Use Your FREE TRANSISTORS with the 6 PROJECTS in this issue!!

What does it cost to run??

telelectric Cost Monitor

Plus... EMERGENCY LIGHT
Much more than just kits quite simply the best way to make music . . .

The smart contemporary styling of the 'black-boxes' contain the easy-to-build advanced electronics that produce everything from high grade amplification to complex lighting effects. These units are among the finest of their kind available and combine, as do all the Powertran kits, constructional ingenuity with high grade performance capability.

The finest materials and components are used throughout and the easy-to-follow fully illustrated and diagrammed manuals make building as pleasurable as operating.

Each unit can, of course, perform its independent function - but it is compatible with its fellows (same cabinet sizes and the same quality and professional finish) to enable you to assemble an impressive bank of wholly controllable power.

MPA 200 - a 100W amplifier with professional finish and performance at an exceptionally low price. Adaptable inputs mixer accepts a variety of sources. Straightforward construction - an excellent beginners kit.

COMPLETE KIT £49.90 (+ VAT)

CHROMATHEQUE 5000 - 5 channel lighting effect system. Sound to light, strobe to music level, random or sequential effects - each channel handles up to 500W yet minimal wiring is needed with our single-board design.

COMPLETE KIT £49.50 (+ VAT)

ETI VOCODER - 14 channel for maximum versatility and high intelligibility; each channel has independent level control. 2 input amplifiers - for speech/external excitation - each with level control and tone control. The Vocoder is a superb machine capable of infinite variety of operation. Construction with our easy to follow, comprehensive builders' manual - is challenging yet within the scope of most enthusiasts.

COMPLETE KIT £175 (+ VAT)

SP2 200 - 2 channel 100W amplifier. Two of the rugged, reliable and economic amplifiers from the MPA200 are fed by separate power supplies from a common toroidal transformer. Fully finished metalwork, fibreglass PCBs, controls, wire - everything you need to make this powerful unit.

COMPLETE KIT £64.90 (+ VAT)

DJ90 STEREOMIXER - a versatile new mixer with 2 stereo inputs for magnetic cartridges, a stereo auxiliary input and mike input. Auto planning for fast or slow, slider controls, multi-mixing, ducking, interrupt, input modulation - everything ... yet still under £100! (Our console below shows the mixer neatly teamed with a Chromatheque and SP2 200)

COMPLETE KIT £97.50 (+ VAT)
CONSTRUCTIONAL PROJECTS

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Can provide instant and long-term cost monitoring of almost any electrical appliance

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OUR APRIL ISSUE WILL BE ON SALE FRIDAY, 12th MARCH 1982
(for details of contents see page 39)
### POLYTETRAFLUORETHYLENE Capacitors

<table>
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<th>Part Number</th>
<th>Value (µF)</th>
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<td>X5R44</td>
<td>0.022 µF</td>
<td>X5R50</td>
</tr>
<tr>
<td>0.047 µF</td>
<td>X5R44</td>
<td>0.068 µF</td>
<td>X5R47</td>
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<td>X5R47</td>
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**Note:** These capacitors are suitable for use in high-frequency applications and are characterized by their low dielectric absorption and high DC voltage ratings.

### RESISTORS

- **Value:** 500 ohms
- **Type:** Fixed 5% carbon film

### COMPUTER I/C's

- **Model:** 74240
- **Part Number:** 74LS240

### TTL 7400

- **Model:** 7402
- **Part Number:** 74HC02

### 75 Series

- **Model:** 74S153
- **Part Number:** 74LS153

### 74LS Series

- **Model:** 74LS125
- **Part Number:** 74LS125

### Practical Electronics

- **Issue:** March 1982
- **Page:** 2

---

**Disclaimer:** The content provided is based on the image provided and may not be entirely accurate. For the exact and most up-to-date information, please refer to the actual issue of the magazine or consult the manufacturer's specifications.
### OPTO ELECTRONICS

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<tr>
<td>24V</td>
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### SPEAKERS

- **Attractive**
  - 2N4444
  - 2N5064
  - C106D38
  - 5A/300V
  - 0A84-100V
  - 6A/800V
  - 64/400V

### TRANSMITTERS

- **Mini-Transmitter**
  - ST2
  - ST2

### CRISTAL

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### DIL SOCKETS

- **Texas**
  - 1 Way
  - 2 Way
  - 3 Way
  - 4 Way
  - 5 Way
  - 6 Way
  - 7 Way
  - 8 Way
  - 9 Way
  - 10 Way

### DIL PLUGS (Standard)

- **90° Wrap**
  - 90° Wrap
  - 90° Wrap
  - 90° Wrap
  - 90° Wrap
  - 90° Wrap
  - 90° Wrap
  - 90° Wrap
  - 90° Wrap
  - 90° Wrap

### TRANSFORMERS

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### EPSON MX SERIES PRINTERS

- **New**
  - MX80T
  - MX80TF

### WATFORD'S UNIVERSAL MICRO EXPANSION SYSTEM

- **New**
  - Full Kit: £36.50
  - Full Kit: £40.50
  - Full Kit: £43.50
  - Full Kit: £46.50
  - Full Kit: £49.50
  - Full Kit: £52.50
  - Full Kit: £55.50

### WATFORD'S ULTIMATE MONITOR IC.

- **A 4K Monitor Chip specially designed to produce the best from your Superboard Series I & II. Improved Superboard & Micro Processor Systems will soon be available.**

### WATFORDS ELECTRONICS

- **Tel:** 0923 40588
  - **Telex:** 896590S
**MASTER ELECTRONICS NOW!**

*The PRACTICAL way!*

This new style course will enable anyone to have a real understanding of electronics by a modern, practical and visual method. No previous knowledge is required, no maths, and an absolute minimum of theory.

You learn the practical way in easy steps mastering all the essentials of your hobby or to start or further a career in electronics or as a self-employed servicing engineer.

All the training can be carried out in the comfort of your own home and at your own pace. A tutor is available to whom you can write personally at any time, for advice or help during your work. A Certificate is given at the end of every course.

---

**DIGITAL VOLTMETER MODULE**

*Fully built & tested*

- Positive and negative voltages with an FSD of 999mV which is easily extended.
- Requires only single supply 7-12V.
- High overall accuracy ± 0.1% + 1 digit.
- Large bright 0.45” (11mm) LED displays.
- Supplied with full data and applications information.

Using this fully built and calibrated module as a basis now means that you can easily build a wide range of accurate equipment such as multimeters, thermometers, battery indicators, etc., etc. at a fraction of the cost of ready-made equipment. Full details are supplied with each module showing how to easily extend the voltage range and measure current, resistance and temperature. Fully guaranteed, the unit has been supplied to electricity authorities, Government departments, universities, the P.D. and many companies.

**Temperature Measurement**

£2.15 +VAT

An easily constructable kit using an I.C. probe providing a linear output of 10mV°C over the temperature range from -10°C to +100°C. The unit is ideal for use in conjunction with the above DVM module providing an accurate digital thermometer suitable for a wide range of applications.

**Power Supply**

£4.95 +VAT

This fully built mains power supply provides two stabilised isolated outputs of 9V providing current levels of up to 250mA each. It is ideally suited for powering the DVM and the Temperature Measurement module.

In addition to the above a wide range of competitively priced electronic components is stocked. Please telephone your specific requirements.

- V.A.T. must be added on all items.
- Shop hours 9 - 5.30 (Weds. 9 - 1)
- Ex-stock delivery on all items.
- Units on demonstration, callers welcome.
- Post and packing charge 50p per order.
- S.A.E. with all enquiries please.

---

**ER TING OFFERS!**

**ULTRASONIC ALARM MODULE**

*Fully built & tested*

- A really effective fully built module which contains both ultrasonic transmitter and receiver, together with the necessary circuitry for providing the appropriate delays and false alarm suppression. Using this module with a suitable 12V power supply and relay unit such as that shown, a really effective though inexpensive intruder alarm may be constructed. The module, which is supplied with a comprehensive data sheet, is easily mounted in a wide range of enclosures. A really drilled case, together with all the necessary hardware, is available below.

---

**RISCOMP LIMITED**

Dept. PE5,
21 Duke Street,
Pricns Risborough, Bucks.
Tel: Prices Risborough (08444) 6326

---

**MATERIAL OPTIONS**

**Power Supply & Relay Unit £3.95 + VAT**

Incorporating a stabilised 12V supply and a s.p.c.o. relay with 3A contacts, this unit is designed to operate in conjunction with the above ultrasonic unit. Fully built and tested, its compact size makes it ideal for constructing the smallest of units.

**Siren Module £2.57 + VAT**

Producing a very loud and penetrating wailing sound, this module operates from 9-15 volts, capable of driving one or two 8 ohm speakers. Suitable horn speakers available at £4.30 each plus VAT.

**Hardware Kit £3.95 + VAT**

A suitable ready drilled case together with the various mounting pillars, nuts and bolts, and including mains switch and 2mm sockets designed to house the ultrasonic alarm module, together with its associated power supply. Size 153mm x 120mm x 45mm.
DO YOU LONG TO HEAR YOUR DOORBELL RING?

Our latest kit gives you a pleasing three-tone harmonically related tone sequence (not a microprocessor controlled buzz or the same old ding dong) at a touch of a button. This kit, based on a new integrated circuit, is supplied complete with a plastic circuit board, loudspeaker and drilled box and requires only 8V battery and push button common to most households.

This may also be switched by logic in such applications as car alarms, clocks, toys, P.A. systems, etc. The unit produces a push output and draws less than 1mA from a PP3 battery when the tone is on. Supplied complete with circuit and assembly instructions.

IDEAL PROJECT FOR BEGINNERS—ONLY £3.00

ALL PRICES EXCLUDE VAT

EDUCATIONAL EXPANSION WITH SOFTY 2

Plug SOFTY 2 into the EPR0M socket of your micro (Z80, 6800, 8035, etc.) and forget it. SOFTY 2 will operate as the ROM in your prototype system but enable you to write data into any location, observe memory contents on any black & white TV and store the programme on a cassette recorder if required. Various editing facilities are also available, permitting data to be inserted, deleted or changed, inserted, deleted, etc., enabling the programme to be developed and run on the host computer.

After "debugging" SOFTY 2 may be used to programme an EPR0M (2176 or 2732). You can also use it as an intelligent EPR0M programmer to copy EPR0M's from a master or from tape.

Housed in a tough ABS case SOFTY 2 comes complete with a mains supply cable and 24-pin interface.

FULLY BUILT AND TESTED—ONLY £119.00

For further details of SOFTY 2 and the new Z80 Assembler/Micro Controller-Menta available at just £113.00 please send stamped addressed envelope.

THE PERFECT AID FOR "LAZYTIS"

Now you can run your central heating, lighting, hi-fi system and lots more with just your programme memory. At your selection it is designed to control four mains outputs independently, switching on and off at pre-set times over a 7 day cycle, e.g. to control your central heating (including different switching times for wakening), just connect it to your micro programme and set it and forget it—the clock will do the rest.

FEATURES INCLUDE—

- 0.5" LED 12 hour display.
- Day of week, custom and output status indications.
- a zero voltage switch mains outputs.
- 10/60E mains operation.
- Battery backup stores stored programmes and continues time keeping during power failures.
- (Battery not supplied)
- Display blanking during power failure to conserve battery power.
- 32 programme memory.
- Powerful "Everyday" function enabling output to be switched on or off at any pre-set time. (eg. to control your central heating or allow the windows to be opened/ closed for ventilation at night).
- 24 timer interface
- (Not all features tested)
- Direct switch control enabling output to be turned on or off at a specified time or immediately after a specified delay.
- 20 function keypads for programme entry.
- Password verification at the touch of a button.

TDF300K Clock Kit £14.30

TDF400K Assembler/Micro Controller (Menta) £4.20

The unit has considerable practical uses, especially for the elderly, infirm and disabled. It works like a conventional dimmer, enabling you to switch the lights on or off, or to dim them to whatever brightness you require, by touch or using the keypad. It can be a permanent or a temporary control. When assembled, it fits into a 5" plastic drawer to replace your conventional switch or dimmer with no wiring.

Add 50p postage & packing & 15% VAT to total.

24 HOUR CLOCK/APPLIANCE TIMER KIT

Switches any appliance up to 1kW on and off at pre-set times, day or night. Kit contains: CT100K Basic Kit £14.90

CT100K with white box (5613) £17.40

(Ready built). £22.50

Add £1.50 (Europe), £4.00 (elsewhere) for p&p. Send S.A.E. for further STOCK DETAILS. Goods by return subject to availability. 9am to 5pm (Mon to Fri) 10am to 4pm (Sat)

THE GARAGE DOOR AT YOUR COMMAND

At last, a kit to enable your motorised garage door to be opened without getting foot from your car, or also on or off at the touch of a button. The unit is a micro controller based circuit with a fully built-in relay option, when included, with a relay,ving, two fact fed, timers fed by a LED switching two, 3a mains feeds, the remote set for solid state switches (1kW mains), A hand-held function keys. Open/Closed, On/Off, etc., covering a range of approximately 40 feet inclusive. A switching lights, television and other appliances. This unit is ideal for the aging or disabled.

304X304K Garage Door Kit £23.75

THE PERFECT AID FOR "LAZYTIS"

24 HOUR CLOCK/APPLIANCE TIMER KIT

Switches any appliance up to 1kW on and off at pre-set times per day. Kit contains: CT100K Basic Kit £14.90

CT100K with white box (5613) £17.40

(Ready built). £22.50

Add 50p postage & packing & 15% VAT to total.

THE PERFECT AID FOR "LAZYTIS"

24 HOUR CLOCK/APPLIANCE TIMER KIT

Switches any appliance up to 1kW on and off at pre-set times per day. Kit contains: CT100K Basic Kit £14.90

CT100K with white box (5613) £17.40

(Ready built). £22.50

Add 50p postage & packing & 15% VAT to total.
Since 1972 Clef Products have consistently produced leading designs in the field of Electronic Musical Instruments, many of which have been published in technical magazines. With musical quality of paramount importance, new techniques have been evolved and the latest musically valid technology has been incorporated into projects which have been successfully completed by constructors over a wide range of technical capability. Back-up TELEPHONE advice to our customers is available from the Designer of all Kits advertised.

**String Ensemble**

(As Published in conjunction with "Practical Electronics")

A very popular Keyboard Synthesizer Kit for Group or Home use, with a four octave compass and split Keyboard facility.

The instrument is fully polyphonic and has two rich Multi-String Voices plus Woodwind and Brass Effects for individual or Mixed use. Variable Attack and Sustain Controls give a good Orchestral Mix with the ideal concert hall reverberation effect produced by sustain coupled with phase modulation in the Chorus Unit. The Component Kit includes Keyboard, Key-switch hardware, and all electronic components plus tone generator linking wire and Volume Pedal. A copy of the PE project series can be supplied for £3.00 inc.

**Component Kit £217**

**Rotor-Chorus**

Comprehensive two speed organ rotor simulator plus a three stage chorus generator on a single chassis, includes all components for the rotor and a stereo headshell driver kit. Easily in installed with existing organ/synthesizer system.

**Component Kit £59.00**

**Keyboards**

Our Square Front Keyboards are chosen for their superior feel for the discerning musician whilst giving adequate physical strength for the high impact playing patterns in the Piano application.

**Component Kit £59.00**

**Experiments**

A number of our Sub-Kits are of interest to Electronic Music and EXPERIMENTERS. Experiments include Viewable MICRO-SEQUENCER and Synthesizer Kit. We offer a complete line of Experiments plus tone generator hardware, and all electronic components plus tone generator linking wire and Volume Pedal. A copy of the PE project series can be supplied for £3.00 inc.

**Component Kit £20.00**

**Pianos**

Four Stage Kit incorporating Master Rhythm.

**Component Kit £244**

**Stage Model**

A revolution in the field of Carstens Music Generation!

A MUSICIANS INSTRUMENT FOR:

SOLOISTS - SINGERS - RECORDING - PRACTICE

A COMPLETE KIT £345

MANFD.

**Prices Include Master Rhythm**

A revolution in the field of Computer Music Generation!

A MUSICAL INSTRUMENT FOR:

SOLOISTS - SINGERS - RECORDING - PRACTICE

A COMPLETE KIT £289

Manuf.

**Prices Include Master Rhythm**

A revolution in the field of Computer Music Generation!

A MUSICAL INSTRUMENT FOR:

SOLOISTS - SINGERS - RECORDING - PRACTICE

A COMPLETE KIT £399

Manuf.

**Prices Include Master Rhythm**

A revolution in the field of Computer Music Generation!

A MUSICAL INSTRUMENT FOR:

SOLOISTS - SINGERS - RECORDING - PRACTICE

A COMPLETE KIT £499

Manuf.

**Prices Include Master Rhythm**

A revolution in the field of Computer Music Generation!

A MUSICAL INSTRUMENT FOR:

SOLOISTS - SINGERS - RECORDING - PRACTICE

A COMPLETE KIT £549

Manuf.
**MICROCOMPUTER COMPONENTS AND SYSTEMS**

**LOWEST PRICES**

**FASTEST DELIVERY**

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**Lowest Prices**

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<th>NEU 12&quot; MONITOR</th>
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<tr>
<td>GREEN DISPLAY</td>
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<tr>
<td>BUILT IN AMPLIFIER AND SPEAKER</td>
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</tr>
<tr>
<td>SPECIAL PRICE FOR CASE, KEYBOARD, TRANSFORMER &amp; HEATSINK IF PURCHASED</td>
<td></td>
</tr>
<tr>
<td>TRANSFORMER Mains transformer suitable for +5V at 2.5A and ±12V at 1A Mounts on special base (similar to the top selling Apple). Finished in charcoal and black.</td>
<td></td>
</tr>
<tr>
<td>CASE Attractively styled personal computer enclosure constructed of structured foam top and steel back (similar to the top selling Apple). Finished in charcoal and black.</td>
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<tr>
<td>EX-STOCK*</td>
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**EPROM PROGRAMMERS AND ERASER**

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<th>EPROM EMULATING PROGRAMMER</th>
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<tr>
<td>COPY PROGRAMME/EMULATE 2704/2706</td>
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<tr>
<td>2716/2560/2561/2562/2563 EPROMS</td>
<td></td>
</tr>
<tr>
<td>4K x 8 STATIC RAM</td>
<td></td>
</tr>
<tr>
<td>VIDEO ENTRY AND 9 DIGIT LED DISPLAY</td>
<td></td>
</tr>
<tr>
<td>POWERFUL EDITING FACILITIES</td>
<td></td>
</tr>
<tr>
<td>SIMPLIFIED VGO AS STD (RS232, TTL, 20mA PARALLEL DMA)</td>
<td></td>
</tr>
<tr>
<td>VAT. (15%)</td>
<td></td>
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<tr>
<td>EX-STOCK*</td>
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</tbody>
</table>

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| SAFETY INTERLOCKED |        |
| ELECTRONIC TIMER |        |
| VAT. (15%) |        |
| EX-STOCK* |        |

**KEYBOARD AND ENCLOSURE**

<table>
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<th>CASE</th>
<th>Attractively styled personal computer enclosure constructed of structured foam top and steel back (similar to the top selling Apple). Finished in charcoal and black.</th>
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</thead>
<tbody>
<tr>
<td>KEYBOARD</td>
<td>High quality electromechanical ASCII Encoded keyboard which can be fitted in above or case used separately. Fully upper and lower case provided.</td>
<td></td>
</tr>
<tr>
<td>TRANSFORMER</td>
<td>Mains transformer suitable for +5V at 2.5A and ±12V at 1A Mounts on special base inside enclosure.</td>
<td></td>
</tr>
<tr>
<td>HEATSINK</td>
<td>Heat sink for TO3 Regulators which mounts inside rear of enclosure.</td>
<td></td>
</tr>
<tr>
<td>VAT. (15%)</td>
<td>-------------------------------------------------------------------------------------------------</td>
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</table>

**SPECIAL PRICE FOR CASE, KEYBOARD, TRANSFORMER & HEATSINK IF PURCHASED TOGETHER:**

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- 指示器：用于指示特定信息或状态的设备，可能包括温度、湿度或风速等。
- 风速和方向定位器：一个测量风速和方向的设备，常用于气象应用。
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<tr>
<th>Qty</th>
<th>Item</th>
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<th>Item price £</th>
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<td>Sinclair ZX81 Personal Computer kit(s). Price includes ZX81 BASIC manual, excludes mains adaptor.</td>
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<td>49.95</td>
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<td>11</td>
<td>Ready-assembled Sinclair ZX81 Personal Computer(s). Price includes ZX81 BASIC manual and mains adaptor.</td>
<td></td>
<td>69.95</td>
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<tr>
<td>10</td>
<td>Mains Adaptor(s) (600 mA at 9 V DC nominal unregulated).</td>
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<td>8.95</td>
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<td>18</td>
<td>16K-BYTE RAM pack.</td>
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<td>27</td>
<td>Sinclair ZX Printer.</td>
<td></td>
<td>49.95</td>
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<td>8K BASIC ROM to fit ZX80.</td>
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**AS REVIEWED IN**

**ELECTRONICS TODAY INTERNATIONAL JUNE '81 ISSUE**

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The solution is a very high power, medium duration, spark generated by the TOTAL ENERGY DISCHARGE system. This gives ignition of the weakest mixtures with the minimum of timing delay and variation for a smooth efficient engine.

