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The kit comprises a mains powered receiver, a four transistor switching light, N.C. closing curtains, etc. Ideal for aged people or disabled persons.

For use with MK6 or MK16 Relay output with DP3 Amp change-over contacts, may be used as an interface circuit, such as relays or contactors.

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ELECTRONIC HOBBIES FAIR
As promised last month some more news on our exciting new exhibition for all interested in the various forms of our hobby. This new venture will take place at the recently built Alexandra Pavilion (in the grounds of the now burnt out Alexandra Palace) from the 18th to 21st of November this year. The new pavilion has been hailed as one of the best exhibition venues in the country. It is London's third largest exhibition hall, has masses of parking space, is easily approached by road, British Rail, underground or bus and has a free shuttle bus service to ferry visitors from Alexandra Palace station.

For wives/girlfriends there is the added attraction of the nearby Wood Green Shopping City, one of the largest centres in the U.K., although we are sure they will find plenty to interest them in the special exhibits at the Fair.

Although planning is still in the early stages we anticipate many special exhibits, showing all aspects of the application of electronics in hobbies, broadcasting, forces communications and weapons systems, entertainment, vehicle technology etc. etc. We also expect to attract trade stands dealing with Amateur Radio, Computing, Radio and CB, in addition to the “regular” electronic hobby suppliers.

Next month we will be starting a monthly Electronic Hobbies Fair information section within News and Market Place to lead up to the event and to keep readers up to date on every aspect of the Fair. We already have the backing of some of the biggest names in the electronic hobby retail business.

COMPUTING
Probably the fastest growing electronic hobby area at the present time is that of computing and many companies have expanded into the computer business or have been launched into it. Like any booming market it attracts all types of new venture and small supplier, as well as the large, established names. There are the usual supply problems and the inevitable failures in the business. There are also the dubious areas where companies sail close to the law.

One area where we do not entirely approve of some practices is in the “user clubs” or “groups”, set up—often by hobbyists—to assist each other in their hobby. This is to be condemned and is in the spirit of “amateur electronics” but when such user groups are run as businesses for the financial benefit of the founders, possibly without the members or subscribers being aware of such a situation, we wonder just how ethical it all becomes?

Comments from readers, members and proprietors of such organisations are welcome for our Readout section!

FRONT COVER
Just in case you are wondering about this month's front cover, which is a departure from our normal illustration of projects, it's not just a fancy design. The photograph shows the view looking into the faceted mirror used on the Infra-Red Burglar Alarm. One of the three projects in our Comprehensive Home Alarm System article. (The “T” piece holds the pyroelectric sensor).

PRICE
We must reluctantly announce an increase in cover price next month. We know only too well the effects of increasing prices, but believe PE will continue to represent good value.

Back Numbers
Copies of most of our recent issues are available from: Post Sales Department (Practical Electronics), IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 OFP, at £1 each including Inland/Overseas p&p. Please state month and year of issue required.

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Copies of PE are available by post, inland and overseas, for £13.00 per 12 issues, from: Practical Electronics, Subscription Department, Oakfield House, Perrymount Road, Haywards Heath, West Sussex RH16 3DH. Cheques and postal orders should be made payable to IPC Magazines Limited.
BBC introduce packaged learning for TV engineers

The BBC's Engineering Training Department have recently produced a revolutionary method of training students in the fundamentals of television engineering.

Based on the "packaged-learning" concept, the students work at their own pace using purpose-designed demonstration equipment, supported by specially written learning texts. Packaged learning has been a feature of BBC Engineering Training for some time, but because of the high cost of broadcast television equipment, it has not been possible to teach television fundamentals in this way until now.

The overall package, which consists of two main racks of equipment, plus four supporting books, and a VHS tape, covers the fundamentals of television engineering. Scanning is covered first, together with synchronisation and interface. Picture signal processing is covered next including clamping and gamma correction. The associated equipment enables demonstration of many aspects covered in the text.

A colorimetry section deals with the principles of colour vision and the simulation of spectral colours using additive mixing techniques. The separation of a scene into its red, green and blue components is considered and the analysis required of a camera determined.

The third and final section of the package describes the coding and decoding of the colour television signal, with specific reference to PAL system 1. In addition to the text this section is supported by its own demonstration equipment.

The total package comes in three parts: i) the basic television principles equipment ii) the colour fundamentals demonstration equipment iii) the support literature and video cassette tape. Each part is easily identified, but is not necessarily self-supporting. For example, the literature requires the appropriate equipment for the student to work with.

It is possible that the package may be made available to colleges, institutions, industry and other broadcasting organisations in the near future. In comes complete except for monitors and oscilloscopes. At present there are no plans to produce SECAM or other television standard versions.

LOW COST LOGIC PROBE

Stotron Ltd inform us that they can now supply a new, low cost, high performance, 10MHz Logic Probe from Sabtronics—the LP-10. Operation is high speed and pulses as narrow as 50 ns are stretched to be easily detected. 'Floating' input levels, caused by open lines, bad sockets and dirty connectors, etc, are easily detected by this logic probe. There is a high impedance input of 100kΩ which avoids circuit loading.

Two I.e.d.'s indicate the presence of a logic '0' or a logic '1'. The relative brightness of these two I.e.d.'s, in a rapidly switching signal, indicates the amount of time spent at each logic state. Invalid logic outputs fail to light either of the I.e.d.'s. Logic transitions are detected and displayed on a third I.e.d.

Clip leads, supplied with the unit, allow the approximately 35 mA required to power the probe to be supplied from the circuit under test.

The LP-10 is priced at £24.95 plus VAT and p & p, and is available from Stotron Ltd, 72 Blackheath Road, London SE10 8DA (01-691 2031).

TIME TO LISTEN

It's gimmicks time again! Not content with the abundance of Walkman-size cassette players and radios, an American company JS&A has gone one step further and produced a digital watch that also incorporates an AM radio. The Advance Digital Watch Radio is sold complete with lightweight samarium cobalt headphones, and the radio is said to run for over 100 hours before a new battery is needed (don't worry, the watch department has a separate battery!)

Doubtless it won't be long before a similar machine is available in this country, and if the price stays about the same ($49 in America), it could mean serious competition for the 'Walkman' market.
Items mentioned are available through normal retail outlets unless otherwise specified. Prices correct at time of going to press.

**NEW FLUKE DMMs**

Two new 1½ digit handheld DMMs are the latest models to emerge from the Fluke stable.

Fluke say that the 8060A is virtually a handheld test-lab, providing direct frequency measurement, dB computation and relative/offset modes in addition to traditional multimeter functions. A simplified sister machine, the 8062A, provides the same high performance, but without the frequency and dB facilities.

The 8060A is the first general purpose handheld DMM to be able to measure modem and communications equipment performance, and as such should be of particular interest to engineers working in the field of computer communications.

Key features include a true RMS capability up to 100kHz, voltage ranges from 10mV to 1000V, autoranging frequency measurements to 200kHz, current to 2 amps, resistance to 300 Mohms, audible continuity detection, conductance and diode test facilities. Readings can be displayed in volts, relative dB or dBm referenced to 600 ohms. Using the relative function, any reading can be offset to zero and only the deviation is displayed on the i.c.d.

To achieve all this performance in a handheld DMM, Fluke have used microcomputer techniques and have even designed and manufactured their own custom CMOS LSI circuit. The built-in microcomputer not only controls all the functions and computes the readings, but also allows sophisticated self-testing to be carried out automatically every time it is used.

The 8060A is priced at £270 and the 8062A at £210. Further information from Fluke (GB) Ltd., Colonial Way, Watford, Herts. WD2 4TT (0923 40511).
The three alarms featured in this article are all based around one p.c.b. design which can accommodate any one of the systems.

The first is a Doppler shift ultrasonic alarm with 32.7kHz transducers driven from a crystal oscillator, resulting in no alignment or interaction problems with other such alarms. The alarm has a range adjustable up to 8 metres.

The second is a Doppler shift radar alarm based on the Mullard CL8960 module which operates on 10.687GHz and has a range up to 30 metres. With suitable weatherproofing it can be used outdoors—some consideration must be given to the fact that rain is a moving object in the eyes of radar. To operate this Radar module a Home Office licence is required which lasts for 5 years and costs a few pounds.

The third is the latest development in the alarm field—an infra-red heat sensor with a sensitivity peaking at human body heat. This device detects a change in heat and gives an electrical signal output. As the device only responds to a change in heat a multi-faceted mirror (US Paten 3703718) or a Fresnel lens is required to concentrate the detected area into zones, so that anyone entering those zones can be detected.

The above alarms all have their own merits for particular uses:

<table>
<thead>
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<th>Feature</th>
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<th>Infra-red</th>
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CIRCUIT DESCRIPTION (ULTRASONIC)

The circuit diagram for the Ultrasonic Alarm is shown in Fig. 1. The mains supply feeds T1 via R1 and its secondary feeds D1–D4, a full wave rectifier, before being smoothed by C1. This unstabilised voltage is fed to IC1 and stabilised to 12V d.c., and further decoupled by C2 and C16.

IC2 forms a crystal oscillator, R3 and R4, R5 and the crystal form the feedback components, whilst C3 terminates the crystal loading capacitance, C4 aids oscillator start up. The output of the oscillator at pin 3 is a 32.7kHz square wave which is filtered by R6 and C5 to remove harmonics before driving the Ultrasonic transducer X1.

The Ultrasonic sound is received by X2, then decoupled by C18 feeding IC3, the 32.7kHz amplifier. R7, R8, R9 and C6 form the biasing for IC3. VR1, R10 and C7 form the feedback components to determine the gain and response of the stage—VR1 being the sensitivity control.

D6, R11, R12 and C8 form a diode detector to remove the 32.7kHz and recover the Doppler frequency envelope which is fed to IC4, a high gain Doppler frequency amplifier. The gain is set by feedback components R14, R13 and C9 and selected for optimum performance for 32.7kHz ultrasound.

The output of IC4 feeds a bootstrapped diode pump detector consisting of C10, D7, TR1, C11 and R15 which converts the Doppler frequency into a d.c. level then buffered by IC5.

![Ultrasonic Alarm](image-url)
SPECIFICATIONS

CONTROL SECTION
1 second invalid movement delay (IR 0-1 sec)
20 second delay on leaving (IR 1 min at power up)
10 second delay on entry
2-3 minutes alarm-on time
10 second inhibit after alarm has ended

Timing activated at power switch on/external control
Panic button facility will instantly sound the alarm and latch until reset—this can be used for other applications, i.e. pressure mats, fire detector etc. The output is designed to easily accommodate common switching and alarm switching. A s.p.c.o. centre off keyswitch provides all switching:

Position (1) Detection 'OFF' panic active
(2) Detection 'ON' panic active
(3) Panic reset only—MUST NOT be left in this position

ALARM UNITS
ULTRASONIC: 8 metres range—full field coverage
RADAR: 30 metres range—full field coverage
INFRA-RED: 15 metres range—12 zones covering 80 degrees

Both the ultrasonic and radar are most sensitive to objects moving in front of and towards the unit. The sensitivity will be reduced when the unit is approached from the side. The infra-red however is most sensitive to humans moving across the field and this must be considered when installing the alarm.

When setting up the alarm the red i.e.d. on the front of the unit should not flicker; if it does the unit is detecting a signal—either re-site the unit or reduce the sensitivity.

All units can drive a solid state sounder rated at 12V d.c. at 25mA directly which can therefore be driven from the alarm's own Ni-Cad power in the event of power failure. These high efficiency sounders can produce sound levels from 95 to 110dB at 1 metre which should be enough to deter all but the most persistent intruder.

Fig. 1. Complete circuit diagram of the Ultrasonic Alarm Unit. *Not required if the panic button is not used.
CIRCUIT DESCRIPTION (RADAR)

The circuit diagram for the radar system is shown in Fig. 2. The mains supply feeds T1 and its secondary feeds D1-D4, a full wave rectifier, before being smoothed by C1. This unstabilised voltage is fed to IC1 and stabilised to 12V d.c., and further decoupled by C2 and C16.

As the radar module requires +7V d.c. within 0.1V d.c. at 150mA, IC2, VR2 and R28 form an adjustable voltage regulator set by VR2. This voltage is adjusted BEFORE the CL8960 is connected to prevent damage to the module and then finely adjusted when connected, measuring the voltage at the module end to compensate for any volt drop in the supply leads. C22 is connected directly onto the module using short leads and provides local rail decoupling. R29 provides correct biasing for the mixer diode, again mounted on the module.

The Doppler output 'AF' is terminated by D15 and C20 to prevent surges being induced in the mixer diode, then decoupled by C18 to IC3, the Doppler frequency pre-amp. R7, R8, R9 and C6 form the biasing for IC3. VR1, R10 and C7 form the feedback components to determine the gain of this stage and select a suitable response for the 10.687GMz radar module. VR1 is the sensitivity control. R11 and C8 form a low pass filter to remove frequencies not required before further amplification by IC4, the 2nd Doppler frequency amplifier, the gain being set by feedback components R14, R13 and C9.

The output of this stage feeds a bootstrapped diode pump detector consisting of C10, D7, TR1, C11 and R15 (the ratios of C10 to C11 and the time constant C11 and R15...
PYROELECTRIC CERAMIC INFRA-RED DETECTOR

The development of infra-red detectors that are both rugged and sensitive such as pyroelectric detectors makes them ideal for use in intruder alarms. Each detector consists of two pyroelectric ceramic elements mounted in a TO5 transistor header complete with silicon filter window coated for maximum transmission at 10μ, blocking radiation and visible light below 6-5μ.

Incorporated within the package is an impedance matching JFET preamplifier.

THE PYROELECTRIC EFFECT

The pyroelectric effect, exhibited by all ferroelectric materials, has been utilised to develop a series of infra-red detectors. Pyroelectric material exhibits a strong temperature sensitive spontaneous electric polarisation. Any infra-red energy absorbed by the material will increase its temperature and produce an associated change in electric polarisation. Before the effect can be utilised, the normally random oriented electric dipoles which exist in the bulk of the material, must be ‘poled’. The effect of this operation is to line up the dipoles along one axis in the crystal.

In many single crystal materials, poling must occur along specific crystallographic axes. Ceramic materials can be poled along any axis, the dipoles themselves as near as possible along this axis in the randomly oriented crystallites.

Depending on the material type, poling is normally perfor-
med at an elevated temperature. The process involves applying an electric field to the material and allowing it to cool under the influence of the field. Heating the material reduces the coercive field and hence the voltage that must be applied for poling to occur. The electric field is applied by depositing electrodes on the opposite faces of the material and applying a potential across them. As a result of the poling process a permanent polarisation of the crystal exists, resulting in an excess of one particular charge at the surface of the material. This charge is captive within the structure of the material, but the equal and opposite charge on the electrodes are free to move. Thus the electrode which was positive during the poling process acquires a positive charge.

A pyroelectric element, which makes use of its self-polarisation effect, produces a change in surface charge with temperature which is detected by the integral JFET to produce a varying current output.

APPLICATIONS OF PYROELECTRIC DETECTORS

A healthy human being dissipates approx 100 watts of detectable radiation. Thus, with suitable collecting optics, it is possible to detect a man well over 100 metres distance. In this project the mirror used has 6 facets and a range of 15 metres which is more in keeping with domestic requirements. The peak emission from a human being, resulting from the natural body temperature, occurs at around 101.1 m which is more in keeping with domestic requirements.

Prototype Infra-Red Alarm

CIRCUIT DESCRIPTION (INFRA-RED)

The circuit diagram for the infra-red system is shown in Fig. 3. The mains supply feeds T1 via R1 and its secondary feeds D1–D4, a full wave rectifier, before being smoothed by C1. This unstabilised voltage is fed to IC1 and stabilised to 12V d.c., and further decoupled by C2 and C16.

When a variation in IR heat is sensed (9µm to 14µm) the output current of the detector varies, producing a voltage change across load resistor R27 (C19 and C20 form interference suppression).

This small voltage change is then decoupled by C18 to IC3, a very low frequency amplifier. R7, R8, R9 and C6 form the bias for IC3 whilst VR1, R10 and C7 are the feedback components to determine the gain of this stage, VR1 being the sensitivity control.

R11 and C8 form a low pass filter to remove frequencies not required before further amplification by IC4, a second very low frequency amplifier, the gain being set by R14, R13 and C9.

The output from IC4 feeds a bootstrapped diode pump detector consisting of C10 (two back to back electrolytic capacitors), D7, TR1, C11 and R15, the ratios of C10 to C11 and time constant C11 to R15 chosen for the infra-red detector.

The invalid movement delay formed by R16 and C12 has been reduced to prevent filtering of 'peak' waveforms encountered with pyroelectric detectors.

CONTROL SECTION (COMMON TO ALL ALARMS)

The output of IC5 is normally low and the output of IC6 pin 11 is normally high, driving the I.e.d. D14 via R17 and D8. As movement is detected the output of IC5 rises, reducing the resultant drive to the I.e.d., reducing the brightness indicating movement. If movement and therefore the voltage at IC5 pin 6 is sufficient to reach the threshold of IC6 pin 13, the output of the gate at pin 11 will go low, turning off the I.e.d. D8 is included so that the I.e.d. will not be reversed biased for reliability.

Therefore the I.e.d. indicates:

(1) That power is connected.
(2) Aids correct setting of sensitivity control—important to prevent false alarms. (Decreasing brightness with movement.)
(3) Indicates the trip threshold of the alarm.
(4) Functions as a walk test—with the alarm in the 'OFF' mode.
(5) The I.e.d. is off when alarm is tripped to be inconspicuous.

