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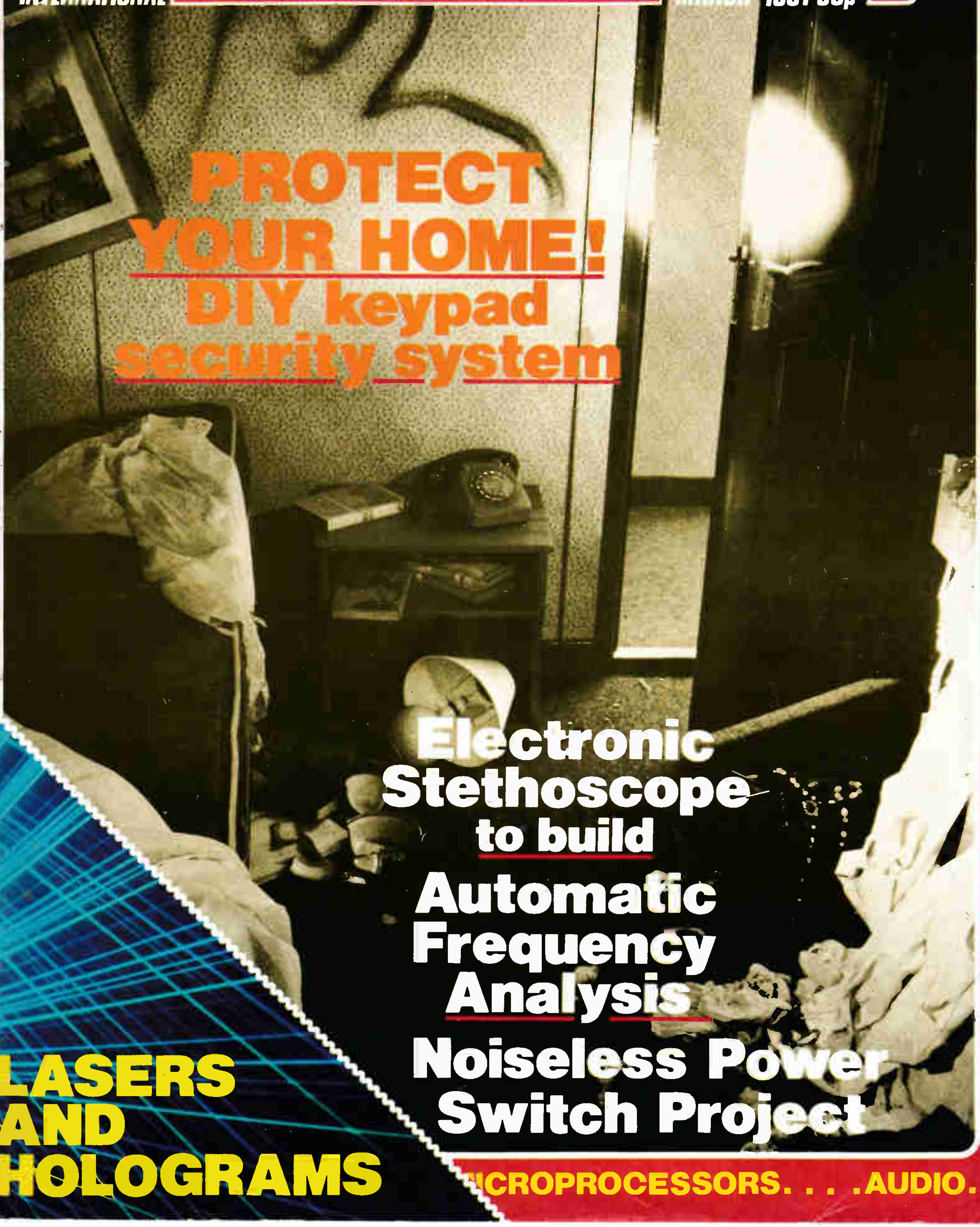
electronics today INTERNATIONAL

MARCH 1981 65p



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Electronic Stethoscope to build

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MICROPROCESSORS. . . .AUDIO. .

TRANSCENDENT POLYSYNTH

By brilliant design work and the use of high technology components the Polysynth brings to the reach of the home constructor a machine whose versatility and range of sounds is matched only by ready built equipment costing thousands of pounds. Designed by synthesizer expert Tim Orr and being featured in this issue of Electronics Today International, this latest addition to the famous Transcendent family is a 4 octave (transposable over 7½ octaves) polyphonic synthesizer with internally up to 4 voices making it possible to play simultaneously up to 4 notes. Whereas conventional synthesizers handle only one at a time.

The basic instrument is supplied with 1 voice and up to 3 more may be plugged in. A further 4 voices may be added by connecting to an expander unit, the metalwork and woodwork of which is designed for side by side matching with the main instrument. Each voice is a complete synthesizer in itself with 2 VCOs, 2 ADSRs, a VCA and a VCF (requiring only control voltages and a power supply, the voice boards are also suitable for modular 12 systems). One of these voices is automatically allocated to a key as it is operated. There are separate tuning controls for each VCO of each voice. All other controls are common to all the voices for ease of control and to ensure consistency between the voices.

Although using very advanced electronics the kit is mechanically very simple with minimal wiring, most of which is with ribbon cable connectors. All controls are PCB mounted and the voice boards fit with PCB mounted plugs and sockets. The kit includes fully finished metalwork, solid teak cabinet, professional quality components (resistors 2% metal oxide or metal film of 0.5% and 0.1%), nuts, bolts, etc.

EXPANDABLE POLYPHONIC SYNTHESIZER

COMPLETE KIT

ONLY

£320 + VAT

(Single voice)

Plug in extra Voices — Kit price £52 + VAT (£48 + VAT if ordered with kit)

Cabinet size 31.1" x 19.6" x 7.6" rear 3.4" front

Kit also available as separate packs

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30 ppm multilayer ceramic cap	£0.50

ICs and details of all packs in our

FREE CATALOGUE

Pack		Price
POLY 1	Pair of PCB's for multiplex cct K B contacts	£9.50
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POLY 4	Contacts & bus bars	£12.00
POLY 5	Double sided plated through PCB for digital control & pitch/gate generator cct	£17.25
POLY 6	Rs, Cs, heat sink for fitting to Pack 5	£10.50
POLY 7	IC's, IC sockets, diodes for fitting to Pack 5	£31.30
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POLY 10	IC's IC sockets, Trs, heat sinks for mother board	£13.10
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POLY 14	PCB for VOICE controls	£6.80
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POLY 24	Solid teak cabinet	£25.80
Total cost for individually purchased packs for single voice instrument		£355.15
Complete kit for 4 voice expander including connectors		**£295.00**

All prices VAT exclusive.

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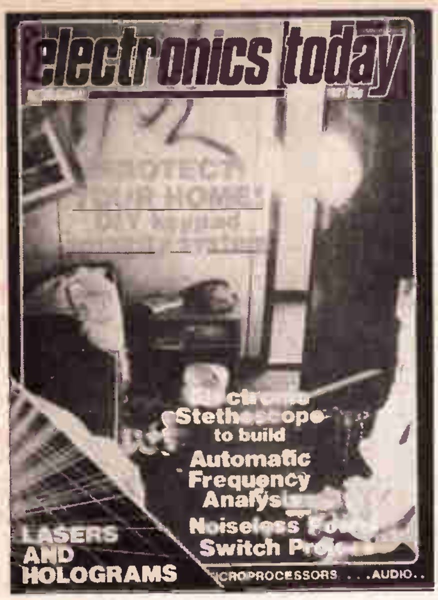
EXPORT ORDERS: No VAT Postage charged at actual cost plus £1 handling and documentation

U.K. ORDERS: Subject to 15% surcharge for VAT No charge is made for carriage, or at current rate if changed

SECURICOR DELIVERY: For this optional service (U K mainland only) add £2 50 (VAT inclusive) per kit

SALES COUNTER: If you prefer to collect kit from the factory, call at Sales Counter Open 9a m 12 noon, 1 4 30p m Monday Thursday

MANY MORE KITS ON PAGE 8



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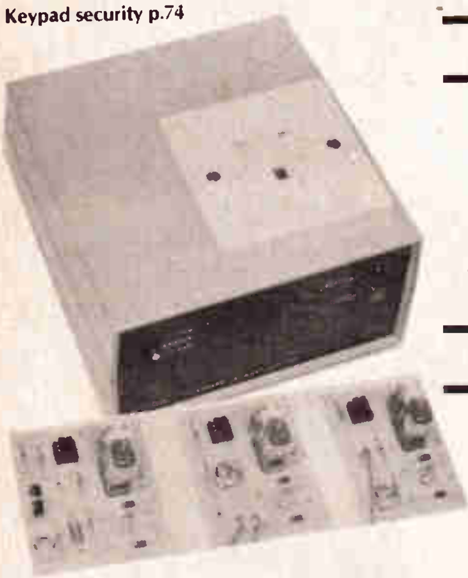

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MARCH 1981 VOL 10 NO 3

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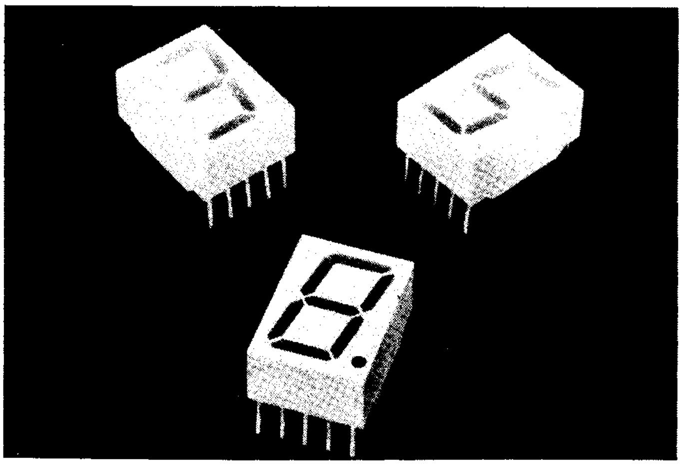


½ Inch Blinders

Hewlett Packard's new 0.56" high seven-segment displays should come with a free tube of suntan oil. They're made to be read clearly at up to 23 feet away. The HPSD 5300 to 5800 family are the brightest HP displays to date, available in red, high efficiency red, yellow or green. The new devices, although featuring a larger display, are packaged in the same size unit as the previous 0.43" display, enabling equipment to be easily uprated. The package features industry standard lead spacings and the devices are fully TTL compatible.

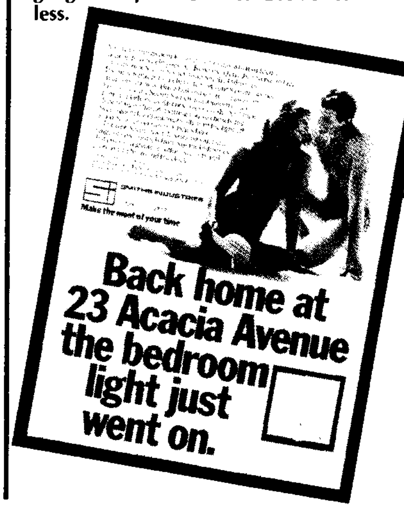
For further information on the HPSD 5300 to 5800 family of high brightness displays, contact Jermyn Distribution, Vestry Estate, Sevenoaks, Kent.

Security Switching

You can give your home or office that 'lived in' look even if you're a thousand miles away by installing the latest automatic light switch from Smiths.

The Securiswitch, which will switch 40-300 W loads, simply replaces an existing wall-mounted light switch and offers both normal on/off switching and a timed automatic function. On auto, the switch is triggered at dusk by a built-in photocell. You can then set it to switch off again after a delay variable from one to seven hours. It then resets for operation during the next dark period. However, shadows or dull periods during the day will not trigger the switch because of an integral delay facility designed to prevent such erroneous switching. For additional security, the switch-off time also varies by a random margin around the set period (up to 10 minutes for each hour set). A 12 V DC version, for use in caravans, boats and mobile homes, should be in the shops soon.

You should be able to buy Smiths Industries Time Controls' Securiswitch in your local clever gadgets department for £10.75 or less.



Hello Sailor!

A new voice recognition unit has been introduced into the system developed by Siemens and Computer Analysts and Programmers (CAP) for using Prestel at sea. The new adaptation is called Seaview and has involved the Post Office, the Home Office, the Departments of Trade and Industry and Liverpool Polytechnic in the collation of data and the design of its basic system. Seaview uses 150 of the 165,000 page capacity of Prestel. Its first trials were carried out off Dover last year, its main function being to supply officers with immediate access to information which is available to shore-based users. The voice recognition unit is made by Threshold Technology of the US, a part-owned subsidiary of Siemens, and converts the voice patterns of human speech into digital code which activates the computer control unit. The software written by CAP converts these into signals that activate the Prestel system. Each user records 240 sounds or words on magnetic tape. To allow for variations in tone or inflexion these are then recorded 10 separate times. Security levels are, according to the designers, very high. The 240 words can then be fed into the system in two different ways. A word can either appear directly on the screen or it can be used in conjunction with an intermediate storage or buffer to trigger other words or information. Its application was recently tested when the command word 'Dover' was used, which resulted in the presentation on the screen of all the information within the Prestel system on the Dover coastline. The designers are confident of its widespread uses and adaptations. Prestel currently has just under 7,000 subscribers.

Fotoboards

Marshall's, a household name in electronic component supply, are now stocking a competitively priced range of pre-sensitised PCBs, called Fotoboards. Single and double-sided boards (both 1.6 mm thick) are available. They are supplied with a protective peel-off plastic sheet and require 10 minutes in an ultra-violet exposure unit or a day out in the back garden under that great UV radiator in the sky. Marshall's can also supply a suitable UV exposure unit kit for £34.50 (or £19.50 without box and 9" x 6" glass screen), Fotoboard developer (to callers only), drafting sheet (0.1 matrix), track, transfers and developing trays. Contact any of Marshall's shops for latest prices.

Gold Scope

The Thandar SC110 portable oscilloscope from Sinclair Electronics Ltd was the only British product to win a gold medal at the 1980 BRNO Trade Fair in Czechoslovakia, the largest Eastern European trade fair. Of the several thousand exhibitors and their products, only forty were awarded gold medals.

The SC110 weighs in at only 2½ lbs with its 2" CRT and is designed to fit inside a briefcase or toolkit. It's a single trace, 10 MHz bandwidth and 10 mV sensitivity instrument featuring low power consumption mains/battery operation.

For more information on the SC110 and other Thandar products, contact Sinclair Electronics, London Road, Huntingdon, Cambs. PE17 4HJ.

Rent-A-Camera

Rediffusion, the High Street TV rental chain, are opening 22 video centres all over the country, from Aberdeen to Brighton. In addition to the Rediffusion range of television sets (including Viewdata and Teletext models) and audio equipment, the centres will stock video recorders, portable video cameras and tuners. A complete package of recording equipment will be available on short term rental — a Hitachi colour video camera, a portable VTR, a video tuner and a rechargeable battery pack.

The camera can be used with a built-in or an external microphone. A fully charged battery will given an hour's shooting. It's also possible to operate the unit from a car battery.

Rediffusion is also launching a VHS video cassette library. Major feature films will be available for sale or rental. This scheme will be extended to several hundred of the group's 450 shops. Each cassette will be yours for three days for a rental charge of £4.95. About 25 films will be available immediately with the addition of three or four new titles each month. The first batch of films to be made available offers something for almost everyone — from Swallows and Amazons to The Stud and The Bitch ..... and from Tales of Beatrix Potter to Blondie.

Prestel Price-cutter

Zycor's new adaptor converts an ordinary TV set into a Prestel terminal for less than £200. The microprocessor-based adaptor, the Teledek 2000, has been developed at a cost of over £100,000, exclusive of Department of Industry support, with export in mind. Information can be displayed in German and Swedish and it will produce VHF signals and a range of UHF signals in addition to those used in the UK. It can be powered from UK, European, US or Australian mains supply voltages.

Screen information can also be output to a printer and to a domestic tape recorder. Teledek 2000 can also be used with TV monitors and receivers such as Thorn TX, which allows the tube to be connected directly to the adaptor.

The handheld keypad operates remotely by infra-red at up to 9 m. It has 12 data keys and four control keys. A directly wired keyboard with a full alpha-numeric character set is also available.

For further information on Teledek 2000 contact Zycor Ltd, 33 Fortess Road, London NW5 1AD.

Cream Of The Movies

Cream Mail Order Movies came into being at the end of 1980. They're in the business of bringing the big box office movies into your living room with their purchase and exchange video cassette service. Buy one cassette for £39.50 plus post (VHS and Betamax available). During the next three months you can exchange your cassette for another Cream movie for £7.95 plus post.

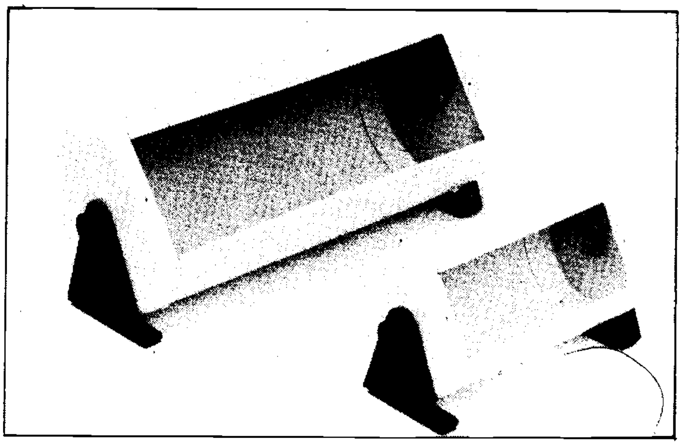
Cream's initial selection of 64 titles includes everything from Jaws to Barbarella and The French Connection to the Exorcist...... plus a selection of children's movies and music cassettes (La Traviatta, Blondie, Jesus Christ Superstar, etc.)

Cream have prepared a full colour leaflet listing all the films available and giving full details of their purchase/exchange scheme. It is available from Cream Mail Order Movies Ltd, The Cloisters, 11 Salem Road, London W2 4BU.

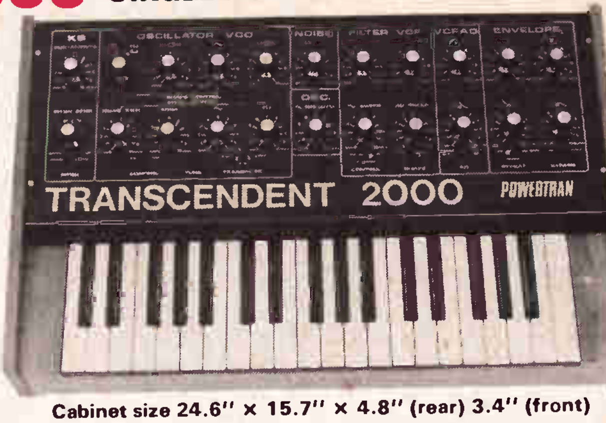
Case In The Round

Daturr Ltd have just introduced an unusual product — the Orbix rotary electronic case. Orbix is steel, round, swivels, locks into position every 15° and can be wall mounted, suspended from the ceiling or plonked on top of your desk.

The system includes case, rear panel/rear panel with opening, two feet, two knurled screws and four adhesive feet. The range of accessories features an anti-dazzle mask to facilitate reading LED displays. The standard colour is beige, but alternative colours are available from Daturr Ltd, Unit E, Roan Industrial Estate, Mortimer Road, Mitcham, Surrey CR4 3HS.



TRANSCENDENT 2000 SINGLE BOARD SYNTHESIZER



Deigned by consultant Tim Orr (formerly synthesizer designer for EMS Ltd.) and featured as a constructional article in ETI, this live performance synthesizer is a 3 octave instrument transposable 2 octaves up or down giving sweep control, a noise generator and an ADSR envelope shaper. There is also a slow oscillator, a new pitch detector, ADSR repeat, sample and hold, and special circuitry with precision components to ensure tuning stability amongst its many features.

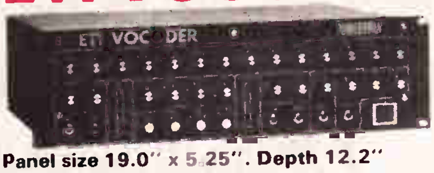
The kit includes fully finished metalwork, fully assembled solid teak cabinet, filter sweep pedal, professional quality components (all resistors either 2% metal oxide or ½% metal film), and it really is complete — right down to the last nut and bolt and last piece of wire! There is even a 13A plug in the kit — you need buy absolutely no more parts before plugging in and making great music! Virtually all the components are on the one professional quality fibreglass PCB printed with component locations. All the controls mount directly on the main board, all connections to the board are made with connector plugs and construction is so simple it can be built in a few evenings by almost anyone capable of neat soldering! When finished you will possess a synthesizer comparable in performance and quality with ready-built units selling for many times the price.

Comprehensive handbook supplied with all complete kits! This fully describes construction and tells you how to set up your synthesizer with nothing more elaborate than a multi-meter and a pair of ears!

COMPLETE KIT ONLY £168.50 + VAT!

Cabinet size 24.6" × 15.7" × 4.8" (rear) 3.4" (front)

ETI VOCODER



Panel size 19.0" x 5.25". Depth 12.2"

14 CHANNELS!
NOISE GENERATOR!
LED PPM METERS!
SLEW RATE CONTROL!
2 OSCILLATORS!
VOICED/UNVOICED DETECTOR!

COMPLETE KIT ONLY £195 + VAT!

Kit includes FREE foot control and test oscillator!

Put speech and the output of an instrument onto the Vocoder and the instrument not the operator now appears to be doing the talking or singing! You now have vocal control of the amplitude and harmonic control of the instrument!

Use the internal excitation oscillators, change the frequency and the speaker suddenly changes sex!

Use the noise generator and there is whispering in the breeze!

Use the output of a cassette deck and the London Symphony Orchestra recites from the Kama Sutra!

Just a few of the possibilities!

If the variations in amplitude and harmonic content of an audio signal can be analysed and applied to suitable electronic control circuitry then the basic sounds of speech can be substituted for by almost anything and this is just what a vocoder does.

Featured as a construction article in **Electronics Today International** this design enables a vocoder of great versatility and high intelligibility to be built for an amazingly low price.

14 channels are used to achieve its high intelligibility, each channel having its own level control. There are two input amplifiers, one for speech either from microphone or a high level source e.g. mixer or cassette deck and one for external excitation (the substitution signal) from either high or low level sources. Each amplifier has its own lever control and a rather special type of tone control giving varying degrees of bass boost with treble cut or treble boost with bass cut. The level of the speech and excitation signals are monitored by LED PPM meters with 10 lights — 7 green and 3 red which indicate the level at 3dB steps. There are three internal sources of excitation — a noise generator and two pulse generators of variable frequency and pulse width. Any of the internal sources and the external source can be mixed together. There is a voiced/unvoiced detector which substitutes noise for the excitation signal at the points in speech where the vocal chord derived sounds of the speaker are substituted for by the unvoiced sounds of sibilants, etc There is a slew rate control which smooths out the changes in spectral balance and amplitude enabling a change of the speech into singing or chanting and other special effects. A foot switch is provided to permit a complete freeze in spectral balance and amplitude whenever required. An LED on this indicates when the freeze is in operation.

An output mixer allows mixing of the speech, external excitation and vocoder output. The majority of the components fit into the large analysis/synthesis board with the rest on 8 much smaller boards with the controls and sockets mounted on them for ease of construction. Connectors are used for the small amount of wiring between the boards.

The kit includes fully finished metalwork, professional quality components (all resistors 2% metal oxide) nuts, bolts, etc. — even a 13A plug!

TRANSCENDENT DPX MULTI-VOICE SYNTHESIZER

Another superb design by synthesizer expert Tim Orr published in Electronics Today International

COMPLETE KIT ONLY £299 + VAT!

Cabinet size 36.3" × 15.0" × 5.0" (rear) 3.3" (front)

The Transcendent DPX is a really versatile 5 octave keyboard instrument. These are two audio outputs which can be used simultaneously. On the first there is a beautiful harpsichord or reed sound—fully polyphonic, i.e. you can play chords with as many notes as you like. On the second output there is a wide range of different voices, still fully polyphonic. It can be a straightforward piano as a honky tonk piano or even a mixture of the two! Alternatively you can play strings over the whole range of the keyboard or brass over the whole range of the keyboard or should you prefer — strings on the top of the keyboard and brass as the lower end (the keyboard is electronically split after the first two octaves) or vice-versa or even a combination of strings and brass sounds simultaneously. And on all voices you can switch in circuitry to make the keyboard touch sensitive! The harder you press down a key the louder it sounds — just like an acoustic piano. The digitally controlled multiplexed system makes practical touch sensitivity with the complex dynamics law necessary for a high degree of realism.

There is a master volume and tone control, a separate control for the brass sounds and also a vibrato circuit with variable depth control together with a variable delay control so that the vibrator comes in only after waiting a short time after the note is struck for even more realistic string sounds.

To add interest to the sounds and make them more natural there is a chorus/ensemble unit which is a complex phasing system using CCD (charge coupled device) analogue delay lines. The overall effect of this is similar to that of several acoustic instruments playing the same piece of music. The ensemble circuitry can be switched in with either strong or mild effects.

As the system is based on digital circuitry digital data can be easily taken to and from a computer (for storing and playing back accompaniments with or without pitch or key change, computer composing, etc., etc.).

Although the DPX is an advanced design using a very large amount of circuitry, much of it very sophisticated the kit is mechanically extremely simple with excellent access to all the circuit boards which interconnect with multiway connectors. just four of which are removed to separate the keyboard circuitry and the panel circuitry from the main circuitry in the cabinet.

The kit includes fully finished metalwork, solid teak cabinet professional quality components (all resistors 2% metal oxide) nuts, bolts etc. even a 13A plug!

POWERTRAN

MANY MORE KITS ON PAGE 96. MORE KITS AND ORDERING INFORMATION ON INSIDE FRONT COVER

All projects on this page can be purchased as separate packs, e.g. PCBs, components sets, hardware sets, etc. See our free catalogue for full details and prices

electronics today INTERNATIONAL
APRIL 1981

NEXT MONTH

The Sub-Atomic Story

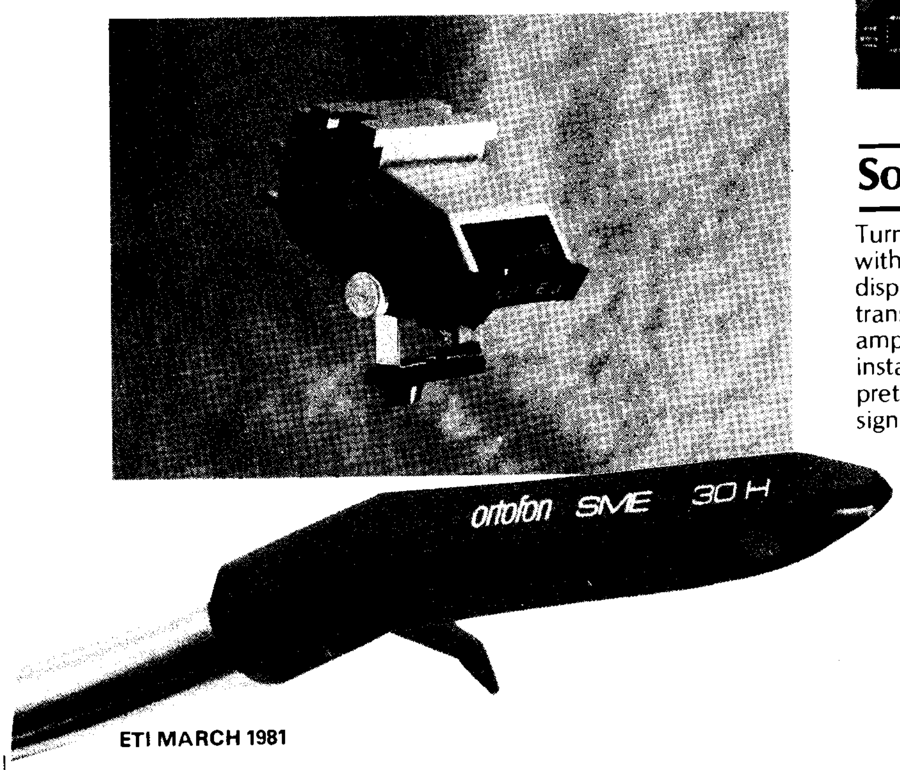
Once upon a Victorian time, physics was a relatively uncomplicated pursuit. It seemed to be just a matter of time before all the laws of nature would be discovered and fully investigated. Matter was made from microscopic billiard balls — protons and electrons. This century, however (particularly during the inter-war years), mesons, kaons, sigmas, neutrinos and their anti-particles began popping out of the woodwork. A.S. Lipson describes the trials and tribulations of the physicists who had to make sense of it all.

Low Ohmmeter

Measuring miniscule resistances accurately can be almost impossible with your common or garden test meter. The resistance range copes happily with resistances most often used — from 1k0 to several tens of kilohms. However, if you want to check that you've got a 1R0 resistor on your bench and not a 0R5 or 10R, the chances are that your meter will give up. Look out for the ETI Low Ohmmeter, designed with remarkably reduced resistances in mind.

Pick-Up Principles

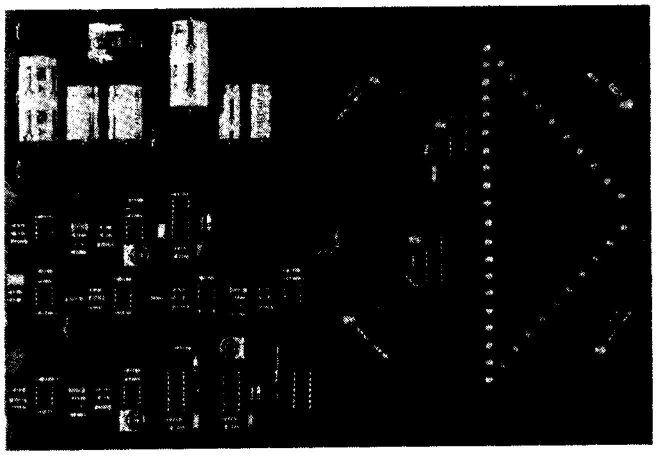
Time was when a copper needle did the trick. When you walk into your local hi-fi shop and gaze at the hundreds of cartridges available, the choice is bewildering. What's the difference between a £5 block of plastic and a £50 block of plastic . . . . . . apart from £45? They all extract music from the grooves, don't they? Next month, Pick-Up Principles looks at the different types of cartridges and how they work.



APRIL ISSUE ON SALE MARCH 6th

Drum Sequencer

If you need a lot of banging in your life (perhaps you're a musician), try your hand at the ETI Drum Sequencer. It's designed in two distinct sections. The drum effects unit will simulate high/low tom-tom and bass and snare drum voices, manually triggered by, say, a loudspeaker sensor. The clever bit is the sequential programmer, which will reproduce the drum rhythm of your choice from the effects unit.



Sound Analyser

Turn your volts and waves into six columns of flashing lights with ETI's Visual Complex Sound Analyser. Plug our six bar display (10 LEDs per bar) into your loudspeaker and transform Tony Blackburn into three bars of instantaneous amplitude in three different bands and three bars of instantaneous frequency in three different bands. Use it as a pretty sound to light display or for amplitude/frequency signal analysis of tape/radio/record programmes.

Articles described here are in an advanced state of preparation. However, circumstances may dictate changes to the final contents.

BI-AND SAVE SALE-81

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OA202	£0.07	IN60	£0.07	IN5406	£0.16
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Any 4 at SPECIAL PRICE of £1.60

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ZN414 .... £0.75
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P.C.B.

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SJ139 Glass Fibre PCB 5-pieces—approx 200 sq. ins £2.25
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SJ11 150 Caps. mixed types & values. £0.50
SJ12 60 Electrolitics all sorts mixed. £0.50
SJ13 40 Polyester/polystyrene capacitors mixed. £0.50
SJ14 50 C280 type capacitors mixed. £1.00
SJ15 Polystyrene Caps 1. 160v £0.50
SJ16 40 Low volts electrolitics mixed values up to 10v. £0.50

TRANSFORMERS

MINIATURE MAINS Primary 240v

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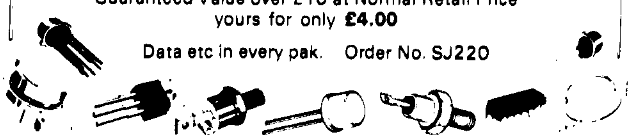

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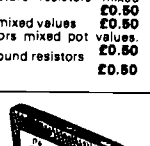

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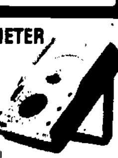

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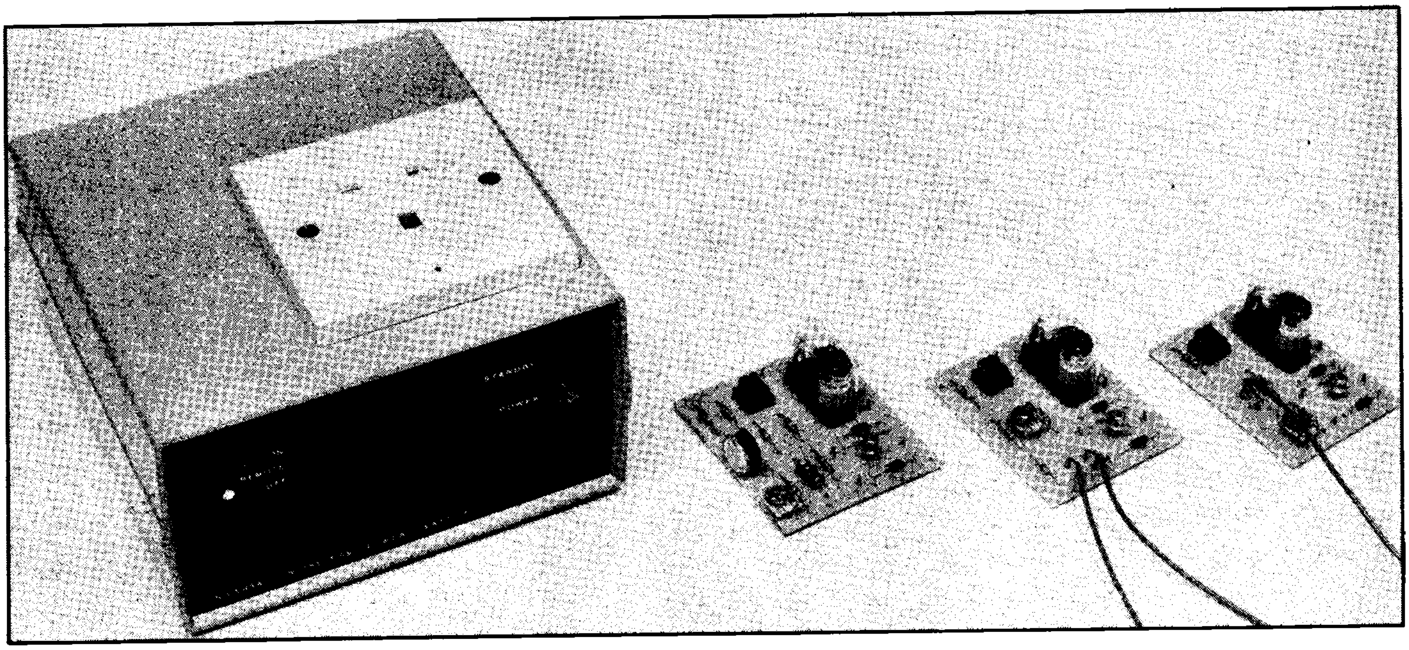
NOISELESS POWER SWITCH



Designed to switch any mains load up to 15A without generating RFI, this unit can be activated either manually or via a remote-control input. Ideal for use with the opto or thermal switches decribed elsewhere in this issue, or with various remote-control projects planned for future issues of ETI. Design by Ray Marston. Project development by Plamen Pazov

This rather sophisticated unit is designed to switch any mains load, up to a maximum of 15A (equivalent to 3.45 kW on 230 V mains), without generating significant electrical noise (RFI) and without excessive power dissipation (heat generation) in the unit. This action is obtained by using a unique combination of logic-controlled triac-plus-relay power switching and has very considerable technical advantages.

The complete power switch can be activated either manually or by a remote-control facility. This facility uses an opto-coupler in its input, giving 4 kV of mains isolation. The remote-switching mains isolation is further backed up by transformer isolation and this transformer is also used to provide an on-board 12 V regulated power supply, which can be used to power external electronic circuitry.

The unit can be remote-switched in a variety of ways. The simplest way is to activate it through the two-wire switch circuit shown in the diagram, which uses the built-in 12 V supply of the unit to provide the required switching current of a few milliamps. In this case the wires can be any length, enabling the control switch (SW2) to be placed anywhere in the house. The 'isolation factor' (isolation from the mains voltage) of this circuit is determined by the breakdown voltage (primary to secondary) of T1. A far greater isolation factor can be obtained by providing the two-wire switch with its own 9 V battery supply, wired so that it connects across the B-C pins of SK1 when SW2 is closed. In this case the isolation factor is determined by the series combination of opto-isolator IC4 and T1 and is greater than 4 kV.

Alternatively, the unit can be automatically switched by any of the two thermal switches or the light-sensitive switch shown elsewhere is this issue, which in turn can be powered from the built-in 12 V supply of the power switch. Finally, the unit can also be switched by an infra-red remote controller that will be described in a forthcoming issue of ETI, or by an even more sophisticated remote control system that we have planned for a future issue of ETI.

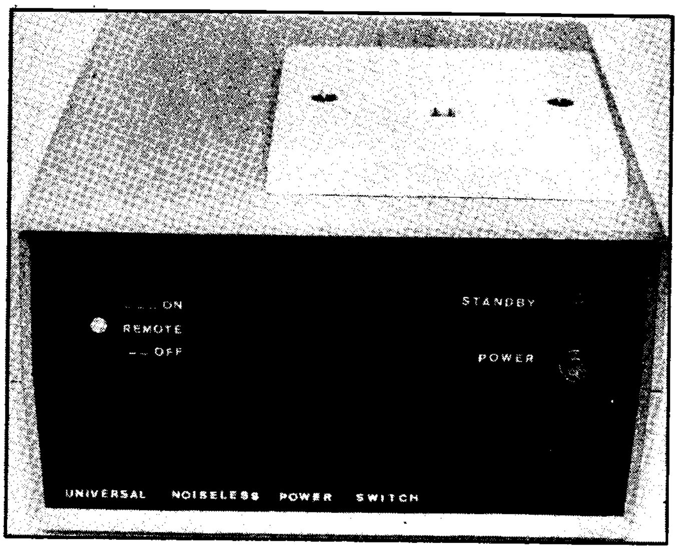
Construction

This project is fairly easy to build, but sensible precautions must be taken during the construction/testing to avoid contact with live mains wiring. Build up the PCB first, noting that the two opto-couplers (IC4 and IC5) are soldered directly to the board and that a small heatsink is bolted directly to the vertically-mounted triac (Q2). The four mounting holes in the PCB are designed to line up with screw-mounting lugs in the plastic case of our prototype.

The heavy-duty relay used in the unit must be mounted in the special octal socket mentioned in Buylines; connections are made to the base by screw terminals. On our prototype the relay unit is mounted horizontally on the rear panel of the case, together with transformer T1 and SK1 (a three-pin DIN on our unit). Three-pin mains socket SK2 is mounted in the top of the case. SW1 (a three-position slide switch on our prototype) and the neon lamp are mounted on the front panel; on our unit we've fitted a second neon to the front panel, wired directly across the SK2 pins to indicate the POWER ON state of the unit.

When completing the interwiring of the unit, note that heavy gauge (15 A) wiring must be used between the triac, relay and SK2. Make the mains input connection to the unit through the rear panel.

When construction is complete, connect the mains input and give the unit a simple functional test via the ON/OFF actions of SW1. If all is well, check that 12 V is available between the A and D pins of SK1 and then check that a remote control action can be obtained by wiring up PLG1 as shown in the circuit diagram. If you want to control the unit automatically in response to light or temperature variations, refer to the light and temperature switching circuits shown elsewhere in this issue.



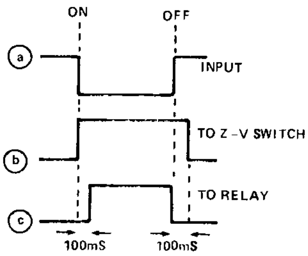
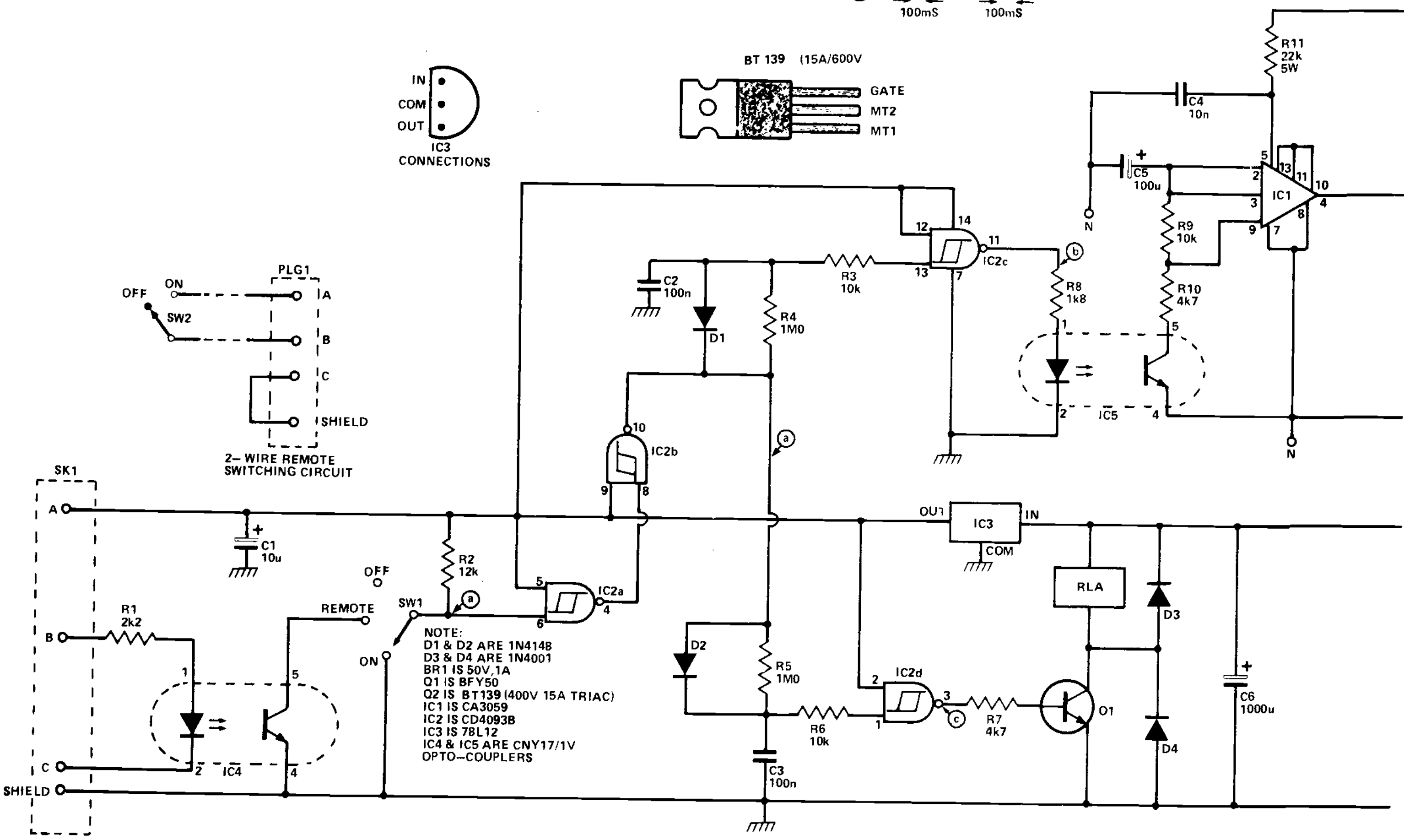


Fig.1 Circuit diagram waveforms are shown for points a, b and c in the circuit.



