasitic tweeter and crossover components.

**Technical Specification:**
- Bass Unit:
  - Flux density - 100 K, speech coil - 1¼" Cone. Triple laminated paper with P.V.C. surround.
- Mid Range Unit:
  - Flux density - 33K, speech coil - 1" with parasitic tweeter.
- Power Handling:
  - 20 watts R.M.S., impedance - 8 ohms, frequency response - 20 Hz to 18,000 Hz.

**OUR PRICE** £6.60. Complete + 90p postage and packing.

**15" 14A/780 BASS UNIT**

Bass unit on a rigid diecast chassis. Superior cone material handles up to 50 watts R.M.S., and is treated to give a smooth frequency response. Resonance 30 Hz. Flux density 360,000 Maxwells. Impedance at 1 kHz is 8 ohms. 3½" voice coil.

Recommended retail price £40.80. **OUR PRICE £18.70 + £1.50 postage and packing**

**950 KIT**

Five matched speakers and crossover unit for handling up to 45 watts, frequency response from 20 to 20,000 Hz.

Hugo 19" x 14" (approx.) high efficiency Bass-Speaker with 16,500-gauss magnet built on a heavy diecast frame. The four 10,000-gauss tweeters, each 3½ dia. approx., are fed by the crossover which critically adjusts signal for maximum fidelity. Impedance at 1 kHz is 8 ohms. Bass coil 2", others 0.5". Recommended list price £44.00.

**Special Offer**

**OUR PRICE £19.50 + £1.50 postage and packing**

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FOR DISCO PAGE AND DETAILS OF HOW TO ORDER - TURN OVER...

Practical Electronics November 1974
PORTABLE DISCO CONSOLE

INCORPORATES: Pre-Amp with full mixing facilities, including switched input for mic with volume control, switched input for auxiliary with volume control, bass and treble controls, volume control and blend control for turntables.

Two B.S.R. single play professional series decks, fitted with crystal cartridges.

The turntables are designed and precision engineered. They combine clean modern styling with superb reproduction. Their many special features include square section aluminium tonearms, (high precision low mass design fully counterbalanced, with calibrated stylus pressure control for perfect tracking), and conveniently grouped easy to read linear controls.

The turntables have viscous cueing devices which allows the tonearms to be placed or lifted at any point on the record.

The two lightweight cartridge shells have slide-in-holders to facilitate easy inspection of needles and cartridges.

TECHNICAL SPECIFICATION:

Pre-amp - Output - 200mV. Auxiliary inputs - 200mV and 750mV into 1 meg.
Mic input - 6mV into 100K. 240 volt operation.

Turntables capacity - 7", 10" or 12" records.

Rumble, wow and flutter - Rumble - Better than -35dB. Wow - Better than 0.2%. Flutter - Better than 0.05% (Gaumont kalle meter).
Finish - Satin black mainplate with black turntable mat inlaid with brushed aluminium trim. Tonearm and controls in black and brushed aluminium.

This disco console is ideally matched for the Reliant IV and Disco 50 or any other quality amplifier.

The unit is finished in black PVC with contrasting simulated teak edging, diamond spun control knobs with matching control panel.

Yours for only £45.00 + £3.50 P. & P.

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45 WATT R.M.S. MONO DISCOTHEQUE AMPLIFIER

Ideal for Disco Work. Output Power: 45 watts R.M.S. Frequency Response 3dB points 30Hz and 18KHz. Total Distortion: less than 2% at rated-output. Signal to noise ratio: better than 60dB. Bass Control Range: 13dB at 60Hz. Treble Control Range: 12dB at 10KHz. Inputs: 4 inputs at 5mV into 470K. Each pair of inputs controlled by separate volume control. 2 inputs at 200mV into 470K.

Size: 19¾" x 10½" x 8" (approx.) | Amplifier £27.50 + £1.50 p. & p.

£15.00 + 60p. post & pack.

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- Sensitivity: 20,000µV/Volt (D.C.), 4,000µV/Volt (A.C.).
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- Accuracy: D.C. Voltage and current ±2.5%, A.C. Voltage and current ±3%. Resistance ranges ±1%.
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NOVEMBER 1974

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THE B.D.2 TURNTABLE ASSEMBLY

The Famous B.D.2 belt drive turntable with press button speed change has now been developed to feature a newly designed mat and brushed aluminium trim, and the perspex cover has an easy ‘hinged-on, hinged-off’ movement. The B.D.2 is available as a chassis unit or spring mounted on a wood plinth.

B.D.1 TURNTABLE KIT

The B.D.1 well known for its superb performance and quality is available in kit form. Construction is simplicity itself with no soldering required. Now it’s so easy to own the best.

Contact your dealer for information or send a stamp for brochure.
PHONOSONICS

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The ever-popular AURORA-4 or 8 channels each can record different sound frequencies and controlling its own light. Can be used with most audio systems and lamp intensities. A must for any Disco, and a fascinating visual display for the home.
4 channel component set (excl. thyristors) £11.49
8 channel component set (excl. thyristors) £26.32
Power supply component set £4.78
PCB for 4 frequency channels £2.50
PCB for power supply and 8 lamp drivers £1.25

CCTV CAMERA
Details in List

VOICE OPERATED FADER
For automatically reducing music volume during talk-over — particularly useful for Disco work, or for home-movie shows.
Component set incl. PCB £2.95

GEMINI 30W STEREO AMPLIFIER
An exceptionally high quality Stereo Amplifier system, specifications for which are shown in detail in our list, together with semiconductor requirements.
Main Amplifier
Set of resistors, capacitors and preset £5.96
Stereo printed circuit board £1.28
Pre-Amplifier
Sets of resistors, capacitors, potentiometers and switches — Standard Tolerance Set £10.57
Superior Tolerance Set £14.66
Stereo PCB (as Published) £2.20
Regulated Power Supply
Set of resistors, capacitors and preset £4.58
Printed circuit board £7.90

HI-FI TAPE LINK
Designed for use with reasonable quality tape decks, this high performance pre-amp includes record, playback and metering circuits.
Stereo component set (excl. panel meter) £20.95
Mono component set (excl. panel meter) £13.31
Power supply component set £3.72
Stereo main PCB £2.50
Stereo sub-assembly £4.63

TAPE-NOISE LIMITER
Very effective circuit for reducing the hiss found in most tape recordings.
Component set (incl. PCB) £2.30
Regulated power supply (including printed circuit board) £3.71

PROJECT Q4
Multi-system Quadrupole Decoder
Decoder component set £13.74
Power supply components £2.22
Set of PCBs £2.80

SEMICONDUCTOR TESTER
Essential test equipment for the enterprising home constructor.
Set of resistors, capacitors, semiconductors, potentiometers, transistors and sub-assembly £8.96

PCB LAYOUT AND CIRCUIT DIAGRAMS SUPPLIED WITH ALL PCBs DESIGNED BY PHONOSONICS
P & P. Add £1.60 to all orders

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LIST
Send S.A.E for free list giving fuller details of kits, PCBs, and other components

PHASING UNIT
A simple but effective manually controlled unit for introducing the "phasering" sound into live or recorded music.
Component set (incl. PCB) £2.20

SOUND SYNTHESIZER
Component sets and printed circuit boards Full details in list.

PHASING UNIT
A simple but effective manually controlled unit for introducing the "phasering" sound into live or recorded music.
Component set (incl. PCB) £2.20

MONO AMPLIFIER
A moderately powerful amplifier of more than adequate performance.
Main Amplifier
Mono component set £6.98
Mono main PCB £2.00
Mono sub-assembly £4.96

ULTRASONIC TRANSMITTER-RECEIVER
A highly sensitive and long range invisible beam detection circuit with numerous applications.
Component set with PCBs but excluding transducers £4.40

RADIO PCB details in List

WIND AND RAIN UNIT
A manually controlled unit for producing the above-mentioned sounds.
Component set incl. PCB £2.40

PHOTOPRINT PROCESS CONTROL
For colour and B & W, an indispensable dark-room unit for finding exposure, controlling enlarger timing, and stabilizing mains voltage.
Component set (excl. meter) £8.95
Printed circuit board £1.80

OVERSEAS
P & P will be charged at cost; VAT does not currently apply. List gives fuller details including kit weights. Charge for list: Europe 16p, other countries 20p.

PHOSPHOR, DEPT. PE21, 25 KENTISH ROAD, BELVEDERE, KENT DA17 5BW
MAIL ORDER ONLY

Practical Electronics November 1974

495
SUPERSONIC 13 HI-MONO AMPLIFIER
A super solid state amplifier. Brand new components throughout. Silicon transistors plus power output transistors. Full wave rectification. Output 13 watts r.m.s. into 8 ohms. Frequency response 12Hz-30KHz. All plastic, fully integrated pre-amplifier stage with separate volume, bass, treble cut controls. Suitable for 6-8 ohm speakers. Laminated for a low price. THD approx. 40% for full output. Supplied ready built and tested. Full fitting instructions included. Overall size 21" x 10" x 14" high. P.P. 200/200v.

HARVESONS MENS MAINS OPERATED SOLID STATE FM TUNER
A.C. mains 200-240v. Requires no earth. Fully integrated mains operated solid state FM tuner. Designed and worked out to match our 10 + 10 amplifier but will suit all other makes as well. The design incorporates the very latest circuitry techniques with a step input of 19 transistor stages. Automatic frequency control to "lock" on station and prevent drift. A straight-forward for maximum stereo separation. Ideal for stereo balconyion. Non-adjutable output of 10 watts per channel. Approximate size 15" x 11" x 4" high. Supplied exactly as illustrated. Fully tested and fully guaranteed (not available in kit form!)

Price £21.60, Post and Packing 50p.

STEREO-DECORDER SIZE 2 x 3 x 4½
Ready built. Pre-aligned and tested. 9m. 8Ω. Power input 1.5M. Fitted with 8Ω. Terminals giving 9M. 2Ω. and 2Ω. equal response at 1W. Fitted with Ceramic or Crystal cartridges. Approx. size 22 x 24 x 30. P & P 115p. B.P. 45p. BARGAIN PRICE £8.06.

SOLID STATE STEREO FM TUNER
Brand new. ONLY 17 86. Limited number of 11C1; C123 Auto Changer De Luxe, SPECIAL BARGAIN OFFER! A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors including Silicon Transistors in the first five stages on each channel resulting in even lower noise level with improved sensitivity. Integrated pre-amp with Bass, Treble and two Volume Controls. Suitable for use with Ceramic or Crystal cartridges. Very simple to fit to suit Hi-Fi magnetic cartridges -instructions included. Output stage for any speakers from to 1500 watts. Compact design, all parts supplied including driving warts, high quality ready drilled printed circuit board with component identification clearly marked, smart braked insulated aluminium front panel with matching knobs, switches, indicator lamp, etc. Post ready. Send £1 1 10 for details.

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VEYRON CATHODE REGENERATIVE SPEAKERS & CARRIER KITS 24½ x 21 x 6½. Price £1 15 10. Length, Width, Depth. 61- flu. Depth. 4 watts per channel output. Only 111840.

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HI-GRADE COPPER LAMINATE BOARDS
8" x 6". Fives for 60p plus P. & P. 5p.

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ALSO available in 8 ohms with EMI 13" x 8" bass speaker with parasitic tweeter £7.60. Carr. 75p.

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SOLID STATE FM TUNER.
Brand new. ONLY 17 86. Limited number of 11C1; C123 Auto Changer De Luxe, SPECIAL BARGAIN OFFER! A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors including Silicon Transistors in the first five stages on each channel resulting in even lower noise level with improved sensitivity. Integrated pre-amp with Bass, Treble and two Volume Controls. Suitable for use with Ceramic or Crystal cartridges. Very simple to fit to suit Hi-Fi magnetic cartridges -instructions included. Output stage for any speakers from to 1500 watts. Compact design, all parts supplied including driving warts, high quality ready drilled printed circuit board with component identification clearly marked, smart braked insulated aluminium front panel with matching knobs, switches, indicator lamp, etc. Post ready. Send £1 1 10 for details.

Price £1 1 10, Post and Packing 50p.

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Beautifully made teak finish enclosure with most attractive and modern design. Approx. weight 10½ x 6½ x 5½. Fitted with E.M.T. Ceramic Magnets 1½" x ½" speaker units, two P.T. tweeter units and crossover. Maximum power handling 10 watts. Available 8, 10 ohms impedance. £3 15 10, Oga 75p.


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Especially designed to provide full range reproduction at an economical cost. Suitable for use with any high fidelity system. Built-in concentric tweeter cone.

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A full range reproduction for high power, Electric Guitars, public address, multichannel systems, electric organs.

Ideal for Hi-Fi and Discotheques.

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A high wattage loudspeaker of exceptional quality with a level response to above 8,000 cps. Ideal for Public Address, Discotheques, electronic instruments and the home.

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Splashed out? Invested is more the word! It cost me just 98 pence (including packing and postage) and I saved more than that on my first order. And if I take into account the satisfaction I’ve gained from using such a comprehensive, clearly set out, well illustrated production, I’ve saved the outlay many times over. Think I’m exaggerating? Why not test it for yourself? The coupon below is just waiting to be filled in and sent off with your cheque or postal order. No need to keep it waiting any longer.

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SONIC SPIN-OFF

A great and thriving audio industry has been built up based upon the almost universal enjoyment derived from listening to well reproduced music, whatever the brow level. However, just “listening” does not offer the ultimate in pleasure or satisfaction for those of a musically creative mind. To such “actively” inclined persons electronics offers a number of paths for exploration. Experimenting with the composition of electronic music, for example. This particular activity received a tremendous boost with the arrival of the synthesiser. Coupled with multi-track recording, the synthesiser offers musically inspired adventurers the chance to create original sound and musical patterns with comparative ease—something that would have been beyond their wildest dreams a mere five years ago.

Also worth noting is the fact that active music making is very much part of life for the younger generation. Not surprisingly among today’s younger people is to be found a real awareness of the exciting possibilities of synthesised sound. So the future of this new form of musical art seems well assured.

But synthesisers are generally complex and costly instruments. Thus they have not reached all those hands that are eager to experiment. We certainly know that many of our readers have been intrigued by the P.E. Sound Synthesiser series, although being unable for various reasons to take on the commitment of building this grand assemblage of electronics. What they learnt from these articles must have made them envious of those able to participate in this rapidly developing form of musical art.

The likely occurrence of such thoughts and aspirations did not escape us. So during the latter stages of development of the P.E. Sound Synthesiser consideration was given to the feasibility of a much simpler synthesiser to meet an obvious popular demand. The aim was to produce an instrument that would be relatively inexpensive and not unduly complicated circuit-wise, but that would embody certain essential features to make it sufficiently versatile for serious experimental work in the fields of music composition and sound effects production, and also to serve as a useful teaching aid.

The outcome of this endeavour has been a great success and it is now revealed for all to see and, of course, to build for themselves. The P.E. Minisonic is unique and unprecedented, the first miniature battery operated instrument fully warranting inclusion in the ranks of synthesisers and in all truth a first class constructor’s item. Incidentally, critics of the larger kind of project might like to ponder the fact that the Minisonic is a practical example of spin-off from a much larger and more complex design. This exciting compact instrument is a direct beneficiary of the development work expended on the P.E. Sound Synthesiser and of operational experience gained in its subsequent use in an artistic role.

F.E.B.
THE P.E. Minisonic is a synthesiser in miniature and contains the necessary circuitry to produce all the basic forms of modulation which have come to be associated with its larger brethren. Thus a ring modulator is incorporated together with the means for producing frequency, amplitude and harmonic modulation.

Being battery operated the P.E. Minisonic is safe for the younger enthusiast to build and operate and can expect to give up to 50 hours of entertainment from one pair of PP9 batteries.

Although an entirely self-contained instrument which includes two 250mW monitoring channels and loudspeakers, the P.E. Minisonic may be connected to a range of external apparatus including power amplifiers, tape recorders, signal generators, etc.

The overall cost to build the P.E. Minisonic is under £50.

SPECIFICATION

Two Voltage Controlled Oscillators (VCOs)
Sawtooth waveform. Ten octave range, logarithmic law control

Two Envelope Shapers with Voltage Controlled Amplifiers (VCAs)
Envelope shapers have variable attack and decay. VCA has up to 54dB attenuation

Keyboard Controller
Incorporates "hold" or analogue memory

White Noise Generator

Ring Modulator
Voltage Controlled Filter (VCF)
Passband variable over 5Hz to 15kHz with a 54dB dynamic range

Two 250mW output amplifiers with input mixer stages

The VCOs and Envelope Shapers are controlled from the keyboard by means of a stylus, but provision is made for plugging in an external keyboard for the benefit of those constructors more musically inclined

(Patent applied for in respect of certain aspects of this design)

PE MINISONIC

A MINIATURE BATTERY OPERATED SOUND SYNTHESISER

By G. D. SHAW

PART ONE
THE popularity of the synthesiser is not in any doubt— the phenomenal growth rate of some of the synthesiser manufacturers, particularly during the 1972-73 period and the great interest shown in various "do-it-yourself" designs which have appeared in the meantime, only go to underline the wide, general appeal of the instrument.