Gates a and b of IC6 form a bistable which is held in the reset mode via R26, D13 and R25 when control terminal 'C' is at 12V d.c. When terminal 'C' is open circuit C15 charges via D12 and R23 (the delay on leaving) until the lower threshold of gate a pin 9 is reached, allowing the bistable to be set by pin 13 going high.

When pin 13 goes high pin 10 goes high, charging C13 via R19 (the entry delay) when the threshold voltage of gate c is reached the bistable formed by IC6 gate c and d is set, causing the output at pin 3 to go high, driving TR3 via R20. TR3 turns on and drives the relay RLA via D10. D11 suppresses the back e.m.f. of the relay coil whilst D10 forms an 'OR' function when more than one unit is used, such as in multiple alarm systems.

As the output of IC6 pin 3 is now high C15 is discharged via R23 and R24 (the alarm on time) until the threshold of
IC6 pin 9 is reached, resetting the bistable, causing its output at pin 11 to go high feeding IC6 pin 1 and resetting the output of the bistable, turning off TR3 and RLA. Pin 10 goes low, discharging C13 via R19 when the threshold of IC6 pin 6 is reached IC6 pin 4 goes high, removing the inhibit formed by R18 and D9 (alarm inhibit) at pin 13 IC6.

The bistable formed by IC6c and d is normally in its reset state, pin 4 high and pin 3 low. TR2 is normally turned off. If terminal ‘P’ is connected to terminal ‘E’ by an external button TR2’s base goes low causing it to turn on. Its collector drives the base of TR3, limited by R21, turning it on causing the relay to be activated and instantly sounding the alarm and will latch until reset. If the external button is released TR3 now holds on TR2. By connecting ‘P’ to ‘+’ TR2 loses its base drive from TR3 and in turn cancels the alarm. C14 and C17 are included to prevent spurious spikes from tripping the panic.

The panic reset switch MUST NOT be left in this position as this will cause the output transistor to overheat and die as the alarm in this position is also in the Ultrasonic active mode and could be tripped via movement. When battery back up is used R2 trickle charges the 2 x PP3 Ni-Cad cells when power is connected and in the event of power failure D5 supplies power for the battery to C1.

When battery back up is required with the radar system, because of the higher current requirements, the PP3’s have insufficient capacity. In this case it is suggested that a more powerful external battery is connected, i.e. 12V car battery. For such a system it is worth while trickle charging a car battery and powering the alarm system from the battery feeding the alarm unit’s 12V rail directly, therefore dispensing with the transformers etc.

SWITCHING
All alarm switching is done at 12V d.c., an s.p.c.o. centre off keyswitch provides the control of the alarm whilst a normally open push button operates the panic. If an alarm test is required a normally open push button will sound the alarm but will not latch and will sound the alarm as long as the button is pressed.

CONSTRUCTION
Any one of the three alarm units can be constructed on the p.c.b. design shown in Fig. 4. The components layouts are shown in Figs. 5, 6 and 7. The prototype ultrasonic alarm unit was housed in a standard ABS box with the two transducers mounted inside 20mm grommets. Before inserting any components into the case the p.c.b. mounting holes should be drilled along with the adjustment hole in the bottom of the case for VR1. Five 10mm holes should be drilled in the rear of the case for the mains and output leads. These holes should be fitted with 10mm grommets. The centre of the front panel should be drilled to accommodate the indicating I.e.d.
Fig. 4. P.c.b. design for all three alarm units

Fig. 5. Component layout for the Ultrasonic Alarm

COMPONENTS...

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<th>2k2</th>
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Capacitors

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All resistors 1W 5% carbon
Semiconductors

- Ultrasonic:
  - D1-D4: 1A bridge rect.
  - D9: 1N4148
- Radar:
  - D5: 1N4002
  - D10: 1N4002
  - D11: 1N4148
- Infra-Red:
  - D1: 1N4002
  - D12: 1N4148

Miscellaneous

- Potentiometers:
  - VR1: 10kΩ
  - VR2: 1kΩ
  - VR3: 1MΩ
- Link: 3mm l.e.d.
- Battery clips, p.c.b. mounting terminals, s.p.c.o. key switch.
- 3mm l.e.d.

Special components

- Ultrasonic system:
  - IC1: 78L12
  - IC2: 78L05
  - IC3: LF351
  - IC4: 741
- Radar system:
  - IC5: 741
  - IC6: 4001
- Infra-Red system:
  - IC7: Pyroelectric dual element detector (PCID)
  - CL8960 radar module

Constructor's Note

Complete sets of kits are available from GJD Electronics, 105 Harper Fold Road, Radcliffe Road, Manchester.
After the components have been assembled onto the p.c.b. carefully check the tracks for any solder splashes and then check the orientation of the semiconductors and the electrolytic capacitors. The leads to the transducers should be kept as short as possible if unscreened cable is used. If screened cable is used then ensure the braid is connected to the OV terminal on both transducers.

The prototype radar alarm unit was mounted in a larger ABS box with both the p.c.b. and radar module mounted onto the case lid. The components and leads should be mounted onto the radar module as shown in Fig. 8. A thin layer of polythene should be placed between the module and base to prevent the ingress of dirt and moisture.

Mounting holes for the p.c.b., the two presets and the i.e.d. should be drilled before the components are mounted on the board.

The infra-red alarm was also fitted into a large ABS box with both the p.c.b. and the faceted mirror mounted on the lid. After the lid has been drilled for the p.c.b. mounting holes, i.e.d. and mirror the p.c.b. can be assembled.

The mirror should be placed in position using double sided adhesive tape. The pyroelectric detector is fitted into a plastic spider to position it correctly at the focal point of the mirror. With the mirror used an 80 degree horizontal angle is obtained over six zones. The dual element pyro doubles this coverage to twelve zones. The mirror can be protected using black polythene although some types may reduce the sensitivity of the unit. Because the infra-red band used is relatively new to this application commercially made filters are not readily available.

**INSTALLATION-ULTRASONIC**

The alarm is prone to both vibration and air currents therefore the following points should be observed to avoid false triggering.

DO NOT place the alarm on a vibrating surface.
CLOSE all doors and windows.
DO NOT point the alarm at a radiator or convector heater.
Try to install the unit away from direct sunlight because of its heating effects.
Try to install the unit away from telephone bells as they can produce high frequency sound which could trigger the alarm.

Dogs, cats, insects and automatic washing machines should be taken into consideration along with warm air central heating.

In practice best results have been obtained with the unit at floor level as air currents are minimal and foot movement is detected. Objects in front of the unit will limit its range.

When setting up the unit with no movement the red i.e.d. should not flicker; if it does the sensitivity is set too high or air currents are being detected—always use the minimum sensitivity required as over sensitivity could give rise to a false alarm. When adjusting the sensitivity externally a clockwise rotation will increase the sensitivity—a very small screwdriver is required for this adjustment.
**ULTRASONIC INFRA-RED RADAR**

**ZONE 1**
- 240V relay output (panic included)
- 12V DC (slave)
- Solid state drive
- Include if only one keyswitch is used
- Live
- Neutral
- Earth

**ZONE 2**
- 12V DC (slave)
- Solid state drive
- 240V relay output (panic included)
- Live
- Neutral
- No earth

---

**Fig. 10. Wiring diagram for multi-zone protection. A slave unit is powered from a master and does not require its own p.s.u.**

<table>
<thead>
<tr>
<th>TEST VOLTAGES (NOMINAL)</th>
<th>ULTRASONIC</th>
<th>RADAR</th>
<th>INFRA-RED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply</td>
<td>15V d.c.</td>
<td>15V d.c.</td>
<td>15V d.c.</td>
</tr>
<tr>
<td>IC2 pin 3</td>
<td>5V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IC3 pin 7</td>
<td>12V</td>
<td>12V</td>
<td>12V</td>
</tr>
<tr>
<td>IC3 pin 6</td>
<td>6V</td>
<td>6V</td>
<td>6V</td>
</tr>
<tr>
<td>IC4 pin 6</td>
<td>5.5V</td>
<td>6V</td>
<td>5V</td>
</tr>
<tr>
<td>IC5 pin 6</td>
<td>3V</td>
<td>3V</td>
<td>3V</td>
</tr>
<tr>
<td>IC6 pin 11</td>
<td>12V</td>
<td>12V</td>
<td>12V</td>
</tr>
<tr>
<td>IC6 pin 10</td>
<td>0V</td>
<td>0V</td>
<td>0V</td>
</tr>
<tr>
<td>IC6 pin 3</td>
<td>0V</td>
<td>0V</td>
<td>0V</td>
</tr>
<tr>
<td>IC6 pin 4</td>
<td>12V</td>
<td>12V</td>
<td>12V</td>
</tr>
</tbody>
</table>

VR1 fully anticlockwise
'C' connected to the supply (no movement)

**Fig. 11. Connections to a slave unit**

Radar reflects off metal objects such as radiators, garage doors, etc. and this effect can be used to increase the area covered by the alarm and also for 'seeing' around corners.

**INSTALLATION—INFRA-RED**

As most of the heat from a human body comes from the head (when it is clothed) the best position for the unit is around eye level; individual tests will soon reveal the correct height. This still enables pet lovers to protect their home even with the family pet roaming around the house. Because draughts and open windows do not readily cause false triggering open fronted premises and warehouses can also be protected.

If an electronic fence is required a narrow twin beam using a Fresnel lens (suitable for transmission of 10μm) can be used to focus the heat onto the pyro. This lens eases weatherproofing problems as the enclosure can now accommodate the lens as a weatherproof window.

Although the pyro itself does not detect draughts it should be protected from direct draughts to reduce any imbalance between the two pyro elements contained within the TO5 style can. The pyro is also microphonic and should not receive any mechanical shocks which could give rise to false triggering.

To prevent excessive heat, do not allow direct sunlight to fall onto the pyro or mirror.

---

**TERMlNAL CONNECTIONS**

- 'L' Mains live feed
- 'N' Mains neutral
- 'E' Earth—also the OV rail of the alarm
- 'P' When connected to 'E' instantly trips the alarm and latches until reset
- 'P' When connected to '+' instantly cancels the alarm
- 'C' When connected to '+' the Ultrasonic is inactive, but in the walk test mode—panic active
- 'C' When left open circuit activates the Ultrasonic after the 20sec leaving delay
- '+' Provides external power up to 12V d.c. at 50mA for solid state sounders
- 'S' When connected to 'E' activates the alarm sounder for as long as the connection is made—also provides expansion facility.
- 'R' Normally open relay contacts for switching loads up to 3A at 240V a.c. resistive

The above switching is all done by a s.p.c.o. centre off keyswitch with separate panic and alarm test buttons.

---

**INSTALLATION—RADAR**

The sighting of the radar alarm must be done with care as walls and windows can be partially transparent to radar, therefore the following points should be observed:

Consider rain, snow, birds if the alarm is to be used outside with suitable weatherproofing.

Water in plastic drain pipes.

Effects of wind on objects.

Fluorescent lights produce ionised gas which radar reflects.
Hydraulic Powered Microprocessor Controlled Robots

HYDRAULIC DRIVE USING SELF-CONTAINED HYDRAULIC POWER PACK

FEEDBACK CLOSED LOOP CONTROL SYSTEM

With prices starting below £1,000 the Genesis range of general purpose robots provide a first rate introduction to robotics for both education and industry. Each has a self-contained hydraulic power source, which enables loads of several pounds to be smoothly handled. The system operates from a single phase 240 or 120V AC supply or a 12V DC supply. The machine can be supplied with up to 6 axes each of which is fully independent but capable of simultaneous operation. Position control is achieved by means of a closed-loop feedback system based around a dedicated microprocessor. Movement sequences can be entered, stored and replayed by use of a hand held controller, alternatively the systems can also be interfaced to an external computer via a standard RS 232C link.

Example prices and specifications

**Genesis S101**
- Base: 19.5" x 11" x 7.5"
- Lifting capacity: 1500gm
- Arm lift: 6.6'
- Weight: 29Kg
- 4 axis model in kit form £390
- 5 axis model in kit form £445
- 5 axis model READY BUILT £790

**Genesis P101**
- Base: 19.5" x 11" x 7.5"
- Lifting capacity: 2000gm
- Arm lengths between axles: 14.0'
- Weight: 34Kg
- 4 axis model in kit form £495
- 5 axis model in kit form £595
- 6 axis model READY BUILT £950

**COMPLETE SYSTEMS AS SHOWN IN PHOTOGRAPH ABOVE**

- **Genesis S101**
  - 4 axis system in kit form £635.50
  - 5 axis system in kit form £895.00
  - 5 axis system READY BUILT £1355.00

- **Genesis P101**
  - 4 axis system in kit form £742.00
  - 6 axis system in kit form £852.00
  - 6 axis system READY BUILT £1525.00

As featured in this journal November ‘81-April ‘82 issues.

For further details please contact:

POWERTRAN CYBERNETICS
PORTWAY INDUSTRIAL ESTATE, ANDOVER, HANTS SP10 3WN
Telephone: ANDOVER (0264) 64455
£12k Off!

We are all suckers for the supposed 3p or 5p off, a bar of soap or a packet of cornflakes in the local supermarket but when exhorted to save £12,000 even the most cynical shopper feels compelled to investigate.

This is the enticing offer made by Piher, the big name in small resistors. Certainly an eye-catching ploy but reading the smaller print we discover that the saving is per million resistors on assembled cost.

Productivity and cost-cutting is the name of the game on production lines so production managers are keenly examining Piher's offer and analysing the argument advanced for using resistor modules.

The modules consist of factory-assembled (by Piher) resistor arrays in 14 or 16-pin dual-in-line packages containing, respectively, 7 or 8 carbon-film resistors to the customer's specified values. Piher's £12,000 is the saving obtained through inserting 125,000 8-resistor modules into PCBs compared with inserting 1,000 one in one at a time.

Certain assumptions are made in Piher's calculations which will probably surprise the electronic hobbyist unfamiliar with large-scale electronics assembly or production costings. First is the assumption that the assembly worker is paid £2.25 per hour wage but with factory overheads added the true cost to the company is £9 per hour. Second is that resistors cost £4 per thousand. Third is that on average throughout the day 360 resistors are manually inserted per hour. On these assumptions the total cost of buying a million resistors and manually inserting them in PCBs is £29,000 of which £25,000 is labour cost.

With the same resistors pre-assembled into 16-pin packages the line assembler inserts only 140 units per hour but as each module contains eight resistors the insertion rate is much faster per resistor and labour cost per million resistors falls to £8,000, a saving of £17,000. But whereas the discrete million resistors cost £4,000 the cost of the same million pre-assembled into modules is more than double at £8,750. This, however, still represents a net gain of £12,250, handsomely meeting Piher's claim of off.

Of course there are a lot of variables in individual cases and Piher thoughtfully provide a set of graphs on which production managers can plot their own labour, overhead and other costs to determine the benefit, if any, he may expect to obtain.

I have described the philosophy of resistor modules in some detail because it so ably illustrates the facts of life in competitive industry. Clearly the equipment manufacturer stands to gain. Equally clearly the resistor manufacturer gains because he has doubled the size of his product and so increased his turnover and profit. The end customer stands to gain if the equipment manufacturer passes some part of his saving on to the purchaser.

It looks as if everybody wins. But not quite. As labour costs have tumbled by two-thirds it suggests that only one assembler is now required rather than three. The resistor manufacturer has increased his workload, of course, but as the modules will be machine-assembled he needs only a marginally increased workforce, a tiny fraction of one of the two workers made redundant. The transfer of work between the two companies does not result in an equal transfer of employment.

Look-Alikes

Piher's low-cost resistor modules are available to anybody, the more the merrier as far as Piher is concerned. The cost benefits, whether more or less, depending on individual circumstances, are universal.

When it comes to an end-product a typical aim is exclusivity. The commonly used protection is to take out a patent but this is not always fully effective. There are many direct infringements bringing good business to lawyers and much ingenuity is often applied to getting round existing patents by would-be copiers.

Thus, Fluke's novel 8020 Series of handheld digital multimeters which appeared in 1978 were unique. Their 'brain' was a custom-built IC chip which gave them exclusivity. Or so Fluke thought at the time. But similar instruments soon appeared on the market and today some 25 manufacturers are making look-alikes using what is said to be an almost identical but commercially available chip.

Fluke's response has been to set up its own chip-making plant in the USA in the hope that a new digital multimeter due for launch about now will retain the marketing edge conferred by a Fluke-designed, Fluke-manufactured IC. By bringing the whole operation in-house the possibility of leak of chip design to outsiders is minimised. No doubt the new design will attract copiers but this time a look-alike competitor model could take longer to achieve and probably not worth while in time or money.

Despite the rash of imitations a Fluke spokesman claims that the company holds over 30 percent of the market in hand-held digital multimeters and expects to win a much larger slice with the new model.

On the Beam

The laser, in its early days very much an invention in search of an application, has turned out to be more versatile than any of us ever imagined and has generated plenty of new business.

Who would have thought that the ladies, God bless 'em, would be queuing up for laser rejuvenation courses at beauty salons? Both pulsed and CW lasers are in use with rival claims for success in revitalising skin tissue. One treatment depends on the laser beam being directed at acupuncture points, so bringing space-age technology and an ancient Chinese therapy into newly fashionable conjunction.

Those most ardent perfectionists, banknote forgers, have latched on to the merits of the laser beam colour scanner in the printing industry. Highest quality counterfeits produced by this technique are appearing in several countries and, according to Interpol, are difficult to detect. In the UK the £10 and £20 denominations are most commonly forged. You have been warned!