HOW IT WORKS

To appreciate the finer points of our power switch design it is necessary to first understand some of the basic principles of conventional mains-power switching, as follows.

SWITCHES AND RELAYS. The major disadvantages of switches and relays in mains-switching applications are that they suffer from contact arcing and generate a good deal of RFI (audible on radio and TV sets) as they switch from one state to the other. Their major advantages are their simplicity and negligible power dissipation in the ON condition.

TRIAC POWER SWITCHES. The main advantages of triacs (solid-state power switches) in mains-switching applications are that they do not suffer from arcing problems and can be controlled from low-power sources. They have several significant disadvantages:

Triacs can generate very significant RFI when they are initially switched on. The magnitude of the RFI is proportional to the rise time and the magnitude of the switch-on current, which in turn is proportional to the instantaneous magnitude of the mains voltage at the moment of switch-on. Switch-on RFI is radiated from all mains wiring through which the current pulse flows. Thus, if the instantaneous mains voltage is at 400 V as the triac switches power to a 20R heater load, a very large pulse of RFI will be generated, but if the instantaneous voltage is only 10 V at the moment of switching the RFI will be negligible.

A second disadvantage of the triac is that it has a typical saturation voltage of about 2 V. It thus dissipates 30 W when driving a 15 A load and may need substantial heat sinking.

A final disadvantage of the triac is that it has a 'minimum holding current' characteristic, which causes the triac to unlatch if its load current is reduced below a certain value with gate drive removed. The net effect of this characteristic is that a 15 A triac power switching circuit may work correctly with a high current load but may be incapable of operating correctly when connected to (say) a 100 W lamp.

ZERO-VOLTAGE TRIAC SWITCHING. The RFI-generation problem of the triac can be overcome by feeding gate (switch-on) signals to the triac only when the instantaneous mains voltage is at, or close to, the zero-voltage crossover point of the mains waveform. Special 'zero-voltage switching' ICs are available for this type of application and are very easy to use. 'Zero-voltage' triac circuits still, however, suffer from the power-dissipation and minimum-load problems mentioned above.

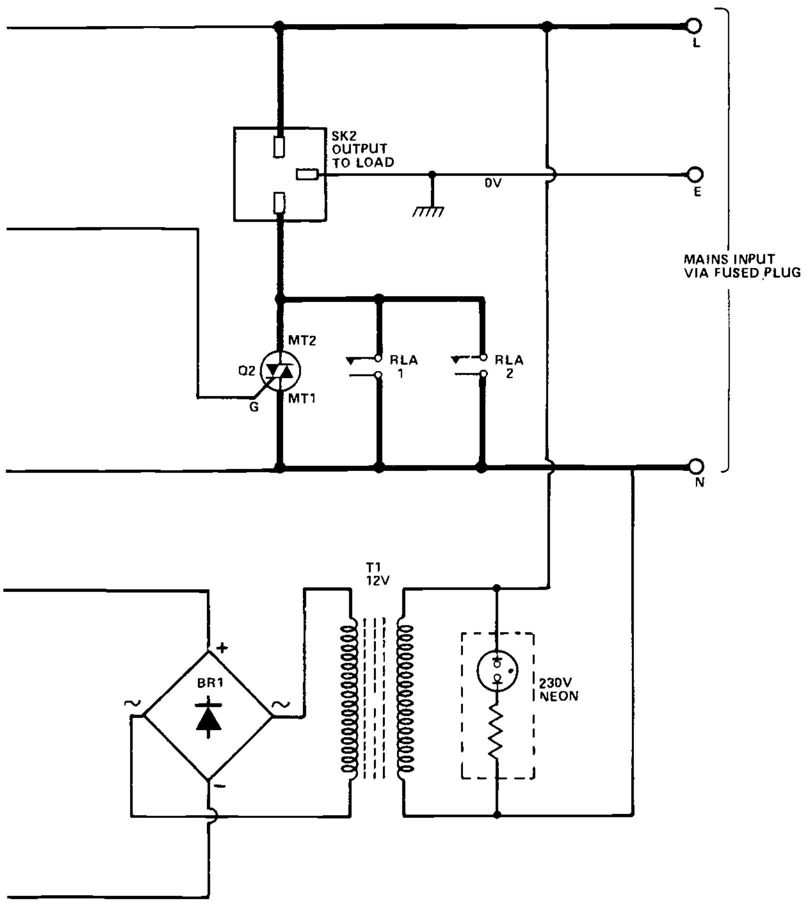
The ETI circuit combines both zero-voltage triac-switching and relay switching techniques to give the best of both worlds, with RFI problems eliminated by the triac circuitry and with power-dissipation and minimum-load problems eliminated by the relay. The basic operating principle of the circuit is quite simple. When an ON command is given, the zero-voltage triac-switching circuitry activates and connects power to the load without generating RFI. 100 mS later, the relay turns on and shorts out the triac, thus maintaining the load connection without the usual power-dissipation and minimum-load problems. Since the relay is required to switch only the 2 V saturation voltage of the triac, it does not suffer from arcing or RFI problems.

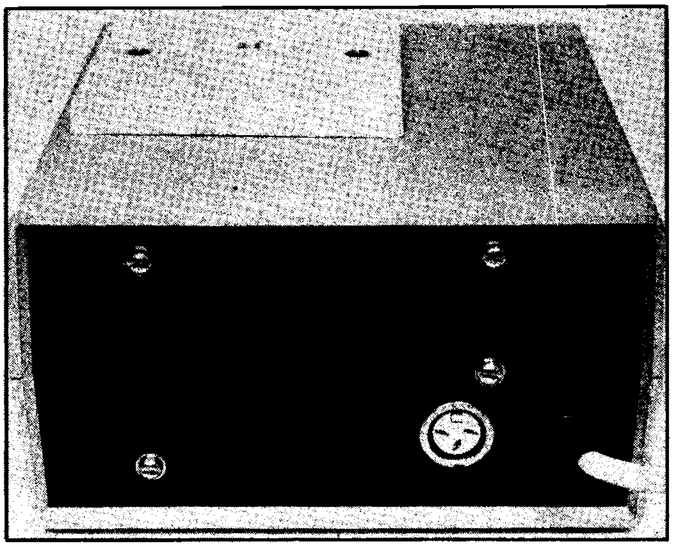
When the OFF command is given, the reverse sequence of actions takes place, with the relay turning off on the arrival of the OFF instruction and the triac turning off 'noiselessly' 100 mS later.

The basic logic waveforms of the circuit are generated by IC2. IC2a-IC2b are wired as a non-inverting Schmitt amplifier with its output fed to a pair of time-constant networks with Schmitt-inverter outputs (D1-R4-C2-IC2c and D2-R5-C3-IC2d). The output of the IC2d network is fed to the relay by Q1 and the output of the IC2c network is fed to the IC1-Q2 'zero-crossing triac' circuitry by opto-coupler IC5.

The relay and the logic network are powered from a DC supply that is isolated from the mains by transformer T1. The logic supply is derived from a 12 V regulator, the 12 V supply being externally available for powering auxiliary circuitry.

The power switch can be activated either manually or by a 'remote' input via SW1. SW1 is fully isolated from the mains voltage by T1 and the opto-coupler IC5. The 'remote' input to the circuit is made through a second opto-coupler (IC4), which provides 4 kV of isolation at the input terminals. This input requires only a few milliamps of current (through R1) to turn the power switch on. This current can be derived from the internal supply, if desired, by using the two-wire remote switching connections shown in the circuit diagram.





BUYLINES

You'll need to hunt around for some of the components in this project. The relay is a Radiospares component (order no. 348-756), but can be supplied by Watford Electronics.

The CA3059 is available from Marshall's. The CNY17/1V opto-couplers are available from Electrovalue. Watford can supply the BT139 triac.

The case chosen for our prototype is a PACTEC CM6, distributed by OK Machine & Tool UK Ltd, Dutton Lane, Eastleigh SO5 4AA.

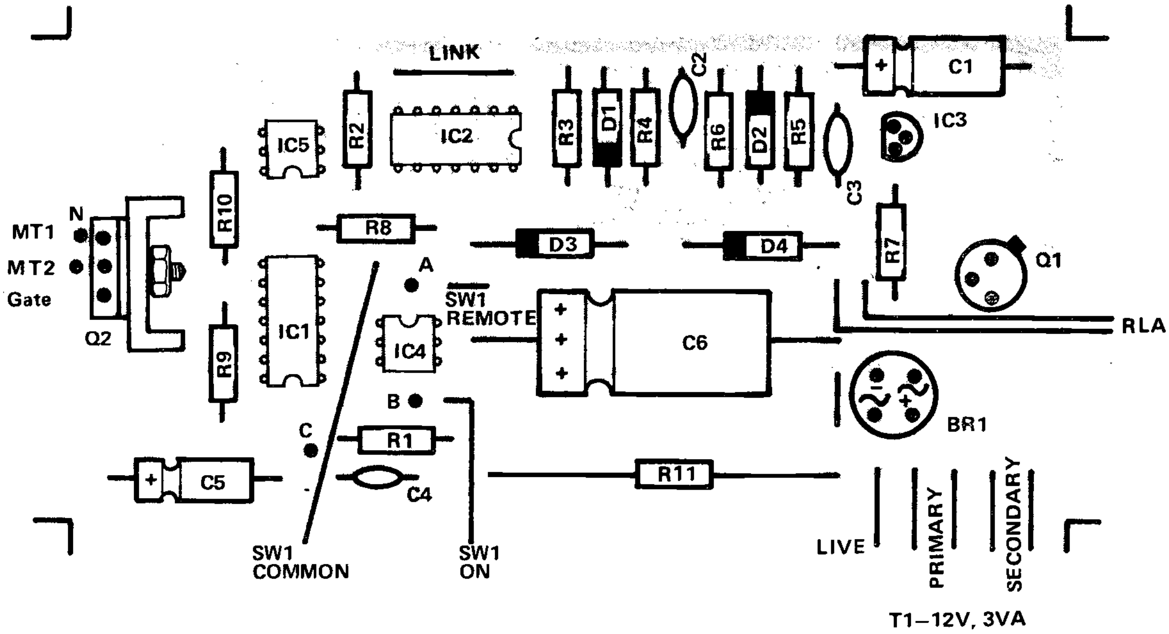
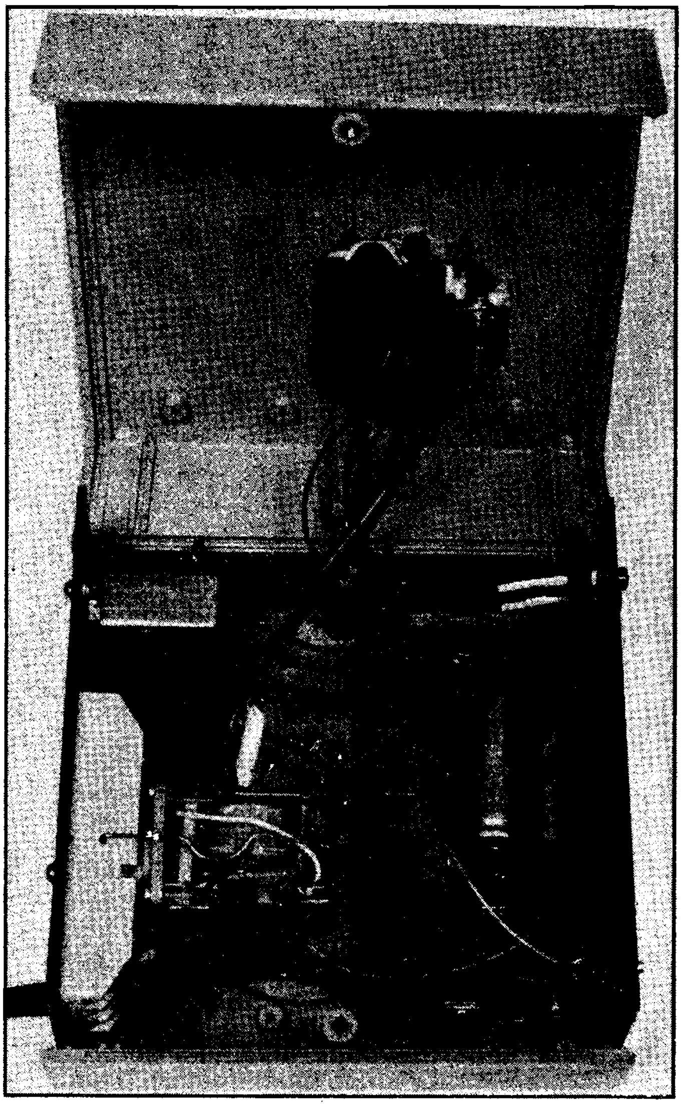


Fig.2 Component overlay.



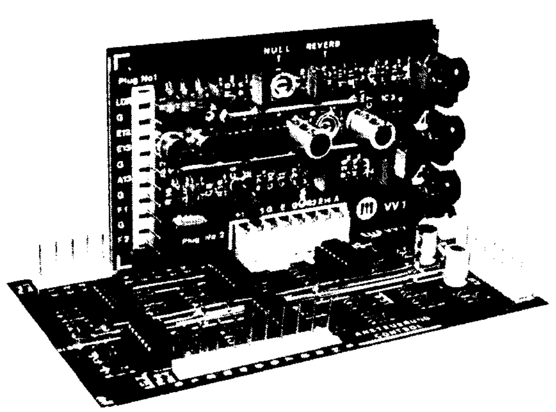
PARTS LIST

Resistors all ¼ W 5%, except where stated

R1	2k2
R2	12k
R3,6,9	10k
R4,5	1M0
R7,10	4k7
R8	1k8
R11	22k 5W
Capacitors	
C1	10u 16 V electrolytic
C2,3	100n polyester
C4	10n polyester
C5	100u 16 V electrolytic
C6	1000u 25 V electrolytic
Semiconductors	
IC1	CA3059
IC2	4093B
IC3	78L12
IC4,5	CNY17/1V (opto-couplers)
Q1	BFY50
Q2	BT139 (triac)
D1,2	IN4148
D3,4	1N4001
BR1	50 V 1 A bridge
Miscellaneous	
RLA	12 V coil resistance >100R, 2 pole changeover contacts rated at 240 V, 10 A, with relay base, 15 A rated (see Buylines).
SW1	three-way slide switch
SK1	three-pin DIN socket
SK2	three-pin mains socket
PLG1	three-pin DIN plug
T1	12 V, 3 VA mains transformer

230 V neon, case, connecting wire, etc.

Create One Yourself!



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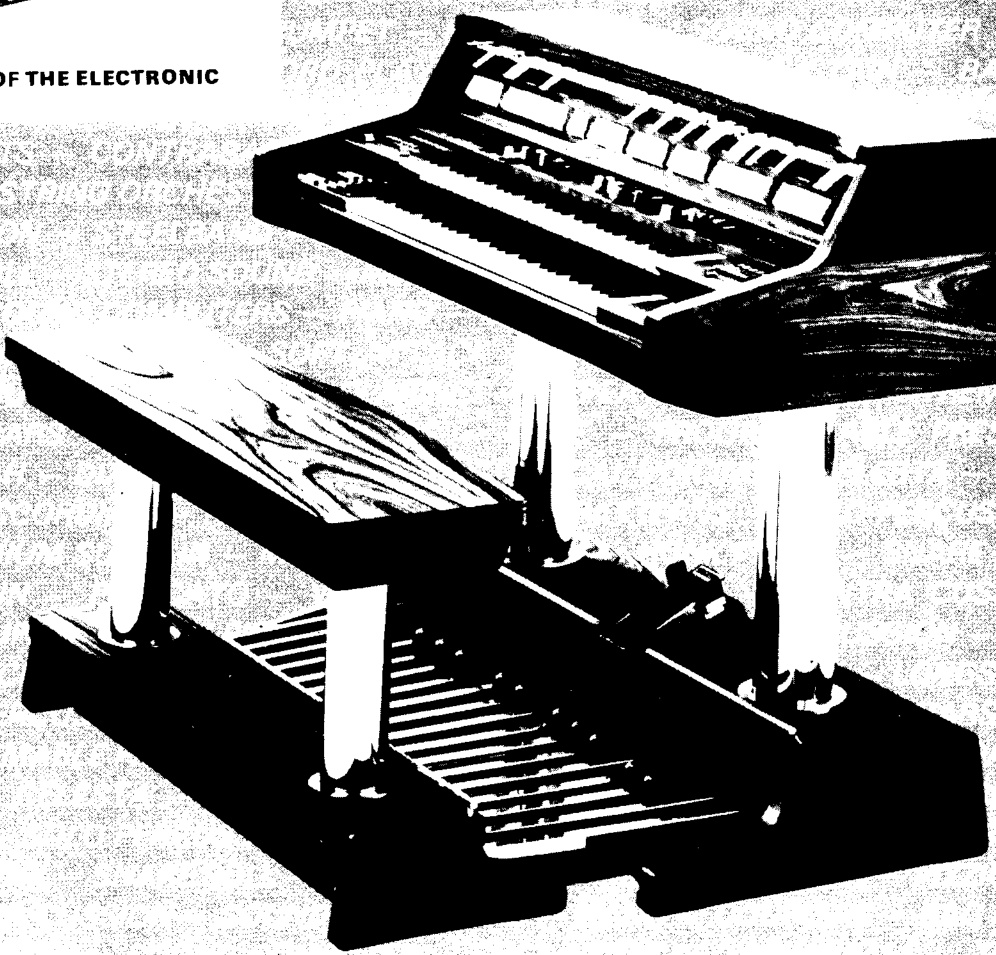

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This is the ZX80. A really powerful, full-facility computer, matching or surpassing other personal computers at several times the price. 'Personal Computer World' gave it 5 stars for 'excellent value'. Benchmark tests say it's faster than all previous personal computers.

Programmed in BASIC – the world's most popular language – the ZX80 is suitable for beginners and experts alike. And response from enthusiasts has been tremendous – over 20,000 ZX80s have been sold so far!

Powerful ROM and BASIC interpreter

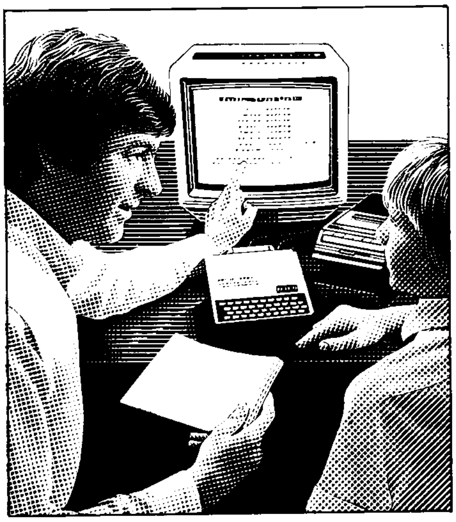
The 4K BASIC ROM offers remarkable programming advantages:

* Unique 'one-touch' key word entry: the ZX80 eliminates a great deal of tiresome typing. Key words (RUN, PRINT, LIST, etc.) have their own single-key entry.
* Unique syntax check. A cursor identifies errors immediately.
* Excellent string-handling capability – takes up to 26 string variables of any length. All strings can undergo all relational tests (e.g. comparison).
* Up to 26 single dimension arrays.
* FOR/NEXT loops nested up to 26.
* Variable names of any length.
* BASIC language also handles full Boolean arithmetic, condition expressions, etc.
* Randomise function, useful for games and secret codes, as well as more serious applications.
* Timer under program control.
* PEEK and POKE enable entry of machine code instructions
* High-resolution graphics.
* Lines of unlimited length.

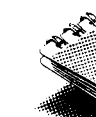
Unique RAM

The ZX80's 1K-BYTE RAM is the equivalent of up to 4K BYTES in a conventional computer – typically storing 100 lines of BASIC.

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



The ZX80 as a family learning aid. Children of 10 years and upwards are quick to understand the principles of computing – and enjoy their personal computer



The Sinclair teach-yourself BASIC manual

If the specifications of the Sinclair ZX80 mean little to you – don't worry. They're all explained in the specially-written 128-page book (free with every ZX80). The book makes learning easy, exciting and enjoyable, and represents a complete course in BASIC programming – from first principles to complex programs.

Kit or built – it's up to you

In kit form, the ZX80 is pleasantly easy to assemble, using a fine-tipped soldering iron. And you may already have a suitable mains adaptor – 600 mA at 9V DC nominal unregulated. If not, see the coupon.

Both kit and built versions come complete with all necessary leads to connect to your TV (colour or black and white) and cassette recorder. Plug in and you're ready to go. (Built versions come with mains adaptor.)

personal computer.

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For example, you could write an interactive or 'conversational' program to show people what your ZX80 can do. With 16K-BYTES of RAM, they could be talking to your computer for hours!

Or you can store a mass of data – perhaps in a fairly simple program – such as a name and address list, or a telephone directory.

And by linking a number of separate programs together into one giant, but modular, program, you can achieve the same effect as loading several programs at once.

We're also confident that it won't be long before you can buy cassette-based software using the full 16K-BYTE RAM. So keep an eye on the personal computer magazines – and brush up your chess perhaps!

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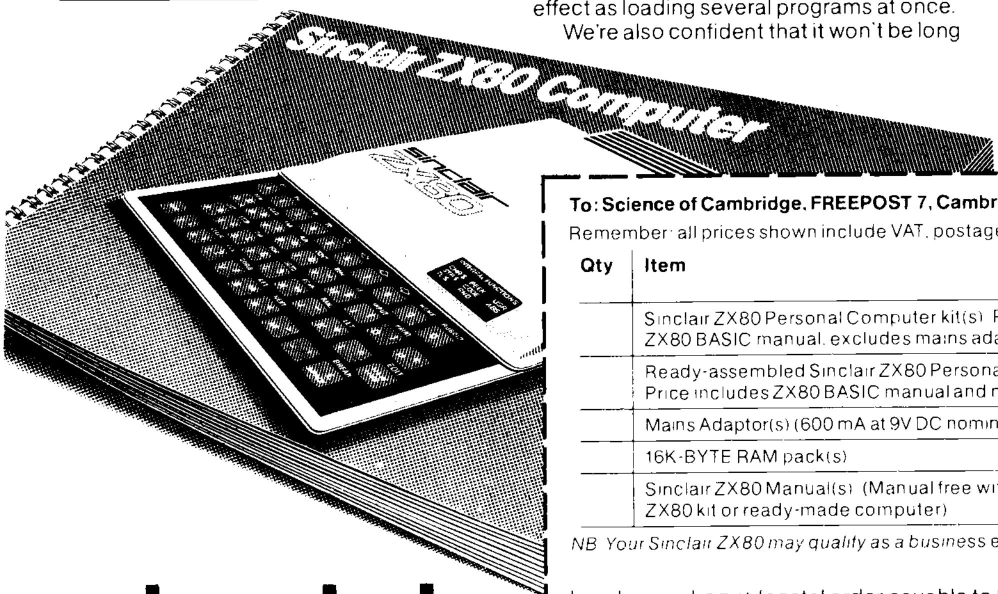

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HOLOGRAPHY

Trip the light fantastic with the greatest of ease as Anne Sullivan unfolds the exotic story of three dimensional photography — holography.

Holography records light waves reflected from an object and reconstructs them to produce a three-dimensional image. Holograms can only be recorded using a strong coherent light, so, to explain holography it is important to understand the nature of light itself. All light travels in waves. White light is composed of all the colours of the spectrum, each colour having its own wavelength. Because white light is composed of many different wavelengths and phase orientations travelling together, it is known as incoherent light. Coherent light is composed of waves of identical length and frequency travelling in phase, such as that produced by a laser.

Mirror, Mirror.....

All objects reflect light, the amount varying in intensity according to the shape and nature of the object. A hologram is recorded when wavelengths of coherent light that are in phase overlap to produce a wavefront known as an interference pattern. The interference pattern, which records the dimensions and depth of the object, is recorded on a photographic plate and when the interference pattern is reconstructed, we see what appears to be a three-dimensional image of the original object — a hologram.

Holography was discovered by Dennis Gabor in 1948 at the British Laboratories in Rugby. His early holograms confirmed this theory, but the images were dim and blurred. Development was hindered by a lack of a sufficiently strong source of coherent light and photographic emulsions of a high enough quality. In 1960 with the invention of the laser, a strong source of coherent light became available and in 1964 two American scientists, Emmett Leith and Juris Upatnicks were able to further the pioneering work done by Gabor. Leith and Upatnicks produced the first bright holograms and the system they developed is known as 'off axis transmission holography'.

Object Lesson

To make a hologram the light from a laser is split into two beams using a beam splitter. One beam is directed onto the object to be recorded (the object beam) and the second beam onto the photographic plate (the reference beam). The intensity of the lightwaves reflecting from all the points of the object combine with waves of the reference beam to produce an interference wavefront in the emulsion. The photographic plate (which is an extremely fine grain silver halide emulsion) is then developed and fixed in a similiar way to conventional photographic film. The developed plate which contains the interference pattern is a hologram.

Image Making

To reconstruct or view the hologram, the reference beam from the laser is directed at the holographic plate at the same angle as in the recording stage. When it emerges it recreates the light waves from the original object and reconstructs a three-dimensional object behind the holographic plate. This type of hologram where the image is reconstructed behind the plate is known as a *'virtual image hologram'*.

Reconstruction of a hologram where the image appears in front of the plate (a *'real image hologram'*) is more complicated. If the procedure is reversed and the holographic plate is lit from behind, the image that is reconstructed in front of the plate will be back to front and with reverse perspective; that is, the objects in the background will appear larger than those in the foreground. This inside-out image is known as pseudoscopic.

In order to create a real image hologram a second hologram is made of the pseudoscopic image. When the second generation hologram is reconstructed, the image appears in front of the plate the correct way round ie orthoscopic, the

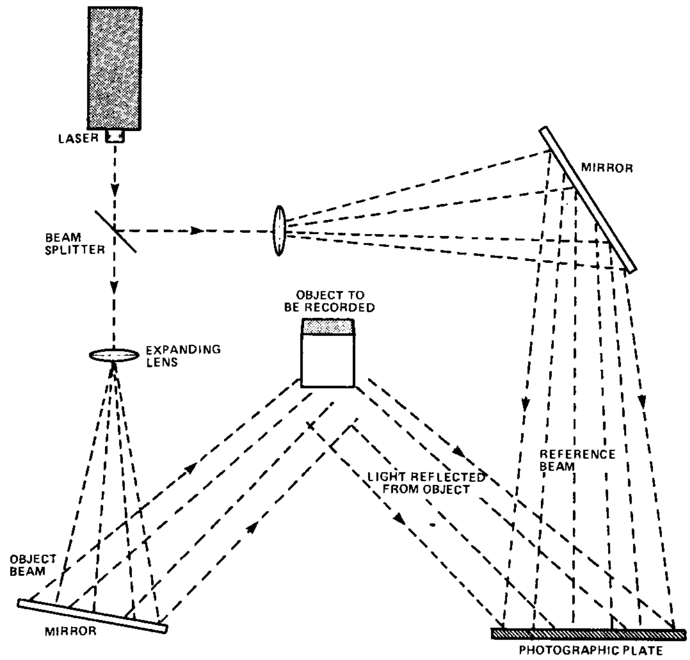


Fig. 1 The single beam from a common-or-garden laser is split in two. One beam (reference) is taken directly to the photographic plate. The other gets there via the object. The two beams produce an interference pattern in the emulsion.

image having been reversed twice. Examples of laser transmission holograms have recently been seen in this country at the "Light Fantastic" exhibitions at the Royal Academy in London.

Another type of hologram was developed in the Soviet Union in the early sixties by Y.N. Denisyuk which eliminated the need for a laser to reconstruct the image and so helped to bring holography out of the laboratory and make it more accessible to the public. This type of hologram is known as *'white light reflection hologram'* and, although a laser is required to make the hologram, the image can be reconstructed using a white light source.

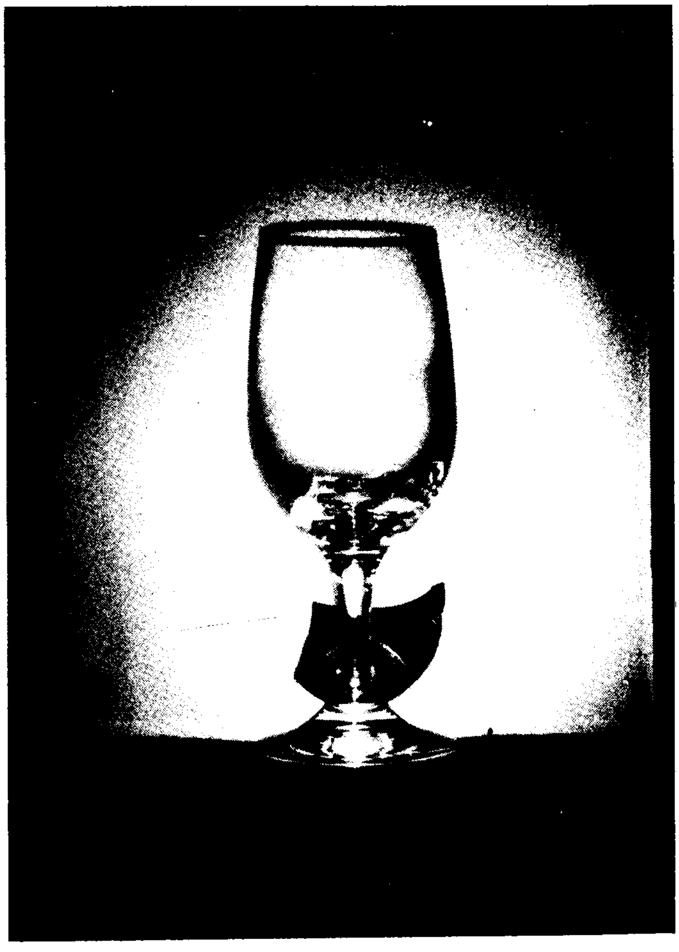
Daylight 3-D

In white light reflection holography, Denisyuk also eliminated the need for a beam splitter. A beam of coherent light is passed through the holographic plate and acts as both the object and reference beam. It illuminates the object to be recorded and is then reflected back through the holographic plate. The emulsion records the interference between the beam and the reflection from the object. The hologram is viewed by directing white light onto the holographic plate. The plate acts as a filter and selects only the coherent light to reconstruct the hologram. This type of holography is being developed in this country by Nick Phillips at Loughborough University for Holoco Ltd. Another method of making white light reflection holograms uses the pseudoscopic image of a laser transmission hologram (in a similar way to making a real image transmission) but with the reference beam of the second hologram coming from the opposite side of the plate.

In 1969 Dr. Stephen Benton, working for the Polaroid Corporation in the USA developed a system that enabled a *'real image hologram'* to be viewed in white light. Making a so-called 'white light 'rainbow' transmission hologram' is a more complicated process, but it basically involves two stages. Initially, a transmission hologram is made. Then a second hologram is made in the same way that a *'real image hologram'* would be recorded except that just a horizontal slit (3-5 mm) of the master is illuminated. The slit is projected in front of the hologram and the white light passing through it acts as a filter. The white light passing through the slit is diffracted and produces a rainbow effect, so, depending on the viewing angle the holographic image appears in all colours of the spectrum. Dr. Benton has since modified his process and is now able to produce achromatic (black & white) images. This type of holography is being developed in this country by See Three Holograms Ltd. Another type of reflection hologram known as a *'dichromate gelatin hologram'* was developed in the USA in the sixties. These holograms are made using ammonium dichromate instead of a silver halide plate. This method produces holograms with a very bright image, but limited depth. Its major application so far has been in the production of holograms in the forms of pendants.

Life Class

In all the methods of holography previously described the subject matter has to be an inanimate object, as any movement, even breathing, would disturb the interference pattern of the wavelengths and no image would result. However, animate objects can be recorded holographically using a pulsed laser. A pulsed laser emits intense flashes of coherent light, rather like a flashgun, which freeze the movement of the subject long enough to record the image. Using a pulsed laser it has even been possible to make a hologram of a bullet in flight. Pulsed



Rick Silbermann's 'The Meeting', a reflection hologram shown at the recent holography exhibition at The Photographer's Gallery. Our lead photograph is Harriet Casden-Silver's 'A Woman', from the same exhibition.

A haunting face — Al Razutis's 'Surrogate' from the holography exhibition at the Photographer's Gallery.

lasers can also be used to make holographic portraits of people, but when making a hologram of a person a large sheet of frosted glass has to be used to diffuse the light from the laser for safety.

Another type of hologram, an *'integral hologram'* incorporates movement. Integral holograms are not strictly holograms, but a marriage of cinematography and holography as the subject matter is not recorded with a laser, but with ordinary 16 or 35mm black and white film. An integral hologram is basically a series of holograms joined together to create movement. The process was developed by Lloyd Cross of the Multiplex Co. in the USA in 1974. An integral (or multiplex) hologram is also made in two stages. First the subject is filmed on a turntable which moves at a fixed speed. Any movement to be recorded has to be slow and smooth or the resulting hologram will have blurred or jerky movement. The black and white film is then scanned by a laser and each frame is made into a vertical strip hologram using a technique similar to the 'Rainbow' method. The resulting series of vertical strip holograms are contained on a flexible photographic sheet. To reconstruct the holograms the film is usually placed in a 120° cylindrical container (360° holograms can also be made). The container is illuminated from below by an ordinary incandescent light source. Integral holograms are popular as they eliminate some of the problem of the other types of holography, in that they are not confined to same size reproduction, allow a certain degree of movement, can be copied relatively cheaply and they can be reconstructed easily using an ordinary light source.

Applications

The applications of holography are numerous — among them, storing digital information, recording works of art and preserving them for posterity, as point of sale displays for advertising, in education to demonstrate complex forms such as molecular structures, as a completely new medium for artists to work in and as an art form in the home.

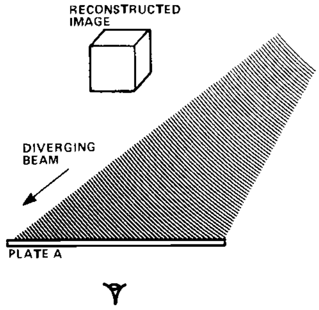


Fig. 2 Recovering a holographic image. A beam of light (white or laser, depending on the method of recording used) is directed at the photographic plate at the same angle as that of the reference beam during recording.

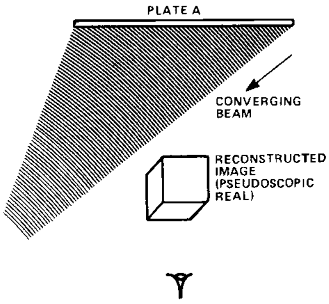


Fig. 3 The image can be made to appear in front of the plate by illuminating it from the front. However, the image is reversed in all respects. Objects in the background appear to be larger than those in the foreground.

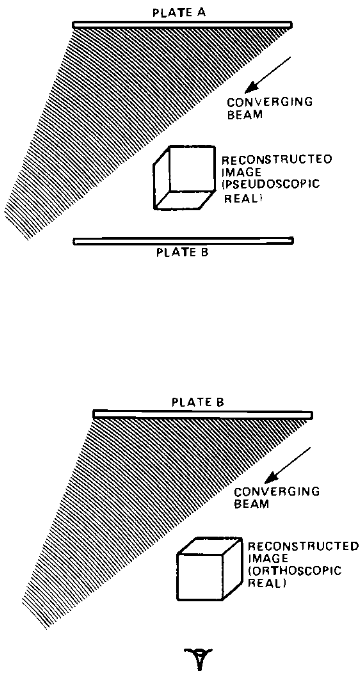


Fig. 4 To return the perspective to normal, a second hologram must be made from the first.

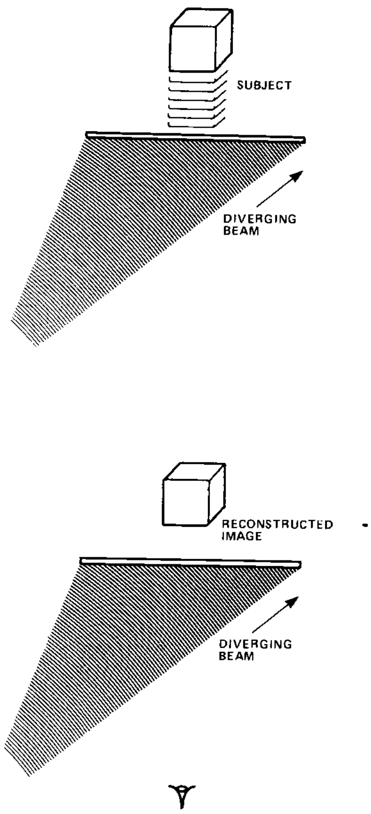


Fig. 5 To make a white light reflection hologram, the recording reference beam and object to be recorded are on opposite sides of the plate. The back of the plate is often coated with black to give a dark viewing background during reconstruction.

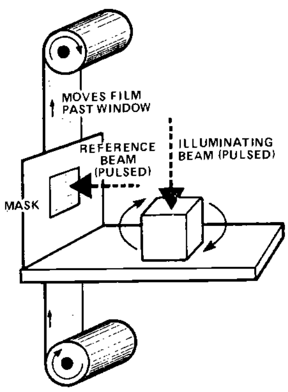


Fig.6 One method of producing a holographic film of a moving object. A pulsed beam illuminates the spinning cube.

I have just given a brief outline of holography, but it is a medium that is now becoming available to people in the same way as photography has done in the past. A holographic lab can be set up for approximately the same price as a quality colour lab. For those people who are interested in finding out more about holography I would recommend the following books and courses:-

Books

Understanding Holography by Michael Wenyon
Published by: David & Charles. £5.50
A good all round introduction to holography, easily understood by the layman and with an extensive bibliography for further reading.

Holograms (How to make and display them) by Graham Saxby.
Published by Focal Press: £7.95
The most recent book available on holography. A good introduction to holography and an easily understood guide to producing your own holograms. Also contains an extensive bibliography.

Light Fantastic 2
Bergstrom & Boyle £2.95
Catalogue of the Light Fantastic exhibition. Includes an introduction to holography and is well illustrated with holograms made by Holoco.

Course

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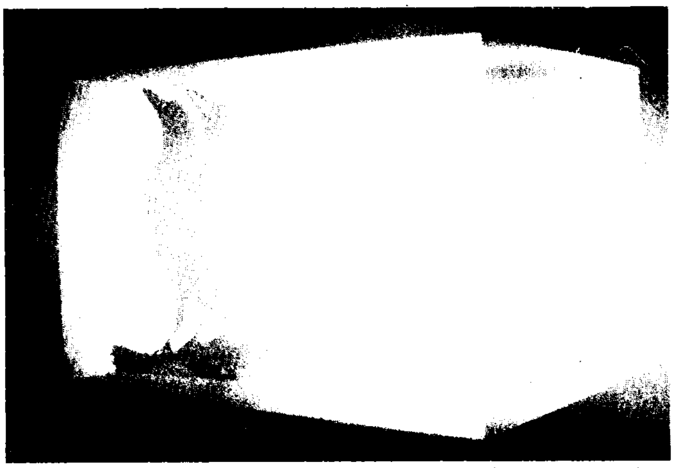
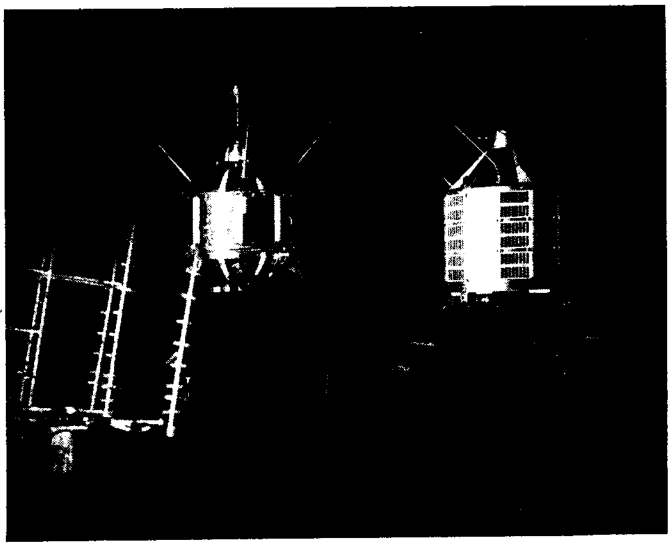
Cormant Road
London SE15
Write to Paul Walton for a prospectus.



A double exposure hologram by Margaret Benyon. The front and back of the box are visible simultaneously (from Holograms by Graham Saxby, Focal Press Ltd).



Spacecraft flying in formation in the Light Fantastic 2 exhibition.