Although the synthesiser may be employed in an enormously diverse range of applications under the general heading of sound manipulation, specifically within the field of music it may be rightly said that the instrument has provided the greatest dynamic to have occurred for centuries. In fact, we, as the listening public, have scarcely begun to feel the impact in terms of new compositions and effects which may be achieved.

As far as the individual is concerned, probably the greatest bar to synthesiser ownership has been the relatively high cost of the commercially available instruments and even the "do-it-yourself" designs which have so far appeared, although significantly lower in cost than their commercial brothers, are by no means cheap to construct. There can be few electronics enthusiasts who would willingly set aside a hundred pounds or so to finance a complex project on which there was no firm guarantee of performance.

Since the P.E. Sound Synthesizer first appeared the author has received many requests to design a simpler, low-cost instrument which could possibly be considered suitable for a schools project and which would serve to introduce to the younger members of our society the fascination inherent in the electronic manipulation of sound.

The P.E. Minisonic is therefore presented with the view of complying with the requests received although it is by no means suggested that it is the complete answer.

**DESIGN CRITERIA**

Most synthesizers rely on a duplication of circuits in order that the most exotic effects may be achieved but such duplication can only be accommodated in terms of additional expense. Consequently there were two principal criteria which governed the design of the P.E. Minisonic.

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**Fig. 1.1. Block diagram of the P.E. Minisonic showing the internal connections between modules**

Practical Electronics November 1974
Firstly, the instrument should be able to produce the four forms of modulation, under controlled conditions, which are generally associated with the synthesiser. Thus there are facilities for amplitude, frequency and harmonic modulation, and a ring modulator is included in the scheme. Secondly, to comply with the possible requirement for duplication of circuits, each circuit within the basic instrument to be described can operate quite independently of the remainder.

The second criterion means that the constructor is offered the option of either tackling the project in accordance with the details to be published or of selecting individual circuits and building these separately for experimental purposes.

As with most synthesiser designs the possible permutations of circuits are legion and there are no hard and fast rules governing the numbers of circuits of a particular type which are to be included within a particular scheme.

THE SYNTHESISER EXPLAINED

For the benefit of those readers who may, as yet, be unsure of what a synthesiser actually does, the following brief explanations are included.

In general, all sounds may be defined in terms of three parameters: the first being pitch or frequency; the second the amplitude or volume of the sound in relation to the period over which it is audible; and the third the timbre or harmonic content of the sound.

Most naturally occurring sounds and many of those produced by acoustic instruments tend to have fairly complex structures. In the case of acoustic instruments the harmonic content, for any defined pitch, generally varies over the audible duration of the produced sound and can be made to change deliberately depending on whether the instrument is played loudly or softly.

These characteristics are not usually built in to electronic musical instruments and consequently the unchanging pitch and harmonic relationship of any particular sound produces a rather bland effect.

In the synthesiser all parameters governing the produced sound are continuously variable and, indeed, may be varied throughout the duration of a sound. This means that the instrument may be used to imitate conventional acoustic instruments with great exactitude or, on the other hand, it may be used to create totally unique sounds which can range from the amusing to the horrendous.

VOLTAGE CONTROL

The circuits in the synthesiser are operated by means of voltage control, a system which has been utilised by electronics designers for quite a number of years.

Robert A. Moog is generally credited with being one of the first designers to bring voltage control into the realms of electronic music and since the inception of his first voltage-controlled oscillators (VCO) and voltage-controlled amplifiers (VCA) the overall principle has been adopted for an ever widening circle of applications.

The great advantage of the system is that, although the controlling voltage may be derived from within the controlled circuit, it may also be derived from an external source. This, in turn, offers the advantages that differing types of circuit can control one another in various ways and also that, since control and signal paths are quite separate from one another, remote control operation becomes a practical possibility.

In the case of the P.E. Minisonic, control voltages are used in the oscillators to vary the pitch, in the VCA’s to vary the sound volume and in the filter to vary the harmonic content.

These examples, of course, relate to the use of voltages of varying levels but there is another form of application in which pulses of fixed polarity voltage can be employed to command the initiation of an event. Again in the P.E. Minisonic this application is utilised in the envelope shaper to signal the start of the envelope which is, in turn, used to drive the VCA.

MINISONIC DESIGN

The overall scheme of the P.E. Minisonic is shown in Fig. 1.1.

Two independent channels are provided each comprising a VCO, an Envelope Shaper/VCA, a mixer stage and a 250mW power amplifier. A white noise generator gives an alternative sound source, whilst a ring modulator and voltage controlled filter (VCF) may be incorporated for additional effects.

To satisfy musical requirements a stylus operated "keyboard" is provided together with a keyboard controller which incorporates an analogue memory. The purpose of this latter circuit is to provide a series of voltages which define the VCO frequencies in terms of musically related tones.

As with the P.E. Sound Synthesiser a variable "Tune" and "Span" facility is available and this means, in practical terms, that the upper and lower frequency limits of the three octave, printed-circuit keyboard can be varied at will either in tune or with a range of semitonal frequency increments.
It is appreciated that a stylus operated "keyboard" is far from ideal in the sense that it requires a great deal of skill to play it satisfactorily and also from the point of view that problems of contact oxidation can present themselves after a period of use. Provision is thus made for the connection of a keyboard of conventional design and it is worth pointing out that, with a little ingenuity, a discarded doll's piano can have contacts fitted and be made to perform quite creditably.

There is also an output point for connection to external amplifier or tape recorder. A tape recorder having "sound-with-sound" facilities is particularly useful in that it facilitates the whole potential of the synthesiser being realised.

Within limits imposed by the specific recorder a number of successive recordings can be made and overlaid in such a way as to result in the production of quite complex sound structures.

OPERATIONAL AMPLIFIERS

With the exception of three different types of special purpose integrated circuit which will be described in detail in the appropriate articles, the overall functions of the synthesiser are based on a combination of discrete semiconductors with the ubiquitous 741 operational amplifier.

Where these latter devices are used as part of an input stage for either control or audio signal applications, they are employed in the inverting mode as shown in Fig. 1.2.

In this type of circuit the junction of $R_1$ and $R_4$ is known as the virtual earth point. This is because current into the inverting input via $R_1$ is balanced by an equal and opposite current through the feedback resistor $R_4$.

The implication is that, when $R_1$ and $R_4$ are equal, the gain is unity and, in fact, the gain of such a stage may be expressed as $R_4/R_1$. The impedance seen by the input signal is effectively the resistance of $R_1$ and this will not change if additional inputs are provided as shown dotted in Fig. 1.2.

Where more than one input is required the gain of the individual stages is determined in terms of the ratios of the input resistors with the feedback resistor as shown above and the output signal of the operational amplifier, at any instant, is equal to the sum of the signals times the gain.

This point is made in some detail because, in the P.E. Minisonic, the minimum numbers of inputs are provided in order to comply with the requirements of simplicity.

PROGRAMMING

In the case of the VCO, four separate inputs are routed to the control stage. One of these provides a fixed voltage bias which sets the minimum operating frequency of the oscillator; another gives a manually variable voltage which will set the oscillator frequency at any point within its working range; a third routes in a voltage derived from the "keyboard" memory circuit; whilst the fourth is used for external modulation.

All four inputs may be driven at the same time and, in combination, "programme" the oscillator to give a specific frequency or effect. When all the inputs are d.c., the output frequency of the oscillator is unvarying but if, say, a sine wave signal is applied to the external modulation input then the output frequency of the VCO will rise and fall in time with the frequency of the modulating signal and in proportion to its amplitude. This particular scheme is illustrated in Fig. 1.3.

The term used to describe the programming of one oscillator by another is "frequency modulation" and in the specific case where the frequency of the programming oscillator lies between 6 and 8Hz, the overall effect is known as "vibrato".

Where additional modulating inputs are included in the scheme and each is coupled to external oscillators having differing frequencies and output waveforms, then it is possible to create some very complex effects. Careful manipulation of the programming frequencies such that each are multiples of the other, or fractionally related, will give rise to repetitive rhythm patterns covering a wide frequency range.

Whereas programming the VCO results in the production of a fixed frequency or frequency pattern, somewhat similar effects may be achieved by programming the VCF, although, in this case, the effect is based on changing harmonic relationships rather than the creation of discrete frequencies.

As with the VCO, the filter is provided with three control inputs, two of them for bias and manual

![Fig. 1.2. An operational amplifier used in the inverting mode](image)

![Fig. 1.3. By connecting a sine wave oscillator to the VCO, frequency modulation is obtained. The other inputs are permanently wired. The manual control sets the centre frequency and the preset bias control sets the minimum operating frequency; the remaining connection is from the "hold" circuit via the stylus](image)
HOUSING — CUTTING DETAILS

Hardwood Strip
A 4ft 3in 74in
B 5ft 1½in 3in
C 1½in 3in

Cut A into two pieces 1½ft in length and two pieces 1½in length.
Cut B into four pieces 10½in, one piece 1½in and two pieces 2in length.

Cut C into four pieces 2½in length.

Hardboard

Two pieces measuring 1½in 1½in will be required. The hardboard should be 1½in (3mm) thickness and should ideally be faced with white plastic on one or both sides.
The type which is faced on both sides is slightly more expensive but shows less tendency to warp.

Fig. 1.4. Details of the case assembly. Major dimensions are shown in inches (1in = 25.4mm)
Fig. 1.5. Details of the front panel drilling required for use with scheme shown in block form in Fig. 1.1
control, whilst the third is from the "keyboard" memory circuit so that the filter pass-band range may be "played".

The VCF is a ladder network filter based on the design originally devised by Moog but very much simpler in circuitry and operation. Even so it is extremely efficient and it is quite an easy matter to "lose" the audio signal within the filter unless some care is taken with its operation.

**ENVELOPE SHAPER**

The envelope shaper is a circuit which produces a voltage which varies with time in a manner prescribed by two controls.

The "attack" control adjusts the period over which the output voltage of the envelope shaper rises to its peak whilst the "decay" control adjusts the period taken by the output to return to zero again.

This so-called "envelope" when applied to the input of a VCA ensures that the audio signal follows, in terms of volume, the prescribed pattern, i.e. with the envelope at its peak; so too is the volume of the audio signal.

Programming of the envelope shaper is not quite as simple as with the VCO and VCF since its operation is dependent upon the application of a pulse of at least —1V which has a duration at least as long as that set by the attack control.

In the P.E. Minisonic two control inputs are provided on the envelope shaper, one coming direct from the keyboard stylus and the other from a manual push button. However, the same basic principles governing the use of additional inputs may be followed although the result is never quite so predictable.

Further details on the programming of the various P.E. Minisonic circuits will be given in the appropriate articles together with instructions for obtaining specific effects.

**CONSTRUCTING THE MINISONIC HOUSING**

In the interests of simplicity the case of the P.E. Minisonic is constructed from a framework made up of standard hardwood strips which are normally available from most "do-it-yourself" stores or timber yards. Fig. 1.4 gives details of the case assembly.

The top and bottom panels of the case are made from white faced hardboard or similar material and are secured into the case by four corner screws as shown. Fig. 1.5 gives details of the front panel drillings which are required for use with the scheme shown in block form in Fig. 1.1.

The case should be assembled with panel pins and adhesive (Araldite is probably the best type to use) and can be sprayed a suitable colour on completion. During assembly care should be taken to ensure that the case is assembled with absolutely square corners and it is a good idea to use the top and bottom panels as a guide in this respect.

Both front and rear panels are secured to the housing by means of four corner screws.

The front panel, once assembled with components, is normally a permanent fixture whilst the rear panel has to be removable to allow for changing the batteries.

Next month: The VCO, Envelope Shaper/VCA, and Voltage Controlled Filter

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**NEWS BRIEFS**

**ON CALL**

With the opening last month of a further Carphone centre for the Midlands, motorists whose cars are equipped with car radiophones are now able to make calls over a much extended area.

Now they can call from a new 3,000 square mile area which includes Wolverhampton, Coventry, Birmingham, Rugby, Northampton and Banbury. This is the first of five new centres to be completed and the station, located in Birmingham, is able to handle 300 users.

The other four areas will be opened up over the next two years but what is perhaps more important to users is the fact that now any user from one area can also operate in another area. Up to the present this has not been possible but the Post Office have now modified the system suitably.

**LICENCE FOR SAFETY**

The car licence plate could well perform a somewhat more complex role in the future if scientists at RCA Corporation have their way.

Using a complex antenna capable of receiving at one frequency and retransmitting at another, twice the first, they propose that an electronic "number plate" can be created which will be capable of interrogation at will on instruction transmitted to it.

Apart from this "big brother" aspect, the system can, of course, also be used for much more apparently useful purposes such as simple radio communication to and from a vehicle or perhaps operation as a transponder in collision-avoidance radar.

With suitable devices buried in the road at intervals, traffic could be examined not only as to quantity but also as to quality, with identification of such items as ambulances and fire engines being used to control traffic lights.

This basic idea is not new but the means for doing it cheaply is, and here RCA scientists reckon the cost could be in the "few dollars" region when manufactured in quantity.

**HIGH FLYER**

Air traffic control systems were well in the news last month with the announcement of two large orders, one to Plessey and the other to Marconi.

The first is an export order from Mexico and involves air traffic control system at Monterrey Airport and instrument landing systems for Puerto Vallarta and Tijuana airports. The equipments form part of the first stage in a multi-million pound programme for the complete modernisation of air traffic operations in Mexico.

The second contract is for the supply of a radar data processing system for Scotland. This is a major contract, worth something in the region of £1.25 million, and involves equipment capable of monitoring both civil and military aircraft in the 2 million cubic miles of airspace above Scotland, Northern England and the North Sea.

Based on the new Marconi Radar Systems Locus 16 processor, one of the first systems in the world to use synthetic "clutter free" radar presentation exclusively, the system will provide an automated radar presentation, simplifying the control of aircraft in the Scottish terminal area which includes the areas round the rapidly expanding Glasgow and Edinburgh airports.
ANTI-THEFT
ALARM
By B.A. ANDERSON

Despite steering locks, "Krookloks", and the like, car stealing is still a thriving business. A possible reason for the apparent failure of many commercial anti-theft devices is the need for a mechanical key to deactivate them. Thieves have been accustomed to mechanical keys for centuries, and it is thus not unduly surprising to hear of vehicles being stolen despite locks of various kinds.

The anti-theft system described here uses an electronic key in the form of a specific value of resistance for deactivation. The system measures the resistance electronically and deactivates only if the value is correct. With careful installation the security offered by this design is exceptionally high, and with a cost of around £3-00 it is good insurance for a possession which may be worth over £1,000.

THE CIRCUIT
As may be seen from Fig. 1, resistors R1, R2, R3 and R4 comprise a Wheatstone bridge with a removable element R1, which connects to the bridge via a plug and socket. With R1 connected, opening a car door operates a courtesy light switch and connects the battery to the circuit. Since the values of R1 to R4 are all equal, the bridge is balanced, TR1 and TR2 remain off, and relay RLA is off. The car can thus be used normally.

If R1 is disconnected however, or is replaced with an incorrect value of resistance, the bridge is unbalanced and an out-of-balance voltage appears between the junctions of R3/4 and R2/incorrect R1. Depending on whether the incorrect value of R1 is too high or too low, this out-of-balance voltage may be positive or negative. Diodes D1 to 4 are thus connected as a bridge rectifier to render the out-of-balance voltage a constant polarity and this is applied to TR1 with positive to base and negative to emitter.

Hence, unbalancing the bridge will always turn on TR1, which in turn switches on TR2 and RLA. The end result is immediate operation of RLA on opening a car door when R1 is incorrect.

The contacts on RLA are arranged to disconnect the starter switch and earth the starter solenoid (RLA4), to sound the horn (RLA3), and to short out the contact breaker points in the distributor (RLA2). In addition contacts RLA1 byss the triggering door switch so that reclosing the door after setting off the alarm has no effect.

Once triggered, the alarm can be immediately deactivated with the correct R1 by the owner, or by disconnection of the battery by the thief. However, battery disconnection precludes stealing the car, and any attempt at reconnection will result in re-triggering of the alarm when the door is reopened.

With R1 inserted, and the doors closed, the alarm is disconnected from the battery, and hence draws no current when the car is parked. Removal of R1 will then activate the alarm, although still no current will be drawn until a door is opened by a thief. Thus the car can be left parked and protected for long periods with no drain whatsoever on the battery.

CONSTRUCTION
The components of the alarm may be assembled on a small piece of Veroboard using the layout of Fig. 1, the relay being mounted separately. A small plastic lunch box may be used as a container for the alarm, and the Veroboard may be glued to a piece of foam rubber and then to the box, and the relay may be glued directly to the box. Connections from the relay and the circuit board may be brought out to a terminal block on the outside of the box for connecting to the car.

Alternative components to those specified may of course be used, however it should be noted that TR1 and TR2 have been chosen for their high Vebo and complimentary gains. Alternatives may be more prone to failure due to voltage spikes from an inductive or capacitive discharge ignition system, and the sensitivity and selectivity of the bridge may be adversely affected.