**SUPER POWER DISCHARGE CIRCUIT**

A brand new technique prevents energy being reflected back to the storage capacitor, giving 3 times the spark energy and 3 times the spark duration of ordinary C.D. systems, generating a spark powerful enough to cause rapid ignition of even the weakest fuel mixtures without the ignition delay associated with lower power 'long burn' inductive systems.

**HIGH EFFICIENCY INVERTER**

A high power, regulated inverter provides a 370 volt energy source — powerful enough to store twice the energy of other designs and regulated to provide sufficient output even with a battery down to 4 volts.

**PRECISION SPARK TIMING CIRCUIT**

This circuit removes all unwanted signals caused by contact volt drop, contact shuffle, contact bounce, and external transients which, in many designs, can cause timing errors or damaging un-timed sparks. Only at the correct and precise contact opening is a spark produced. Contact wear is almost eliminated by reducing the contact breaker current to a low level — just sufficient to keep the contacts clean.

**TYPICAL SPECIFICATION**

<table>
<thead>
<tr>
<th>TOTAL ENERGY DISCHARGE</th>
<th>ORDINARY ENERGY DISCHARGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPARK POWER (PEAK)</td>
<td>140 W</td>
</tr>
<tr>
<td>SPARK ENERGY (STORED ENERGY)</td>
<td>36 mJ</td>
</tr>
<tr>
<td>SPARK DURATION</td>
<td>500 µs</td>
</tr>
<tr>
<td>OUTPUT VOLTAGE (LOAD 50Ω)</td>
<td>38 KV</td>
</tr>
<tr>
<td>OUTPUT VOLTAGE (LOAD 50Ω + 500 KΩ)</td>
<td>26 KV</td>
</tr>
<tr>
<td>VOLTAGE RISE TIME TO 20 KV</td>
<td>25 µS</td>
</tr>
</tbody>
</table>

**TOTAL ENERGY DISCHARGE should not be confused with low power inductive systems or hybrid so called reactive systems.**

Goods normally despatched within 7 days.
This easy to build 3 band stereo AM/FM tuner kit is designed in conjunction with Practical Electronics (July issue). For ease of construction and alignment it incorporates three Mullard modules and an I.C. IF System.

FEATURES: VHF, MW, LW Bands, interstation muting and AFC on VHF. Tuning meter. Two back printed PCB's. Ready made chassis and scale. Aerial: AM- ferrad, FM -75 or 300 ohms. Stabilised power supply with 'C' core mains transformer. All components supplied are to P.E. strict front specification. Front scale size 10½"x 2½" approx. Complete with diagrams and instructions.

SPECIAL OFFER!  

- Matching L.C. 10+10 Stereo Power amplifier kit (usually £3.95 + £1.15 p&p)
- Mullard LP1183 built preamp - suitable for magnetic/ceramic and auxiliary inputs (usually £1.95 + 70p p&p)
- Matching power supply kit with transformer (usually £3.00 + £1.95 p&p)

TUNER KIT PLUS:  

£21.95 plus £3.80 p&p.  

ONLY  

£17.95 plus £2.50 p&p.

HIGH POWER AMPLIFIER KITS  

READY BUILT OR IN KIT FORM

<table>
<thead>
<tr>
<th>Power</th>
<th>Kit</th>
<th>BUILT</th>
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<tbody>
<tr>
<td>125 WATT</td>
<td>£10.50</td>
<td>£14.25</td>
</tr>
<tr>
<td>200 WATT</td>
<td>£14.95</td>
<td>£18.95</td>
</tr>
</tbody>
</table>

SPECIFICATIONS:  

- Output power (RMS)  
- Operating voltage (DCI)  
- Load  
- Frequency response  
- Sensitivity for 100 watts  
- T.H.D.  
- Dimensions (all models)  
- Power amp kit is a module for high power applications - stereo units, pulser amplifiers, public address systems and even high power domestic systems. The unit is protected against short circuiting of the load and is safe in an open circuit condition. A large safety margin exists by use of generously rated components, resists, a high powered rugged unit. The PCB Board is backed printed, etched and ready to drill for ease of construction and the aluminium chassis is preformed and ready to use. Supplied with all parts, circuit diagrams and instructions.

ACCESSORIES: Suitable LS coupling electrolytic for 125W model.  

<table>
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<tr>
<th>Power</th>
<th>Kit</th>
<th>BUILT</th>
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<tr>
<td>£1.00 plus 25p p&amp;p.</td>
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MONO MIXER KITS  

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<thead>
<tr>
<th>Power</th>
<th>Kit</th>
<th>BUILT</th>
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</thead>
<tbody>
<tr>
<td>50 WATT</td>
<td>£3.95 plus 25p p&amp;p.</td>
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</tbody>
</table>

- Six individually mixed inputs for two pick ups (C/O, or Mic.), two moving coil microphones and two auxiliary for tape, tuner, organs, etc. Eight slider controls - six for level and two for master bass and treble, fourteen extra treble controls for micro and aux inputs. Size: 13½"x5¾"x4" approx. Power output: 50 watts R.M.S. (continuous) for use with 4 to 8 ohm speakers. Attractive black vinyl case with matching fascia and knobs. Ready to use. | £39.95 plus £2.10 p&p. |

- Five vertical slider controls, master volume, tape level, mid level, deck level. PLUS INTERDECK FADER for perfect graduated change from record deck No. 1 to No. 2, or side verse. Pre fade level controls (PFL) lets YOU hear the next disc before fading it in. | £76.00 plus £4.50 p&p. |

MAIL ORDER ONLY  

218 BLACK STREET, ACTON, W3 BN6.

Note: Goods dispatched to UK postal addresses only. For further information send for instructions 20p plus stamped addressed envelope. All goods delivered within 14 days of receipt of order.
FREE
While reading the local paper recently, the thought occurred that there must be hundreds of electronics hobbyists with odd bits of test gear, audio equipment, or components stacked away that they could sell in an "under a tenner" column of the type now found in many local papers. During discussions in the editorial office it was thought to be an excellent idea and that we could run advertisements with no price limit, provided the service was only available to private readers and not to the trade or anyone making money from buying and selling anything to do with electronics. After all, the trade can advertise in our pages or take a classified space, but with the cost of classifieds rising it is not a viable proposition for the reader who would like to sell a few components, a speaker or a meter.

We think a readers free ad. page will be of interest to most readers, will encourage an interface between hobbyists and could realise some cash to help with our hobby. We want to encourage you to buy, sell or swap anything to do with electronics from a bag of resistors to a printer, computer, organ, TV or oscilloscope but we have decided that we cannot accept ads. for computer software. After all, if you're writing and selling software you are "in business" and if you're selling someone else's you're probably infringing their copyright!

PE BAZAAR
We have decided to call the feature PE Bazaar as we feel this term describes perfectly just what it's all about. As we have said it is for PE readers only and we have thus instigated a coupon system for sending in ads. This means that you must have an up to date issue to send in your ad. and you must sign a declaration to say you are not running a business dealing with electronics in any way. We have reserved the right to refuse ads. if we are worried about the contents or the private reader/business situation.

In order to give everyone a chance we can only accept one ad. per coupon and...we have limited the number of words in each ad. so that we can get a good variety on a page, or in any small space we may have—say at the end of an article. Full details of PE Bazaar and the first ad. coupon can be found on page 31. If we get some ads. back very soon after the publication of this issue, we hope to be able to get them in next month—it's first come, first served.

RESPONSIBILITY
One final point, we must make it quite clear that PE cannot be held responsible for any errors in the free ads. or for any transactions that take place between readers as a result of a free ad. We will not enter into correspondence concerning free advertisements, their contents or transactions.

However, we must say that in our editorial dealings with our readers we have found you to be a wonderfully reliable, trustworthy and honest lot. We have often sent odd items to readers, requesting payment on receipt and almost without exception have received prompt payment. We would like to take this opportunity to thank you—it saves us all time, trouble and money when things work in this way. Let's hope PE Bazaar is popular, helps as many of you as possible and leads to some useful exchanges and friendships within our hobby. It's up to you now!

Like everything else, it seems to be such a good idea, we wonder why we didn't think of it months ago?

Mike Kenward
Public consultation on radio frequencies

Wider public consultation on proposals which could affect frequency allocations for some aircraft and shipping radio services has been announced by the Home Office.

The Home Secretary was giving details of the United Kingdom's preparations for the 1983 World Administrative Conference for Mobile Telecommunications, to be held in Geneva, in answer to a Parliamentary Question from Mr. Peter Viggers MP. The decisions made at the Geneva Conference will govern frequency allocations for certain maritime and aeronautical mobile radio services.

The Home Secretary pointed out that non-government organisations had already been consulted about the UK's provisional proposals for the conference, but he had decided that views should be sought from a broader public so that no significant point was overlooked.

Grand Prize

British Telecom's Prestel world viewdata service is offering a £1000 prize to the designer of the best Prestel adaptor for the top-selling Sinclair ZX81 personal computer. Sinclair Research, which is to provide one of the judges, strongly supports the competition and believes that a successful design will offer its established 150,000 UK users a valuable new application. Although a number of microcomputers can already receive Prestel, these numbers would mark a very significant service extension for British Telecom.

Telesoftware—computer programs distributed via teletext or viewdata to computers in schools, homes and offices—is now a major Prestel growth area, and many program publishers are becoming active and establishing libraries that can hold up to 1,000 pages following the Department of Industry's initiative in funding the Educational Telesoftware Project.

The prize will be awarded to the adaptor which best combines "low price, elegant design and practical robustness", and the working design submitted must be capable of being modified to receive approval for attachment to the telephone network.

Closing date is March 14th, 1982, and further details, specification and entry forms are available from Tony Sweet, Prestel Headquarters, Telephone House, Temple Avenue, London EC4 0HL (01-583 9811).

AM CB: AN APRIL FOOL

Following numerous rumours that the Government is considering legalising CB on 27MHz AM, the Home Office has issued the following statement:

"Don't be misled by unfounded rumours claiming that the use of illicit 27MHz AM sets will be legalised. The Government has no intention of making any changes to the new legal 27MHz FM CB service."

Reports abound of AM sets carrying labels stating that the apparatus cannot be used "until April 1982". Any such stickers are quite simply hoaxes.
Items mentioned are available through normal retail outlets unless otherwise specified. Prices correct at time of going to press.

Briefly...

This year, the All-Electronics/ECIF show will be doubled in size and held at the Barbican Exhibition Centre in the City of London. It will run from Tuesday April 20th to Thursday April 22nd, and, say the organisers, will offer the largest and most comprehensive display of the electronics industry that the capital has seen for many years.

Tempus—often featured in these pages as suppliers of Casio products—have moved from their premises in East Road, Cambridge. Their new address is: 38 Burleigh Street, Cambridge CB1 1DG.

Barrie Electronics Ltd. inform us that they have been appointed a franchised distributor for the "budget range" of toroidal transformers manufactured by Cotswold Electronics Ltd.

The fifty-eight toroidal transformers will complement the 150 stacked laminated types stocked by Barrie Electronics on an off-the-shelf basis.


PCB Drill Offer

Due to demand for this exceptionally priced tool which was on Special Offer in our January issue, the offer closing date has been extended to March 26th 1982. Please contact Watford Electronics to ensure supply. Price is £8.60 inclusive.

Wersi's Comet

Recently unveiled by Aura Sounds in London, the Wersi Comet is the latest addition to the increasingly popular range of Wersi Organs. The Comet is a completely new model—not a modification or development of any other Wersi organ, and has been designed to give the best possible sound quality and features at a budget price.

As well as traditional drawbar and orchestral sounds, the Comet provides a wide range of other voices, including various guitars, synthesiser and percussion. Numerous effects are incorporated, including three way vibrato, slalom and the Wersivoice rotating speaker sound. A totally new feature is the Comet’s facility to accept connection of up to four ‘satellite’ keyboards, so that up to five musicians can play the one organ together.

As with all other Wersi instruments, the Comet is available ready built or as a kit. If you choose to build a Comet yourself (which is a very straightforward operation estimated to take only 100 hours, due to the use of plug-in circuit boards and ribbon cable wiring) you can save almost half the cost of the ready built unit.

The Comet is available either as a home console model (W10S) or as a portable unit with detachable legs (W10T). Prices are as follows: W10S £3,620—ready built: £1,899—complete kit. W10T £3,592—ready built: £1,971—complete kit. Further information is available from Aura Sounds Ltd., 14-15 Royal Oak Centre, Brighton Road, Purley, Surrey (01-668 9733).

Countdown...

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

Microsystems Feb. 24-26. West Centre Hotel, London. Z1
Seminesc Mar. 29-Apr. 2. Imperial College, London. H1
CAD Mar. 30-Apr. 1. Metropole, Brighton. Z1
ETM Mar. 30-Apr. 1. The Forum, Wythenshawe, T
Peripherals Mar. 31-Apr. 2. West Centre Hotel, London. Z1
Laboratory Manchester Apr. 7-8. New Century Hall, Manchester. E

BEX Brighton Apr. 28-29. K
Compee Europe May 4-6. Centre Int. Rogier, Brussels. Z1
BEX Leeds Jun. 9-10. K
BEX Croydon Jun. 30-Jul. K
Leeds Electronics Show Jul. 6-8. University. E

A1 Institute of Electronics, Rochdale, Lancs.
E Evan Steadman, Saffron Walden 7 0799 22612
H1 Seminesc Ltd., Tunbridge Wells 9 0892 39664
K Douglas Temple, Bournemounth 9 0202 20533
L1 World Trade Centre 9 01-488 2400
T Trident Tavistock 9 0822 4671
V SDL 9 Dublin 763871
Z1 IPC Exhibitions, Sutton 9 01-643 8040

Practical Electronics March 1982
introducing
The WERSI Comet

Aura Sounds have pleasure announcing the Comet, the "Band in One" organ, is now available through our branches. Once again the Comet achieves the optimum performance in its class.

It offers:
- Numerous realistic and interesting tonal colours with guitar voices, synthesiser and other modern sounds together with the more traditional drawbar and orchestral sounds
- Playing aids include chord memory, WRS, Keyboard Selector, Wersiomatic rhythm and automatic accompaniment section plus much, much more
- Comet can accept up to four satellite keyboards (in addition to the 2 keyboards on the organ - a five man band can play on one instrument.
- Wersi have simplified self assembly even more with plug in circuits, etc.
- Ergonomic playing table eases operation.

The Comet is available in the elegant lines of the spinet (W10 S) and with chromed steel legs (W10 T) for transportability.

The Comet, the Organ to see us through the eighties - available now.

For more details of this superb organ, ring us now on 01-668 9733 or write to Aura Sounds Ltd. at the Purley Branch.

Alternatively, fill in the coupon below for free details. For immediate action telephone 01-668 9733 24 hour answering service.

Please send me FREE, all the details of The Comet and Wersi Range

NAME
ADDRESS

Send to Aura Sounds Ltd., 14/15 Royal Oak Centre, Brighton Road, Purley, Surrey.
Salaries
A new year always brings thoughts of what lies ahead and reflection on the past. A main preoccupation is the personal one of jobs and salaries. On the broader front there is the anxiety that political hot-heads will rock the industrial boat and put all our jobs at risk. But assuming, hopefully, that contains were still be a good year for recovery.

Backward Glance
Last year was pleasurable in the number of success stories we were able to record. And it finished up with the giants of the industry continuing to improve not only their sales (including exports) and profits but also their order books. GEC-Marconi, for example, managed another scoop with a £500 million contract for the Royal Navy's heavyweight torpedo. On the technological front there were also gains with many new equipments and systems on offer.

Personality of the year was unquestionably Sir Ernest Harrison, mastermind of the Racal Electronics Group, who was heaped with honours, principally a well-deserved Knighthood but also Honorary Doctorates from Cranfield Institute of Technology and the University of Surrey. He finished the year with a flourish, winning the Businessman of the Year Award.

The citation of the latter mentioned the acquisition and subsequent turn-round in fortune of Decca but I think the last part would have pleased Sir Ernest best. It added, "And for providing a rallying point for industry, a much-needed demonstration that where the will is present, British companies, their managements and their products can equal the best in the world, even in the toughest high-technology markets which are too often considered to be the preserve of Japan and the USA'.

Another well-deserved honour, the Gold Medal of the Royal Aeronautical Society, went to J.E. (Jack) Pateman for 'building-up British technical and industry leadership in the avionics field'. Pateman is managing director of Marconi Avionics and in ten years he created 8,000 new jobs, tripling the size of the company to become Europe's largest producer and top exporter of aviation electronics.

In case you imagine these men are nothing but workhorses, I should mention that Jack Pateman enjoys gardening and sailing and Sir Ernest shares Jack's enthusiasm for gardening but also lists wild-life, all sports, but particularly soccer. I recall he was an Arsenal fan at one time and maybe still among his interests.

Up North
With the great bulk of the electronics industry concentrated in the South and South East, the Midlands and Northern regions get less attention than they deserve. I recently had the opportunity of visiting three companies in regions which are generally described as depressed. This is certainly true of the inner city areas I saw on the trip but there was nothing depressing in the companies.

Maybe I was lucky in my choice but all three had emerged from the recession, had new products and services in planning, and all believed in a great future. One of the companies, to my astonishment, had been running three shifts round the clock throughout the whole of the recession.

None of them had had an easy time but there were no complaints. Just enthusiasm to get on with the job.

Energy
It seems only yesterday that we were all talking of the energy famine. Today we have a glut of oil and coal. But yesterday's scare triggered a surge of activity in developing alternative sources of energy.

One result is IBA's experimental sun-and-wind powered TV relay station at Bossiney on the north Cornish coastline. All power for the transposers and receivers come from natural sources. The idea of a hybrid sun-and-wind system is that if the sun isn't shining there is more than a fair chance that the wind will be blowing, and often both will be generating at the same time.

It seems not generous the system is backed up by a reservoir of three dozen lead-acid batteries with a capacity of 1,000Ah. The windmill produces 150W at wind speeds of 15 m.p.h. and 864 solar cells produce up to 780W in peak sunlight. The TV relay equipment consumes 150W.

To get Channel Four available to a target of 99.9 percent of the population some extra hundreds of such low power relay stations will be needed. But energy conservation is only part of the reason for the self-contained station. The other, often more compelling, reason is that these low-power relays, sometimes serving as few as 500 people or less, are on difficult and remote sites where the capital cost of running power lines to them is out of proportion.