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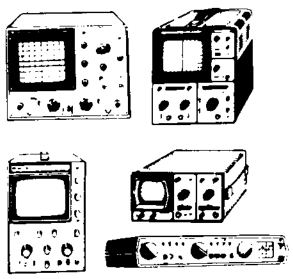

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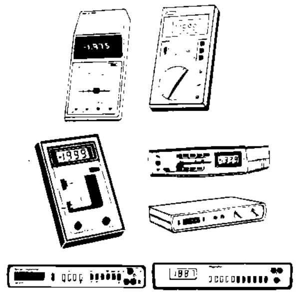

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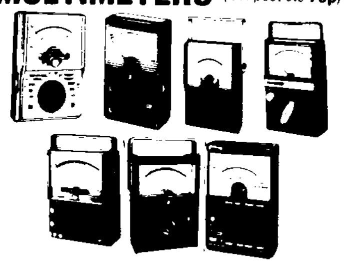

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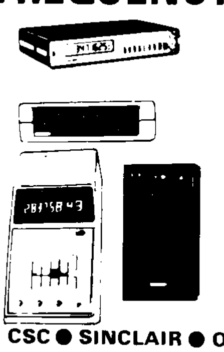

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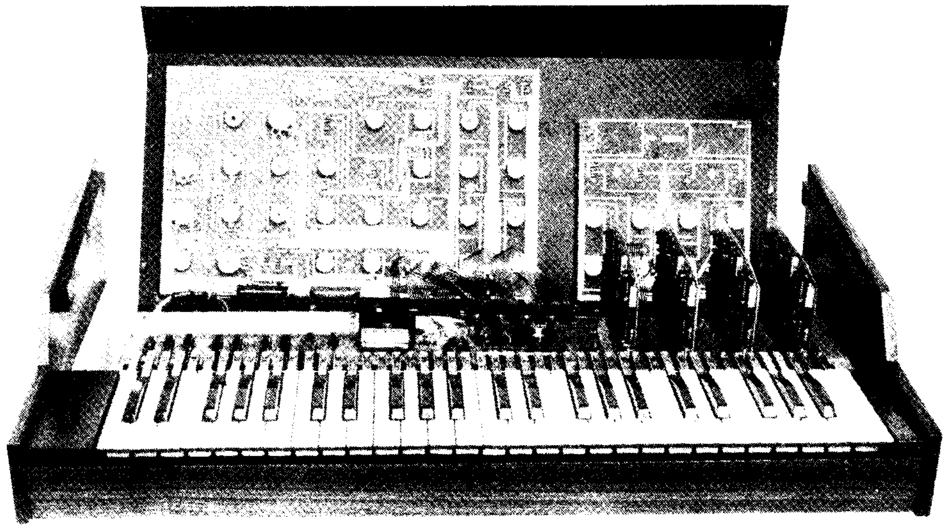


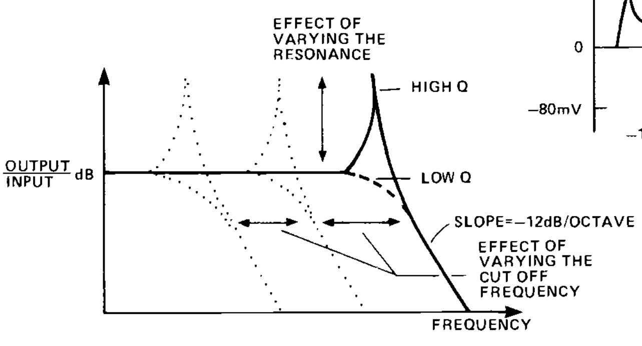
We conclude the Polysynth project with the final setting up and alignment procedure. Design and development by Tim Orr.

Assuming that the rest of the synthesiser has been checked out and found to be working then the voice boards can be tested and aligned. When inserting or removing the voice boards make sure that the power is *always* turned off. Set up the panel as shown in Fig. 4. Insert a voice into slot number four with the component side facing the centre of the machine, the copper track side facing the wooden end. Make certain that the ICs are the correct way around, in particular IC1,4. Turn on the power and check the ±15 V and -5 V rails on the voice board. Both VCOs should be oscillating. Check pins 4,8 and 10 for square, ramp and triangle waveforms. Next look at IC2 pin 2 and IC3 pin 3 and check that the two waveform selectors function properly. Also check that the two VCO tuning pots control their respective VCO frequencies. When the machine has been calibrated, these pots will have a two octave tuning range.

Check that the two transpose controls affect the VCO frequency. Move the pitch bend lever; this will slightly change the VCO pitch. Also check that the keyboard controls the pitch, although it will not yet be in tune. Test out the three vibrato controls. Turn off the vibrato and tune the two VCOs to the same frequency. They should slowly beat with each other. Look at IC15 pin 5 (the top of R51). Check that the level controls for each VCO operate correctly. Turn both of them on. Turn on the sync switch. VCO1 should lock onto the frequency of VCO2. Turn off the sync and turn off the volume to VCO1. Select a square waveform from VCO2. Test the VCO2 MS (mark/space) control pot. With the pot anticlockwise the waveform will be square. As the pot is rotated to its central position the square will turn into a thin pulse. Clockwise of centre the pulse width is controlled by the mark/space oscillator. Check out the mark/space speed and waveform controls. Repeat for VCO1.

Select a 100 Hz ramp waveform from VCO1. Turn VCO1 level to maximum, and VCO2 level to off. Look at the VCF output, IC9 pin 1 (the left hand side of R58). The VCF frequency pot will vary the filter cut-off frequency, and the resonance control will vary the Q factor (Fig. 5). Press a note on the keyboard. This will generate the ADSR sweep waveform as shown in Fig. 2. Adjust PR3 so that with the ADSR sweep pot in its central position there is no VCF sweep. Now rotate the ADSR sweep pot anticlockwise. When the note is pressed it should be possible to get a filter sweep that sounds like a 'DOW' noise. In the clockwise position the sound is a 'WAH'. Check out the VCF ADSR controls. They should behave as shown in Fig. 3. Also test the TRACK switch. This will generate

Fig.1 VCF frequency response.



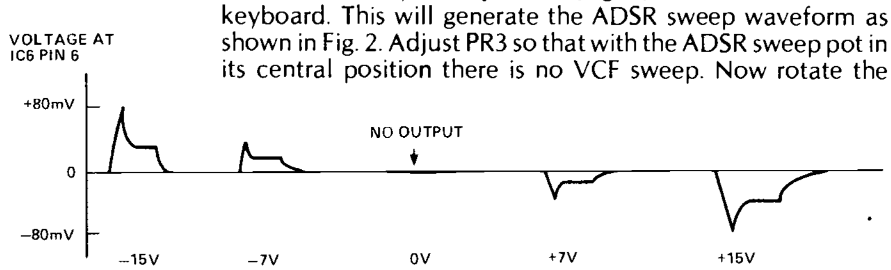


Fig.2 Waveforms associated with the ADSR sweep potentiometer.

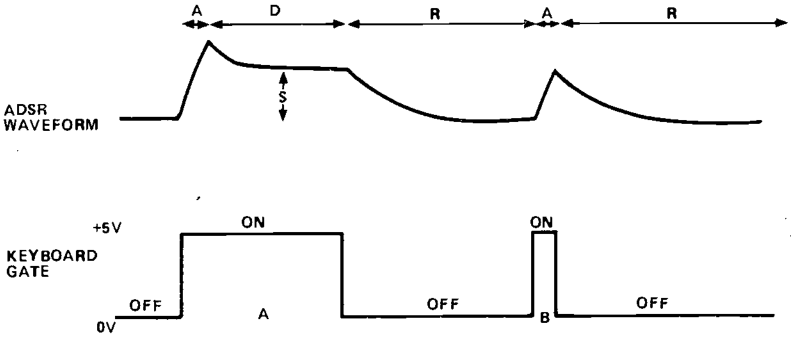


Fig.3 ADSR operation.

fast time-constants at the top end of the keyboard and slower ones at the bottom end. Now check out the VCF TRACK switch. Turn it on and play notes up and down the keyboard. The shape of the waveform at the VCF output will remain roughly the same as the frequency varies. But with the VCF TRACK off, the high notes will be sinusoidal, but the low notes will contain a strong harmonic content. Turn the VCF TRACK switch on. Turn up the noise level to test that it makes it to the filter.

The next and last section is the VCA. Turn off both the VCOs, the noise source and the VCF sweep. Set up the VCA ADSR as shown in Fig. 4. Press a note on the keyboard. This will start the ADSR which generates a fast envelope contour, causing a click at the VCA output, IC8 pin 5. Adjust PR1 until this click reaches a minimum. Turn on VCO1 so that the VCA has a signal to modulate. Test the VCA ADSR controls and the TRACK switch. When the note is released and the ADSR waveform has decayed away the output of the VCA will die away completely. Turn the ADSR/CONT switch to CONT. The sound will return and will be unaffected by the VCA ADSR. Now turn the relevant voice ON/OFF switch to OFF. The voice will now be off.

This concludes the initial alignment and debugging of the voice. Repeat all of this process for voices 3,2 and 1 until all four voices are plugged in and working. Allow the machine to 'burn in' for 24 to 48 hours, then retest all the functions.

The next section deals with aligning the VCF and VCOs for frequency and tuning.

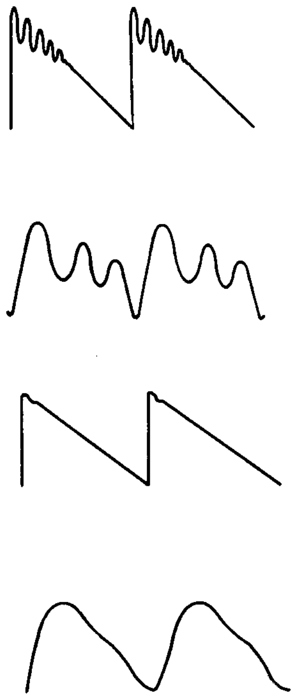


Fig.5 VCF response. From top to bottom: high frequency, high Q (resonance control clockwise); low frequency, high Q; high frequency, low Q (resonance control anticlockwise); low frequency, low Q.

BUYLINES

Powertran Electronics can supply a complete kit of parts for each option of the Transcendent Polysynth.

1 voice	£320
2 voices	£368
3 voices	£464
4 voice expansion kit	£295

All prices are exclusive of VAT. Powertran Electronics, Portway Industrial Estate, Andover, Hants SP10 3NM.

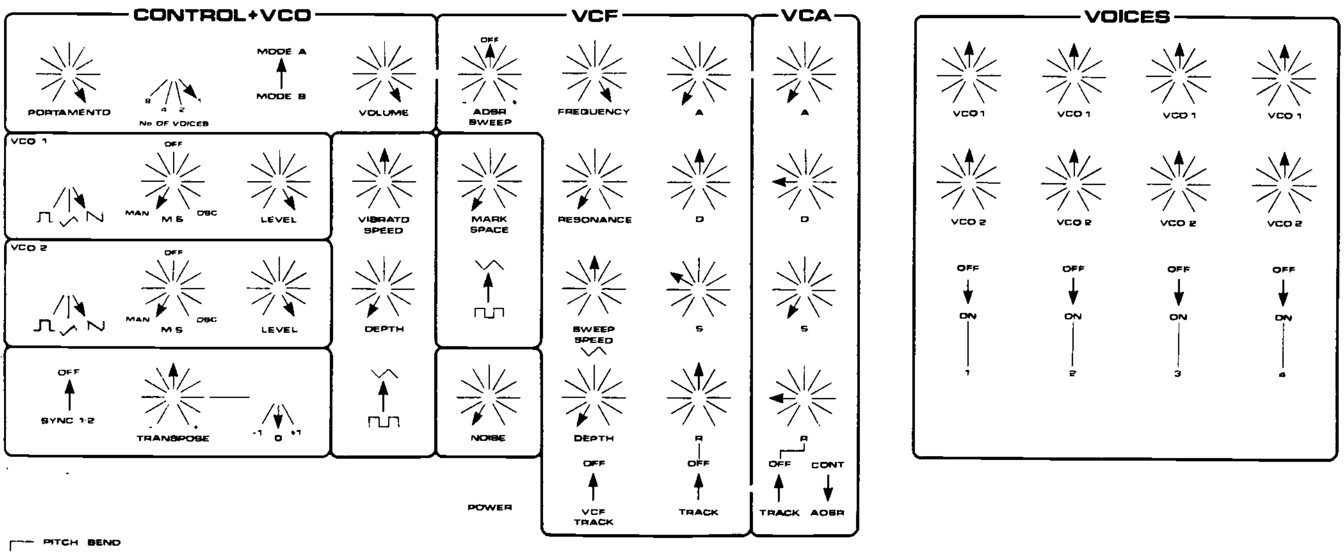


Fig.4 Front panel control positions for setting up procedure.

Pitch Spread

The pitch spread adjustment is very sensitive, but in order to obtain a musically useful synthesiser it must be properly set up. When two or more VCOs are being controlled from the keyboard it is imperative that they track. If they do not then objectionable frequency beating will occur as the keyboard pitch is altered. The Polysynth can have up to 16 VCOs in operation at once and so the pitch adjustment must be spot on. The VCOs have an exponential transfer function, which is musically very useful. It enables linear voltage changes from the keyboard to generate musical intervals from the VCOs. Also you can transpose VCO1 relative to VCO2. This relative tuning is maintained as the VCO pair is moved in pitch by the keyboard voltage.

This is a very powerful feature of the music synthesiser but it relies on the transfer function of all the VCOs being a perfect exponential curve. If one VCO deviates from this curve then it will never track with the other VCOs. If all the VCOs have the same curve but it is not an exact exponential then they will not track when transposed (VCO1 relative to VCO2) or when played in the polyphonic mode. If all the VCOs have exactly the same true exponential curve and yet the digital pitch generator has significant errors then the VCOs will not track in the polyphonic mode. However, if all these problems are properly resolved then you end up with a marvellous polyphonic music synthesiser. Figure 7 shows the VCO transfer function on a log/lin graph. Here a perfect exponential is shown as a straight line. The VCOs tend to go flat at high frequencies, which is caused by the accumulation of timing errors in the oscillator plus the effect of bulk resistance in the exponentiating transistor. However, the CEM3340 has a high frequency tracking adjustment to improve the top end tuning.

VCO Pitch Spread Adjustment

Turn the unit on and let it warm up for 10 minutes. The digital pitch generator must be working properly with a resolution of about 10 bits. If it cannot obtain this accuracy then it will not be possible to align the VCOs. Look at the VCF output (the left hand side of R58). Turn off VCO2 and select a sawtooth from VCO1. Turn all high frequency track presets (PR5,6) anticlockwise (this turns them off). Select one-voice operation and remove all modulations and sweeps. Turn off the sync. Set the VCF to maximum frequency and resonance to minimum. Play the bottom note on the keyboard and bias the VCO to 100 Hz. Now play the note one octave up. It should shift the VCO by an octave, but it won't! This is because the pitch spread trim is wrong. The pitch spread trim for VCO1 is PR9. Turning it clockwise gives more VCO octaves per keyboard octave; it gives the VCO a sharper tuning. Turning it anticlockwise gives less VCO octaves per keyboard octave; it gives the VCO a flatter tuning. So if VCO1 is sharp one octave up turn PR9 anticlockwise. However, adjusting the preset also alters the bottom note. This makes the tuning of the VCOs rather difficult unless you have a good musical ear. If you are blessed with this then it is possible to tune the VCO by playing scales or octaves, listening to the VCO output and making suitable changes to the preset.

For those who were born with tin ears a more technical approach should be employed. A frequency meter can be used to set the VCOs to give 'almost' octave intervals. As the frequency meter gate is asynchronous to the VCO then the reading will be slightly different every time. A frequency meter with a 1 S gate will give 1 Hz accuracy for a 100 Hz signal. A 10 S gate will give 0.1 Hz accuracy but 10 S is a long time to wait for two gate periods (20 S). A frequency meter is useful to give you the tuning to within a fraction of a percent.

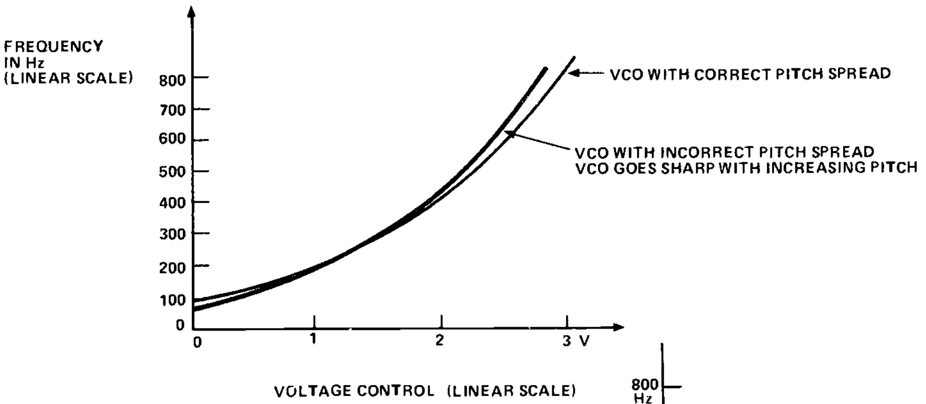


Fig.6 Exponential transfer function of a musical VCO.

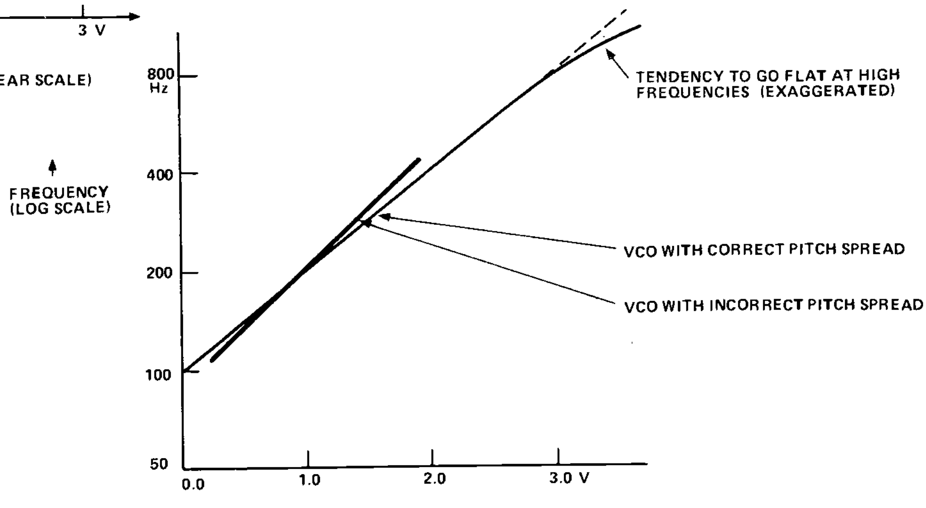


Fig.7 Pitch spread details.

The best method is to tune the VCOs relative to a fixed tone. I use a crystal oscillator divided down to 400 Hz. You can mix this with the VCO output so that you can hear the beats, or even better you can display the two frequencies on a dual beam oscilloscope.

Oscilloscope Method

Display the 400 Hz fixed reference squarewave on one beam and sync from it. Display the VCO to be aligned on the other beam. Press the bottom note on the keyboard and set the VCO to 100 Hz. The VCO output will remain almost stationary relative to the reference squarewave. It will drift slowly to the left or to the right, which should be corrected by fine tuning the VCO. Play a note one octave up and adjust the PR9 preset so that the VCO output is stationary (ie 200 Hz) relative to the reference signal. Now go back to the bottom note. The pitch of this will have been changed by PR9, and so retune the VCO (to 100 Hz) with the fine tuning pot. Repeat the process again and again until the VCO interval converges to one octave. When altering PR9 it is best to overcorrect as you will then converge more rapidly. Now the tuning can be more finely set up by repeating the process for higher octaves. When finally set up the VCO output will be almost static relative to the reference tone on all five octave notes. Best results are obtained by tuning the VCO to be static relative to the reference tone at the top end of the keyboard. In fact when tuning up a synthesiser, musicians always tune up the VCOs for unison at the top of the keyboard. Then any pitch spread errors will cause minimum beat frequencies. Tuning the VCOs at the bottom of the keyboard generates maximum beats.

Repeat the entire tuning process for VCO2 using PR8 to adjust the pitch spread. Then tune the other voices. If all the VCOs track relative to a fixed reference then they will track with each other. Select one-voice mode, using both VCOs. Turn on all four voices and press the top note on the keyboard. Tune all the VCOs to 1600 Hz so that they are slowly beating together (a total of eight VCOs). Now play the lower notes down the keyboard. If the VCOs track then they will continue to slowly beat. The pitch spread tuning should be such that over the keyboard's range the beat rate does not exceed 1 to 2 Hz. If the VCOs track properly the synthesiser can now be switched to four voice polyphonic operation.

Octave Transpose Switch

Set the octave transpose switch to 0. Tune a VCO to 200 Hz so that it slowly beats with the reference 400 Hz. Turn the octave transpose switch to +1 and adjust the preset (PR3 on board PS5) for an exact one-octave increase. Now set the switch to −1 and adjust the other preset (PR2 on board PS5) for an exact one-octave decrease. Set the number of voices to one, the octave transpose to 0 and turn on and tune all eight VCOs to be in unison. Now try the effect of the transpose switch and pot. All the VCOs should be transposed without a significant or objectionable increase in the beat rate. If the beat rate does become objectionable it will be because of an inaccurate transposition in one or more of the VCOs. This is due to the mismatch of resistor pairs R117/R113 or R112/R76 on the voice board, which should be matched to 0.01% for optimum results.

VCO Bias

Set the transpose pot and switch to maximum. Set all the tuning pots to maximum and play the top note on the keyboard. Adjust PR4 (for VCO1) and PR7 (for VCO2) on each voice board for a VCO pitch of 4 kHz. This is the maximum frequency of operation for the machine.

VCF Bias

Select one-voice operation. Tune all the VCO1s to 400 Hz (ramp waveform). Turn on the VCF TRACK switch. Set the ADSR SWEEP pot to off and the VCF frequency pot to its central position. Turn the resonance control to maximum. Adjust PR2 so that the VCF rings with the eighth harmonic of the ramp (3200 Hz). Repeat this for the other voices. Now try altering the filter frequency. The VCF on each voice should generate the same tone.

HF Track

Set the bottom note of the keyboard to 200 Hz and tune it against the 400 Hz reference note. Now play the top note (3200 Hz). The VCO may have gone slightly flat in which case adjust the HF TRACK preset to restore the high frequency tuning. Repeat this for every VCO. The Curtis data sheet recommends aligning the HF tracking at 10 kHz. This is, however, outside the tuning range of the Polysynth. At 4 kHz (the maximum frequency of the machine) it may not be necessary to use the HF track. The HF presets are PR9 for VCO1 and PR6 for VCO2.

Drift

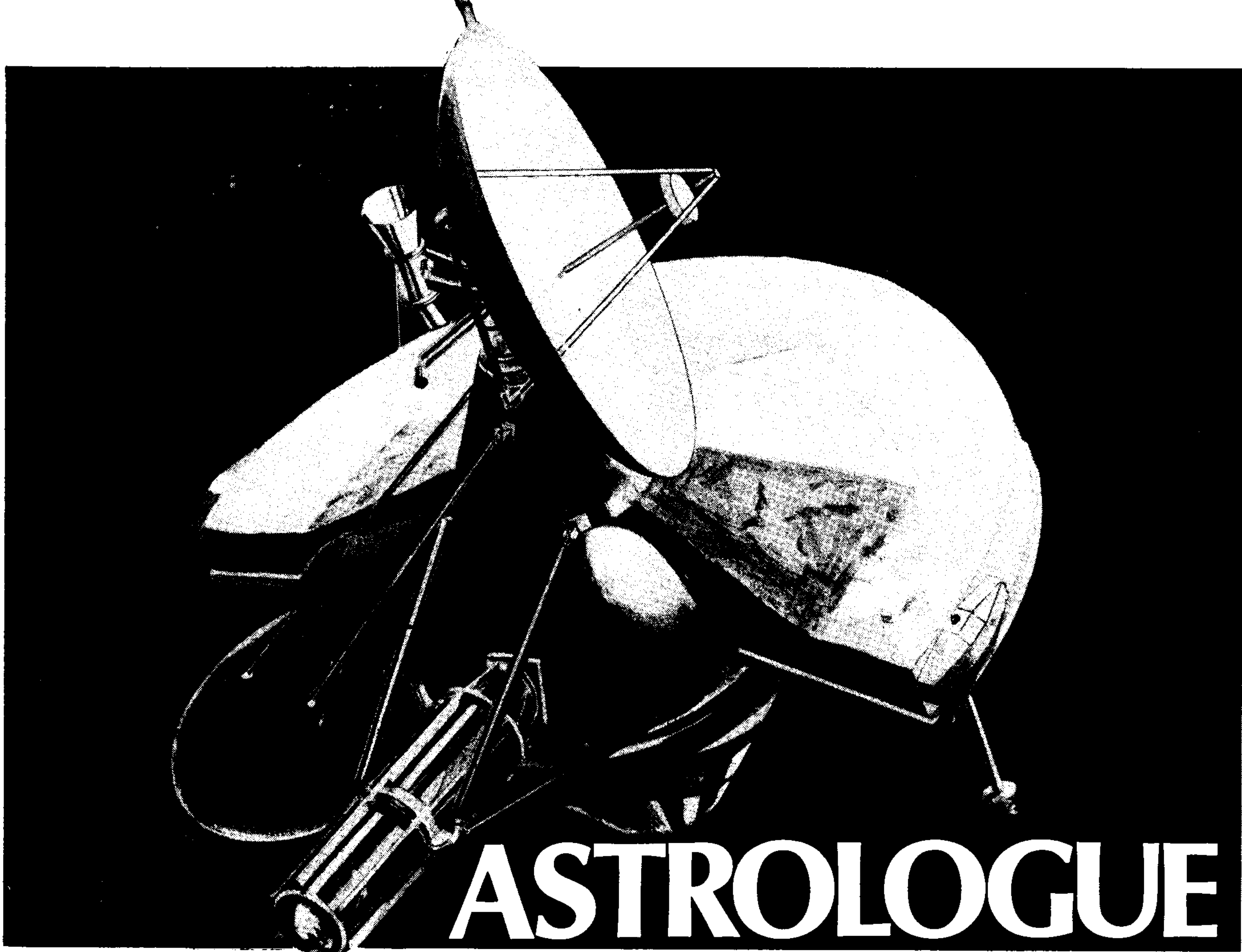
Both the absolute frequency and the pitch spread drift with time and temperature. There is a turn-on drift caused by the warming up of the VCO chips and the power supply. The −5 V rail will change slightly as it warms up and this causes a frequency and pitch spread change. The same is true for the ± 15 V rails but to a lesser extent. The VCO bank should be finally aligned after the chips have been burnt in for 24 hours and after the unit has been powered up for at least 10 minutes.

Long-term drift is caused by the ageing of the ICs and precision components and the voltage references in the power supplies. This will probably necessitate slight recalibration of the unit every six to twelve months.

Portamento

The portamento circuits are designed to generate virtually zero voltage change between input and output at all portamento speeds. If eight voices are set up to play in unison they will track over the keyboard range when the portamento is set to fast or slow. On the slow setting, a full-range keyboard transition will take place about 2 S.

Set the synthesiser up for four voice operation and tune up the voices on the top note. Now with the portamento slow (anticlockwise) play a four-note chord in the bottom octave. The four VCOs will shoot off from the top note and zoom down and land exactly on the chord. Lots of wild sounds can be generated using this polyphonic portamento facility. **ETI**



Ian Graham reports on the next flight to Jupiter in 1984, the latest news of Ariane and developments in the Soviet Soyuz programme.

In March 1984 the space shuttle cargo bay doors will open and a spacecraft will emerge on its way to Jupiter. Three and a half years later the Galileo probe will begin its descent to the Jovian surface. The spacecraft is to be built by the Hughes Aircraft Company. It will be based on the design used during the Pioneer Venus planetary multiprobe programme in 1978. It will comprise two components — the probe itself and the probe carrier. 10 days before Jupiter encounter the two components separate. The probe is sent on its way to the planet. As it descends through the atmosphere it will transmit data to the carrier which will relay the data back to Earth across 560 million miles.

NASA's Galileo programme is named after the founder of experimental physics and astronomy who discovered four of Jupiter's 13 known moons in the early seventeenth century. The probe's seven experiments are designed to investigate the planet's atmosphere, magnetic field, satellites and radiation belts. The mission also includes a Jupiter orbiter, built by the Jet Propulsion Laboratories (JPL) in California. The orbiter will take close-up photographs of the planet and its satellites.

Originally the orbiter and carrier/probe were to be launched during a single shuttle flight using a common Inertial Upper Stage (IUS). However, shuttle programme delays have meant postponing the launch from 1982 to 1984 and separating the mission into two different launches.

March, April, . . . Blast-Off

Talking of the Space Shuttle — how are preparations for the first flight going? The orbiter has now been attached to the external tank. If all goes well (always a dangerous thing to say where the shuttle is concerned) the system interfaces will be checked out and then the shuttle/external tank assembly will be moved to launch pad 39A where it will undergo a pre-flight engine trial burn before the launch itself. Plans still call for a March 14th launch. Any further delays will undoubtedly push the big day back.

European News

I reported in ETI January that the Ariane rocket crash was due to vibration in the first stage engine. Two high frequency phenomena have been identified. One in the 2300 Hz band has been rectified. The other at 2700 Hz still needs some work. In view of that the third flight test will probably take place in June 1981 and the fourth will follow in the Autumn of the same year. If the programme is not delayed any further, ESA will still be able to meet its commitments to launch scientific and telecommunications satellites in late 1981 and 1982. Despite the extra expenditure involved in rectifying the engine faults, the programme will remain within the overall financial envelope fixed at its outset. A 20% margin was built in for unexpected contingencies.

Spacelab

The American and European payload specialists who will crew Spacelab are undergoing training at the Centre National D'Etudes Spatiales (CNES) at Toulouse and at the CNRS Laboratoire D'Astronomie Spatiale (LAS) at Marseilles in preparation for the first mission.

O. Garriot, B. Parker	: mission specialist selected by NASA.
M. Lampton, B. Lichtenberg	: NASA payload specialists (one of whom will be selected for the first mission).
Dr. U. Merbold, C. Nicollier, Dr. W. Ockels	: ESA payload specialists (one of whom will be selected for the first mission).
D. Frimount, C. Lewis	: responsible for the co-ordination and training of the ESA and NASA Spacelab crews respectively.

When the 11 French experiments for the first flight have been built and tested, they will be delivered to ESA at the Toulouse Space Centre and sent to NASA for a final check and integration with Spacelab. If all goes to plan, the first Spacelab payload will be launched in June 1983.

Soyuz T3

The successful completion of the latest Soyuz/Salyut mission involved the use of a new spacecraft design, returning the crew to its full complement of three men. The last three-man Soyuz craft flew in 1971. At the end of the record-breaking flight (the crew spent 24 days in space) an air valve failed during re-entry. As crews did not carry spacesuits, the Soyuz 11 crew died during the rapid depressurisation of the spacecraft. The landing continued under automatic control.

There was some Press speculation at the time that the deaths were due to the debilitating effects of long spaceflights, perhaps weakening cosmonauts to the point where they could not withstand the sudden exposure to G forces during re-entry. However, NASA was able to verify the Soviet accident report, to which they insisted on access before the joint Apollo-Soyuz mission. Hardware modifications tested on Cosmos 496 and 573 and implemented on Soyuz 12 included an improved valve system. Crews began to carry spacesuits with a direct oxygen supply. These changes took up so much space that the crew had to be reduced to two men.

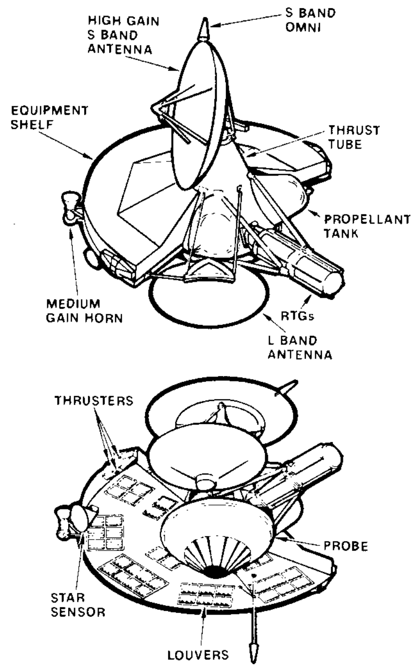


Fig.1 Structural details of the Galileo probe carrier. The conical probe hangs underneath.

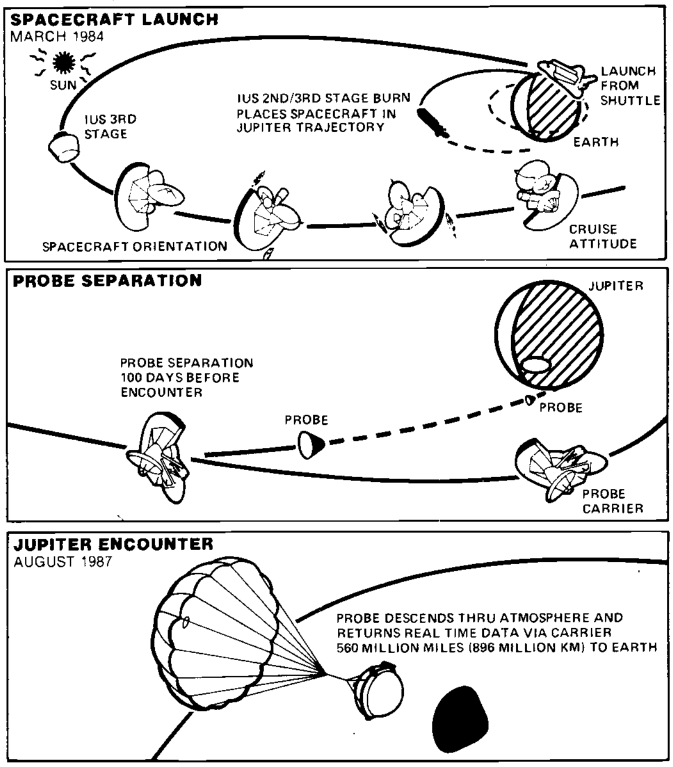


Fig.2 Flight plan of the Galileo Jupiter exploration mission. Unlike the spectacular Voyager and Pioneer fly-bys, the Galileo probe will actually enter the Jovian atmosphere and send data back to Earth via its carrier spacecraft.

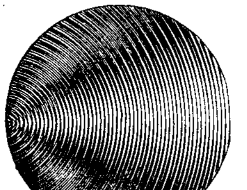
The new Soyuz T3 spacecraft is the same size and weight as the older design but it incorporates smaller, lighter components. New features include an on-board computer, new life support system, new orbital manoeuvring system and a new pressure suit. The first three Soyuz T3 crewmen (Kizim, Makarov and Strekalov) carried out several experiments in the Salyut 6 space station between November 28th and December 11th, including making the first hologram in orbit.

SHORTS

Ireland has become the eleventh member of the European Space Agency (ESA). Although Ireland signed the convention which brought ESA into being in December 1975, its application was not ratified until December 1980. Ireland's contribution to ESA comes to 0.54% of the total budget. In addition, Ireland participates in the remote sensing programme and in the Ariane production programme for the promotional series of six launches.

The International Maritime Satellite Organisation (INMARSAT) is to lease two MARECS satellites (MARECS A and B) from ESA in 1982. The deal will be worth about 65 million dollars and represents part of INMARSAT's new world-wide maritime telecommunications service for the international shipping community. MARECS A will be placed over the Atlantic ocean and MARECS B over either the Indian or Pacific ocean. The advantage of the MARECS system is its flexibility, in that MARECS satellites can, during their lifetime, be moved from one ocean area to another. Each satellite has a capacity of approximately 50 channels and will provide direct connections to subscribers on both telephony and telex and will also enable ship-to-shore search and rescue messages to be relayed quickly.

ETI



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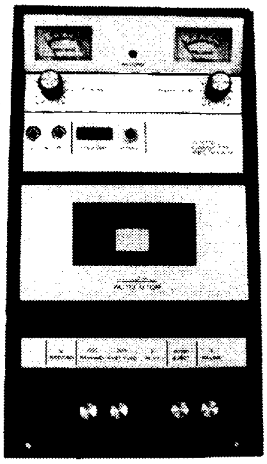

6 piano type keys

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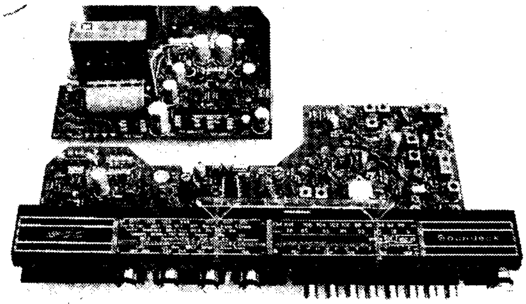

GEC AM/FM STEREO TUNER AMPLIFIER CHASSIS. Originally designed for installation into a music centre. Supplied as two separate built and tested units which are easily wired together. **Note:** Circuit diagram and interconnecting wiring diagrams supplied. **Rotary Controls:** Tuning, on/off volume, balance, treble, bass. **Push-button controls:** Mono, Tape, Disc., AFC, FM (VHF), LW, MW, SW. **Power Output:** 7 watts RMS per channel, at better than 2% THD into 8 ohms. 10 watts speech and music. **Frequency Response:** 60Hz-20kHz within ±3dB. **Tape Sensitivity:** Output — typically 150 mV. Input — 300 mV for rated output. **Disc Sensitivity:** 100mV (ceramic cartridge). **Radio:** FM (VHF), 87.5MHz — 108MHz. Long wave 145kHz — 108kHz. Medium wave 520kHz — 1620kHz. Short wave 5.8MHz — 16MHz. **Size:** Tuner — 2¾in x 15in x 7½ in approx. Power amplifier — 2in x 7½in x 4½in approx. 240V AC operation. Supplied complete with fuses, knobs and pushbuttons, and LED stereo beacon indicator. **Price £23.50** plus £2.50 postage and packing.

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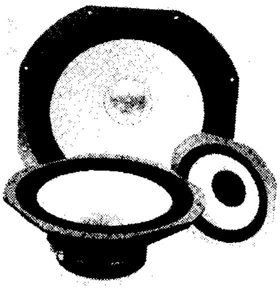
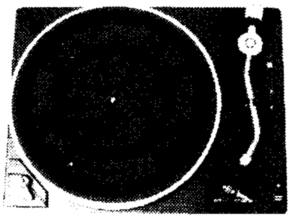


15" 100 watt. Impedance 8ohm. 50 oz. magnet. 2" aluminium voice coil. Resonant Frequency 20Hz. Frequency Response to 2.5KHz. Sensitivity 97dB. **Price £32 each.** £2.00 Packing and Carriage each.

12" 100 watt. Impedance 8 ohm. 50 oz. magnet. 2" aluminium voice coil. Resonant Frequency 25Hz. Frequency Response to 4KHz. Sensitivity 95dB. **Price £23.70 each.** £2.00 Packing and Carriage each.

8" 50 watt. Impedance 8 ohm. 20 oz. magnet. 1" aluminium voice coil. Resonant Frequency 40Hz. Frequency Response to 6KHz. Sensitivity 92dB. **Price £8.90 each.** £1.00 Packing and Carriage each.



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Size — 12¾in x 15¾in (approx).
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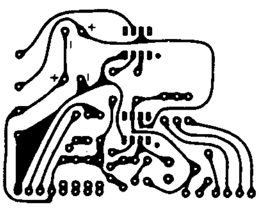

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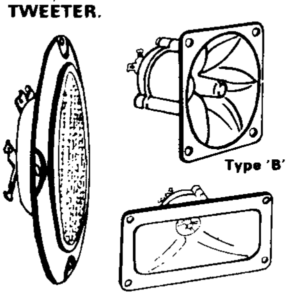

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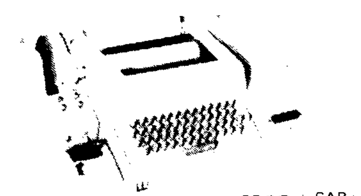

£235 + CAR + VAT

Fully fledged industry standard ASR33 data terminal. Many features including: ASCII keyboard and printer for data I/O, auto data detect circuitry, RS232 serial interface, 110 baud, 8 bit paper tape punch and reader for off line data preparation and ridiculously cheap and reliable data storage. Supplied in good condition and in working order. Options: Floor stand £12.50 + VAT
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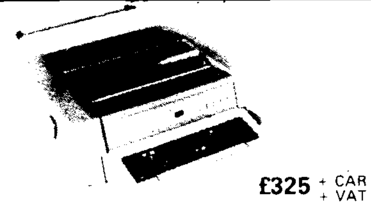

£325 + CAR + VAT

Made under licence from the world famous GE Co. The ICL Termiprinter is a small attractive unit with so many features it is impossible to list them in the space available! Brief spec. as follows; RS232 serial interface, switchable baud rates 110, 150, 300, (30 cps), upper and lower case correspondence type face, standard paper, almost silent running, form feed, electronic tab settings, suited for word processor applications plus many more features. Supplied in good condition and in working order. Limited quantity.

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CONNECT DIRECT TO YOUR MICRO

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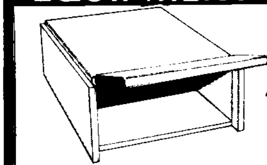

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★50/60 HZ

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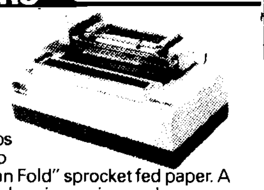

This must be one of our greatest bulk deals, this fabulous printer is listed at over £1800 and judging by the construction we are not surprised. Made under license from the LOGABAX Co. the DMZ180 is an exceptionally sturdy high speed 180 cps matrix printer, capable of printing up to 132 characters per line on standard "Fan Fold" sprocket fed paper. A precision 7 × 7 matrix head using ruby bearings, gives a clear concise type font. Many other features include internal buffer for high throughput, standard ink ribbon, software controllable form and tab functions, standard "CENTRONICS" ASCII parallel interface etc. etc.
Optional extras **Floor Stand £30.00 + VAT, Paper Stand £18.00 + VAT**

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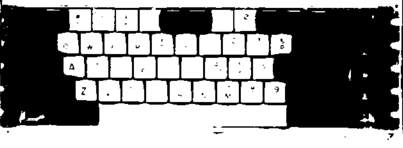

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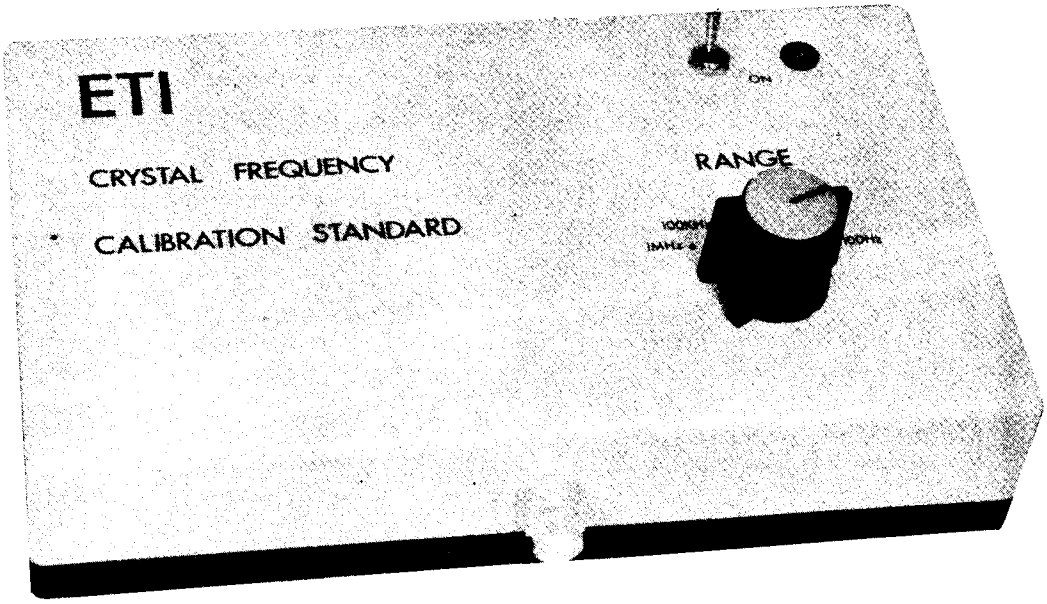
Following the recent "SELL OUT" demand for our 5v 3 amp P.S.U. we have managed to secure a large quantity of ex-computer systems P.S.U.'s with the following spec., 240 or 110v A.C. input. Outputs of 5v @ 3-4 amps, 7.2v @ 3 amps and 6.5v @ 1 amp. The 5v and 7.2v outputs are fully regulated and adjustable with variable current limiting on the 5v supply. Unit is self contained on a P.C.B. measuring only 12" × 5" × 3". The 7.2v output is ideal for feeding "on board" regulators or a further 3 amp LM323K regulator to give an effective 5v @ 7 amp supply.
Supplied complete with circuit at only **£10.95 + £1.75pp.** Believed working but untested, unguaranteed.