Diodes D1 to 4 must be of the specified types, since alternatives may have a higher turn-on voltage which would severely restrict the sensitivity of the bridge. If using a different relay, ensure that the coil
Fig. 1. Circuit diagram of the Anti-theft alarm (above) and the Veroboard and component layout (below)

COMPONENTS . . .

<table>
<thead>
<tr>
<th>Resistors</th>
<th>See Text, 5%, 1W</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1 to R4</td>
<td></td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Semiconductors</th>
</tr>
</thead>
<tbody>
<tr>
<td>TR1 ME4102</td>
</tr>
<tr>
<td>TR2 ME0411</td>
</tr>
<tr>
<td>D1 to D6 OA81</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Miscellaneous</th>
</tr>
</thead>
<tbody>
<tr>
<td>RLA Omron type MY4, 12V d.c.</td>
</tr>
<tr>
<td>Veroboard, wire, terminals, terminal strip if required, box, etc.</td>
</tr>
</tbody>
</table>

ANTI-THEFT ALARM
connections are given in Fig. 2 for an Omron relay. Connections to the contacts of circuits to be controlled. that chosen will not exceed the dissipation of TR2, and that the contacts are of adequate rating for the circuits to be controlled.

INSTALLATION
By reference to your car's wiring diagram, determine whether it is negative or positive earth. Additionally determine whether the horn push operates the horn by earthing or by connecting to the "live" side of the battery. Connections to the contacts of RLA vary for negative and positive earth, and for earthing and live horn pushes, and the four possible connections are given in Fig. 2 for an Omron relay. Other relay types can be determined from the interconnecting point routes.

Whatever the polarity of your car's system, if the horn push is of the earthing type, check that it can be sounded with the ignition switched off. If it cannot, it will be necessary to disconnect the live supply horn lead from its ignition switched terminal at the fuse box, and reconnect it to a terminal that is unswitched by the ignition switch, i.e. a terminal that connects directly with the battery. Make certain the fuse ratings are suitable.

TESTING
Having wired RLA correctly, and having connected the Veroboard, the alarm should be tested by connecting 12V, positive to terminal 1 and negative to terminal 6. The relay should operate immediately, and drop out as soon as the correct value of RI is connected.

With this test satisfactorily completed, seal the container (lunch box) against moisture, and mount it in the car. It should ideally be in the passenger compartment somewhere, well hidden, and in most cars a suitable place can be found up behind the dash panel, the box being secured with adhesive.

Connections to the car wiring harness are shown for positive and negative earth systems in Fig. 3, and both possible types of horn push circuit are shown.

WIRING-IN
All connections should preferably be soldered, well insulated and waterproofed with good quality PVC tape. Wires can be run back to the alarm along the existing harness, and should be bound over with PVC tape to match the rest of the harness for concealment when installation is complete. Connections particularly prone to tampering by the thief are the horn connection, the contact breaker connection, and the live battery connection, and these wires should be carefully concealed.

If utmost security is needed, the wires may be run in metal conduit and all terminations sheathed in metal terminal boxes. The fitment of air horns in place of the standard horn is an excellent measure, and suitable types including relay are available from Ivoriet Limited, 124 Cricklewood Broadway, London, N.W.2, at prices varying from £4 to £12, according to the number of trumpets with which you wish to disquiet the thief.

If you really want to induce cardiogenic shock in the criminal you can fit an air siren in place of the horn. A suitable type, the Mono 12V siren, is available from Klaxon Limited, Warwick Road, Tyseley, Birmingham, price about £10. Persons of a delicate constitution are warned not to set this device off accidentally.

If your car has a mechanically operated starter switch, and hence no starter solenoid—the early British Leyland Minis have such an arrangement, then terminal three of the alarm may be taken to the petrol pump, and terminal two should receive the wire formerly connected to the pump. The alarm will then immobilise the petrol pump in place of the starter motor.

OUT OF SIGHT
If you regularly leave your car out of earshot of yourself and passers-by, then there is little point in having the horn operated by the alarm, since it will only flatten the battery in time. The thief will not be able to steal your car with a flat battery, but clearly it will cause you inconvenience, and thus an on/off switch may be wired between terminal four and the horn, and hidden somewhere in the car. Switching it off will prevent the horn being sounded by the alarm, but the immobilising features will remain.

The connection between RI and the alarm is by a plug and socket of the constructor's choosing. RI is mounted inside the plug, and the socket is mounted somewhere on the exterior of the car. If you do not wish to drill the bodywork directly to
mount the socket, on the majority of vehicles it can be mounted in an air-grille or mounted in the centre of a badge. Removal of the socket at a later date can be concealed by a new badge. If mounting has to be done directly through the body, if the hole is in an unobtrusive position it may be sealed with a grommet on removal, and nine times out of ten will not be noticed.

The type of plug and socket chosen and the value of R1 are individual choices which ensure the security of the design.

The author has used connectors varying from Post Office jacks to multi-way edge connectors with success. If a multi-way connector is used additional security results since any two contacts may be used.

Values of R1 have varied from 47Ω to 47kΩ with equal success, but 5% tolerance or better should be used. Temperature drift offers no problems, but if the car is kept outside, values much above 2kΩ should be avoided since condensation can give problems with higher values.

When mounting the socket, remember it must be accessible to the driver who removes and replaces R1 each time the car is used, and the socket must also be mounted away from direct road spray. In the choice of type of connector, use only high quality professional types that will withstand the constant use and the elements.

HOW MANY
Three plugs and three R1's are required. One to use and carry in the pocket, one spare on the car key-ring, and another spare in the wallet or purse.

If your car does not have courtesy light switches, or it lacks them on the rear doors, extras are easily fitted and cost about 13p from garages. They mount via spring clips in a ½in hole in the door pillars, and should be fitted to the boot and bonnet too if it can be opened from outside the car. Wire all switches in parallel and to the appropriate terminal on the alarm.

USE
Park the car, close all doors, and remove R1 in its plug. The alarm is now set. If it is triggered by a thief or accidentally the horn will sound, the ignition will be immobilised and the starter motor will not operate. Reclosing the triggering door will have no effect. Triggering by accident may be quickly silenced with the insertion of R1, and if you forget to insert the plug, unlock the door, and set off the alarm, the spare plug on the key-ring is readily available to stop the false alarm. Removal and replacement of R1 soon becomes automatic, and since it is removed on parking, no-one can tamper with the resistor. The car is of course driven with the resistor in place.
555 CHIP IMPULSES PENDULUM

Readers interested in horology may find this circuit, using a 555 I.C., to impulse a pendulum, handy. The reed switch S1 of Fig. 1 is closed when the magnet swings near the reed, proximate the end of the pendulum swing.

The timer is triggered and stays high for 1.1 x Cl x VR1 seconds and there can be no re-triggering until the output has again gone low. Period adjustment is by VR1.

The period should be adjusted until the I.E.D. just goes on when the pendulum is vertically over the solenoid so that the pendulum is pulled towards the centre and when it reaches the centre the force is removed.

If required, a TTL output for counters or the like can be taken from pin 3 of the chip via a potentiometer. Changes in supply voltage make little or no difference to the time period of the chip but will change the force exerted by the solenoid. The circuit may be operated from between 5 and 18V depending on the type of solenoid and amplitude needed.

Component values are not critical and were selected more because they were to hand. For example C1 was selected at 1000µF but can be something smaller with suitable alteration of VR1. The solenoid used came from Henry’s Radio and the reed switch from Electrovalve Ltd.

R. J. Wylde
Eton College
Windsor

BASS BOOSTER

Most of the popular slanted front-facing speakers used in car stereo systems have a very poor bass response. One way around this problem, without sacrificing the stereo image, is by mounting a third speaker in-between, flush mounted from the inside of the car boot. An Elac 8in x 5in was used.

This third speaker can be fed by crossover components, but this method was found unsatisfactory and expensive. Instead, the circuit of Fig. 1 was used, which proved to be cheaper, and offered much more flexibility.

The first stage can be fed directly from the speaker lines of the tape unit as shown in Fig. 1. This stage serves as both mixer and Miller integrator. The capacitor of the integrator was chosen to be 10nF so as to pass only real Bass and very little of the middle range, preventing shrinking of the stereo stage; this value is not too critical.

The next stage recovers the big loss of the first stage, and feeds the signal into a power amplifier through the Bass control. The amplifier used was Sinclair’s super IC12, but any other cheap package will do. The decoupling capacitor (400µF) should be mounted as close as possible to the first transistor stage, which is prone to the pick up of low frequency engine noise. The IC12 module has its own decoupling capacitor, which should also be of a similar value.

M. Greenfeld
Leeds

Practical Electronics November 1974
VOLTAGE CONTROLLED OSCILLATOR

With the current interest in voltage controlled oscillators, it seemed to me that they were all rather complicated. Perhaps the readers will be interested in this circuit.

It is a linear device giving about 1kHz per volt. It can be built for less than £2.

Integrated circuit IC1 acts as an integrator and IC2 as a threshold circuit. The input signal is applied to both inputs of IC1. The f.e.t. acts as a switch controlled by the output of IC2. When the output of IC2 is near the positive rail TRI acts as a near short circuit so the input is applied to the non-inverting input of IC1 giving a positive going output.

The non-inverting input of IC2 is approximately 6.3V and as soon as its inverting input rises above this level IC2 rapidly switches to -6.3V.

Suitable transistors may be selected using the circuit of Fig. 2; they generally have a leakage of a few microamps to 1mA and the flicker noise is visible as a very slight irregular vibration of the meter needle.

Resistor R1 (Fig. 1) is selected to give a collector voltage of about 6V for TRI. C1 removes high frequency noise, and the signal is coupled to the amplifier by C2.

To obtain a log law there is no reason why the transistor oven described in PE could not be adapted to drive this VCO.

J. S. Broadhurst
Winnington
Cheshire

RANDOM IMPULSE GENERATOR

The circuit described here was designed as a novelty light flasher, but it may be used to control higher power devices, or in conjunction with a TTL divider to replace a low frequency impulse generator. Noise pulses are generated at about 1 to 10Hz.

The noise generator TRI (Fig. 1) acts as a transistor which generates a low frequency flicker noise. All transistors do this to some extent.

The best sources of suitably noisy transistors appears to be the widely advertised packs of unmarked, untested transistors. The type used in the prototype were BFY50/51/52.

Negative feedback via D2 and R6 provides thermal stability for the amplifier and also limits pulse length (determined by R6, C2 and VR1). VR1 adjusts the bias of TR3 providing some measure of threshold and therefore repetition rate. If the degree of control provided by VR1 is insufficient, R6 must be altered.

TR5 and R5 may be added as shown if the circuit is to drive TTL in which case a Schmitt trigger (e.g. 7413) should be used to obtain fast rise and fall times. If TR5 is connected as an emitter follower, a power transistor, thyristor or triac may be driven to control larger loads.

J. S. Jolley
Preston
Lancs
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These kits include all parts to build a complete gas and smoke detector, but keep cost as low as possible. All parts including detectors, printed circuit board and cases are available separately.

### PRICING TABLE

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<th>KIT</th>
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<tr>
<td>3A</td>
<td>Mains operated</td>
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<tr>
<td>5</td>
<td>Portable gas/smoke</td>
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<tr>
<td>6A</td>
<td>12V or 24V detector</td>
<td>£12.80</td>
</tr>
</tbody>
</table>

### CASES

**CASES**

**KIT 1**—Ali Box AB15

**KITS 3 and 5**—Ali Box AB17

**KIT 6**—Control Box

Remote sensor

**P.C. BOARD**

Fibreglass—lined and drilled

**SENSORS**

**TGS 105**—Smoke detector

**TGS 109**—General Purpose Gas/Smoke Detector

**TGS 308**—Similar to 109 but for low voltage application

**TGS 102**—Smoke and Carbon Monoxide Detector

**TGS 202**—Similar to 102 but for low voltage application

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Catalogue sent free on request. 10p stamp appreciated.

**PLEASE ADD 8% V.A.T.**
What will probably prove to be a very useful integrated circuit has been produced by Intersil, the 8038 precision waveform generator and voltage controlled oscillator. This is a monolithic device capable of providing the user with square, sine, triangle, sawtooth and pulse outputs of high accuracy with a minimum of external components.

As the frequency or repetition rate can be varied from 0.001Hz up to above 1MHz and is stable over a wide temperature range, this device will doubtless see applications in audio waveform generation as well as in instrumentation and control circuitry.

The output frequency can be voltage controlled so this makes for simple swept frequency provisions and indeed the frequency can be programmed digitally using either resistors or capacitors.

One important application which will doubtless be useful in view of the current interest in phase locked loops is the ability of the 8038 to interface with such circuitry to reduce temperature drift to below 50 parts per million.

Circuit Description

A simplified block schematic of the 8038 is shown in Fig. 1. The full circuit includes over 100 devices; it is somewhat complex to reproduce here.

The 8038 can operate from a single or a double power supply of up to ±18V or 36V max., whilst the dissipation is only 750mW. Input to any pin should not exceed the supply voltage and the input current to pins 4 and 5 (those governing duty cycle frequency) should not exceed 25mA.

In fact the duty cycle can be varied between 2 and 98 per cent which means that whilst the chip outputs are in fact basically three, sine, square and triangle, the modification of the square and the triangle by duty cycle variation provide pulse and ramp waveforms. The symmetry of all three basic shapes is varied at the same time so that the sine output is also altered as can be seen in Fig. 2 which shows first a 50 per cent duty cycle (squarewave) and then the effect of adjustment to a 20 per cent duty cycle. The phase relationship of the waveforms remains constant throughout such alterations.

There are several ways in which the timing function can be adjusted dependent on requirements for adjustment of the duty cycle and accuracy of the various components.

Thus Fig. 3 shows a suitable circuit for adjusting the frequency and duty cycle with most accuracy. Here the two timing resistors $R_A$ and $R_B$ are kept separate. $R_A$ controls the rising portion of the triangle and sine wave and the $O$ portion of the square wave.

The magnitude of the triangle waveform is set at $1/3V_{cc}$ so that the rising portion of the triangle becomes:

$$i_t = \frac{C \times V}{C} = \frac{1}{3} \times \frac{V_{cc} \times R_A}{R_A} = \frac{1}{3} R_A \times \frac{C}{V_{cc}}$$

Fig. 2. The waveforms available from the 8038 using a 50 per cent duty cycle and a 20 per cent cycle. The small blips on the sinewave are switching transients from the square wave

Fig. 1. A simplified block schematic of the 8038 integrated circuit

Practical Electronics November 1974
The falling portion of the triangle and sine wave and the 1 state of the square wave is:

\[ t_s = \frac{C \times V}{f} = \frac{C \times \frac{1}{2} \times V_{cc}}{f} = \frac{5 \times R_A R_B C}{2 R_A - R_B} \]

Thus a 50 per cent duty cycle is achieved when \( R_A = R_B \).

If the cycle is to be varied over a fairly small range then the circuit of Fig. 4 can be used and finally if no adjustment of the duty cycle is needed then the circuit of Fig. 5 suits.

With this last suggestion there is an inherent variation of the duty cycle which exists which may cause problems.

With two separate timing resistors the frequency is given by:

\[ f = \frac{1}{t_i + t_f} = \frac{5}{3} R_A C (1 + \frac{1}{2 R_A - R_B}) \]

If \( R_A = R_B = R \) then:

\[ f = \frac{0.3}{R C} \]

for Fig. 3. If a single timing resistor is used as in Figs. 4 and 5 then:

\[ f = \frac{0.15}{R C} \]

As both currents and thresholds are direct linear functions of the supply voltage their effects cancel out and neither time or frequency are dependent on supply voltage.

**SINEWAVE OUTPUT**

If the most important output is sine wave then perhaps the circuit of Fig. 6 should be used. Here the 8k Ohm resistor wired between pins 11 and 12 is made variable (100k Ohm) so that a distortion of less than 1 per cent can be achieved. In fact the introduction of the second 100k Ohm potentiometer feeding pin 1 takes the reduction in distortion down to around 0.5 per cent.

**SELECTING THE TIMING COMPONENTS**

The timing components \( R_A, R_B \) and capacitor \( C \) can be selected from quite a wide value range bearing in mind one or two constraints which must be applied. The charging current should be controlled for optimum performance so that at the low end it does not fall below 1µA and at the upper end it does not rise above a few milliamps.

In the first place the lower current limit is placed by the effect of other circuit leakage currents and at the upper end the transistor betas and saturation voltages will introduce errors at about 5mA. Thus the best range is between 10µA and 1mA. If pins 7 and 8 are shorted together the charging current for \( R_A \) can be determined from:

\[ I = \frac{R_A \times V_{cc}}{R_1 + R_2 \times R_A} = \frac{V_{cc}}{5 R_A} \]

and a similar equation holds for \( R_B \).

**VOLTAGE LEVELS**

Using a single power supply the average levels of triangle and sine output will be at one half of the supply voltage whilst the square output will move between +V and ground. Using a split supply the waveforms are symmetrical about ground.

As the square output is not committed it may be fed to a different power-supply as long as the applied voltage remains within the breakdown capacity of the chip (30V). Thus the chip may give a TTL compatible square wave output with its load resistor connected to +5V whilst being fed from a much higher voltage.