Inmos
The Inmos factory at Newport, Gwent, some 85,000 sq.ft. of it, is now becoming a reality. Building has been in progress for a full year and the 30,000 sq.ft. clean area should be installed by March.

The Newport plant appears to be definitely scheduled for wafer fabrication and an eventual workforce of 1,000 is still envisaged. But assembly might still take place in the Far East.

A number of questions still overshadow the Inmos project, not least the departure of Paul Schroedor who as Executive Director, corporate development, was clearly a key man. The product strategy and future funding remain unclear. Obviously there are elements of commercial security involved. Anyway, with so much now invested and a tentative foothold in the market we can do no more than wish Inmos the best of British luck.

Vigorous ATE
Automatic Test Equipment (ATE) is still a blossoming market under vigorous attack by all the leading manufacturers. Typical is Marconi Instruments System BOX, unveiled at the ATE Exhibition in Brighton last December. The BOX has been designed with the US market in mind and is an ATE facility at Sunnymede in an attempt to gain a larger market share. Prices start at £80,000 and rise to £150,000 for a complex system with up to 2,000 test points.
THE cost of electrical energy consumption has become increasingly significant in recent years as the price of primary fuels has risen more quickly than the average increase in the cost of living. In order to control costs in the house, it is necessary to know which appliances cost the most to use and to what extent savings can be made by reduced usage, turning thermostats down, etc. The watt-hour meter provided by the electricity supply authority does give a means of calculating total consumption and hence the staggering quarterly bill. However, it gives no indication of the rate at which costs are being incurred or which appliances are consuming energy at the greatest rate and what the individual cost is.

All appliances are supplied with a label indicating their power rating but to calculate the cost of running a washing machine through a 45 minute cycle with intermittent motor running, thermostatically controlled heating, pumping and spinning would be almost impossible for the average person.

The device described in this article continuously measures the current being consumed by such an appliance and having previously had the latest cost per unit of electricity keyed into it, displays the charge as it is being incurred. It was designed about three years ago and is the subject of a UK Patent application. Only recently has the cost of the components used reduced to the level where a home construction kit has become an attractive proposition.

TELECTRIC BASICS

The basic operation of the Telectric can be explained with reference to the block diagram of Fig. 1. The current consumed by the appliance plugged into the 13A socket flows through the primary turns of the current transformer and the secondary voltage induced forms the input to IC3 in order to measure this current. The PSU provides a 5 volt supply and also a sync pulse which occurs at the zero crossing of the a.c. mains voltage. The microprocessor reads the control keys, provides the display drive and multiplexing and samples the output of IC3 at the peak of the mains voltage waveform on both negative and positive half cycles. From the stored value of the cost per unit the incremental cost per half cycle is calculated and added to the running total for display.

There is one control switch and four push button keys. When the switch is in the cost per unit position the display initially reads Ent. and a single push of any key increments the display digit directly above it in order to enter the cost per unit in pence to three decimal places. When the control switch is in the electricity bill position the four push buttons assume their control functions. These are:

- **Start** Resets the accumulated charge and elapsed time to zero and starts new sequence.
- **Pause** Holds the current reading of charge and time. A second push of this key restarts from the previous readings.
- **Time/Cost** Toggles the display between displaying time and charge.
- **Check** Whilst held down, the current value of the cost per unit is displayed as a check on operation.

DISPLAY FORMAT

In the cost per unit position the decimal point is located between the two left hand digits and the display indicates the unit cost in pence. With the control switch in the electricity bill position the display is auto ranging, the device having been designed to accumulate up to £99.9 in cost and 99.9 days in time. The ranges and examples of their display formats are as follows:

- **Cost**
  - up to 9.99p: e.g. 2.14p
  - 10p to 99.9p: e.g. 47.1p
  - £1.0 to £9.99: e.g. £7.85
  - £10.0 to £99.9: e.g. £90.6

- **Time**
  - 1 second to 1 hour: e.g. 27.59
  - 1 hour to 1 day: e.g. 14.27
  - 1 day to 99 days: e.g. 9.9d

CIRCUIT DESCRIPTION

All the circuitry in the device uses a 5 volt supply and the circuit diagram is divided into two parts; Fig. 2 showing the power supply and sync pulse generator and Fig. 3 showing the processor, etc. The 5 volts is generated using a 9V (6VA) transformer, bridge rectifier and a 7805 i.c. regulator. The sync pulse generation can be described with reference to Fig. 5 which shows the waveforms through IC8. The full wave rectified input to IC8a is inverted and produces a positive going pulse about 2ms wide and symmetrical about the zero crossing of the a.c. mains waveform. This is delayed by R21, C6. The output of IC8b is a negative going 2ms pulse with its leading edge corresponding approximately...
**SPECIFICATION**

**Display**
4 digit 7 segments I.e.d.s 0.5" high with decimal points.

**Controls**
- S1: Cost per Unit/Electricity Bill
  - Output socket power switch (No effect on metering function)
- S2-S5

**Functions**

A) Switch in 'Cost per Unit' position
- S2: Most significant digit increments every time key is pressed, 0-9
- S3, 4, 5: As S2 for digits 2, 3, 4 of pence per unit figure. This position of the switch serves only to enter the pence per unit figure. The decimal point second from left is illuminated. The electricity cost is not monitored. Cost and elapsed time functions are set to zero

B) Switch in 'Electricity Bill' position
- S2 ('Check'): While pressed pence per unit is displayed (operational check)
  - Otherwise S5 controls display
- S3 ('Start'): Each depression of key zeroes electricity bill and time elapsed. Electricity bill begins to total from moment of depression
  - Subsequent depression zeroes and restarts
- S4 ('Pause'): Depression of key halts totalling of cost and elapsed time
  - Subsequent depression restarts from previous reading without zeroing
- S5 ('Time/Cost'): Display shows electricity bill initially. First depression causes display to show elapsed time. Second depression electricity bill, etc.

Maximum cost per unit 9.999 pence
Maximum electricity bill total £99.9
Maximum elapsed time 99.9 days
Accuracy better than 1% for 13A load

with the zero crossing. IC8c speeds up these edges and C8 couples them to IC8d which is biased below its threshold by R22 and R23. Thus the output from IC8d is a negative pulse approximately 20μs wide corresponding to the zero crossing and this forms a synchronising pulse.

The microprocessor controlling the Telelectric is the 8035 which contains its own clock generator, reset, and interrupt input pins. It has 64 bytes of on chip RAM, an 8 bit data/address bus, two 8 bit I/O ports and external memory read and write timing signals. It also has an on chip timer which is used to time the ADC sampling at the peak of the a.c. voltage waveform.

**CURRENT MEASUREMENT**
In measuring mains current, the simplest way would be to use a series resistor but this has several drawbacks. The ADC requires a 5 volt peak-to-peak waveform at its input for maximum current corresponding to a 40 amp peak to peak sinusoidal current or 14.14 amps r.m.s. The power developed in such a resistor would be 25 watts at peak load which is obviously not desirable. A smaller resistor could be used with an op-amp to multiply up the voltage generated but this technique still requires the circuitry to be connected to the mains and faults could be catastrophic. It was therefore decided to use a current transformer to provide full isolation.

Purpose designed current transformers are quite expensive and so a 3VA mains to low voltage transformer is used in the Telelectric. This has its low voltage winding removed to enable one and a half turns of the mains neutral lead to be threaded onto the transformer before connection to the output socket.
**Components . . .**

**Resistors**
- R1, R10, R12, R14, R16, R18: 10k (6 off)
- R18
- R2 to R9: 220 (8 off)
- R11, R13, R15, R17: 2.2k (4 off)
- R19: 47k
- R20: 470k
- R21: 1M
- R22: 100k
- R23: 220k
- R24/R25: (see construction notes)

**Capacitors**
- C1: 68p
- C2, C3: 22p (2 off)
- C4: 1µ tan bead
- C5: 0.1µ
- C6: 680p
- C7: 680µ 16V
- C8: 470p
- C9: 47µ tan bead
- 3 off 0.1µF disc ceramic and 2 off 0-01µF disc ceramic decoupling capacitors as per layout diagram.

**Semiconductors**
- Bridge rectifier (REC1): 50V, 1A
- D1, D2: 1N314 or equivalent
- TR1 to TR4: BC213L or equivalent (4 off)

**Integrated Circuits**
- IC1: 2716 2K x 8 UVEPROM
- IC2: 74LS373
- IC3: ADC0804 (National Semiconductors)
- IC4: 8035 microprocessor
- IC5, IC6: 7401 (2 off)
- IC7: 74LS365
- IC8: 4069B
- IC9: 7805 (regulator + 5 volts)

**Displays**
- DL507B (Litronix): Common anode 7 segment i.e.d. displays (4 off)

**Miscellaneous**
- 4 push buttons; 1 rocker switch; 1 switched 13A mains socket; 1 grey moulded ABS box, 190 x 110 x 60mm; 1 mains transformer 9 volt, 6VA, 10% regulation; 1 mains transformer 3VA to convert to current transformer; 1 crystal 3.579MHz (NTSC subcarrier); 1 heatsink for 7805; 2 metres 13A mains cable; 3 metres connecting wire; 8 i.c. sockets (3 x 14 pin, 1 x 16 pin, 2 x 20 pin, 1 x 24 pin, 1 x 40 pin); 1 p.c.b., double sided but designed for pin through as well as plated through holes; 1 display p.c.b.

A complete constructor’s kit for the Telectric is available from Response Co., Stoner End, Froxfield, Petersfield, Hants (0730 3063). Price £47.50 + VAT (£54.62). A limited number of fully assembled Telectrics are also available at £64 + VAT. All parts are also available separately. Send SAE for details.

![Fig. 3. Complete circuit](image)
CONSTRUCTION

All of the components except the display and switches are mounted on the main p.c.b. which is double sided. The foil layouts are shown in Figs. 6 and 7 and the component layout in Fig. 8. Although the p.c.b. is double sided it has been designed with no through connections on i.c. pins and the position of these is shown by large dots in Fig. 8. Also shown are some extra decoupling capacitors which do not appear as components in the circuit diagrams. The p.c.b. should preferably be assembled using i.c. sockets for all i.c.s so that faults can be easily rectified.
The pads for the mains transformer have been made quite large to accommodate a variety of pin arrangements. The current transformer load resistors must be fitted before the ADC is plugged into the circuit. Without these resistors a high voltage may be generated which could damage or destroy the ADC. The values of R24 and R25 are found experimentally (they are supplied correct value with the kits) by using a one kilowatt load such as an electric fire. The exact current is measured with an Avo or similar and will be around 4 amps r.m.s. The voltage across the load resistors is then given by the relationship $V_{\text{r.m.s.}} = I \times 0.125$ volts, where $I$ is the exact current. R24 can now be selected to produce a slightly high voltage reading and R25 will be a higher value resistor to provide the final trim. (R24 may be 390 and R25 10k giving a total equivalent load of 376).

**NEXT MONTH** Detailed discussion of the microprocessor circuitry and software and more construction details.
All eight Beckman digital multimeters have a very positive switch, giving no chance of pushing the wrong button. Plus guaranteed long-term high accuracy, five ac and dc current ranges and six resistance ranges, and a battery life ten times longer than most competitive instruments (2000hr, hand held; 12000hr, bench models).

Options vary from a simple buzzer on the continuity test to the sophistication of direct temperature measurement, true RMS and even complete submersibility without damage.

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WHERE WERE YOU WHEN THE LIGHTS LAST WENT OUT?

For around £20 and a little d.i.y. you could be automatically cut into the limelight with our rechargeable Emergency Lamp! Alternative? The next power cut might be your darkest hour.

IT IS likely that most householders will experience at least one power failure. This can be very inconvenient, because it is then that the candles and matches can't be found, because of the dark! However, such a failure can be more serious, as the author found when carrying a tray of crockery on the stairs at the moment of failure. The shock alone was enough to send both flying, resulting in a painful fall. The idea for this project was thus conceived during convalescence. It obviously needed to be automatic, pleasing and cheap.

The project described here is intended to enable constructors to build a ni-cad powered emergency light, drawing no battery current in its quiescent state (less than 1 mA from the rectified supply), switching on automatically in the event of a mains failure. When mains is restored, the ni-cad can then be recharged, and a built-in timer lights an I.e.d. when the batteries should be charged (assuming they were fully exhausted to start with). Two switches are provided, one to act as an on/off control and as a reset switch, the other to activate the charging and timing circuits.

HOW IT WORKS

Mains voltage is reduced by the transformer, and then rectified by the diodes D4-5 (4-7). The resulting d.c. is then smoothed to a degree by C1 and flows via R1 to light I.e.d. 1. This d.c. also ensures that pins 1 and 2 of IC1a (used as an inverter) remain high, so that its output pin 3 is low, preventing the thyristor from turning on. When the mains does fail C1 rapidly discharges with R1, I.e.d. 1, R2 and R3, and pin 3 goes high, providing gate voltage to the thyristor which then fires, allowing current to flow via the three bulbs. C1 has to be relatively low in value, otherwise it would take a long time to discharge, causing a delay before the light came on. S1 now acts as a simple on/off switch. When mains is restored the lights will stay on, because once fired, gate voltage can be removed from a thyristor. However, briefly opening S1 disconnects the anode from the battery which does reset the thyristor ready for the next failure.

When S2 is closed current flows through R5, which acts as a current limiting resistor to protect the batteries. D1 prevents battery voltage from reaching pins 1 and 2, as does D2. The purpose of D2 and D3 is to provide voltage to the supply pins of the i.c.s. Because the rectified d.c. voltage is higher than the battery voltage, D3 is normally reverse-biased, so no current flows out of the battery. However, in the event of a mains failure D3 is now forward biased, maintaining supply to the i.c.s.

The closing of S2 also gates the slow oscillator constructed around IC1c and d. The frequency is adjustable to a certain extent by VR1. The output clocks IC2, a ripple counter, and after 16384 pulses pin 3 goes high, lighting I.e.d.s.

CONSTRUCTION

Assembly of the p.c.b. is straightforward. The plastic case used is the widely available Pifco "Everywhere Wall Light". It is first necessary to modify this case in the following way: The large bulb holder must be removed by drilling out its mounting rivets. Next, drill out the cord operated on/off switch. Drill two holes to accommodate the miniature toggle switches (see Fig. 1). These holes should be one above the other in the side of the case, directly opposite the "cord hole". This cord hole will be used to admit the mains cable. Two holes should also be drilled into the lens cover to take the I.e.d.s and (preferably) their bezels. Similarly, two further holes will need to be drilled through the internal diffuser to pass the i.e.d. wires (these wires should be fairly lengthy for lid removal). Hole diameters are dependent on switch and I.e.d. sizes, the former being subminiature types.

Only three nickel-cadmium cells are to be used, the mains transformers taking up one of the former battery positions. Various small transformers of the type needed are frequently seen advertised for as little as £1, therefore this component has not been rigidly specified. For this reason the rectification system has been made versatile to accommodate differing types, but the space available and the dimensions of the transformer must be taken into account. A little more spatial...
Fig. 1. Circuit diagram. The PSU section may incorporate either a centre-tapped or single-winding secondary transformer. The appropriate wiring points on the p.c.b. are indicated in circles. The timer section, which drives D7 (green), indicates the necessary full-charge period for the ni-cads.

**Components**

**Resistors**
- R1, R2, R7 1k (3 off)
- R3 10K
- R4 4.7
- R5 10.2 watts
- R6 10M
- R8 100k
All resistors 1/2 watt 5% unless otherwise specified

**Potentiometers**
- VR1 4M7

**Capacitors**
- C1 10μ 16V electro.
- C2 470n polyester
- C3 100n polyester

**Semiconductors**
- D1, D2, D3, D4-5 1N4001
- D6-7 1N4148 (2 off)
- IC1, IC2 4011
- IC1c, IC1d, IC2c, IC2d 4020
- SC1, SC2 2N6170

**Miscellaneous**
- 3 bulb holders (cat. No. PLH2 Home Radio)
- 3 torch bulbs 3V5
- 3 x 4AL V2 equiv. ni-cads
- 1 SPST toggle
- 1 DPST toggle
- Transformer 7-0-7 Volts at 200mA
- Pifco Everywhere Wall Light, Model No. 1644

**Constructors’ note**

The MES bulb holders are available from: Home Radio Components, 240 London Rd., Mitcham, Surrey, CR4 3HD. They may be second-sourced from: Electrovalue, 28 St. Jude's Road; Englefield Green, Egham, Surrey, TW20 0HB. (Order skeleton lampholder type MSS36.)

The transformer’s electrical requirements are less critical than its physical dimensions. For example, a 6-0-6V 250mA transformer will suffice so long as its measurements do not exceed 55mm wide, by 40mm high, by 35mm (the latter dimension to include any tags etc.).

If a 0-6V or 0-7V single-winding secondary transformer only, can be found, then the bridge rectifier arrangement may be used (insert D8 and D9 on p.c.b.). The Pifco lamp is available in high street shops.

---

Emergency Light (prototype)
Prototype Emergency Lamp. This has been substantially rearranged mechanically, and serves as a guide only.

Fig. 2. Printed circuit board (actual size)

Fig. 3. Component layout for the p.c.b. If T1 has a centre-tapped secondary, leave D8 and D9 off the board. If T1 has a single-winding secondary, use terminals A and C only, and include D8 and D9.

Fig. 4. The Pifco "Everywhere Wall Light" showing the necessary modifications to be made.

Fig. 5. Wiring and layout details. The three MES bulbs are wired in parallel. Wires to the battery base-plate should be soldered first, then the base-plate fitted before wiring up the switches. The lampholders and switches are repeated in this illustration to show the wiring more clearly.

Skeleton MES bulb-holders which have been bent to the dimensions shown below.
flexibility will be allowed if the two contact springs originally intended for the battery, are snipped out. Be careful how this is done. Do not remove the part which provides anchorage!

The three skeleton bulb-holders should be formed to the shape illustrated, and fixing holes drilled through the battery base-plate for mounting these. This shape has been conceived to aid the retention of the heavy nickel-cadmium cells. The round hole at the centre of the diffuser will not be large enough to clear the three MES bulbs in our new system, and therefore should be opened out using a knife or abra-file. It may be found necessary to bore some ventilation holes in the vicinity of the transformer to prevent gradual discoloration of the plastic.

When wired, the bulbs should light if S1 is closed. Switch on the mains, and the light should stay on; however, briefly opening S1 will extinguish them. Ensure that S1 is left in the closed (on) position, turn off the mains and the light should come back on. To check that the batteries receive charge when S2 is closed, the most simple technique is to push a small piece of double sided p.c.b. in between the +ve of the battery and the battery holder. Attach pulses from a current meter (black to the +ve battery side because charge should be flowing from the more positive rectified d.c. side into the battery) and check that charging is taking place. Also check that when the mains is on S2 is open, that no current flows out of the battery (with the lights out of course)! To set the timer for 18 hours, monitor pin 7, which should change state every 63 seconds (63-27 secs—approx)

CONCLUSION

One of these lights at the head of the stairs is a real safety feature at home. It makes an ideal present, perhaps particularly for elderly people who may find a sudden blackout more difficult to cope with.

The only component possibly to cause problems when purchasing the parts is the case. It is manufactured by PIFCO and is called the “Everywhere Light” (model 1644) though other cases may, of course, be used. Because the batteries are not being trickle-charged, it is good practice to check the state of charge every so often.

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Date

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PE BAZAAR
MARCH '82

Practical Electronics March 1982
HERE is a light that will deter a burglar in your absence as it automatically switches on at dusk and off at dawn. As such, it is ideally suited as a porch light, giving the impression that the premises are occupied.

Whilst the supply requirements are low, the period when the unit is in operation is long, so the use of the mains voltage was considered imperative and anyway, if the light was not powered from the mains it would probably give the game away.

CIRCUIT

In Fig. 1, a mains transformer T1 is used to step down the 240V supply to the operating potential. The secondary winding supplies the rectifier pair D1/D2 to provide rough d.c. which is further smoothed by the electrolytic capacitor C1.