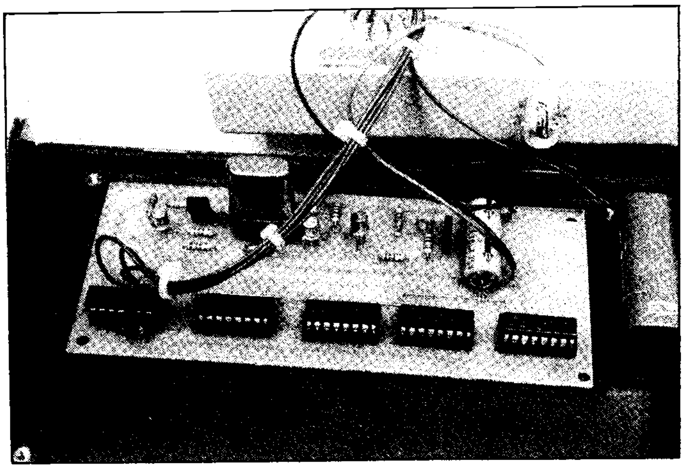
CRYSTAL CALIBRATOR

A simple but useful piece of test gear. Ideal for spot calibrating radio dials, 'scope timebases, etc. Design by Ray Marston. Development by Steve Ramsahadeo.



This simple piece of test gear produces a square wave output with any one of six selected frequencies or periods. The outputs which range from 100 Hz (10 mS) to 1 MHz (1 uS), are derived from a crystal oscillator via decade divider stages and thus have a high degree of frequency/period precision. The instrument is thus specifically intended to be used as a precision frequency/period standard, for calibrating items such a radio dials, 'scope timebases, etc.

To calibrate a radio dial, loosely couple the output of the instrument to the radio antenna (i.e., dangle a bit of output wire near to the aerial), switch to the 1 MHz range and then tune the radio through its ranges, marking off the dial points at which the 1 MHz signal and its harmonics (up to about 30 MHz) are heard as a heterodyned 'zero beat' audio signal.



Then repeat the procedure at lower standard frequencies (100 kHz, 10 kHz, etc) until the dial is adequately calibrated.

To calibrate a 'scope timebase, simply connect the output of the calibration standard to the Y amplifier of the 'scope and then run through the timebase ranges, checking that the indicated periods agree with those of the calibrator.

Construction

This is a fairly simple project and construction should present few problems. Most components are mounted on a single PCB. Note here that five links are used on top of the PCB and that the crystal and the five ICs must all be mounted in suitable sockets.

When the PCB construction is complete, mount it in a suitable box and make the interconnections to SW1, SW2 SK1 LED1-R9 and B1. The unit is then ready for use.

The basic instrument has a typical accuracy of better than 0.01% with the C2 value shown. If you want better accuracy than this and have access to a precision frequency standard (such as Droitwich, which has an accuracy that is within 2 parts in 10^{11}), replace C2 with a 100pF trimmer and adjust it to give a precise 1 MHz crystal oscillator frequency.

For those of you who have always wanted to know what the inside of a crystal calibrator looks like but were too bashful to ask, here it is. You could go mad with a power drill (or sharpened boy scout) drilling holes for PCB bolts and battery clips. We've found sticky pads to be perfectly adequate. →

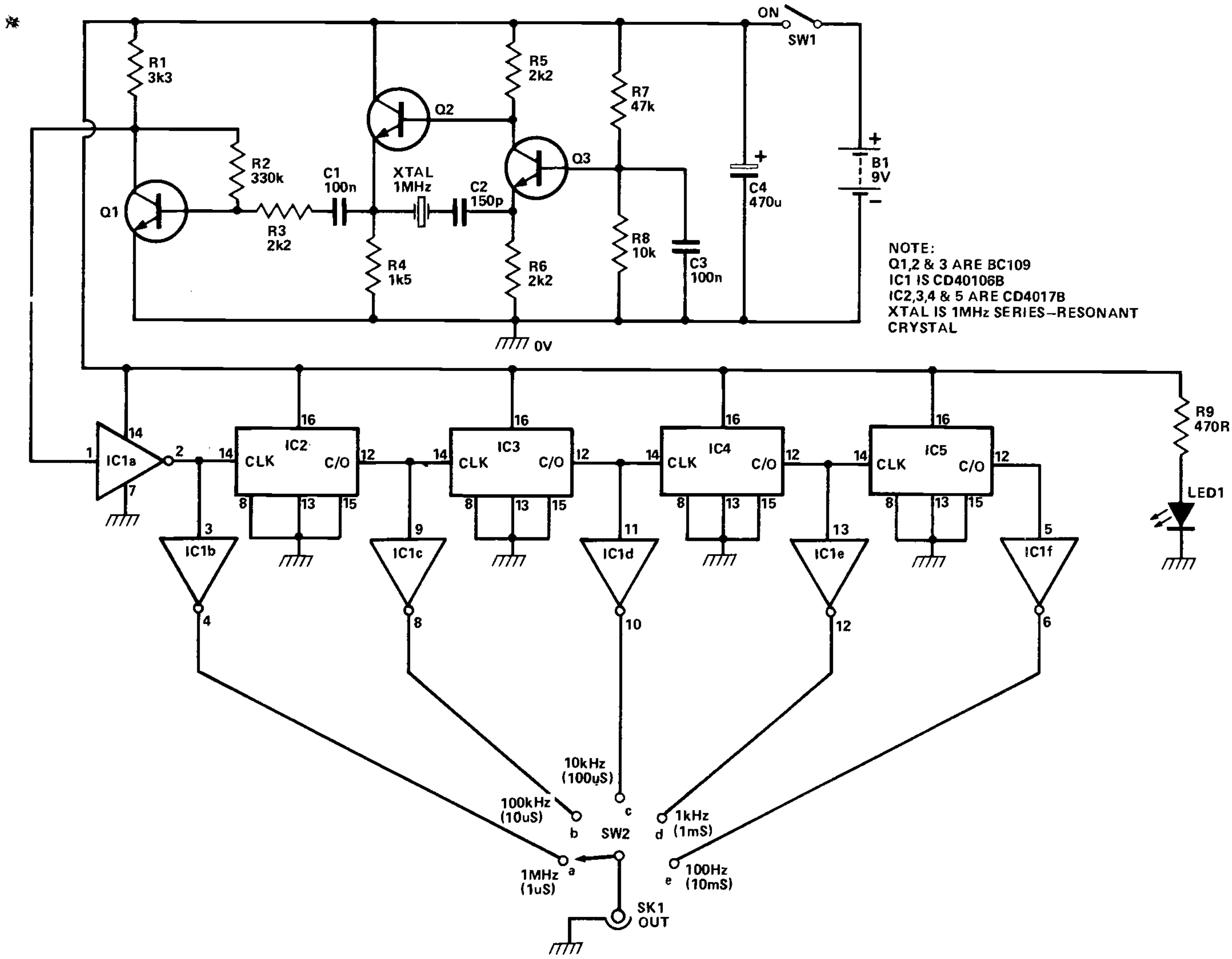


Fig.1 Circuit diagram. R9 is mounted off-board between LED1 and SW1.

HOW IT WORKS

The heart of the instrument is the crystal oscillator designed around Q2-Q3. Q3 is wired as a common base amplifier. Its collecter signal is buffered by emitter follower Q2 and then coupled back to Q3 emitter via the series-resonant 1 MHz crystal, thereby causing Q2-Q3 to oscillate at the crystal frequency. The oscillator output signal is then amplified by Q1 and converted to a clean square wave by Schmitt trigger IC1a.

The 1 MHz square wave from IC1a is used to clock a chain of cascaded decade dividers to generate standard frequencies of 100 kHz, 10 kHz and 100 Hz. All of these signals are made available at output socket SK1 via SW2 and are individually buffered by Schmitt inverters (IC1b to IC1f).

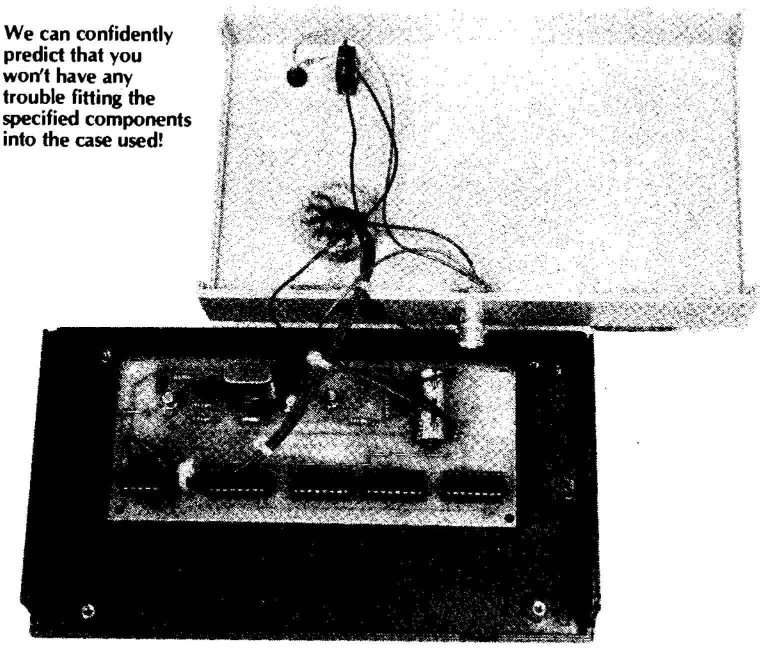
The instrument is powered from a single 9 V battery. LED 1 illuminates while SW1 is closed.

BUYLINES

The case for the Crystal Calibrator was selected from West Hyde Developments (order as Box 434).

Mail order companies such as Maplin, Watford and Electrovalue are able to supply the 1 MHz Crystal.

We can confidently predict that you won't have any trouble fitting the specified components into the case used!



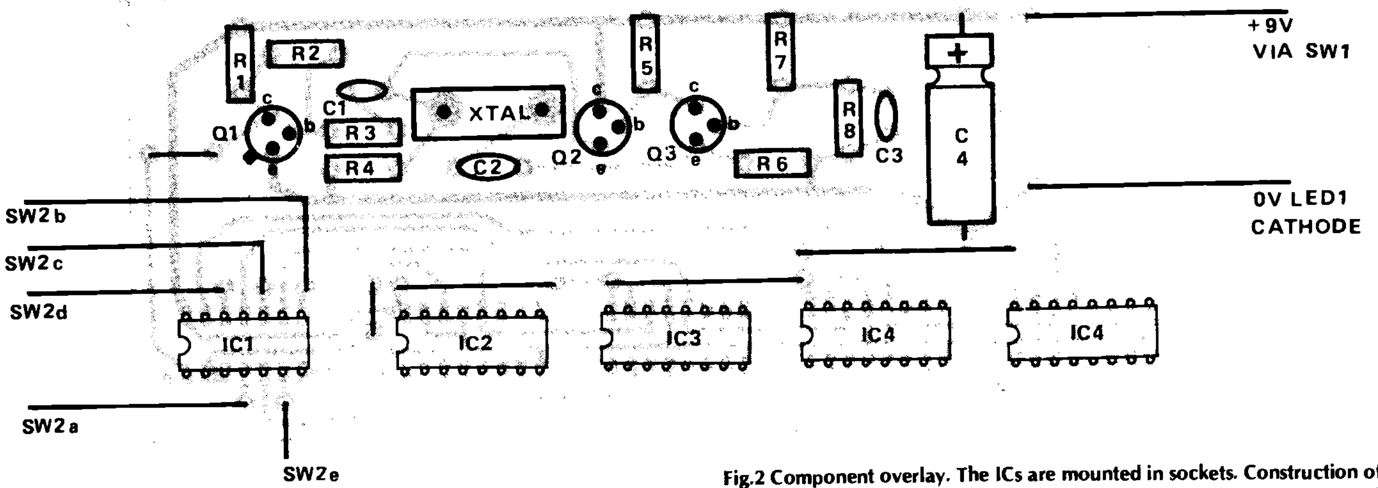


Fig.2 Component overlay. The ICs are mounted in sockets. Construction of the board is fairly straightforward.

PARTS LIST

Resistors all ¼ W 10%		**Semiconductors**	
R1	3k3	IC1	CD40106B
R2	330k	IC2,3,4,5,	CD4017B
R3,5,6,	2k2	Q1,2,3	BC109
R4	1k5	XTAL	1 MHz
R7	47k	LED 1	TIL 220
R8	10k		
		Miscellaneous	
		SW1	SPST miniature toggle
Capacitors		SW2	1 pole rotary switch
C1,3	100n ceramic	Case	(see Buylines)
C2	150p polystyrene	SK1	BNC (50R) Socket
C4	470u 25 V electrolytic	knob to suit	

ETI

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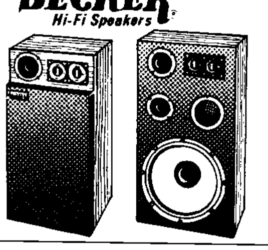

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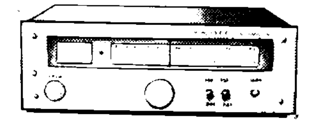

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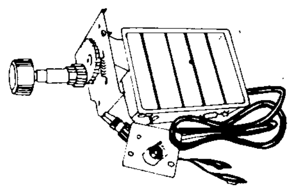

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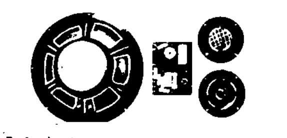

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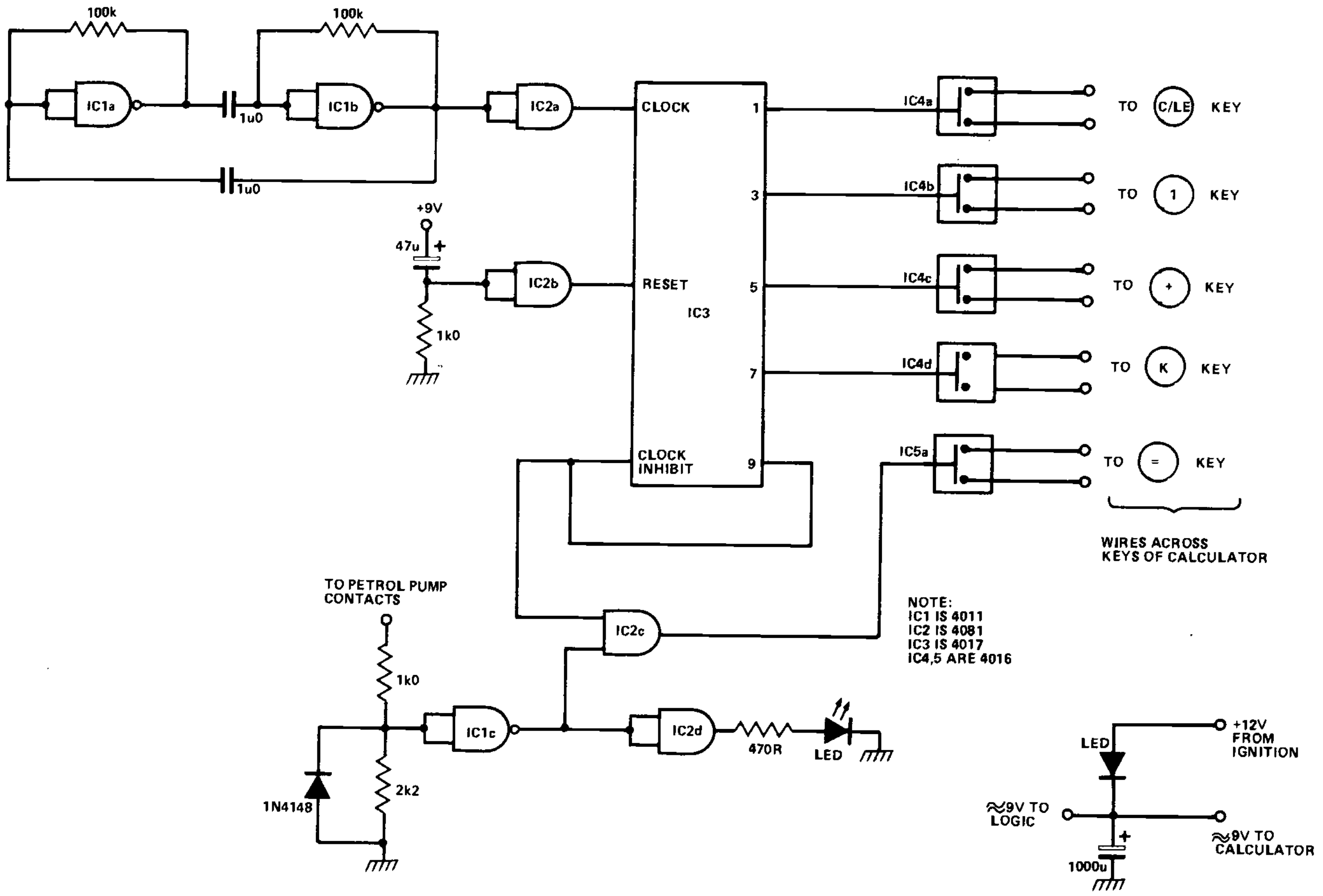


Trip Petrol Meter

S.J. Stamps, Portishead

This circuit can be used to measure the amount of fuel used in a single car journey with greater accuracy than that of the standard petrol gauge. The circuit counts the number of pulses of the (electric) petrol pump over the journey, using a converted calculator to give a digital display. Interesting results can be obtained by taking measurements of the same journey whilst varying the route or just the driving style.

Circuit operation depends on the 'junk' calculator chosen — a suitable calculator can be bought for the price of a couple of seven-segment displays alone.

The function of most of the circuitry is to initiate the calculator chip to increment by one on each simulated press of the = key. I used a TI30 machine, so the sequence on power up was; C/CE , 1 , + , K. On power-up the reset pin of the 4017 is held high. As the capacitor charges, the reset pin goes low and the counter counts from zero. As each output goes high the respective switch of the 4016 is enabled, simulating a key press. When the counter reaches '9', the clock is disabled and the pulses from the petrol pump are enabled to switch the = key. Now each time the petrol pump pulses, the displayed value on the calculator is incremented by one. At the end of the journey the displayed value thus reflects the volume of petrol consumed since switch-on.

Ballpoint Spacers

W. McEwan, Argyll

The use of dried-out ballpoint pen plastic bodies as test prods is well known. Recently, I discovered that they also make excellent spacers for printed circuit boards. Simply cut them to size with a Junior hacksaw — excellent for awkward lengths. The internal hole is suitable for either M3 or M4 bolts.

Tech-Tips is an ideas forum and is not aimed at the beginner. We regret we cannot answer queries on these items. ETI is prepared to consider circuits or ideas submitted by readers for this page. All items used will be paid for. Drawings should be as clear as possible and the text should preferably be typed. Circuits must not be subject to copyright. Items for consideration should be sent to ETI TECH-TIPS, Electronics Today International, 145 Charing Cross Road, London WC2H 0EE.

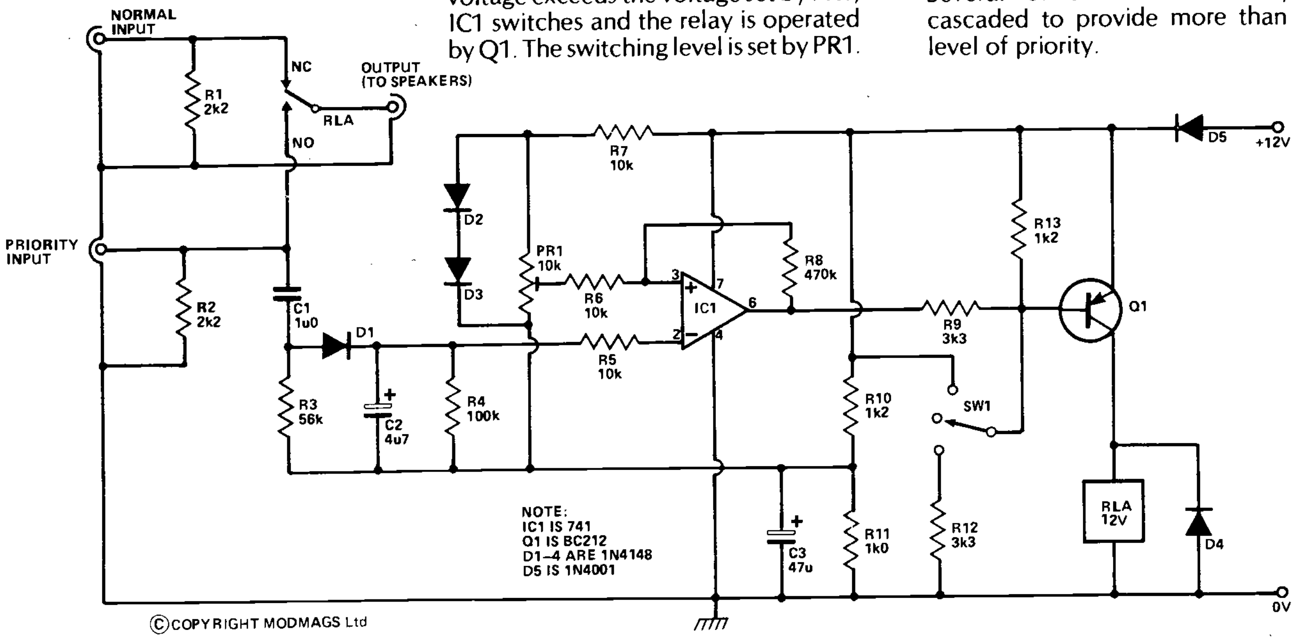
Priority Audio Switch

T.P. Hopkins, Manchester.

This circuit switches a single loudspeaker from a 'normal' to a 'priority' circuit whenever a signal appears on the priority input. The prototype was used to switch between a cassette player and a two-way radio whenever a call was received. Other uses include priority calls in PA systems, monitoring several infrequently-used radio channels, etc.

Audio from the priority input is rectified and applied to the Schmitt trigger circuit, IC1. If the rectified voltage exceeds the voltage set by PR1, IC1 switches and the relay is operated by Q1. The switching level is set by PR1. The hysteresis is controlled by R8 and the delay before the relay switches back to the normal channel at the end of a priority call depends on C2 (approximately 2 S with the value shown).

If stereo outputs from the cassette recorder, etc. are to be switched, RLA will require two changeover contacts. Several of these circuits may be cascaded to provide more than one level of priority.



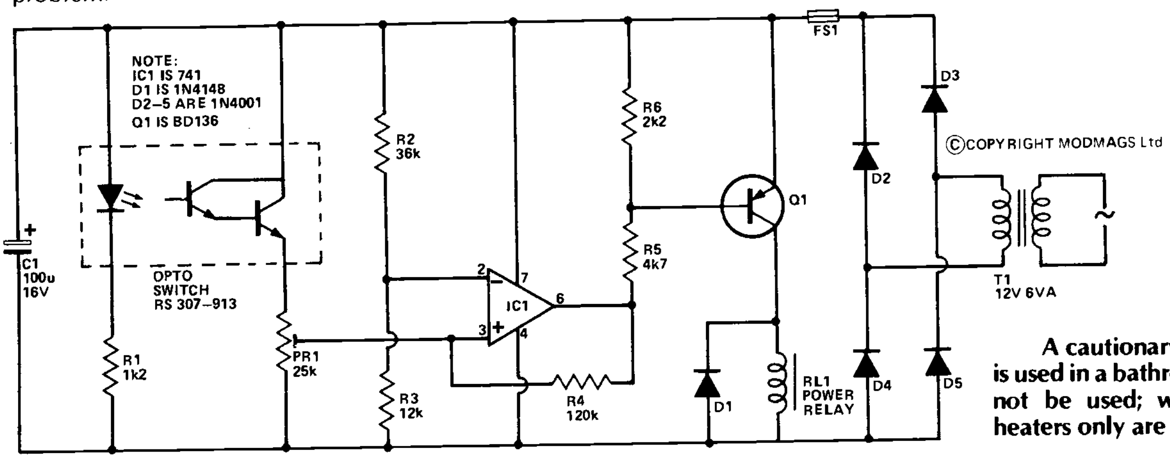
Condensation Detector

T.M.H. Jenvey, Langport.

This circuit was designed to prevent condensation on a glider when stored in its trailer, by switching on a fan heater as soon as condensation occurs and off again when the condensation has evaporated, but it is equally applicable to kitchens, bathrooms or anywhere with a condensation problem.

The detector is built around an RS307-913 reflective opto-switch. This consists of an infra-red diode and a photo Darlington transistor in one package arranged so that when a reflector is placed close to the switch (optimum distance 4.6 mm) the photo Darlington is turned on. In this device the reflector is a small piece of highly polished stainless steel, the reflectivity of which is reduced when misted by condensation, thus switching the heater on.

A reference voltage of about 4 V is applied to the inverting input of the 741 op amp from the voltage divider R2 and R3. The voltage at the non-inverting input can swing either side of the reference voltage depending upon the conduction state of the photo Darlington and the setting of the sensitivity control, PR1. Positive feedback is obtained via R4, providing Schmitt trigger action to prevent relay chatter at the changeover point. The rest of the circuit is straightforward, but ensure that the relay is adequately rated.



A cautionary note — if the device is used in a bathroom a fan heater must not be used; wall mounted radiant heaters only are permissible.

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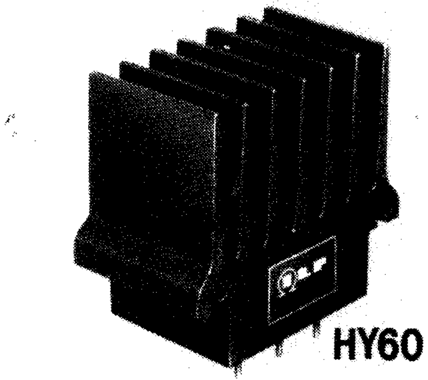

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Model	Output Power RMS	Distortion Typical at 1KHz	Slew Rate	Rise Time	Signal/Noise Ratio DIN AUDIO	Price & VAT
MOS120	60W into 4-8Ω	0.005%	20V/μs	3μs	100dB	£25.88 + £3.88
MOS200	120W into 4-8Ω	0.005%	20V/μs	3μs	100dB	£33.46 + £5.02

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Model	Output Power RMS	Distortion Typical at 1KHz	Slew Rate	Rise Time	Signal/Noise Ratio DIN AUDIO	Price & VAT
HY30	15W into 4-8Ω	0.015%	15V/μs	5μs	100dB	£7.29 + £1.09
HY60	30W into 4-8Ω	0.015%	15V/μs	5μs	100dB	£8.33 + £1.25
HY120	60W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£17.48 + £2.62
HY200	120W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£21.21 + £3.18
HY400	240W into 4Ω	0.01%	15V/μs	5μs	100dB	£31.83 + £4.77

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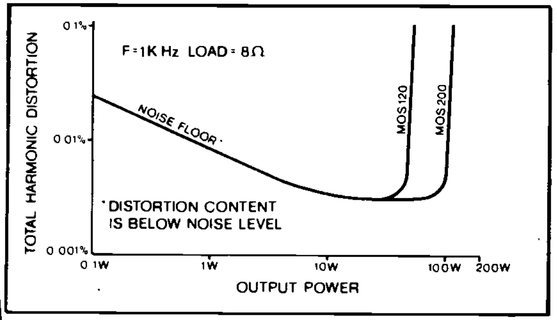
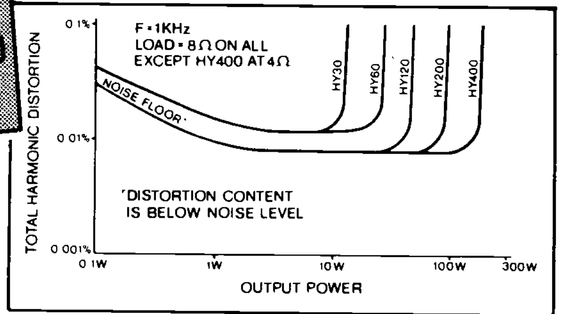


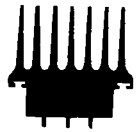
Load impedance both models 4Ω - ∞ Input sensitivity both models 500mV

Input impedance both models 100KΩ Frequency response both models 15Hz-100KHz – 3dB



Load impedance all models 4Ω - ∞ Input sensitivity all models 500mV

Input impedance all models 100KΩ Frequency response all models 15Hz-50KHz – 3dB



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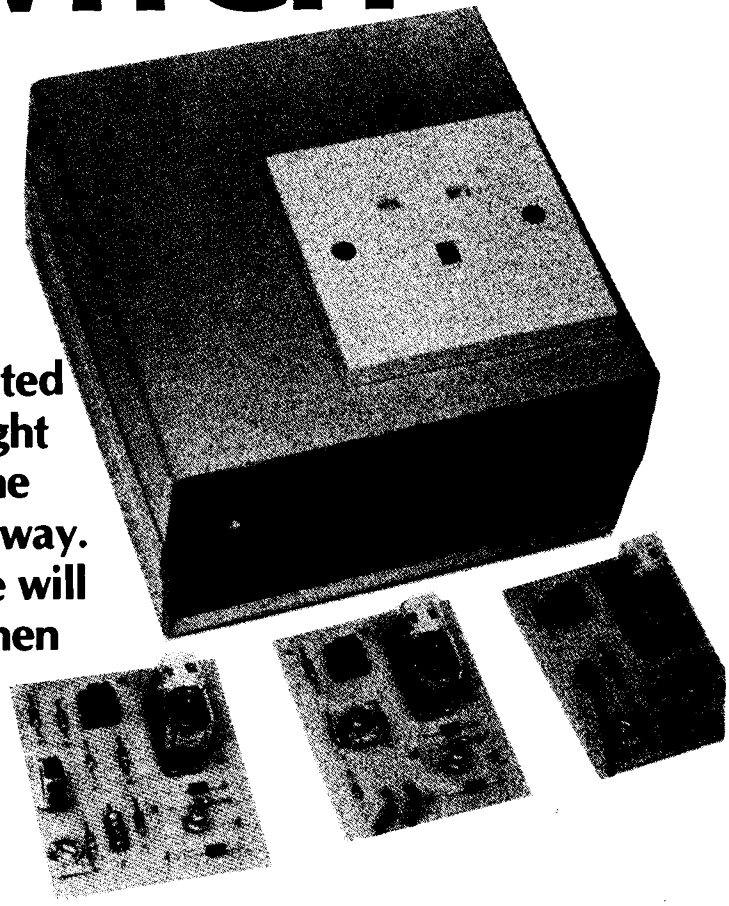
POWER SWITCH MODULES



You can use your ETI Noiseless Power Switch on its own OR trigger it automatically with one of three remote control modules. Use the Dark Activated Module to switch your lights on at night and off in the morning to deter the neighbourhood villains when you're away. The Differential Temperature Module will switch off your living room heater when the weather outside verges on the tropical and the Under Temperature Module will sound a red alert when your front path ices over. No doubt you can think of a hundred and one uses for this versatile family of projects around the home. Your options are endless.

DIFFERENTIAL TEMPERATURE MODULE

Activate extractor fans or fire alarms automatically with this easy-to-build unit. The device can be used either as a stand-alone project or to interface with the Noiseless Power Switch described elsewhere in this issue. Design by Ray Marston. Project development by Plamen Pazov.

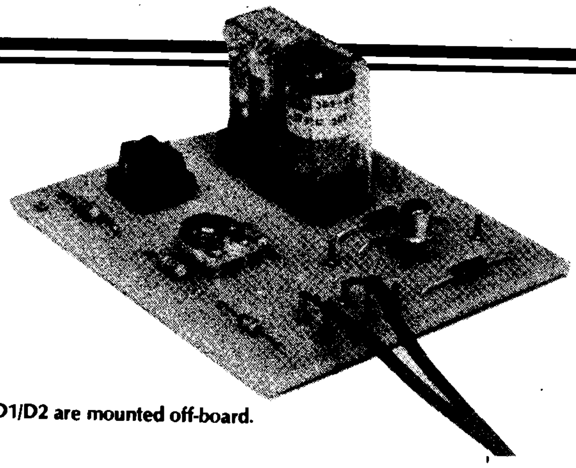
This useful little project uses a pair of inexpensive silicon diodes to monitor temperatures at two different points and turns a relay on when the temperature of D1 goes above that of D2 and off when the temperature of D1 goes below that of D2. The circuit responds to relative, rather than absolute, temperatures. The temperature switching differential of the unit can be varied over a limited range by a preset pot.

The circuit has a variety of practical uses. It can be used as an automatic fire alarm (using the relay contacts to activate a bell, etc) by placing D1 at the top of an internal wall and D2 half-way down the wall, so that the alarm is activated by excessive rising heat. Alternatively, the unit can be used to give automatic operation of heat extractors or ventilators in cellars or workshops, etc, by placing D1 in the cellar and D2 outside the building, so that the extractor only operates when the inside temperature is greater than that outside.

The basic circuit can be used as a stand-alone project, with a relay output, or can be used without the relay and its associated transistor-diode network to give fully automatic operation of the Universal Noiseless Power Switch described elsewhere in this issue.

Construction

Construction of this project should present absolutely no problems if the specified components are used (IC1 MUST be a CA3140). If you intend to construct the unit as a stand-alone (relay output) project, build it as shown in the overlay, noting the →



Here, D1/D2 are mounted off-board.

use of the PCB-mounting relay. If you want to use the unit to interface to the Universal Noiseless Power Switch, simply cut the PCB in half along the dotted line, assemble all indicated components on the non-relay side of the board and connect the unit to the Power Switch via the SK1 connections shown in the circuit diagram.

Whatever form of construction you use, note that Veropins should be used to facilitate the connections to D1 and D2 and that these two temperature-sensing diodes will normally be mounted remotely from the PCB.

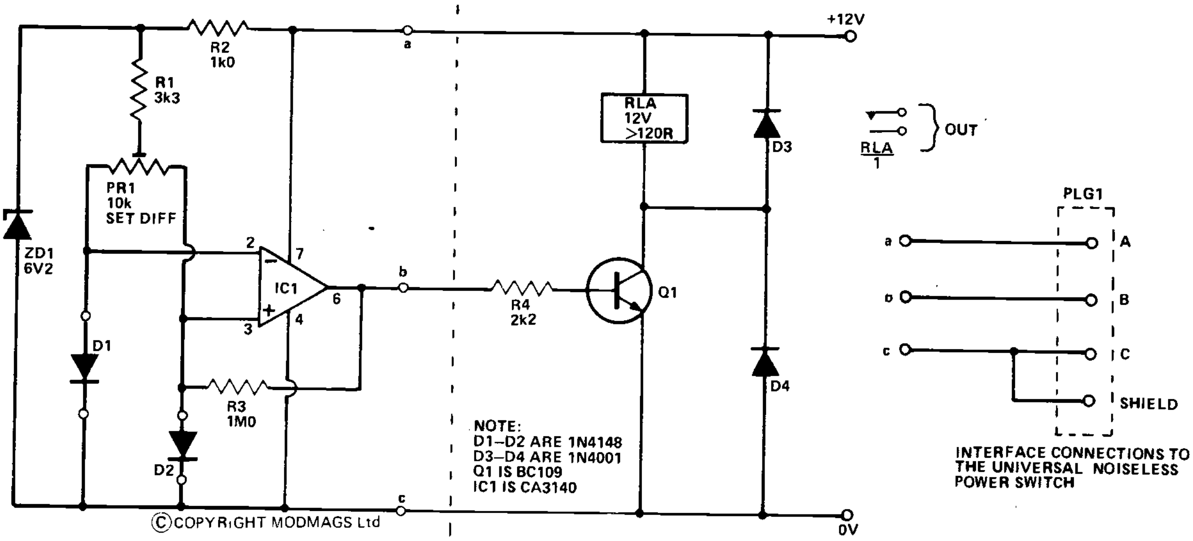


Fig.1 Circuit diagram. If required, PLG1 is used to connect the module to SK1 on the Noiseless Power Switch.

BUYLINES

The components for this project should not present any supply problems. The relay used is an RS 349-658 or Maplin order code YX98G type.

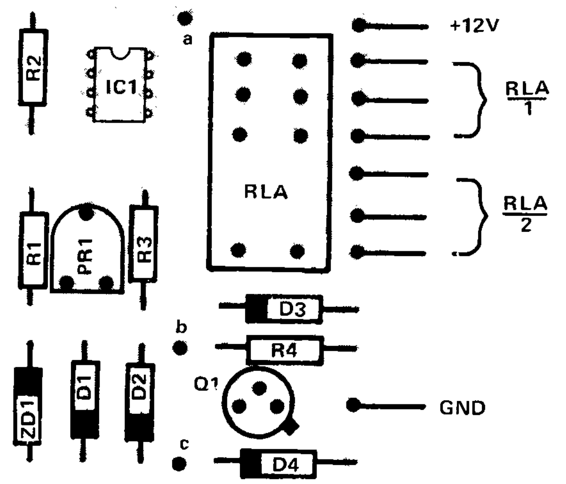


Fig.2 Component overlay. Note that one or both of D1, D2 will normally be mounted off-board.

HOW IT WORKS

Ordinary silicon diodes have temperature coefficients of -2 mV/°C and can readily be used in temperature measuring/switching applications. In our circuit the two sensing diodes (D1 and D2) are fed with similar standing currents (via ZD1-R1-PR1) and their voltage differentials are fed to voltage comparator IC1, which has a small degree of hysteresis applied by R3.

The circuit action is such that, when the D1 temperature is above that of D2, the D1 voltage is below that of D2 and the output of IC1 (pin 6) is driven high and turns Q1 and the relay on via R4. When the D1 temperature is below that of D2, the D1 voltage is above that of D2 and the output of IC1 is driven to 0 V, cutting off Q1 and the relay.

The temperature differential of the circuit can be varied over a limited range by PR1, thereby altering the relative standing currents of the two diodes.

PARTS LIST

Resistor all ¼W 5%	
R1	3k3
R2	1k0
R3	1M0
R4	2k2
Potentiometer	
PR1	10k miniature horizontal preset
Semiconductors	
IC1	CA3140
Q1	BC109
D1,2	1N4148
D3,4	1N4001
ZD1	6V2 ¼W Zener
Miscellaneous	
RLA	12 V, coil ≥ 120R, PCB-mounting
PLG1	3 pin DIN plug
Case to suit	

UNDER TEMPERATURE MODULE

Turn home or greenhouse heating on and off automatically with this easy-to-build project. The device can be used either as a stand-alone project or to interface with the Noiseless Power Switch described elsewhere in this issue. Design by Ray Marston. Project development by Plamen Pazov.

This inexpensive little project can be used to turn home or greenhouse heating on and off automatically, to maintain temperatures within close limits (typically better than 1°C). The circuit uses a carbon-rod thermistor for temperature sensing and incorporates a small degree of hysteresis to give a sharp switching action. The switching temperature range is variable over a fairly wide range with a preset pot.

The unit can be used as a stand-alone project, with a relay output, to give automatic operation of home or greenhouse heating, or can be used without the relay and its associated transistor-diode network to give fully automatic operation of the Universal Noiseless Power Switch described elsewhere in this issue. In the latter case the unit is powered from the built-in 12 V supply of the Universal Power Switch.

The switch can readily be made to give Over-Temperature operation (for operating fire alarms, etc) by simply transposing TH1 and PR1; we've made special provision for this on the PCB. In either case, thermistor TH1 can be mounted either directly on the PCB or can be located at a remote monitor point.

HOW IT WORKS

TH1-PR1 and R1-R2 are wired in the form of a bridge network (or double potential divider), the output of the bridge being taken to the input of voltage comparator IC1. In this configuration, the pin 3 voltage of IC1 is fixed at half-supply volts, but the pin 2 voltage is temperature-dependent and rises with increasing temperature. The comparator has a small degree of hysteresis applied via R3.

In use, PR1 is adjusted so that the pin 2 voltage of IC1 is above that of pin 3 under warm conditions, in which case pin 6 (the output of IC1) is driven to 0 V, so Q1 and the relay are cut off. Under cold conditions the pin 2 voltage falls below that of pin 3, in which case pin 6 is driven high and drives Q1 and the relay on via R4. PR1 can be adjusted to cause switching at virtually any desired temperature level. The circuit action can be inverted, so that it acts as an over-temperature switch, by simply transposing TH1 and PR1.

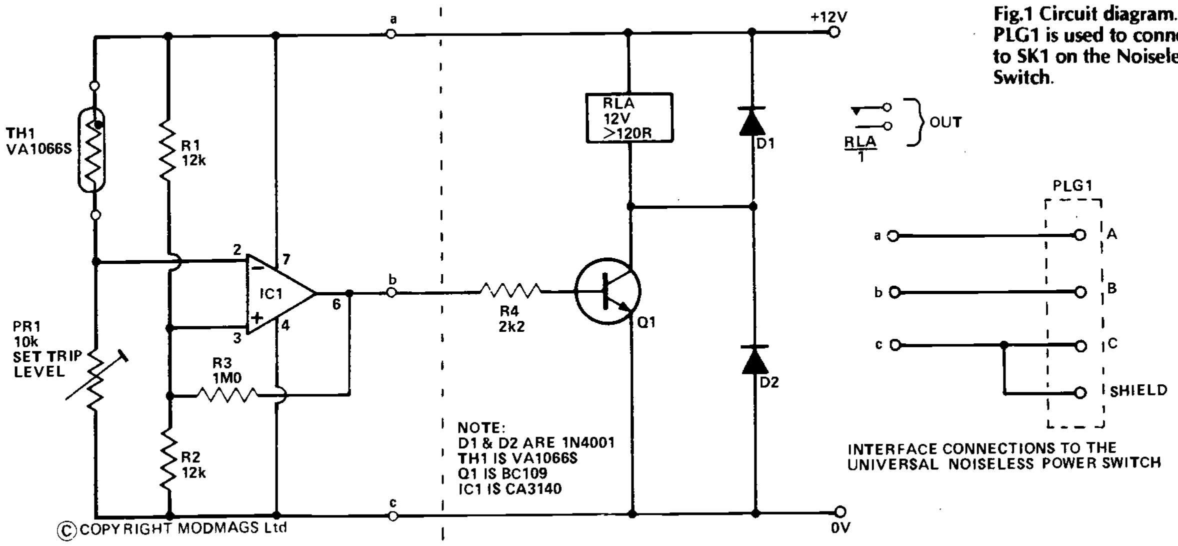


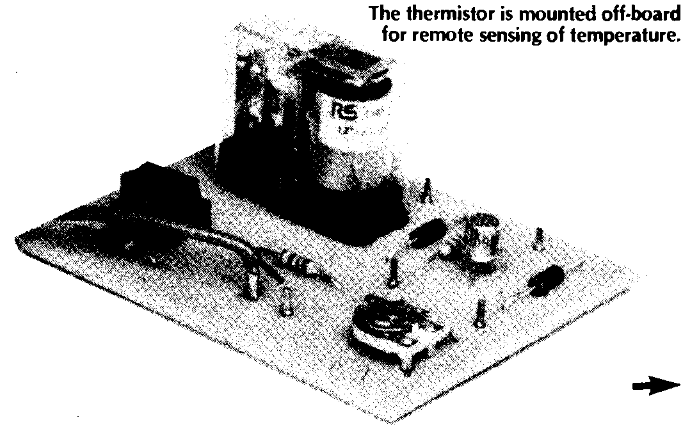
Fig.1 Circuit diagram. If required, PLG1 is used to connect the module to SK1 on the Noiseless Power Switch.