**FREQUENCY MODULATION**

As the frequency generated is a direct function of the voltage at pin 8 as measured from +Vcc frequency modulation can be achieved by altering this voltage suitably.

Small frequency deviations up to say 10 per cent can be generated by using the circuit of Fig. 7 in which the deviation voltage is fed to pin 8, decoupled with a capacitor. The resistor connected from pin 7 to pin 8 serves to increase input impedance and can be ignored in which case the pins are shorted when the input impedance becomes 8k Ohm.

For larger deviations or for frequency sweeping the sweep signal is applied between pin 8 and +Vcc. Pin 7 is ignored and the circuit is otherwise identical to Fig. 7. Quite large sweeps can be obtained up to 1,000:1 but care must be taken to regulate the supply voltage since in this configuration the frequency becomes dependent on the supply voltage. The potential on pin 8 can be swept from \( V_{cc} \) to \( 2/3 V_{cc} \).

**APPLICATIONS**

The 8038 has very obvious applications in signal generation areas such as music synthesis, the more so as it lends itself to simple voltage-frequency control and could easily form the basis of a monophonic system as a simple instrument in its own right or in a synthesiser used in conjunction with other envelope generating equipment.

In phase locked loop systems such as are used in f.m. reception it has a valuable role used in conjunction with a phase detector and an amplifier, both of which are available in l.c. form. Whilst several steps have to be taken to assure the alignment of the parts of such a system the benefits are useful.

Not only is a free-running frequency with very low temperature drift provided but a large reconstituted sinewave is available with the frequency of the input.

Finally there are many areas of instrumentation and measurement where the chip should prove invaluable, particularly to the cost-sensitive experimenter and amateur.

These devices and further information are available from Celdis Ltd., 37/39 Loverock Rd., Reading, Berks, priced at £2.85, post and packing 25 pence plus VAT.

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**CAPACITORS**

- **POLYESTER C320**
  - Radial leads for P.C.B. mounting. Working voltage: 250V.
  - Value in pF: 0.00047, 0.00087, 0.01, 0.03, 0.05, 0.015, 3p each; 0.018, 0.02, 0.025, 0.03, 0.039, 0.047, 0.056, 0.08, 0.082, 0.1, 0.4p each.
  - Total value 1p, 1p, 1p, 1p, 1p, 1p, 1p.

- **TANTALUM BEAD**
  - Value in pF: 0.1, 0.2, 0.47, 0.1, 0.035, 0.039.
  - Total value 1p, 1p, 1p, 1p, 1p, 1p.

**Polycarbonate**

- Type B325/40 Working Voltage: 250V d.c.
  - Value in pF: 0.0047, 0.005, 0.01, 0.02, 0.03, 0.05, 0.08, 0.15, 3p each; 0.018, 0.02, 0.025, 0.03, 0.039, 0.047, 0.056, 0.08, 0.082, 0.1, 0.4p each.
  - Total value 1p, 1p, 1p, 1p, 1p, 1p, 1p.

**Silver Mica**

- Working voltage 500V d.c.
  - Value in pF: 0.001, 0.002, 0.003, 0.004, 0.005, 0.006, 0.007, 0.008, 0.009, 0.01, 0.015, 0.02, 0.025, 0.03, 0.039, 0.047, 0.056, 0.08, 0.082, 0.1, 0.4p each.
  - Total value 1p, 1p, 1p, 1p, 1p, 1p, 1p.

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- C | 1.7 | 4.7k | 10k | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11

**POTENTIOMETERS**

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  - Size 18 x 12in x 10in. Complete kit, including pack-flas cabinet, £8.40.
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In the first article on hybrid computers the advantages and limitations of both analogue and digital computers were outlined in some detail. From this it is obvious that some combination of these two types of computer would be desirable and the motivations for hybrid computers were then identified and set out in detail. In this part the spectrum of hybrid computing techniques is outlined and the "balanced" hybrid computer is described. Applications are then dealt with in some detail.

**The Range of Hybrid Techniques**

In the broad sense the term "hybrid computing" can be used to envelop a wide variety of computing systems that combine some aspects of both analogue and digital techniques.

The techniques can be broadly divided into three major categories, namely those that are predominantly digital, those that are predominantly analogue, and those having a balanced combination of both computers.

Systems in the first two categories can be further subdivided into three types, namely those that are purely of one type, those that contain aspects of the other type in concept, and those that contain aspects of the other type in hardware.

**Pure Digital Computers**

These include all the large, mid, and mini type machines made by such manufacturers as ICL, IBM, Boroughs, Digital Equipment Corporation, Computer Automation, Scientific Data Systems, and so on. The larger type is often provided with a number of remote keyboard terminals to provide a time-shared service to schools, colleges and other users. They are generally provided with programme packages to enable users to write their problem in a high level language such as Fortran, Algol, PL1, Basic, etc. A high level language approaches the written word, the higher—the nearer. The lower the language the more like a machine code it becomes. This latter is the language of the computer itself. Those that have remote terminals are usually operated "on-line" so that the user can feed his problem and get the results in a matter of minutes.

**Digital with Analogue Languages**

Some of the large computers mentioned above are supplied with high level simulation languages that can perform integration. This enables the user to write his problem as a set of differential equations without the need to write integration routines himself. Among the many such languages are Speed, SL1, and CSMP.

**Digital Differential Analysers**

These are digital computers designed to perform integration in a similar way to analogue computers. "Digital hardware integrator" is another term used to describe them. They include the serial, parallel and hybrid types. The serial type handles one integration at a time, while the parallel type is provided with a number of these integrators to perform many integrations simultaneously in a similar way to an analogue computer. The hybrid type includes both digital and analogue hardware for faster integration.

**Digital with Analogue Elements**

These are conventional general purpose digital computers connected to a number of analogue integrators and other analogue elements to speed up simulation.

**Digital with Analogue Subroutines**

This is a further extension of the previous type where a complete portion of analogue simulation is connected to the digital computer. The analogue simulation acts as a subroutine in this case, which is then called up by the digital computer programme when required.

**Balanced Hybrid**

This is perhaps the most powerful combination of hybrid computers, consisting of a general purpose digital computer connected to a general purpose analogue computer. Both computers can be used on their own to solve a variety of problems, and by interconnecting them an even more powerful computer system is created.

*North Staffordshire Polytechnic*
Most modern hybrid computers employ the smaller type digital computer due to their lesser cost and ease of interfacing to analogue computers.

**ANALOGUE USING DIGITAL FOR SPECIAL TASKS**
In such systems an extensive analogue computer utilises the mathematical power of a small digital computer to perform special calculations.

**ANALOGUE WITH DIGITAL SUBUNITS**
The majority, if not all, of modern analogue computers are provided with digital voltmeters for precise measurements of variables. Digital memory devices and function generators are used occasionally to supplement the power of the analogue computers.

**ANALOGUE WITH DIGITAL CONTROL LOGIC**
Most modern analogue computers include digital logic circuits to control the analogue simulation. These include counters, flip-flops, gates, comparators, etc. which are terminated in an auxiliary patch board to facilitate connections.

**ANALOGUE PROGRAMMED BY DIGITAL**
In simulations involving a large number of equations the problem of scale factor calculations becomes somewhat tedious. To overcome this, special digital computer programs have been developed to process the given set of equations and produce scale factors, potentiometer settings, patchboard connections etc. Examples of these programs are Apache and Apse, standing for analogue programming and checking, and analogue programming and scaling of equations, respectively.

**ANALOGUE USING NUMERICAL ANALYSIS**
The majority of modern analogue computers include facilities for operating in a repetitive mode. They often include provisions for memorising data from one repetitive cycle for use in subsequent cycles. This permits the use of numerical analysis techniques, such as derivative calculation, in pure analogue computers.

**PURE ANALOGUE COMPUTERS**
These include the basic forms of analogue computers such as the one-shot type, and the repetitive type mentioned above. They are mainly used as teaching aids for the general principles of analogue computing theory.

**BALANCED HYBRID COMPUTERS**
The words “balanced” and “true” are some of the terms used when the hybrid system consists of an appreciable amount of digital and analogue hardware, particularly when the system contains general purpose digital and analogue computers linked together. A typical form of this link, or interface, is shown in Fig. 2.1.

As can be seen the interface between the two computers must allow for the passing of data and control signals in both directions. Data processed within the digital computer must be passed on to the analogue computer, together with control signals, such as the setting of potentiometers and analogue mode selection.

Similarly the solution of the equations patched on the analogue computer must be easily accessible to the digital computer. Control signals generated within the analogue computer such as results of comparisons, logic outputs, and interrupts requesting the attention of the digital programme, must all be passed to the digital computer in a fast and reliable manner.

To convert the data from analogue to digital forms and the reverse, analogue-to-digital (A-to-D) and digital-to-analogue (D-to-A) convertors are employed. Generally only one of each of these convertors is employed, but extensive use is made of multiplexers and demultiplexers to provide multi-channel communications between the two computers.

Analogue sample-and-hold devices are usually used with the A-to-D convertors to maintain the signal level at a constant value for a sufficiently long enough time to permit reliable conversion. Hold devices are also employed at the output of the D-to-A convertor to provide a continuous signal level between successive conversions.

Buffers are used to adjust the level of the signals to be compatible with that of the signals within the digital and analogue computers. Control and timing circuits are also required to synchronise the overall communications of data and control signals between the various units of the hybrid system.

**HYBRID SOFTWARE**
Another important aspect of hybrid computers is that of the "software". This is the programme that converts the electronic hardware into a usable entity. The user is not so much interested in how the computer actually works, but in getting results in a convenient and speedy way.

This, in general, means that either the user has to know the machine code, the most basic of programming techniques, or the machine has to understand the user's language.

High level computer languages, such as Fortran, present an attempt to make the machine easier to use by the problem designer. Similarly, in hybrid computers suitable software must be provided. This will have the prime function of operating and maintaining the analogue part of the system, as well as the usual facilities of performing mathematical and logical operations within the digital computer.

One such language is that based on Fortran and named Hytran (Hybrid Fortran). Apart from the usual features of a high level language, a hybrid language performs operations that can be said to belong to one of two areas, namely operational and diagnostic.

Operational features include communication of data and control information, and synchronisation of the operations of the analogue and digital computers. In advanced hybrid installations special programme packages are written to optimise computation time. This is very important in "real-time" simulations, such as missile and spacecraft simulators.

The optimisation programme carries out a process of partitioning the set of differential equations between the analogue and digital parts in order to achieve the best possible combination of speed, accuracy and stability of solution.

**DIAGNOSING TROUBLE**
The diagnostic aspect of hybrid software enables the servicing engineer and problem designer to easily locate hardware and programming faults in the sys-
The hardware faults will generally fall into one of three areas namely, digital computer, interfacing hardware, and analogue computer. The diagnostic programme helps isolate the faulty sub-unit by a gradual process of elimination. Programme faults will either be digital or hybrid in nature.

The diagnostic programme will enable the problem designer to examine memory locations and introduce break points in the digital programme to test the response to parameter changes. It will also enable him to test portions of the analogue programme online, to modify the programme and change variables as necessary.

The digital computer part of the hybrid language may contain special facilities for simulation. These may include integration routines, function generators, and variable time delay. These are often needed when the analogue computer is fully utilised and more integration capacity is required. Another use is to provide the solution to very slowly varying equations, where the analogue integrator usually suffers from low signal-to-noise ratio due to integrator drift.

**HYBRID APPLICATIONS**

Simulation of engineering and scientific systems is perhaps the most widespread application for hybrid computers. The essence of simulation is the formation of a mathematical model representing the system under study by a set of differential equations. These equations are then solved on the hybrid computer for varying initial conditions, parameter values, input excitations, and so on to provide a detailed knowledge of the behaviour of the system under study.

**OPTIMISATION**

The car suspension example referred to in Part 1 is typical of those in the area of system optimisation. Optimisation is generally used for the determination of a set of values for system parameters which will minimise, or maximise, a given function. Here this involved the determination of a set of values for the spring stiffness, shock absorber damping, and friction coefficient that will minimise the extent and duration of car bounce.

In general, the function to be minimised, or maximised, is called the performance or cost function, and can indeed in some cases represent £'s and P's such as the cost of fuel. An example of this is that of moving a satellite from one orbit to another with the minimum of fuel. The sequence of manoeuvres that will achieve this can be determined by using a hybrid computer.

The satellite dynamic equations are set up on the
analogue part, while the digital computer is programmed to carry out a series of optimisation procedures to deduce the best sequence of manoeuvres in terms of minimum fuel.

**SPACE VEHICLE GUIDANCE**

The determination of the trajectory of a long range ballistic missile represents a formidable task to engineers and scientists. Hybrid computers are used extensively in the simulation of these systems to study, as well as determine complete trajectory, the behaviour of on-board control units. The high frequency dynamic equations requiring only modest accuracy are generally patched up on the analogue computer, while those slowly varying equations representing the trajectory and requiring very high accuracy, are solved numerically by the digital computer.

The division of the problem between the digital and analogue computers will therefore depend on the speed and accuracy of the individual equations, as well as the availability of sufficient units on the analogue computer, and sufficient memory and computing time on the digital computer.

**SIMULATORS FOR MAN/MACHINE SYSTEMS**

Many hybrid computer systems are specially designed to behave as the "real" machine in a man/machine system. Examples of man/machine systems range from driver/car, captain/ship, engineer/power-station, to pilot/aircraft and astronaut/spaceship. The value of these simulators in the training of human operators cannot be over estimated, particularly in situations where human safety and/or high cost are involved.

The training of new aircraft pilots will involve both risk and cost, which can be reduced or eliminated by the use of aircraft simulators. Fig. 2.2 shows a typical flight simulation.

Similarly submarine and tank simulators are used in the training of operators to avoid the high cost and general inconvenience incurred in these operations. Inconvenience to the general public is avoided by using simulators when training pilots for supersonic aircrafts creating sonic booms, or low flying aircrafts generating an unacceptable high level of noise. Power station simulators are used in the training of operating engineers to cope with abnormal and other situations, such as various faults on the Grid, start-up and shut-down sequences of generators and turbines, and other procedures.

**RANDOM DISTURBANCES**

The ability to determine the effect of manufacturing tolerances of components on the overall behaviour of a system is useful. By modelling the system with a suitable set of equations, and patching those up on the analogue part of the hybrid computer the response of the system can be examined when various parts of the model are subjected to random effects.

These effects can in general be in the form of random initial conditions, random excitation on the input, or random parameter variations. Examples of such randomness may arise in the study of the variations of aircraft engine thrust with small deviations in fan blade angle due to manufacturing and assembly tolerances, or in investigation of the effects of thrust misalignment on the path of a missile.

**OTHER APPLICATIONS**

A large number of other applications exist for hybrid computers including both theoretical and practical aspects of engineering and science. Solutions of problems represented by partial differential equations can be conveniently carried out using hybrid computers. In non-linear equations of more than one independent variable considerable advantages in speed and accuracy can be achieved over the purely analogue and digital computer solutions.

The simulation of industrial process control systems is ideally suited to hybrid computers. In such simulations the equations representing the process under consideration, e.g. a chemical reactor, a steel mill, etc., are patched on the analogue computer, while the control system hardware is simulated by a programme in the digital computer.

The control system parameters can then be investigated by easily modifying the digital programme to obtain an optimum design of the control system.

**MEDICAL AND ECONOMIC STUDIES**

Applications of a lesser engineering nature include the study of biological and economic systems. Studies of the chemical reactions and dynamic forces taking place in animal muscles can be carried out on a hybrid computer as both discrete and continuous signals are involved in live tissues. Analysis of medical records and electrocardiogram (ECG) signals can be speeded up, and even performed in real-time, by the use of hybrid computers.

"Analogue Pre-processing" carried out on ECG signals on-line enables the reduction of data to eliminate redundant information and thus facilitate data storage in moderate memory sizes.

Simulation of economic systems is another area of application in hybrid computing techniques. Mathematical economic models are formulated to represent the state of a company, a country, or even recently the entire resources and drains of the economy of the whole world. These models are usually characterised by a set of difference differential equations ideally suited for hybrid computer solution.
MANY of the measurements that have to be made on audio equipment involve the use of ratios, usually of one voltage to another, and for this purpose many engineers prefer the use of a calibrated attenuator to a millivoltmeter.

An indicator is required, but it does not have to be particularly accurate, provided it has a flat frequency response over the bandwidth to be measured. A datum point has to be established, but then the attenuator takes over, and it is surprising how quickly and easily measurements can be made simply by adjusting the attenuator to re-establish the datum every time it changes, whatever the reason.

The attenuator to be described was built to fulfil such a function, and has been found to be a most useful instrument.

THE PI NETWORK ATTENUATOR

The attenuator is based on a series of π (pi) networks in cascade; the elements of this are shown in Fig. 1. The attenuation afforded by a single section is dependent on the ratios of R1 to R2, and R2 to R3, and can be calculated by the following expressions:

\[ R1 = R \left( \frac{n+1}{n-1} \right) \text{ and } R2 = R \left( \frac{n^2-1}{2n} \right) \]

When the input impedance is equal to the output impedance, as it usually is, then \( R1 = R3 \), and there are only two resistances to calculate.