Defence

The political and military confrontation over the Falkland Islands is bound to have a long term effect on the defence electronics industry. This was the first ever major naval engagement in which the whole range of modern defence electronics has been fully deployed in real, rather than simulated, battle. Moreover, deployment was in the most testing physical environment. What equipment worked well, badly or not at all will be the subject of months of study. How efficient was the man-machine interface when the man himself was weary after weeks at action stations and constant alarms? How reliable the communications and command network?

The analysis will be rigorous, the lessons one hopes honestly faced and acted upon. But as well as performance analysis of the equipment in the South Atlantic environment there is certain to be a reappraisal of overall defence strategy which will probably result in greater emphasis on the conventional surface fleet and less on the sub-surface nuclear deterrent.

Defence electronics is a key element in the industry as a whole and is likely to be stimulated rather than retarded by the Falklands experience.

Indicators

Meanwhile, despite the crisis, all the economic indicators showed continued improvement. Shares, balance of payments, strength of sterling remained on an upward trend. Investment continued with Honeywell putting up £1.3 million for a new keyboard plant in Scotland as just one example. Employment remains the domestic trouble spot. That £1.3 million, for instance, creates only 40 new jobs initially, with a potential of 100 jobs, but the probability is that they will be filled by internal transfers as productivity increases elsewhere in Honeywell.
A TOP performance "combo amplifier" costs a good deal of money these days. The design offered here can be constructed for about half the price of an amplifier with similar facilities and comparable performance, in fact the performance is better than comparable with others at present available since it is based on the Practical Wireless "Winton" high fidelity amplifier design by E. A. Rule.

The facilities available with the PE combo amplifier are as follows:
1) Completely self-contained.
2) Maximum power output: 50 watts—single 8 Ohm speaker/100 watts—two 8 Ohm speakers in parallel.
3) Twin preamplifier channels with mixing facilities.
4) Bass and treble controls both channels.
5) Auxiliary preamplifier for high level signals.
6) 6dB bass lift (20Hz) for full frequency range—hi-fi range.
7) Inputs for microphone or guitar on each channel.
8) Output/input sockets for external accessories such as Wah and Fuzz units etc.
9) Speaker system tested and proved in an Anechoic chamber to hi-fi standards.
10) Output stages use latest and virtually indestructible power MOS-FET's.

THE CIRCUITY
A block diagram of the system is shown in Fig. 1. The primary inputs on each of two channels are for microphone (200 Ohms or higher) and/or guitar. The arrangement therefore allows one microphone and one guitar to be used simultaneously at any set level, or, of course, two microphones or two guitars.

The Accessories Links (one for each channel) allow for the insertion of wah-wah, fuzz unit or reverb units etc. on either channel. The following stage (IC2) provides full bass and treble lift or cut (approx ±10dB) after which the channel outputs are mixed into IC3 (one half). This stage, and the auxiliary amplifier (half of IC3) each have a facility for a +6dB bass lift at 20Hz to compensate for speaker roll-off. The combined outputs from IC3 then go to the main amplifier which is capable of driving one 8 Ohm bass mid/range speaker system at 50 watts or two similar speaker systems in parallel at 100 Watts.

PREAMPLIFIER PERFORMANCE SPECIFICATION
The full circuit for the preamplifier stages is given in Fig. 3 in which IC1 is the initial stage for the microphone and guitar inputs on each channel. The output (each channel) is taken to an accessory output socket (JK5 and JK7) for feeding wah, fuzz, phasing or reverb units etc. with outputs being returned to the input(s) of IC2, and which also has the tone control networks in feedback between output and input. The outputs from IC2 are taken via a mixing network VR3-VR4 and R15-R16 to the final stage (IC3B) which has provision

<table>
<thead>
<tr>
<th>Mic. inputs</th>
<th>Suitable 200 ohm or higher 2mV for max output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guitar input</td>
<td>Impedance approx 100Kohms 30mV for max output</td>
</tr>
<tr>
<td>Aux. input</td>
<td>Impedance approx 100Kohms 30mV for max output</td>
</tr>
<tr>
<td>Accessories socket OUT</td>
<td>J5 or J7 low Z 200mV</td>
</tr>
<tr>
<td>Accessories socket IN</td>
<td>J6 or J8 low Z 150mV</td>
</tr>
<tr>
<td>Signal to Noise</td>
<td>Guitar and mic inputs—60dB relative to maximum output</td>
</tr>
<tr>
<td>Signal to Noise</td>
<td>Auxiliary input —75dB relative to maximum output</td>
</tr>
<tr>
<td>Distortion factor</td>
<td>Comparable with that of power amplifier</td>
</tr>
<tr>
<td>Tone controls</td>
<td>±10dB 50Hz—10,000Hz.</td>
</tr>
<tr>
<td>Frequency response</td>
<td>Flat 20—20,000Hz (with S1 at +dB bass recovery). See responses in Fig. 2.</td>
</tr>
</tbody>
</table>
for a bass lift (S1) of 6dB at 20Hz to make the overall frequency response including speaker system virtually flat between 20 and 20,000Hz. The remaining half of IC3 is the auxiliary input amplifier with feedback adjusted gain to provide an input sensitivity of 300mV suitable for line output from a tape recorder or similar source. This also has provision for the 6DB bass lift at 20Hz. The combined outputs of channel 1 and 2 (via IC3b) and the auxiliary amplifier (IC3a) are taken directly to the power amplifier unit which will be fully dealt with in Part 2.

**NOTE:** R21 and R41 in the preamplifier circuit have been deleted and the capacitors (68p) marked CX1, 2 and 3 have been added.

**THE CIRCUIT BOARD**
Layout and component positions for the preamplifier printed circuit board are given in Fig. 4. Note that R21 and R41 as in the circuit diagram Fig. 3 have been replaced by wire

---

**A three part project describing the following:**
1) Pre-amplifiers performance and construction
2) Power amplifier and PSU construction
3) Cabinet construction
Fig. 3. Full circuit of the P.E. Combo Amp. pre-amplifier stages
Fig. 4. Printed circuit layout of preamp

Fig. 5. Component overlay of preamp
Fig. 6. Location of input/output sockets, panel controls and wiring. (Circuit board is mounted on pillars)

Fig. 7. Details for drilling of front panel
COMPONENTS...

**PREAMPLIFIERS**

<table>
<thead>
<tr>
<th>Resistors</th>
<th>Value</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1, R3, R15, R16, R23, R25, R37</td>
<td>100k</td>
<td>7</td>
</tr>
<tr>
<td>R2, R24</td>
<td>12k</td>
<td>2</td>
</tr>
<tr>
<td>R4, R14, R26, R36, R47</td>
<td>68k</td>
<td>5</td>
</tr>
<tr>
<td>R5, R27</td>
<td>470k</td>
<td>2</td>
</tr>
<tr>
<td>R6, R8</td>
<td>1k</td>
<td>2</td>
</tr>
<tr>
<td>R7, R12, R29, R34</td>
<td>10k</td>
<td>4</td>
</tr>
<tr>
<td>R8, R13, R18, R30, R35, R38</td>
<td>47k</td>
<td>6</td>
</tr>
<tr>
<td>R9, R31, R42, R45</td>
<td>4k7</td>
<td>4</td>
</tr>
<tr>
<td>R10, R32</td>
<td>3k9</td>
<td>2</td>
</tr>
<tr>
<td>R11, R33</td>
<td>2k7</td>
<td>2</td>
</tr>
<tr>
<td>R19, R39</td>
<td>68k</td>
<td>2</td>
</tr>
<tr>
<td>R20, R40</td>
<td>220k</td>
<td>2</td>
</tr>
<tr>
<td>R21 and R41</td>
<td>680 ohms</td>
<td>4</td>
</tr>
</tbody>
</table>

**Capacitors**

| C1, C2, C3, C7, C8, C10, C11, C12, C13, C17, C18, C20 | 2\(\mu\)F 50V elect. | 12        |
| C21, C22, C23, C24 | 47\(\mu\)F 50V elect. | 4        |
| C4, C5, C9, C14, C15, C19 | 47n      | 6        |
| C16, C17 | 3n3      | 2        |
| C25, C26 | 10n      | 2        |
| CX1, CX2 (68p) | 68p (silver mica) | 3        |

**Semiconductors**

| D1, TR1, TR2, IC1, 2, 3 | Red, BC566 | National LF353N or Texas TLO72CP | 3 off |

**Miscellaneous**

| Printed circuit board | Standard \(\frac{1}{2}\) in. jack sockets with closed contacts | RP477-573 | 9 off |
| JK1--JK9, S1, P.c.b. pillars | DPDT miniature toggle | RS316-989 |

straps and CX1 and CX2 (68p) have been connected between pins 1 and 2 and 6 and 7 respectively on IC3. Note also that screened leads must be used for connections to the jack sockets JK1/2, JK3/4, JK5/6, JK7/8. The finished board is mounted on stand-off pillars on the front panel and details of this will be found in Fig. 6.

The front panel may be made from black or coloured perspex backed with a thin aluminium panel (20 or 22SWG) as in the prototype or the panel may be all aluminium of 16SWG thickness. If perspex, or other non-conducting material, is used, the thin aluminium backing panel must be included. Details for drilling are given in Fig. 7. Distribution of the panel components is shown in Fig. 6.

The preamplifier could, of course, be completed before the main amplifier (details in part 2) and this could be checked out with a suitable voltage supply. Input signal levels and frequency responses etc., as quoted, can be related to approximately 150mV output from the preamplifier with volume controls at maximum.

**NEXT MONTH:**

the power amplifier and PSU module
MICRO-PROFESSOR REVIEW

MICHAEL TOOLEY B.A.

Michael Tooley is Principal Lecturer in Electronics at Brooklands Technical College, Weybridge.

THE Micro-Professor is a low-cost Z80 based microcomputer system intended for the hobbyist and enthusiast as well as the student and technician. The Micro-Professor aims to provide the user with an interesting and inexpensive introduction to the microprocessor world and, since it is primarily intended as a learning aid, the accompanying “User's and Experiment Manual” forms a significant part of the package. Other applications include process control, timing, sequential tone generation (“music”) and as a low-cost microprocessor development aid.

The basic system incorporates an Z80 central processor unit (CPU), 2K read-only memory (ROM) and 2K random access memory (RAM) together with a keyboard and hexadecimal display consisting of six seven-segment l.e.d. indicators. A cassette tape interface is included; also a small loudspeaker. An on-board regulator provides power for the system in conjunction with an external a.c. mains adaptor. The system is fully expandable and a range of additional modules is available which includes additional RAM and ROM, programmable input/output (PIO) and counter/timer circuits (CTC). For those wishing to develop the system even further, speech synthesis and EPROM programmer boards may also be added.

FIRST IMPRESSIONS

The Micro-Professor comes securely packed in a corrugated cardboard box measuring 350 x 210 x 70mm (approx.). Inside, the Micro-Professor itself is contained within a neat, but rather “plastic”, book-style case measuring 255 x 200 x 48mm (approx.). The case is secured by means of a press-stud fastener and opens out to reveal the microprocessor board in the right hand leaf and a deep recess in the left hand leaf. Just what this, apparently unused, space is intended for is not immediately obvious since neither the “User's Manual” nor the a.c. power unit will fit into the space! However, it appears that an earlier (and smaller) edition of the manual was intended to occupy this position and it can also be used to accommodate such items as the optional speech synthesiser or EPROM programmer boards.

The a.c. mains adaptor operates from a nominal 240V 50Hz supply and provides a nominal 9V output at 600mA. Early Micro-Professor power units were enclosed in a moulded case fitted with an integral 2-pin round mains plug. This type of plug is very inappropriate for use in the U.K. unless, of course, you happen to have an abundance of shaver sockets in your home! Happily, the unit is now supplied with a conventional 13A mains plug.

HARDWARE

The hardware specification of the Micro-Professor is shown in Table 1. The system clock at 1.79MHz is derived from a TTL oscillator and 3.58MHz crystal. The fundamental frequency is divided by a 74LS74 bistable and then applied to the Z8-CPU. A second 74LS74 bistable provides system reset from the keyboard 'RS' button. A 2516 EPROM contains the monitor (address 0000-07FF) whilst a 6116 static RAM provides 2K bytes of user memory (address 1800-1FFF). To provide a further 2K bytes of memory a second 6116 RAM may be fitted in a “memory expansion area”. Alternatively a 2516 (or similar) EPROM may be fitted in order to facilitate demonstration or i.c. pin-outs. The second section (51 pages) contains a full monitor listing (Copyright Multitech Industrial Corporation) which has 2659 statements. The final section (144 pages) provides an introduction to the design of microcomputer programs and gives details of 18 varied experiments based on the Micro-Professor system.

The system hardware is mounted on a neat and tidy p.c.b. measuring 220 x 155mm (approx.). This screen printed, double sided p.c.b. is a push-fit into the book-style case and includes a user breadboard area. The display and keyboard are both eminently visible and easy to use. These items alone render the Micro-Professor superior to many of its rivals.

The sizeable manual has a format just slightly smaller than standard A4 size and contains well over 300 pages. The manual is divided into three parts; a “User's Manual”, monitor listing, and a section entitled “Microcomputer Experiments (Software/Hardware)”. The first section (111 pages) is extremely comprehensive and includes basic operations, program de-bugging and monitor sub-routines as well as a description of the software and hardware (including full circuit diagrams and
**Table 1 HARDWARE SPECIFICATION OF THE MICRO-PROFESSOR**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPU</td>
<td>Zilog Z-80 CPU with 158 instructions and 2.5MHz maximum clock rate. For MPF-I, system clock is 1.79MHz.</td>
</tr>
<tr>
<td>ROM</td>
<td>Single +5V EPROM 2516(2532)x1, total 2K(4K) bytes. Monitor EPROM Address: 0000-07FF(0FFF).</td>
</tr>
<tr>
<td>RAM</td>
<td>Static RAM: 6116, total 2K bytes. Basic RAM Address: 1800-1FFF.</td>
</tr>
<tr>
<td>Memory Expansion Area</td>
<td>Single +5V EPROM 2516/2716/2532/2732 EPROM or 6116 static RAM on-Board Expansion Address: 2000-2FFF.</td>
</tr>
<tr>
<td>I/O Port</td>
<td>Programmable I/O Port 8255x1, total 24 parallel I/O lines. I/O Address: 00-03.</td>
</tr>
<tr>
<td>Programmable PIO</td>
<td>Programmable PIO, a total of 16 parallel I/O lines. I/O Address: 80-83H.</td>
</tr>
<tr>
<td>Programmable CTC</td>
<td>Programmable CTC, a total of 4 independent counter timers. I/O Address: 40-43H.</td>
</tr>
<tr>
<td>Display</td>
<td>6 digit 0-5 inch 7-Segment red I.e.d. display.</td>
</tr>
<tr>
<td>Keyboard</td>
<td>36 keys including 19 function keys, 16 hexadecimal keys and 1 user defined key.</td>
</tr>
<tr>
<td>Speaker and Speaker Driver Circuits:</td>
<td>A 2.25 inch diameter speaker is provided for user's expansion.</td>
</tr>
<tr>
<td>User Area:</td>
<td>Provides a 3.5 inch x 1.36 inch wire wrapping area for user's expansion.</td>
</tr>
<tr>
<td>Audio Tape Interface</td>
<td>Can be connected to any cassette. Data rate is 165 bps.</td>
</tr>
<tr>
<td>System Clock Rate</td>
<td>3.58MHz crystal divided by 2, cycle time is 0.56 micro-sec.</td>
</tr>
<tr>
<td>System Power Consumption</td>
<td>Single 5V power supply, current consumption 500mA.</td>
</tr>
<tr>
<td>Mains Power Input</td>
<td>Power adapter Input 240V 9V/600mA.</td>
</tr>
<tr>
<td>Physical Characteristics:</td>
<td>Height: 1-60mm (W/O case)</td>
</tr>
<tr>
<td></td>
<td>Width: 15-75cm (W/O case)</td>
</tr>
<tr>
<td></td>
<td>Depth: 22-30cm (W/O case)</td>
</tr>
<tr>
<td></td>
<td>Weight: 1.41lb (with case)</td>
</tr>
</tbody>
</table>

The software specification of the Micro-Professor is shown in Table 2. The 2K byte monitor program contained in a 2516 EPROM provides the necessary facilities to enable the user to develop and run his own programs. The most elementary function of the monitor is that of allowing the user to inspect and alter the data at each address in the user RAM. Various other functions, such as single-step, set break point etc, are available together with routines which allow reading and writing of data from an external cassette recorder. A full listing of the monitor program is included in the “User’s Manual” and, although this may be of little use to the beginner, it will undoubtedly prove to be of considerable value to the more advanced student.

A few simple safeguards are provided in order to warn the user of error conditions. One of these alerts the user to “illegal” key entry by blanking out the display. The display returns when the “illegal” key is released. The monitor functions are, on the whole, straightforward and easy to use however, the “User’s Manual” has some serious shortcomings, particularly when the user is unfamiliar with the terminology and may have no previous experience of programming in machine-code. Furthermore, the relatively complex Z80 is a rather inappropriate choice of microprocessor for use in an elementary training aid which concentrates on machine level programming. Many other 8-bit microprocessors would have been better suited to this application and one can only speculate as to why the Z80 was chosen.