Construction

Construction of this project should present no problems if the specified components are used (IC1 MUST be a CA3140). If you intend to construct the unit as a stand-alone (relay output) project, build it as shown in the overlay, noting the use of the PCB-mounting relay. If you want over (instead of under) temperature operation, simply transpose TH1 and PR1. In either case, TH1 can be mounted either remotely or directly on the PCB.

If you want to use the unit to interface to the Universal Noiseless Power Switch, simply cut the PCB in half along the dotted line, assemble all indicated components on the non-relay side of the board and connect the unit to the Power Switch via the SK1 connections shown in the circuit diagram.

The thermistor is mounted off-board for remote sensing of temperature.



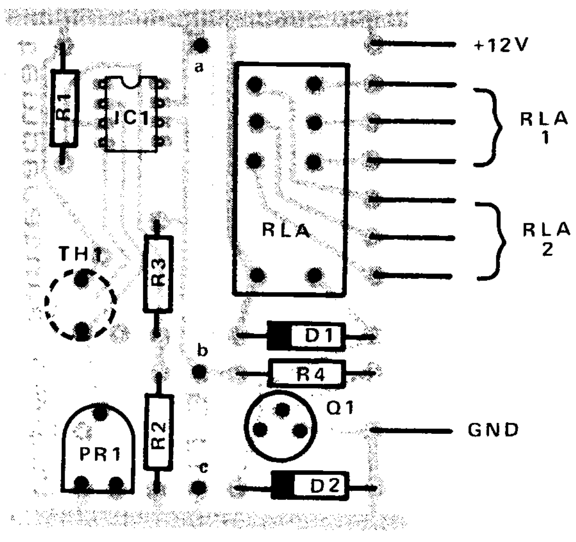


Fig.2 Component overlay. Note the provision of extra pads on the PCB so that TH1 and TV1 may be transposed, if required. TH1 may be mounted remotely.

PARTS LIST

Resistors all ¼W 5%	
R1,2	12k
R3	1M0
R4	2k2
Potentiometer	
PR1	10k miniature horizontal preset
Semiconductors	
IC1	CA3140
Q1	BC109
D1,2	1N4001
Miscellaneous	
TH1	VA1066S
RLA	12 V PCB-mounting relay coil resistance 120 R or greater
PLG1	3 pin DIN plug

BUYLINES

The thermistor (VA1066S) is available from Maplin or Electrovalue. The relay is Radiospares type 349-658, or Maplin type YX98G.

DARK ACTIVATED MODULE

Turn house or car lighting on automatically with this easy-to-build unit. The device can be used either a stand-alone project or to interface with the Noiseless Power Switch described elsewhere in this issue. Design by Ray Marston. Project development by Plamen Pazov.

This simple-looking project can be used to turn house or car lighting on automatically at dusk and off again at dawn. The circuit incorporates a transient-suppressor network and has a degree of built-in hysteresis to ensure that it is not switched by momentary changes in light level, as caused by passing shadows or lights, but responds only to mean light levels, integrated over several seconds.

The unit can be used as a 'stand-alone' project, with a relay output, to give automatic operation of car or house lights, or can be used without the relay and its associated transistor-diode network to give fully automatic operation of the Universal Noiseless Power Switch described elsewhere in this issue. In the latter case the unit is powered from the built-in 12 V supply of the Universal Power Switch.

To use the unit to give automatic operation of house lighting, simply provide a 12 V DC supply and use the relay contacts (RLA/1) to turn the lights on and off.

To give automatic operation of car lights, wire the unit's supply line connections to the vehicle's ignition switch and the relay contacts to the vehicle's lighting switch. In this case the lights will operate automatically only when the car ignition is turned on.

The switch can readily be made to give 'light-activated' operation by simply transposing the LDR and PR1 positions; we've made special provision for this on the PCB.

Construction

Construction of this project should present absolutely no problems if the specified components are used (IC1 MUST be a CA3140). If you intend to construct the unit as a stand-alone (relay output) project, build it exactly as shown in the overlay,

PARTS LIST

Resistors all ¼W 5%	
R1	1k0
R2,5	100k
R3,4	12k
R6	2k2
Potentiometer	
PR1	10k miniature horizontal preset
Capacitor	
C1	4u7 12 V axial electrolytic
Semiconductors	
IC1	CA3140
Q1	BC109
D1,2	1N4001
ZD1	6V2 ¼W Zener
Miscellaneous	
LDR	ORP12
RLA	12V (coil > 120R) PCB-mounting
PLG1	3 pin DIN plug
Case to suit	

BUYLINES

All components should be widely available. The relay used is Maplin order code YX98G; RS 349-658.

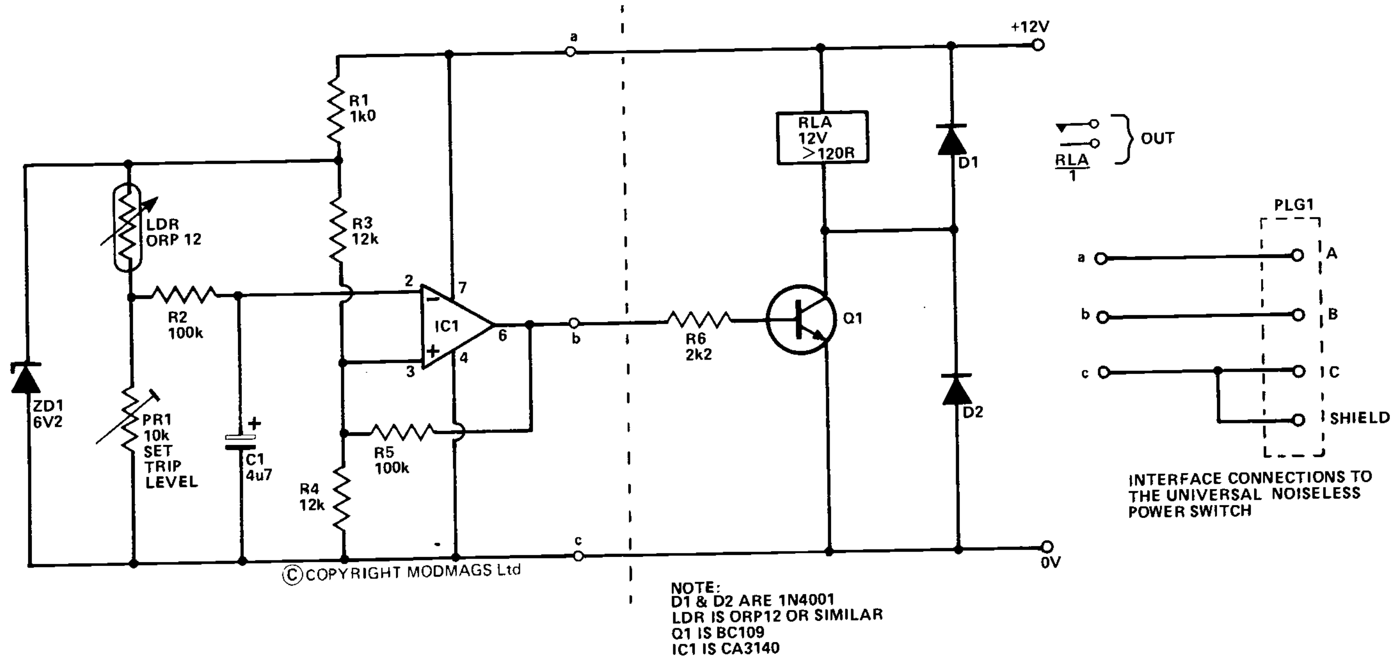


Fig.1 Circuit diagram of the Dark-Activated Switch. If required, PLG1 is used to connect the module to SK1 on the Noiseless Power Switch.

noting the use of the PCB-mounting relay. If you want light (instead of dark) activated operation, simply transpose LDR and PR1. In either case, the LDR can be mounted either remotely or directly on the PCB.

If you want to use the unit to interface to the Universal Noiseless Power Switch described elsewhere in this issue, simply cut the PCB in half along the dotted line, assemble all indicated components on the non-relay side of the board and connect the unit to the Power Switch via the SK1 connections shown in the circuit diagram.

HOW IT WORKS

IC1 is wired as a voltage comparator, with a fixed reference voltage applied to pin 3 and with a light-dependent voltage applied to pin 2 (from the LDR-PR1 light-dependent potential divider) via the R2-C1 integrator network. The action of LDR-PR1 is such that the pin 2 voltage rises with increasing light levels. The comparator has a small amount of hysteresis applied via R5.

In use, PR1 is adjusted so that the pin 2 voltage of IC1 is above that of pin 3 under light conditions, in which case pin 6 (the output of IC1) is driven to 0 V, so Q1 and the relay are cut off. Under dark conditions the pin 2 voltage falls below that of pin 3, in which case pin 6 is driven high and drives Q1 and the relay on via R6. PR1 can be adjusted to cause switching at virtually any desired darkness level. The circuit action can be inverted, so that the circuit acts as a light-activated switch, by simply transposing LDR and PR1.

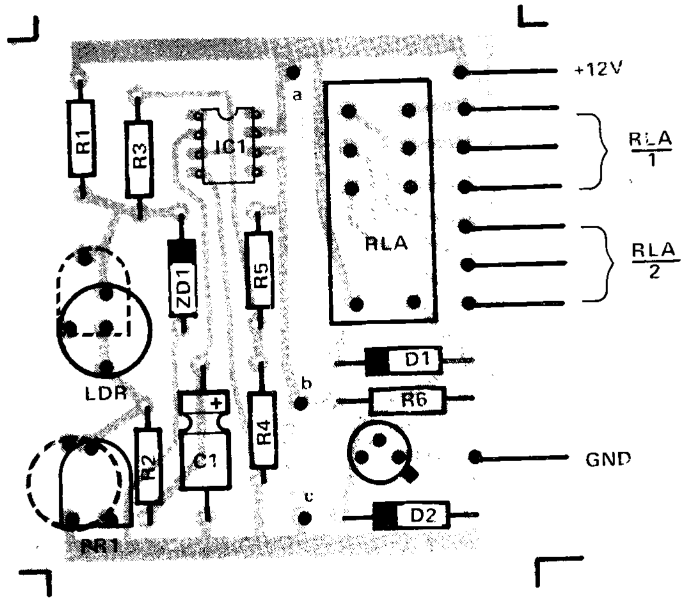
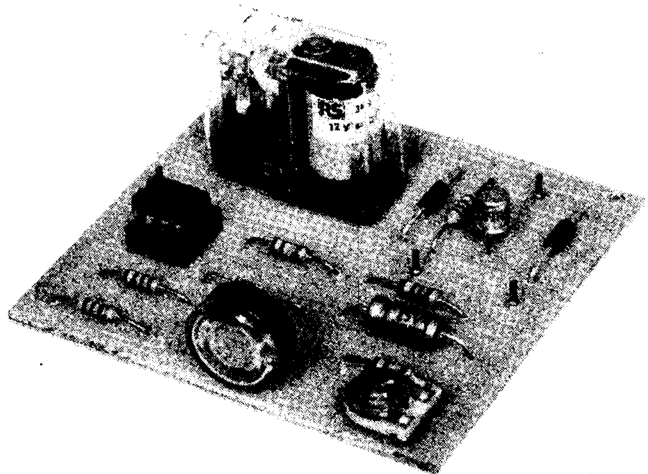


Fig.2 Component overlay for the Dark-Activated Switch. The circuit is converted to light-activated operation if the LDR and PR1 are transposed as shown by the dotted lines.



The Dark-Activated Switch board follows the same general layout as the other two modules. The ORP12 light sensor is mounted next to PR1; it could also be mounted remotely.

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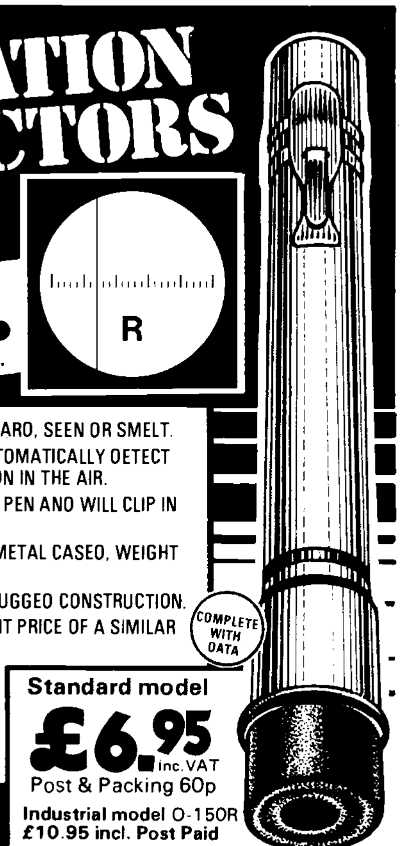

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Microprocessors have revolutionised test instrument design. Morris Stanley of SE Labs (EMI) describes the use of new techniques to produce a fully automatic frequency response analysis system for state-of-the-art dynamic analysis.

In almost every field of industrial and scientific research, design, manufacturing and field site maintenance, it is necessary to measure, accurately and easily, the dynamic performance of components, modules and complete systems. Dynamic is defined here as the response of the device under test to signals (self-generated or externally applied).

The ratio of output signal to input signal (expressed as both ratio magnitude and ratio phase) at all frequencies of interest, is the transfer function of the device under test.

Time Domain Techniques

Considering Time Domain Techniques, the data may, in special cases, be inferred indirectly from response observations made in the time domain ie by applying an accurately known complex signal (eg a near ideal unit pulse) and comparing the resultant output with the input using an oscilloscope or a fast chart recorder (Fig.1). However, in addition to the heavy computational and interpretive burdens the technique imposes on the user, its accuracy and validity are severely limited, in practice, by the masking effects of noise (Fig.2). Moreover, it rarely provides sufficient resolution (of raw data) to reveal small but highly significant resonances (glitches) or similar second-order anomalies. Therefore, it is generally agreed that Time Domain response testing is at best a qualitative technique — even considering the merits of the new digital oscilloscopes. Precision does not, after all, eliminate anamolous signals.

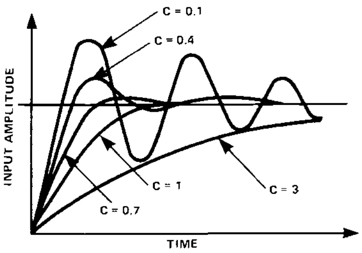


Fig.1 Ideal system responses to unit pulse showing various damping factors.

In another, far more complex use of the Time Domain for transfer-function and related testing, the complex input signal applied is a known pseudorandom sequence, single level (binary) or multilevel. The delays and/or level shifts recorded at the output can be correlated with the input signal to reject noise and other anomalies and can be made to yield the transfer function data required. However, this information can only be obtained after extensive (and expensive) computer manipulation. Pseudorandom testing is chiefly of historical interest now.

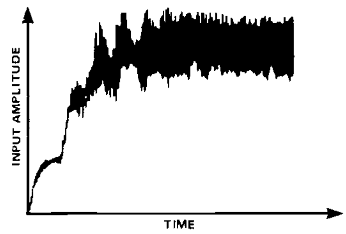


Fig.2 Typical system response to a unit pulse.

Frequency Domain Techniques

Far more useful results are obtained when some form of frequency domain testing (ie obtaining the frequency response) is performed. In this approach, the instrumentation yields data that represent, more or less completely and accurately (depending on the technique selected), the Fourier spectrum of the transfer function. This may be used in several different ways, such as the Bode plot or a Nyquist or Nichols plot (Figs 3,4,5) — or to implement the Evans root-locus approach. To be useful

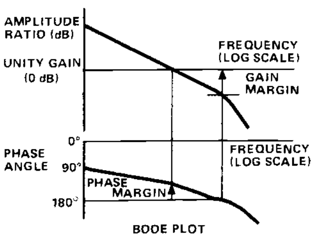


Fig.3 Bode plot.

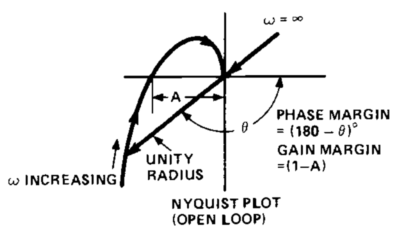


Fig.4 Nyquist plot.

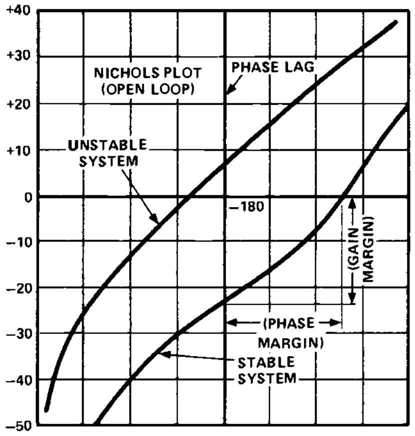


Fig.5 Nichols plot.

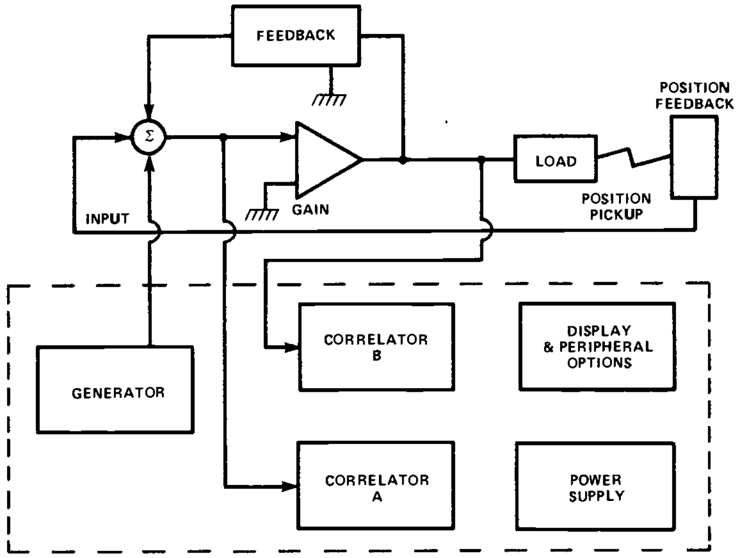


Fig.6 Typical FRA system.

and informative, the transfer function must be expressed in both magnitude of ratio and phase.

Various techniques are currently available for making such measurements and before proceeding further, two additional introductory observations can be made. First, these techniques are equally useful in measuring the dynamic behaviour of all kinds of physical systems. Because all the instrumentation available today is electronic, it is frequently necessary to use one or more transducers in the measurement set-up: accelerometers, tachometers, position sensors, temperature sensors, chemical cells, load cells, etc. In every such instance, it is necessary to know the transfer function of the transducer (either to correct for it in response calculations, or to be certain that it may safely be ignored) and it is equally necessary to calibrate the transducer independently and accurately (usually by using the same instrumentation).

Finally, to comment on the wide range of needs and capabilities of those who use dynamic analysis. The maintenance technicians who perform pre-flight 'depot' check-outs on control systems for supersonic fighter aircraft work to a very different time scale, have totally different information needs and generally have very much less mathematical capability and theoretical intuition than did the scientists and engineers who originally designed those systems in the relatively serene and convenient environment of a laboratory. To be efficient, the depot system must be highly automated and fully pre-programmed; to be effective and equal to every research and design task, the laboratory system should be as versatile, and as responsive to creative manual programming, as possible.

The Classic Approach : FRA

In practice, the most direct, accurate and convenient method of measuring the transfer function of any circuit or device (or, indeed, of simply measuring the Fourier spectrum of any signal with respect to a reference signal) is shown in Fig.6. This is the basic block diagram of any frequency response analyser, regardless of how the individual blocks may be implemented. A sine-wave signal of high purity and stability, programmable in both amplitude and frequency, is generated in the FRA and fed to the device under test. In open loop testing, the sinewave signal is simply applied to the input terminals. In testing a closed-loop system, the signal may be inserted at any convenient point in the loop, in series with the normal signal path or at a summing junction. In the simplest applications, only one of the two correlators is used. These are applications in which the transfer function to be measured is the one between the input-signal interface and some other point in the device under test. In other important applications, both correlators must be used, because what is wanted is the transfer function between two points in the system, neither of which is the point of introduction of the test signal.

Correlation

It may be appropriate at this point to consider correlation in a little more detail. A correlator is defined as a circuit that has the ability to accept a signal of any kind (within its ratings) and extract from that signal only that part of it that corresponds exactly in frequency to a reference signal (also fed to the correlator). The correlator then produces two outputs — (1) a signal proportional to the in-phase component of the ratio of input amplitude to reference amplitude and (2) a signal proportional to the quadrative component of that ratio. From these signals, it is easy to compute the corresponding magnitude and phase values.

Perhaps the simplest way to think of a correlator is that it is a nearly-zero-bandwidth (very high Q) phase-sensitive detector. In fact, analogue correlators are just that and were originally called "synchronous detectors". In modern FRAs the technique used to obtain correlation is actually a digital computation that applies a simple algorithm to digitised samples of the input waveform and to known digital values of the reference waveform — but the effect is the same. The digital synthesis of the correlation integral merely optimises the performance of the correlator at significantly lower cost that would be possible by any comparably efficient analogue circuitry.

Cross Correlation

When two correlators are used, they are interconnected in such a way as to produce 'cross-correlation', ie to produce amplitude and phase (or in-phase and quadrature) signals proportional to the ratio of the two correlator inputs, having rejected all input components that do not correspond to the reference signal frequency.

The Correlation Integral

There is no doubt that the heart of any FRA is the correlator. Programmable wide range signal generators are straightforward enough and are not new in the art, but creating a fast, high performance, wide dynamic range correlator can present a

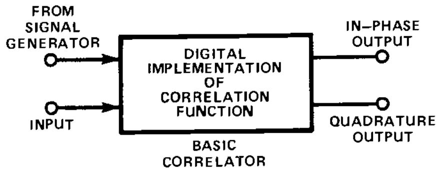


Fig.7 Basic correlator.

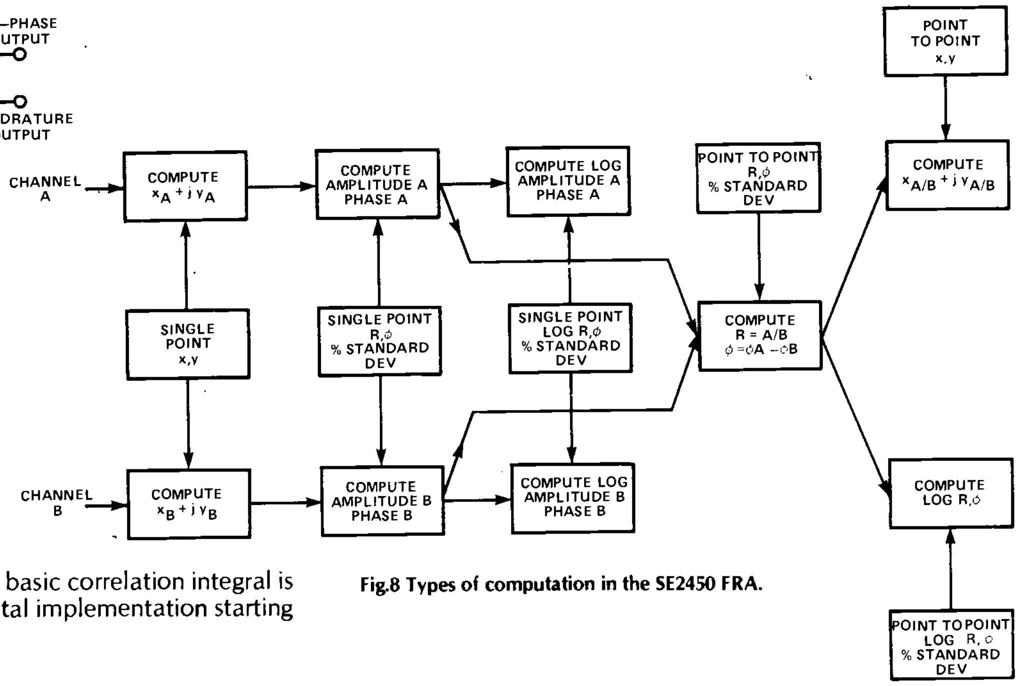


Fig.8 Types of computation in the SE2450 FRA.

formidable design challenge. If the basic correlation integral is examined, the algorithm for its digital implementation starting with;

$$X_a = \frac{1}{nT}\int_0^{nT} V_{max}\ \sin(\omega t + \theta) + \sin\omega t dt$$

$$Y_a = \frac{1}{nT}\int_0^{nT} V_{max}\ \sin(\omega t + \theta) + \cos\omega t dt$$

Where X_a = real part in volts — V_{max} = peak of correlator input signal

nT = integration time

Y_a = quadrature part in volts — θ = phase shift of correlator input signal relative to generator output

Let a,b,c,d,e, . . . etc be the values of sin ωt for t_0, t_1, t_2, . . . T, and let A,B,C,D,E, . . . etc be the values of sin($\omega t + \theta$) for t_0, t_1, t_2, . . . T then,

$$X_a = \frac{1}{nT}\quad [\Sigma\ aA + bB + cC + dD + \ldots\ldots]$$

As so often happens, we find that digital computation of a complex mathematical function is reducible to what has called a 'thundering redundancy' of 'fetch . . . multiply . . . add . . . fetch . . . multiply . . . add,' many times, as fast as possible. Trigonometric functions are reduced to table look-ups and vector matrices are all essentially boring variations on 'fetch . . . multiply . . . add'. It is in the critical implementation of the analogue A/D and the elegant reduction of the logic to minimal hardware that a design competence shows through; and, for the latter, we can consider the computations made in this latest Frequency Response Analyser, the SE Laboratories 2450. These computations are shown in detail in Fig.8.

Automating Frequency Response Analysis

The advent of the microcomputer has made it possible to automate not only the measurement process, but also the programming of specific tests at the operator or system interfaces. Fig.9 shows how the new FRA utilises such a system. The tasks performed by the microcomputer include:

- Translating keyboard commands (typically, a single keystroke, plus a single numerical value) into all of the internal functions required to set up a test-mode format.
- Generating a display that presents the formatted test conditions to the operator at any time he requests them.
- Providing cursor-linked guidance for the operator to speed and simplify the manual input of test parameters and conditions.
- Providing error detection, default (fallback) conditions and self-checking services.
- Controlling the signal generator during performance of the test run; frequency; amplitude; starting angle; number of cycles; DC bias (offset).
- Automatically executing harmonic analysis when so commanded on a specified harmonic (up to the 15th).
- Synchronising the FRA's signal generator to an external source when a standard option is installed.
- Executing the correlation computations.
- Ranging the correlators and generating (or compensating for) offset at the correlator inputs as commanded.
- Executing statistical computations when commanded.
- Scaling and/or converting the results to the selected units and generating result displays.
- Storing sets of results and displaying them, as commanded, in convenient page formats.
- Storing test conditions and parameters until no longer needed.
- Providing a full parallel standard IEEE 488 (1978) interface with external peripherals and/or external controller, calculator, or other CPU, when a standard option is installed.
- Providing a two-way RS232 serial interface — eg for teletypewriters or modems, when a standard option is installed.
- Controlling an external digital X-Y plotter, when a standard option is installed (provided that the IEEE 488 Interface option has also been installed).

The advantages of comprehensive internal automation of an instrument as sophisticated as the SE Labs model 2450 are not, perhaps, fully evident at first glance; but they become increasingly apparent as the various operating modes and design features are utilised. It is interesting to note that a typical non-automated FRA of roughly comparable range and facilities has more than sixty front panel controls and no interactive means of guiding the operator during set-up.

Simplified Programming For ATE Systems

To the designer of large Automatic Test Equipment systems, in which the automated FRA may be but one of several instruments, the advantages of its comprehensive internal

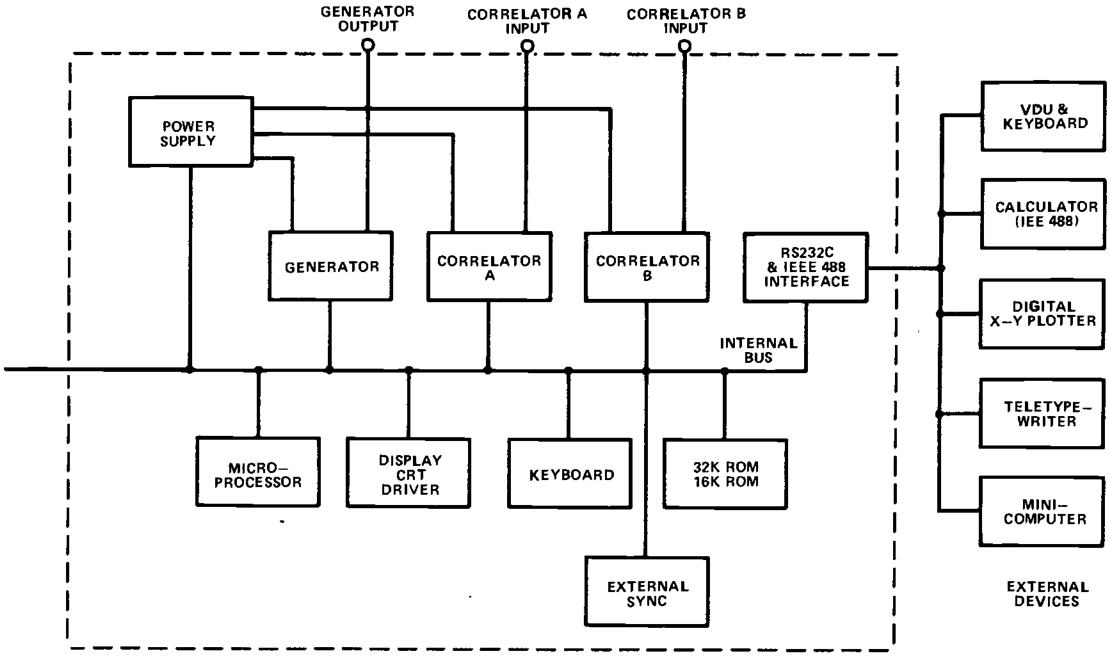


Fig.9 An automatic frequency response analyser SE2450.

automation appear most impressively as substantial simplifications in programming. Just as the microcomputer makes it easy to set up a complex test run manually with perhaps 15 or 20 keystrokes, so it also simplifies the software required to command such a test via the system bus. It is never safe to generalise about software tasks, but one can observe that program generation for the 2450 is often an order of magnitude simpler and faster than it is for less 'intelligent' instruments and the interactive display of such a system as the SE2450 is always ready to help verify, edit, detect errors, etc., without external program-checking instrumentation.

Major System Specifications

By appropriate keystrokes, one may call into service either of two modes, spot frequency or sweep frequency. The generator frequency can be selected anywhere in the range from 0.0001 Hz to 10000 Hz, a ten million to one range, with a resolution of one part in 9999. The RMS or peak amplitude of the signal may be programmed to any value between 1 mV and 9V99. The operator may choose high-purity sinusoidal, precise triangular, or precise square waveforms, all of which are digitally generated with a resolution of 1024 steps per cycle and with essentially glitch-free transitions. The waveform generator may be selected to start at 0°, 90°, 180°, or 270° of its normal cycle. A DC bias (offset) voltage may be added to or subtracted from the generated waveform. Any bias voltage may be called for in the range from -9V98 to +9V99 in 10 mV steps.

The input sensitivity of the correlator(s) in use may be allowed to autorange, over the entire rated and usable sensitivity range of 250 mV to 1000 V, RMS or peak; or it may be manually set to any one of the following nominal ranges: 50 mV/500 mV/5 V/500 V, RMS or peak. If the signal fed to the correlator is less than 5% of nominal range, the diagnostic legend 'underrange' will appear and computation will stop. If the signal rises above 200% of manual selected range, the instrument will revert to automatic ranging. If the correlator input rises above 500 V on the top range, the diagnostic legend 'overrange' will appear and the computation will stop. The number of cycles over which the measurement is made may be specified by keyboard entry at any value from 1 to 9999, improving the results by integration of the noise over more and more cycles.

If harmonic analysis is required, the number of the harmonic to be measured is specified, from two to 15, by keyboard entry and the specified measurement is made at that harmonic frequency, with the system excited at the fundamental frequency. In the sweep frequency mode, the SE 2450 actually performs a sequence of spot-frequency measurements, over a specified frequency range, with a specified number of frequencies. The instrument may be programmed to sweep either up or down, the spacing of frequencies specified as linear (equal spacing) or logarithmic (a constant ratio of each frequency to the preceeding frequency). The 2450 automatically computes the test frequencies that will yield the desired spacing and on command the test proceeds automatically. The results of each of the individual tests made in the sweep frequency mode are stored and reported on a maximum of 10 pages of data, 12 results per page, consecutively numbered.

The form in which the test results are computed and expressed may be selected from: cartesian (real and imaginary terms of the output-to-input ratio, or a + jb); polar (magnitude and phase angle of the output-to-input ratio, or R, ϕ °); or log-polar (log R, expressed in dB and phase angle ϕ °).

There is no doubt that the frequency-response concept is a useful and powerful tool for all aspects of engineering and as Alistair G.J. Macfarlane rightly pointed out in his paper to the IEEE (1), this form of measurement enables engineers to quickly and fluently communicate to each other the essential features of a feedback control situation. The SE Laboratories new frequency response analyser is certainly the first major step forward in producing a truly automatic system that will contribute to the future development of feedback and control.

Reference.

(1) Alistair G.J. Macfarlane, IEEE press 1979 Frequency-Response methods in control systems.

ETI

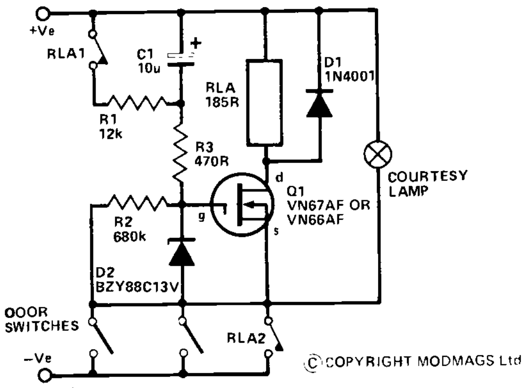
SPOT DESIGNS

Courtesy Light Timer

This courtesy light timer switches on the courtesy light of a car for a nominal period of 30 S after one of the car doors is opened, but the length of the switch-off delay can be altered to suit individual requirements. The circuit has been designed for use with 12 V negative earth electrical systems, but it is easily modified for use with positive earth systems.

One of the door switches closes if a car door is opened and this connects power to the courtesy lamp and to the timer circuit. As C1 will be totally uncharged at switch-on, it takes the gate terminal of VMOS transistor Q1 fully positive. This biases Q1 hard into conduction so that it operates the relay which forms its drain load. Make contacts RLA2 then close and connect power to both the courtesy light and the timer circuit. These both remain operational, therefore, even if the car door is closed. RLA1 is a break relay contact and this opens so that C1 is free to charge up by way of R2.

After approximately 30 S the charge voltage on Q1 reaches almost the full supply potential and the gate potential of Q1 drops to the point where this device switches off and deactivates the relay. RLA2 then opens again and the courtesy light and timer circuits are switched off. RLA 1 closes and rapidly discharges C1 through R1 so that the unit starts a new timing run when it is activated again and no residual charge is left on C1 (which would give a shortened timing period).



The length of the timing period is proportional to the value of R2 and is, therefore, easily modified if necessary. The circuit should function correctly with positive earth systems provided the door switches and RLA2 are connected in the positive supply lead rather than in the negative one. D2 and R3 are to protect Q1 against an excessive input voltage if the supply should go above 15 V. D1 is the usual protection diode for a highly inductive load in a semiconductor circuit.

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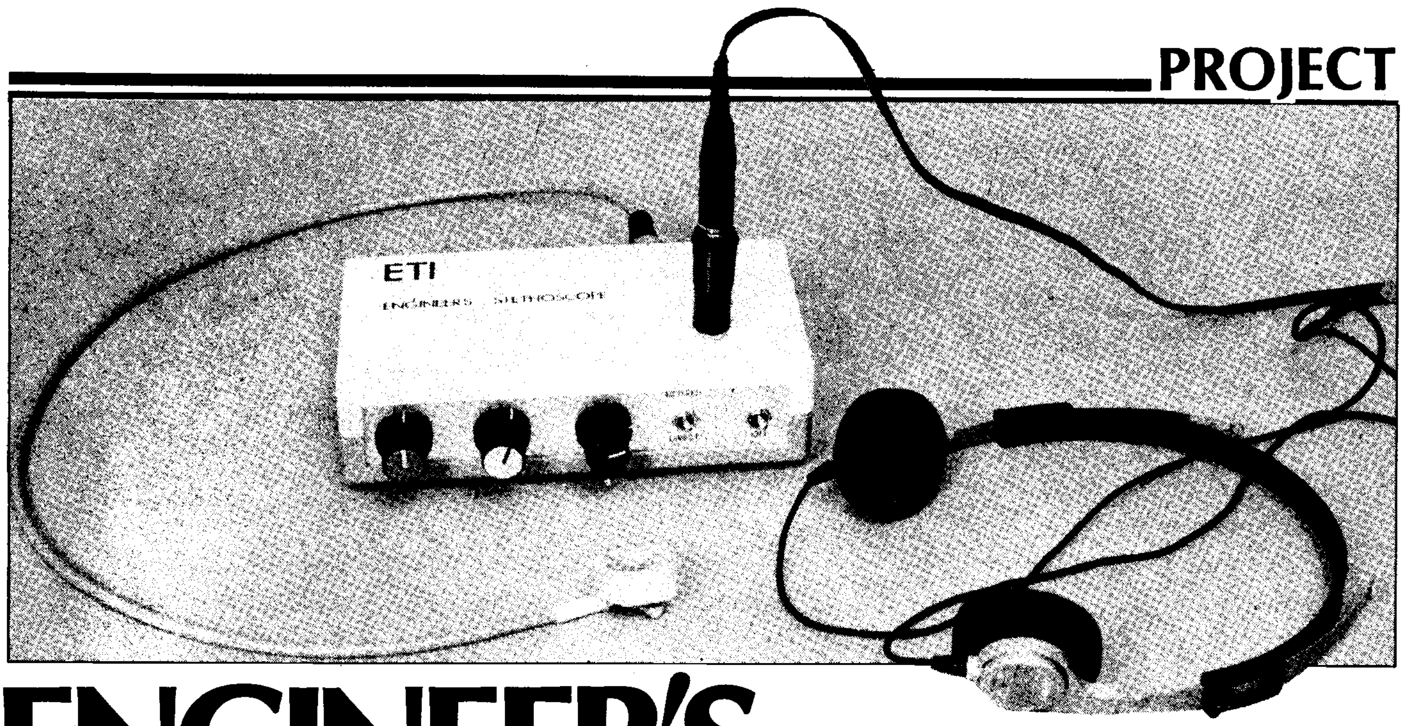


ENGINEER'S STETHOSCOPE

This unusual device lets you locate or listen to internal engine sounds, such as the rumble of bearings or the rattle of tappets. An essential project for the DIY nut. Design by Ray Marston. Project development by Steve Ramsahadeo.

This very unusual project enables you to effectively and effortlessly get right inside an engine and listen to, or locate, all of its internally-generated sounds, such as the noises of bearings, pistons, tappets, etc. The device is fitted with a double filter network that can be used to pick out one set of sounds (such as those of the bearings or the tappets, etc) from all others, thus facilitating fault-finding on engines and motors.

The Stethoscope project comprises an acoustic probe unit, a 'box-of-tricks' and a pair of conventional headphones. The headphones help muffle ambient sounds, so that you can concentrate on the sounds of the stethoscope even in a very noisy environment. The probe unit is used to make mechanical contact with the engine or mechanism under test and is coupled to the 'box-of-tricks' by flexible leads.

The probe unit relies on mechanical coupling or contact between itself and the engine (or whatever) for acoustic pick-up. This coupling can be achieved either directly or by a metal rod. The rod can take any one of a variety of forms eg a screwdriver or a needle. If a needle probe is used, the stethoscope can even be used to listen to the sounds of individual jewelled bearings in a watch mechanism.

Operating Principles

The stethoscope operation relies on the simple fact that what is commonly called sound is a series of mechanical vibrations transmitted through a medium of some sort — air, water, metal etc. Thus, all the internally-generated sounds of a petrol (or any other) engine, such as the sounds of tappets, pistons, bearings, etc, are transmitted throughout the engine block and can readily be further transmitted down a metal rod (or screwdriver, etc) to the body of an acoustic pick-up device such as a microphone.

Our stethoscope relies on this mechanical coupling principle. We use a crystal insert as the pick-up device, with all of its air holes blocked off (to exclude dirt) and with the coupling made to its body either directly or by some kind of metal rod. The use of rod coupling enables the source of a given sound to be precisely located within (say) an engine block, by simply probing to find the position of maximum noise. If a needle probe is used, the sound source can be located with pin-point accuracy.

Construction

The Stethoscope circuit is fairly simple and construction should present very few problems. Wire up the PCB first, noting the use of 20 Veropins to facilitate interwiring, as shown in the component overlay. When wiring up RV1 and RV2 take special care to connect the two halves of each component in the same phase, so that the resistances increase or decrease together.

On our prototype we've fitted the two batteries (PP3s) into the top half of the case, secured by double-sided sticky-pads. We've fitted a small jack socket to the case top to facilitate connection to the external low-impedance headphones and have used a 3-pin DIN socket for connecting the probe unit.