When these expressions are used, \( R \) is equal to the characteristic impedance required, i.e. 600 ohms, and \( n \) is the attenuation required, i.e. \( V_1/V_0 \), where \( V_1 \) is the voltage being fed into the attenuator, and \( V_0 \) is the voltage coming out of the attenuator. The output will therefore be less than the input, and is always expressed as a ratio in terms of decibels.

ATTENUATORS IN CASCADE

A single attenuator, as described, can be fairly easily constructed and is sometimes used to provide any given amount of attenuation. It is more usual, however, to use a number of such attenuators to provide a number of attenuation ratios, and if the characteristic impedance remains fixed, and the attenuation ratios are in equal steps, then it is a fairly simple matter to connect a number of individual attenuators in cascade.

If we consider the case of a number of attenuators of the Fig. 1 type in cascade, then, since there are now two resistors of equal value (R1 and R3) connected in parallel, all that is required is to replace them with a single resistor having half the value, giving Fig. 2.

\[ R0 = \frac{n^2 - 1}{2n} \]

where \( R \) is the characteristic impedance (=600 Ω) and \( n = V_1/V_0 \)

Fig. 1. Simple pi network whose attenuation and impedances are determined by the following relationships:

If \( Z1 = Z0 \), then \( R1 = R3 = R \cdot \frac{n+1}{n-1} \text{ and } \)

\[ R0 = \frac{n^2 - 1}{2n} \]

where \( R \) is the characteristic impedance (=600 Ω) and \( n = V_1/V_0 \)

Fig. 2. Connecting attenuators in cascade produces further steps of attenuation. This type of compound attenuator is found in the output stages of signal generators giving ratios of 10:1, 100:1, 1,000:1 etc.
Such a compound attenuator is often found in the output stage of a signal generator giving attenuation ratios of 20dB, 40dB, and 60dB, i.e. 10:1, 100:1, and 1,000:1.

**VARIABLE STEP ATTENUATOR**

For frequency response plotting purposes, such an attenuator has to be replaced with a different type of attenuator in which the steps are not of the constant variety, but must be variable in much smaller steps, each step being different from the preceding, and following one. This is the attenuator illustrated in Fig. 3.

In this, the smallest step is 1dB, the next is 2dB, doubling up to a maximum of 16dB, giving a total attenuation of 31dB, more than adequate for its intended purpose. The smallest step of 1dB is not small enough for really precise measurements, although it is possible to make an educated guess as to the precise attenuation when it falls outside the 1dB limit.

The reader who decides to construct the attenuator, can, if he so feels inclined, include the 4dB step.

**CONSTRUCTION**

The attenuator was constructed in an aluminium cabinet 10in long, 3in deep, and 2in high, all the switches and the terminal posts being mounted on an L-shaped piece of aluminium. This forms the top and front of the cabinet, and was given an attractive “brushed” appearance by means of a piece of steel wool drawn repeatedly across the aluminium. The rest of the cabinet was painted matt black.

![Fig. 3. Circuit of the complete attenuator giving attenuation in 1dB steps from 0dB to 31dB. If 4dB accuracy is required an extra stage may be added at the input end using resistor values given in the components list](image)

**COMPONENTS . . .**

**Resistors**

<table>
<thead>
<tr>
<th>Resistor</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1, R3</td>
<td>10kΩ in series with 470Ω (2 off)</td>
</tr>
<tr>
<td>R2</td>
<td>68Ω</td>
</tr>
<tr>
<td>R4, R6</td>
<td>5kΩ in series with 150Ω (2 off)</td>
</tr>
<tr>
<td>R5</td>
<td>100Ω in series with 39Ω</td>
</tr>
<tr>
<td>R7, R9</td>
<td>2kΩ in series with 240Ω (2 off)</td>
</tr>
<tr>
<td>R8</td>
<td>470Ω in series with 18Ω</td>
</tr>
<tr>
<td>R10, R12</td>
<td>1kΩ in series with 180Ω (2 off)</td>
</tr>
<tr>
<td>R11</td>
<td>560Ω in series with 75Ω</td>
</tr>
<tr>
<td>R13, R15</td>
<td>820Ω (2 off)</td>
</tr>
<tr>
<td>R14</td>
<td>2kΩ</td>
</tr>
<tr>
<td>R16</td>
<td>1kΩ in parallel with 1kΩ</td>
</tr>
</tbody>
</table>

All resistors 2% ±W carbon

For 4dB section use circuit of Fig. 1 with R1, R3 =68Ω in parallel with 68Ω, and R2=18kΩ in series with 3kΩ (or 2kΩ)

**Switches**

<table>
<thead>
<tr>
<th>Switch</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1—S5</td>
<td>Double pole double throw, toggle (5 off)</td>
</tr>
<tr>
<td>S6</td>
<td>Single pole on/off</td>
</tr>
</tbody>
</table>

**Miscellaneous**

Insulated terminal posts (4 off) 
Aluminium for case

Toggle switches were used, as these are much more easily operated than the much cheaper slide switches, and were mounted in a straight line configuration; this has the advantage of greatly reducing stray capacitances between sections, and the response at 100kHz was only 4dB down compared to that at 1kHz.

An 18 s.w.g. busbar runs from end to end, connecting the two earth terminals. All the resistors are connected directly to the switches, their earthy ends connecting conveniently to the busbar (see Fig. 4).

![Fig. 4. Construction of the attenuator showing the layout of the resistors and the busbars](image)
4). This form of construction also reduces stray capacitances, this time to earth (cabinet), thus preserving the high frequency response.

RESISTOR VALUES

The resistance values, as calculated, are sometimes non-standard, but a very close approach to the required value can be obtained by series connecting easily available two per cent carbon film resistors.

Any discrepancies between measured and calculated values will be slight, and should be easily restored by a change in one or more of the associated resistors. This is clearly a valuable facility, as it enables a very accurate attenuator to be constructed, the ultimate accuracy then being dependent on the checking facilities available.

For checking, say, tone control response the procedure is to set the attenuator at zero attenuation and then feed in a signal at 1kHz to provide a suitable output from the amplifier, and the meter reading, or index mark, is noted. The tone controls must be set at the position supposed or believed to provide a level response.

One of the tone controls, let us say the bass control, is turned to the position providing maximum boost.

If the turnover frequency is around 1kHz, the output should not alter significantly.

The oscillator frequency is then reduced in steps of an octave to the lowest frequency of interest. At each octave reduction, the meter reading will increase, and the attenuator must be adjusted to return the meter reading to its original mark. The amount of attenuation required is also noted at each reduction. The bass control is then returned to its original position.

The treble control is then turned to provide maximum treble boost. This time the frequency is increased in octave steps to the maximum frequency of interest.

At each increase of frequency, the meter reading will increase, and, as before, the attenuator is adjusted to restore the original meter reading, and the amount of attenuation noted.

CHECKING THE ATTENUATOR

When complete, the attenuator must be checked for overall accuracy; any discrepancy can be corrected by a resistance change as described earlier. An accurate a.c. voltmeter is essential, to monitor the attenuation ratios actually produced.

An a.f. signal generator is also desirable; failing this the 50Hz mains can be used, suitably reduced by a transformer. The voltage input, whilst testing, and in subsequent use, must never exceed the rating at which the resistors will be damaged, bearing in mind that they are half watt types, and that wattage is given by $E^2/R$.

If, after due calculation of the voltages required in testing, it is found that half watt types are not sufficiently rated, then it is essential that one watt types, or even higher if required, are used. The attenuation ratios that should be obtained are shown in Table 1.

THE ATTENUATOR IN USE

In use, the attenuator is placed between the oscillator and the equipment under test, with the equipment output feeding the voltmeter, and, if required, a suitable dummy load. The set up for measuring an a.f. amplifier is shown in Fig. 5.

Table 1: ATTENUATION RATIOS

<table>
<thead>
<tr>
<th>$d$dB</th>
<th>$\alpha$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0dB</td>
<td>1</td>
</tr>
<tr>
<td>1dB</td>
<td>0.944</td>
</tr>
<tr>
<td>2dB</td>
<td>0.891</td>
</tr>
<tr>
<td>3dB</td>
<td>0.794</td>
</tr>
<tr>
<td>4dB</td>
<td>0.631</td>
</tr>
<tr>
<td>5dB</td>
<td>0.398</td>
</tr>
<tr>
<td>6dB</td>
<td>0.159</td>
</tr>
</tbody>
</table>

BASS AND TREBLE CUT

Bass and treble cut can be checked in exactly the same way, only this time the attenuator is set to provide a predetermined amount of attenuation before any measurements are made. This is because bass and treble cut effect a reduction in output and therefore attenuation—via the attenuator—must be removed in order to determine the amount of cut.

The overall frequency response of an amplifying system, or part of a system, can also be checked in exactly the same way, by setting up a datum point...
at 1kHz, and then increasing and decreasing the frequency in octave steps. Since any given system may contain both peaks and troughs in its response, it is customary to introduce a small amount of attenuation at the commencement of the test, this can then be removed if troughs exist, or increased if peaks exist.

UNDERSTANDING THE DECIBEL

The first fact to firmly grasp is that the decibel, or dB, is a ratio of something to something else. The ratio can be relative sound levels, relative voltages, or currents, or powers. But it is a ratio, and to mention "x" number of dB's without saying in relation to what can be grossly misleading, since a listener can interpret the "dB's" in his own way.

Possibly the simplest way of using decibels is by reference to dB tables, or to a dB graph of which a typical example is shown in Fig. 6.

Thus, if a ratio is known, it is simply a matter of looking up the table, or running a rule from one axis to the other, and it is at this point that uncertainty can arise, for there are two lines on the graph, one for power (watts) only, and the other for voltage or current.

CALCULATING DECIBELS

If two power ratings are given by \( P_1 \) and \( P_2 \) then the ratio between the two (in decibels) is given by

\[
\text{Power gain (dB)} = 10 \log \frac{P_1}{P_2}
\]

However for current or voltage ratios the formula becomes

\[
\text{Voltage gain (dB)} = 20 \log \frac{E_1}{E_2}
\]

or

\[
\text{Current gain (dB)} = 20 \log \frac{I_1}{I_2}
\]

The difference in magnitude is due to the equation for power \( P = I^2 R \) (or \( P = V^2/R \)). When logs are taken one obtains \( \log \frac{I_1}{I_2} = 2 \log \frac{I_1}{I_2} \) (similarly with voltage).

Where the ratio is less than unity there is a loss and the dB figure is preceded by a minus sign; if greater than unity the decibel figure is positive.

The graph of Fig. 6 is a straight line because one axis (the decibel) has been made logarithmic.

HANDLING DECIBELS

Supposing two amplifiers are connected in cascade, one having a gain of 30 and the other a gain of 40. To get the total gain we simply multiply the two giving a total of 1,200.

Looking at the situation in terms of decibels we see from the chart that a gain of 30 equals 30dB and 40 is 32dB. As with logs, to get the total gain we simply add the two figures giving a total gain of 62dB which, on checking with the graph is seen to equal 1,200.

Similarly, if we had two attenuators in series, one with a "gain" of 1/30 and the other with a "gain" of 1/40, to get the total gain we again add the relevant decibel figures (which are now negative quantities). Thus total gain is \(-30\text{dB} + -32\text{dB} = -62\text{dB}\) (i.e. \(-1/1,200\)).

To generalise, we can calculate the total gain of a number of stages in cascade by simply adding all the gains, remembering that stages which produce a loss will have a negative decibel figure.

The vital point to always remember is that the datum point, the 0dB level, is an arbitrary level that can be set anywhere it is desired, and that after that everything else is in relation to this. 0dB can be zero output, or it can be maximum output, or anywhere in between.

This makes it delightfully versatile, but danger lies hidden under the cloak of versatility, for misunderstandings can so very easily arise unless 0dB is clearly defined.

THE IMPORTANCE OF IMPEDANCE

The equation for voltage gains and losses of 20 log \( E_1/E_2 \) applies only when the impedances across which \( E_1 \) and \( E_2 \) are measured are the same, and this is a point which is so very easily overlooked, but one which can nullify any results obtained.

If the impedances are different the equation becomes 20 log \( E_1/E_2 + 10 \log R_2/R_1 \), where \( R_1 \) and \( R_2 \) are the resistive parts of the impedances.

This correction must be applied when attempting to measure the dB gain of a high input impedance amplifier with a low output impedance, an exercise as futile as it is misleading.
Most constructors have a box of odd transistors with a lack of markings or dubious working capability. Add to this the fact that bargain packs containing, for example, “50 untested and unmarked transistors for 55p” are widely advertised, and it can be seen that a quick and simple transistor tester would be of great value.

The device described in this article has the ability to determine the polarity of the transistor under test (pnp or npn) and to show the approximate d.c. gain ($h_{FE}$) in four groups: under 20, over 20, over 60 and over 120. Diodes can also be tested and their cathode ends identified.

The device may be constructed for under £5 including case and using all new components.

**CIRCUIT DESCRIPTION**

The circuit consists of two main parts: the type indicator and the gain indicator. The type indicator is shown in Fig. 1a and the gain indicator in Fig. 1b.

The two inverters IC1a and b are connected to form a multivibrator running at about 2kHz. The two outputs are buffered by the second two inverters IC1c and d. The emitter and collector of the transistor under test is connected to the outputs of these two inverters.

The signal applied to the base of the transistor via IC2a and R3 is always of the same phase as the signal applied to the collector so that the transistor, whether it is pnp or npn, will always be turned hard on every half cycle of the clock pulse.

The 7400 series of logic i.c.s are current limited by means of resistors in the positive side of the push-pull output stage. Therefore if, as in this circuit with the transistor under test turning on every half cycle, a positive output is connected to an output driven to 0V then the positive going output will be pulled down to 0V.

With an npn transistor in the test position, the transistor will be on when the emitter is connected to 0V by the circuit so that the collector of the transistor will be at almost 0V; on the second half of the clock cycle the collector will be switched to 0V by the circuit and the emitter to the supply voltage. Thus it can be seen that the collector will always be near 0V if a working npn transistor is connected in the circuit.

With a pnp transistor in the circuit the action will be similar except that the emitter terminal will be held near to 0V.

The final two inverters, IC1e and f are used to detect which terminal is being held at 0V and then to drive one of the l.e.d.s D1 or D2 via the appropriate current limiting resistor R4 or R5.

The polarity detector could have been constructed using a single SN7404N hex inverter but since a spare inverter was available in IC2 it was decided to buffer the base drive to the transistor under test.

**GAIN INDICATOR**

The gain indicator part of the circuit shown in Fig. 1b uses a Zener diode and resistor (D3 and R6 or D4 and R20, depending on the polarity) to give a base current of about 100µA for the transistor under test. A current sensing chain consisting of three resistors each connected to the base of a transistor forms the collector load.

If the transistor is npn and has a gain of over 20, insufficient voltage to turn on TR1 and TR2 will be developed across R8 and R9 but the total voltage across R8, R9 and R10 will turn on TR3 causing a logic 1 to be applied to the input of IC3c so that its output falls to near 0V causing l.e.d. D7 to conduct and light.

If the transistor has a gain of over 60, both TR2 and TR3 will conduct so the logic gate IC3b lights D6 but the connection to pin 9 inhibits IC3c so that only one l.e.d. lights.

Similarly for a gain of over 120 all three transistors conduct but the logic ensures that only D5 lights.

Operation of the circuit for pnp transistors is similar except that the outputs from the transistors are inverted before being fed to IC3 because of the opposite voltages being used.

The standard resistor values will give reasonable accuracy even allowing for the variation in base-emitter voltages of the transistors.

Switching is shown in Fig. 1c. Two outputs are provided to a transistor under test, one via a standard socket and the other via three sockets to flying leads.
Fig. 1a. Circuit diagram of the polarity indicator

Fig. 1b. Circuit diagram of the gain indicator. In both the above diagrams the circled designations are connections from the circuits to the switching in Fig. 1c

Fig. 1c. Power supply and switching system. The battery can be used to make the unit self-contained or an external power source can be used
CONSTRUCTION

The layout of the components on a piece of perforated board is shown in Fig. 2 and the arrangement of the components on the front panel can be seen in the photographs. A standard diecast box measuring 3 x 4 x 2 inches was used to house the board.

POWER SUPPLY

The unit draws a maximum current of approximately 110mA and since the power is only used for short periods at a time, batteries would be fairly economical to use. However, the prototype has always been used within easy reach of a 6V power supply so the unit was fitted with external sockets rather than a battery holder. The constructor can choose which method better suits his purpose.

OPERATION OF THE TRANSISTOR TESTER

When the wiring has been checked and the power supply or battery connected, the operation of the unit may be checked in the following manner.

Set the function switch SI to TYPE and connect a transistor to the test sockets. When the POWER button is pressed either the NPN or the PNP lamp should light indicating the polarity of the transistor.

Now set the function switch to whichever type of transistor was indicated and again press the POWER button. One of the lamps should light indicating the approximate gain of the transistor. If none of the lamps light this could be due to the fact that the transistor has a gain of below 20.

If, with the function switch in the TYPE position, both the NPN and the PNP lamps light, it indicates that the transistor under test is open-circuited; if neither lamp lights then it is short-circuited.