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**THE USER’S MANUAL**

The “User’s Manual” is extremely comprehensive but does not, unfortunately, adequately cater for the absolute beginner. This may be of little consequence when the user is following an established course of study but could present very severe problems for the individual starting from scratch. An early introduction to the general concepts and terminology of microprocessor systems would be highly desirable. The manual is also a little illogical in its structure. Early “examples” of the use of the keyboard are more readily understood if the “description” (which follows each section) is studied before attempting to key the examples into the microcomputer. Furthermore, some of the examples are explained in bewildering terms and there are numerous (and sometimes inexcusable) typographical errors. It
SOFTWARE SPECIFICATION OF THE MICRO-PROFESSOR

2K-byte monitor provides key functions and incorporates a memory checking routine. The key functions are as follows:

- **RES**: system reset.
- **MEM**: set memory address.
- **REG**: set register name.
- **DATA**: input data to memory or register.
- **PCL**: recall program counter.
- **ADDR**: check the next memory address or register.
- **LADDR**: check the last memory address or register.
- **STEP**: execute user's program, a single step.
- **BRK**: set break point of user's program.
- **CBR**: clear break point of user's program.
- **CUP**: immediately break user's program.
- **GOTO**: go to user's program or execute some monitor function.
- **IN**: insert 1 byte into memory.
- **DELETE**: delete 1 byte from memory.
- **DVAR**: move data block from one area to another.
- **RDATA**: relative address calculation.
- **REDATA**: store memory data onto audio tape.
- **RDATA2**: retrieve data from audio tape.
- **INT**: maskable interrupt, connected to CPU's INT pin.
- **KEY**: user defined key, connected to input port 00, bit 6.
- **HEX**: hexa-digit or register name.

really is a great shame that, with so much useful information presented, it has not been offered in a form that can be readily assimilated.

The experiments themselves occupy the last part of the manual. They are adequately structured; each has a declared "purpose", the "time required" is stated (often this is 4-8 hours), and some "theoretical background" is given for each. The experiments have been chosen so as to familiarise the student with various facets of microcomputers. The topics are varied and well chosen and include such items as branch instructions, program loops, sub-routines, binary-to-BCD, and BCD-binary conversion, and keyboard and display multiplexing. Altogether this is a program which will be welcomed by both teachers and students of microprocessors.

EXPRESSION

One of the most crucial aspects of any microcomputer system is the degree of expansion that is possible. Where a microcomputer is purchased primarily as a learning aid it is, of course, quite likely that the owner will wish to progress to a more powerful system when the time comes. For many, however, the cost of such an upgrade can be prohibitive and, whilst there seems to be an active second hand market for microcomputers, it would be nice to think that a "first" system would be sufficiently flexible to adapt and grow to meet its user's future needs. What, then, has the Micro-Professor to offer?

Firstly there are three vacant sockets on the Micro-Professor's p.c.b. One of these constitutes the "memory expansion area" to use its rather grandiose title! This 24-pin i.c. socket can accept either RAM or ROM devices and thus the user-memory may be extended to 4K or, alternatively, a 2K tiny-BASIC ROM may be fitted. The remaining two unoccupied i.c. sockets accept the Z80-CTC and Z80-P10 devices. These i.c.'s may, of course, be obtained from a large number of U.K. suppliers. They are, however, very competitively priced when purchased as part of the Micro-Professor system.

Secondly two expansion boards are available. One of these is a complete speech synthesis unit whilst the other provides EPROM programming facilities. Both boards are built to the same high standard of construction as that of the Micro-Professor and occupy exactly half the area of the host-controller p.c.b. They thus fit together neatly in the left hand leaf of the Micro-Professor book-style case. Connection to the Z80-CPU bus is by means of 40-way ribbon connectors — the only slight criticism being that the case will not close when the ribbon connectors are in place. All this makes for a very neat, tidy, and compact system.

BASIC

The 2K tiny-BASIC ROM plugs into the "memory expansion area" and allows the user to program in BASIC. The available commands and statements include CALL, CONTINUE, FOR ... NEXT, GOTO, GOSUB, IF ... THEN, LET, LIST, LOAD, NEW, PRINT, RETURN, RUN, SAVE and STOP. Users may also call machine-code sub-routines resident in the Micro-Professor memory. A keyboard overlay is provided and the display is used to examine the program on a line-by-line basis. This, unfortunately, takes some getting used to—particularly when the display moves! Tiny-BASIC is, of course, very limited by comparison with its more powerful counterparts. It does, however, help to bridge the gap between machine-code and high level language and may be a worthwhile addition for those wishing to progress beyond Hex.

SPEECH SYNTHESIS

The speech synthesis board is designed around the TMS5200/5220 voice synthesis processor. This device employs linear predictive coding and data held in ROM determines the instantaneous signal frequency and amplitude. The ROM fitted is a 4K TMS2532 which contains 32 words; sufficient for a simple time-clock program. Sockets are fitted which can accept two further ROMs in order that the vocabulary to over 150 words and there is a choice of eight ROMs, each containing approximately 30 words. The ROM supplied provides two speech programs a test/demonstration vocabulary and a small user storage area. The speech synthesiser uses the Micro-Professor as host controller and the keyboard, display and loudspeaker of the Micro-Professor act as input and output devices.

Voice pitch and volume are adjustable by means of multi-turn pre-set potentiometers. The manual contains operating instructions (which are somewhat brief by comparison with those supplied with the Micro-Professor), hardware details, and a program listing. There are no "experiments" as such, however, the system can be regarded as more a demonstration than an experiment package. There is, of course, considerable scope for the more intrepid programmer wishing to include speech output with programs devised for the Micro-Professor. For him, the speech synthesis board can be considered an exciting and challenging extension to the basic unit.

EPROM PROGRAMMER

Like the speech synthesis board, the EPROM programmer connects to the Z80-CPU bus via a 40-way ribbon cable. It is, in fact, possible to have both the speech synthesis board and the EPROM programmer board linked to the Micro-Professor.
simultaneously by virtue of duplicate 40-way male connectors fitted to each p.c.b. The EPROM programmer caters for TMS2508, 2516, 2532 and 12758, 2716, and 2732 devices. It incorporates an 8255 PIO together with 4K of static RAM in the form of two 6116 integrated circuits. The monitor is a 2516 and the 5V and 25V rails are regulated by 7805 and 723 devices respectively. A zero insertion force socket is fitted to accept the EPROMs for programming.

The manual explains the function of the monitor program and contains instructions in much the same form as that used in the Micro-Professor “User's Manual”. The EPROM programmer has its own mains adaptor (as is the case with the speech synthesis board) and the system becomes a little cumbersome when all three a.c. adaptors are connected to it. The alternative would be to have one power supply for the whole system. This, of course, would have to be substantially up-rated by comparison with any one of the existing power units. If the whole system were to be powered from a single +5V rail (from, say, an external 317 bolted to an adequate heatsink) the +25V rail for the EPROM programmer could be derived from a simple on-board d.c.-d.c. converter. In the first instance this would, of course, make the system a little more expensive but it would effect a considerable saving later on and would make the fully expanded system a good deal tidier.

**SUMMARY**

In any equipment review, the question “Is it good value for money?” inevitably arises sooner or later. In the case of the Micro-Professor, it really depends upon what you want from the package. In terms of the hardware offered the Micro-Professor certainly does represent good value. The keyboard and display are of a particularly high standard and the quality of construction is excellent. In terms of software, and the “User’s Manual” in particular, it is important to be aware of the shortcomings of the system. Prospective purchasers should be warned that the system (in its most basic form) is only really suitable for those requiring a rigorous, if a little tedious at times, introduction to system (in its most basic form) is really only suitable for those who have no previous experience of microprocessors. However, to do a considerable amount of background reading in order to derive full benefit from the Micro-Professor.

The Micro-Professor is available from the U.K. distributors; Flight Electronics Ltd, at Flight House, Quayside Road, Bitterne Manor, Southampton, Hampshire SO2 4AD.

The price of the basic Micro-Professor (including mains adaptor and manual) is £69.95. The Z80 PIO and CTC devices each cost £4.02, the Speech Synthesiser Board £64.95 and the EPROM Programmer Board costs £74.95. The latter items both include power supplies, manuals, and interconnecting ribbon cables. The tiny-BASIC ROM costs £15 and is supplied with a manual and keyboard overlay. Note that prices do not include VAT. Postage and packing is £2.95 per system and 50p for individual ROM’s and i.c.’s.

**NOTE:** The following information has been received from Flight Electronics since this review was written:

From the middle of June all Micro-Professor 1 systems will have the 2716 Monitor EPROM replaced with a 2532 EPROM that will contain both the monitor source program list and the BASIC interpreter. Also included will be a BASIC Manual, Keyboard Overlay and a seven segment I.e.d. Interpreter Card. In addition, the User’s Manual will be supplied as three separate parts to aid the user. However, the price of the system will remain the same.
Part Three  A.R. Bradford M.Sc.

In this final part setting up of the synthesiser will be covered together with a series of test programs. Case construction is also covered.

**VCOs**
Selecting the square wave output from VCO1, take VCO1 down to its lowest frequency by pressing the lowest key, setting the Range switch to 16', and then using the Sweep pot routed via the thumbwheel into the Keyboard, so that VCO1 is just oscillating. Adjust VR13 for the fastest buzz. Reduce frequency again using the thumbwheel and readjust VR13 for the fastest ticking. This process has nulled the offset on VCO1 integrator IC11, enabling the oscillator to stay in tune for very low input currents. Switch off VCO1 using the switch on the “Shape” pot and turn the thumbwheel to zero (towards the front). Repeat the above process for VCO2, selecting the square wave output and using the VCO2 frequency control and adjusting VR17. Remember to turn VCO2 Level up.

The ramp waveforms from each VCO are now adjusted in turn. Turn VCO2 Level down and switch VCO1 on. Selecting the ramp waveform from VCO1 sweep the oscillator over its entire range using the Range switch and the Sweep/Thumbwheel combination, and adjust VR15 to ensure that the output does not disappear or become distorted at either end of the range. An oscilloscope is useful here but by no means essential. Repeat the process for VCO2 adjusting VR19.

Next, using VCO1 at the low end of its range (16'), play a scale; this should be in tune, so bend the frequency down very low using the thumbwheel and adjust VR8 for an accurate scale. This process nulls out the offset on the keyboard range amplifier, IC7.

**OCTAVES**
Now the octaves may be set up using the keyboard and the Range switch. Working either side of the 4' range, which requires no adjustment, set the ranges an octave apart by adjusting VR5 and VR6 (8' and 2' respectively), followed by VR4 and VR7 (16' and 1' respectively). Tuning of the whole instrument relative to another instrument is achieved by turning VR1.

**VCF**
Select a ramp waveform from VCO1 and switch the VCF “Kbd Mod” on. Set the VCF frequency control half way thus filtering the ramp waveform down to a smooth tone and sweep the keyboard using the range switch. VR22 should be adjusted so that there is no obvious change in harmonic content as the keyboard is swept. Switch both VCOs off and turn up the Noise Level control. With the Q control at maximum it should now be possible to play a crude scale of whistles from the filtered white noise.

**ENVELOPE**
Set the Attack and Release controls about one quarter turn, and switch the Envelope Shaper to “Auto” using S8. Upon pressing a key the output may latch up (not decay away once the Attack cycle has been completed). If this is the case turn VR11 anti-clockwise until the sound dies away again. If VR11 is too far anti-clockwise, the output volume in “Auto” mode may be appreciably quieter than in “Manual” mode. Therefore turn VR11 clockwise to equalise the output volume in the two modes of operation, but making sure that the envelope resets correctly without latching up. Check also that the ‘Repeat’ functions. If not turn VR11 clockwise. Finally, each time a key is pressed there will probably be a thump at the output; this should be nulled out using VR25.

**FAULT FINDING**
Assuming there are no faults up to now the Microsynth should be set up and ready for use. If the VCOs malfunction for no apparent reason, it may be that CMOS chip IC14 has been damaged by static during insertion. Replacing this chip usually cures such inexplicable faults. It now remains to test out all the various functions of the Microsynth. It is
suggested that the test programs listed below are run through—if these all work it is unlikely that there is anything wrong with the circuitry.

Should any function fail to work, check the p.c.b. against the component schedule and circuit diagrams, inspecting the relevant area of the p.c.b. for incorrect components, dry joints, solder bridges, diodes or transistors in the wrong way round, etc. Where one part of the synthesiser is connected to another some distance away, follow the relevant tracks making sure that there are no breaks, shorts, pins missing, etc, in these links. 99 per cent of all faults can be isolated in this way and will generally be found to be due to some trivial mistake in construction.

TEST PROGRAMS

Set all function switches (except "Drift") to the left between programs.

**Star Wars**

Switching VCO2 to LFO mode disables the audio output and sets the operating range from about 0.1Hz to 30Hz. The LFO may be used to sweep the keyboard automatically; use the ramp waveform from VCO1 and try the effect of the various waveforms available from VCO2/LFO. Route the LFO output either directly into the Keyboard using S14, or via the thumbwheel, setting “Source” to “LFO” and “Destination” to “KBD”. Use the square wave from the LFO in conjunction with the “Shape” control to vary the duty cycle.

**Waa-waa**

Switch the Envelope output into the VCF. Set the Q control about two thirds up and VCF Frequency fairly low; set Envelope Level about half way positive. Keep Attack and Release times fairly short and remember to only use VCO waveforms with a high harmonic content, that is, ramp or square waves. You should now have the typical Moog sound. A slightly longer Attack and shorter Release and you will start to get a trumpet-like voice. Try switching in some Sub Octaves at this point!

**Wind**

Disable both VCOs and turn up the Noise Level control. With the VCF Q knob set fairly high and the low pass output selected, varying the VCF Frequency control will generate wind effects. Switch the VCF output to band pass and get rain too! Try the envelope on “Auto” and “Repeat” (or alternatively triggered from a slow-running LFO) for generating percussive, rhythmical effects—steam trains are quite easy using a repeat time of about 0.3 seconds and suitably short Attack and Release times. Don’t have the Q control too high though. Alternatively, turn the Attack and Release times right round to maximum and switch the Sustain to “Hold”. Use the “Repeat” facility rather than LFO triggering. Q low, VCF frequency mid-way, and a small positive Envelope Modulation in to the VCF and you will start to get a seascape. When you are happy with this, turn VCO1 on with a triangle output, switch the Range to 2’ and the “Drift” switch to "Down". The repeatedly hit keys at random for the complete treatment.

**Bells**

Using the triangle outputs from both VCOs, switch VCO2 to “Ring Mod” and switch VCO2/LFO modulation into the VCA. Pressing a key and bringing up the volume of VCO2 will gradually introduce sum and difference tones. Set VCO2 at some anharmonic ratio of VCO1’s frequency. Switch the Envelope to “ADSR” and sustain to “Auto” with short Attack and fairly long Release times. Alternatively use VCO2 in LFO mode to modulate the keyboard with a slow, low amplitude triangle (vibrato). Note that the LFO speed can be changed by the Envelope as it rises and falls (switch Envelope Modulation into VCO2) so that the speed of the vibrato is fast to start with and slows as the envelope dies away, or vice versa. Try the effect of the sub octaves with VCO1.

**Organ**

The use of triangle oscillators to provide relatively pure tones, while the VCF filters other waveforms (in this case the Sub Octaves, one each under VCO1 and VCO2), really comes into its own with this program. Switch the “ADSR” off, Sustain to “Manual”, with Attack and Release times short. Tune VCO2 to, say, an octave and a third below the pitch of VCO1, and there you have it!

**Random/Staircase**

Have the envelope repeating at a fairly brisk rate (remember to have the Sustain on “Auto” for this effect to work; with Sustain on “Manual” and the “Repeat” on you will get a sort of echo every time you release a key!) and switch the thumbwheel Source to “S & H” (Sample and Hold). Push the thumbwheel fully up. Route the thumbwheel output into the keyboard. With VCO1 and VCO2 tuned to some interval...
or other, the Sample and Hold will sample VCO2 waveform and the pitch of both VCOs will be modulated apparently at random. Alternatively switch VCO2 to LFO mode, running slowly with a ramp or triangle output. VCO1 will now be modulated by the staircase waveform coming from the Sample and Hold. Next set up the wind effect again and switch the thumbwheel output into the VCF to achieve trendy random or staircase filtering effects (the LFO must be running, with the level control fully up). This also works well with a ramp output from one or both VCOs—listen to a Jean Michel Jarre album sometime!

**VCO1 mark/space modulation**

Use the triangle output from the LFO to modulate the VCO1 squarewave (remembering to select the square wave output from VCO1). Slow, large amplitude modulation will give a phasing effect while somewhat faster, small amplitude modulation will give a chorus or string ensemble effect. Try switching in the Sub Octaves.

**Harpischord**

Try the chorus effect with a sharp Attack and longish Release, the “ADSR” switch on, and the VCF switched to band pass. Vary VCF Frequency control for the best result. Try the sub octaves. See what effect the VCF “Keyboard Mod” switch has.

Once the whole instrument has been tested you can really start experimenting! Try anything and everything—the most interesting effects tend to be discovered by accident. Keep a stock of program sheets and record the settings for any effect you wish to keep—there are so many possibilities it is pointless relying on memory.

**CASE CONSTRUCTION**

Ready built cases and panels will be available from Clef, but for those constructors wishing to make their own the dimensions are shown here. It is possible to use a longer keyboard if desired simply by extending the length of the case and the front panel. The end cheek shown in Fig. 14 is the same regardless of the length of keyboard used, while the front, back and keyboard support bars (all of equal length) should be 15\(\in\)in for the 25 note keyboard.

The case was assembled by drilling \(\frac{1}{4}\)in holes in the end cheeks in the positions shown and screwing 2\(\in\) wood screws through these directly into the front and back pieces, but if preferred there is ample room for gluing batons into the corners and screwing into these. Either way the screw heads should be countersunk into the wood of the end cheeks. Having built the basic frame, the bottom panel is cut from \(\frac{1}{4}\) plywood or hardboard and glued and screwed in place, again countersinking. This bottom panel should be cut slightly larger than the framework and then planed off flush with the walls once in place.