TR1 is used as a switching transistor having the relay coil as its load. The diode strapping this is to suppress the transient high reverse voltage which would normally develop when the relay is switched off. Its action is to simply short circuit the high voltage spike, which could damage the transistor, reducing it to a value of about half a volt.

Bias is provided to the switching transistor by a resistive chain which includes a cadmium sulphide light dependent resistor, the resistance of which reduces as the light falling on the device increases. Typically, for an ORP12 this resistance ranges from 10M in total darkness to less than 100 ohms in bright conditions, and around a few kilohms for a cloudy day.

COMPONENTS

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistor R1</td>
<td>3kΩ</td>
</tr>
<tr>
<td>Capacitors C1</td>
<td>1000μF 25V</td>
</tr>
<tr>
<td>Semiconductors D1-D3</td>
<td>BA155</td>
</tr>
<tr>
<td>TR1</td>
<td>BC171A</td>
</tr>
<tr>
<td>Transformer T1</td>
<td>12-0-12V (RS 196-303)</td>
</tr>
<tr>
<td>Relay RLA</td>
<td>100mA</td>
</tr>
<tr>
<td>Fuse FS1</td>
<td>100mA</td>
</tr>
<tr>
<td>Lamps LP1-LP2</td>
<td>110</td>
</tr>
</tbody>
</table>

Variable Resistor VR1: 47k
LIQUID ALARM

A sensor that sounds for liquid or vapour

ONE of the simplest and most versatile of direct coupled circuits is the super-alpha or Darlington pair. Super alpha derives from the gain multiplication produced by connecting transistors this way, so that the composite pair shown in Fig. 1 have a very high current amplification which for the transistors being used approximates to 125².

![Circuit of Alarm](image1)

**Fig. 1. Circuit of Alarm**

**VEROSWITCH**

A piece of 0.1 in matrix Veroboard with the alternate track layers commoned (Fig. 1) makes an ideal sensor as liquid or vapour bridging these will form a base input to TR1.

In the initial setting up, the sensitivity of the device is set by VR1. If steam is applied to the parallel copper strips of the sensor, VR1 is rotated until the alarm sounds. At this point the adjustment is for maximum sensitivity.

In its appointed role as a laundry protector, obviously the housewife will only be concerned with rain that has started falling so that she can make the quick rescue, so a high sensitivity adjustment should be made.

![Veroboard layout](image2)

**Fig. 2. A mains supply that can be used**

**LIQUID LEVEL**

If a liquid level switch is intended, where two stiff conductive probes are substituted for the Veroboard, then the simple expedient is to use lengths of 16 s.w.g. tinned copper wire for the probes, these being terminated with the input connections to the device.

The retainer for these stiff wires could be a five-way terminal so that adjustment for probe separation, and therefore liquid level, would reduce to loosening the screws of the block and moving the wires relatively as required.

To complete the assembly, the two outer connectors of the block could retain a suspension hook of wire.

Obviously the probes could be manually adjusted for any liquid level rise or simply left with the tips adjacent to detect a level.

**ALARM**

The choice of supply was deliberately kept low for battery conservation, as the current consumption of the alarm rises almost linearly with the voltage applied. For the circuit shown and the alarm arranged for pulsed tone operation (3.2kHz approximately pulsed at 5Hz), the current is an intermittent 10ma. Nevertheless, sound output is strident and will almost certainly be heard anywhere around the house. However, if you do need a bigger output then you can simply raise the supply voltage to 9V. There are no circuit changes to be made, but remember, whilst the db output level rises so does the current consumption.

**OUTPUT ALTERNATIVES**

With the alarm specified the output alternatives are continuous or pulsed tone depending on whether the yellow sense lead is connected. The instruction for this is to leave it unconnected for pulsed operation or to connect to battery negative for a continuous tone. The remaining two leads (red and black) are connected as shown in the circuit.

With its obvious long-term utility there is a need to substitute a simple mains supply for batteries and a suitable 9V circuit is given in Fig. 2.
## COMPONENTS

<table>
<thead>
<tr>
<th>Component</th>
<th>Value/Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistors</td>
<td></td>
</tr>
<tr>
<td>R1</td>
<td>1k</td>
</tr>
<tr>
<td>10% 1/2 watt carbon</td>
<td></td>
</tr>
<tr>
<td>Potentiometer</td>
<td>VR1 10k preset</td>
</tr>
<tr>
<td>Transistors</td>
<td>TR1-TR2 BC171A (2 off)</td>
</tr>
</tbody>
</table>

**Warning Device**
- WD1—Surface mounting audible alarm (RS 248–788)

**Battery**
- B1—see text

---

# DOUBLE SIREN

## Alarm options with one transistor

This project makes use of only one of the free transistors but offers two siren options: an American police siren with the characteristic short rise and longer fall and alternatively the urgent rising bursts of sound reminiscent of the alarm status signals of the starship Enterprise. It should be noted that although the component count is small the sound output is large.

### BLOCKING OSCILLATOR

Both these sounds are initiated by S1 and S2 respectively, but for the starship alarm S1 must be kept closed while pressing S2. Power consumption is relatively low—about 24mA—but if batteries are heavy on the pocket then there is the simple expedient of knocking up the simple 9V power supply given previously in this supplement.

This circuit has the rather formidable description of a blocking oscillator. Here, the transformer provides regenerative feedback by phase inversion from the collector to the base of TR1; so remember, if your unit does not work just reverse the connections to the primary or secondary of T1.

When S1 is pressed the tone produced through components C1, T1, R1 and R2 is raised by the charging of C2 through R3. When S1 is released the charge in the electrolytic capacitor leaks away so that the tone gradually falls. By introducing the diode with the switch S2, C2 is very rapidly discharged so that with operation of this switch you only have a series of rising tones.

### OUTPUT

In introducing this project it was stated that the sound output is large. This statement is true if a large speaker is used, anyway, you can have fun experimenting. I used a 4in type and found the output adequate.

Since sound expansion has been touched upon there
**COMPONENTS**

**Resistors**
- R1: 10k
- R2: 18k
- R3: 3.3k
- All 1/4W 10% carbon

**Capacitors**
- C1: 100n
- C2: 500μ 25V elect

**Switches**
- S1-S2: Press switches

**Transformer**
- T1: T/T7 output (RS)

**Transistor**
- TR1: BC171A

**Loudspeaker**
- LS1: 4in 8Ω

**Battery**
- B1: 9V

**Fig. 2. Board assembly**

---

**AF/RF GENERATOR**

**Broad band signal source**

This little generator makes no pretensions towards a high specification, but with it you could quite easily troubleshoot a radio covering the medium and long wavebands, which includes the r.f. and a.f. components, or any audio entertainment equipment.

**FREE RUNNING**

The circuit shown in Fig. 1 is a free running square wave generator which produces a basic tone of frequency 1/(1-4CR) cycles where C is the single coupling capacitance (farads) and R the base bias resistance (ohms), which works out to 1kHz.

---

To reduce signal output the simple expedient of starving the circuit is used via VR1.

**ACTION**

When power is first applied to the circuit from the battery, since there is no means of maintaining a permanent voltage at the base of either transistor the circuit has no stable state. The unbalance between each half of the circuit induces one transistor towards current cut-off and the other towards full conduction. However, there is no d.c. stable state and the current alternates between the two quasi-stable states at the previously mentioned rate fixed by the 200k/5n pairs. As the value of these are equal the output forms a symmetrical square wave.

**Fig. 1. Circuit of Generator**
HARMONICS
The harmonics produced to cover the r.f. bands mentioned are the normal components of a square wave. How far they extend upward being set by the characteristic of the wavefront. The shorter the time of the rise the higher the harmonics extend upwards.

OUTPUT
Since the transistors are switched hard on the output voltage is that of the supply. To vary this output it is convenient to vary the supply with the potentiometer VR1, since the current drawn from the battery is extremely low. In fact, the generator will work with nothing more than a meagre 0.5V.

The output coupling capacitor C3 has a working voltage which has been chosen deliberately high for any valve circuit applications. Make sure the signal lead from this is coax suitably terminated with crocodile clips.

USING IT
Assuming you have no test equipment, when applying the generator to entertainment equipment fitted with its own loudspeaker the rule is always to work back from the output stage to the input. The evidence of stage and then component failure in proceeding in this logical manner is loss of signal.

With, say, a radio, this should be tuned off a station with the volume turned up. You should then work back through the a.f., i.f., and r.f. stages to locate the faulty component. A good set will produce a loud tone if the generator output is brought close to the ferrite aerial.

COMPONENTS

<table>
<thead>
<tr>
<th>Resistors</th>
<th>10k</th>
<th>200k</th>
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<tbody>
<tr>
<td>R1</td>
<td></td>
<td></td>
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</tr>
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<td>R2</td>
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</tr>
<tr>
<td>R3</td>
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<td></td>
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<td>R4</td>
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<tbody>
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<tr>
<td>C3</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Transistors</th>
<th>TR1–TR2</th>
<th>BC171A (2 off)</th>
</tr>
</thead>
</table>

BENT WIRE GAME

Touch tournament with a memory

HERE is a constructional variation of the old 'steady hand' game where a loop of wire has to be run along another piece of wire bent into an irregular pattern. The object of the game is to run the loop from one end of the shaped wire to the other without making contact between them. If this is done, then the loop is returned to the start and the next competitor makes his move.

Since any number of people can compete and presumably complete the course, the winner must be the one who does it in the shortest time.

MORE DIFFICULT
The difficulty of the game can be improved upon by any
one of the following changes, which are a) making the curves of the wire length more irregular, b) lengthening the run, and c) decreasing the diameter of the loop. These are all variations which can be tailored to suit the age and skill of the competitors and which cost very little in time or money to arrange.

HOW IT WORKS

The circuit shown in Fig. 1 is that of a compound emitter follower which has a characteristically high input impedance seen from the base of TR1 and the cathode of D1.

If, say, there was a short between the competitor's loop and the shaped wire the light emitting diode would switch on and in the absence of the electrolytic capacitor C1 this would switch off as soon as contact was broken.

You can imagine, then, the argument that would ensue if the offending party refused to own up to the instantaneous flicker, so C1 was introduced to remove any conflict.

In practice, the i.e.d. will remain lit for periods in excess of five minutes for the slightest touch so it does arbitrate conclusively. The switch S1 discharges C1 in preparation for a new game.

CONSUMPTION

The unit consumes no current in the stand-by condition and 40mA when switched on. This is, in fact, the maximum forward current of the i.e.d. specified and if a battery is to be used some might like to conserve power with a reduction of light emission.

To do this, resistors from the one specified up to a value of 1k can be used. The 1k limit provides a visible lamp but considerably reduces the consumption to about 5mA.

POWER SUPPLY

Once again we can solve the problem of battery cost by building the p.s.u. shown in the Liquid Alarm project.

CAR BATTERY CONDITION INDICATOR

Lights the way to happy motoring

Just over a generation ago the voltmeter and ammeter were standard equipment for the motorist so that he was constantly aware of what was happening to the battery, dynamo and regulator when the vehicle was started or running.

Today's economies reduces all electrical awareness of a satisfactory circuit to the standard ignition warning light, which, apart from a perfunctory introductory glow, tells you nothing about the battery state of charge.

FULL INDICATION

This three i.e.d. alternative will continuously monitor the general state of the battery from 'poor' (red i.e.d. lights), when suspicion should be cast on the battery voltage regulator or dynamo or combination of these. For this condition the battery voltage is below 11-6V.

MOST car manufacturers pay scant attention to dashboard indicators in the charging department. A red light that comes on and goes off when you start the journey leaves you electrically ignorant in its absence until something like a broken fan belt occurs.
A battery terminal voltage above this would light D4, the yellow i.e.d. This condition warrants an investigation if it does not charge up after a few minutes and is marked ‘fair’ on the circuit.

Indication of a satisfactory circuit with a battery voltage of above 12.6V is given by the green i.e.d. lighting. This is labelled ‘good’ in Fig. 1.

There are transitional states between these as when the yellow lamp reduces in brilliance and transfers to a brightening green lamp, as a battery is charging, and vice-versa as it is discharging.

**Fig. 1. Circuit of Indicator**

**IN GENERAL**

Broadly, the green light on indicates all is well; red, the battery is defunct and yellow the output voltage is low which will be confirmed by poor light from the lamps, low hydrometer reading and lack of power to the starter motor when the battery is switched in.

This condition may be due to the dynamo not charging or giving a low or intermittent output in which case D4 will flicker.

**POSSIBLE REMEDY**

To remedy this latter condition the charging and field circuit wiring should be examined. Tighten any loose connections, particularly those at the battery, also renew any damaged cables. Check the tension of the dynamo driving belt also the regulator setting and adjust if necessary.

**MOUNTING**

The small board can be mounted directly on the car dashboard using the black panel clips supplied with each i.e.d. These suit a 6.35mm (0.25in) panel and will retain the circuit board when fitted.

A layout with equally spaced light emitting diodes is shown in Fig. 2. The viewing angle for the specified i.e.d.s is 30° which might produce a relatively low light output in bright conditions, so I am proposing an alternative device, the ‘stackable i.e.d.’ from RS Components, which has a viewing angle of 100° and provides a clear colour contrast when viewed at even oblique angles.

**Fig. 2. Veroboard layout**

**COMPONENTS**

<table>
<thead>
<tr>
<th><strong>Resistors</strong></th>
<th><strong>Semiconductors</strong></th>
<th><strong>ANOTHER ADVANTAGE</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>R1 390</td>
<td>R1</td>
<td>An additional advantage of this indicator is that being ‘in circuit’ continuously means that the battery condition can be tested as different loads are applied such as operation of car lights, starter motor, accessory items, etc. This way one can readily keep an eye on a deteriorating battery and know the time for replacement rather than be caught unawares.</td>
</tr>
<tr>
<td>R2 390</td>
<td>D1, D4, D7</td>
<td></td>
</tr>
<tr>
<td>R3 390</td>
<td>D2, D5, D6 TR1, TR2</td>
<td></td>
</tr>
<tr>
<td>R4 390</td>
<td>11V 500mW Zener</td>
<td></td>
</tr>
<tr>
<td>R5 390</td>
<td>12V 500mW Zener</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IN4148 (2 off)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>BC171A (2 off)</td>
<td></td>
</tr>
</tbody>
</table>

**CIRCUIT ACTION**

In the circuit, at voltages below 11.6V, the brightness of the i.e.d. D1 is set by R1. As 11.6V is approached then D4 starts to light as TR1 conducts, the latter subtracting current from D1 causing it to extinguish.

This same procedure is repeated as the line voltage moves up to 12.6V when D7 will be lit. So you can see that there is always a continuous visual indication of battery state, and in living with it you should become extremely adept at interpreting impending problems.

**CHECKING IT**

When checking over the completed unit a variable power supply is useful to make sure the unit is switching through its ranges.

If dry batteries are used for this purpose it should be borne in mind that for a ‘good’ indication the total current drawn is around 80mA, which is largely made up of shunt current through D5.

The i.e.d.s chosen for this project are for panel mounting and could be attached to the car dashboard but first you should view these in daylight when the unit is powered up (take the 12V line from the ignition switch) for optimum positioning as brightest viewing is directly over the lens.
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Y Deflection
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- Auto + level control
- Bandwidth: 2Hz - 1 MHz

General Information

- Component Tester: For single components and In circuit
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- A.C. Input: 110, 127, 220, 237, V.A.C., 50-60 Hz
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NEXT MONTH

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PRACTICAL ELECTRONICS
APRIL ISSUE ON SALE FRIDAY, MARCH 12th
THE transmitter circuit is built on a small printed circuit board as shown in Figs. 1 and 2 which holds all the components except the i.e.d.s and the push switches. Care should be taken to ensure that transistors and electrolytic capacitors are mounted the correct way around. Although the i.c. is a bipolar device and, therefore, not prone to static damage, it is wise to mount this in a socket. If only one switch is to be used, a panel mounted push to make type may be fitted directly on to the box and connected to the appropriate pads on the transmitter board by wires. If more than one switch is required, these should be mounted on the switch board (Fig. 3), which is designed to fit "piggy back" style on the transmitter board using four stiff wires (pins). Care should be taken to ensure that the switches are positioned as shown in Fig. 4 and firmly seated on the p.c.b. before soldering.

The complete circuit may be housed in a small box together with the battery. The i.e.d.s should be mounted on the front of the box using i.e.d. clips or the reflectors if a greater range is required. If the box specified is used then these would be mounted on the aluminium front panel and soldered to the p.c.b. using flexible wires. The wires to the i.e.d.s should be kept as short as possible as relatively large currents will flow in these leads and any inductance will have a detrimental effect on the range. Since there are no heavy components on the p.c.b., the transmitter circuit may be secured to the box with a double-sided adhesive pad. The distance between the main p.c.b. and the keyboard will have to be carefully chosen to ensure that the switches are free to move when the box is clipped together. If the assembly is made too high, one or more of the switches may be depressed permanently, which would, of course, result in the transmitter operating continuously. When the correct height has been ascertained, the connections between the two p.c.b.s may be made using tinned copper wire or discarded component leads. The two p.c.b.s have been designed so that the holes for the interconnections line up when the two assemblies are mated. The connections for which holes are provided should be made, the spare holes on the main p.c.b. (which are for use with other keyboards) should be ignored.

The battery clips should be assembled in the box battery compartment and connected to the p.c.b. pads marked + and − with wires. If there is any danger of incorrect battery connection, it is wise to place a diode (type 1N4001) in the positive lead to avoid damage. The circuit is powered by a 9V PP3 battery and draws an average current of 20mA when operating. Since the standby current consumption is only a few micro-amps, no on/off switch is required. A piece of polystyrene or similar material may be required to hold the battery in place within the battery compartment.
Fig. 1. P.c.b. design for the transmitter

Fig. 2. Component layout

Fig. 3. Switch p.c.b.

Fig. 4. Switch layout

Fig. 5. P.c.b. design for the Receiver board

Fig. 6. Component layout
The receiver is built on one printed circuit board as shown in Figs. 5 and 6 with all the components, including the transformer, mounted on it. (Construction on Veroboard or other p.c. layouts is not recommended as the high gain amplifier IC1 may become unstable.) Only D1 and the opto isolator and triac are mounted remotely. D1 may be connected to the p.c.b. with wires although the length of these should be kept as short as possible to avoid noise pickup. A screened lead is best although the length should be kept to less than 6 inches as any capacitance across the photodiode will reduce the sensitivity of the circuit to the transmitted IR pulses. As the photodiode will need to be mounted externally, some form of protection from the weather will be needed.

The sensitive face of the diode is the curved one and this should be arranged to face in the direction from which the IR radiation is expected. Any transparent or translucent enclosure of the type supplied for panel mounted neon signs would be suitable provided the diode is mounted against the front of the moulding to avoid making the unit too directional. If the unit is to be used in a room to control lamps or appliances, the photodiode mounting will not be so critical as multiple reflections occur from walls and ceilings making the controller largely non-directional.

The unit may be tested by connecting the mains to terminals J and K and transmitting the open/close code. VR1 should be adjusted until I.e.d. D2 lights and remains lit while the transmitter button is pressed. The other codes may be tested by connecting l.e.d.s directly to terminals E F and G H, with the l.e.d. cathodes connected to E and G. Transmitting ON 1 and ON 2 will switch each l.e.d. on while pressing OFF will cause both l.e.d.s to switch off.

APPLICATIONS

The obvious application for the unit and indeed the purpose of the design is in the control of motorised garage doors. In this context the momentary output would be used to trigger the open or close sequence while the two latched outputs could control mains lamps (via the slave switches) to illuminate the drive and garage if required.

The circuit could of course be used for a multitude of other functions around the house. As mentioned, the ON/OFF outputs could be used to switch virtually any appliance on or off such as radios, tape recorders, lamps, etc. The momentary output controlled by the open/close button could be used to change the channel on a suitably modified TV receiver. An interesting application would be to control room lighting. Many modern touch controlled lamp dimmers incorporate an input for connecting to slave touch plates. These normally require a momentary low current connection to the live terminal to effect switching or dimming of the light.