TESTING DIODES

A diode may be tested by connecting it between the emitter and collector sockets and setting the function switch to TYPE. If the PNP lamp lights then the end of the diode connected to the collector socket is the cathode and if NPN lights then the cathode is to the emitter. As with the transistor, if both or neither lamp lights then the device is open- or short-circuited.
SYNTHESISERS

Last year Boosey and Hawkes provided a scintillating display of what man, three ARP synthesisers and an organ could accomplish. To have repeated this performance this year with the addition of the new ARP “Explorer” would have defeated the ability of the most agile demonstrator, I am sure.

Of the ARP range to my mind the most fascinating is the Pro-Soloist. This provides 30 preset instrumental and electronic effects at the touch of a key. Using memory circuits the recreated instrumental sounds are truly amazing. Used with an organ it is an ideal “second” solo keyboard.

With an eye to the obvious market Yamaha have introduced a similar instrument, the SY-1. The three octave keyboard provides touch control for vibrato, wah-wah and volume. Instrumental voices available number 26, but synthesiser “sounds” can be readily created with either selectable presets or continuously adjustable controls. Although I marvel at all things Japanese I still prefer the Pro-Soloist.

The Bentley Organ showcase included the Solina String-Ensemble described as a polyphonic portable “mini-orchestra”. Voices offered are viola, violin, trumpet, horn, contra-bass and cello. The instrument name derives from the fact that violin and viola registers can be played polyphonically as can trumpet and horn. Contra-bass and cello are monophonic only.

Tone generation is digital with only one master oscillator which enables easy transposition with other instruments.

PIANOS

Of the electronic pianos probably the most interesting is the new Compton-Edwards Pianotron. It offers as much as the genuine article with an 88 note keyboard, velocity sensitive key action and soft and loud pedals with all the additional advantages that electronics can add such as three additional voices: Honky-Tonk, Harpsichord and Synthesiser all with available vibrato and reverberation effects.

Keeping the instrument in tune should never be a problem as a pitch slider enables this to be done over the whole keyboard in one adjustment.

As a musician who finds transposing at sight a difficult task, I found the 12-position switch transposer very gratifying. Each step of this changes the pitch by a semi-tone.

The internal amplifier provides a cracking peak power of 150W (?).

Bentley were also showing a new piano covering six octaves with an additional Harpsichord voice and pitch control. This, however, is an add-on unit to a main console.

ORGANS

Every year one expects more “Easy-Play” organ gimmicks to be added to the now considerable list.

The Compton-Edwards Pianotron home model
With so much organ sales literature aimed at making the most callow amateur sound like a pro, we have seen, a whole new vocabulary grow up.

There have been “Autochord”... just make a chord and the organ does the rest for you; “Walking Bass”... play the root note on the pedal and all of the rest of the notes are automatically produced in sequence in perfect pitch and tempo to the music being played on the keyboard; “Fantom Fingers”... providing cascades of arpeggios for little effort; “Musi-Computer”... this is a form of electronic piano roll. A computer tape records digital pulses on playing and on playback these voltages are applied to the key contacts so that the sounds are reproduced. Obviously this is a useful teaching aid particularly as the notes that are sounding can be visually indicated and new registrations added at will.

There are other novelty features aimed at selling self-generated home entertainment.

New entrants to this market include the Lowrey Teenie Genie organ with an accompaniment offering “Genie Chords” which can be played with one finger of the left hand and the Baldwin Fun Machine.

Baldwin also include a new “Real Rhythm” feature on their Encore and Bravo organs. This I found particularly exciting as the strict tempo feature of the electronic rhythm box has been modified. Here, manually selected rhythm voices are programmed to follow playing on the accompaniment manual and pedals. Alternatively automatic patterns may be played or complex patterns with the automatic and manual facilities.

In the “Easy-Play” market, Wurlitzer were strongly represented with seven models incorporating “Spectra-Sound”, illuminated keyboard, note finder, bass riff, walking bass, touch tone programmed accompaniment. “Swingin’ Rhythms”, etc., etc.

Hammond had their “dynamic duo” Regent and Concorde on display and two new models, the 7100 and 5200 models.

EFFECTS

I discovered a box which produced some very satisfying noises when hooked to an organ on the Kentucky stand. This, the Multi-mate, provided controlled frequency shifting proportional to input frequency which when re-mixed with the original input provided a curious spatial effect completely different from reverberation. Kentucky state that the device would be compatible with any input.

A stunning effects box in combination with an organ is the Mellotron 400 from Dallas Musical. This is best described as a tape machine manipulated by a keyboard. The standard instrument provides three basic sounds of flutes, violins and cellos recorded on tape. However, other tape frames can be easily added to extend the repertoire to provide a unique instrument as evidenced by the many famous groups using it.

The new SY-1 solo synthesiser from Yamaha

The new Compton-Edwards Symphonia organ

The new CSY-1 Electone organ from Yamaha with synthesised instrumental sounds and shaping controls
Now—two fascinating ways to enjoy saving money!

NEW! Sinclair Scientific kit £19.95
(INC. VAT)

Britain's most original calculator now in kit form
The Sinclair Scientific is an altogether remarkable calculator.
It offers logs, trig, and true scientific notation over a 200-decade range—features normally found only on calculators costing around £100 or more.
Yet even ready-built, the Sinclair Scientific costs a mere £32.35 (including VAT).
And as a kit it costs under £20!

Forget slide rules and four-figure tables!
With the functions available on the Scientific keyboard, you can handle directly:
- sin and arcsin,
- cos and arccos,
- tan and arctan,
- automatic squaring and doubling,
- log\(_10\), antilog\(_10\), giving quick access to \(x^y\) (including square and other roots),
- plus, of course, addition, subtraction, multiplication, division,
and any calculations based on them.

In fact, virtually all complex scientific or mathematical calculations can be handled with ease.

So is the Scientific difficult to assemble?
No. Powerful though it is, the Sinclair Scientific is a model of tidy engineering.
All parts are supplied—all you need provide is a soldering iron and a pair of cutters. Complete step-by-step instructions are provided, and our Service Department will back you throughout if you've any queries or problems.

Of course, we'll happily supply the Scientific or the Cambridge already built, if you prefer—they're still exceptional value. Use the order form.

Components for Scientific Kit (illustrated)
1. Coil
2. LSI chip
3. Interface chips
4. Case mouldings, with buttons, windows and light-up display in position
5. Printed circuit board
6. Keyboard panel
7. Electronic components pack (diodes, resistors, capacitors, etc)
8. Battery assembly and on/off switch
9. Soft carrying wallet
10. Comprehensive instructions for use
Assembly time is about 3 hours.

Features of the Sinclair Scientific

- 12 functions on simple keyboard Basic logs and trig functions (and their inverses), all from a keyboard as simple as a normal arithmetic calculator's. Upper and lower case operation means basic arithmetic keys each have two extra functions.

- Scientific notation Display shows 5-digit mantissa, 2-digit exponent, both signable.

- 200-decade range 10^-99 to 10^+99.

- Reverse Polish logic Post-fixed operators allow chain calculations of unlimited length—eliminate need for an = button.

- 25-hour battery life 4 AAA manganese alkaline batteries (e.g. MN2400) give 25 hours continuous use. Complete independence from external power.

- Genuinely pocketable 4 1/3" x 2" x 11/16". Weight 4 oz. Attractively styled in grey, blue and white.
Sinclair Cambridge kit

At its new low price, the original Sinclair Cambridge kit remains unbeatable value.

In less than a year, the Cambridge has become Britain's most popular pocket calculator.

It's not surprising. Check the features below - then ask yourself what other pocket calculator offers such a powerful package at such a reasonable price.

Components for Cambridge Kit
1. Coil
2. LSI chip
3. Interface chip
4. Thick film resistor pack
5. Case mouldings, with buttons, window and light-up display in position
6. Printed circuit board
7. Keyboard panel
8. Electronic components pack (diodes, resistors, capacitors, transistor)
9. Battery clips and on/off switch
10. Soft wallet

Assembly time is about 3 hours.

Features of the Sinclair Cambridge

- Uniquely handy package. 4 1/3" x 2" x 11/16", weight 3 1/2 oz.
- Standard keyboard. All you need for complex calculations.
- Clear-last-entry feature.
- Fully-floating decimal point.
- Algebraic logic.
- Four operators (+, -, ×, ÷), with constant on all four.
- Powerful constant with separate 'K' button.
- Constant and algebraic logic combine to act as a limited memory, allowing complex calculations on a calculator costing less than £15.
- Calculates to 8 significant digits.
- Clear, bright 8-digit display.
- Operates for weeks on four AAA batteries.

Take advantage of this money-back, no-risk offer today

The Sinclair Cambridge and Scientific kits are fully guaranteed. Return either kit within 10 days, and we'll refund your money without question.

All parts are tested and checked before despatch - and we guarantee any correctly-assembled calculator for one year. (This guarantee also applies to calculators supplied in built form.)

Simply fill in the preferential order form below and slip it in the post today.

Scientific
Price in kit form £19.95 inc. VAT.
Price built £32.35 inc. VAT.

Cambridge
Price in kit form £14.95 inc. VAT.
Price built £21.55 inc. VAT.

---

To: Sinclair Radionics Ltd,
FREEPOST St Ives,
Huntingdon, Cambs. PE17 4BR

Please send me
☐ Sinclair Scientific kit at £19.95
☐ Sinclair Scientific built at £32.35
☐ Sinclair Cambridge kit at £14.95
☐ Sinclair Cambridge built at £21.55

All prices include 8% VAT.

* I enclose a cheque for £______________, made out to Sinclair Radionics Ltd, and crossed.

* Please debit my *Barclaycard/Access account. Account number

* Delete as required.

Signed

Name

Address

Please print. FREEPOST - no stamp needed.
Ideally suited for:

- Home Entertainment
- Lecturing
- Remote Monitoring
- Surveillance

Previous articles in this series have discussed all the electronic aspects of the C.C.T.V Camera. This month case construction, final wiring and setting up procedures are discussed. The Modulator required for interfacing with a domestic Television receiver will be described next month.

**THE LENS**

Several factors are to be considered in the choice of a lens for a TV Camera. The fundamental requirements of the lens which is to transmit the viewing scene to the Vidicon may be summed up by considering the following four points—

(a) the dimensions of the maximum usable area of the photoconductive target,
(b) the sensitivity of the Camera tube,
(c) the viewing angle required,
(d) the depth of focus required.

EMI specify a maximum usable area of their type 9677 Vidicon target as being the central ½in × ½in, and a minimum illumination of 2 lux for full video signal current. Factors (a) and (b) are hereby fixed by the Vidicon characteristics, however, flexibility of factors (c) and (d) is made possible by the optical properties of the chosen lens.

Illumination of the required scene must be controlled before it is transmitted to the Vidicon target by the lens. Only when this is achieved will the video signal faithfully represent the dynamic range of the picture. An aperture stop is incorporated in all camera lenses expressly for this purpose, and a target illumination of approximately 2 lux is made possible by a simple manual adjustment.

The chosen lens is required to produce an image of the scene onto the specified ½in × ½in area of the target, and therefore calls for precise positioning in relation to the target. The lens must be either a 16 mm, or 35mm size and have a relatively short focal length.

One point to remember when using any lens is that a deeper depth of focus is obtained by using smaller apertures, e.g. f11, f16, f22). To achieve this, of course, we require brightly lit scenes.

**CAMERA ENCLOSURE**

All the mechanical details of the enclosure are shown in Fig. 3.1. The chassis is made from 18 s.w.g. aluminium and strengthened by four square cross section bars which run front-to-back near the corners of the enclosure. Each horizontal bar has two 6BA tapped holes to enable the p.c.b.s to be mounted vertically at the sides of the chassis and provide a good chassis earth p.c.b. connection.

Standard photographic tripod mounting is facilitated by introducing a further strengthening bar to the base of the chassis. A ½in × ½in cross sectional bar of aluminium is mounted at the centre of gravity of the TV Camera for a well-balanced ½in BSW thread tripod attachment. The lens is screwed into a square aluminium block which is then mounted onto the front panel by 4BA bolts. These four mounting bolts will clear the aluminium front plate and screw into the scan coil assembly.

Four additional holes are drilled in the base of the chassis and countersunk from the bottom to
Fig. 3.1. Mechanical details of camera enclosure
Fig. 3.2. Wiring diagram of case mounted components

TABLE 3.1

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Heater</td>
</tr>
<tr>
<td>2</td>
<td>Modulator</td>
</tr>
<tr>
<td>3</td>
<td>Mesh G4</td>
</tr>
<tr>
<td>4</td>
<td>Internally connected</td>
</tr>
<tr>
<td>5</td>
<td>Limiter G2</td>
</tr>
<tr>
<td>6</td>
<td>Wall anode G3</td>
</tr>
<tr>
<td>7</td>
<td>Cathode</td>
</tr>
<tr>
<td>8</td>
<td>Heater</td>
</tr>
<tr>
<td>Index pin</td>
<td>Internally connected</td>
</tr>
</tbody>
</table>

Pin details for (left) vidicon tube and transistors (above)

enable the two mains transformers to be firmly secured at the rear of the Vidicon and scan coils. The relative positioning of these components is quite critical due to the sensitive nature of the camera tube and the magnetic fields generated by the transformers.

The cover is made from 20 s.w.g. aluminium and secured with 6 BA self-tapping screws.

WIRING DETAILS

The majority of connections exist at the rear of the Camera assembly—between the p.c.b.s, control panel, transformers and along to the Vidicon pin connector (Fig. 3.2). Fortunately, a large percentage of the system wiring is not critical and a series of bundled cables may be used to give very neat results. In the prototype, for example, the full colour range of solid, p.v.c. covered 1/024in wire was used (the coloured wire certainly helped in tracing connections!)
There are, however, four connections within the system that should be made to the following instructions in order to prevent undesirable signal pickup—

(a) The composite video output signal should be connected from the Video Amplifier to the coax socket via coaxial cable, whose outer braiding is earthed at both ends.

(b) The line and field scan coil connections should be made with tightly twisted cable and be as short in length as possible.

(c) The Vidicon target connection should be the shortest possible length (i.e. made with P.C.B. 1 screwed in position).

HANDLING THE VIDICON

As the Vidicon is enclosed in a thin glass envelope, this device must be handled with care during the construction of the project. No harm should come to this rather expensive and fragile component if the following hints are observed—

(a) Take great care not to scratch the target window—this is made of a very soft glass and would scratch very easily.

(b) Never solder any connections to the electrode pins of the Vidicon—use the available pin connector and refer to Fig. 3.3 for target connection details.

(c) Do not overtighten the metal clamp located on the coil assembly—this could contract in low temperatures to break the neck of the camera tube.

(d) Never operate the Vidicon in a face-down position—small granules sometimes break free from the cathode and may collide with the target with detrimental effect.

The target connection may be made by carefully wrapping a length of thin wire around the metal target connector ring, adding a few tiny drops of adhesive to secure the wire.

SETTING UP

It would be a shame to damage the Vidicon, or for that matter—any component at this final stage. So upon the initial application of power, with the Vidicon pin connector carefully disconnected from the tube, check that all electrode potentials are reaching their designated points. Once you are confident that this is so, then replace the connector and proceed with the setting-up of the TV Camera.
The TV Camera in conjunction with either a TV Monitor or domestic TV Receiver exists and two optical controls are then set to establish good picture brightness, contrast and focus.

**Brightly Lit Conditions**

You will have to prevent most of the light intensity from reaching the Vidicon target by limiting the aperture size to f11–f22. Assuming the target image to be correctly illuminated to give a good dynamic range (contrast) the brightness may be set by adjusting the target voltage. Again, you will probably have to operate a brightly-lit scene at minimal sensitivity (target voltage control more clockwise).

Avoid rapid panning with the TV Camera under bright-light conditions, as the bright highlights may cause picture lag (a smearing effect as the scene moves across the screen).

One distinct advantage of using well lit scenes is the large depth of focus which results from small operating apertures.

**Poorly Lit Conditions**

For indoor use under average domestic lighting conditions, for example, the lens aperture will have to be increased towards f1.9. The sensitivity of the Vidicon may also have to be increased (an anti-clockwise movement of the target voltage control) to give sufficient picture brightness.

If a good depth of focus is required for a poorly lit scene, the aperture may be decreased in size and target voltage increased accordingly to give the same working sensitivity.

**Night Light Conditions**

The camera video amplifier has been designed to have sufficient gain to operate the Vidicon in very poorly-lit conditions.

To enable operation under moonlight conditions, turn the video gain preset VR2 fully clockwise, open the lens aperture to f1.9 and turn the target voltage control anticlockwise. It may also be necessary to make full use of the brightness and contrast controls in the TV Monitor/Receiver.

**TV MONITOR/RECEIVER**

As previously mentioned, we are faced with using our TV Camera in conjuntion with either a TV Monitor or domestic TV Receiver (via a u.h.f. Modulator). The TV Monitor has the advantage of being devoted to the use of displaying camera pictures, whilst the domestic receiver presumably already exists and simply becomes twofold in application.

The TV Monitor is an expensive but useful item to add to your CCTV equipment—Japanese models being available in the price range £50–£100.