**Showing hinged keyboard assembly**

Dummy keys are cut from \(\frac{1}{4}\)in wood as shown in Fig. 13 and glued inside each end cheek, having first securely araldited the thumbwheel to the left hand end cheek. Remember to solder the wires to the edge pot first, as you won’t be able to get at it afterwards. \(\frac{1}{4}\)in square x \(6\in\) strips of wood are glued along inside the top edges of the end cheeks to form panel supports, being placed slightly below the tops of the end cheeks to allow for the thickness of the panel. Plane off also the top edge of the back wall at a slight angle to allow for panel thickness, so that when in place the panel will fit flush with the tops of the end cheeks.

A cut out should be made in the back wall of the cabinet and a small piece of 16 s.w.g. aluminium drilled to take the sockets and the mains cable. This should then be sprayed black and labelled and screwed in place behind the cut out, see Fig. 15. The dimensions will depend on the type and number of sockets used: the sequencer terminal should be a 5 pin 180° latching DIN socket; the outputs will normally be \(\frac{1}{4}\)in jack sockets, although professional users may prefer cannons, while for purely domestic use through a hi-fi, phono sockets may be best.

Fill the screw holes with wood filler and sand down; the
entire case is now covered with black plasticised cabinet cloth (obtainable from Maplin or most electronic/disco shops), using a 'Thixofix' type adhesive. Both surfaces must be completely covered with a thin layer of adhesive and allowed to dry, in order to obtain the best finish and avoid peeling.

Screw some rubber feet to the corners and bolt a strap handle through the left hand end cheek if required.

**PANEL**

The panel is constructed from 16 s.w.g. aluminium as shown in Fig. 16. Having cut all the holes, thoroughly clean the drilled and filed aluminium with 'Brillo', then thoroughly dry with tissues taking care not to get any grease back onto the metal, and spray with several thin coats of matt black car paint, allowing a few minutes to dry between each coat. The white lines are put on with white car stripe (from most car spare shops and garages). The panel is labelled with white "Letraset" or similar, and the labelled panel is finished by spraying with a thin coat of clear matt fixative (from stationers).

**FITTING THE KEYBOARD**

If the keyboard chassis protrudes beyond the ends of the keys, the excess must be cut off with a hacksaw; then fix the hinge at the back of the keyboard to the rear support in the cabinet using self tapping screws. If the keyboard used does not have a hinge at the back, it is recommended that the rear support be made to pivot in the cabinet by drilling \( \frac{1}{2} \) in deep holes in the end cheeks and in the ends of the support bar and inserting 1 in metal rods (such as 1 in 4BA bolts with the heads sawn off) into the holes. In any case, position the keyboard carefully so that it will pivot freely between the dummy keys at either side, and so that the keys do not foul the front of the cabinet. Check that the panel fits correctly with a slight gap between the sloping front and the tops of the keys.

The keyboard p.c.b. of Fig. 11 is glued underneath the keyboard chassis, having first mounted the resistors. The gold wire contacts should then be soldered in place so that the longest wire presses against the bottom of the key plungers. The other contacts are then added, and bent so that there is a small gap between each of the wires when the keys are not pressed. Ensure that all three wires under each key meet when that key is depressed, but avoid having too small gaps between them when the keys are not depressed, or else mechanical vibration may cause spurious triggering.

**FINAL ASSEMBLY**

Having made all the various connections between the three p.c.b.s, the thumbwheel edge pot and the back panel, and after setting up the circuitry, the main p.c.b. bolts beneath the front panel using 2 in threaded spacers. The power supply p.c.b. should be bolted to the floor of the cabinet behind the keyboard using \( \frac{1}{2} \) in threaded spacers. Assembly is completed by fixing the front panel in place with four self tapping screws and then pushing the knobs over the pot spindles protruding through the panel.
WAVEFORM DIGITISER

Able to store a waveform in memory and replay it for analysis or troubleshooting. It is particularly useful for capturing transient events such as musical instrument waveforms, power supply glitches, etc. Another application is the recording of daily temperature variation, the result of which can be retraced on an oscilloscope at much higher frequency to provide a time compressed record.

C.B. SCANNER

This design provides push button up/down single step or channel scan with pause on channels in use. Simply key the mic to stay on any channel. The neat p.c.b. can be fitted inside most rigs and, with the option of all controls on the mic, provides an easy to use system—especially when driving.

SEAT BELT REMINDER

...YOU KNOW IT MAKES SENSE!

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PE BAZAAR

ZXS1 16K in homemade case with proper keyboard and built-in power supply £110. F. R. Barrow, 35 Rectory Lane, Tootling, London SW17 9PZ.

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SINCLAIR ZX81 Personal computer, plus fifty programs, plus two books, plus p.s.u. all for £55 C.W.O. R. Wood, 35 Griffel Road, Bellevue, Carlisle, Cumbria CA2 7QP. Tel: 0228 28412.

WANTED service manual or circuit diagram Tektronix Oscilloscope Type 502A to buy or load, with Transformer, 51308. Carlisle, Cumbria CA2 7QP. Tel: 0228 28412.

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TY 58, 58C, 59 owners, for sale, one PC-100C printer as new, £95 ono. Mr. G. Bearzot, 294 311191.

ZX81 computer and 16K RAM, p.s.u. and extras, £110 ono. Owner moving abroad soon. T. G. Kua, 96 Cedars Walk, Hemel Hempstead, Hertfordshire HP3 9ED.

ZX81 16K external keyboard, books and cassettes, £100. 4½ inch black and white video monitor, £35. Tel: Roger (evenings) 0702 67453.

WANTED, any books on the 280, Programming, Interfacing, etc. Good price paid (Sargo Chess perhaps?). E. Ball, 49 Brandearth Hey, Carl Vill Farm, Liverpool L28 1SB. Tel: 051 489 7906.

TRANSFORMERS, 330/0/330V, 300mA, 4V2A, 5V2A, 6-3V7-5A, and 600/0/600V, 5V3A, encased, both 200/250V, £5 each. G. Jordan, 60 Thorne Park Gardens, Stoneleigh, Epsom, Surrey. Tel: 01-393 9870.

HEATKIT oscilloscope model 10-103 10MHZ. 5 inch single beam. Perfect condition, new mains transformer, £90. Offers considered. Mr. P. Metcalfe, 36 Quarry Bank Road, Market Drayton, Shropshire TF9 1DT. Tel: M/Drayton 3535.

AVO electronic test meter, ohms, dc/ac, volts, dc amps, capacitance, watts, very good order, £65. Tel: 06041 27644.

MULTIMETER for radio t.v. incl. case, £16. Tel: 01-584 2913 (evenings).

WANTED all types of used radio/amplifier valves and bases. Urgent are: PM4, PX25, MP-41-45. Mr. R. Joseph, 21 Western Way, Letchworth, Herts SG6 5SE. Tel: Letchworth 79681.

ZX80 with manual and circuit, £30, MX14 with video board and extras, £35. Mr. J. W. Walsh, 29 Crompton Avenue, Bolton BL2 6PF. Tel: 382796.


MAPLIN 5600S Synth. ready to play In Maplin case reasonable offer accepted. Mr. R. Massey, 7 Ivy Road, Northampton. Tel: Northampton (0606) 27644.


ZX81 Sinclair built + Inverse Video, white characters on Black background + joystick, £70. 16K ZX81 memory. £35. S. Thickett, “Edgewise”, Church Road, Brown Edge, Stoke-on-Trent, Staffs ST6 8RA.

ZX81 Sinclair built + Inverse Video, white characters on Black background + joystick, £70. 16K ZX81 memory. £35. S. Thickett, “Edgewise”, Church Road, Brown Edge, Stoke-on-Trent, Staffs ST6 8RA.

WANTED, circuit diagram for solid state automatic pulse generator to h.t. transformer. Gene Hetherington, Ballinamore, Co. Leitrim, Ireland.

QUANTITY small components new or used on order, all serviceable list, large s.a.e. G. A. Noble, 50 Croft Hill Road, Slough, Berks SL2 1HF.

THE PRODIGIOUS invasion of photography by electronics has resulted in the automation of almost every function of the modern camera, including focussing. Now, even the photographer can be replaced by this electronic robot!

MOVING IMAGE DETECTOR
As the name suggests, the Moving Image Detector is a device for detecting the presence of moving objects. It can be used in applications where a light gate would usually be required. But unlike a light gate, it does not require a beam.

The M.I.D. unit described here is designed to operate the shutter of cameras which have an electrical release socket, such as most Contax/Yashica models. This type of release fires the shutter when shorted.

However, with the addition of a servo unit to fire the mechanical release, almost any camera could be used.

GENERAL DESCRIPTION
An image is focussed by lens 1 (see Fig. 1), on to two photosensitive elements 2 and 3, which form a potential divider. These elements occupy only a small central area of the total scene.

Under normal circumstances, the two elements are of approximately equal resistance and so about half the supply voltage will exist at point A.

This condition is maintained indefinitely, despite ambient light fluctuations, clouds obscuring the sun for instance. The reason for this is that both photo-elements would be affected equally, which means that the potential divider ratio would remain the same and therefore, so would the voltage at point A.

If now, something moves across the scene being monitored and affects the amount of light falling on the elements consecutively, the ratio will be unbalanced and the voltage at point A will change.

This triggers the voltage change detector 4, the output of which is used to fire the shutter of the camera.

PRACTICAL CIRCUITS
The most simple circuit that it is possible to build is shown in Fig. 2.

The two photo-transistors TR1 and TR2 are extremely small devices, measuring just a few millimetres across. They only have two leads, as the base connection is not made. The anode lead has a small tag on it.

Resistors R1 and R2 limit the current flowing through TR1 and TR2. Two are necessary to maintain balance under fluctuating light conditions.

C1 blocks the d.c. level at the junction of TR1 and TR2 and transmits any a.c. pulses to the thyristor SCR1. This is the Voltage Change Detector, although of course it will only fire on reception of a positive going pulse. This is perfectly adequate, as the moving object will produce a positive going pulse sooner or later, regardless of whether it be lighter or darker than the background.

Objects that contrast poorly with the background may escape detection, but this is a surprisingly rare event.

The 2N5062 is a very sensitive thyristor. Other types might not be suitable.

The circuit works well in fairly bright daylight. The following circuits, however, will operate in bright sunlight down to quite dim domestic lighting.

In Fig. 3, a comparator is used to detect changes in the voltage at point A. When this rises above a reference voltage at the inverting input of IC1, the output goes positive and fires SCR1.

The fine control VR2 is initially set at its central position. Then the coarse control VR1 is adjusted so that D1 is just on. Finally VR2 is readjusted until D1 just goes out.

Capacitors C1, C2 and C4 provide transient suppression. The circuit will be prone to repetitive triggering if they are omitted.

The circuit in Fig. 4 uses the same i.c., but connected in the "follower with gain" mode, which amplifies the pulses before feeding them to the thyristor.

It does not require adjustments of any kind and also has the advantage of negative feedback at 50Hz and above via C2. This prevents the circuit from being triggered by mains interference, especially from fluorescent lighting. Fig. 7 shows the pattern for a p.c. board suitable for the circuit of Fig. 4. Fig. 8 shows the component layout.
Fig. 1. Differential light detection system. Ambient changes common to the whole field are cancelled out.

Diodes, for protecting the thyristor from excessive back e.m.f., are not required in the preceding circuits if they are used for operating automatic cameras directly, as these include such a diode internally.

**CONSTRUCTION**

It is recommended that the two photo-transistors are soldered to the board first. Avoid overheating the leads. The encapsulation should be polished with a soft cloth. A small piece of black card may be placed between the photo-transistors to cut down reflections, but this is not absolutely vital.

The completed circuit board is housed in a small box. This is made of aluminium to provide screening and must be lightproof. Fig. 6 shows a M.I.D. unit (2) attached to an SLR camera (1).

The lens (4) need not be an expensive one. Any single element lens with a focal length of between one and three inches can be used.

For maximum picture brightness however, the lens should be a short focus type, and its diameter should be equal to the diagonal length of the camera viewfinder.

The prototype used a two inch lens, taken from an inexpensive 35mm slide viewer. The lens should be focussed at infinity if it is intended to look through the viewfinder. The detachable eyeshade of the author's camera was used for the bracket (3). This unscrews into two parts, so is easily fixed to the M.I.D. unit.

The output from the unit is connected to a coaxial socket (5), which is coupled to the electrical release socket of the camera by a short length of coaxial cable bearing corresponding plugs.

The metal housing (6), is connected to the negative rail of the printed circuit board (8) by way of the fixing pillar and screw (9).
TESTING
The completed circuit may be tested by connecting a 6V bulb and battery, wired in series, between the output and 0V terminals of the board, the negative terminal of the battery going to 0V. The 9V separate supply needs to be connected also. Passing a shadow or light source across the phototransistors should light the bulb.

Now all that remains is to install the board inside its box and test it on your camera.

Initially, the unit does not have to look through the viewfinder. Just plug it in and walk in front of the lens. Don’t stand too close, as the M.I.D. tends to ignore subjects that are out of focus!

Switching the M.I.D. on or off while connected to the camera may fire the shutter. So to avoid wasting film, always switch on before plugging in and unplug before switching off. Moving the camera will also fire the shutter.

Where >50Hz rejection is not required, then the buffer circuit of Fig. 5 is recommended.

Here, the 3140 is used to match the high output resistance (at low light levels), of the photo-transistors to the relatively low input resistance of the thyristor.

The circuit of Fig. 4 can be readily converted to the buffer circuit, using the same p.c.b. Referring to the component overlay, Fig. 8, the necessary changes are: Remove R4, R6, R7, C2 and C4. Replace R5 and C1 with links. Replace R3 with a 1n capacitor.

COMPONENTS...
(for the circuit of Fig. 4)
Resistors
R1, R2  470 (2 off)
R3  10M
R4  1k
R5  2M2
R6  4k7
R7  5k6
R8  1M
Capacitors
C1, C4  10n (2 off)
C2  1n elect.
C3  100n
Semiconductors
SCR1  2N5062
TR1, TR2  BPX81 (2 off)
IC1  CA3140E
Miscellaneous
P.C.B. or stripboard
JK1 sub. min. jack socket
PP3 battery and stud

CONSTRUCTORS’ NOTE
The BPX81 photo-transistors are available from:
Synchro Services,
High Street, Harrold, Bedford.
Tel. 0234-720575.
The 2N5062 thyristor is available from:
Macro Marketing Ltd.,
396 Bath Road, Slough, Bucks.
Tel. 06286-4422

COMPONENTS...
(for the circuit of Fig. 5)
Resistors
R1, R2  470 (2 off)
R8  1M
Capacitors
C1  1n
C3  100n
Semiconductors
SCR1  2N5062
TR1, TR2  BPX81 (2 off)
IC1  CA3140E
Miscellaneous
P.C.B. or stripboard
JK1 sub. min. jack socket
PP3 battery and stud
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MICRO SYNTHESER

Some time ago I reported on a device coded CY500 produced by a newcomer to the semiconductor scene called Cybernetic Micro Systems of Los Altos, California. The CY500 is being sold as a CMS product, and it performs the task of an intelligent stepper motor controller which can be instructed by either a microprocessor or by a simple ASCII keyboard. The most interesting thing about the CY500 is that it is not a special chip design and it is not even made by Cybernetic Micro Systems!

The secret behind this apparent sleight-of-hand is, I think, that CMS was set up by a more powerful version coded CY500 joined by a more powerful version coded CY360 has applications.

Like the CY500, the CY360 has been designed for a second party to produce a brand new functional building block based on its own software which is frozen into someone else's microprocessor chip at manufacturing stage, for sale to third parties. The CY500 was such a success that it was soon joined by a more powerful version coded the CY500 this device is controlled via a parallel ASCII interface from either a keyboard for simple systems, or a microprocessor for the bells-and-whistles applications. Also like the CY500, the CY360 has its own on-chip high level language interpreter for its set of generation and synthesis functions which come complete with Jumps and Loops so that a complete synthesis program or Macro can be coded with a very few steps and stored in the on-board RAM space.

At this point the similarities with the CY500 end, because, of course, the CY360 has a totally different purpose in life. Its instruction set is based on single alphabetic characters which may be mixed with necessary numeric data describing waveform parameters such as amplitude, phase, frequency and delay. Readily available from the CY500 are sine, triangle, sawtooth and square waveforms with programmable frequency and number of cycles per burst. It is also possible to synthesise pseudo-random (i.e. noise) signals and to generate linear approximations of many arbitrary functions—for example exponential delay.

The CY360 is a digital processor of course so it does not output analogue voltages directly. Instead, it outputs numeric data on two eight-bit ports which can be connected directly to Digital to Analogue converters to recover the analogue waveform. These ports can be used to provide two separate phase-different signals, or they can be used together for a single higher resolution signal if necessary.

Because of the digital synthesis used by the CY360, there are of course some disadvantages. If the generated waveform is examined closely enough it will be seen to be made up of a stair-step approximation to the desired function, a fact which may not be a problem in many applications and which can anyway be reduced by filtering. Also, because of the need for the processor to execute code between waveform steps, the device is limited to low frequency applications.

The CY360 draws 100 milliamps from a single 5 volt supply and is housed in a 40 pin plastic package.

VOLTAGE FOLLOWER

A voltage follower can be made with a single transistor with an input to the base and an output from the emitter. Its job is to provide impedance transformation so that the input voltage from a high impedance source can drive a low impedance load: a current amplifier if you prefer. In these days of integrated circuits people have tended to forget the simple approach and use instead an Operational Amplifier with unity gain feedback (equals a piece of wire!). In some cases this is the proper thing to do because the OP AMP solution does not suffer from the base-emitter offset voltage of the transistor which makes all output voltages from the emitter 700 millivolts or so less than the input voltage. In other applications, particularly small signal amplification, the transistor may be better as it contributes much less noise than the multi-transistor OP AMP.