Finally, to complete construction, wire up the probe circuit as shown in the circuit diagram, taking care to fit Q1 and R1 as near as possible to the crystal insert terminals and connect the assembly to a suitable plug and lead.

At this stage, give the unit a simple functional test by plac-

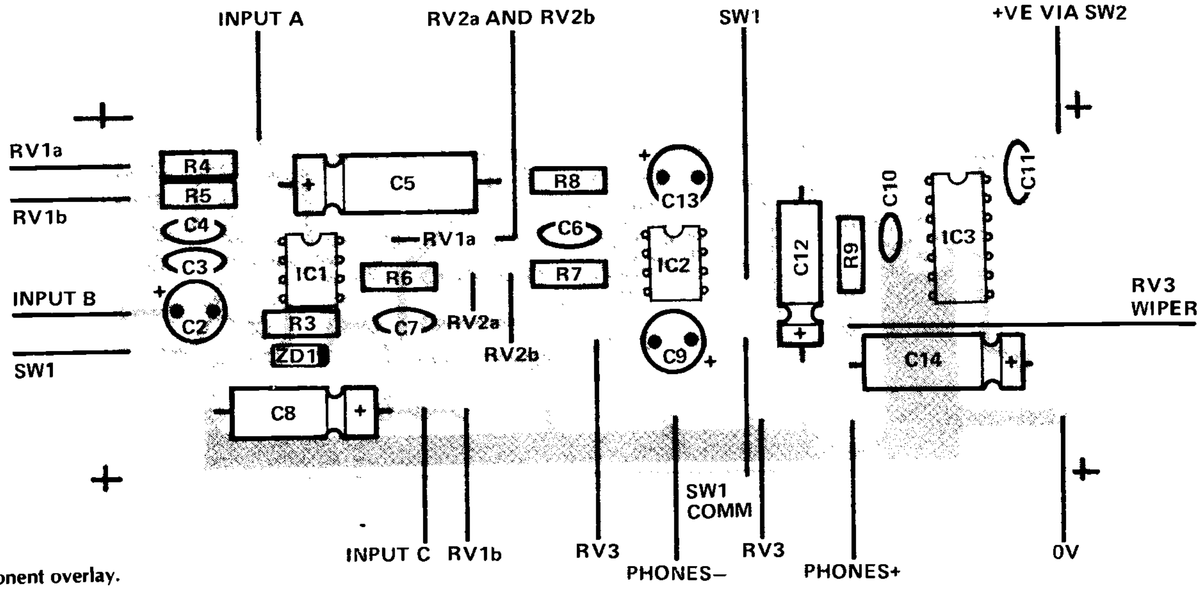


Fig.1 Component overlay.

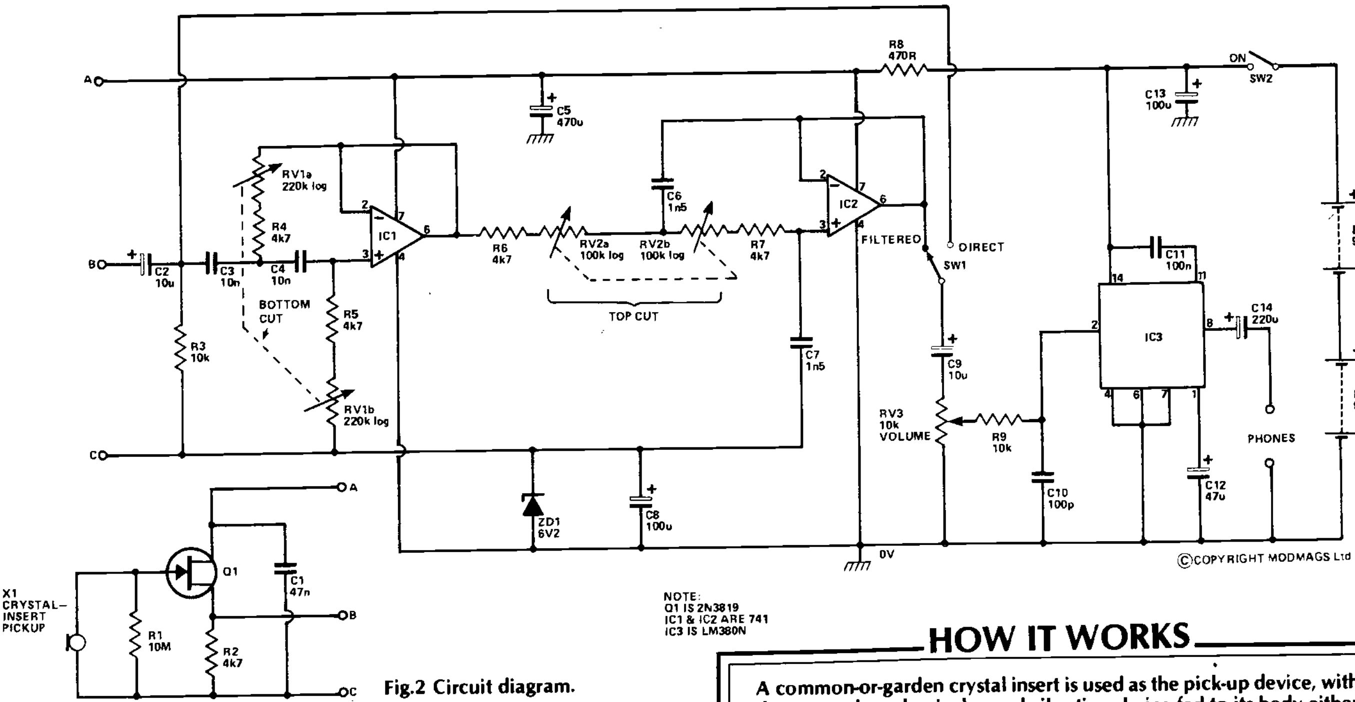


Fig.2 Circuit diagram.

ing the head against the speaker of a small radio. Check that tone quality and volume can be varied with the three controls. When the above test is satisfactory, complete the probe construction by blanking off (with tape) any air holes in the insert (to exclude dirt and oil) and encapsulate the electronics in wax or resin. On the completed circuit the probe can be used as it stands or can be epoxied to a screw terminal or clip (or both) that can be used to make connections to a variety of probe types (metal rods, a screwdriver, etc). The Stethoscope is intended for use with a pair of headphones of not less than 8R0 impedance.

BUYLINES

All components used in the Engineer's Stethoscope are common types and should present no availability problems.

In case of difficulty Watford Electronics can supply the crystal microphone insert (order code C2).

HOW IT WORKS

A common-or-garden crystal insert is used as the pick-up device, with the external mechanical sound vibrations being fed to its body either directly or by a metal rod from the engine (or whatever) under test. FET source follower Q1 is wired directly to the output of the pick-up device, to give a low-impedance output from the resulting probe. The output of the probe circuit is then fed, either directly or through a double filter network, to a power amplifier stage (IC3) and thence on to a pair of headphones.

When the stethoscope is used in the filtered mode, the output of the probe circuit is first passed through high-pass (bottom-cut) filter IC1 and thence on to the power amplifier via low-pass (top cut) filter IC2. Both of these filters are second-order variable types. The IC1 filter can be used to reject signals below roll-off frequencies that are variable from 80 Hz to 3 kHz via RV1 and the IC2 filter can be used to reject signals above roll-off frequencies that are variable from 700 Hz to 15 kHz via RV2. These two filters can be used to pick out specific sounds, such as the low-frequency rumble of bearings or the high-frequency rattle of tappets, from the broad spectrum of sounds that are generated by an engine.

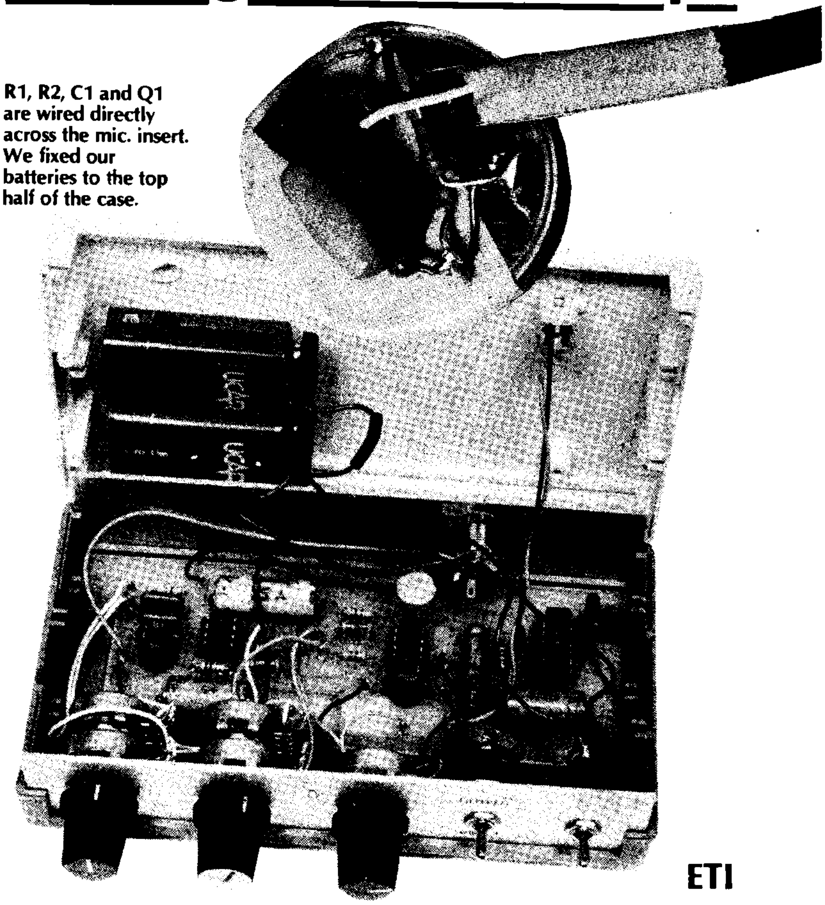
The complete stethoscope is powered by a pair of 9 V batteries and typically consumes about 15 mA when driving a pair of 8R0 headphones. The split power supplies to the IC1-IC2 op-amp filters are generated with the aid of ZD1 and C8.

PARTS LIST

Resistors all ¼ W 10%

R1	10M
R2,4,5,6,7	4k7
R3,9	10k
R8	470R
Potentiometers	
RV1a,b	220k dual logarithmic
RV2a,b	100k dual logarithmic
RV3	10k logarithmic
Capacitors	
C1	47n polycarbonate
C2,9	10u 63 V electrolytic, PCB type
C3,4	10n polyester (C280)
C5	470u 25 V axial electrolytic
C6,7	1n5 polycarbonate
C8,13	100u 25 V axial electrolytic
C10	100p ceramic
C11	100n polyester (C280)
C12	47u 25 V axial electrolytic
C14	220u 25 V axial electrolytic
Semiconductors	
IC1,2	741
IC3	LM380
Q1	2N3819
Miscellaneous	
SW1, 2	DPST miniature toggle
SK1	3-pin DIN socket
SK2	3.5mm jack socket
Case	Vero order code 202-21040

3 off knobs to suit
Crystal insert (see Buylines)



R1, R2, C1 and Q1 are wired directly across the mic. insert. We fixed our batteries to the top half of the case.

ETI

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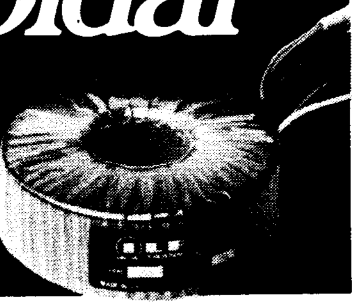

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1X010	6+6	2.50
1X011	9+9	1.66
1X012	12+12	1.25
1X013	15+15	1.00
1X014	18+18	0.83
1X015	22+22	0.68
1X016	25+25	0.60
1X017	30+30	0.50

50VA *80mm dia. x 35mm Weight 0.9 Kg* **£5.19** *(+£1.10 p.p. +0.94 VAT)*

2X010	6+6	4.16
2X011	9+9	2.77
2X012	12+12	2.08
2X013	15+15	1.66
2X014	18+18	1.38
2X015	22+22	1.13
2X016	25+25	1.00
2X017	30+30	0.83
2X028	110	0.45
2X029	220	0.22
2X030	240	0.20

80VA *90mm dia. x 30mm Weight 1 Kg* **£5.76** *(+£1.20 p.p. +£1.04 VAT)*

3X010	6+6	6.64
3X011	9+9	4.44
3X012	12+12	3.33
3X013	15+15	2.66
3X014	18+18	2.22
3X015	22+22	1.81
3X016	25+25	1.60
3X017	30+30	1.33
3X028	110	0.72
3X029	220	0.36
3X030	240	0.33

120VA *90mm dia. x 40mm Weight 1.2 Kg* **£6.72** *(+£1.30 p.p. +£1.20 VAT)*

4X011	9+9	6.66
4X012	12+12	5.00
4X013	15+15	4.00
4X014	18+18	3.33
4X015	22+22	2.72
4X016	25+25	2.40
4X017	30+30	2.00
4X028	110	1.09
4X029	220	0.54
4X030	240	0.50

160VA *110mm dia. x 40mm Weight 1.8 Kg* **£8.88** *(+£1.40 p.p. +£1.54 VAT)*

TYPE	SECONDARY RMS VOLTS	SECONDARY RMS CURRENT
5X012	12+12	6.66
5X013	15+15	5.33
5X014	18+18	4.44
5X015	22+22	3.63
5X016	25+25	3.20
5X017	30+30	2.66
5X018	35+35	2.28
5X028	110	1.45
5X029	220	0.72
5X030	240	0.66

225VA *110mm dia. x 45mm Weight 2.2 Kg* **£10.59** *(+£1.50 p.p. +£1.81 VAT)*

6X014	18+18	6.25
6X015	22+22	5.11
6X016	25+25	4.50
6X017	30+30	3.75
6X018	35+35	3.21
6X026	40+40	2.81
6X028	110	2.04
6X029	220	1.02
6X030	240	0.93

300VA *110mm dia. x 50mm Weight 2.6 Kg* **£12.27** *(+£1.60 p.p. +£2.08 VAT)*

7X016	25+25	6.00
7X017	30+30	5.00
7X018	35+35	4.28
7X026	40+40	3.75
7X025	45+45	3.33
7X028	110	2.72
7X029	220	1.36
7X030	240	1.25

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8X017	30+30	8.33
8X018	35+35	7.14
8X026	40+40	6.25
8X025	45+45	5.55
8X033	50+50	5.00
8X028	110	4.54
8X029	220	2.27
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74LS26	45p
74LS27	45p
74LS30	18p
74LS32	23p
74LS37	35p
74LS38	35p
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74LS132	79p
74LS138	69p
74LS139	75p
74LS148	170p
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4025	20p
4026	130p
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4028	75p
4029	80p
4030	50p
4031	195p
4033	145p
4035	104p
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4038	110p
4039	290p
4040	99p
4041	75p
4042	73p
4043	86p
4044	88p
4045	160p
4047	99p
4048	56p
4049	38p
4050	40p
4051	69p
4052	75p
4053	73p
4054	111p
4055	121p
4056	121p
4059	560p
4060	112p
4063	112p
4066	56p
4067	422p
4068	19p
4069	19p
4070	28p
4071	25p
4072	25p
4075	20p
4076	88p
4077	23p
4078	29p
4081	23p
4082	25p
4085	86p
4086	68p
4089	130p
4093	68p
4094	225p
4095	99p
4096	325p
4098	110p
4099	180p
4501	25p
4502	112p
4503	68p
4507	52p
4508	288p
4510	76p
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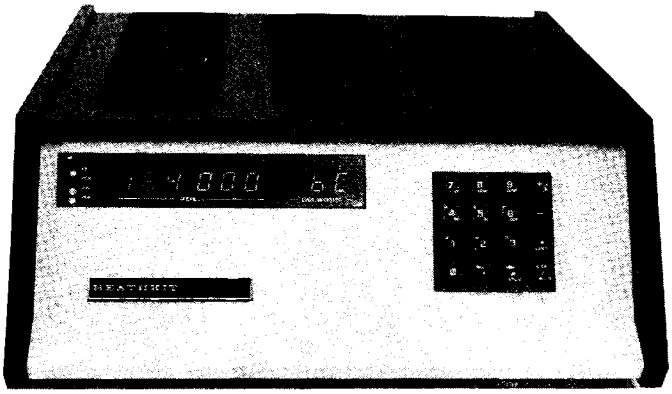
MICROBASICS

Henry Budgett explains the functions of various elements of the Heathkit H8 microcomputer



We are now, at long last, in possession of a complete microcomputer. All the various components, both hardware and software, have been assembled into a working system. The only remaining task is to explain how they all interact. If you have been following the series you should have at least the last part close at hand as I shall be making reference to various bits and pieces.

The obvious place to start is with the CPU card, and the obvious item to look at first is the clock generator.

Keeping It Ticking

The CPU requires a two-phase clock signal (the device we actually use in the H8 is an 8080A which runs at 2 MHz) and this is produced by a master oscillator, the Intel 8224. The 8224 is driven from a single 18.432 MHz crystal and produces the power-on reset pulse, the two-phase clock and a couple of other synchronisation signals. The power-on reset is simply generated by an RC time constant which charges up and, after a given time, crosses a logic threshold, producing a nice, clean pulse that is passed to the CPU and all the other circuitry.

The second phase of the clock, $\phi 2$, is also sent to all the other circuitry as a control signal. Together with the system sync pulse it will ensure that the rest of the computer keeps in step with the CPU. In actual fact the CPU card contains very little indeed. Apart from the discrete components there are only 15 main ICs. The simplicity of the circuit is in no way an indication of incompleteness; the system is modular in design and makes full use of both the bus-based design (separate functions on separate cards) and the sophisticated control ICs that have been developed to go with the 8080 series.

There is, as mentioned previously, *no* RAM on the CPU card at all. The only memory is the 1K front panel monitor in ROM. This means that without an additional memory card you can't get the machine up-and-running, but it does simplify the memory mapping. All the address and data lines are connected onto the 50-way bus as detailed in last month's article. The data bus is, as explained in an earlier article, bi-directional in nature. The direction of the data is decided by the memory and I/O controls which will be discussed later. The only memory address decoding done on the CPU card is to determine if an address lower than 1024 is being accessed. If so then the contents of that location in the monitor ROM are read. At all addresses greater than 1024 the ROM is disabled and its output set in the high impedance state.

Reading And Writing

To access RAM and ROM memory the computer needs to be able to control the 50-way bus. To write to memory the following actions occur. The system controller, an 8238, looks at the current processor status word and finds that the CPU is requesting a memory write cycle. It now sets its control line, $\overline{MEMW}$, low indicating to the bus that a memory write cycle is about to take place. The data bus is set to transmit from the CPU to the memory and the current address on A_{13} to A_{15} is decoded to determine the memory block required just as the address on A_0 through A_{12} determines the actual memory cell to be written to. Once the decoding is done the MEMW signal on the bus switches the data (on the bus) into that location. The reading of data from the memory location is much the same. The control signal in this case is $\overline{MEMR}$ and the data bus buffers are set to read from memory to the CPU but, apart from that, it's the same.

For the memory card itself, we used a 16K static board. The board start address (where it resides in the memory map) is controlled by a set of switches. The top two address lines can be decoded into four possible states. This determines which 16K block of the available 64K is being accessed. If the preset code and the current address code match, then you are using that board. The next two address lines can again be decoded into four possible states. These determine which 4K memory block of the 16K is being accessed. The remaining 12 address lines are decoded within the memory ICs and determine which of the 4096 memory cells is actually being used at that instant. Simple really! For those of you who like to see proof, Fig.1 reveals all.

The Ins And Outs

The 8080 treats I/O in much the same way as memory in that it has a pair of control signals, $\overline{IOW}$ and $\overline{IOR}$, produced by the system controller at the correct times which determine the direction of the operation. Because the 8080 can only have 256 I/O ports, the lower eight address lines are used to specify the device address. Each address signifies a discrete port or location, much as a memory address is only valid for one location, but certain addresses are already designated by the monitor software. It should be fairly obvious by now that computers are pretty dumb, so the system designer decides to allocate certain peripheral devices to certain addresses. This means that any software written for the machine can use these defined addresses and know, in advance, what will be there.

A typical I/O card is the serial I/O and cassette card. This is intended to be used with a VDU and/or printer and a cassette tape recorder for storing programs and data. The system defines that the serial I/O port is expected to reside at the octal address 372/3 (FA/B Hex). Similarly the cassette is expected at 370/1 (F8/9 Hex). Both ports are extremely flexible. The serial port can operate at any of eight different transmission speeds with a

A_{12}	A_{13}	A_{14}	A_{15}	Block in use
1	1	1	1	60-64K
0	1	1	1	56-60K
1	0	1	1	52-56K
0	0	1	1	48-52K
1	1	0	1	44-48K
0	1	0	1	40-44K
1	0	0	1	36-40K
0	0	0	1	32-36K
1	1	1	0	28-32K
0	1	1	0	24-28K
1	0	1	0	20-24K
0	0	1	0	16-20K
1	1	0	0	12-16K
0	1	0	0	8-12K
1	0	0	0	4-8K
0	0	0	0	0-4K

Fig.1 How the memory decodes into discrete 4K blocks simply by using the top four address lines. In the case of the H8 we can page the memory into 16K units, ie one card is a page.

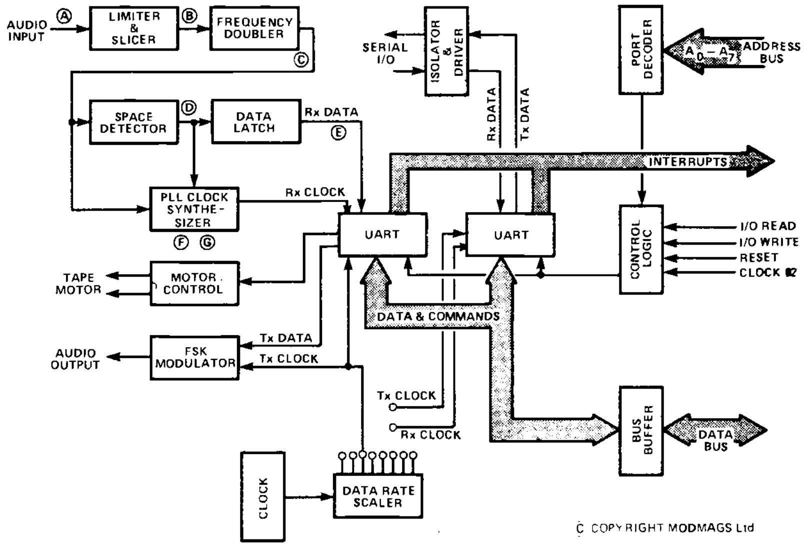


Fig.2 Block diagram of the serial I/O card. A detailed explanation of the cassette interface is given in the text, the normal serial port is conventional in operation and the techniques used have been discussed in earlier articles.

number of code options in either RS232 or 20 mA modes. The cassette interface will operate at either 300 or 1200 baud and includes full motor control.

All the clock rates are controlled by a special crystal on the card whose output is divided down to produce a number of accurate clocks. These clocks actually run at 16 times the expected transmission speed to drive the UARTs. The reasons for this were explained in an earlier episode.

Cassette Taped

It is worth taking a close look at how the cassette interface actually works as this aspect of computers is seldom explained. Figure 2 shows the block diagram of the complete I/O card, which will serve to guide us through the details of the various circuit sections.

The cassette interface stores data on tape in a serial format. As discussed in an earlier article, serial data needs extra codes to indicate the start and end of each data byte and, you will be relieved to hear, the cassette interface is no exception. Data is stored on tape as a string of 'ones' and 'zeros' with '1' being represented by a burst of 2400 Hz and '0' being a burst of 1200 Hz. To be able to read the data back, the interface must, therefore, be able to distinguish the start and finish of any data byte and the difference between the two tones.

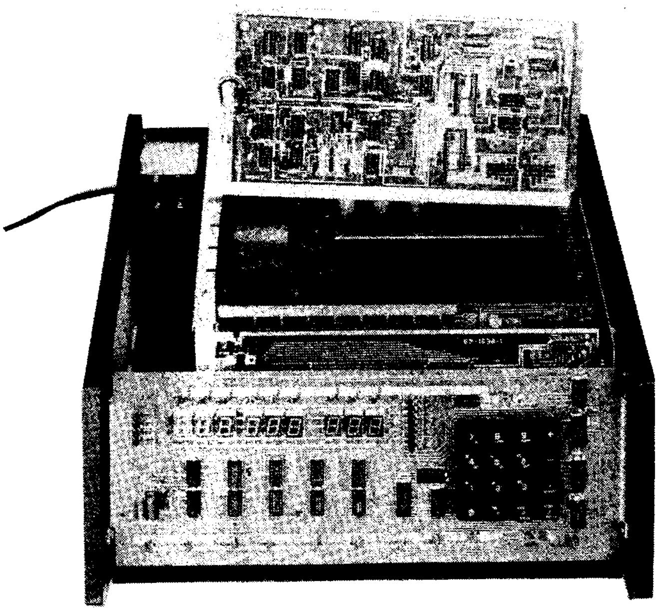
We will concentrate on the input section first and it is important to follow Fig.3 as we go through it. The audio input is first limited in size by chopping the signal with a pair of diodes. This eliminates the possibility of overloading the circuitry with any large amplitude signals. The signal is now fed into a comparator so that a square wave of similar frequency is produced. These are the top two traces in Fig.3.

This signal is fed into a frequency doubler. This consists of two monostables. Each produces a short pulse but on opposite 'edges' of the signal, as shown in the third and fourth traces. These are then combined to produce the fifth trace, which is a signal of twice the frequency of the original. The signal is now split to feed a space detector and a clock synthesiser. The space detector is simply a retriggerable monostable whose time constant is 't'. As can be seen from the diagram the monostable will remain triggered for a 2400 Hz source signal but drop out during a 1200 Hz signal, so we have now detected the 'space'. This signal is fed into a data latch which simply consists of a bistable that triggers on the positive edge of the signal and resets on the 'space'. We now have a serial data stream of '0s' and '1s' that we can feed into a conventional UART. We still need a clock to drive the UART and this is actually produced by the data itself in the following way. The twice-frequency signal is fed into a divider IC that is set to divide by one if the signal is 1200 Hz or divide by two if it is 2400 Hz, ie the output will always be same frequency regardless of the input frequency. This signal has an uneven mark-space ratio and this is fed into a bistable which divides the frequency by two and makes it into an even mark-space signal. This is fed into a PLL (Phase Locked Loop) device which multiplies the frequency by 16. This is the signal that the UART needs. We have now recovered the data from the tape and used it to produce its own clock. This is called a self-clocking code.

Now, you are probably wondering, just how did the clock get *onto* the tape in the first place? The simple answer is that a system known as FSK or Frequency Shift Keying was used, but there's more to it than that. The UART is clocked by either a 19,200 Hz or a 4800 Hz signal depending on the baud rate you have chosen (1200 or 300) and this causes the serial output of data, which is inverted and fed into a bistable clocked by a 4800 Hz signal. When the data is set high the bistable will divide the clock signal by two and produce the 2400 Hz 'mark' signal. When the data is set low the 4800 Hz signal is fed through two bistables thus dividing it by four to produce the 1200 Hz 'space' signal. Because the controlling factor in this process is the length of time that the data is present, the length of tone recorded on the tape is directly related to the *original* transmission speed, which we can recover in the manner detailed above.

Expanding The System

The equipment that we currently have forms the basis of a complete computer system. The simple front panel controls can be replaced by a VDU (Visual Display Unit) or a Teletype, both of which will allow you to take advantage of the various high and low level languages available. You can attach a printer to another RS232 port for nice listings of your programs or



A different view of the box with its lid off. We have removed the front panel so you can see the control card and the elevated card at the rear is a part-built serial I/O and cassette unit. As can be seen at the back of the box, the mains transformer is not exactly small. The shielded area to its left is the mains input and that to its right is the power supply smoothing capacitor. All the components of the case are extremely robust — it's built like a tank. All the circuit boards are well legended and construction is rather laborious but not difficult.

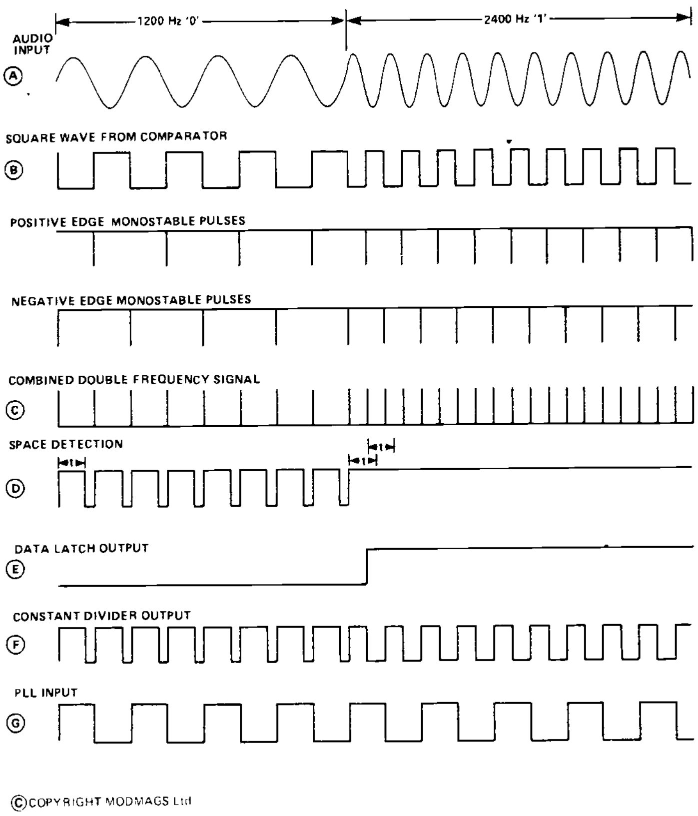


Fig.3 What the waveforms look like during cassette interface operation. They are all referred to in the text and are related to sections of Fig.2.

results of calculations. Sooner or later you will find that the speed or capacity of the cassette unit is less than you need and then you can add devices like floppy discs. At this time the original microcomputer has completely vanished from sight; it has become 'transparent' to the user.

The point of change between computer and system is hard to define but from the user's viewpoint it is probably the moment when the hardware ceases to be important and the software takes over. The best designed computer hardware in the world can be reduced to a useless heap of junk if it is equipped with bad software. It is true to say that with the vast increase in the complexity of the various ICs the actual design of the computer is considerably less of a problem than the production of the necessary software.

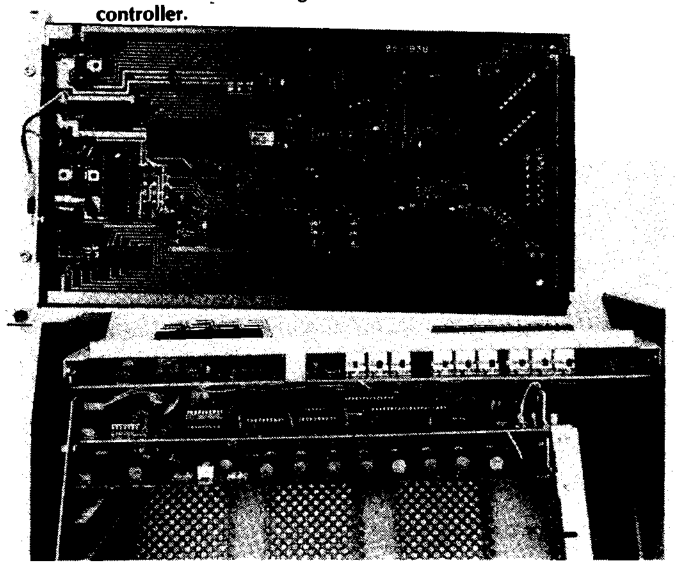
All the future range of assemblers, high level languages, compilers, editors and utility packages will rely on the correct design of the original monitor. At least one major personal microcomputer system has been dogged by the continual release of 'up-dated' monitors. Enhancements to an existing piece of software are fine but complete re-writes tend to cause major problems, not just in the supplying company but in the whole support industry that grows up around each system. One of the original reasons behind my choice of the H8 for use in this series was that it was a tried, tested and proven machine that wasn't being continually messed around with.

The Soft Solution

I've just about exhausted the hardware possibilities, at least as far as this series is concerned. If you have any specific questions that you feel should be answered then please drop a line to Microbasics, c/o Electronics Today International, 145 Charing Cross Road, London WC2H OEE and I'll endeavour to reply to the best, in print, in our June issue which will be the last in the series.

For the next two months I'm going to take a brief look at some simple software techniques. We'll be working in BASIC and the programs will be as 'universal' as possible, so you should be able to try them out on any machine equipped with the language.

The H8 CPU card is supplied ready-built and contains remarkably little. The 8080A is in the centre next to the crystal, the large IC to its left is the monitor ROM and the large IC below the CPU is the master system controller.



A bird's-eye view of the H8's internals showing how the front panel card stacks in. The first bus card is the CPU card, the next one is a 16K static RAM card, both of which are supplied ready-built to avoid nasty and expensive accidents with static electricity.

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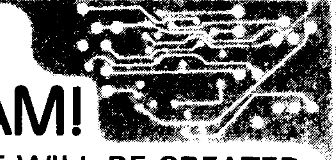

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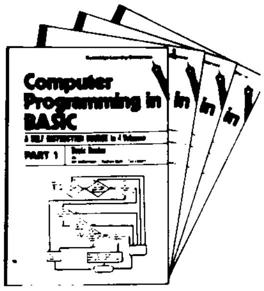

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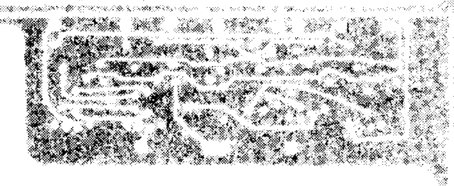

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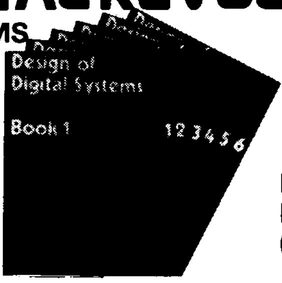

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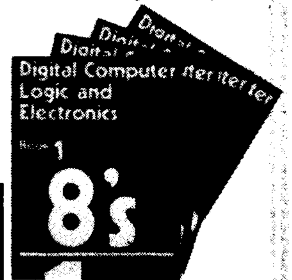

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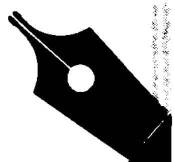

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COMBINATION

LOCK

ETI presents the ultimate security device, a semi-intelligent security lock. It is key-pad operated and has 100 million possible key-code combinations. Design by Ray Marston. Project development by Plamen Pazov.

We at ETI are rather proud of this project, which can justly be described as a semi-intelligent key-pad-operated combination lock that can be used to protect the home, office or car. The unit's key-pad has 10 buttons numbered 0 to 9, plus reset and unlock buttons. To open the lock, a pre-determined eight-digit combination must be punched into the key-pad. If the correct number is punched in, an 'unlock ready' LED illuminates, at which point a relay (the 'lock') can be activated by pressing the 'unlock' button. If a wrong number is punched in, the lock will not open but will initiate an action (ranging from 'do nothing' to sounding an external alarm) dependent on the nature of the error. Any desired combination of the owner's choice can be chosen by hard-wiring a DIL plug; the combination can be changed in seconds simply by swapping DIL plugs.

The really smart feature of the unit is its ability to distinguish between authorised and unauthorised operators. The circuit measures keying factors such as the total durations of key-pad and reset switch closures, the elapsed time since keying initiation and the presence or lack of keying errors. The circuit can, on the basis of these measurements, distinguish between childish fiddlers, drunken operators, authorised operators who make genuine keying errors and thieves who are trying to break the combination, and take appropriate action in each case.

Authorised Operation

The security lock is provided with three LEDs, marked 'ready', 'unlock ready', and 'disabled'. All three LEDs are normally off, indicating that the unit is ready to accept a keying sequence. As soon as the first key-pad closure is made, the 'ready' LED turns on and the keying sequence can continue.

When the fifth digit is punched in, the circuit checks to see if any keying errors have been made and if so generates a brief bleep sound, at which point the operator can cancel the sequence with the reset button and then punch in a new set of numbers. If no errors have been made, the circuit continues to accept keying instructions until the eighth digit is punched in, at which point the circuit again checks for errors. If no errors have been made, the 'unlock ready' LED illuminates and the lock-control relay can be activated by pressing the unlock button. If, on the other hand, an error has been made, an alarm tone will sound, at which point the operator can cancel the sequence and the alarm with the reset button and punch in a new set of numbers.

The security lock incorporates a timing network which measures the elapsed time since the initiation of key-pad operation. This timer enables the operator to have two or three goes at opening the lock, enabling a reasonable number of keying errors to be accommodated. Once the correct combination has been punched in and the lock has been opened, the operator should reset the lock using the reset button. If the operator forgets to reset manually, the timing circuit will perform the operation automatically after a delay of (typically) about 30 S, but will then go into an auto lock-out mode (indicated by the turning on of the 'disabled' LED) in which it accepts no further keying instructions for 30 S. At the end of the lock-out period the 'disabled' LED turns off and the circuit is ready to accept a new keying sequence. The key-pad must not be actuated when the 'disabled' LED is on.

Childish Fiddling

If children try activating the security lock by pressing the key buttons at random the circuit will, on the fifth key button actuation, detect a keying error and generate a brief bleep tone and then refuse to accept any further keying instructions unless the circuit is reset, in which case the same set of actions will recur. After a total of 6 S of key-pad closures, or a maximum of 60 S after the first push-button closure, the circuit will go into the auto lock-out mode and will accept no further instructions until 30 S after all key-pad buttons are released, at which point the circuit will automatically reset in readiness for an authorised keying instruction.

Operation By Thieves

It should be noted that the first five digits of the lock code have 100,000 possible combinations, so the chances of an unauthorised person getting past the fifth digit are very slight. If an operator does get past the fifth digit, the security lock automatically regards them as potential thieves and reacts accordingly.

Consequently, if keying errors are made subsequent to the fifth digit and are not corrected within a reasonable space of time (an absolute maximum of 60 S) the circuit goes into an emergency alarm and auto lock-out condition in which an alarm tone is generated and a relay (which can be used to activate an external alarm) turns on and cannot be turned off again manually, but will only turn off (automatically) if the keypad remains unused for 30 S or so.

Operation By Drunks

The automatic protection circuitry of the security lock measures a variety of keying factors and the on-board timing networks can readily be adjusted to that the lock can be opened by the deft and nimble fingers of a sober operator, even allowing for two or three keying errors, but not by the fumbling and slow-operating fingers of a drunk.

Applications

The security lock requires a 12 V power supply and typically consumes a mere 1 uA or so when in the standby mode. The unit can be used to protect the home or office by using the lock-control relay to activate an electric door latch and the alarm relay output to actuate an external siren or burglar alarm, etc.

The device can be used to protect a car against thieves or drunken drivers by wiring the lock-control relay in the self-latching mode via the ignition switch, using the output to control the ignition circuit and the alarm relay output to actuate the car horn.

Construction

The unit is built up on two PCBs — one small and one large. The small PCB holds the keypad switches plus IC1 and its associated resistors and diodes. In domestic applications, this PCB is intended to be fitted in a small box and mounted on the outside (access side) of a door, together with the three LEDs and the small acoustic transducer, while the remaining circuitry (on the large PCB) is mounted on the inside of the door. The two units are interconnected by a length of multi-way ribbon cable.

The large PCB is a fairly complex single-sided affair using a couple of dozen jumper links. We've made provision for either mounting two small PCB-mounting relays on this large board or for mounting larger relays remotely, as preferred. We've also made provision for wiring the desired key-code through a 24-pin DIL plug.

Start the construction by building the small PCB, remembering to mount IC1 in a suitable socket and noting that the PCB is designed to accept the Ambit key-pad switches mentioned in 'Buylines'. When construction is complete, fit the unit into a suitable die-cast box, together with the three LEDs and the small acoustic transducer and a reasonable length of interconnecting ribbon cable.

Now build up the large PCB, again remembering to provide all ICs with suitable sockets. Do not fit the ICs in place at this stage. When construction is complete, double-check the assembly against the component overlay, paying particular attention to the jumper links and to the polarities of all diodes. Now wire the desired keyboard code sequence into the unit using the 24-way DIL plug, wiring the first number from point 'a' to the desired number on the left hand side of the plug, the second from point 'b' to the desired number and so on until all eight digits are wired in. If you want to use six or seven (rather than eight) digits in your code, simply wire a suitable link from 'x' to the appropriate number on the right hand side of the plug, as shown in the diagram.

At this stage, interconnect the two PCBs and then fit the ICs to the large board IN NUMERIC SEQUENCE (IC2 to IC8). If it is subsequently necessary to remove an IC, note that all higher-numbered ICs must be removed in reverse sequence until the offending IC is reached. Now connect the unit to a 12 V supply, briefly press the reset button and check that all LEDs are off. Give the unit a functional check by keying in the appropriate sequence of numbers and check that the 'unlock ready' LED illuminates. Check that the alarm sounds briefly if an incorrect sequence is punched in, as already described. The unit is then ready for installation and use.

Installation

The key-pad security lock can be used to protect a car against drive-away thieves or drunken drivers by using one set of lock-control relay contacts to make or break the vehicle's ignition circuit, as shown in Fig.1. Here, the security lock unit is permanently wired to the vehicle's battery, but the connections to relay RLA and driving transistor Q1 are made via the ON position of the ignition switch; the relay is wired in the self-latching mode via contacts RLA/1 and the RLA/2 terminals are used to make/break the supply connections to the vehicle's ignition coil. The RLB/1 connections are taken to the car's horn. Note in this application that unlock button PB12 should be permanently shorted out.

The key-pad security lock can be used to protect access doors in homes and offices, or safe doors, etc. The electrical connections are quite simple in these applications (see Fig.2), but some ingenuity may be needed in implementing the electro-mechanical latching mechanism. Here, the lock is permanently powered from a mains-derived IC-regulated 12 V DC supply, contacts RLA/1 are used to make or break a DC supply to the electric door-latch and RLB/1 is used to make or break an AC supply to a 12 V alarm bell.

Electric door latches are available from major locksmiths and from security firms such as BSG (Security) Ltd, 34/35 Dean Street, London W1V 5AP (Tel: 01-439 4536), but are rather expensive, typically costing some £12 to £15 each. Ingenious readers may be able to find far cheaper ways of implementing effective electric door latches.