In Fig. 2.8 R44 (680Ω) should be connected between VR8 and the 15V line.

Because of imperfect reproduction of printed circuit board Fig. 2.2, we have decided to make available a free reprint of this diagram. Readers requiring copies should send a large stamped addressed envelope to the Editorial Offices.

**Next month**: The modulator will be described.

**CAMERA OPERATING HINTS**

Once the TV Camera has been aligned and is boxed up and ready for use, we then consider the correct settings of the camera unit controls to suit a wide variety of scenes.

Beam current and electrical focus controls have been set during the alignment process and should remain at their established positions. The remaining one electrical and two optical controls are then set to establish good picture brightness, contrast and focus.
It is often required to run a cassette recorder during long car journeys. This can prove very expensive in dry batteries and it would obviously be desirable to run the recorder from the car battery if possible. The unit to be described here gives a stabilised 7.5V output at just over 1A (suitable for most cassette recorders) from a standard 12V car battery.

The prototype was built for about £1.50, approximately half the cost of the cheapest available commercial unit.

Instructions are also included for modifying the unit to operate from the mains, or to give a 9V stabilised output, suitable for operating some transistor radios.

CIRCUIT DESCRIPTION

The circuit is based on the 723 voltage regulator integrated circuit, using a 2N3055 external current pass transistor (Fig. 1). The prices of these components have fallen rapidly recently, and it should be possible to obtain both for less than £1.

The 723 has three separate internal sections; a voltage reference amplifier providing a stable reference voltage of nominally 7.15V, an error amplifier, and an internal current pass section (with a current limiting transistor) which will give an output current of up to 150mA. As we require an output current of up to 1A, we must use this output to drive an external current pass transistor, TR1.

COMPONENTS . . .

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistors</td>
<td></td>
</tr>
<tr>
<td>R1</td>
<td>0.56Ω 1W</td>
</tr>
<tr>
<td>R2</td>
<td>100Ω ½W</td>
</tr>
<tr>
<td>R3</td>
<td>2.2kΩ ½W</td>
</tr>
<tr>
<td>All 10%</td>
<td></td>
</tr>
<tr>
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<tr>
<td>Capacitors</td>
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<td>C1</td>
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<td>Semiconductors</td>
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<tr>
<td>TR1</td>
<td>2N3055</td>
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<tr>
<td>IC1</td>
<td>723 voltage regulator</td>
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<tr>
<td>Miscellaneous</td>
<td></td>
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<tr>
<td>0.1m Veroboard 3.75in × 1.75in, Heatsink for TO3 transistor</td>
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</table>
The assembled unit

The reference voltage (pin 6) is connected directly to the non-inverting input (pin 5) of the error amplifier, while R2, VR1 and R3 form a resistive divider to tap off a portion of the output to feed to the inverting input (pin 4). Variations of this voltage compared to the reference cause IC1 to vary the current applied to TR1 base, so tending to hold the output voltage constant. Hence, varying VR1 allows us to set the output to precisely 7.5V.

Current limiting is accomplished by R1 and the internal current limiting transistor. This turns on so preventing any further current being drawn, in the event of a short circuit on the output. Here the voltage across R1 is about 0.65V, and so the maximum available current in the design will be approximately 1.1A. This should be more than adequate for most portable recorders.

CONSTRUCTION

The unit is constructed on a piece of 0.1in matrix Veroboard, 3\t in × 1\t in. The layout is shown in Fig. 2.

A small heatsink was used for TR1 in the prototype, although this is probably not strictly necessary since a 2N3055 should be able to dissipate up to 10 watts without a heatsink, and it is only required to dissipate about 5 watts maximum in the present design. However, without the heatsink, there would be a fairly large temperature rise when running at full output, which would not be desirable, especially if the unit was mounted in a hot place, for example near a heater outlet, or possibly near the engine, and so the heatsink was used as a safety measure.

Fig. 2. Component layout and wiring detail
The cassette p.s.u. complete with connectors

Provision is normally made on the recorder for an external 7.5V supply to be connected via a five pin DIN plug; no details of pin connections are included, however, since these may vary with different makes of recorder.

TESTING

After rechecking the board the unit can be connected to a 12V supply and tested. The output should be somewhere near 7.5V. This can then be set precisely by adjusting VR1. The unit should then be ready for installation.

No details of casing for the unit have been given, since the board is small enough to be hidden away unobtrusively somewhere behind the dashboard or possibly in the glove compartment. A 12V supply may also be conveniently available from a cigar lighter, if one is fitted.

![Rectifier circuit for mains use](image)

Fig. 3. Rectifier circuit for mains use

MODIFICATIONS FOR 9V

The unit can be readily modified to give a 9V output by changing the values of R2, R3 and VR1 to 750Ω, 2.7kΩ and 1kΩ respectively.

Either the 7.5V or 9V version can be operated from the mains by use of a simple rectified power supply, as shown in Fig. 3.

Practical Electronics November 1974
JUPITER ORBITER

The success of the Pioneer 10 mission has led to a study, by the NASA-ESRO group, of the possibility of launching an orbiter spacecraft to Jupiter. It seems likely that they are of the opinion that the back up facilities that are provided for the Pioneer missions could be employed for this purpose.

Data already examined showed that there were two parts to the magnetic field and that this alone could justify a closer look. There are a number of problems raised by this anomalous magnetic field. While the off-set field, first noted by W. Neuk and confirmed by others, explains some of radiation phenomena, Pioneer 10 also confirmed these data but in addition detected a field reaching out to 108 Jupiter radii. This field has a special relationship with the equator of the planet.

The high energy electrons and protons that were measured by the spacecraft indicated a magnetosphere quite different from that of the Earth. The sudden burst of particles at the same time is thought that the gravitational forces of particles and belts around the Earth remains unexplained at the moment. An orbiting vehicle could help to resolve this. The design of such a craft would have to take into account the high radiation hazard. Shielding would be important for the vehicle to be in the magnetic belt a long time. The spin stabilised Pioneer is a better choice than the Mariner type for this mission.

It is thought that the gravitational fields of Jupiter's satellites could help to retard the spacecraft and could also be used to change trajectory. The payload could consist of detectors for particles and fields. These would make up about 70 per cent of the total payload. The remainder would provide for visual, ultra-violet and infra-red monitoring. The vehicle would also carry a probe that could be dropped through the Jovian atmosphere. Launching would need to await a favourable Jupiter position. The probable time would be during the 1980's.

MORE ABOUT MERCURY

Some of the data received from Mariner 10 on Mercury has now been processed and added to our understanding of this planet. The magnetic field of Mercury seems to be very much weaker than that of the Earth. Though a magnetosphere was recognised as being like that surrounding the Earth there are certain peculiarities.

Particle detectors on Mariner 10 indicated that there were protons at energy levels of 550 keV and electrons at levels of 300 keV, inside the magnetosphere. These particles were not trapped in the magnetosphere but seem to respond to some special mechanism.

There are large oscillations in the electron density having an apparent period of change of the order of 6 seconds. Sometimes there are active bursts of protons at the same time. The weak field of the planet precludes the trapping of radiation in the form of belts around it. The presence of the magnetic field was rather a surprise for the small size and the slow rotation period of 58.5 days did not seem to support the idea.

However, the field does not seem to be generated by the effect of the solar wind and must therefore be intrinsic. If this is the case then it could be that there was once a core like the Earth's and that a dynamo system exists now or there are the remains after an original active dynamo ceased to function. If this should prove to be the case it would mean that Mercury once rotated much faster on its axis.

The infra-red region lies between 1 micron and 2 millimetres. Over the last ten years or so research activity has increased steadily in this area. The technology mainly responsible for these advances has been solid state electronics, cryogenics and thermal detectors.

The science of infra-red astronomy is still in its infancy yet some dramatic discoveries have been made. There is already a 1.5 m flux collector on Tenerife. This was designed and built by Imperial College with the aid of funding from the S.5. Valuable experience has been gained on this project apart from the scientific experiments.

The design of the 3.8 m flux collector makes use of the 1.5 m experience and also the design studies by Sir Howard Grubb Parsons and Dunford Hadfields Ltd. The improvement in facilities of the 3.8 m instrument will be considerable, not least the fact that observation times will be reduced by a factor of 40. This will give considerable improvement in angular resolution.

The Director of the Royal Observatory, Edinburgh (Professor H. A. Bruck) is in overall control of the project, the project manager being J. G. Carpenter of ROE. The project manager will be advised by a steering committee under the chairmanship of Professor J. Ring of Imperial College. It is expected that the construction phase will last about three years.
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already steps to cut back employment, production rates, stocks and to spread capital investment over a longer period. Prudent measures, no doubt, especially as some market analysts are already predicting a fall in demand for semiconductors of as much as 25 per cent by mid-1975 which could lead to yet another big round of competitive price-cutting as device manufacturers struggle to keep their production lines filled.

CAKE NOW

Company reports in the UK still make good reading though, here again, there are many warnings for the future. Thorn reported record turnover and record profits, helped considerably by overseas operations, but see a "very difficult trading year in the UK". GEC had record profits, improved productivity and good order intake but Lord Nelson is forced to conclude that "... we are surrounded by so many uncertainties that it is virtually impossible to predict the future".

Smaller companies, too, have been doing well. Multitone has a record turnover, largely from increased business in pocket paging. Unitech, who controls a number of bright young companies, has never had it so good. Membrain, another vigorous striping building automatic test equipment report deliveries up to 80 per cent during the first half of 1974. We can say for certain that companies with a major interest in consumer electronics will have a tough time ahead. Those with widely spread exports will be less badly hit. One silver lining to the cloud is that limps that a slump in home demand for colour TV could well put British electronics balance of trade back in the black because many observers believe that a very large proportion of the components currently imported go into domestic TV sets and, of course, many TV sets, tape recorders and domestic radios are imported as complete units.

SLOWDOWN?

While reporting increased sales and earnings, Fairchild Camera and Instrument Corporation gives warning that tough times may lie ahead. Fairchild’s views are worth noting because they were learnt the hard way. In the mid-1960’s Fairchild was the greatest in semiconductor technology and a huge producer but it still got itself in a mess. So much so that C. Lester Hogan, then heading up the commercially successful Motorola semiconductor operation, was invited to take over at Fairchild and put matters to right. When he joined Fairchild he took with him no less than seven top managers from Motorola, which caused quite a stir in semiconductor circles.

When Hogan joined Fairchild with his ex-Motorola team in 1968, Fairchild was still the leader in technology but was heavily dependent on digital circuits and the computer industry with a base of only 600 customers and a bank balance well in the red. This year’s results show Fairchild back again in the black, and with a much wider product range selling to 5,000 customers so that the company is no longer too dependent on any one market sector which might suffer temporary setbacks. Hogan, his major task completed, has just stood down as Chairman and promoted one of his ex-Motorola proteges, Wilfred J. Corrigan, into the hot seat. Hogan remains with Fairchild as vice-chairman so will still be available for advice and it could be that Corrigan will need it.

For Corrigan, in his first annual report as Chief Executive, there was already talking of a slowdown in growth. The forward order book is declining and therefore there are no less than seven top managers which Fairchild he took with him semiconductor technology and a huge producer technology but was heavily dependent on digital circuits and the computer industry with a base of only 600 customers and a bank balance well in the red. This year’s results show Fairchild back again in the black, and with a much wider product range selling to 5,000 customers so that the company is no longer too dependent on any one market sector which might suffer temporary setbacks.

HARBOUR RADAR

Decca Radar have long been the world’s major supplier of marine radar on ships. The total score of delivered radars is about 60,000 and the current order rate is something like 10,000 sets a year. Over 90 per cent of the orders are from overseas.

What is not so well publicised is Decca’s effective stranglehold on the harbour radar industry. The score here is over 200 installations world wide and increasing fast. Some of them are big installations involving up to three radars with raw radar data being fed by microwave link to an operations centre where there are multiple displays and computer-assisted tracking systems. Others are less complex but all need careful planning and design to meet the particular needs of the pattern of traffic, the local topography and navigable channels.

The overseas list is a real Cook’s tour. Installations just being completed are at Halifax, Vancouver, Placentia Bay, Cape Town, Ras Tanura, Doha, Malmo, Honolulu, etc. Those who haven’t got them are Placentia Bay, Cape Town, Ras Tanura, Doha, Malmo, Honolulu, etc. Those who haven’t got them are Placentia Bay, Cape Town, Ras Tanura, Doha, Malmo, Honolulu, etc. Those who haven’t got them are Placentia Bay, Cape Town, Ras Tanura, Doha, Malmo, Honolulu, etc. Those who haven’t got them are Placentia Bay, Cape Town, Ras Tanura, Doha, Malmo, Honolulu, etc. Those who haven’t got them are Placentia Bay, Cape Town, Ras Tanura, Doha, Malmo, Honolulu, etc. Those who haven’t got them are Placentia Bay, Cape Town, Ras Tanura, Doha, Malmo, Honolulu, etc. Those who haven’t got them are Placentia Bay, Cape Town, Ras Tanura, Doha, Malmo, Honolulu, etc. Those who haven’t got them are Placentia Bay, Cape Town, Ras Tanura, Doha, Malmo, Honolulu, etc. Those who haven’t got them are Placentia Bay, Cape Town, Ras Tanura, Doha, Malmo, Honolulu, etc. Those who haven’t got them are Placentia Bay, Cape Town, Ras Tanura, Doha, Malmo, Honolulu, etc. Those who haven’t got them are Placentia Bay, Cape Town, Ras Tanura, Doha, Malmo, Honolulu, etc. Those who haven’t got them are Placentia Bay, Cape Town, Ras Tanura, Doha, Malmo, Honolulu, etc. Those who haven’t got them are Placentia Bay, Cape Town, Ras Tanura, Doha, Malmo, Honolulu, etc.

The reason for Decca’s remarkable success in this specialised field is speed. The policy is to use off-the-shelf radars and displays as used at sea and re-package them for shore use. The radars are generally mounted on towers, perhaps 100ft tall, on headlands so that the whole area is covered with good overlap. The microwave links for transmitting radar data and VHF radio systems for talking to the ships are all bought-in items. So Decca can quickly tailor a system for an individual port or harbour.

A change of circumstances can suddenly demand a fairly quick installation. Who would have imagined five years ago that Aberdeen would need a harbour radar? The huge upsurge in traffic movements now comes from North Sea Oil. Decca has designed a Marshall’s traffic, safety and, one imagines, to the profit of all.
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---

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**SPEAKER BARGAINS**

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
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<tbody>
<tr>
<td>ELAC 10m 8 ohm Dual cone</td>
<td>3.90</td>
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<tr>
<td>GOODMAN 6ji6 8 ohm Dual cone</td>
<td>2.15</td>
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<tr>
<td>FANE, 3 in x 4 in, 3 8 ohm</td>
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<tr>
<td>ADAPTRAP 10m, 8 or 15 ohm, 10W</td>
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<tr>
<td>BAKER GROUP 12 in, 8 or 15 ohm 20W</td>
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<td>7 in, 8 ohm, 64 ohm</td>
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<td>10W</td>
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**TWISTED & CROSSOVER**

<table>
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<tr>
<td>Twist Tweeter 5 ohm, 8 ohm C/Mag.</td>
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<td>Cone Tweeter 8 or 16 ohm, 10W</td>
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<td>Cone Tweeter 8 ohm, 20W</td>
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<td>Horn Tweeter 8 ohm, 20W</td>
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**KITS & COMPLETE CABINETS**

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<tr>
<td>SW25</td>
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<tr>
<td>8 in x 5 in speaker</td>
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<tr>
<td>8 in x 5 in x 9 in with 8 in</td>
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<tr>
<td>8 in x 5 in x 9 in with 6 in 2in cutout</td>
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<td>17 in x 10 in x 9 in with 8 in</td>
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**MICROPHONES**

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<tr>
<td>CM75 Plastic shell metal &amp; crystal switch</td>
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<tr>
<td>EM100 Dynamic condenser, ball metal</td>
<td>2.85</td>
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<tr>
<td>UD120 100/600 ohm, unidir. ball metal</td>
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**SOLDERING IRONS**

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<tr>
<td>ANTEX CN4010 15W</td>
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<td>SK1 Kit 15W iron, 15W</td>
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**CARTRIDGES AND STYLIS**

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<tr>
<td>ACOR GP1'/28c or 28c Stereo C/Mag.</td>
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<td>GP1'/28c or 28c Stereo ceramic</td>
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<td>GP1'/28c or 28c Stereo ceramic</td>
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<td>BR 5W-25T or 25T Stereo crystal</td>
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<td>SX100 or SX100H Crystal comp.</td>
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<tr>
<td>3.00 or 3.0H Crystal comp.</td>
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**LOW NOISE CASSETTES**

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<tr>
<td>C60 35g 35g 80g</td>
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<td>C30</td>
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<td>C100 50g 50g 50g</td>
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**BI-BIB ACCESSORIES**

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<td>Tape Editing Kit, Ref. 25</td>
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<td>Recording Tape Splicer, Ref. 20</td>
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<td>Cassette Tape, Editing, Ref. 4.50</td>
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<tr>
<td>Cassette Balage Kit, Ref. 29 0.45</td>
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<tr>
<td>12 in Cassettes Case, Ref. 34</td>
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<td>20 in Cassettes Case, Ref. 35</td>
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<td>Service Record, Ref. 46</td>
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<tr>
<td>Hifi Stereo Test Cassette</td>
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<td>Groove-Kleen Record Cleaner</td>
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**BARGAINS**

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Practical Electronics

November 1974
AUTOMATIC CHOKE CONTROL FOR CARS

In BP 1 334 532 Joseph Lucas (Industries) Ltd. describes circuitry suitable for alternately operating a pair of electromagnets to allow the step-by-step movement of a car choke cable back into an off position depending on engine temperature.