In future it seems there will be a third choice in the shape of the TL068 from Texas Instruments. This device is a sort of OP AMP-in-transistor-clothing, because although it lives in an innocuous looking 3-pin plastic transistor package, internally it contains an i.e. input amplifier with a ready made feedback connection to provide the voltage follower configuration. This device provides a number of improvements over the transistor scheme because it has an extremely high input impedance, an input bias current of less than 400 picamps, and an offset voltage of less than 15 millivolts. In addition it has a 1MHz bandwidth, can draw as little as 125 microamps from its supply, and will operate with input signals of 3 to 36 volts.

The three pins of the TL068 are labelled INPUT, OUTPUT and VEE (ground), with the connection of this device into a practical circuit being as easy as you might expect from such a simple package. The lack of a positive supply pin is overcome by obtaining bias from the driven load via a bias resistor.

The TL068 will be most useful as a buffer amplifier for remote transducers which have to drive long lines, but its extremely high impedance also makes it suitable as a charge amplifier for capacitive devices such as electret microphones.

The main advantages it has over the use of standard OP AMPS is its simplicity and low cost.

MUART

Most microprocessor systems need extra peripheral circuits to provide the essential system facilities which cannot easily be placed on the processor device because of the extra cost incurred or because of a lack of package pins, or for example the "extras" required are a UART (Universal Asynchronous Receiver Transmitter) to provide serial communication to a system console or a modem, a parallel port to drive a line printer or accept data input from panel switches, a few time/counters to provide pulse generation and the ability to measure the time taken by external events, and an interrupt controller to ensure that all those other devices get a fast response from the processor when they need attention.

Until now you needed to buy as many as four additional and expensive chips to provide these functions, and these chips may have had many fancy features which the average system did not need, not to mention the extra system complexity caused by all the necessary interconnections. Now Siemens have decided to come to the rescue of the small systems builder by combining all the required features onto one relatively inexpensive chip. The new device is coded SAB8256A and is called a MUART by its designers, although how that M manages to convey the provision of a parallel interface, five timer/counters and an interrupt controller in addition to the UART I really don't know! Personally I think that the MUART is the best development to appear in microprocessor peripherals for a long time, and it seems that I am not alone, because no less a manufacturer than Intel has decided to act as an alternative source for the chip.

The SAB8256A is basically 8080 system orientated and is therefore easy to hook up to 8085 and 280 systems but this device is so attractive that it will almost certainly be in demand for 6800 or 6502 based systems too. Interface to these processors can be easily achieved with the addition of a few external gates.

The MUART comes in a 40-pin plastic package and will operate from a single 5 volt supply.

Practical Electronics August 1982
This final part sets out initial tests, calibration and examples from the wide range of measurements possible.

**INITIAL TESTS**

Before connecting to the supply the front and rear panel controls (shown in Figs. 8 and 9, respectively) should be set as follows:

**Front Panel**
- Function: 'Voltage out'
- Voltage Range: '1V'
- Frequency Range: 1kHz-10kHz
- Output Level Range: '2V'
- Output Level Fine: Fully clockwise—'Min'
- Monitor: 'Out'
- Waveform: 'Sine'
- Monitor Volume: 'Min.'
- Supply: 'a.c.'

**Rear Panel**
- TR6 gate
- +12V from P9
- L. mains from FS1
- C30
- a.c. mains to 11
- +12V on PCB

A d.c. voltmeter should be used to check the voltage at the positive connection of C38. This should be in the range 16V to 18V. If there is no voltage at this point check the a.c. supply connections, mains transformer and fuse. Now transfer the d.c. voltmeter to measure the voltage at the link (LKA). This should be in the range 11.5V to 12.5V. If this is not the case check IC2. Transfer the d.c. voltmeter to the emitter of TR8 and adjust VR7 to obtain a reading of approximately 6-5V at this point. If this cannot be obtained check the wiring and connections to the p.c.b. in the vicinity of TR6, TR7 and TR8. Advance the monitor volume control to about 30% of its full range and adjust VR6 until a relatively pure tone (at about 1kHz) is heard from the loudspeaker. If necessary adjust the monitor volume to obtain a comfortable listening level from the loudspeaker once oscillation has commenced. Observe the indication on the meter and note the effect of (a) changing the calibration to 'r.m.s.' and (b) switching from the '1V' to the '3V' range. Both should cause the deflection on the meter to fall to about one-third of its previous reading. If necessary adjust VR4 to provide a sensible indication on the meter before carrying out this test. Now switch to 'square' wave and change the function to 'Frequency Out'. The meter reading should increase as the frequency-fine control is turned anti-clockwise. (The tone...
from the loudspeaker should also increase in frequency.)

The foregoing tests establish that, in the order given, the power supply, signal generator, monitor amplifier, a.c. voltmeter, and frequency meter sections are functional. If, at any stage, the required indications are not produced, reference should be made to the d.c. voltage table. The presence of unusually high or low voltages will rapidly pinpoint the area of a fault. Note that a difference of about 10% can be expected without indicating that a fault is definitely present. When a fault has been identified the p.c.b. and associated wiring should be checked in the appropriate area. Full calibration cannot be carried out without the aid of additional test equipment. This should consist of a digital frequency meter and an oscilloscope. An accurate r.m.s. reading a.c. voltmeter may also prove to be useful.

CALIBRATION

Connect an oscilloscope and digital frequency meter in parallel to the signal output socket. Adjust the signal generator to produce a sine wave output at 1kHz (use the 1kHz to 10kHz frequency range). Adjust VR6 for a pure sine wave output as viewed on the oscilloscope. This may be close to the position at which oscillation just ceases and it may be necessary to confirm that oscillation continues over the full frequency range of the instrument. With the output attenuator controls set at maximum, adjust VR8 and VR10 respectively for 2V pk-pk sine and square wave outputs as observed on the oscilloscope. Now set the frequency of the signal generator output accurately to 5kHz (again using the 1kHz to 10kHz frequency range). Set the function switch to ‘Frequency Out’ and adjust VR5 for a reading of exactly ‘5’ (on the ‘0–10’ meter scale). Vary the frequency over the full range and check that the meter indication agrees with the digital frequency meter reading. Repeat this check over the full range of the instrument and check that the accuracy is within 5% of full-scale on each range. Re-set the output frequency to 1kHz and check that the output is still 2V pk-pk. Set the function switch to ‘Voltage Out’ and select the ‘3V’ range with ‘pk-pk’ calibration. Adjust VR4 for a meter indication of ‘2’ (on the ‘0–3’ meter scale). Finally switch to ‘square’ wave output and adjust VR9 for a perfectly symmetrical square wave as displayed on the oscilloscope. This completes the calibration of the instrument and it is now ready for use.

USING IT

The Audio Tester is an instrument which allows the user to make a wide range of measurements on items of audio equipment and on whole systems. The capabilities of the constituent modules within the tester (signal generator, frequency meter, voltmeter, monitor amplifier, and load) do not, however, restrict their use solely to conventional audio applications. Individual modules, or combinations, may be used in a wide range of general applications which involve repetitive waveforms at frequencies up to 100kHz.

An example of this alternative use is in generating test signals for digital circuits. This requires the use of the signal generator and the monitor amplifier, with the frequency meter used to set the output frequency. The signal generator is capable of producing a signal of maximum amplitude of 2V pk-pk. The monitor amplifier can be used to boost the level to a maximum of approximately 9.5V pk-pk; the output is then taken from SK12 rather than SK3/4. Similarly, the frequency meter may be used directly to measure the frequency of digital signals.

When used in fault finding in audio systems, the Audio Tester modules can be used to replace system components when trying to identify the faulty unit. The signal generator is used to substitute for programme sources, the amplifier may be replaced by the monitor amplifier, and the dummy loads may be used in place of the loudspeakers. Continuity of leads can be checked using the signal generator as a signal source, and the voltmeter.

The mainstream purpose of the Audio Tester, however, remains the testing of audio circuits. The following section gives some examples of typical audio measurements which may be made using the Audio Tester.

The output of an audio amplifier is normally quoted in terms of the maximum power which it is capable of delivering continuously into a stated load at a particular frequency before the onset of any significant distortion. The actual values given will vary from model to model, and the method of quoting the performance usually varies among manufacturers. Typically, however, the output power is quoted in terms of the number of watts r.m.s. which can be delivered into an 8 ohm load at 1kHz at the onset of waveform clipping.
The loudspeaker, which forms the normal load in a hi-fi system, has an impedance which shows an often significant variation across the audio range (see Fig. 10). In addition, the impedance which is presented to the amplifier is rarely a purely resistive quantity, and this only serves to further complicate the measurement of output power when attempting to use a loudspeaker as a test load. The dummy loads in the audio tester, however, provide test loads which have substantially constant resistive impedances across the audio range. The impedances available (4 ohms, 8 ohms and 16 ohms) are suitable for the vast majority of contemporary audio equipment, and the various load connection arrangements are shown in detail in Fig. 12.

Where it is intended to carry out sustained high power testing, care should be taken to avoid the possibility of overheating of either the dummy loads (rated at a minimum of 30 watts r.m.s.) or the output stages of the amplifier under test. It may be advantageous, therefore, to increase the ventilation in the audio tester if sustained testing is envisaged since the load resistors will reach a temperature of 70°C at maximum dissipation. Driving both 8 ohm loads at full power simultaneously will require the dissipation of 60 watts of heat! It should also be borne in mind that the efficiency of the amplifier under test may fall significantly at frequencies above the audio spectrum (i.e. above approximately 20kHz), and this can lead to the possibility of unexpected amplifier over-heating. For this reason, a check that correctly rated line and output fuses have been fitted is a very worthwhile precaution before any prolonged high power testing; prevention is always cheaper than cure.

Fig. 13 shows an arrangement which can be used to measure the output power characteristics of an audio amplifier. The Audio Tester's dummy loads are used here in place of the loudspeaker, the signal generator provides the input signal, and the oscilloscope (or distortion meter, etc.) is used to detect the onset of waveform clipping. Fig. 14 shows the type of oscilloscope trace which is obtained when waveform clipping occurs; users who wish to observe these waveforms before testing an amplifier may do so by connecting the generator output, set to maximum sine wave output, to the monitor amplifier, and turning up the volume control while observing the output. In the test set-up the signal generator output should be connected to an 'auxiliary' or 'radio' amplifier input since these inputs should have a nominally flat frequency response. The generator output level should be set in accordance with the amplifier specifications (to typically 250mV or 500mV r.m.s.), and the frequency to 1kHz in sine wave mode. Starting at low amplifier volume control settings, the output power may be found by measuring the r.m.s. voltage across the load and then converting to power with the following equation:

\[
\text{Power in watts r.m.s.} = \frac{(\text{r.m.s. voltage across the load})^2}{\text{Load impedance in ohms}}
\]

Alternatively, the conversion from voltage to power may be performed using either the graphs in Fig. 15 or the figures given in Table 3. These give conversions for the three different load impedances catered for by the audio tester. Conversions for other loads may be prepared using the equation given above.

An interesting measurement which is easily made is to determine how the output power varies according to the setting of the volume control on the amplifier. The result, which is usefully plotted on a graph, can also be compared for different load impedances. It is a good idea to adjust the level from the signal generator so that, at maximum volume setting, the amplifier's rated power is achieved or clipping commences, whichever is sooner. The results can then be...
GENERATOR DISTORTION

The standard is usually considered by hi-fi enthusiasts to be a gain that should not vary by more than +1.5dB, although this standard specifies a range of 40Hz to 16kHz over which the all frequencies across the audio range. The DIN 45-500 pick-up in the wiring.

Pick-up on more sensitive inputs may be simplified by the use of an amplifier volume control to maximum. The signal generator's output level is equal to the amplifier input sensitivity. Measurements across the load, as determined by measuring the equivalent r.m.s. voltage. The signal generator output at this point is then slowly increased until the rated power is developed.

The measurement of the input sensitivity of an amplifier involves finding the lowest signal level at which it is still possible to achieve the maximum rated power into the stated load. This is a relatively simple test to perform and is often carried out at full output power. The frequency range between the upper and lower -3dB points (where the output power falls to 50% or the voltage across the load falls to 70-7% of the maximum) is known as the full power bandwidth of the amplifier. An equally useful measurement, and probably more appropriate to normal listening, is to measure the amplifier bandwidth at a level which is more representative of average listening levels. The high power level which is available from most systems is provided to allow programme peaks to be handled without distortion. The average level of even 'loud' music can be surprisingly low, and speech typically has a 'peak factor' (ratio of the peak to the r.m.s. value) over a period of time of 20dB. For these reasons, therefore, it is often of interest to measure both the full power bandwidth and the low power (typically 1 watt r.m.s.) bandwidth in order to fully characterise an amplifier; anyone in any doubt about power levels is invited to

Table 3 Voltage developed across a load and power

<table>
<thead>
<tr>
<th>Voltage across load (Volts r.m.s.)</th>
<th>Power (watts r.m.s.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4Ω load</td>
<td>8Ω load</td>
</tr>
<tr>
<td>1</td>
<td>0.250</td>
</tr>
<tr>
<td>2</td>
<td>1.00</td>
</tr>
<tr>
<td>3</td>
<td>2.25</td>
</tr>
<tr>
<td>4</td>
<td>4.00</td>
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<td>5</td>
<td>6.25</td>
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<tr>
<td>6</td>
<td>9.00</td>
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*Testing at this power level will require the use of alternative loads.
will typically show some variation across the audio range, constant, over the audio range and beyond. The output level of the selected test load. The generator frequency is then adjusted to produce the required power dissipation in accordance with the amplifier’s specifications, and the volume control is set to the ‘flat’ positions. The input level is set in accordance with what would normally require a number of separate instruments.

Once the basic frequency response characteristic has been measured, the effects of the amplifier’s tone controls can be investigated. Setting each of the tone controls to the extremes in turn, and then re-measuring the frequency response, will show the total range of bass and treble boost and cut which is available. Fig. 17 shows the type of response which can be expected in any amplifier, but the exact rates of boost and cut, and the associated frequencies will vary. The measurements on tone controls are best made at a level of around 1-2 watts in order to allow for the wide range of boost and cut provided on most amplifiers. Similar measurements may then be made on any fixed frequency filters which may be provided on the amplifier. Typical responses for an amplifier fitted with a ‘rumble’ filter at 45Hz and three ‘scratch’ filters at 7kHz, 12kHz, and 16kHz are shown in Fig. 18.

It is quickly apparent from a brief look through the specifications for any item of hi-fi equipment that the range of possible tests is almost inexhaustible. The measurements described above are a few examples of the range of amplifier tests which are possible with the Audio Tester. These tests provide useful and meaningful results without the need for an abundance of additional and sophisticated equipment. As such, they serve to demonstrate the usefulness of the Audio Tester as an item of general purpose test equipment. The constructor will doubtless be able to find a wide range of situations where the Audio Tester alone will suffice in place of what would normally require a number of separate instruments.

**Fig. 16. Frequency response at full power**

**Fig. 17. Tone control characteristics**

**Fig. 18. Response characteristics for an amplifier with a rumble and three scratch filters**
### ACTIVE COMPONENTS

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#### DIL SOCKETS LOW PROFILE

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#### LOW PROFILE - GOLD

| 6 pin | 0.22 | 8 pin | 0.25 | 14 pin | 0.27 | 16 pin | 0.29 | 18 pin | 0.33 |

#### UHF MODULATORS

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#### POPULAR HI-FI

- "Switching to the Minimaks from any of the others produced an open and natural sound as though something had been taken away. It had, the colouration had gone."
- Comparative test OCTOBER 1975.

#### HI-FI ANSWERS

- Their modest appearance and price disguise their startling abilities. Never have we heard such a small speaker sound so big!"
- JANUARY 1975.

#### PRACTICAL HI-FI & Audio

- "The depth, clarity and openness of sound produced is quite astonishing".
- JUNE '75

#### WHAT HI-FI

- "... the ability of the Mini-"

---

**NEW IMPROVED MINIMAX 2**

With the Minimax II, Videotone revolutionised the market by establishing an opening for small, high quality speakers. Natural evolution has brought about the new Minimax 2, retaining all the qualities of clarity and sensitivity. This ideal combination of size and performance is a proven success, acclaimed by the press and public for seven years.

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**WHAT HI-FI**

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CASIO, makers of those ingenious and reliable calculators, started to add musical bleeps to their machines a few years ago. Thus you could programme in a short, simple melody to annoy office colleagues! Perhaps we should have guessed what was coming next.

The idea was extended to something more musical when the Casio VL-Tone was introduced and featured in 'Tomorrow's World' early last year.

**VL-TONE**

Everything in this two-octave instrument derives from a 64-pin LSI chip which provides 5 pre-programmed voices. It is also possible to choose waveform, envelope parameters, vibrato and tremolo and programme these variables. Auto-rhythm, 100-note sequencing, stepping and a calculator are featured, the latter's display doubling as the toreadout of pitches entered from the keyboard.

The price of this keyboard, considering its many facilities, is very reasonable: the instrument is suitable for a young and enquiring mind getting used to music and its technicalities. Unfortunately, the keyboard is composed of press-buttons, its size is roughly one half of the standard and it only suits a small hand as a result.

My reaction at the time was that this instrument was an interesting toy (because of its keyboard) but that it might be the start of something big. It certainly seems that the VL-Tone was a test-bed and its popularity has been such that new and improved keyboards have followed.

As it is fitted with a pitch control but, oddly enough, somewhat larger keyboards (M-10, CT-201 and MT-30) lack this important feature and keyboards were still non-standard. Even so, they were often extremely close to concert pitch as supplied.