For the elderly or disabled, the unit could be used to control heating or lighting. Since the connections to the power switch of Fig. 4, shown last month, need only to be low voltage/low current wires, it would be easy to arrange for the controller to be situated in one room and control an appliance in another location, enabling, for example, the central heating or an electric blanket to be switched on or off without the necessity of leaving the living room.

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The purpose of the S-meter module is to provide a d.c. output proportional to the amplitude of the 455kHz IF signal. The module samples the level of the IF signal in the Ranger preceding the amplitude limiting stages within IC100. At this point (the output of FL100) the IF signal is only at a relatively low level and hence some amplification is essential before detection. To prevent instability the module must be housed within the Ranger transceiver and its output taken via the 7-way ancillary connector to the Base and Mobile Adaptor. Where signal strength indication is not required, the S-meter module may, of course, be omitted. In this case there will simply be no meter indication on 'receive' but otherwise the performance and operation of the unit will remain unchanged.

The circuit diagram of the S-meter module is shown in Fig. 3.1. Source follower, TR1, provides impedance matching and its high value of input impedance minimises loading of the IF amplifier at the point where the signal is derived. This is an important consideration as the filter needs to be accurately matched in order to obtain optimum performance. TR2 and TR3 form a voltage amplifier with gain adjustable by means of VR1, D2 and D3 rectify the amplified IF signal and the supply voltage is held constant by means of D1.

The S-meter module is assembled on a small single sided p.c.b. for which the foil layout is given in Fig. 3.2. The corresponding component layout is shown in Fig. 3.3. The completed p.c.b. should be wrapped in a polythene sleeve and located at right angles to, and on the right hand side of, the main p.c.b. in the area adjacent to IC100 and IC101. Only four connections need to be made to the Ranger and these should again be kept as short and direct as possible.

**Fig. 3.1. Circuit diagram of the S-meter module**

The input is taken from the junction of R111 and FL100. This connection may most conveniently be made by soldering to the left-hand end of R111 (the end nearest FL100) on the top side of the p.c.b. The positive supply is derived from test point G and the common rail is taken from pin-2 of SK203 (or any other convenient 0V point). The output of the module is taken to pin-1 of SK203 and note that, regardless of whether the S-meter module is fitted or not, some minor modifications to the wiring of SK203 are necessary and these are covered in the next section.

**Fig. 3.2. P.c.b. design for the S-meter module**

**Fig. 3.3. Component layout for the S-meter module**

Testing and alignment

During the test and alignment procedure it is recommended that a current limited regulated d.c. power supply be
used. The supply should be set to give 12V d.c. (±0.5V) and its current trip set to 1A (±100mA). The Base and Mobile Adaptor does have its own internal 1A fuse but this should not be relied upon in the initial stages. Protection is essential in order to minimise the risk of damage to both the external power supply and to the Base and Mobile Adaptor in the event of incorrect component connection or faulty assembly (e.g. solder bridges between p.c.b. tracks). Under no circumstances should the external supply be allowed to exceed 17V as this may result in permanent damage to both the Ranger and the Adaptor.

Two interconnecting leads are required. Both need be no more than 160mm long since it is envisaged that the two units will normally be operated 'piggy-back' rather than 'side-by-side'. Constructors should, however, make the connecting cables long enough to allow the two units to be operated 'side-by-side' during the setting-up process. The RF connecting lead (at the front of the set) should use good quality 50ohm coaxial cable. (e.g. UR43 or UR76) terminated with PL259 plugs. The correct method for fitting these plugs is shown in Fig. 3.4. and 3.5. The control lead (at the rear of the set) has seven ways and should be terminated with 7-pin DIN plugs. Care must be taken to ensure that the pins are correctly linked and this is best done by checking pins 1 to 6 with an ohm-meter both for continuity and for the presence of short circuits between adjacent pins.

Make the following adjustments and connections in the order given before connecting the external d.c. supply:
(a) Ensure that the interconnecting leads are in place.
(b) The channel selector should be switched to channel 14.
(c) The 10dB attenuator should be switched 'off'.
(d) The RF gain control should be set to maximum (fully clockwise).
(e) VR1 should be set to minimum resistance.
(f) The cores of L1/L2 and L3 should all be set two full turns from the furthermost position into the former.

(g) The variable capacitors should be set as follows:
   VC1 and VC2; plates 20% meshed.
   VC3 and VC4; plates 50% meshed.

(h) If the filter modules have been fitted they should be temporarily removed and replaced by shorting links.

(i) Connect an external loudspeaker (of between 4 and 16 ohms impedance) to the Adaptor via SK3.

(j) Switch the 'squelch' on the Ranger 'off'.

(k) Connect a matched 50ohm aerial to the Adaptor.

The external d.c. supply should now be connected and the steps which follow should permit alignment of the Base and Mobile Adaptor:

---

**COMPONENTS**

**S-Meter Module**

**Resistors**

- R1, R4 100k (2 off)
- R2, R5 2k2 (2 off)
- R3 4k7
- R6 1k5
- R7 1k

All resistors ½W 5% Carbon.

**Capacitors**

- C1 22p
- C2 1n
- C3, C4 4n7 (2 off)
- C5 100n

All capacitors ceramic disc or plate

**Semiconductors**

- D1 BZY 88 C55V6
- D2, D3 OA91 (2 off)
- TR1 2N 3819
- TR2, TR3 BC 548 (2 off)

**Miscellaneous**

- VR1 220 min preset skeleton (hor)
<table>
<thead>
<tr>
<th>STEP NUMBER</th>
<th>PROCEDURE</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Switch 'on' the external d.c. supply. Switch 'on' the Ranger and the Adaptor unit.</td>
<td>The 'receive' I.e.d. indicator on the Adaptor should be illuminated and noise should be heard from the Adaptor's loudspeaker when the volume control on the Ranger is advanced. If the S-meter is not fitted adjust for minimum background noise (maximum quieting). Only a slight adjustment, if any at all, should be necessary.</td>
</tr>
<tr>
<td>2</td>
<td>Adjust the core of L1/L2 for maximum indication on, the S-meter using the signal from a fairly strong local station. If a full-scale reading has been obtained reduce the setting of the RF gain control and continue to adjust L1/L2.</td>
<td>If the RF stage has been correctly aligned and is working properly there should be an increase of approximately two S-units (around 12dB). If no discernible change is obtained or if there is a reduction in signal strength check the RF stage and repeat steps 1 to 5. The 'transmit' indicator I.e.d.'s should be illuminated on both the Ranger and the Adaptor, and the noise from the loudspeaker should cease.</td>
</tr>
<tr>
<td>3</td>
<td>Select a channel on which there is a weak but stable signal. Adjust the RF Gain control to provide a reading of about ½ to ½ scale. Re-peak L1/L2 for maximum.</td>
<td>The adjustments are fairly critical and there is interaction between them. These adjustments are fairly broad with some interaction between them. If this is not the case repeat steps 7 to 9 inclusive.</td>
</tr>
<tr>
<td>4</td>
<td>Disconnect the RF (coaxial) cable linking the Ranger and Adaptor. Connect the aerial directly to the Ranger thus bypassing the Adaptor. Note the S-meter reading obtained when a weak but stable signal is present.</td>
<td>The output power will be somewhat less than that obtained previously and should be typically between 2W and 5W. Slight adjustment to the output stage and/or filter in the Ranger may help improve the drive level if necessary. If the output power is greater than 500mW the value of R9 should be increased to 100 ohm 2W. If the output power is less than 300mW the value of R9 should be decreased to 47ohm 2W.</td>
</tr>
<tr>
<td>5</td>
<td>Re-connect the Adaptor and note the new S-meter reading with the RF gain control turned to maximum. (The same signal should be present as in step 4.)</td>
<td>If an RF power meter (or SWR bridge which incorporates power measuring facilities) is available, check the output power delivered to the load. This should be between 3W and 6W. (See Fig. 3.6.)</td>
</tr>
<tr>
<td>6</td>
<td>Replace the aerial with a 50ohm resistive dummy load capable of dissipating 5W. (Such devices are available from most CB accessory stockists.) Operate the Ranger on 'transmit' by either using the 'press-to-talk' facility on the microphone or by using a shorting link as described in the Ranger alignment procedure.</td>
<td>Insert the filter modules and carefully adjust the ferrite cores for maximum output. Some minor re-adjustment of VC3 and VC4 may be beneficial.</td>
</tr>
<tr>
<td>7</td>
<td>Adjust VC1, VC2, L3, VC1 and VC2 in the sequence given for maximum output power indication from the meter. Repeat several times and adjust the setting of VR1 to reduce the indication on the meter if necessary.</td>
<td>Adjust VR2 in the Ranger for an output power of 4W. Slight adjustment to the output stage and/or filter in the Ranger may help improve the drive level if necessary.</td>
</tr>
<tr>
<td>8</td>
<td>Adjust VC3 and VC4 for maximum meter indication. Repeat several times for maximum output. Again adjust VR1 if necessary.</td>
<td>If this is not the case repeat steps 7 to 9 inclusive. The output power will be somewhat less than that obtained previously and should be typically between 2W and 5W. Slight adjustment to the output stage and/or filter in the Ranger may help improve the drive level if necessary.</td>
</tr>
<tr>
<td>9</td>
<td>If an RF power meter (or SWR bridge which incorporates power measuring facilities) is available, check the output power delivered to the load. This should be between 3W and 6W. (See Fig. 3.6.)</td>
<td>The 'transmit' indicator I.e.d.'s should be illuminated on both the Ranger and the Adaptor, and the noise from the loudspeaker should cease.</td>
</tr>
<tr>
<td>10</td>
<td>If an RF power meter (or SWR bridge which incorporates power measuring facilities) is available, check the output power delivered to the load. This should be between 3W and 6W. (See Fig. 3.6.)</td>
<td>The adjustments are fairly critical and there is interaction between them. These adjustments are fairly broad with some interaction between them. If this is not the case repeat steps 7 to 9 inclusive. The output power will be somewhat less than that obtained previously and should be typically between 2W and 5W. Slight adjustment to the output stage and/or filter in the Ranger may help improve the drive level if necessary. If the output power is greater than 500mW the value of R9 should be increased to 100 ohm 2W. If the output power is less than 300mW the value of R9 should be decreased to 47ohm 2W.</td>
</tr>
<tr>
<td>11</td>
<td>Insert the filter modules and carefully adjust the ferrite cores for maximum output. Some minor re-adjustment of VC3 and VC4 may be beneficial.</td>
<td>Adjust VR2 in the Ranger for an output power of 4W. Slight adjustment to the output stage and/or filter in the Ranger may help improve the drive level if necessary.</td>
</tr>
<tr>
<td>12</td>
<td>Adjust VR2 in the Ranger for an output power of 4W.</td>
<td>If this is not the case repeat steps 7 to 9 inclusive. The output power will be somewhat less than that obtained previously and should be typically between 2W and 5W. Slight adjustment to the output stage and/or filter in the Ranger may help improve the drive level if necessary. If the output power is greater than 500mW the value of R9 should be increased to 100 ohm 2W. If the output power is less than 300mW the value of R9 should be decreased to 47ohm 2W.</td>
</tr>
</tbody>
</table>

This completes the setting-up procedure and the Adaptor is now ready for 'air-testing'.
Screw plug onto the cable. Solder braid through holes and ensure that a good electrical connection is made. Solder centre conductor.

Final plug assembly with coupling ring free to mate with a socket.

Fig. 3.5. Method of fitting PL259 connector to RG 8/U, UR67 or similar 0.4in diameter coaxial cables.

**AERIAL MATCHING UNIT**

There will doubtless be many occasions where, for one reason or another, it is not possible to achieve a good match between the transceiver and an aerial system. Usually this is because the radiating element is not cut to the correct length; either it is too long or too short. Aerials with adjustable radiating elements are obviously to be preferred but they can be tiresome and inconvenient to adjust, particularly when they are mounted at some considerable distance from the rig. A most useful accessory, therefore, is a device for accurately matching the transceiver to any aerial system. The effect of providing an accurate match between the transceiver, feeder and aerial is to guarantee a low value of SWR. This helps to improve the radiation efficiency by eliminating additional SWR losses in the feeder and maintains the performance specification of the transceiver itself.

The matching unit consists simply of a pi-network of two variable capacitors and a fixed inductor. An added bonus is the reduction of harmonic radiation associated with the low-pass characteristic of the network.

The circuit diagram of the aerial matching unit is shown in Fig. 3.7 together with an internal layout and wiring diagram in Fig. 3.8. A metal screening enclosure is essential to the correct operation of the matching unit and this can take the form of a diecast or aluminium box measuring approximately 150x80x50mm. The variable capacitors may be difficult to obtain but fortunately their exact maximum value is unimportant and can be anywhere between 365pF and 500pF. The prototype employed dual gang 176 and 208pF capacitors with the two gangs connected in parallel to make a total maximum value of approximately 384pF. Capacitors of this type were commonplace in AM (medium and long wave) transistor portable radios of some 10 to 20 years vintage. Whatever type of capacitor is used they MUST be air spaced types and should be fitted with a pointer knob and scale. This is important for providing accurate reference points for re-setting the matching unit when it is to be used with several aerial systems. The unit should preferably be fitted as close to the aerial as possible. This is particularly important when a high SWR (greater than 2:1) is present. In many situations, however, this may not be practicable and it will be necessary to place the unit in the vicinity of the transceiver and SWR bridge. This is a less efficient arrangement (due to the high SWR in the feeder) but it will at least provide a reasonable match for the transceiver. A typical arrangement is shown in Fig. 3.9 and the aerial matching unit is simply adjusted for minimum VSWR. In practice, and with careful adjustment (both controls need to be used) it is possible to obtain an SWR of 1.1:1 or better with even the most difficult aerial systems.

**COMPONENTS**

**Aerial Matching Unit**

SK1, SK2  S0239 sockets (2 off)
VC1, VC2  Air spaced variable, max. capacity in the range 365 to 500pF, see text
L1  8 turns 18 s.w.g. enamelled copper wire, inside diameter 10mm, winding length 10mm approx.

Metal case or diecast box
Pointer knobs (2 off) fitted with '0-10' scale, see text

Practical Electronics  March 1982
In the series so far we have looked at the design of logic systems, from simple combinational and sequential circuits up to multiplexing and bus-oriented networks. It's only a small step now into the world of microcomputing and microprocessors. We need only one more 'building block' of circuitry; the memory.

**BASIC REQUIREMENTS OF MEMORY**

Essentially, 'memory' is a collection of logic 1's and 0's which are stored in a system. There must be some way to 'write' these logic states into the memory, and some way to 'read' the logic states out of the memory and into other circuitry.

In some cases it might not be necessary to write information into the memory more than once. If a fixed set of binary numbers was to be stored, always the same and never requiring modification, then a 'Read Only Memory' or 'ROM' could be used; in its simplest form this would be a set of wire links or switches permanently set to give a logic 0 or logic 1 where required. In many cases, though, it is necessary to be able to frequently write information into the memory, as well as being able to read it. Such a memory is known as a 'RAM', which stands for 'Random Access Memory', meaning that all bits stored in the memory can be directly and independently written into, or read from. 'RAM' is actually a bad name for the device; all bits can be accessed randomly in a ROM, too. Unfortunately, this is a terminology that we'll have to live with!

In both ROM's and RAM's we want to be able to choose a specific point in the memory, known as the 'address', and read (or write) the information present there into the rest of our system. The memory device, therefore, will have a number of binary inputs which together form the address, and a number of binary outputs (or inputs/outputs in the case of RAM) which together form the data output (or input). Each value of the binary number on the address inputs is known as an address 'word'. In the case of RAM's, there is a read/write control input, and in many devices an 'enable' input is provided, to allow all functions of the device to be turned on or off. The timing of the logic signals can be very important; in many memory systems there must be certain minimum time periods allowed between data changing and the logic state of the read/write control being changed. Failure to observe this can cause incorrect data storage and retrieval, and is an important consideration when designing with many different types of memory device.

**STORAGE DURATIONS**

Systems which lose their information when the power supply is turned off are known as 'volatile', while those that retain their information are 'non-volatile'. In some cases it is possible to use battery back-up supplies with a volatile memory to provide short term storage with the power off. In other instances it is possible to specifically design non-volatile memories, although this is usually done at the expense of performance or memory cost.

Frequently, the use of memories can be broken down into 'bulk storage', and temporary or general purpose storage, often known as 'scratchpad memory'. The former is usually a non-volatile technology, often with relatively slow access or operating speed but capable of holding a massive amount of information for permanent records, storage, filing, etc. The latter is used on a 'day-to-day' basis by the circuitry it serves, mostly for short term storage of information, rather in the manner of a jotter or scribble pad on a writing desk. (Hence the term 'scratchpad memory'). In order to avoid slowing down the surrounding circuitry, this memory has to be a fairly high speed type, although it does not usually need to store a very large amount of information.

**MEMORY TECHNOLOGIES**

Memories can be implemented by using various different technologies; electromechanical devices (relays, uniselectors, and the like) being one of the simplest, although these are far too slow, bulky, and cumbersome for the majority of applications. In early computers the non-volatile 'magnetic core' was used. This consisted of a large number of small ferrite rings with wires passing through their centres. By passing impulses of current through selected wires, the ferrite rings could be magnetically saturated and hence these cores were written into. By passing current pulses of the opposite polarity into the selected wires, and measuring the resulting e.m.f., the saturation of the cores could be determined and the memory could be read. Although a widely used technique several years ago, the magnetic core has now all but disappeared. More recent magnetic technologies are those of tape, disc, and bubble.

Magnetic tape is familiar to us in the form of audio cassettes, and indeed these are often used in small 'personal' computers as bulk storage, with differing frequencies of tone being recorded in bursts to indicate logic 0's and logic 1's as appropriate. Larger computers use larger tape; many times the thickness, width and length of cassette tape, running at very high speed, and with many tracks used in parallel to increase the speed of reading and writing of the memory.

Magnetic tape can store fantastic amounts of information, but is inherently very slow; if the data that you want is at the opposite end of the tape it can take several minutes to get there! A natural progression, therefore, was to use a...
magnetic disc. With this system, a circular disc coated with a thin ferromagnetic material (similar to that used on tape) is continuously rotated at high speed. In the large, solid, 'hard' disc units, the read and write heads float on an air cushion fractionally above the disc, whereas in the case of the smaller flexible 'floppy' discs, the head and disc actually touch, the disc being coated with a lubricating material to reduce friction.

Information recorded anywhere on the disc can be accessed in a fairly short time by moving the heads inwards or outwards along a radius from the centre of the disc, and then by waiting for the disc to rotate sufficiently to bring the required information directly underneath the heads. In this respect, the disc is analogous to an LP record; you don't have to play the whole LP to reach a track that you want to hear—the pickup can be placed on that track directly, manually, saving a great deal of time. This method of bulk storage is fairly fast, and can store large amounts of data; typically between 0.1 and 1 Megabytes (a 'byte' is a group of eight bits) for a floppy disc and over 10 Megabytes for a hard disc.

A fairly recent development in non-volatile bulk storage is the 'Bubble Memory'. This device consists of a very thin layer of garnet crystal, grown on a non-magnetic substrate, wrapped with flat wire coils, and enclosed within a pair of permanent magnets. A large number of geometric 'shapes' are deposited on the surface of the garnet, in a soft magnetic material. Tiny magnetic 'bubbles' can be generated in the garnet; these are small areas only a few micro-metres in diameter, in which the magnetic field is opposite to that in the rest of the crystal. Magnetic fields generated by the coils produce and control the magnetic polarisation of the deposited geometric 'shapes', in turn manipulate the bubbles. The presence of a bubble represents a logic 1, and the absence of one a logic 0.