In Fig. 1 operation of electromagnets 1 and 2 is dependent on the temperature sensed by thermistor R1, the resistor having a sharply decreasing resistance with increasing temperature.

When the choke knob is pulled out the wipers of the rotary switch S1a and S1b move into engagement with fixed contacts. When the engine starts, the generator speed increases and the vehicle voltage regulator closes contact S2 in conventional manner. Electromagnet 1 is now energised by contact 5, S1a wiper and moves the choke cable back towards its inoperative position. Additionally the wiper is moved onto contact 4a and S1b wiper onto contact 4b. Thus the circuit to electromagnet 1 is broken; electromagnet 2 is effectively inoperative because the current flowing through it via resistors R2 and R3, diode D1 and VR2 is insufficient to energise it.

When the temperature sensed by R1 rises further its resistance falls and transistor TR1 turns off. Current now flows via R6 and D2 to turn on thermistor CSR1. The current flows through D4 to energise electromagnet 2 and the choke cable now moves further back towards its inoperative position. At the same time the wiper of S1b is moved onto contact 3b and the wiper of S1a onto contact 3a. This breaks the circuit to electromagnet 2 and electromagnet 1 receives insufficient current to energise it via VR4. The thyristor is "off", its circuit being broken upon movement of S1b away from contact 4.

When the engine temperature rises further the resistance at R1 drops further and the CSR1 turns "on". Electromagnet 1 is energised, via D6, and S1a, b moves onto the contacts 2a and 2b. The sequence continues with electromagnet 2 energised via D3 when the engine temperature rises further and the S1a and S1b move into the position shown in Fig. 1.

As a final step, electromagnet 1 is energised, via D5, bringing the choke cable into its inoperative position.

The setting of potentiometers VR1 to VR4 determines the temperature at which the cable moves back step by step; a thermistor R5 compensates for changes in ambient temperature.

VARIABLE TONE AUDIBLE ALARM

Various audible alarm generators are known but few of them have the facility to produce a wide range of different sounds. But a tonal range may be highly desirable, for instance, to signal different conditions, e.g., smoke warning, flame warning, gas warning.

In BP 1 341 842 A. J. Whetton and Company (Manufacturing) Ltd. describes a fairly simple circuit which will emit different sounds depending on the condition of any suitable external switching system.

The circuit, Fig. 1, uses a relatively low frequency multivibrator, a high frequency multivibrator, an output amplifier and a loudspeaker.

The two multivibrators and amplifier are of known type except that the second multivibrator has a gate in the form of TR4 arranged between the base of TR3 and the negative line. Thus, when a sufficient voltage is applied to TR4 base to drive it into conduction, the operation of the multivibrator is inhibited.

The frequency of the multivibrators is adjusted by potentiometers VR1 and VR2. The alarm circuit can function in five different manners depending on the externally switched inter-connections between the inputs.

A slow warbling sound will be produced when input 3 is switched to input 4 so that the square wave output of first multivibrator causes a periodic frequency shift in the second multivibrator. In this condition the mean or basic frequency of the sound produced is adjustable by potentiometer VR2 and the frequency of warble by VR1.

A fast warbling sound is produced by connecting input 2 to input 1 to short out VR1. The mean or basic frequency can still be adjusted by VR2 although the frequency of warble can no longer be adjusted.

A slow intermittent pipping sound is produced if inputs 5 and 3 are connected so that the operation of the second multivibrator is periodically inhibited by the operation of the first multivibrator. The frequency of the sound is adjustable at VR2 and the frequency of the pip at VR1. For a fast pipping sound input 2 is switched to input 1 to short out VR1.

Finally a continuous note may be produced by connecting input 6 to the positive supply line to cause continuous operation of the second multivibrator. TR3/5. The frequency of the note is adjusted at VR2. In this mode diode D1 prevents operation of the first multivibrator.

Copies of Patents can be obtained from the Patent Office Sales, St. Mary Cray, Orpington, Kent. Price 25p each.

Fig. 1
MARKETPLACE

Items mentioned in this feature 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.

WIRING AID

It is always rewarding to bring to the attention of readers a new product that will be used just as much, if not more, by the amateur as the professional.

This should certainly be the case with the new self-adhesive wiring staples from Special Products Distributors Ltd. Known as the Bendorau staple they are ideal for all types of wiring both domestic and equipment wiring.

By peeling off the protective backing from the adhesive pad the staples can be positioned and pressed into place. The adhesive pad is such that it will adhere to most surfaces. Once in position the wire is placed across the clamping fingers which are easily bent up over the wire to hold it in place.

In use the staples have been found particularly useful where groups of wires have to be routed to control panels. Also, they helped to improve wiring layouts and made it far easier for lead tracing when using this method.

One obvious use for these staples that comes to mind is for tidying up the masses of wiring used in projects like an electronic piano or an electronic organ.

Further details and addresses of nearest stockists can be obtained from Special Products Distributors Ltd., 81 Piccadilly, London, WIV 0HL.

VAT CALCULATOR

Readers who have trouble with VAT may be interested in the Vatman pocket calculator from Decimo Ltd.

Aimed at the businessman who needs to save time working out his VAT returns when doing his monthly accounts, the calculator is a four function machine with a fairly large, clear readout display. Operation of the percentage key gives an instant per cent readout and can cover any percentage should the present 8% VAT rate change.

With the incorporation of the percentage key it is claimed that at £21.95 (plus VAT) the Vatman is one of the cheapest calculators of its kind on the market. The price of the calculator includes a mains adaptor unit.

Full details of its capabilities can be obtained from Decimo Ltd., Park House, 96–98 Park Street, Luton, LU1 3RX.

Further information and full details of the complete range of speaker kits and enclosures can be obtained from Helme Audio Products Ltd., Summerbridge, Harrogate, HG3 4DR.

LOW VOLTAGE FLUORESCENT LIGHT KIT

It now seems to be an annual event at this time of the year for industrial relations to become very strained and an investment in any form of emergency lighting is a wise precaution against any power cuts. With this in mind Electronic Design Associates are now producing an 8W 12V fluorescent lighting kit.

The kit consists of a printed circuit board, components, pre-drilled metalwork, clips, end caps, cable, the tube, nuts and bolts and full constructional instructions.

The light is ideally suited as a caravan and camping light, for garage or workshop lighting, as an inspection light, and for general home use. In use the light is reverse polarity protected and takes approximately 0.6A from the battery.

Available from Electronic Design Associates, 82 Bath Street, Walsall, WS1 3DE, the cost of the kit is £3.19 including VAT, postage and packing. A light diffuser is available as an extra for 59p including VAT and p&p.

It is only fair to point out that several of our advertisers also produce excellent 12V fluorescent lighting kits from 8W to 13W.
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N.B. PS70 is not suitable for the SA50

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DISCO MODULE £9.50 Carr. 20p
Thousands sold of this extremely popular mono version. A mix input may be fitted using the VA30 (see below). Low consumption from a 9V battery. Features the same high standards of reproduction as the Stereo version. Controls: H/phone select, vol, Left deck vol, Right deck vol, bass, treble, master vol. Size 12in x 3in x 2in deep.

3-CHANNEL SOUND-LITE £22.50 Carr. 30p
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SINGLE CHANNEL VERSION £7.50 Carr. 20p
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MULTI-PURPOSE MIXERS

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VA30 CHANNEL £3.50 Carr. free
This is the basic channel module in the above mixers and may also be used for extra inputs on either the mono or stereo mixers. Fitted with volume, bass and treble controls, requires just a jack and supply (9-100V)

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- Dressing Plinth Cover
- £14.95

**SANYO 2W Audio I.C. Amp LA4031P**

<table>
<thead>
<tr>
<th>Component</th>
<th>Price</th>
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<td>Thorens 10135AB Mk II</td>
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<td>Thorens 10145 ABC</td>
<td>£52.95</td>
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<tr>
<td>Transcriptor Saturn with Vesuvial Arm</td>
<td>£83.95</td>
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**TUNERS**
- Please add £1.05 for P & P & Ins.
- Amstrad MLX 3000
- £24.95
- Eagle A410
- £45.95
- Eagle T1102
- £22.05
- Metro Sound FMS20 Mk II
- £33.35
- Telefun T700
- £28.70

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- Please add £1.05 for P & P & Ins.
- Garrard SP25 Mk IV Chassis
- £29.95
- Pioneer A510D
- £32.95
- Eagle AA8
- £24.45
- Eagle AA8 3000
- £28.70

**GARRARD SP25 Mk IV Chassis**

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<td>Goldring GL75 P C 0800</td>
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<td>Garrard 401 Chassis</td>
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<td>Garrard 86SB Chassis</td>
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<td>Pleas. add 01.05 for P. &amp; P. &amp; Ins.</td>
<td>£13.95</td>
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**CARTRIDGES**
- Please add £1.05 for P & P & Ins.
- Goldring G800E
- £32.95
- Goldring G800H
- £36.75

**SPEAKERS**
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- Goodmans Compact 10 (Teak)
- £191.00

**COMBINATION UNITS**
- Please add £1.10 for P & P & Ins.
- Goodmans Compact 10 (Teak)
- £191.00

**COMBINATION UNITS**
- Please add £1.10 for P & P & Ins.
- Goodmans Compact 10 (Teak)
- £191.00

**Stereophone Kits**

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</tr>
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<td>Eagle AA8 3000</td>
<td>£24.45</td>
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</tbody>
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- *Smoother running at high speed*  
- *Fuel saving*  
- *Easier starting from cold*  
- *No more contact-breaker burn.*

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Ready Made Unit £14.75 inc. VAT and p & p.  
State 6V or 12V system.

Send SAE now for details and free list.

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As featured in the May 1973 issue of 'Practical Electronics'.
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- *All components as specified by original authors, and sold separately if you wish.*
- *Full constructional data book with specification graphs, fault finding guides, etc. 55p plus 4p postage.*
- *Price List only. Please send S.A.E. (preferably 9 x 4 minimum) for full details.*
WILMSLOW AUDIO

THE Firm for speakers!

SPEAKERS

<table>
<thead>
<tr>
<th>Brand</th>
<th>Model</th>
<th>Price</th>
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- 2A: £6.20
- 5mA: £7.70
- 1mA: £7.70
- 2mA: £7.70
- 5mA: £8.80

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- 100mA: £3.30
- 200mA: £3.30
- 500mA: £3.30
- 1A: £3.30
- 6A: £3.30
- 5mA: £4.10
- 1mA: £4.10
- 2mA: £4.10
- 5mA: £4.10

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- Size: 42 x 42mm
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- 100mA: £3.00
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- 500mA: £3.00
- 1A: £3.00
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- 1mA: £3.80
- 2mA: £3.80
- 5mA: £3.80

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- 200mA: £5.45
- 500mA: £5.45
- 1A: £5.45
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- 5mA: £7.70
- 1mA: £7.70
- 2mA: £7.70
- 5mA: £7.70

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- 6A: £3.90
- 5mA: £5.00
- 1mA: £5.00
- 2mA: £5.00
- 5mA: £5.00

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- 200mA: £4.45
- 500mA: £4.45
- 1A: £4.45
- 6A: £4.45
- 5mA: £5.20
- 1mA: £5.20
- 2mA: £5.20
- 5mA: £5.20

## POSTAGE & PACKING 15p

**TOTAL PURCHASE PRICE**

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**Total**

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<th>Size cm.</th>
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<td>6.5 x 11.8 x 10.2</td>
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<td>187</td>
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<td>1.5</td>
<td>0.21</td>
<td>3.0 x 2.0 x 1.0</td>
<td>£4.40</td>
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<td>3.0</td>
<td>0.42</td>
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<td>0.83</td>
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<td>9.0</td>
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Other Digitronic clocks, fully built: DIT/4 Four-digit version, £29.65; DIT/7 Fourdigit version, £33.65; DIT/12 StopWatch version, £43.65; DIT/17 placed in clear Perspex, £39.65; DIT/7 placed in clear Perspex, £42.65.

Quartz Xmas available on built versions of all DIT clocks, £9.65. DITTime/Date/Alarm, £4.50.

Digitronic clocks are also available through many other retail outlets including: Merry's Radio Ltd., Edgeware Road, Studio Electronics, Harlow, Goddards Components, St. Albans.

Payment by Cash—reg letter, Cheque, P.O., M.O. Access—simply quote your number.

Bywood Electronics, 181 Ebbwans Road, Hemel Hempstead HP3 9RD. Tel. 0442 62757

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Complete kit with leaflet £21·00 (G.B. post paid).

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---

**TRANSCISTORIZED MODULES**

Tuners-Power Suppliers-Amplifiers

**Amplifiers (All single channel unless stated)**

<table>
<thead>
<tr>
<th>Power</th>
<th>Model</th>
<th>Type</th>
<th>Model</th>
<th>Type</th>
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<tbody>
<tr>
<td>4-300</td>
<td>9V</td>
<td>Mono</td>
<td>2500V</td>
<td>Mono</td>
</tr>
<tr>
<td>230V</td>
<td>9V</td>
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<td>2500V</td>
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<tr>
<td>105</td>
<td>12V</td>
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<td>2500V</td>
<td>Mono</td>
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<td>205</td>
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<td>76</td>
<td>12V</td>
<td>Mono</td>
<td>2500V</td>
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</table>

**FM Modules**

Mullard LP116 FM tuner (reprint edition) with 10 MHz. 0.1% 4.45
Mullard LP118s (0.7 MHz) with unit 4.45
Garvin Perren FM tuner (reprint edition) with 10 MHz 4.45

**FM and AM tuners and decoders**

FMS31 (12) 2.6 AM FM tuner 7.95

**Preamplifiers**

S120 Mono/Mono Power Preamplifier 6.75

**Power Supplies—Mains input** (chassis-rest cased)

<table>
<thead>
<tr>
<th>Model</th>
<th>Type</th>
<th>Model</th>
<th>Type</th>
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<tbody>
<tr>
<td>100/24</td>
<td>12V</td>
<td>Mono</td>
<td>500mA</td>
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<tr>
<td>100/24</td>
<td>12V</td>
<td>Mono</td>
<td>500mA</td>
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<tr>
<td>100/24</td>
<td>12V</td>
<td>Mono</td>
<td>500mA</td>
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</tbody>
</table>

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**EXCLUSIVE DECCA KELLY SPEAKERS**

12W speaker. Stereo systems. 8in bass loudspeaker. Monaural 2.5W, 2.5W, stereo 5W, 5W. £18.00 each. Complete kit with tweeters and control circuit. £25.00 each. £40.00 pair. (See also page 45).

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15W 8 ohm speaker (pair £25.00)
15W 8 ohm speaker (pair £25.00)
15W 8 ohm speaker (pair £25.00)

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Printed Circuit Panels 50p

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**SINCLAIR MODULES**

**SINCLAIR PROJECT No. 1**

ST80 stereo amp 11.75

**SINCLAIR PROJECT No. 2**

ST40 30W Amp 6.51

**SINCLAIR PROJECT No. 3**

ST40 30W Amp 6.51

**SINCLAIR PROJECT No. 4**

ST40 30W Amp 6.51

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**JOSTY KITS IN STOCK**

(Post stc. 15p each)

<table>
<thead>
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<th>Code</th>
<th>Description</th>
<th>Price</th>
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<td>Mono transistor amp</td>
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</tr>
<tr>
<td>AF3</td>
<td>25W Mono transistor</td>
<td>3.30</td>
</tr>
<tr>
<td>AF30</td>
<td>Mono transistor pre-amp</td>
<td>3.30</td>
</tr>
<tr>
<td>AF4</td>
<td>15W Mono transistor</td>
<td>3.30</td>
</tr>
<tr>
<td>AF5</td>
<td>Monaural 3W amp</td>
<td>3.30</td>
</tr>
<tr>
<td>AF50</td>
<td>Mono 3W amp (for stereo use)</td>
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<tr>
<td>AF6</td>
<td>Microphone</td>
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<td>AF7</td>
<td>Microphone 3W</td>
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<td>AF8</td>
<td>Line level HF pre-amplifier</td>
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<tr>
<td>AF9</td>
<td>5W Mono no. 8</td>
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<td>AF10</td>
<td>Mono HF pre-amplifier</td>
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<tr>
<td>AF11</td>
<td>Mono HF pre-amplifier</td>
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</tbody>
</table>

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**SPECIAL PURCHASE**

**EMI SPEAKERS**

**EXCLUSIVE**

5 WATT IC

**SPECIAL PURCHASE**

**FREE STOCK LIST**

No 36 Transistors估值 semiconductors

**FREE SAMPLES**

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