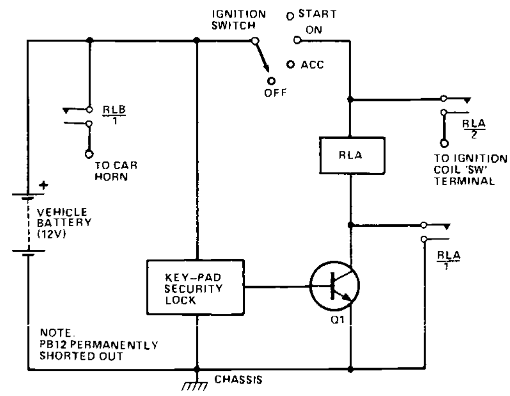


Fig.1 Method of wiring the security lock for use in a car.

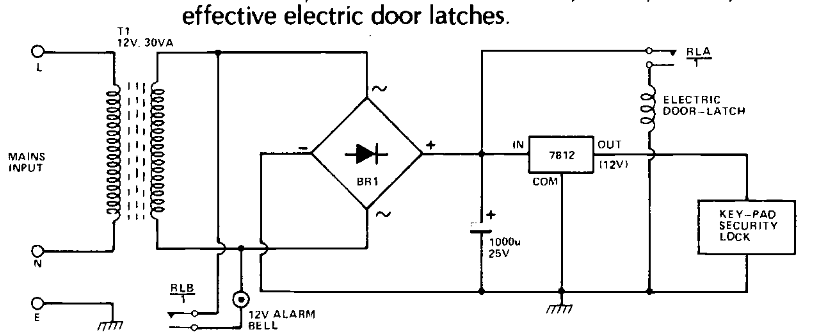


Fig.2 Method of wiring the security lock for use in the home or office. In applications where power failure might occur, the switch and latch should be powered from a back-up battery (Ni-Cd or lead acid) under constant trickle charge. The alarm is still powered from the mains.

HOW IT WORKS

The key-pad security lock circuit comprises three major sections, the most important being a dual code-word generator/comparator network. The remaining two are the error detection/indication and auto lock-out circuitry.

The basic operating principle of the complete circuit is fairly easy to grasp. The dual code-word generator/comparator network, which is the heart of the unit, contains two four-bit code word generators and a two-word comparator. One of these generators is driven from the 10-button key-pad and generates a specific code word for each of the 10 buttons and, simultaneously, generates a press-detection waveform when any button is pressed. This press-detection waveform is used to clock an eight-step counter. The second code-word generator is driven from the output of the eight-step counter and generates one of 10 possible four-bit code words in each position of the counter. A sequence of eight four-bit code (or reference) words (corresponding to the desired eight-digit code) is hard-wired into this generator.

At the start of each sequence of keying operations, the counter is reset to zero. Thus, when the first key-pad press operation is performed, a four-bit key-pad code word is generated and, simultaneously, the counter selects the first of the four-bit reference words. The circuitry then compares the two words and if the numbers are not identical an error detector latch is activated. This process is repeated, with a new key-pad and reference number being generated and compared, each time that a key-pad button is pressed.

If no key-pad error is detected by the time the eighth key-pad operation has been performed, the output relay will be enabled by the error detection circuitry and can be activated by operating an unlock push-button. If, on the other hand, an error is detected, an alarm indication will be given and the unlock relay will not be enabled. The type of alarm indication depends on the nature of the keyboard error and ranges from a simple bleep to the actuation of an external alarm through a relay output.

The auto lock-out circuitry measures factors such as the total duration of key-pad press operation and the elapsed time from the start of a keying sequence, etc., and rejects keying operations if certain parameters are exceeded.

The dual code-word generator/comparator section of the unit is designed around IC1 to IC5, plus IC8a and IC8b. IC1 and IC2 are eight-input priority encoders. They have eight independent inputs (coded 0 to 7) and generate a three-bit binary code output in accordance with the highest activated input. The code ranges from 000 when the 0 input is active to 111 when the 7 input is active. Pin 15 of the chip is normally high, but switches low when any input is active.

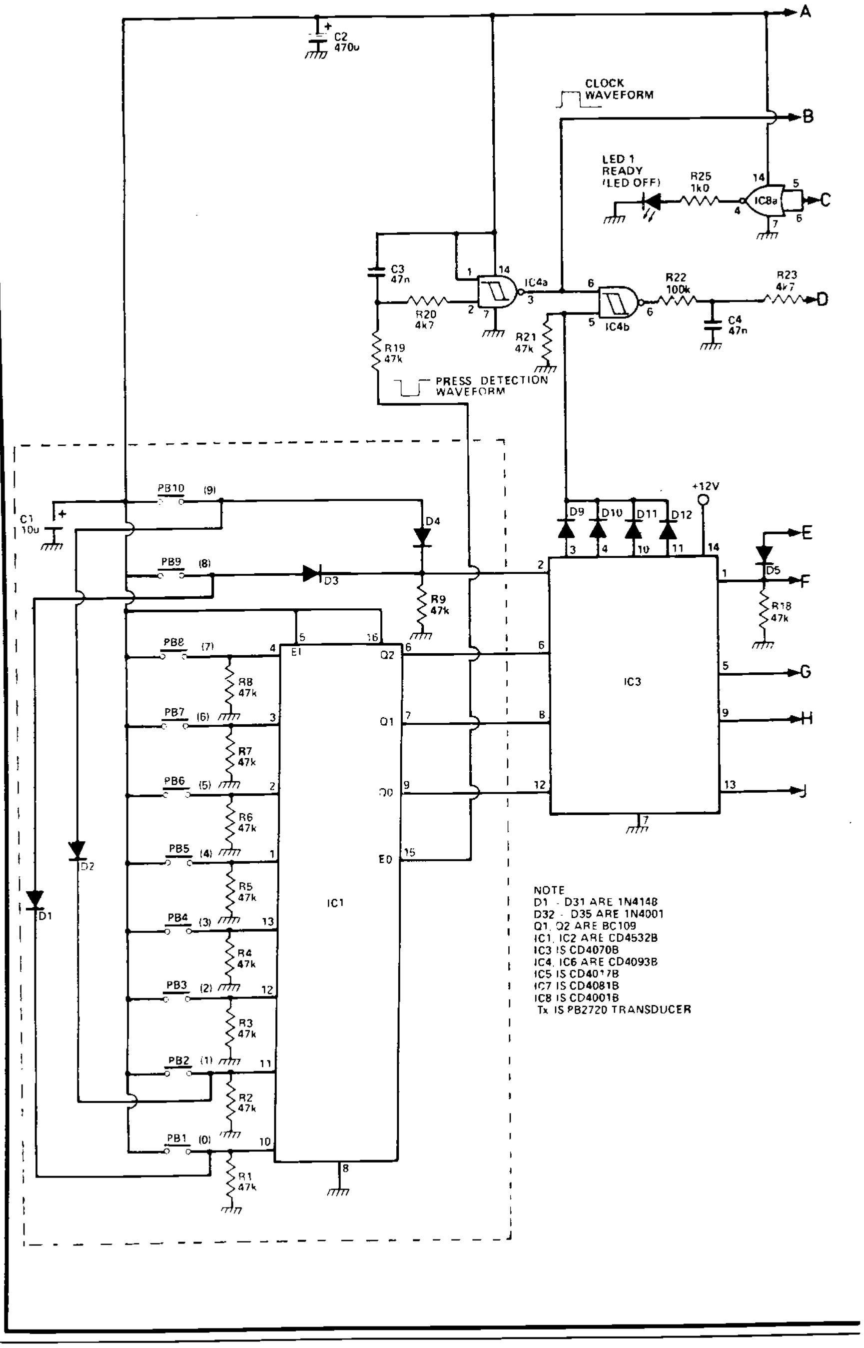
In our application, IC1 and IC2 are each supplemented by a diode gate network that enables a four-bit code to be generated via 10 input terminals. The inputs to the IC1 code-generator are derived from the 10-button key-pad, and the pin 15 press detection waveform is used to generate a positive clock pulse by the IC4a bounce suppression circuitry. The clock pulse is fed to the input of a 4017 counter/decoder (IC5), which thus shifts one step each time a key button is pressed. The inputs to the IC2 code-generator are derived from the decoded outputs of IC5 through D16 to D23 and can be hard-wired to give any desired code sequence.

The four-bit outputs of the two code-word generators are compared by the IC3 quad two-input EX-OR gate and by the D9-D12 four-input OR gate and NANDed with the clock waveform by IC4b. The output of IC4b is glitch-suppressed by R22 and C3 and the resulting signal is fed to one input of the IC4c-IC4d bistable latch. The outcome of all this is that the C3 voltage is normally high, but goes low (in synchrony with the clock waveform) if an incorrect codeword is generated from IC1 by the keyboard.

At the start of each keying sequence the IC5 counter is reset, either automatically or by PB11 and pin 3 goes high. This voltage is inverted by IC8a to drive 'ready' LED1 off and by IC8b to reset the IC4c-IC4d bistable so that the output of IC4c goes low. As soon as the keying sequence is initiated, pin 3 of IC5 goes low and LED1 illuminates via IC8a and, simultaneously, the IC4c-IC4d fault detection bistable is enabled. If any keying fault is subsequently detected, the IC4c output of the bistable latches into the high state.

The error detection/indication circuitry section of the circuit is designed around IC7, IC8c-IC8d, IC6a-IC6b, the Q1 relay driver and the IC4c-IC4d bistable already described. IC6a-IC6b are wired as a gated astable with a buffered output that is used to drive a small acoustic transducer and IC8c-IC8d are wired as a latching alarm bistable.

If a keying error occurs, the output of IC4c locks into the high state. If the error occurs within the first five keying operations, the output of AND gate IC7a will go high on the arrival of the fifth keying operation and feed a brief gating pulse to the IC6a-IC6b astable via C4-R32-D24-D25 and cause a brief audible tone to be generated.



Simultaneously, D15 drives the inhibit terminal of IC5 high and causes the counter to ignore all subsequent clock signals until the counter is reset.

If the keying error occurs between the fifth and eighth operation, the output of IC7b will go high on the arrival of the eighth keying operation and activate the IC6a astable via D26, causing an alarm tone to be generated until IC5 is reset. Simultaneously, the IC8c-IC8d alarm bistable will latch and, if the keying error is not corrected within a reasonable time (by resetting the counter and re-keying the correct number sequence) it will cause the output of IC7d to switch high (via the auto lock-out circuitry) and drive the IC6a astable on via D27 and relay RLB on via Q2. The RLB contacts can be used to activate an external alarm generator. The counter inhibits via D15 when its 8 output goes high.

If the correct sequence of numbers is keyed into the security lock, the counter will again inhibit on the arrival of the eighth keystroke, but in this case 'unlock ready' LED2 will be driven on by IC7c, enabling lock-control relay RLA to be activated by PB12.

The auto lock-out circuitry is designed around the IC6c-IC6d

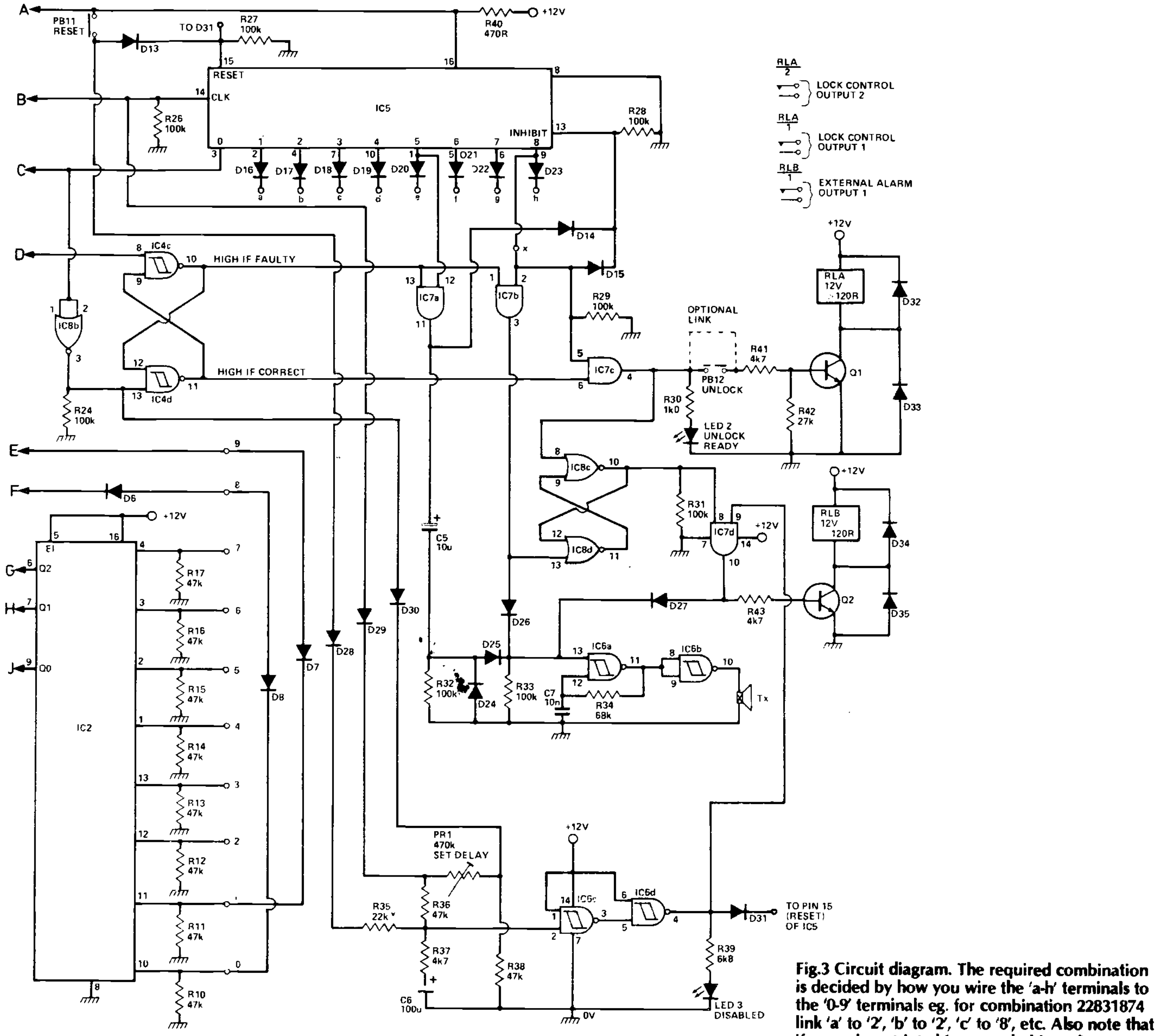


Fig.3 Circuit diagram. The required combination is decided by how you wire the 'a-h' terminals to the '0-9' terminals eg. for combination 22831874 link 'a' to '2', 'b' to '2', 'c' to '8', etc. Also note that if space is restricted (e.g. car dashboard) you can dispense with all but, say, two pushbuttons. The combination is then reduced to pushing the two buttons in the correct sequence.

non-inverting Schmitt network, which has its input applied via C5 and its output taken to the reset terminal of the IC5 counter by D31. In essence, this circuit is used to measure various time-related characteristics of keyboard operation and to inhibit operations if these characteristics exceed preset limits.

C5 can be charged by any of the D28-D30 networks, and discharges by PR1 and R38 (and possibly R36) and the circuit is configured so that LED3 turns on and the circuit is disabled (by locking the counter into reset by D31) if the C5 voltage rises to two thirds of V+; LED3 turns off and the counter is re-enabled if the C5 voltage falls below one third of V+. C3 can be charged from any of three sources. It can be charged through reset button PB11 and D28-R35, in which case LED3 will turn on with 3 S of continuous PB11 closure, but will not turn off again until roughly 30 S after PB11 release. The circuit thus responds to the number of manual reset operations.

C5 can also be charged by the clock pulse waveform (which gives a direct measure of key-pad press durations) and D29-R36, in which case LED3 will turn on with a total of 6 S of keyboard closures, but will not turn off again until 30 S after the final release of all keyswitches.

Finally, C5 can also be charged through D30 and PR1. In this instance, charging commences as soon as any key-pad switch is activated (pin 3 of IC5 goes low) and LED3 typically turns on 60 S after the initiation of key-switch operations (the precise period can be varied by PR1). This input ensures that the circuit will eventually reset automatically if the owner forgets to reset the circuit manually after keying a correct number sequence, or if unauthorised persons (children) try playing with the keyboard.

The C5 charging network has an additive time constant such that an authorised and sober operator can have two or three tries at opening the lock before auto lock-out occurs, whereas a drunken operator (with fumbling a slow-operating fingers) will have little chance of opening the lock. Similarly, unauthorised persons can make very few key-pad operations before auto lock-out occurs, ensuring that there is virtually no chance of cracking the lock combination (there are 100 million possible combinations). If auto lock-out does occur, the circuit can be re-enabled by simply allowing the key-pad, etc., to 'rest' for 30 S or so until LED3 turns off, at which time a further attempt can be made at opening the lock.

PARTS LIST

Resistors all ¼ W 5%	
R1-19,21,36,38	47k
R20,23,37,41,43	4k7
R22,24,26,27,-28,29,31,32,33	100k
R25,30	1k0
R34	68k
R35	22k
R39	6k8
R40	470R
R42	27k
Potentiometer	
PR1	470k
Capacitors	
C1	10u 16 V axial electrolytic
C2	470u 16 V axial electrolytic
C3,4	47n polyester
C5	10u 16 V axial electrolytic
C6	100u 16 V axial electrolytic
C7	10n polyester
Semiconductors	
IC1,2	4532B
IC3	4070B
IC4,6	4093B
IC5	4017B
IC7	4081B
IC8	4001B
Q1,2	BC109
D1-31	1N4148
D32-35	1N4001
LED1-3	0.125" red LEDs
Miscellaneous	
PB1-12	KHC10901 (push-to-make non-locking)
RLA, RLB	2 pole C/O, 12 V, coil > 120R
Tx	Piezo-electric sounder (PB 2720)

Verocase (code 202-21035F), diecast box (120 x 65 x 40 mm), 24 pin DIL socket and 24 pin DIL Header, 14 pin DIL insulation displacement connectors (2 off), ribbon cable, caps for switches (KT5 — 12 off).

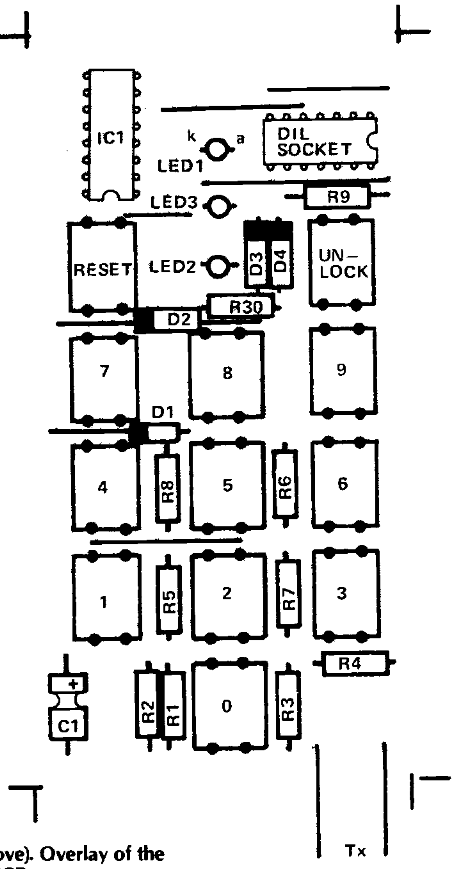


Fig.4 (Above). Overlay of the key-pad PCB.

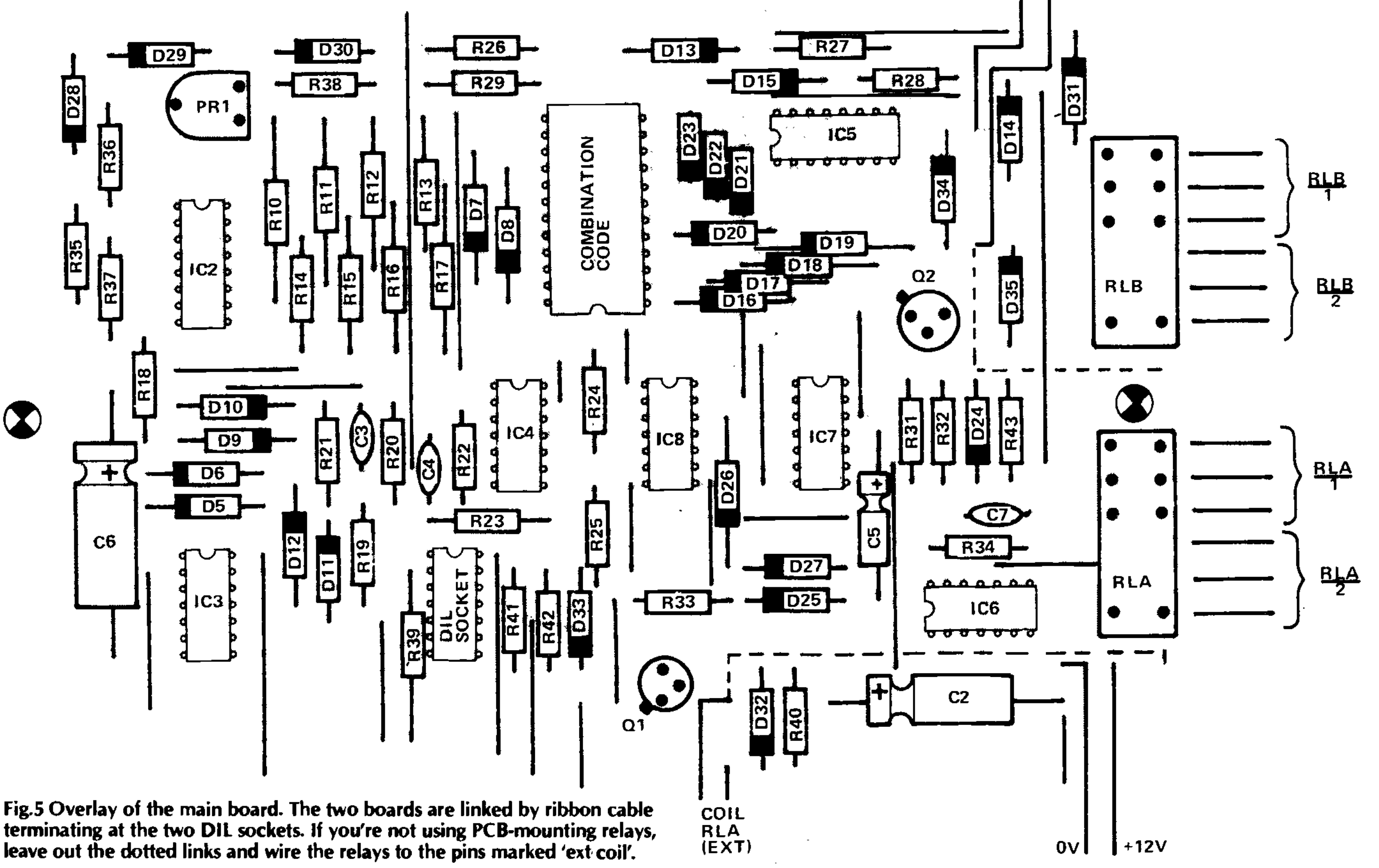
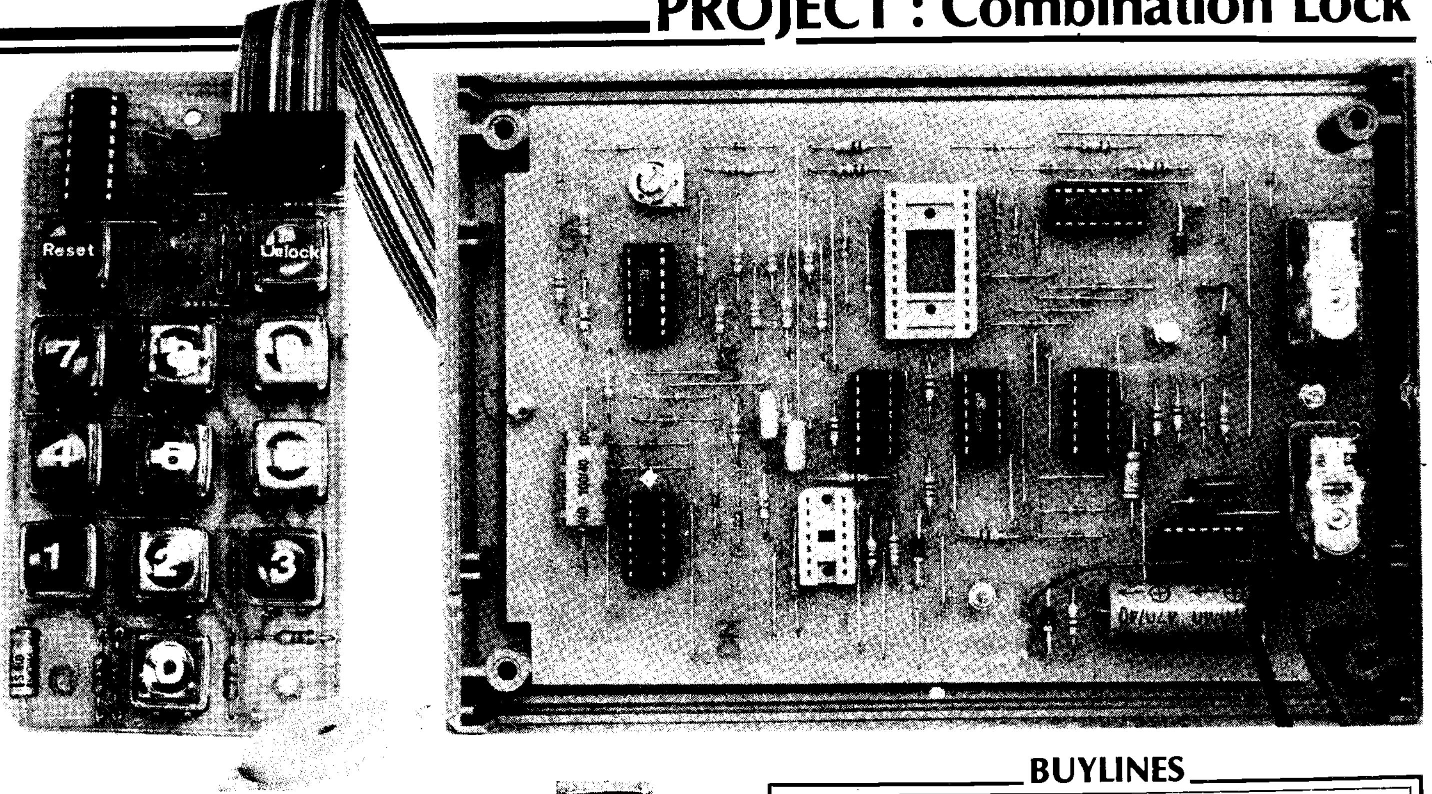
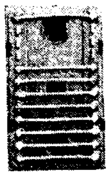


Fig.5 Overlay of the main board. The two boards are linked by ribbon cable terminating at the two DIL sockets. If you're not using PCB-mounting relays, leave out the dotted links and wire the relays to the pins marked 'ext coil'.





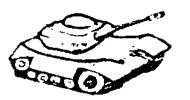
The key-pad PCB (above), and the main board in its case. The main board has the ribbon cable connector and the DIL header removed. The header is shown wired for a combination of 01234567 — with a range of pre-wired headers you can change the combination in a few seconds.

BUYLINES

There shouldn't be any problems with the majority of the components for this project. The pushbuttons and the piezo-electric sounder are available from Ambit. The relays are RS types, also available from Maplin or Watford. DIL headers can be obtained from Maplin and Electrovalue, and DIL insulation displacement connectors are available from Electrovalue.

ETI

THE REMOTE CONTROL STORY



ONCE UPON A TIME

If you wanted to control any equipment remotely you had to buy a dozen logic ICs, chase around the shops for crystals and expensive ultrasonic transducers and then spend a few days getting the unit to work. Then one day TK began stocking a new system All you required was one IC, a couple of transistors, resistors and a keyboard for the transmitter and a couple of ICs plus a few capacitors for the receiver, to give you up to 16 on/off (digital) outputs or 10 channels plus three analogue (0-10V) outputs The SL 490 transmitter/encoder accepts inputs from a keyboard (up to 32 way) and encodes these into a pulse train which may be transmitted using infra red, ultrasonic, radio or even wire links For the receiver you may use the SL480 pre-amplifier if you want an infra red link or a suitable pre-amplifier for ultrasonic or radio links, and one of the ML920 series decoders depending on the number and type of outputs required The only adjustment you need to make is to set one preset (by trial or with a 'scope) and that's it

LD271 IR Emitting Diode	.36	ML926 16-channel receiver 4 momentary binary outputs	1.40
SFH205 Photodiode Detector	.95	ML928 16-channel receiver, 4 latched binary outputs	1.40
SL480 IC Pulse Amp.	1.70	ML929 16-channel receiver, 4 latched binary outputs	1.40
SL490 32 Command Encoder/transmitter	2.40		
ML922 10-channel receiver + 3 analogue outputs	4.20		

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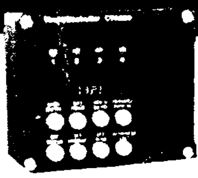

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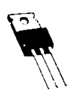
TRIACS



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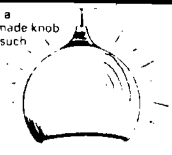

Two years ago TK Electronics launched a touchdimmer kit the TD300K, which made knob controlled dimmers obsolete This was such a great success that many magazines and more retailers soon produced similar designs SO THAT OTHERS MAY FOLLOW, TK have designed a touch dimmer kit with an Infra Red Remote control enabling you to switch and control the brightness of your lights from the comfort of your armchair etc (as well as manually by touching the frontplate or by using the TDE/K extension kit) As with all our kits, these come complete with all components **including** RFI suppression frontplate a neon to help you find the switch in the dark and a neat box for the transmitter The plastic frontplate has no metal pads to touch ensuring complete safety and enabling the plate to be covered with a decorative finish to blend with your room decor

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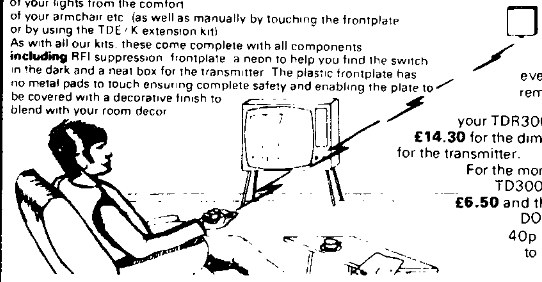

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0 033	7p	0 47	15p
0 047	7p	0 68	18p
0 068	7p	1 0	24p
0 1	7p	1 5	27p
0 15	12p	2 2	31p

Electrolytics A Axial R Radial

63V	1.0	R	5p	16V	10	R	5p
	2 2	R	5p		22	R	5p
	4.7	R	6p		33	R	5p
	10	R	7p		47	R	6p
	47	R	12p		100	R	8p
25V	22	A	8p		220	R	11p
	47	A	10p		470	R	14p
	100	A	14p		1000	R	20p
	110	A	15p	10V	47	A	8p
	470	A	24p		100	A	8p
	1000	A	34p		220	A	12p

Tantalum (bead)

35V	0 1	9p	10V	22	20p
	0 22	9p	6 3V	33	20p
	0.47	9p		47	27p
	1 0	9p	3V	100	27p
25V	2 2	10p			
	4 7	14p			
	10	20p			

Ceramic 50V

		1 000pF	4p
100pF	4p	2 200pF	4p
220pF	4p	4 700pF	5p
470pF	4p	10 000pF	5p

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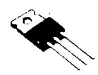

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1N5401 3A 50V	8p
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BC182	8p	TIP31A	40p
BC182L	8p	TIP32A	40p
BC212	9p	2N3055	45p
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DESIGNER'S NOTEBOOK

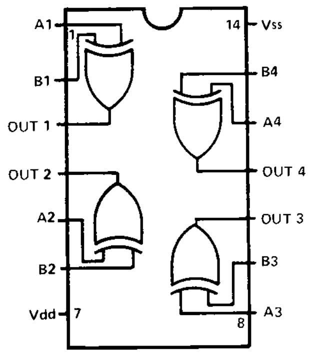
EX-OR gates and magnitude comparators feature in this month's edition of Ray Marston's 'Designer's Notebook'

The 4070B quad EX-OR gate is one of the least known but most useful members of the commonly-available family of CMOS quad two-input gate ICs. The device's gates can readily be used as programmable (inverting or non-inverting) pulse amplifiers, phase comparators, free-running or gated astables, or multi-bit magnitude checkers, etc. Pretty good for a chip that costs a mere 20-30 pence.

Figure 1 shows the outline and pin notations of the 4070B, together with the truth table for each of the EX-OR gates in the package. The most important point to note here is that the output goes high only (EXclusively) if a logic 1 is applied to only one of the inputs (A OR B). The output takes a logic 0 state if identical inputs are applied to both inputs.

Figure 2 shows how individual gates can be used as programmable pulse amplifiers. With the connections shown in Fig. 2a, the circuit functions as an inverting amplifier. In Fig. 2b the amplifier acts in the non-inverting mode, while the Fig. 2c circuit shows the connections for making a switch-programmable amplifier.

The EX-OR programmable amplifier can be used as the basis of a so-called scrambler system, of the type used on security telephones, etc., by using the basic circuit shown in Fig. 3. Here, in the transmitter, the audio signal is converted to digital form by an A-to-D converter and fed to one input of the EX-OR gate, while the other input is fed from a digital white noise or 'scramble' signal. The output of the EX-OR gate is thus inverted or non-inverted in a random manner and can not readily be deciphered.



A	B	OUT
0	0	0
1	0	1
0	1	1
1	1	0

1 OF 4 GATES

Fig.1 Pin notations, outline and truth table of the 4070B quad two-input EX-OR gate.

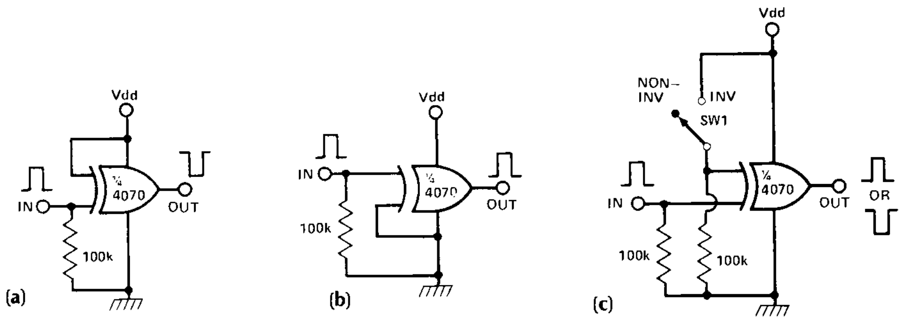


Fig.2 The EX-OR gate can be used as an a) inverting, b) non-inverting, or c) switch programmable pulse amplifier.

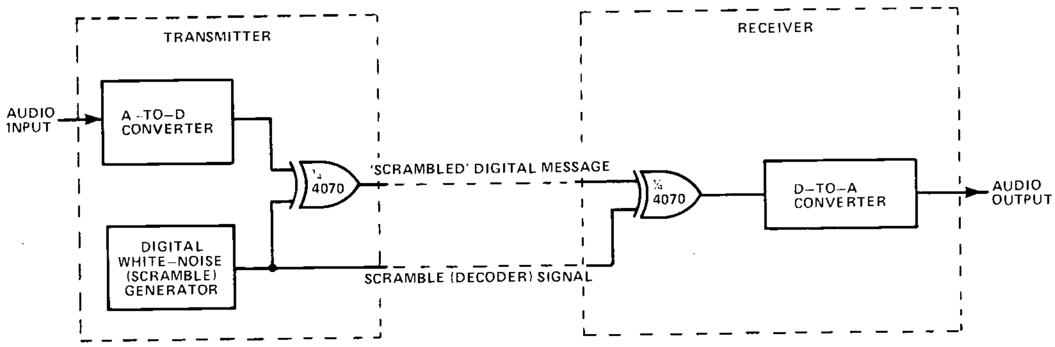


Fig.3 Basic circuit of an audio (telephone etc) scrambler system.

Both the scrambled message and the scramble signal are sent out (on separate lines) from the transmitter. At the receiver, the two signals are picked up and fed to the two inputs of a second EX-OR gate, where the digital analogue signal is restored (unscrambled) to its original form (the simple principle here is that if both gates are either inverted or non-inverted, the net effect will be an overall non-inversion of the signal). The restored digital signal is then converted back to analogue form by a D-to-A converter. Neat.

More Circuits

Figure 4 shows ways of using an EX-OR gate as a digital phase comparator and as a frequency-doubler. The two circuits use the same basic principle of operation, so let's look at the phase comparator first. The comparator is meant to be fed with digital (ideally, square wave) signals that are identical in form and frequency but which may differ in relative phase. A digital signal is available directly at the output of the gate, or a DC signal may be available from an R-C low pass output filter.

From the circuit waveforms, you can see that if both input signals are precisely in phase the two inputs will always be identical and the output will be zero. If, on the other hand, the two signals are not in phase, the output switches high at those points in the waveform where the two inputs are in opposite logic states. This situation occurs twice in each input cycle, so the output signal is frequency-doubled. The pulse width of the output signal and thus the mean DC output levels of both the gate and the low-pass filter are directly proportional to the magnitude of the phase difference between the two input signals. The level is low with a small phase difference, rises to a maximum at 180° difference and then reduces again as the phase difference is shifted from 180° towards 360°.

From the above, it is easy to see how the Fig. 4 frequency-doubling circuit works. The digital input signal is fed directly to the 'A' input terminal of the EX-OR gate but is fed to the 'B' terminal through the phase-shifting network formed by R-C; the resulting phase-shift implements the frequency-doubler action.

Figure 5 shows how a pair of EX-OR gates can be used to make a 1 kHz astable multivibrator or square wave generator. The circuit operates as a standard CMOS astable, the two gates being made to function as pulse inverters by taking one of their two inputs high.

Figure 6 shows how to modify the above circuit so that it functions as a gated 1 kHz astable circuit. Useful features of this design are that it uses a logic 1 (high) gate signal and its output goes to the logic 0 (zero) state when the astable is gated off.

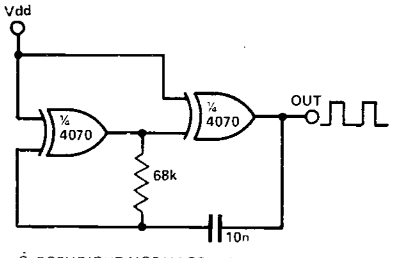


Fig.5 A 1 kHz EX-OR astable.

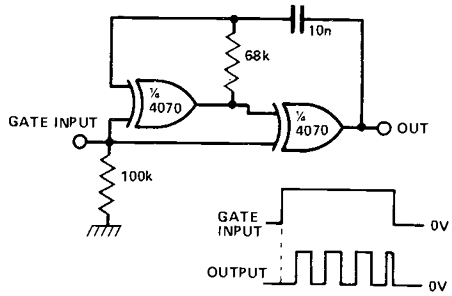


Fig.6 A gated 1 kHz EX-OR astable.

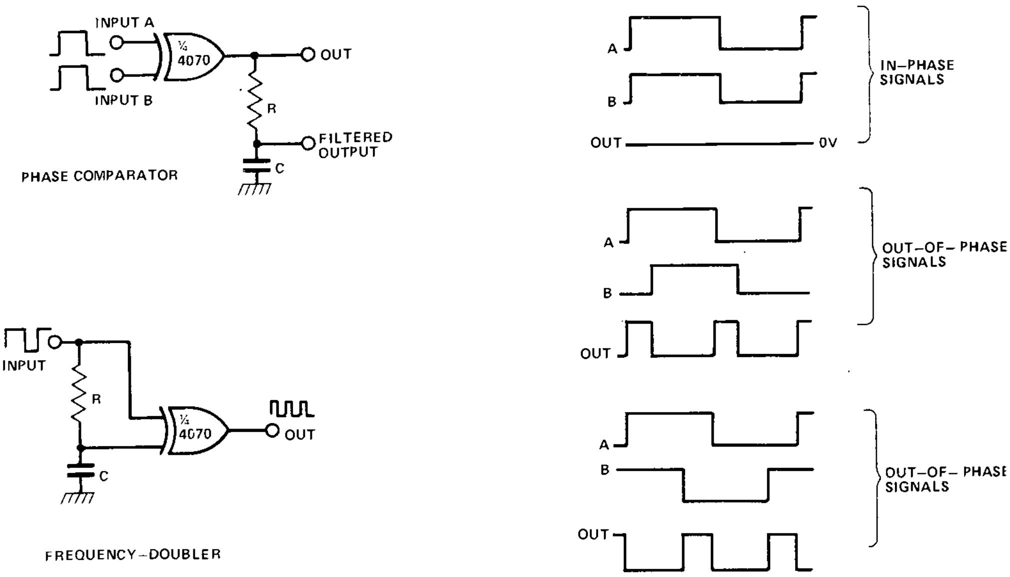


Fig.4 An EX-OR gate can be used as both a phase comparator and a frequency doubler. Typical waveforms for the phase comparator circuit are shown on the right.

Magnitude Comparators

We've already seen that the output of an EX-OR gate goes low if its two inputs are identical, or high if the inputs differ. The device can thus be used to compare a pair of digital bits, or a number of gates can be used to compare the magnitudes of a pair of multi-bit digital words. Figure 7 shows how a 4070B can be used to compare two four-bit words and give a high output if the two words are not identical. In Fig. 7a, the outputs of the four EX-OR gates are ORed by one half of a 4072 dual four-input OR gate. In the Fig. 7b circuit the outputs are ORed by a four-input diode gate.

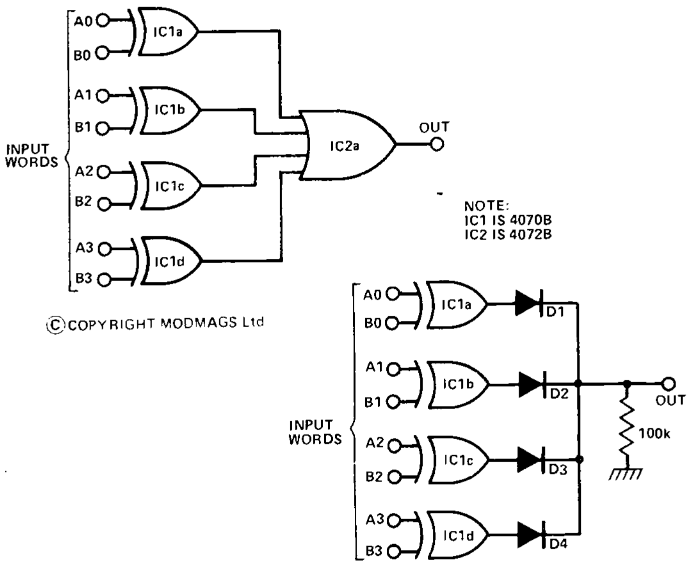
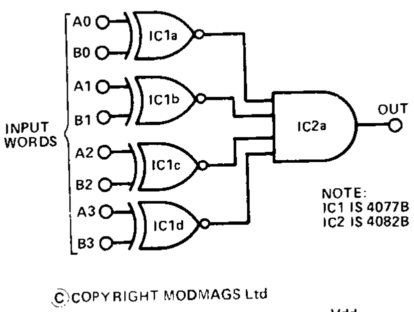


Fig.7 Alternative ways of using a 4070B and a four-input OR gate to make a four-bit two-word comparator. The outputs go high if the two input words are not identical.