Bubbles can be sensed by monitoring the resistance of extra 'detector' shapes. As the bubbles pass under these detectors, the resistance of the deposited shapes changes, and this can be amplified by a suitable detection circuit. The circuitry needed to control a bubble memory is complex and expensive, and the whole technology at the moment is a rather specialised one. In its favour, it is fairly compact, non-volatile, low power, and has reasonable speed performance. Of all the memory technologies in current use, it has perhaps the greatest potential for improvement and developments.

The memories that we've looked at so far have had attractions for bulk storage, but even the fastest floppy discs or bubble memories are much slower in operation than most logic families. The problem is not so much the rate of transfer of data, but rather the 'access time', i.e. the time taken between deciding that you wish to read or write to a specific location in memory, and actually being able to read or write that data. Although discs may be able to transfer data at many hundreds of thousands of bytes per second, it can take many tens of milliseconds to begin that data transfer. This is an unacceptably long time if it is to be repeated often within a system. As a result of this, extensive use is made of a much faster accessing memory technology.

**SEMICONDUCTOR MEMORIES**

Looking first at the RAM, its implementation is very straightforward since all that is required is an array of flip-flops or latches! Any flip-flop or latch can be used to store a 1 or a 0, can be written into (by changing the logic state of the clock), and can be read from by simply looking at the logic state of the Q output. However, the design of typical CMOS flip-flops and latches is rather over-complex for a large memory system; too much space on the i.c. 'chip' would be taken up with each device, and the total power consumption of the large numbers of devices involved would be prohibitive. As a result, a far simpler design of memory element or 'cell' is used, based on the 'bistable' circuit design. This is shown in Fig. 8.1, and is known as a 'static' RAM cell. ('Static' refers to the fact that data is stored in the cell for as long as power is applied; there is no decaying away of charge, or any other effect which may cause the cell to lose its data after a time.)

The memory is arranged in a matrix form; rows and columns of cells selected by control logic. To write a logic 1 into the static cell, the DATA column line for the column in question is taken to logic 1, and the DATA column line to logic 0. The word line, which determines the row in which the cell sits, is pulsed to logic 1, then back to 0 again. This forces the bistable into the state where point A is at logic 1 and point B at 0. (To write a logic 0, DATA column line = 1, DATA column line = 0, and again the word line is pulsed from 0 to 1 and back again). To read from the memory cell, the word line is pulsed again, but this time the logic states on the relevant column lines are monitored. If the DATA column line pulses to logic 1, then the bit stored was a logic 1. If the DATA column line pulses to logic 1, then the bit stored was a logic 0.

**DYNAMIC MEMORY**

The static memory cell contains four MOS transistors and two 'resistors' (also formed from MOS transistors), and hence is fairly bulky when used in quantity on an i.c. 'chip'. Supply current requirements are also relatively high, and this also restricts how closely packed the cells can be; too close together, and the resultant heat generated cannot be dissipated by the i.c. package, causing heat damage. Because of these restrictions, a lower power and more compact memory design is frequently used; the 'Dynamic' memory cell, as shown in Fig. 8.2.
To write a logic 1 into the cell, the DATA column line is held at logic 1, and the word line is pulsed from logic 0 to 1 then back to 0 again. This stores a charge on the 'capacitive element', which is actually another MOS transistor since capacitors are very difficult to fabricate effectively on an i.c. chip. To write a logic 0, the process is repeated with the DATA column line at logic 0. To read from the cell, the word line is again pulsed and the logic state of the DATA column line is monitored; if it pulses to logic 1, the stored bit was also a 1, if it does not change at all then the stored bit was a 0. (The logic 1 pulse is caused by the 'logic 1 charged' on the capacitive element discharging, via the MOS transistor, into the circuitry monitoring the DATA column line). Therefore, the Plessey 'NOVOL' range being a prime exam-

states. 'EEPROMs', or electrically erasable PROMs, have the bits to a logic for typically between 10 minutes and an hour. This sets all the i.c. package, to a specific wavelength of ultra violet light posing the i.c. chip, via a transparent window in the top of to start again from scratch, and is most usually done by ex-

devices restores all the 'fuse links', enabling the programmer to make errors create the required pattern of Us and 1's. Because it is easy purchased "blank", and is then written into; by applying high -

which are unalterable. 'PROM' refers to a device which is term ROM is used for 'Mask Programmed' devices, i.e. those i.c. as soon as possible after the address has been selected), it can be addressed in a similar way to the RAM, that it can

similar to that of the RAM. This is necessary, to ensure that there are two inherent weaknesses of this design. The first is that, unlike the static cell, reading is 'destructive'; any charge stored on the capacitive element is discharged into the control circuitry upon readout, so the memory has been lost. The second weakness is that the charge on the capacitive element leaks away after a very short time (the actual capacitance value is very small), so the memory is lost after a short time anyway—well under a second! To over-

come both these problems, 'refresh' circuitry is used to re-

write any memory which has just been read with its 'own'
data again, and to continually re-write all the data out of the memory and back into it again. These days, many popular dynamic RAMs have all the refresh circuitry built in, so they appear to the user to be static; no external refreshing is necessary.

THE ROM

Although the ROM is supposedly little more than a large array of pre-set switches, in practice it has a complexity similar to that of the RAM. This is necessary, to ensure that it can be addressed in a similar way to the RAM, that it can have a very high speed (i.e. the data should be fed out of the i.c. as soon as possible after the address has been selected), and in many cases that it can be programmed; it becomes a programmable read only memory, or 'PROM'. Naturally all ROMS have to be programmed at some time or other, so the term ROM is used for 'Mask Programmed' devices, i.e. those which have fixed programs built in during manufacture, and which are unalterable. 'PROM' refers to a device which is purchased 'blank', and is then written into; by applying high-

voltage pulses into the device at the relevant address, the memory locations can be 'blown', rather like fuse links, to create the required pattern of Os and 1's. Because it is easy to make errors while programming in this way, most PROMS are made erasable; 'EPROMS'. Erasing such devices restores all the 'fuse links', enabling the programmer to start again from scratch, and is most usually done by ex-

posing the i.c. chip, via a transparent window in the top of the i.c. package, to a specific wavelength of ultra violet light for typically between 10 minutes and an hour. This sets all the bits to a logic 1 state; when memory locations are sub-

sequently 'blown', this sets the bits in question to logic 0 states. 'EEPROMS', or electrically erasable PROMS, have recently started becoming available, and use electrical erase signals; they become, in effect, a non-volatile semiconductor memory of fairly large size, although their erase and write times can be very long.

Non-volatile semiconductor stores are available in their own right, the Plessey 'NOVOL' range being a prime exam-

ple. This is a range of counters, counters with 7-segment decoders, and one latch circuit, which have non-volatile cir-

cuit elements built in to retain the last logic states of the device for up to one year in the absence of power. In these devices, of course, only small numbers of bits are involved, so they are only a very small-scale memory in terms of ROM, RAM and bulk storage techniques.

MEMORY ORGANISATION

Most semiconductor memories are organised in terms of 1 bit, 4 bits, or 8 bits per address word. Hence, a memory device which claimed to be 256 words x 8 bits would have a total of 2048 cells within it, i.e. a total storage of 2048 bits. We refer to a unit of 1024 bits as '1K' bits (1024 being equal to 210) hence, 2048 is 2K bits, 4096 is 4K bits etc. When memory devices are grouped together in a microprocessor or microcomputer system, we arrange them to suit the number of bits that the microprocessor uses. For example, the majority of microprocessors today work on an 8 bit system, so our memory will be arranged to be 8 bits 'wide'. Also, (by putting two 4-bit memories side by side, with common address lines, or eight 1-bit memories, etc.) Each set of eight bits is known as a 'BYTE', so a 4K Byte memory consists of 4 x 1024 x 8 bits i.e. 32,768 bits. Of-

ten, computer jargon shortens the term '4K bytes' to just '4K', which could cause confusion with 4K bits. It is usual to talk about individual memory i.c.s. in terms of bits, but assemblies of memory devices, memory systems, and microcomputers in terms of bytes. Typical 'personal' or 'home computers' are available with between 1K and 48K (bytes) of RAM, and up to 12 or 16K (bytes) of ROM.

THE MICROPROCESSOR

The 'micro', as it is known, is a very complex and technically advanced electronic device, and there certainly isn't room in this article to go into detail about its design and operation. However, we can take a look at the basics, to give an idea about the way that the technology is used, and the sort of facilities that can be provided. Two months ago, we looked at bus-oriented systems and gave an example of some data manipulation in an A.L.U. using such a system.

Let's now take those principles further, and look at a greatly simplified 8-bit microprocessor system. (Note that a microprocessor will often be referred to as a 'Central Processing Unit' or CPU.)

A block diagram of a simplified microprocessor is shown in Fig. 8.3. The internal 8-bit data bus, ALU, accumulator, and general purpose registers have all been met before in Part 6 of this series. The data and address bus controllers are basically bi-directional register and latch arrangements to permit the feeding of data and addresses to and from external switches, transducers, bulk memory, displays, etc. The address bus controller normally uses 16 bit words, which are made up from two separate 8 bit words obtained from the internal 8-bit data bus. Most of the general purpose registers are 8 bit, but there are some specific exceptions; the 'Program Counter' and 'Stack Pointer' registers are both 16 bit, for example.

The 'Instruction Register' is used, together with the Control Unit, to identify and verify specific binary numbers called 'Instruction Codes', which are fed into the microprocessor from the program written in the external ROM or RAM. These numbers provide specific instructions to the microprocessor; 'reset the accumulator' or 'increment' (add 1) to register B, etc. When identified and decoded by the control unit, each instruction causes a specific number of control and timing signals to be sent out to the relevant registers and areas of circuitry, in order to cause that instruction to be implemented. The number of different instructions that can be performed by a micro is a very good indication of the 'power' of that micro, along with the number of registers that it makes available to the user. The popular Intel 8080A, for example, has 78 instructions in its instruction set, whereas the Zilog Z80 (acknowledged as one of the most powerful 8 bit microprocessors available) has 158 instructions, including all 78 of the 8080. The Z80 is also well sup-
Fig. 8.3. Simplified 8-Bit microprocessor block diagram

As an example, the requirement to flash an LED on and off for a certain number of times as determined by a thumbwheel switch. The simplified flow chart for this program is shown in Fig. 8.4. The ‘loop’ is gone round as many times as the LED is flashed on. The type of instruction causing the program to jump from the question “Is the content of register B zero?”, to the “turn on LED” sequence is known simply as a ‘jump’ instruction. In fact, the probable instruction would be ‘jump if not zero’, which is an example of a conditional jump. These conditional jumps make programming very much easier, because they effectively test for a specified condition (“accumulator = zero”, or “a certain logic state = 1”, etc.) then either jump to a different part of the program, or continue to the next program step in the list, depending on the result.

The turning on of the LED would be accomplished by an external circuit driven from the microprocessor’s 8-bit data bus, and the thumbwheel input would likewise be fed into the micro. The half second delay could be created by using an external monostable circuit, again, via the data bus, or by software methods; the computer takes a finite time to perform each program step, so by making it do a ‘trivial’ exercise a few tens of thousand of times, then time can be wasted, and a suitable delay created. In all programs, the most important thing to remember is that within the circuitry in question, both the instructions and the data are being represented as logic 0’s and 1’s; simple binary numbers.

THE USE OF MICROPROCESSORS

There are, essentially, two ways of using a ‘micro’ within a system. The first is ‘dedicated’ usage; the microprocessor has a single fixed program held in ROM, which it always per-
forms in the same way, while using small amounts of RAM for temporary storage if necessary. The user will have no means of re-programming this device. The microprocessor in this application is simply replacing large amounts of conventional logic circuitry. Test instruments, hand held electronic games, sewing machines, washing machines, cassette recorders; etc., whenever they use a microprocessor, they do so on a dedicated basis, and in each case the micro gives a fixed set of responses to a fixed set of stimuli, or inputs.

'Non-dedicated' use introduces us to the domain of the microcomputer, where the full performance, instructions, and capabilities of the microprocessor are fully at our disposal.

THE MICROCOMPUTER

The term 'microcomputer' means more than just a small computer. It is a computer in which the CPU is manufactured as a single i.c.; a microprocessor. Unlike the dedicated micro-based systems, it requires definite operator interaction before it can be of very much use at all! It is a programmable device, so without the program written into it, it can do very little. The constituent parts diagram of a typical microcomputer is shown in Fig. 8.5.

The video output of the microcomputer is normally in the form of a 9 to 12 inch CRT; often a portable domestic television set. This video monitor is usually arranged to display a number of ASCII characters corresponding to the binary numbers held in a particular part of the memory. Imagine the screen being divided up into a matrix of squares, with each square having a specific and unique address. There are typically around one thousand (1K) of these. Part of the RAM known as the 'Video RAM' is usually dedicated for this use, and the display is then known as 'memory mapped'. The keyboard enters ASCII codes into the computer, which are normally fed up onto the screen as the program is being written. The bulk storage, printer, and external outputs and inputs are all fairly self-explanatory.

The microprocessor has many extra circuits and devices surrounding it; encoders and multiplexers to feed the keyboard information in, character generators and modulators to enable the memory to be displayed on the screen, and (of course) ROM and RAM. The ROM in a microcomputer normally carries the 'monitor program' (not to be confused with the video monitor); this is the 'apparent intelligence' of the computer, and is the interface point between the microprocessor logic, and the human operator and keyboard. Depending on the size and complexity of this monitor program, the facilities offered to the user can be considerable. The monitor contains basic and fundamental information within the computer, to tell it to scan the keyboard for any keys pressed, then to feed the ASCII character corresponding to the key pressed into the section of video RAM corresponding to the relevant position on the screen. It also enables, editing of the video RAM; deletion of characters, moving the display up and down ('scrolling'), etc.

Although the microprocessor operates on binary numbers, known as 'machine code', the human operator can program the computer in the hexadecimal equivalent to those binary numbers, making it quicker to type in, and easier to understand. This hexadecimal listing is known as 'object code'. Some systems help still further, by allowing the program to be written in 'mnemonics', which is a means of writing hex instructions in an abbreviated English language format. For example, "JP" could be used to represent a jump instruction, the hex code for which might be C3, or 'INC B' might be used to represent the instruction 'increment the contents of register B', who's hex code might be 04. By using mnemonics (pronounced 'nimnics'), the program (when written down or typed in) can be much easier to follow and understand; the instructions all mean something and are no longer a collection of fairly arbitrary looking letters and numbers!
To produce machine code from the mnemonic program, an 'assembler' program must be used, which acts as a 'converter' between mnemonic and binary. (To translate back from binary to mnemonic, a program called a 'disassembler' is brought into use.) Much of the programming for dedicated microprocessors is written on microcomputers in object code or mnemonics, because this level of computer operation is very fast; the computer operates very efficiently when using these codes. However, programming can still be a complex, slow, and difficult task, as the detailed internal operation of the microprocessor is still dominant; programs are written in terms of registers, clock signals, ALUs, flags, etc. To bring the program one step higher in level, to a nearer approximation to the English Language, we must use a 'high level language'.

HIGH LEVEL LANGUAGES

The high level language raises programming to a fairly easily understood level. Instruction such as 'GO TO', 'PRINT', and 'IF X = Y . . . ' are used, and enable people who are not immediately familiar with the computer or program in use to make sense of it all fairly quickly. There are many different languages; FORTRAN, COBOL, ALGOL, BASIC, PASCAL, FORTH, etc., the most commonly used of these (in the case of microcomputers) being BASIC, which stands for 'Beginners Allpurpose Symbolic Instruction Code'. Although there are several 'dialects' of BASIC they all share many common properties, and BASIC programs for one make of computer can usually be run on other computers with only a small amount of modification, if any at all. The opposite is true of object code and mnemonics, since these are specific to the microprocessor and monitor program in use, and can be quite difficult to translate for other systems. A special program must be used within the computer to convert programs, written by the user in BASIC, into machine code, and to convert machine code 'replies' from the computer back into the relevant BASIC statements and comments. This special program is normally held in a ROM, as firmware.

High level languages, because of the extra complexity involved, are relatively slow in use; each step of the program takes longer to execute than in the case of machine code based programs. Even so, the operation can be fast enough for all but the most demanding applications.

GETTING TO GRIPS WITH THE 'MICRO'

Unfortunately, the microprocessor is not something that you can just 'dabble' at; you can read all that you like about it, but until you get 'hands on' experience with a micro-based system you will still know very little about the practicalities of the subject. By far and away the best learning aid is a microcomputer itself, which will cost a significant amount of money, so it is important to shop wisely. There are microcomputers on the market that may seem attractive because of their very low cost, and some good publicity. Indeed, they demonstrate considerable engineering achievement in squeezing so much circuitry into remarkably small spaces, for a reasonable price. However, they can be very restricting in performance; the keen user will find that the capabilities of the machine, even with 'expansion' (more memory), can be very limiting. For what they are, they are excellent, but they are not fully fledged microcomputers in the same class as machines costing over £200. It is strongly suggested that if you are serious about learning about microprocessing and computing, you spend more money to avoid disappointment in the very near future. As a compromise, some computers in kit form can enable you to start off with a simple and inexpensive system (working on the object code level), then build it up slowly, and add a high level language, to finish up with a system which is worth several hundred pounds.

The machine to buy is very much a personal choice, to be made in combination with a study of magazine reviews, advice gleaned from other, more experienced microcomputer users, and a trip or two to your local dealer. Obviously, you get what you pay for, but to a certain extent you can pick and choose your approach. For those interested in the hardware side of the subject, the kit computers mentioned earlier can be a good starting point, but only if your standard of construction, especially soldering, is very good. Kit computers are NOT for beginners! Nascom 1, Nascom 2 and Tangerine products, amongst others, can certainly be recommended. Ready-built computers are for those less confident in the hardware side; Tangerine, Video Genie, Sharp and Tandy all have ready-built products, and the new 'BBC micro' is attracting a lot of attention at the moment, although at the time of writing it is not yet on the market. Paying out still more can provide small business computers such as the PET, APPLE or Tandy, but these represent a considerable investment and are not necessary unless you are likely to need their very advanced facilities later. A choice in the microprocessors used comes down to 6502 versus Z80 in the case of most microcomputers mentioned. The Z80 is undoubtedly more powerful, but the 6502 is somewhat more widely used, so once again the choice is a personal one.

Another point to make is in the interest of domestic harmony! Computing can take up a surprising amount of time. 'De-bugging' programs has kept most people busy into the early hours on a number of occasions, and you should be aware that demands on your time can be considerable, especially at first. Computing is not something that you can do a little at a time; several hours at a stretch is needed to get to grips with the problems, and preferably in peace and quiet, too. Don't let this put you off, though—it's a useful and fascinating subject, and well worth spending time and effort on!

In conclusion, if microcomputing or microprocessors are of interest to you, then the only real way to learn is to buy a microcomputer, and spend some time with it. Before committing yourself, why not see if the local school or technical college has evening classes in computing or microprocessors, or even runs a suitable club? This would enable you to try out various machines before buying, learn more about the subject, and ask the advice of other enthusiasts.

IC TECHNOLOGY

As technology has advanced through the years, so the number of active devices on an i.c. chip has increased. We can define the 'scale' of integration as follows (remember that each gate is made up of a number of transistors or MOS devices):

- Small Scale Integration (SSI); up to 12 gates per i.c. Most NAND, NOR, inverter, and similar combinational logic i.c.s fall into this category.
- Medium Scale Integration (MSI); from 12 to 100 gates per i.c. This covers the range of counters, registers, decoders, flip-flops, etc.
- Large Scale Integration (LSI); from 100 to several hundred gates per i.c. Multiplexed counter/driver i.c.s digital clock i.c.s, and similar complex devices all fall into this category.
- Very large Scale Integration (VLSI); from several hundred to several thousand gates per i.c. This is the realm of the microprocessor and the large memory i.c.s. Some micros even have memory i.c.s. both ROM and RAM, built in! Many 'accessory' i.c.s to the microprocessor are needed, such as
programmable timers, peripheral management devices, memory controllers, input/output controllers, etc., and most of these are LSI or VLSI devices in their own right. In many cases, the microprocessor is only a very small part of the whole system; its support i.c.s can take up a lot more space and cost more than it does itself!