I suppose that these problems are inevitable when a concern—even as experienced as Casio—breaks into a new field. More recent additions to the Casio keyboard range have seen improvements to the point that we now have really interesting and totally playable instruments.

**COMPUTER**

These keyboards are occasionally described as polyphonic synthesizers. One immediately thinks of voltage-controlled circuitry but the heart of these instruments is a CPU so 'computer keyboard' may well be a better term. The attraction of the current keyboards, especially to those who have engaged in synthesizer construction in the past, is polyphony: eight notes may be keyed simultaneously.

It is probably unnecessary to add that it would be impossible to build similar keyboards—and at the price—because of the use of special purpose LSI chips!

Using computer principles is not new: the computer organ has been with us for some years and the RMI Computer Keyboard was described in this column six years ago. What is new is the value for money aspect and the neat but rugged design of these compact keyboards.

Let us look briefly at just three of the current keyboards:

**MODEL 202**

This instrument and Model 403 are similar in price and the choice between them will depend on musical requirements.

The 202 has 49 preset sounds, their names being inscribed above the keys of the four-octave polyphonic manual. Four Tone-Memory keys allow recall and changes of registration, the capture system operating as follows: in 'Set' mode, a tone-memory switch is pressed, followed by pressing the key representing the chosen tone-colour; after returning the mode switch to 'Play', the playing keys operate normally and the musician can make changes between the four memories as he wishes.

Sustain, Volume and degrees of Vibrato may be altered by means of controls on the left hand cheek. Alternatively, Sustain and Volume may be foot-controlled from jack sockets on the rear panel, which also include 'line out' for external amplification and a phone jack. A fine tuning control completes the back panel line-up.

An internal 4" speaker delivers up to 10W and the instrument weighs about 16lb. The preset sounds are varied and include various pianos and pipe organs and their electronic varieties. The usual orchestral instruments are featured and there are several harps and guitars. Certainly, it could be said that some of these sound similar to others, but there is still plenty of variety. With four octaves of polyphonic sound, the 202 could be used equally well by a choirmaster or pop musician.

**OPERATION**

Naturally, circuitry differs from model to model as do the LSI chips involved. Taking model 202 as being a typical and uncom-
right along the bar-code score: chord information is read in a similar manner. Audible indications tell the user whether the information has been accepted, or an error has arisen. Editing allows for changes in tone or error correction.

The chosen chords can be fingered or used in Autochord mode when the memory is being recalled. For the beginner, 'Melody Guide' can be used. This function causes the stored music to light i.e.d.s fitted above each playing key, inviting the learner to press the key: when he has done so, the next i.e.d. in the sequence lights. The usual jack sockets are fitted to the 701's back panel, including connection for the light pen. Two books of music and a wire stand are supplied with the keyboard: an optional pedalboard is available.

It is not possible to cover adequately all the features of these keyboards in this article. Take a look at them locally and I am sure you will agree that they are excellent value musically. And, unlike many VCOs, the tuning of the computer system is something easy to live with—in short, a quality product.

Casio has not entered the field of organ manufacture—which is already overcrowded—so far, but it is interesting to note the optional pedal board for Model CT-701. Bearing in mind what has already been achieved in a short time, the Casio organ may not be that far distant.
INSTANT SOUND DEVELOPMENT

The use of the AY-3-8912 or AY-3-8910 sound chip with the UK101 adds a new dimension particularly to games. Being such a versatile device employing 14 registers can sometimes mean that producing the exact sound you want is a lengthy process bogged down with bit-patterns and binary to decimal conversions to give the values to be POKEd into the registers. Ideally for sound development one would like to be able to call upon the resources of the device in a straightforward manner.

To this end a program has been written which uses the keyboard to control the sounds in much the same way as an audio mixer. Each of the three channels can be independently selected to contain tone, noise and envelope effects. Frequency sweeps can be carried out until the required sound has been produced. At this point another keypress gives a printout of register contents so that the same sound can be produced in any program. For complex sweeps the start and finish sounds can be printed out separately. It will be clear from the printouts how to program the sweep with a FOR...NEXT loop.

Recapping on what the chip is capable of: Each of the three channels can independently produce tone and/or noise. The tone generators can give different frequencies on each channel but there is only one noise generator which all channels must share. The amplitude of each channel can be set unless control of that channel is given to the envelope generator. The shape and period of the envelope can be specified.

Fig. 1 shows a simplified diagram of the generator showing the effect of selecting the various options in the program (T1, E1, N1 etc.). It also indicates where the period and amplitude controls fit into the system.

At program startup, all of these options are deselected and all the periods and amplitudes are set to zero. A single keypress will select an option and a second press will deselect again. A printout on the VDU shows the status of the device after each selection.

Envelope shape selection is by means of an increment key which steps through the ten profiles returning eventually back to the first again.

The use of the keyboard is shown below right. Below, right, are some examples which demonstrate how quickly different sounds can be demonstrated:

Three Examples

a) 5 second press on E1, N1. Two presses on N1. This gives you an ancient aeroplane whose engine speed can be controlled by E1 and N1.

b) 15 second press on T1, T2, N2, 10 second press on E1. This gives you a ancient aeroplane whose engine speed can be controlled by T1 and T2.

c) 7 second press on E1, N1, 4 presses on E1. E1 and you have a train which can be heard to pass by if E1 is held down. Fine tune the speed of the train with N1 and E1.

Lines 4-30

Set up constants. Sound = 61680, 61681.

4-30 Set up constants.

100-220 Scan keys 1-9 and select/deselect options

230 Increment envelope shape if "Q" pressed.

240-251 Increase/decrease envelope period.

300-380 Scan keys W to I.

400-480 Scan keys S to K.

1000-1099 Status printout.

2000 Delay to prevent too rapid response to option select.

3000-3031 Register printout of array X.

5000-5300 Put current values in array X prior to output to PSG.

5400 Output to PSG.

6000-6610 Calculate periods and amplitudes and output.

Fig. 1. Simplified diagram of the Sound Generator, and the key functions related to it.

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<td>GIVES A PRINTOUT OF THE CURRENT REGISTER VALUES.</td>
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KEYBOARD ANNUNCIATOR

Sir—When typing a program into the computer, I found it convenient to have the solid state annunciator "beep" to show that I had correctly entered a figure or letter, this saved me having to continually view the monitor screen for missed characters. It also proved useful in some animated games to have the "beep" function sounding for added interest.

The annunciator may be switched off by two methods. Firstly, by a switch in the 5 volt rail to the unit. If this is done, then R1, D9 and TR1 are not needed. The second method is to make use of the RTS line at Pin 6 of J2 on the rear of the computer board. For the RTS line to function, IC68 and associated components need to be fitted on the computer board.

On first switching on the computer the "beep" will not sound until the screen is cleared of the garbage with the Reset key, thereafter it will be actuated by any keystroke. To disable the "beep", the RTS line is actuated by typing POKE 61440,81. To return to "beep" mode just type POKE 61440,17.

The circuit is very simple, TR2, TR1, R2, and C1 form the oscillator circuit which drives the flat, disc-like, piezo-electric buzzer. Operating the keyboard puts a lower voltage on the cathode of one of the diodes D1 to D8, this switches TR3 on and puts about 4 volts on to the centre tap primary of a small audio output transformer, the secondary winding is not used. Capacitor C1 need not be fitted and is only fitted if the tonal quality does not suit the user's ear. A typical value of 100n or less may be used. Capacitor C1 need not be fitted and is only fitted if the tonal quality does not suit the user's ear. A typical value of 100n or less may be used.

TR1 is switched on by the command POKE 61440,81 and damps the oscillator circuit so that all can be heard is a faint click from the piezo stripboard buzzer. The circuit was built on a small piece of stripboard and stuck on to the computer board close to the "O" key with the piezo buzzer glued to a clear spot on the computer board.

Anthony Green A.S.M.
Hong Kong.

PRINT WITH FN

Sir—Here is a short routine which works on my UK101 with Wemon:

10 DEF FNA(A)=53194+X+(Y*64)
15 DEF FNB(A)=INT(FNA(A)/256)
20 DEF FNC(A)=FNA(A)-FNB(A)-*256
180 POKE 549, FNB(A)
720 POKE 512, FNC(A)

It demonstrates how you can PRINT on to any part of the screen using X/Y coordinates. Lines 10-20 need only be written once and the contents of line 100 need to be written just before each PRINT statement. Here is an example:

P. Beckett,
Blackpool.

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

Sir—For those who may not have the skill or the money to build a programmable sound generator, I have found a cheap and easy alternative. A great many weird and wonderful sounds can be heard by placing a small Medium Wave radio beside, or carefully on the computer itself and tuning it for the best results.

I myself use a cheap radio which I have placed on top of the Basic and Monitor ROMs which give excellent results on fast games such as Space Invaders and Gremilns. The different cycles set up for different routines inside the ROMs appear as audio signals on the radio.

Y. Gillihan, Sittingbourne, Kent.

**INITIAL SNAGS**

Sir—I think your readers might be interested in the following modifications to the UK101, if recently bought from Compshop with 2716 substitute chips, for the UK101 KEYBOARD GRAPHICS

1) The graphics program occupies 163 bytes and one zero page address at 00E7; and is located at 0235–0268. Unfortunately, the programming of the UK101's ROMs masks the MSB of all characters whilst loading, so a simple load routine must also be used, and occupies 24 bytes of RAM from 02D9–02DF. Both routines reside in an otherwise unused and protected area of RAM and are consequently unaffected by "Cold Starts".

The graphics routine is entered by changing the Input Vectors from FF8A to 0235, i.e. **POKE35,53; POKE35,72** (Note: both POKEs must be executed together).

The keyboard will still function as before, but on pressing CONTROL G, a display block will appear in the top right-hand corner of the screen. Any graphic character may now be obtained by a two-stage operation:

1) Select a letter (A–Z), which will be displayed within the display block. **RUBOUT** will delete this letter.

(1) The letters actually correspond with the vertical column of the UK101 character set published in the March 1980 edition of PE.

2) Select a number (0–9). The corresponding graphic character will be displayed. **RUBOUT** will delete the last entry.

Return will commit the BASIC line to memory and automatically exits the graphics routine. CONTROL C also exits the routine but enables the user to continue the program line using a "standard" keyboard. However, the input vectors remain unaffected and **CONTROL G** can be operated at any time.

Certain characters such as CR and LF can be used within program lines but they will produce error messages when loaded and should therefore be avoided unless a different form of load routine is used. Also, **NULL** is not displayed and causes subsequent characters to be deleted from that particular line.

As already stated, an additional LOAD routine must be used to retrieve recorded programs, due to the character mask of the UK101.

To place the routine in a LOAD mode enter:

**POKE35,53; POKE35,72**

The data from the cassette will be loaded as normal, but at the end of the listing the Reset keys must be operated and **Warm Start** selected (A Warm Start resets the Input Vectors to FF8A.)

It has already been mentioned that although CR/LF can be used within program lines, these lines will be rejected when loaded from cassette.

However, if we assume that CR/LF characters are always correctly enclosed by character string inverted commas, then loading is possible.

A suitable routine is provided and is located at 0235–0268 plus a zero page address at 00E7. The program initially searches for at least 12 consecutive NULLS, placed at the beginning of a program listing on tape, in order that the character string flag may be correctly set.

From then on, after every inverted comma, the routine accepts every character as a string rather than a control. Therefore, if the tape is halted within the program or a string exists without a terminating inverted comma, the LOAD routine may then be out of step with the character strings and subsequent error messages will result.

The routine is entered by:

**POKE35,53; POKE35,72**

and **RESET** must be operated at the end of the LOAD cycle.

In order to SAVE a program containing control characters, one must ensure that all character strings have their associated terminating inverted comma and the following line is added to the program:

**1 SAVE: FOR I = 1TO25:**

**PRINTCHR$(I); : NEXT:**

**(where N is the 1st program line to be SAVE())**

Then enter **RUN**, start the tape recorder and press **RETURN** to execute the SAVE.
Graphics Routine

0235 LDA AD 2AD0
0238 CMP A9 0C Graphics Block Present
023A BEQ F0 07 (0243) Get Key
023C JSR 20 00FD
023F CMP C9 07
0241 BNE D0 6D (02BO) Control “G”?
0243 JSR 20 C202 Display Graphics
0246 LDA A9 20 Blank Space
0248 STA 8D 74DD in “Graphics” Block
024B JSR 20 00FD Get Key
024E CMP C9 1C
0250 BEQ F0 5E (02BO) Rubout?
0252 CMP C9 20
0254 BEQ F0 41 (0297) Space?
0256 CMP A9 03
0258 BEQ F0 4D (02A7) Control “C”?-
025A CMP C9 0D
025C BEQ F0 45 (02A3) Return?
025E CMP C9 41
0260 BMI 30 E9 (024B) Key Valid?
0262 CMP C9 5B
0264 BPL 10 E5 (024B) Key Valid?
0266 STA 8D 74DD Display Key
0269 SEC 38
026A SBC E9 40 Determine
026C TAY A8 Correct
026D LDA A9 F5 Key Weighting
026F ADC 69 0A
0271 CLC 18
0272 DEY 88
0273 BNE D0 FA (026F)
0275 STA 85 E7 REM Key Value
0277 JSR 20 00FD Get Key
027A CMP C9 1C
027C BEQ F0 C8 (0246) Rubout?
027E CMP C9 20
0280 BEQ F0 15 (0297) Space?
0282 CMP C9 03
0284 BEQ F0 21 (02A7) Control “C”?-
0286 CMP C9 0D
0288 BEQ F0 19 (02A3) Return?
028A CMP C9 30
028C BMI 30 E9 (0277) Key Valid?
028E CMP C9 3A
0290 BPL 10 E5 (0277) Key Valid?
0292 SBC E9 2F Determine
0294 CLC 18 Correct
0295 ADC 65 E7 Key Weighting
0297 STA 95 13 Store Key Code
0299 JSR 20 E5A8 Display
029C INX E8 Cursor Pointer
029D LDA A9 00
029F CPX E0 47
02A1 BNE D0 0D (02B0) Max. Line Length?
02A3 LDA A9 0D
02A5 BNE D0 02 (02A9) Branch
02A7 LDA A9 00
02A9 LDA A9 00
02AA LDA A9 20
02AC JSR 20 B302 Clear Graphics Block
02AF PLA 68
02B0 RTS 60
02B1 LDA A9 0C
02B3 LDA A9 0C
02B5 STA 99 29D0 Graphics Block
02B8 STA 99 69D0
02BB STA 99 A9D0
02BE DEY 88
02BF BNE D0 F4 (02B3)
02C1 RTS 60
02C2 JSR 20 B102
02C5 LDY A0 08
02C7 LDA B9 D0D2

Simple Graphics Load Routine

02CA STA 99 6AD0 Graphics Message
02CD DEY 88
02CE BNE D0 F7 (02C7)
02DO RTS 60
02D1 47 52 41 50 48 49 43 53 GRAPHICS ASCII Characters

Graphics Load Routine (CR/LF + other control characters)

02D9 LDA AD 00F0 Cassette Port
02DC ROR 6A
02DD BCC 90 FA (02D9) Data Ready?
02DF LDA AD 01F0 GetData
02E2 CMP C9 0A
02E4 BEQ F0 F3 (02D9) LF?
02E6 CMP C9 00
02E8 BEQ F0 EF (02D9) NULL?
02EA CMP C9 0D
02EC BEQ F0 0F (02FD) CR?
02EE STA 9D CDD3 Display
02F1 STA 95 13 Store
02F3 INC EE 0002 Cursor Position
02F6 INX E8 Cursor Pointer
02F7 CPX E0 47 Max. Line Length?
02FB BNE D0 DE (02D9)
02FD RTS 60

REM To call Graphics Routine:
POKE356,53: POKE357,2
REM To call Graphics Load:
POKE356,217: POKE357,2
To enter Graphics Mode—Control G
To exit Graphics Mode—Control C
RETURN automatically exits and executes LF/CR
RUBOUT either deletes 1st letter entry or backspaces
SPACE continues to function correctly

Graphics Load Routine

0235 LDY A0 0C Set Tally
0237 DEY 88 Tally-1
0238 BNE D0 02 (023C) Tally=0?
023A STY 84 E0 Clear CR/LF Flag
023C LDA AD 00F0 Cassette Port
023F ROR 6A
0240 BCC 90 FA (023C) Data Ready?
0242 LDA AD 01F0 GetData
0245 BEQ F0 F0 (0237) NULL?
0247 TAY A8
0248 CPY C0 22
024A BNE D0 06 (0252) ??
024C LDA A5 E0
024E EOR 49 01 EX-OR CR/LF Flag
0250 STA 85 E0
0252 LDA A5 E0
0254 BNE D0 08 (025E) CR/LF Flag Set?
0256 CPY C0 0A
0258 BEQ F0 DB (0235) LF?
025A CPY C0 0D
025C BEQ F0 0B (0269) CR?
025E TYA 98
025F STA 95 13 Store Data
0261 JSR 20 E5A8 Display Data
0264 INX E8 Cursor Pointer
0265 CPX E0 47
0267 BNE D0 CC (0235) Max. Line Length?
0269 LDA A9 0D CR
026B RTS 60

REM To call Graphics Load Routine:
POKE356,53: POKE357,2
REM To Save Programs:
Line No. 2A
SAVE: FOR1=1 TO 2B: PRINTCHR$(0):: NEXT:

Practical Electronics August 1982
The VL-5 can read and store Casio's unique bar-coded music, or alternatively you can program the memory directly from the 3-octave keyboard. Select one of the 10 instrument voices and choose one of the 8 auto rhythms, then play back your stored melody by means of the One Key Play button, or the Auto Play button. The 4 note polyphonic voice keyboard can also be played manually.