A	B	OUT
0	0	1
0	1	0
1	0	0
1	1	1

4077B TRUTH TABLE

Fig.8 Method of using 4077B EX-NOR gates to make a four-bit two-word comparator that gives a high output if the two input words are identical.

An opposite action, in which the output goes high if the two words are identical, can be obtained by replacing the 4070B with a 4077B EX-NOR IC and ANDing the outputs by one half of 4082B, as shown in Fig. 8. The 4077B has the same outline and pin notations as the 4070B.

The two magnitude comparator circuits described above are quite inexpensive and, clearly, are not particularly sophisticated. If a more sophisticated magnitude comparator performance is required, special chips such as the 4063B or 4585B four-bit magnitude comparators can be used. Figure 9 shows the outlines and pin notations of these two CMOS devices. Note that these chips have three outputs, one going high if the two words are identical, one if the 'A' word is greater than the 'B' word, and the remaining output going high if the 'A' word is less than the 'B' word. Obviously, only the one output can be high at any given time.

A useful feature of the 4063B and 4585B comparators is that they can readily be cascaded to compare words of any desired 'bit' length. Figure 10, for example, shows the basic connections for making a 12-bit comparator, using three cascaded ICs. When using these comparators, either singly or in cascade, note that the cascading inputs of the least significant comparator are connected as follows: (A < B) and (A > B) are biased low, and (A = B) is biased high.

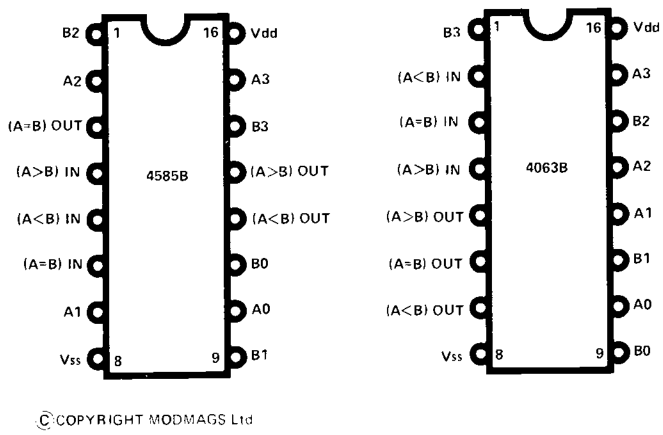


Fig.9 The 4585B and the 4063B are four-bit magnitude comparator ICs.

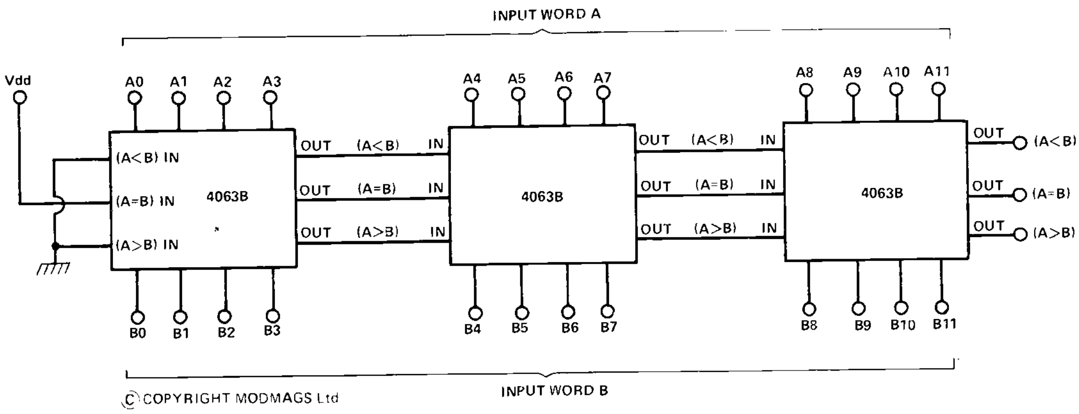


Fig.10 Method of cascading three 4063Bs to make a 12-bit two-word comparator.

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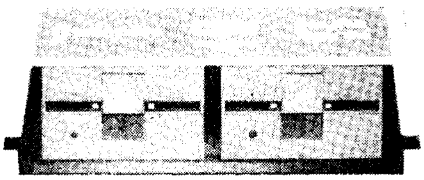

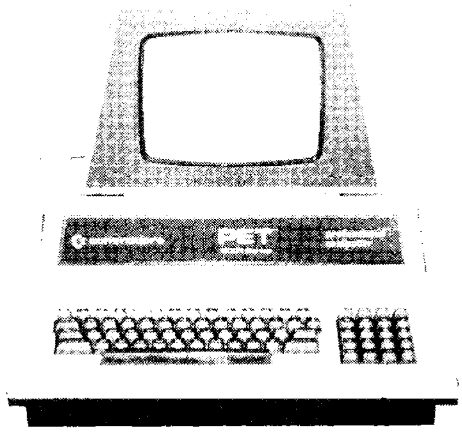

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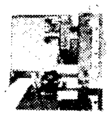

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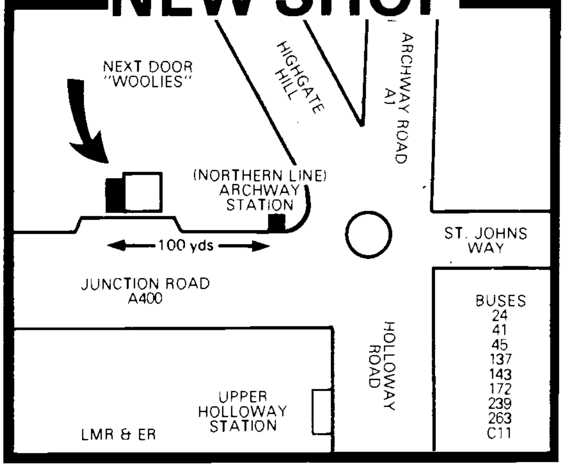

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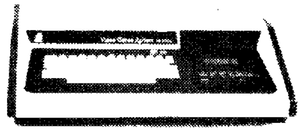

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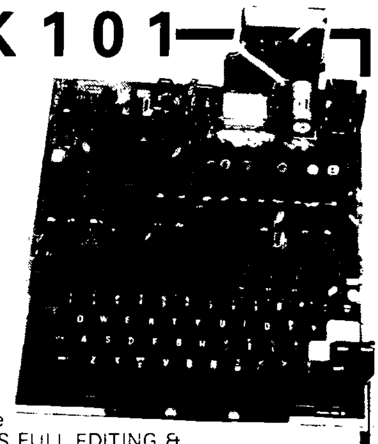

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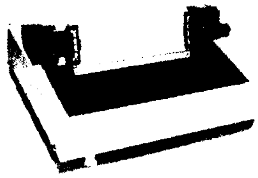

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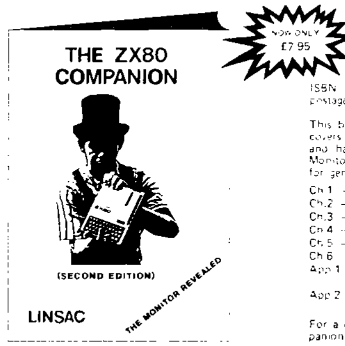

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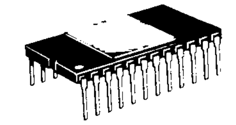

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LS38	39
LS40	28
LS42	80
LS47	85
LS48	120
LS49	120
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LS54	30
LS55	70
LS63	150
LS73	40
LS74	40
LS75	48
LS76	45
LS78	45
LS83	106
LS85	106
LS86	45
LS90	50
LS91	125
LS93	75
LS95	115
LS96	180
LS107	45
LS109	75
LS112	80
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LS114	49
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LS132	95
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LS138	70
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LS145	120
LS148	175
LS151	95
LS153	85
LS155	96
LS156	96
LS157	78
LS158	85
LS160	120
LS161	98
LS162	110
LS163	100
LS164	115
LS165	155
LS166	175
LS168	210
LS169	210
LS170	288
LS173	105
LS174	147
LS175	110
LS181	295
LS190	120
LS191	120
LS192	125
LS193	125
LS194	125
LS195	125
LS196	120
LS202	345
LS221	120
LS240	225
LS241	225
LS242	232
LS243	232
LS244	225
LS245	360
LS247	135
LS248	135
LS249	135
LS251	130
LS253	130
LS257	115
LS258	120
LS259	160
LS261	450
LS266	75
LS273	180
LS275	320
LS279	88
LS280	250
LS283	190
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LS293	130
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LS298	215
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4012	24
4013	45
4014	85
4015	85
4016	42
4017	82
4018	28
4019	48
4020	99
4021	106
4022	95
4023	25
4024	75
4025	25
4026	180
4027	48
4028	82
4029	106
4030	80
4033	175
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4041	80
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4043	95
4044	95
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4073	25
4075	25
4075	99
4078	30
4081	28
4093	89
4502	125
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4514	195
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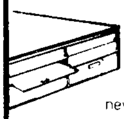

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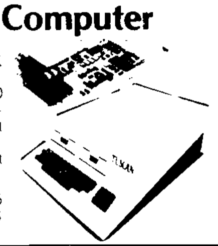

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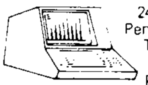

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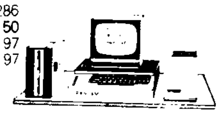

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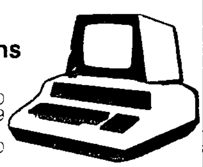


Put Pascal on your PET now

Pascal conversion ROM	£ 20
Pascal manual	£ 9
Complete package including compiler	£120

VAT

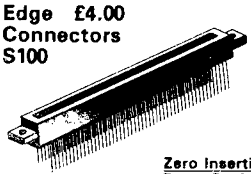
ALL OUR PRICES EXCLUDE VAT & P/P

CENTRONICS 737 PRINTER

LETTER QUALITY FOR £425

Uses any paper roll, fanfold, single sheets. 96 character ASCII, 7 x 7 dot matrix, 50 CPS, RS232 or parallel I/O

Edge £4.00 Connectors S100



DIP Switches

4 way	£1.20
7 way	£1 75
8 way	£1 80

DIP Plugs

14 DIL	£ 65
24 DIL	£2 20
40 DIL	£3 60

DIL SOCKETS (TEXAS)

	Low Prof	Wire Wrap
8pin	10p	26p
14pin	12p	35p
16pin	13p	42p
18pin	16p	60p
20pin	22p	90p
22pin	25p	—
24pin	30p	65p
28pin	35p	90p
40pin	40p	1.10p

Zero Insertion Force Sockets

16 way	£4 95
24 way	£6 00
40 way	£9 50

D-Types

25W Male	£2.80
25W Female	£3 80
25W Cover	£1 80

Edge Connectors

	1	.156
2x 6 way	–	1 75
2x12 way	–	3 00
2x10 way	–	2.00
2x15 way	–	3 20
2x18 way	–	3.50
2x22 way	3 20	3.65
2x25 way	3 60	–
2x30 way	4 15	–
2x36 way	4 75	3 90
2x40 way	5 00	–
2x43 way	5 50	4 60

Insulation/Piercing Ribbon/Cables

I/OHEADER		PLUG	
10 way	£2 20	10 way	£1 60
20 way	£3 40	20 way	£2.30
26 way	£4 00	26 way	£2.70
34 way	£4 80	34 way	£3 30
40 way	£5.40	40 way	£3 75
50 way	£6 00	50 way	£4 60
60 way	£6 50	60 way	£6.00

Insulation Piercing Edge Connectors

20 way	£3 60	40 way	£5.30
26 way	£4 00	50 way	£6.00
34 way	£4.60		

Insulation Piercing DIP Plugs

14 way DIP Plug	£1 30
16 way DIP Plug	£1 50
24 way DIP Plug	£2 80

Ribbon Cable
PRICE/M

Grey		Coloured	
10	65	10	.90
14	90	14	1.20
16	1 20	16	1 40
20	1 40	20	1 60
26	1 60	26	2.40
34	2 40	34	2.80
40	2 80	40	3.30
50	3 30	50	4 00
60	4.00	60	5 50

OK TOOLS

Full range of wire wrapping accessories & boards & dip jumpers etc. Visit our showroom or send for our catalogue

VERO

S100 prototyping boards and full range of accessories.

BOOKS

Complete range of microcomputer books and magazines on sale in our showroom.

CATALOGUE AVAILABLE

Catalogue available. Send 50p & S.A.E. (A4 size).

CRYSTALS FOR MICROS

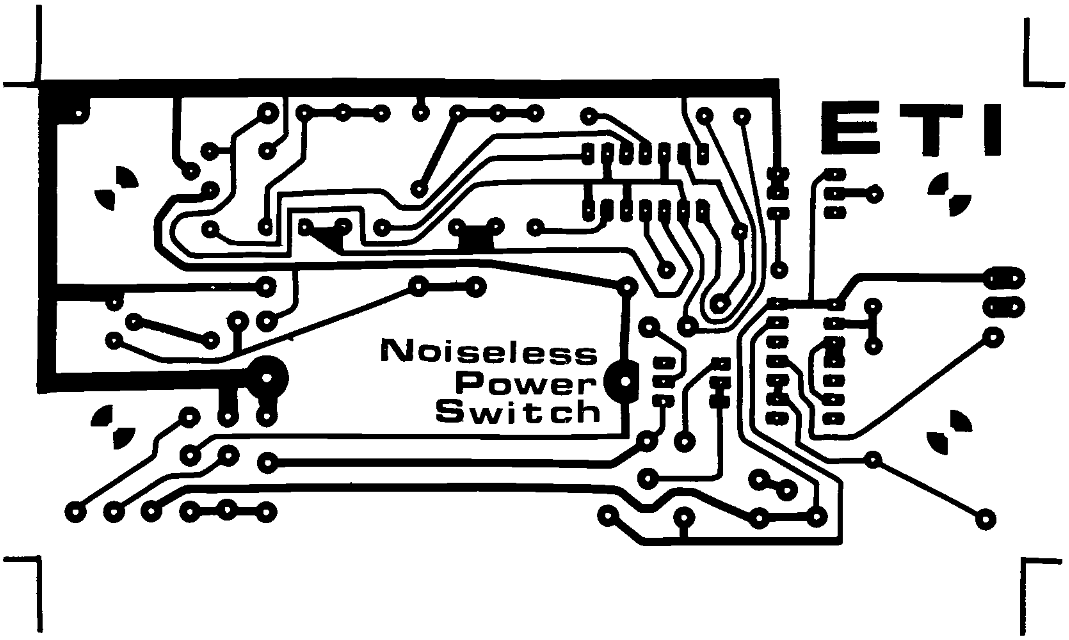
32 768KHz	3 00	4.00MHz	2 70	10 00MHz	2 70
100KHz	3 00	4 43MHz	1 00	10 7MHz	2 70
200KHz	3.70	5 0MHz	2 70	16 00MHz	2 90
1.0MHz	3.60	6 0MHz	2 70	18 00MHz	2 90
1.008MHz	3 50	6 144MHz	2 70	18 432	2 90
1.8432MHz	3.00	7 0MHz	2 70	36MHz	2.90
2 00MHz	1 50	7 168MHz	2 50	48 0MHz	2 70
2.45760MHz	3 05	8 00MHz	2 70	100MHz	2.90
3.276MHz	2.70				

TRANSAM

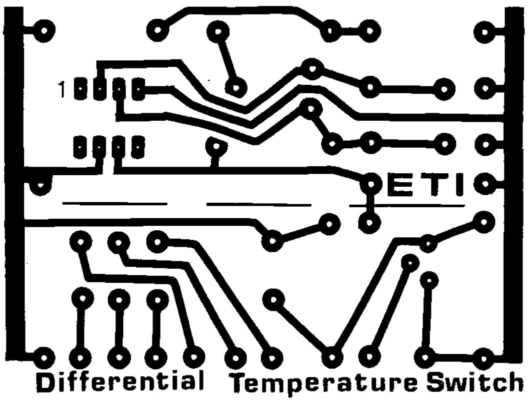
59/61 THEOBALDS RD
LONDON WC1
TEL: 405 5240/2113
TELEX 444198.

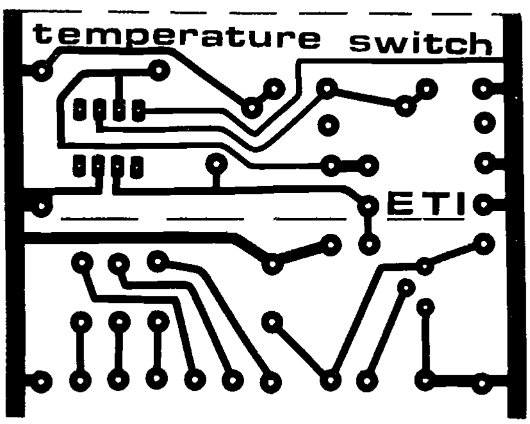
TRANSAM

PCB FOIL PATTERNS

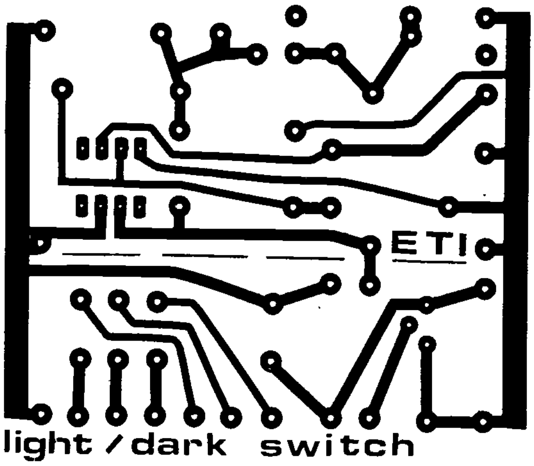


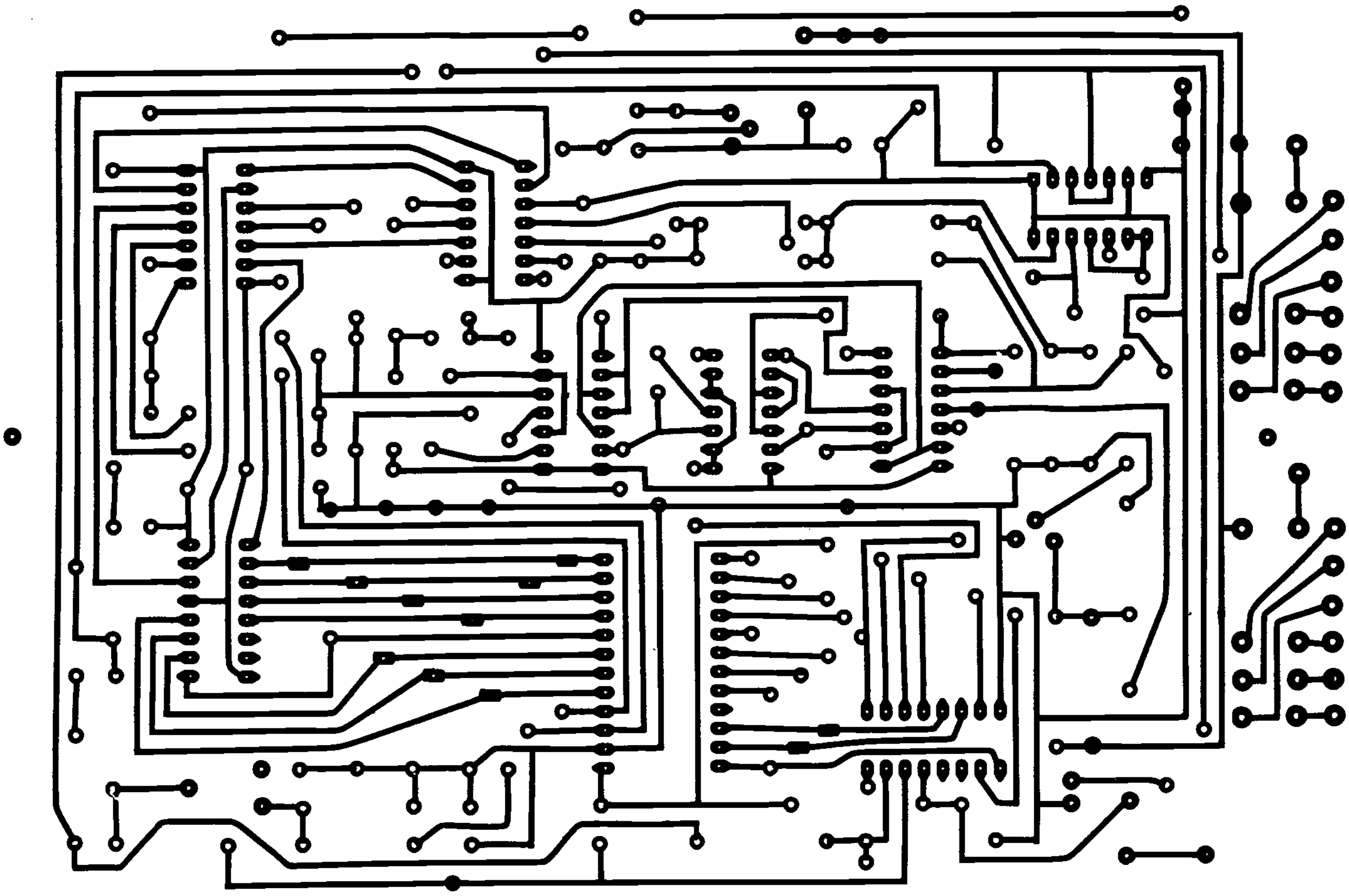
The Noiseless Power Switch PCB (above).

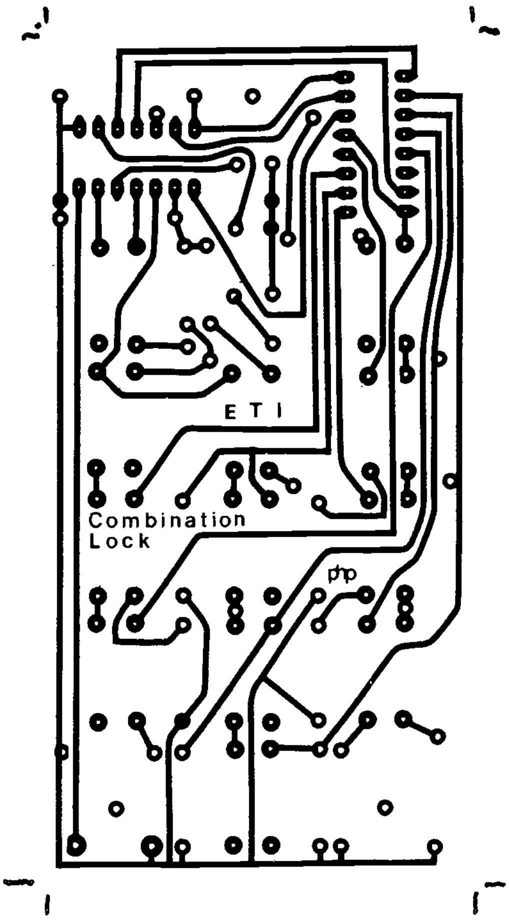




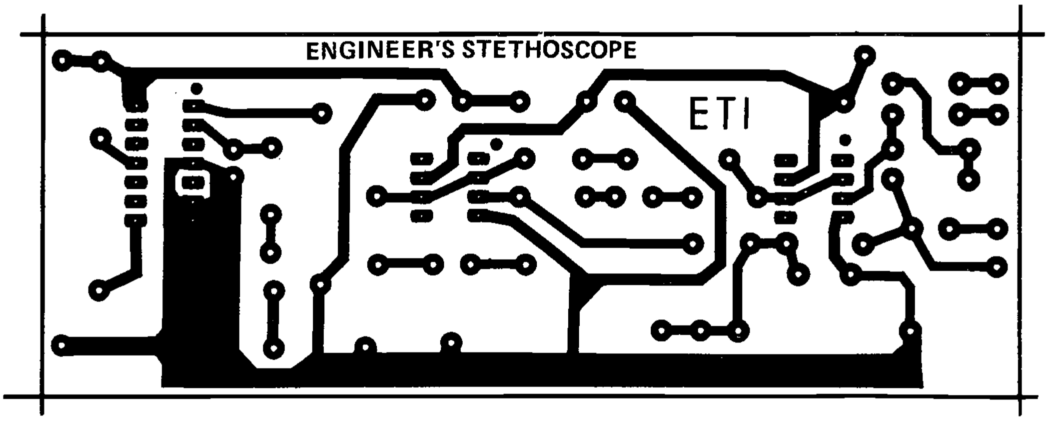
The PCBs for the Differential Temperature Switch (left), the Under Temperature Switch (below left), and the Dark Activated Switch (below). To use the modules with the Noiseless Power Switch, cut the PCBs along the dotted line and use the top half only.





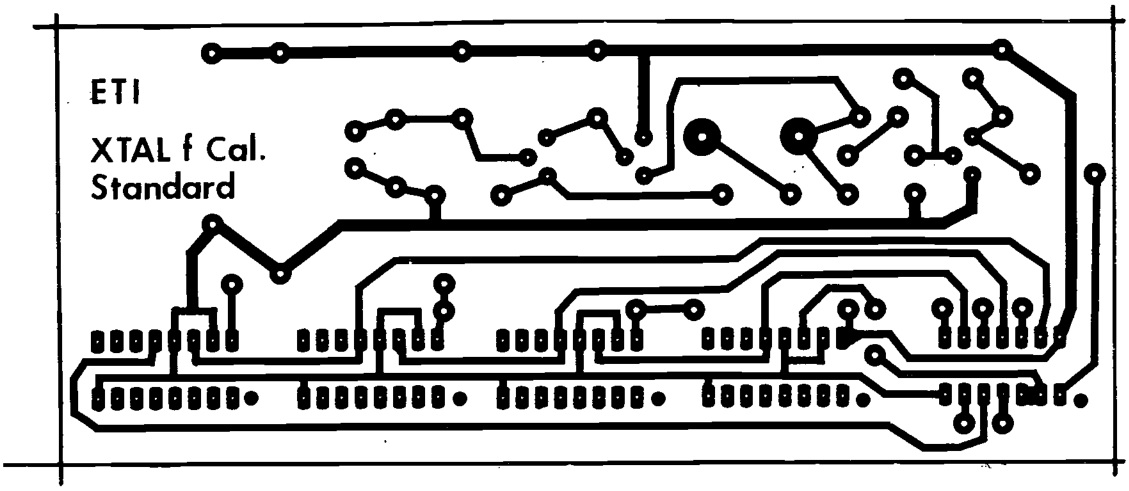


The ETI Combination Lock main PCB foil pattern (above) and keyboard foil pattern (left).



Engineer's Stethoscope PCB (left).

Crystal Calibrator (bottom).



ETIPRINTS

ETIPRINTS offer you the easy way to produce high quality printed circuit boards. Each ETIPRINTS sheet contains a set of etch resistant rub down transfers of the printed circuit board designs for several of our projects.

ETIPRINTS are made from our original artwork ensuring a neat and accurate board. We thought ETIPRINTS were such a good idea that we have patented the system (patent numbers 1445171 and 1445172).

PARTS LIST

040A	ETI 80 VCO/VCLFO	Feb 80
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048A	Sustain/Fuzz Box Flash Trigger FM Radio Control Receiver: (Top side) (Bottom side) FM Radio Control Transmitter	Oct 80
048B	Vocoder Slew Rate Control Vocoder Output Amp Vocoder Input Amp Vocoder PSU Vocoder LED PPM Display	Oct 80
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049	AF Generator Multi-Option Board Space Invasion PSU	Nov 80

BUYLINES

Sheets for Sep 79, Dec 79, Jan 80 and April - July 80 are temporarily out of stock. Earlier ETIPRINT sheets are available.

Send a cheque for PO (payable to ETI) for £1.20 per sheet with details of the project for which you require an ETIPRINT, and the month and year of publication to:

ETIPRINTS,
ETI,
145 Charing Cross Road,
London WC2H 0EE.

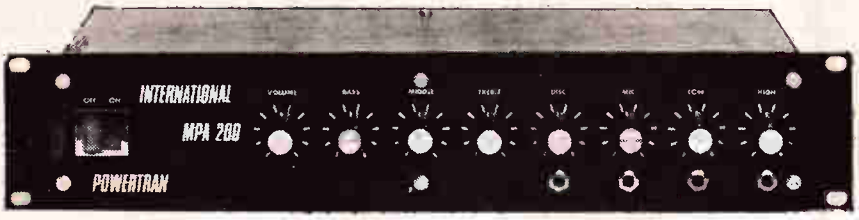
HOW IT WORKS

Lay down the ETIPRINT and rub over with a soft pencil until the pattern is transferred to the board. Peel off the backing sheet carefully making sure that the resist has transferred. If you've been a bit careless there's even a 'repair kit' on the sheet to correct any breaks!

ETIPRINTS

MPA 200 100 WATT (rms into 8Ω) MIXER/AMPLIFIER

Featured as a constructional article in ETI, the MPA 200 is an exceptionally low priced — but professionally finished — general purpose high power amplifier. It features an adaptable input mixer which accepts a wide range of sources such as a microphone, guitar, etc. There are wide range tone controls and a master volume control. Mechanically the MPA 200 is simplicity itself with minimal wiring needed making construction very straightforward.
The kit includes fully finished metalwork, fibreglass PCBs, controls, wire, etc. — complete down to the last nut and bolt.



Panel size 19.0" × 3.5". Depth 7.3"

COMPLETE KIT ONLY £49.90 + VAT!

MATCHES THE CHROMATHEQUE 5000 PERFECTLY!

CHROMATHEQUE 5000 5 CHANNEL LIGHTING EFFECTS SYSTEM

This versatile system featured as a constructional article in ELECTRONICS TODAY INTERNATIONAL has 5 frequency channels with individual level controls on each channel. Control of the lights is comprehensive to say the least. You can run the unit as a straightforward sound-to-light or have it strobe all the lights at a speed dependent upon music level or front panel control or use the internal digital circuitry which produces some superb random and sequencing effects. Each channel handles up to 500W and as the kit is a single board design wiring is minimal and construction very straightforward.

Kit includes fully finished metalwork, fibreglass PCB controls, wire, etc. — Complete right down to the last nut and bolt!

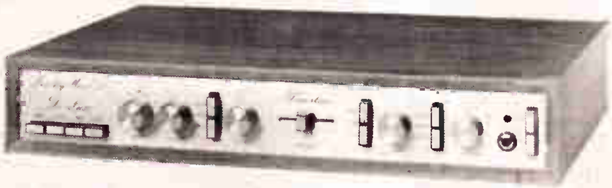
COMPLETE KIT ONLY £49.50 + VAT!

Panel size 19.0" × 3.5". Depth 7.3"

POWERTRAN

SYNTHESIZER KITS ON PAGE 9. MORE KITS AND ORDERING INFORMATION ON INSIDE FRONT COVER.

All kits also available as separate packs (e.g. PCB, component sets, hardware sets etc.). Prices in our FREE CATALOGUE



DE LUXE EASY TO BUILD LINSLEY HOOD 75W STEREO AMPLIFIER £85.00 + VAT

This easy to build version of our world-wide acclaimed 75W amplifier kit based upon circuit boards interconnected with gold plated contacts resulting in minimal wiring and construction delightfully straightforward. The design was published in Hi-Fi News and Record Review and features include rumble filter, variable scratch filter, versatile tone controls and tape monitoring while distortion is less than 0.01%.

T20 + 20 20W STEREO AMPLIFIER £33.10 + VAT

This kit, based upon a design published in Practical Wireless, uses a single printed circuit board and offers at very low cost, ease of construction and all the normal facilities found on quality amplifiers. A 30 watt version of this kit (T30 + 30) is also available for £38.40 + VAT

MATCHING TUNERS — See our FREE CATALOGUE

Above 2 kits are supplied with fully finished metalwork, ready assembled high quality teak veneer cabinet, cable, nuts, bolts, etc and full instructions — in fact everything!

BLACK HOLE

MUSIC EFFECTS DEVICE — AS FEATURED IN ELECTRONICS TODAY INTERNATIONAL!

The BLACK HOLE designed by Tim Orr, is a powerful new musical effects device for processing both natural and electronic instruments offering genuine VIBRATO (pitch modulation) and a CHORUS mode which gives a 'spacey' feel to the sound achieved by delaying the input signal and mixing it back with the original. Notches (HOLES) introduced in the frequency response, move up and down as the time delay is modulated by the chorus sweep generator. An optional double chorus mode allows exciting antiphase effects to be added. The device is floor standing with foot switch controls, LED effect selection indicators, has variable sensitivity, has high signal: noise ratio obtained by an audio compander and is mains powered — no batteries to change! Like all our kits everything is provided including a highly superior, rugged steel, beautifully finished enclosure.

COMPLETE KIT ONLY £49.80 + VAT (single delay line system)

De Luxe version (dual delay line system) also available for **£59.80** + VAT

Cabinet size 10.0" x 8.5" x 2.5" (rear) 1.8" (front)

AND THERE'S MORE WHERE THIS CAME FROM

It's a long time since one of our adverts was presented in 'list' form - but simply because we do not try to squeeze this lot in every time doesn't mean that it's not available. Our new style price list (now some 40 pages long) includes all this and more, including quantity prices and a brief description. The kits, modules and specialized RF components - such as TOKO coils, filters etc. are covered in the general price list - so send now for a free copy (with an SAE please). Part 4 of the catalogue is due out now (incorporating a revised version of pt.1).

LINEAR ICs - NUMERIC LISTINGS

TBA120S 1.00
L200 1.95
U237B 1.28
U247B 1.28
U257B 1.28
U267B 1.28
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LM301N 0.30
LM308H 0.96
LM308N 0.65
LM339N 0.66
LM348N 1.86
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LF353N 0.76
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NE560N 3.50
NE562N 4.05
NE564N 4.29
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NE570N 3.85
SL624 3.28
TBA651 1.81
uA709HC 0.64
uA709PC 0.36
uA710HC 0.65
uA710PC 0.59
uA741CH 0.66
uA741CN 0.27
uA747CN 0.70
uA748CN 0.36
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uA758 2.35
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TBA820M 0.75
TCA940E 1.80
TDA1028 2.11
TDA1029 2.11
TDA1054 1.45
TDA1062 1.95
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TDA1074A 5.04
TDA1083 1.95
TDA1090 3.05
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HA1196 2.00
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SL1611P 1.60
SL1612P 1.60
SL1613P 1.89
SL1620P 2.17
SL1621P 2.17
SL1623P 2.24
SL624C 3.28
SL1625P 2.17
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SL1640P 1.89
SL1641P 1.89
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ULN2242A 3.05
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CA3080E 0.70
CA3089E 1.84
CA3090AQ 3.35
CA3123E 1.40
CA3130E 0.80
CA3130T 0.90
CA3140E 0.46
CA3189E 2.20
MC3357P 2.35
LM3900N 0.60
LM3909N 0.68
LM3914N 2.80
LM3915N 2.80
KB4400 0.80
KB4406 0.60
KB4412 1.95
KB4413 1.95
KB4417 1.80
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KB4420B 1.09
KB4423 2.30
KB4424 1.65
KB4431 1.95
KB4432 1.95
KB4433 1.52
KB4436 2.53
KB4437 1.75
KB4438 2.22
KB4441 1.35
KB4445 1.29
KB4446 2.75
KB4448 1.65
NE5044N 2.26
NE5532N 1.85
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SL6270 2.03
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11C90DC 14.00
LM1232 19.00
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MSL2318 3.84
MSM5523 11.30
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ICM7106CP 9.55
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SP8629 3.85
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4001 0.17
4000 0.17
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4008 0.80
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4010B 0.58
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4013 0.55
4015 0.95
4016 0.52
4017 0.80
4019 0.60
4020B 0.93
4021 0.82
4022 0.90
4023 0.17
4024 0.76
4025 0.17
4026 1.80
4028 0.72
4029 1.00
4030 0.58
4035 1.20
4040 0.83
4042 0.85
4043 0.85
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4046 1.30
4047 0.99
4049 0.52
4050 0.55
4051 0.65
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4053 0.65
4063 1.09
4066 0.56
4068 0.25
4069 0.20
4070 0.20
4071 0.20
4072 0.20
4073 0.20
4075 0.20
4076 0.90
4077 0.20
4078 0.20
4082 0.20
4093 0.78
4175 0.95
4503 0.69
4506 0.51
4510 0.99
4511 1.49
4512 0.98
4514 2.55
4518 1.03
4520 1.09
4521 2.36
4522 1.49
4529 1.41
4539 1.10
4549 3.50
4554 1.53
4560 2.18
4566 1.59
4568 2.18
4569 3.03
4572 0.30
4585 1.10

TTL N and LSN

7400N 0.13
74LS00 0.20
7401N 0.13
74LS01 0.20
7402N 0.14
74LS02 0.20
7403N 0.14
74LS03 0.20
7404N 0.14
74LS04 0.24
7405N 0.18
74LS05 0.26
7406N 0.28
7407N 0.38
7408N 0.17
74LS08 0.24
7409N 0.17
74LS09 0.24
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74LS10 0.24
7411N 0.20
74LS11 0.24
7412N 0.17
7413N 0.30
7414N 0.51
74LS15 0.24
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7417N 0.30
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74LS20 0.24
7421N 0.29
74LS21 0.24
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7425N 0.27
7427N 0.27
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74LS30 0.24
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74LS32 0.24
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74LS74 0.28
7475N 0.38
7476N 0.37
74LS76 0.38
74LS78 0.38
7480N 0.48
7481N 0.86
7482N 0.69
7485N 1.04
74LS85 0.99
74LS86 0.40
7489N 2.05
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7492N 0.38
74LS92 0.78
7493N 0.32
74LS93 0.99
7494N 0.78
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7496N 0.58
74LS96 1.20
7497N 1.85
74LS107 0.38
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74110N 0.54
74111N 0.68
74LS112 0.38
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74LS114 0.38
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74121N 0.42
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74125N 0.38
74LS125 0.44
74126N 0.57
74LS126 0.44
74128N 0.74
74132N 0.73
74LS132 0.78
74LS136 0.40
74LS138 0.60
74141N 0.56
74142N 2.65
74143N 3.12
74144N 3.12
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74148N 1.09
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74167N 2.50
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74176N 0.75
74177N 0.78
74181N 1.65
74LS181 3.50
74LS183 2.10
74184N 1.35
74185N 1.34
74LS190 0.92
74192N 1.05
74LS192 1.80
74193N 1.05
74LS193 1.80
74194N 1.05
74196N 0.99
74LS196 1.10
74LS197 1.10
74198N 1.50
74199N 1.60
74LS247 0.93
74LS257 1.08
74LS260 1.53
74LS279 0.52
74LS283 1.20
74LS293 0.95
74LS365 0.49
74LS366 0.49
74LS367 0.43
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8251 6.25
8255 5.40
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6852 4.85
MC2708 7.50
2114 6.50
4027 5.78
2102 1.70
2112 3.40
2513 7.54
HM4716 4.50
81LS97 1.25

CRYSTAL FILTER PRODUCTS

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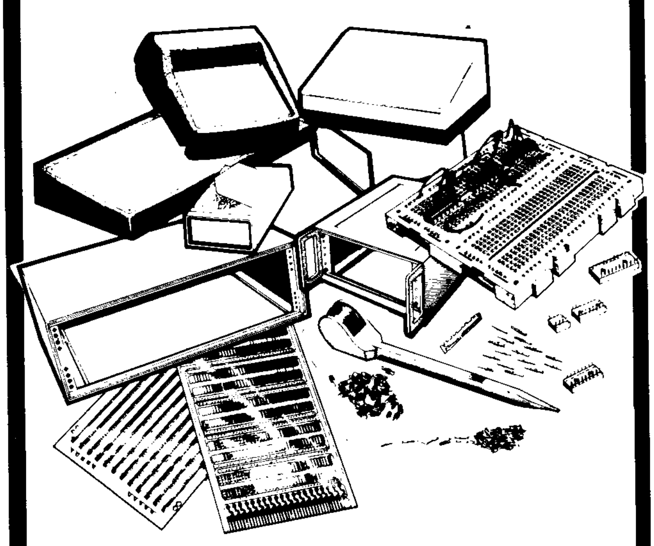

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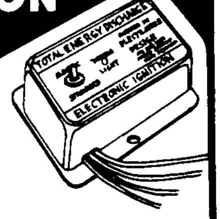

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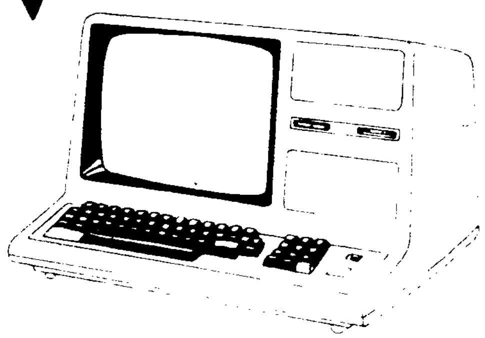

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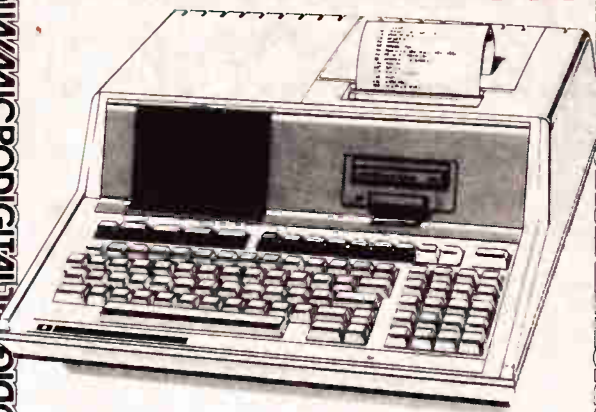

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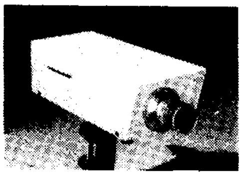

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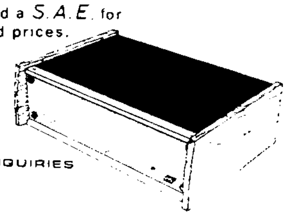

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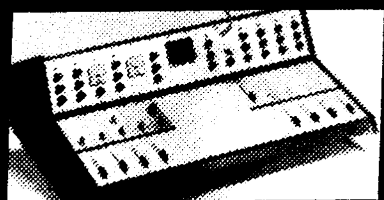

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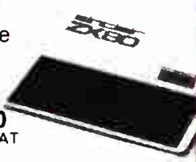

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