To help cut down on the number of 'accessory' i.c.s in any logic circuit or system, the 'Uncommitted Logic Array', or 'ULA' has been developed. This is a very large collection of logic gates which have no pre-determined interconnections. By designing a suitable pattern of interconnections of these gates, a custom-built i.c. can be created which will do the job of a large number of 'off the shelf' devices. Because the ULA is a standard device, with only the final interconnection layer being customised for each application, it is considerably cheaper than having an entire i.c. designed and built, and this approach, therefore, holds great promise for further miniaturising circuit designs in the years to come.

DIGITAL ELECTRONICS IN THE FUTURE

The pace of technological advance is so fast at the moment that it is difficult, if not impossible, to predict developments in the medium or long term future. However, it is possible to extrapolate current trends and developments, and to fairly accurately assess the changes that we can expect to see in the next few years.

In terms of microprocessors, the trend is towards larger and larger numbers of bits being used in a device. The industry 'standard' is currently 8 bits. 16 bit micros are now readily available and are starting to be used in large quantities, yet already we have seen the first appearances of the 32 bit micro; an incredibly powerful i.c. which will enable us to out-perform the much larger 'mini-computers' with single board VLSI microcomputer systems. 64 bits is still long way off, but is far from being an unrealistic or impossible dream. To keep pace with the speed and power of these large devices, memory manufacturers will continue increasing the number of cells per chip, and increasing their operating speeds, probably with dynamic RAM, EEPROMS, and bubble memories showing the greatest improvements.

The 'in' subject at the moment is voice synthesis and speech recognition systems. Cheap, high quality synthesis i.c.s are readily available at low cost but have the severe restriction of a very limited vocabulary. Infinitely variable 'phonetic' synthesisers are more expensive, and most of them suffer from a very poor quality of speech. However, the i.c. manufacturers seem determined to trust the 'talking hot drink vending machine', and similar ideas, upon us, so this is sure to be an area of considerable future expansion! Speech recognition is a much more difficult task, due to the subtle nuances, inferences, dialects and idiosyncrasies that punctuate the speech of all of us. Again, systems are available with limited performance, and these will be improved upon considerably in the years to come.

Combining speech synthesis and recognition will allow direct communication between the computer and the 'man-in-the-street', which offers vast scope for technological advance and integration of the computer into our everyday life. From the other angle, the man-in-the-street is becoming more familiar with the subject of computing in its own right. All British schools are being equipped with at least one microcomputer, and already many schoolchildren are achieving stunning levels of proficiency and knowledge about computing. The 'electronic office' is with us; word processing, facsimile machines, electronic filing, and data transfer systems are all available and are being used in many of the large companies. Expensive, yes, at the moment, but as with most electronic goods a continued demand will result in dramatically lowered costs.

Returning to technological advances at the device level, the Uncommitted Logic Array, as mentioned earlier, will help in the miniaturisation of circuit assemblies, which in turn will increase the number of everyday products which have electronics incorporated into them. Speed limitation is a major problem in many microprocessors and computers, and advances are already being made towards providing the technological basis for the next generation of devices. Gallium Arsenide semiconductors, and those using the 'Josephson Junction', both of which need very low temperature cooling systems to operate, offer considerable decreases in gate propagation delays, with the resultant increase in computing speeds, and show great potential for the future. The one thing that seems certain about the times ahead is that they will be filled with change, challenge, and interest, just as the last few years have been. The profession, and hobby, of electronic engineering is guaranteed to have a colourful future for many years to come!

DIGITAL DESIGN TECHNIQUES

We now conclude this series on digital design techniques; there's no 'mini-project' this month because of the level of complexity that we have now reached, and the resultant limitations of space, so for the final project see next month's issue. In the past few months we have worked through from binary logic and combinational gates, all the way up to microprocessors. The pace has been swift, and to get full benefit from the series it is strongly suggested that you follow up the points made, and do further reading, experimenting, and designing of your own. There is much to be learnt and a great deal of fun and enjoyment to be had, so start putting together your own projects today!

ACKNOWLEDGEMENT

I would like to express my grateful thanks to my father, Peter Gaskell, and to my friend and colleague John Miller, for all their help, criticism, and suggestions in the preparation of this series.

T.A.G.

Our book PE Popular Projects containing a selection of popular projects is now available. The book costs £1.25 from retail outlets and is also available for £1.50, UK post paid, or £1.80 overseas surface post paid, from Post Sales Department (PE Popular Projects), IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF.

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- Fits all 12v neg. earth vehicles

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- The brandleading system on the market today
- Unique Reactive Discharge
- Combined Inductive and Capacitive Discharge
- Contact breaker driven
- Three position changeover switch
- Over 130 components to assemble
- Patented clip-to-coil fitting
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- Not an auto item but great fun for the family
- Total random selection
- Triggered by waving of hand over dice
- Bleeps and flashes during a 4 second tumble sequence
- Throw displayed for 10 seconds
- Auto display of last throw 1 second in 5
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- Three position switch with Auxiliary back-up inductive circuit
- Reactive Discharge. Combined capacitive and inductive.
- Extended coil energy storage circuit
- Magnetic contactless distributor trigger head.
- Distributor triggerhead adaptors included
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- Fits all 12v neg. earth vehicles
- Over 250 components to assemble

**EDA SPARKRITE LIMITED**
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<table>
<thead>
<tr>
<th>Self Assembly Kit</th>
<th>Ready Built Units</th>
<th>Price Inc. VAT, Postage &amp; Packing</th>
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<tr>
<td>SX 1000</td>
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<td>£19.95</td>
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<td>MAGIDICE</td>
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</tbody>
</table>

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CUT OUT THE COUPON NOW!
**RESUME**

Genesis is a series of hydraulic computer controlled robots ideal for education, light industry and as microcomputer peripherals.

Features are: extremely low cost, up to six controllable axes, positional sensing, servo control, continuous path motion, learning ability, RS232 interface, and IR remote control for the mobile unit.

**Constructor's Note**

Complete kit of parts for this project can be obtained from Powertran Cybernetics, Portway Industrial Estate, Andover, Hants SP10 3WN. Tel Andover (0264) 64455.

Prices are as follows...

- **Genesis M101 4 axis model (excluding wheel base)** £295.00
- **Genesis M101 5 axis model (excluding wheel base)** £345.00
- **Genesis M101 wheel base** £79.00
- **Genesis P101 4 axis model** £450.00
- **Genesis P101 6 axis model** £545.00
- **Genesis S101 4 axis model** £355.00
- **Genesis S101 3 axis model** £405.00
- **Position detector coil set for M101, S101 4 axis models** £15.00
- **Position detector coil set for M101, S101 5 axis models** £19.00
- **Position detector coil set for P101 4 axis model** £15.00
- **Position detector coil set for P101 6 axis model** £24.00
- **Position detector board for M101, S101 4, 5 axis models** £6.50
- **Position detector board for P101 4, 6 axis models** £7.50
- **Motor drive board for M101 wheel base** £11.50
- **(2 required per machine)**
- **Control electronics for M101 (microprocessor board, interface board, display board and mounting bracket)** £135.00
- **Processor box for S101, P101 (microprocessor board, interface board, display board, power supply, interface cables, conduit, cabinet)** £175.00
- **Parts for RS232C interface (fits on microprocessor board)** £14.50
- **Hand held controller box for M101 (includes infra red transmitter and rechargeable battery)** £47.00
- **Hand held controller box for S101** £33.00
- **Hand held controller box for P101** £33.50

All prices subject to 15% V.A.T.
### Components

#### CONTROL BOX (MOBILE)

**Resistors**
- R1, R4, R6: 180k (3 off)
- R2: 120k
- R3, R5, R23, R29: 47k (4 off)
- R7: 470
- R8: 3k9
- R9, R12, R14, R15, R28: 10k (5 off)
- R10, R11: 1M (2 off)
- R13: 2k2
- R16: 33
- R17: 1
- R18, R22, R24: 100k (3 off)
- R21, R27: 560k (2 off)
- R19, R20, R25, R26: 12k (4 off)

All resistors 1W 5%

**Capacitors**
- C1: 1n Siemens B32560
- C2: 10n ceramic Piher
- C3, C4: 39p ceramic Piher (2 off)
- C5, C6: 100µ/16V elect. Axial lead (2 off)
- C7, C8: 10n Siemens B32560 (2 off)

**Transistors and Diodes**
- TR1, TR2: BC184L
- TR3, TR4, TR5: BC182L (3 off)
- D1–6, D9–14, D17, D18, D21, D25–30, D33–38, D43: 1N4148 (27 off)
- D46, D47, D48: 5V6 Zener
- TR3: BC182L

**Integrated Circuits**
- IC1, IC2: 4051B (2 off)
- IC3: 4024B
- IC4, IC9: 4013B
- IC5: 40106B
- IC6: 4023B
- IC7: 4011B
- IC8: LM324
- IC9: ICM7555 IPA
- IC10: 10k SIP

**Miscellaneous**
- D1/N plug 5-pin 240°
- 5-way cable (3 metres)
- Slide switch
- Push-button switches
- 8-pin d.i.l. socket
- 14-pin d.i.l. socket (5 off)
- 16-pin d.i.l. socket (2 off)
- Slide switch
- 3.5 jack socket
- Jack-to-jack lead (1 metre)

*Note: In part 2, Interface board components list, under Miscellaneous—SIP1 and SIP2 should be considered as IC22 and IC23. SIP3 is IC24.*
Fig. 1. Robot controller *RS232 version only. **Not used at present
INTERFACE BOARD

The Robot requires many more than the 20 I/O lines available from one PIA. To obtain these without going to multiple PIA’s, the interface board uses a secondary 8 bit bus connected to one side of the PIA whilst the other side generates latch clocks for output latches or output enables for system inputs. Although careful attention to detail was necessary in the software to avoid bus clashes, this method makes efficient use of board space and means that the software can be debugged easily from an external computer.

The outputs from the expanded I/O scheme comprise two sets of 8 bits for controlling the solenoids and the motors, 8 bits for the display and bleeper and 8 bits for extra devices. On the input side there are 2 bits for the keyboard decoder interface one bit to signify RS232 connection and 5 bits for extra inputs.

SYSTEM DESCRIPTION

On manual control which is available in the EDIT mode, the robot arms can be moved around using the appropriate control buttons on the control box. There is logic to prevent both solenoids for an axis being activated simultaneously. The robot is taught by being moved under manual control to the desired position. Pressing the INSERT button enters the position and the microprocessor stores it in the battery backed-up CMOS RAM.

When a position is to be remembered, a combination of an analogue multiplexer and an eight bit analogue-to-digital converter (interface board — IC25 and IC24) selects each of the 5 transducer voltages in turn, and digitises them.

On replay, the ADC/multiplexer combination is constantly scanning the 5 inputs under software control, the measured positions of the five axes being compared by the microprocessor with the current target positions. These comparisons are used to activate the correct solenoids to achieve the target positions.

Manual control of the drive motors (on the mobile unit is made variable by mark/space modulation of the motor drive switching transistors. These mark/space modulation timings are derived by the program from an internal look-up table that gives the mark/space ratios for the left and right motors from the position of the panel Speed slider and the Steering pot. These timings are themselves also generated by the microprocessor.

RS232 input

To control the robot from an external computer, an RS232 input is provided. If the RS232 lead is plugged in when the unit is powered up, the unit will ignore the keyboard and wait for a command from an external computer.

A move command is simply sent as a string of ASCII characters. The format consists of an "M" followed by six pairs of hexadecimal digits (each pair representing a number between 0 and 255 — the desired position for each axis). The last pair is the jaw command, and should be 00 for "jaws open", and FF for "jaws closed"; e.g. M8080808080FF will move all axes to a central position and close the jaws.

When the move has been completed the robot will send back a "*" down the RS232 line to inform this to the sending computer.

On five axis units, the format is the same, but the last-but-one pair of digits is ignored.

This concludes the hardware and control of the robots. NEXT MONTH we embark on the software description and routines, and final constructions.
THE TWO topics in this month's Micro-Bus show how micros can be used in amateur radio. The first program acts as a Morse-code tutor, for those trying to learn Morse code. Both programs were developed by Steve Platt, a radio amateur in Cambridge (G6AZ1).

RECEIVING FAXSIMILE PICTURES

Pictures can be transmitted over channels normally used for speech, such as the telephone, or over the air by radio, using a system known as 'faxsimile' or 'fax'. This system is used by radio amateurs to send diagrams such as weather maps and charts on the HF and VHF bands, but one problem faced by amateurs wishing to try their hand at fax is displaying the received pictures without expensive equipment.

The program to be described solves the problem by using the high-resolution four-colour graphics on an Acorn Atom computer to display fax transmissions on a TV screen straight off the air from a receiver. It was developed by Steve Platt of Cambridge (G6AZ1), and what follows is based on his description.

"Radio amateurs generally use fax on the HF bands (short waves) where many commercial transmissions can be received. Fax is also used on the popular VHF 'two-metre' band where the calling frequency is 144-700MHz. A sample fax picture, of a street scene, is shown in Fig. 6; it is composed of three brightness levels, and has a total resolution of 128 x 192. It was received on 144.675MHz using the program of Fig. 7 with the calling frequency is 144.700MHz. Both programs were developed by Steve Platt, a radio amateur in Cambridge (G6AZ1).

Fig. 1. Facsimile picture decoded and displayed by the program of Fig. 2

The picture was transmitted (by G8RYL) using a surplus fax machine fed into the transmitter microphone socket. The picture is wrapped around a rotating drum, and scanned with a photocell. The photocell moves slowly along the drum to give a vertical scan, while the drum's rotation provides the horizontal scan. The output from the photocell is then used to vary the frequency of an oscillator with the brightness of the picture. Drum speeds of 60, 90, 120, and 240rpm are most popular; the program to be described works with 120rpm. The picture's 'aspect ratio' is varied by setting the number of drum rotations for each inch that the photocell moves. Further details may be found in Radio Communication, August 1978, and Wireless World, December 1976 and March 1977.

PROGRAM DESCRIPTION

"The main task of the program is to determine the audio frequency of the incoming fax signal. This is done by counting 'zero-crossings' during fixed intervals of time. The number of zero crossings is then related to a scale of brightness levels, and a point of the corresponding brightness is put on to the Atom screen by poking directly into the graphics memory.

"First the vectors and labels are declared, and the labels are cleared (lines 10 to 40). Variables C and S are parameters which can be varied to tune the program to the machine being received; the values given, C = 77 and S = 8, seem to work best. The time interval over which zero crossings are counted is determined by C, and S determines the number of drum rotations that correspond to the fax sync-pulse level; i.e. the lightest part of the picture. The call to subroutine 2000 in line 125 assembles the machine code; note that this code uses C and S as constants, so these must be set before assembly.

"Vector B is a look-up table of brightness values. If X zero-crossings are counted, the colour of the point plotted will be B'X. Values of 2, 0 and 3 correspond to white, grey and black respectively. The brightness levels are set up in lines 130 to 150, based on the value of S selected.

"The main program loop, in lines 210 to 240, first waits for a key-press; locations #84 and #85 are then pointed to the start of the screen memory (line 230), and the machine-code routine JJ3 fills the screen.

ASSEMBLER ROUTINE

"Lines 2000 to 3000 constitute the assembler routines to receive a fax transmission, and display it in three brightness levels on an Atom screen. Routine LL1, from 2020 to 2380, is the key subroutine and is actually the key subroutine and is actually the key subroutine and is actually the key subroutine and is actually the key subroutine and is actually
much simpler than it looks; it acts as a software frequency meter, counting the number of zero crossings on the cassette input in a fixed time interval.

"Each time the main loop is executed it reads the cassette input, and increments location \# 82 if the input has changed. The main loop takes 32 usec, and is balanced with NOPs so that each decision branch takes the same number of cycles. The number of times the loop is executed is determined by locations \# 82 set to 0 in lines 2503 and 2035, and although in the present application C was only 77, a two-byte counter was used to allow expansion to longer measurement times. With this value of C the routine counts zero crossings for about 2.5 msec, before returning with number of zero crossings in location \# 82.

"As a debugging aid, lines 2400 to 2470 will dump 100 samples of the input frequency in the vector D. Typing LINK LL17 followed by printing the values D70, D71 ... D700 will allow the input to be checked. If the values are not the range 7 to 12 the value of S may need to be changed.

DISPLAY ROUTINE

"The display routine, JJ3 in lines 2500 to 2590, is called from the main BASIC loop. It waits for the synchronising pulse which precedes each line of video information (lines 2500 and 2505), and then fills a line on the screen. To do this it calls the LL1 routine to sample the input frequency, then looks up the corresponding brightness value in vector B (line 2520). This is a 2-bit pixel value which is shifted into the screen memory via a work byte, \# 83, in line 2530. When four pixels have been packed the byte is updated in the graphics area (line 2530). At the end of a line (when the address is a multiple of 32-line 2560) the program goes back to wait for another sync pulse.

"The remaining part of the routine updates the upper byte of the screen address, and checks for reaching the bottom of the screen. The assembler code in lines 900 to 995 of the program presents letters in groups of four, separated by a single space. This is similar to the test format used in the amateur radio examination, and so the program can be used to test whether the required standard has been reached. The program can also be used to learn letters, by watching the words on the screen as the Morse is played.

Many people have their own theories as to the best way of learning Morse code. Generally it is thought to be better to hear the letters at full speed from the beginning. This way you identify the sound of each letter without thinking of a written pattern of dots and dashes, which can be a distraction when trying to gain speed! It is therefore best to start with the speed set to your target speed, and have extra time between letters, over and above the normal spacing. The Post Office test for radio amateurs requires a speed of 12 words per minute, where words are defined as having five letters; other tests may need less.

CODE STORAGE

The code for each letter occupies two bytes, in vectors C and L. The byte in C holds a binary sequence which gives the code for that letter, with '0' for a dot (short bleep) and '1' for a dash (long bleep), starting with the lowest value greater than 0 to give extra spaces between letters (g). The remaining part of the routine updates C and L. The byte in C holds a binary sequence which gives the code for that letter, with '0' for a dot (short bleep) and '1' for a dash (long bleep), starting with the lowest value greater than 0 to give extra spaces between letters (g). The remaining part of the routine updates C and L.

PROGRAM DESCRIPTION

Lines 10 to 25 allocate space for vectors, C, L, and S, and for labels VZ0 to VV8, and for the machine code at P. The values of C and L for the Morse code of the letters A to Z are set up in lines 100 to 170, and the assembly code is then assembled (line 180). The string S contains the alphabet in the order of shortest letters first; i.e. in rough order of difficulty. The program presents subsets of the alphabet starting with the first letter, S1.

The main control loop of the program, from line 200 to line 295, determines how the codes are presented, and this could be altered to suit individual requirements. For example, the program could present codes one letter at a time, with you trying to say the word in your head. K determines how many different letters from string S are being taught; thus, with K = 3, only letters E, T, and A are presented. G can be set to a value greater than 0 to give extra spaces between letters when learning (line 205). The main loop presents a total of 24 'words', each of which consists of 5-letter groups (lines 210 and 220) picked at random from the first K letters in string S (lines 240 and 250). Each letter is "beeped" in Morse code by subroutine 'c' (line 260), followed by any extra spaces wanted between letters (line 265). After each word there is an extra space (line 275), and the word is printed to the screen (line 280).

BLEEP ROUTINE

The assembler code in lines 900 to 995 of Fig. 3 is a routine to beep the Atom's speaker, and is similar to the one in the Atom operating system. Location \# 80 gives the pitch of the tone and location \# 81 the length. The same routine is used for dots, dashes, and gaps, with location \# 82 set to 4 for a tone and to 0 for silence; this ensures that tones and gaps are all exactly the right length.