With integral amplifier and speaker; Line Out and Headphone jacks; Sustain and Pitch control. Powered by 5 AA size batteries, or the optional mains adaptor, AD-1E (£5). Supplied with light pen, instruction manual and music paper. Dims: 33 x 320 x 86mm (1 1/4 x 12 3/8 x 3 5/8”). Weight 510g (18oz).

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CT-701 (£7) (£15) (£25) (£35)
CT-101 (£10) (£20) (£30)
CT-601 (£15) (£30) (£50)
MT-10 (£7) (£14) (£21)
VL-1 (£10) (£19) (£28)
VL-10 (£15) (£29) (£38)

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PLUS £10 worth of accessories FREE!

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12/24 hour time & calendar.
Time is always on display.
12/24 hour dual time.
Professional 1/100 stop-watch.
Optional hourly signal.
Daily alarm with pre-alarm.
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W-20

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This revolutionary new synthesizer has 10 superb preset instrument voices, PLUS switchable FFEET, ENVELOPE and MODULATION – the three elements of sound creativity – giving you 10 x 10 x 10 variations, numbered from 0 to 999. You can store up to 10 of your favourite sounds, in a battery protected memory, for instant selection.

The 5-octave, 8-note polyphonic keyboard can be split into two separate keyboards, with different preset voices.

In addition to a 16-step preset arpeggio, there is a programmable arpeggio function with up to 127 steps, 9 note pitches, and rests, which can also be used as a real time sequencer.

Frequency is displayed digitally, and the wide range pitch control allows transposition between -1 octave and +0.5 octave.

Complete with Sustain, and 3 Vibrato functions, etc; integral amplifier/speaker; Output and Headphone jacks; protective moulded end plates.

Dimensions: 117 x 916.5 x 363.5mm (4 1/2 x 36 x 141”). Weight 10kg (22lbs).

Casio's unique bar-coded music, or alternatively you can program the memory directly from the 3-octave keyboard. Select one of the 10 instrument voices and choose one of the 8 auto rhythms, then play back your stored melody by means of the One Key Play button, or the Auto Play button. The 4 note polyphonic voice keyboard can also be played manually.

With integral amplifier and speaker; Line Out and Headphone jacks; Sustain and Pitch control. Powered by 5 AA size batteries, or the optional mains adaptor, AD-1E (£5). Supplied with light pen, instruction manual and music paper. Dims: 33 x 320 x 86mm (1 1/4 x 12 3/8 x 3 5/8”). Weight 510g (18oz).

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and other edged parts. The theory is that this manoeuvring systems, the vertical stabiliser sensors and astronomical tasks.

There observation on the dark side of the vehicle. It was itself on the last shuttle mission. Photographs by a very high resolution radiometer operating for forecasts of flooding. The image is provided covered with tiles give off this glow when separating from the vehicle. It is believed when atomic oxygen. It is thought that the atomic photos as they slow down when separating from the vehicle. It is believed that all parts of the spacecraft which are covered with tiles give off this glow when facing into the velocity vector.

INSAT 1A SATELLITE TESTED IN ORBIT

The first pictures from the Indian satellite, a multipurpose spacecraft, indicated weather patterns over India and the surrounding oceans and land mass. This satellite will enable India to make observations for detailed forecasts of flooding. The image is provided by a very high resolution radiometer operating in the range 0.55-0.75 micrometres. There is also infrared imagery capability in the range 12-5 to 10-5 micrometres.

Most systems seem to be working according to the planned programme. It is however a disappointment that the solar sails were not able to be successfully deployed.

SOVIET ACTIVITIES

The Soviet Union have been active in orbits which can monitor happenings in the South Atlantic. It has been the custom by the Soviet Union to regularly use this region in order to replace spacecraft which become degraded. The task of surveillance is thus kept in continuing operation. A particular vehicle Cosmos-1355 was launched at 0953 GMT from Tyuratam on the 29th April. It was put into a 402 x 128-km orbit at an inclination of 65-1 deg. After the initial orbit was satisfactorily achieved it was put into a higher orbit of 459 x 438-km but in the original inclination. This would take it over the Falkland Islands.

SHUTTLE ORBITER

A new problem of natural science has shown itself on the last shuttle mission. Photographs show that the vehicle glows in the dark. It was an unexpected phenomenon and could give rise to adverse conditions when carrying out observation on the dark side of the vehicle. There are a number of planned optical payloads for observations on the dark side of each orbit. Also there are scheduled tasks involving infrared techniques, low level light sensors and astronomical tasks.

The glow appears on the edges of the manoeuvring systems, the vertical stabiliser and other edged parts. The theory is that this is a chemiluminescent effect caused by atomic oxygen. It is thought that the atomic oxygen impacting the vehicle builds up into molecules of oxygen and when these are shed they may give off photons as they slow down when separating from the vehicle. It is believed that all parts of the spacecraft which are covered with tiles give off this glow when facing into the velocity vector.

SHUTTLE CREWS

In accordance with the new policy to be adopted by NASA for the Shuttle Missions of the future, the next three crews have been named. For Mission 7 the commander will be Robert L. Crippen with Frederick H. Hauck as pilot. The Mission specialists will be John M. Fabian and the first woman astronaut Sally K. Ride. She has already gained much experience as a key communicator for shuttle crews from her post at the Johnson Spaceflight Centre. This shuttle will be named Challenger and is due for launch on a date in April 1983.

The payloads will be a pallet satellite from Germany, a Canadian communications satellite, Telstar-F, a second instrument package from the Office of Space and Terrestrial Applications and an Indonesian communications satellite, Palapa-B. The Mission will be for six days.

In July the shuttle Mission 8 will be launched with Richard H. Truly as commander and Daniel C. Brandenstein as pilot. The Mission specialists will be Dale A. Gardner and Guion S. Bluford, Jr. This will be a three day mission. On this flight there will be an Indian communications satellite, Insat-B, and a satellite from NASA for tracking and data relay named TDRS-B. This is the second and final part of a system for advanced voice control and data control between the orbiting shuttles and the mission control centres.

Mission 9 will be the European Spacelab. The date is set at September 1983. This will be a seven day mission. The commander will be John W. Young and the pilot Brewster H. Shaw, Jr. The two specialists will be Owen K. Garriot and Robert A. Parker. The payload specialists for this mission have not yet been released.

SALUT ACTIVITIES

Another cycle in the Soviet manned space station missions began with Salut 7. This is probably intended for the Soviet-French joint cosmonaut team which has been expected in June or July 1982. The orbital parameters are apogee -278km, perigee -219km, with a revolution period of 89.2 min. The inclination of the orbit is 51-6 deg. A Soviet team may visit the station before the joint mission takes place.

Meanwhile, Salut-6 remains docked with Cosmos 1,267 and will remain in orbit as a back-up for the joint mission. A progress supply vehicle is expected to visit the station between the inspection team and the final joint Soviet-French team.

Salut-7 will continue to test systems and space station equipment. This mission is controlled from the Moscow control centre and tracked by the research ship Sergey Korolev somewhere in the Atlantic.

It is worth remembering that the Soviet approach was, from the early days of space research, geared to space station technology. On the many occasions that invitations came from Kensington Gardens to attend film shows and discussion sessions there was always the same question put by the hosts 'which do you consider the best way to plan visits to the Moon and other planets'. Many of us were of the opinion that the two step method seemed the most economical. The concept is still the same but the method now is the Shuttle. A bias there are fewer invitations for such discussions now. The early dreams are somewhat later than was expected yet perhaps the improvements in the techniques have been worth it.

There is however another side to all this. At the moment the financial restraints are beginning to bite. The bite is indeed so great that there is a danger that a great deal of expertise and valuable data will be thrown away at a time when quite exceptional new knowledge is available for collection. Yet these are very successful units are to be axed. Axed for the want of funds so small when considered against the background of the whole of industry. Half a century of endeavour will be jettisoned at the very moment when the object of that endeavour is within reach.

Is it that the world has become so blasé that a football match is of more importance than an achievement which can contribute to the eradication of problems? Is it perhaps too much to expect that every thinking person should have some regard for the future and be willing to learn that their peace of mind and well being can be assured by wise use of the resources of the solar system? The exploitation of these resources for the benefit of the people of the solar system is, surely, a worthwhile goal. The sum of money required to continue is the cost of the annual operations to collect and analyse data which cannot be repeated perhaps for as much as a hundred years, yet that cost is less than the cost of an airplane for weather research.

PIONEER 10 AND 11

The principal objects which technology has put into space and which have given returns so far which exceed by a great margin the design expectations, are the spacecraft Pioneer 10 and 11. The chronicle of what has been achieved and the impact made on even general knowledge is immense. Part of the next SPACETRACK will be devoted to a survey of the accomplishments such as the accurate survey of the magnetic field of Jupiter; determination of the distribution of high energy particles in Jupiter's magnetosphere (including an explanation of the source of Jupiter's previously known decimetric radio emission); discovery of adsorption effects of the Galilean satellites; discovery of the planet's magnetodisc and many contributions to understanding the sources; and the physical dynamics of charged particles trapped in the planet's magnetic field.

In the present time both these craft are in the outer areas of the solar system and moving out in opposite directions. By 1990 Pioneer 10 will be in the interstellar medium and still healthy.

Frank W. Hyde
COURTESY LIGHT DELAY

With this circuit, when a door is opened and the ignition turned off, in either order, capacitor C1 is discharged through switch S1 via diode D1 and transistor TR2 is turned off. When the door is closed, switch S1 opens and transistor TR1 conducts the lamp current since its gate is held at +12V via resistor R1. The potential drop across transistor TR1 causes capacitor C1 to charge through resistor R2. As the potential across capacitor C1 increases transistor TR2 begins to conduct and the potential at). The output of IC1 goes high releasing the reset hold on the oscillator IC2. The tone output of this is fed, via C4 and R7, to the microphone input. TR2 inverts IC1 output and uses it to hold down the ptt line. C5/VR1 ensure ptt goes high again, switching off the transmitter, just before IC1 completes its monostable action, thus ensuring it does not retrigger itself. R4/C2 will set the monostable time. R5/R6/C3 set the frequency of the tone. Finally, VR1 is set to maximum then backed off, whilst keying the transmitter on and off, until IC1 stops retrigging itself. S1 (on/off) holds down the reset on IC1 disabling the circuit. I rewired the channel 9/off switch on my radios to accomplish this. Vcc may vary from radio to radio so some experimentation may be necessary with the CR times.

CB ‘ROGER BLEEP’

This circuit has been used in conjunction with my CB radios for some three months now. It produces a short burst of tone, on releasing the transmit switch, whilst also holding the radio in the transmit mode for the duration of the tone. I have found it very useful for communicating over a distance when the signals are weak and barely audible in that it gives a positive indication of when one party has ceased transmission.

Apart from supply and ground, there are two connections to the radio. One is the ‘press to talk’ (ptt) line and the other is the microphone input to the radio. In order to transmit, the ptt line is grounded. On releasing the transmit switch the line moves to nearly Vcc. TR1 and its CR input converts this voltage change into a pulse, inverts it and triggers the monostable IC1. The output of IC1 goes high releasing the reset hold on the oscillator IC2. The tone output of this is fed, via C4 and R7, to the microphone input. TR2 inverts IC1 output and uses it to hold down the ptt line. C5/VR1 ensure ptt goes high again, switching off the transmitter, just before IC1 completes its monostable action, thus ensuring it does not retrigger itself. R4/C2 will set the monostable time. R5/R6/C3 set the frequency of the tone. Finally, VR1 is set to maximum then backed off, whilst keying the transmitter on and off, until IC1 stops retrigging itself. S1 (on/off) holds down the reset on IC1 disabling the circuit. I rewired the channel 9/off switch on my radios to accomplish this. Vcc may vary from radio to radio so some experimentation may be necessary with the CR times.

G. H. Wostenholm,
Manchester.

C. J. Lawrie,
Norwich, Norfolk.
The thumps, hisses and crackles that emerge from the speakers as most audio amplifiers are switched on and off are annoying and probably damaging. These noises arise from several sources, although the biggest offenders are capacitors which give rise to current surges as they charge and discharge.

It is desirable to prevent these from reaching the speakers and the easiest way to do this is to connect a relay in series with the amplifier outputs. This relay should close (connecting the speakers) about five seconds after switch on and open immediately after switch off. The circuit described here performs this function at a reasonably low cost, and is, above all, easy to connect to an existing amplifier. Apart from the relay only three connections are required, these being two a.c. lines and a centre tap.

An unrectified a.c. supply with a centre tap is required from the amplifier. The exact voltage is unimportant, but at least 15 volts must be available.

The a.c. supply is rectified by D1 and D2. The unsmoothed d.c. is passed via the current limiting resistor R1 to the power down detector. D3 allows C1 and R2 to develop a very rough d.c. voltage clamped by D4 at 10 volts. This d.c. voltage decays very rapidly (in less than 15 ms) when the power is removed. As a result pin 6 of the i.c. will be high for five seconds after switch on and immediately after switch off. A Schmitt trigger follows because the inputs to the gate are slow edged and the output will be prone to jitter. The Schmitt trigger is composed of gates b and c, R5 and R6. The values of resistor have been chosen to give hysteresis between \( \frac{1}{2} \) and \( \frac{3}{4} \) of the gate threshold.

The output from the trigger is inverted by gate d and drives the relay by means of the Darlington pair TR1 and TR2. Any back e.m.f. from the relay is caught by D8.

The relay used is a 2-pole heavy duty continental type. This relay will be suitable for all amplifiers with up to 27 volt a.c. supplies (indicating an amplifier of greater than 33 watts per channel output). A printed circuit board socket must be purchased with the relay.

For larger amplifiers a member of the Octal series is recommended, and the 48 volt version is generally suitable. This relay will not fit onto the circuit board and must be connected using flying leads from the relay drive points marked on the p.c.b. If R8 and R9 (see below) are not required, the end of the p.c.b. is redundant and may be cut off.

If the d.c. voltage on C2 is likely to exceed 63 volts, a 100 volt version must be used for C2 and a 560 ohm 1 watt resistor connected in series with the relay coil. It is assumed that if this is the case the "Octal" style relay will be used as a matter of course.

If the amplifier is d.c. coupled (i.e. has no output capacitor) then R8 and R9 may be omitted. However, an a.c. coupled amplifier must be provided with a means to allow the output capacitors to charge up. In this case R8 and R9 must be installed—a value of 8 ohms will do for all amplifiers. The resistors should be at least 3 watt wire wound types.

It is quite probable that the amplifier will have some resistors already present to attenuate the headphone signals. It is quite convenient to use these. Indeed, a small modification to the circuit allows the relay to be used as a headphone switch or a convenient mute system.

I. C. Lare, B.Sc., M.Sc.,
Hartford, Cheshire.
ICE WARNING

British patent application 2 083 244, from Damien McDonnell of Malvern, Worcestershire, gives full technical details of a new development from the Royal Signals and Radar Establishment in Malvern. The idea is to replace existing road cat's eyes with a new type which use the temperature sensitivity of a liquid crystal material to give a tell-tale of road conditions. For instance above 0°C the cat's eye reflects blue light, but as the temperature drops to 0°C and below the colour changes through green and yellow to red. In this way a car driver knows whether there is likely to be black ice on the road. The invention is particularly interesting because it ties in with other work on liquid crystals which is going on at Malvern.

Much of the pioneering work on liquid crystal displays was carried out at Malvern. Even now many Japanese companies buy their liquid crystal raw materials from British companies, such as BDH of Poole. (It is a tragedy that Britain, having developed liquid crystal technology, never took advantage of the lead and left the mass production of finished liquid crystal displays to Japan.) Several Japanese companies, for instance Hitachi and Toshiba, have already demonstrated prototype pocket tv sets which use a liquid crystal display for the screen. Until recently it had been supposed that I.C.D.s, which modify the play for the screen. Until recently companies, for instance Hitachi and Toshiba, have already demonstrated prototype liquid crystal displays was carried out at Malvern.

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FM NOISE ELIMINATION

The Clarion Company of Tokyo has two liquid crystal layers 20 and 36 are sandwiched between Mylar sheets. Front layer 36 is clear above 0°C, but turns red below freezing point. The rear layer 20 changes its colour at temperatures above 0°C. So coloured light from the rear layer 20 is seen through layer 36 while it remains clear. Then the front layer takes over as the active element. In this way a much wider range of colour changes can be produced. This suggests one line of approach towards producing a full spectrum of colour from an I.C.D. tv screen.

path is earthed by gate 10. Capacitor 6 charges with L+R, and current flows through resonance circuits 7 and 8 which store the pilot tone and carrier signal energy. Only the signal from the second path reached combiner 5. When noise is detected at 9, gate 10 changes state and the charge on capacitor 6 is cancelled by the phase-inverted signal from circuit 2. Simultaneously, resonance circuits 7, 8 release their stored energy to cancel the pilot tone and sub-carrier. Hence only the noise components are faithfully transmitted to input 5a of the combiner 5 while the complete stereo signal is applied to terminal 5b. Because the noise is phase inverted it is cancelled out across resistor 5 and a noise-free output is derived. There is no circuit element connected to the second signal path so the noise reduction circuit should have no effect on phase and amplitude of the stereo signal.
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Practical Electronics August 1982
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<td>515</td>
<td>100</td>
<td>1 Megohm Resistors</td>
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<td>520</td>
<td>2pc</td>
<td>4.7mm Twist bit</td>
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<td>520</td>
<td>1pc</td>
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<td>1pc</td>
<td>PCB Drill Kit</td>
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