An assembler routine at VV3 (line 982) gets the ASCII value of the next key pressed in location \# 83.

MORSE CODE OUTPUT

The final routine, 'c', outputs the code for the letter in I, where I = 1 to 26 for Z; any value outside this range is treated as a space (inter-letter gap). The routine uses vectors C and L, set up as described above. Each dot is a beep of length T (lines 1025 to 1040), and each dash a beep of length 3T (lines 1050 to 1052). There is a gap of length T between each dot or dash (lines 1065 to 1070), and a gap of length 3T at the end of the letter (lines 1065 to 1085).

This routine could form the basis of a program to generate automatic Morse code from a file typed in at the keyboard. However, writing the complementary program to receive and decode Morse is a much tougher problem, and this would provide an interesting challenge to any radio amateurs with micros.
In this, the final part of the camera, we first catch up on some Logic Board constructional notes. The f.e.t. TR20 (VN66AF) should have its heatsink doubled over, as shown in Fig. 3.1, to clear its headroom.

Scrape a small amount of track off the top-right hole where the coil is situated on the p.c.b. Link the coil to the casing as shown in Fig. 3.2. There are two links, and C50 (15μ/16V) to be mounted. The coil board is then mounted with C50 going to the lower part of the board (near IC3).

Final assembly instruction

Having completed the construction of the individual boards of the camera, the final assembly consists of fitting the boards together and making the necessary interconnections. The vidicon tube and scan coil assembly is supplied complete with connecting wires to make assembly simpler.

The individual component boards may be sent for testing and setting up to Security Electronics and Engineering (Printoid Ltd.), 20/21 Alfric Square, Woodston, Peterborough. 0733 329111. All components are available separately. Technical and supply problems should be sent direct to: PE/Seescan Camera Project, Security Electronics and Engineering, 20/21 Alfric Square, etc.
Connect the four boards together using the varelco connectors—these are polarised so that the connectors will only mate correctly in one position. Check that all connectors are making good contact.

Mount the inner rear panel to the rear of the camera chassis using four M3 6mm screws. Mount the co-axial socket on the inner face of the rear panel using two countersunk M3 screws, one tag washer and two M3 nuts. The tag washer fits on the screw in the red hole.

Using heavy gauge tinned copper wire, connect the co-axial socket core and the tag washer to the points indicated on the diagram of Fig. 3.4.

Connect the three wire plug from the video board to the logic board so that the black wire is near pin 8 or IC9 on the logic board.

Mount the tube/coil assembly onto the front of the camera chassis using four M3 20mm screws with M3 nuts, ensuring that the coil and tube are orientated as shown in Fig. 3.5.

Plug the scan coil connector onto the logic board so that the blue wire is nearest to the scan coils.

Fit the tube base connector to the tube ensuring that the short tube pin fits in the unnumbered hole of the connector.

Solder the earthing connections from the scan coil assembly to the earth rail on the video board, as shown in Fig. 3.6.

Solder the screened target connection to the video board as shown.

Screw the lens into the front of the camera. The camera chassis is now complete.

SETTING UP

The general description of the camera electronics, and of the methods of setting up have been left until last, as it was felt that it would be easier to visualise the camera as a whole once the individual sub-assemblies had been constructed. In making final adjustments to the camera, it is essential that a clear understanding of the function of each control has been achieved.

We hope to show how these units inter-connect and work together to form a high quality black and white television camera.

VIDICON TUBE

The inverter and high voltage power supply boards provide all the necessary dc voltages for the correct operation of the vidicon tube. When correctly adjusted, the vidicon will produce a voltage at its target ring which will be proportional to the intensity of light falling on the centre of the target window. In the absence of scanning wave-forms, the electron beam will produce a focussed spot near the centre of the target window. On no account should the tube ever be allowed to operate in this fashion as it will result in a spot being burnt onto the vidicon target.

If the video amplifier were connected to the target ring, it would amplify this smaller voltage, and an amplified signal would be fed to the UHF modulator. The purpose of the logic/scan board is twofold. First, it scans the electron beam across the target of the vidicon tube. Line scan moves the beam from left to right, field scan from top to bottom. These two scan waveforms are precisely locked together, and are carried out at the same speed as the electron beam moves across the monitor screen. Therefore, the voltage at the target ring of the vidicon will be continually changing—at any instant being proportional to the intensity of light at a particular spot on the surface of the vidicon target upon which the optical image of the scene is focussed. We now therefore have picture information available at the output of the video amplifier ready to send to the monitor. However, at the moment, the scanning of the vidicon tube is not linked to the scanning of the monitor cathode ray tube. We need to ensure that when the camera starts a scan at the top left hand corner of the picture the monitor is also scanning at the top left hand corner. To do this we send out a pulse (called a sync. pulse) at the start of each line and field. The monitor is forced to keep in step by these pulses, ensuring that a stable fully locked picture is obtained. Our line and field sync. pulses are obtained from the logic board, and are mixed with the video signal in the video amplifier. The waveform handled by the last two stages of the video amplifier, and then fed to the modulator is a composite containing both the video signal and synchronisation pulses. As mentioned in part four, blanking signals are also added to prevent the electron beam retracing its steps across the picture when it rapidly flies back to start the next line or field. These signals
fed to the cathode of the vidicon tube cut off the electron beam between lines and at the end of fields preventing it reaching the rear of the target surface.

In testing the camera, it is important to ensure systematically that each of the sub-assemblies are correctly working.

### SETTING UP

Before applying power, turn all presets to midway position, with the exceptions of beam current, target voltage and automatic light control. The beam control should be adjusted for maximum negative voltage on its wiper, the target control turned fully anticlockwise until zero volts is on the wiper. The automatic light control should be fully anticlockwise. With these settings, the vidicon tube is fully cut off, and it will not be possible to damage the face of the tube in the event that the scan waveforms are incorrect.

<table>
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<th>PRESET CONTROLS</th>
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<tr>
<td>Logic Board</td>
<td>Master clock oscillator Width Magnetic focus Height</td>
</tr>
<tr>
<td>Video Board</td>
<td>Automatic light control Pedestal Sync DC level</td>
</tr>
<tr>
<td>High Voltage Power Supply Board</td>
<td>Target Beam Electrostatic focus</td>
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</table>

Switch camera on; line frequency whistle should be heard immediately from the inverter transformer; if not, switch off and recheck connections. Set the height and width controls to maximum, i.e. fully clockwise. At this stage, if the camera is connected to a TV set tuned to channel 36 a pattern of lines should be seen on the screen. Adjust the master oscillator control to stabilise the pattern as far as possible. If no pattern is visible, just a blank, noise free raster, try altering the position of the pedestal black level control. Place a finger on the target connection; a great deal of noise (random patterns) should be visible on the TV screen. Adjust the pedestal control for the strongest display. Use an oscilloscope to check that correct scan wave forms are present at coil plug. See Fig. 2.11.

Set beam current control to give 30V at its wiper, and target control to \( \frac{1}{2} \) maximum. By adjusting the beam control carefully, it should now be possible to detect some sensitivity to light when the camera lens is wide open. Now set the camera lens to about f.8 in normal illumination, then adjust the electrostatic focus control to give the crispest image. Aiming at an object 2 metres away, with a lens set at 2 metres, slacken off the tube retaining clamp and slide the tube carefully backwards and forwards to obtain the sharpest focus. Adjust the height and width controls until the edges of the picture just exclude the target windows; readjust the electrostatic focus, and beam controls, for the best picture. Trim the pedestal control for best picture with no crushing of dark greys into blacks. Adjust sync. control for best contrast and stability; or use oscilloscope and set up video output wave form to CCIR standard. Adjust all the presets one at a time for optimum picture quality. Finally, advance the automatic light control preset until it just has an effect on the picture; back off this setting slightly. This is the correct setting for normal use.

### JAPANESE IDEAS

The Nissan Motor Company of Japan has been toying with the idea of building a factory in Britain to make cars. Already the company is filing patents in Britain. The latest (British patent application 2 074 313) suggests an interesting new application from Nissan for light links.

Currently any switches on the steering wheel of a motor car, for instance the horn button, produce electrical control signals. These are fed to the main car wiring harness via electro-mechanical slip rings between the moveable steering wheel and stationary steering wheel column. But slip rings suffer from wear. Also the contacts are bulky, and this limits the number of connection paths and thus the number of switches which can be accommodated on the steering wheel. Nissan proposes replacing this electrical path with a light path.

Figure 1 shows the basic layout. A bank of switches 17 on the steering wheel 13 controls the engine or ancillary equipment. The electrical output of the switch bank is encoded at 21 to control the pulsing of a LED 22. The pulsed light is beamed at light-transmitting ring 23, made for instance of acrylic or polycarbonate. Light pulses emerging from the ring are picked up by photo-diode 24 which is secured to the steering wheel column. The electrical output diode 24 is amplified at 25, shaped at 26, decoded at 27 and fed to drive circuit 28 for control of the appropriate car function. This could for instance be the wave-band change and volume control of a radio.

Light fibre links can be used to improve optical coupling. The ring 23 is shaped to allow light from the diode to propagate inside the ring and escape only at the face adjacent the photo sensor.

The transmission code relies on pulses of 2.78 millisecond width at a frequency of 180Hz and a duty factor of 50%. This enables a full message to be transmitted in 15 milliseconds. Because the switch is likely to be depressed for at least 100 milliseconds, each coded message is transmitted at least twice for safety.
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REMOTE CONTROL

In days of yore, when I ran a sort of audio amplifier assembly factory in my back shed, I became well versed in the tricky business of connecting sensitive volume, bass, and treble pots into the rest of the circuitry using carefully screened and earthed leads. Of course, these amplifiers used transistors or even valves (Ah! Pentodes!) which always needed an element of black-magic to ensure success anyway, but in today’s chip oriented circuitry, electronic sorcery at the soldering iron stage seems out of place somehow. My own special witches’ brew for amplifier control connections has been rendered obsolete overnight by a new chip from National, the LM1035.

The trouble with the old method of connecting amplifier controls was the fact that the pots had to be on the front panel while the amplifier itself was several inches away, and the interconnections made marvellous transmitting or receiving aerials for cross-talk, noise, mains hum, and even Radio Luxembourg. What National have done is to provide electronic control circuits which are controlled directly by dc voltage levels, so that the sensitive audio signal path never has to leave the chip. Pots are still used of course, but now they are used to get, not a signal level, but a dc level which can be slugged with a big electrolytic capacitor to remove any stray signals which could interfere. Inside the chip are two signal channels (for stereo) which have individual electronic attenuators for gain and balance, and in-(for stereo) which have individual electronic attenuators for gain and balance, and individual voltage controlled filters for treble and bass control with each feature being controlled by a single voltage level so that there is no longer a need for expensive ganged pots.

The LM1035 has a distortion level of 0.02% at 1kHz and gives a volume control range of 0dB with 22dB of balance range. Maximum bass and treble boost or cut is 15dB, channel tracking is good to within 1dB and channel separation is -60dB at 1kHz. An on-chip voltage regulator is provided to allow the device to operate on un-stabilised supply rails of from 8 to 20 volts, and the whole thing lives in a tiny 20 pin package.

SUPERCHARGED 9900

When Texas Instruments introduced the first true 16 bit microprocessor, the 9900, they claimed that it spelled “The end of the two-bit eight-bit” and sat back to watch their tall-in-the-saddle processor steal sockets from Intel and Motorola who were then still clinging to their puny 8-bit devices. Unfortunately the market was not really ready for a 16 bit chip, and although the 9900 was reasonably successful, it certainly did not sweep the other 8 bit chips off the board, and even found itself a poor second when Intel, Zilog, and then Motorola introduced their own 1000 series 16 bitters several years later.

Well Texans don’t take a licking easily, and so after a long cool analysis of the opposition, Texas have supercharged their 9900 design and brought out a new bit slinger family which appears to have the drop on those upstarts from the competition. Their new chip is still a sixteen bitter and is downwards compatible with the instruction set of the 9900, but there the similarity ends because the 99000 series offers some real innovations which increase its speed and power far beyond that of its ancestor and even beyond the fast guns of the Motorola 68000. First to hit the streets will be the 99105 which has 82 basic instructions including multiprecision arithmetic, stack operations, memory bit manipulations, and parallel I/O instructions to overcome the limitations of the weird serial-only scheme of the 9900. Next will be the 99110 which has the great additional feature of an on-chip floating point arithmetic library which allows it to add, subtract, multiply, divide, move and convert real variables in the IBM format, a feat which has hitherto required substantial external software.

Fundamental to all members of the new processor family will be a clock speed of 24 MHz (almost v.h.f.) which is twice as fast as the competition and means that with a memory cycle time of just 167 ns it will be necessary to choose the faster memory chips to take advantage of the power available. Inherent in the architecture of the family is a main memory address range of 256K bytes and a separate “Macro-Store” address range of 120K bytes which can be used to augment the instruction set of the basic processor without the need to use main memory. The 99110 has its floating point arithmetic instructions implemented in Macro store space and actually uses a special on-chip 1K ROM and 32 byte RAM for this purpose. In the future other family members will use this same on-chip store to provide other high level features such as a real-time operating system or special I/O control routines. Unlike the 9900 which used a monster 64 pin package, the first members of the 99000 family both use 40 pin packages and have multiplexed data and address buses to suit.

FIFO

If you have a pet micro with a printer you probably get frustrated waiting for it to output listings at a rather pedestrian rate, during which it studiously ignores its keyboard and refuses to do anything else. One way round this problem is to create a spooler program which runs under interrupt control to give apparently simultaneous service to both the printer and the keyboard so that you can go on typing in more code while the listing is printed. This scheme relies on the fact that it takes a short time to send a character to the printer but it takes a much longer time for the printer to actually print it. Since the micro is only involved in the sending operation the spare time can be used to service other tasks.

Unfortunately, all the spooler programs I have seen implemented on micros have suffered from shortcomings such as missed keyboard characters while printing, and of course there is the complication of running under interrupt control which needs careful attention while writing programs. A much simpler solution is possible which is used already on many printers such as the Nascom Imp and involves the use of a character buffer store implemented in hardware and not under the control of the microcomputer itself. In this case the micro “sees” an apparently very fast printer and dumps whole pages of text in next to no time. If the listing will fit entirely within this print buffer then no waiting is involved, and with memory prices dropping all the time a big print buffer looks economically feasible. The buffer can be fitted between a micro and a printer, and needs to be organised as a FIFO (First In First Out), which raises the problem of how to control the two memory address pointers required to control writing at one rate and reading at a different rate. The Nascom printer uses a microprocessor to control this feature, but this starts to look a bit complicated for a stand alone buffer unit which is why, to my knowledge, no designs have been published. Fortunately the concept has now become much more practical thanks to a new chip from Signetics called the 8X60 FIFO controller.

This 28 pin device contains all the arbitration and control logic and two 12 bit address pointer registers to handle a buffer RAM array of up to 4K characters, quite adequate for the majority of day to day printouts. If you used a couple of 2K by 8 static RAMs you could make the heart of a print buffer with just three chips, with additional devices probably required to handle interfacing to the micro and the printer. The exact form of this interface would depend upon whether serial or parallel drive is required. In the case of a serial in-serial out link two UARTs would be needed, but a Centronics parallel interface would be much simpler. In addition to Read and Write strobe inputs and address outputs, the 8X60 also has outputs to say whether the buffer is full, half full, or empty.
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Practical Electronics
March 1982

A major problem has been forcing its attention upon the groups who examine and analyse the data from satellites and probes. As usual the basic delay is funding. The amount of data has been so great that a very systematic priority clamp has had to be imposed upon some important sections of this work. It is of course readily understood that certain political requirements are involved and what might be considered by many of us as of humanitarian areas of priority are only of secondary consideration. With the present recession brought about indeed by the wrong priorities in many cases it could be deemed prudent to take an honest look at the terms of priorities. This requires a state of mental honesty extremely difficult to achieve when judged by action. A great many researchers all over the globe are seeking ways to improve the lot of mankind but work under conditions that demand for the continuance of their activities a constant campaign of begging donations from private resources for the funds to continue. So the reverse spiral of illogical thought publicly eulogises the endeavours of those engaged in these humanitarian works but denies them at the same time the means to forward them.

Now is the time to remember that the whole Earth and its environs is a system which is self-generating or perhaps more correctly, regenerating and that every individual part is also the whole. Only now are some of the answers beginning to emerge. Much of the data could come from the environment of the atmosphere. Many false notions are still being bandied about such as that increasing carbon dioxide in the atmosphere will sooner or later make life impossible on Earth. Strange ideas with names like ‘nose, lips, profile etc.’ based on the shape which the graphs took as a result of the changing frequency. It would be interesting to know how many readers remember those days.

Now all this has been brought up to date as a result of DE-1 and DE-2 activity. The orbits of the satellites are:
- DE-1 an eccentric orbit apogee 15,000 mi., perigee 354mi.
- DE-2 apogee 628mi., perigee 192mi.

The arrangement of these two spacecraft allows the bracketing of the region of the leaking of low energy plasma into the magnetic field cusp from space where it is transformed into the high energy stream which initiates the aurora. It is well known now that the aurora is formed at a level which varies from 3,000 to 12,000 miles several times in 24 hours. At these levels the electrons trapped in the magnetic field are reflected back along the field lines and may continue this oscillating activity until their energy falls below a certain level.

The imaging system of DE-1 consists of three spin-scan photometers which permit day-time viewing of the aurora. The images are built up from line scans of the Earth at the rate of one line per rotation of the spin stabilised satellite. This system uses ‘super-reflecting’ mirrors to avoid the light scatter which prevents the use of lenses for this work. Two cameras operate in the visual part of the spectrum and a third operates in the ultra-violet. This imaging system is being used for other tasks also which include ozone observations, a special search for marine bioluminescence from space and the observation from high polar altitudes of the Earth-glow which is now called the geo-corona.

As the DE-1 apogee moves towards the Earth’s equatorial region it is hoped that the cameras will be able to observe the red-glow that circle the Earth north and south of the equator. The drifting of the apogee will later enable the south polar regions to be observed. DE-2 carries instrumentation for the observation of particle and wave field environments. The instruments are capable of providing details of electron velocity every 2km.

A report by S. D. Shawhan on the radio waves generated in the auroral regions revealed that the more powerful emissions are associated with auroral storms. The frequencies are of the order 100-200kHz though sometimes as high as 80kHz (this was the range of whistlers). They are directed away from Earth and have powers of the order of billions of watts and can be picked up more than 15,000 miles from the auroral zones. This is of the same order as the radiations from Jupiter. They are characterised by rising and falling tones, each burst lasting about a second and changing in frequency by 1kHz. Detailed measurements of these waves have been made by DE-1. Its plasma instrument which monitors frequencies from a few Hertz to 40MHz detects the most intense waves when the spacecraft crosses magnetic field lines that pass through the aurora. Waves were detected by both satellites in the audio range, that is below 20kHz. This suggests that these waves must be guided away from the power source by the Earth’s magnetic field.

High winds and high temperatures have also been recorded by DE-2. Data reveals that there are winds in the auroral zone which are of the order of hundreds of miles per hour and at times over 1,000 miles an hour. Temperatures have reached the order of 1,500 to 2,000K.

It is not possible to resist commenting that the Earth is far from approachable by alien spacecraft.

TIME FOR DATA PROCESSING

The Boeing Aerospace Company has been selected to conduct a one year study for the National Aeronautics and Space Administration of an unmanned launch vehicle.

The vehicle which is designated SRB-X is being considered as a means of augmenting the space shuttle when payload and space is not immediately available in the shuttle orbiter. It will be capable of boosting a 65,000lb payload into low earth orbit with a geosynchronous orbit. The SRB-X would be built from tried components with minimum modifications to boosters and launch facilities.

There are also three other studies—a liquid rocket booster and a side mounted shuttle derived cargo vehicle, studied by Martin Marietta; and another shuttle derived cargo vehicle—in line version, under study by Boeing.
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