AN ARGUS SPECIALIST PUBLICATION
NOVEMBER 1983

Hobby Electronics

Project Electronics For Everyone

85p

PARA-Q: The Professional Audio Processor

Build this project for hifi systems, synthesis and all musical signal conditioning

Sensational In Car Entertainment Offer
See Page 19 for the details!

Personal Cassette Battery Saver

"Home Base" Power Supply Unit To Build

MORE FOR THE MOTORIST
Two Easy-to-Build Accessory Projects

Hobby Electronics

NOVEMBER 1983
VOL 5 No 11

PROJECTS

FEATURES

SPECIALS

REGULARS

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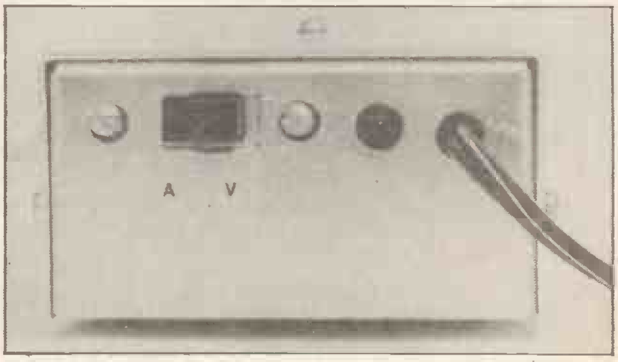

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MONITOR

Show In Scotland

The first **Scottish Home Computer and Electronics Show**, sponsored by the Evening Times, will be held at the Anderson Centre, Glasgow from 11th to 13th November.

Opening times are: Friday 11th, 12 noon to 8 pm; Saturday 12th, 10am to 6pm; Sunday 13th, 10am to 5pm. The show is planned to cover home computers, hardware, software, add-ons, CB, amateur radio, hifi and video. The Anderston Centre is adjacent to the main bus depot and not too far from Central Station; car parking is said to be good.

Futher information from **Trade Exhibitions Scotland, 53/55 Commissioner Street, Crieff, Perthshire PH7 4DA. Tel: (0764) 4204.**

CMOS Z80

A CMOS version of the popular Z80 microprocessor, fully hardware and software compatible with the NMOS part, is now available from **Altek Microcomponents**. The Sharp LH5080/5080L has all the features of the standard Z80, with a DC to 2MHz5 clock rate and the added bonus of low power consumption. Typical operating current is 10mA from a 5V power supply, and this can be cut to just 2uA with the LH5080L, which offers a power-down mode. The low power consumption offered by this design is of great importance in battery-powered equipment, such as portable instruments and remote telemetry stations.

Enquiries to **Altek Microcomponents Ltd., 22 Market Place, Wokingham, Berks. RG11 1AP. Tel: (0734) 791579.**

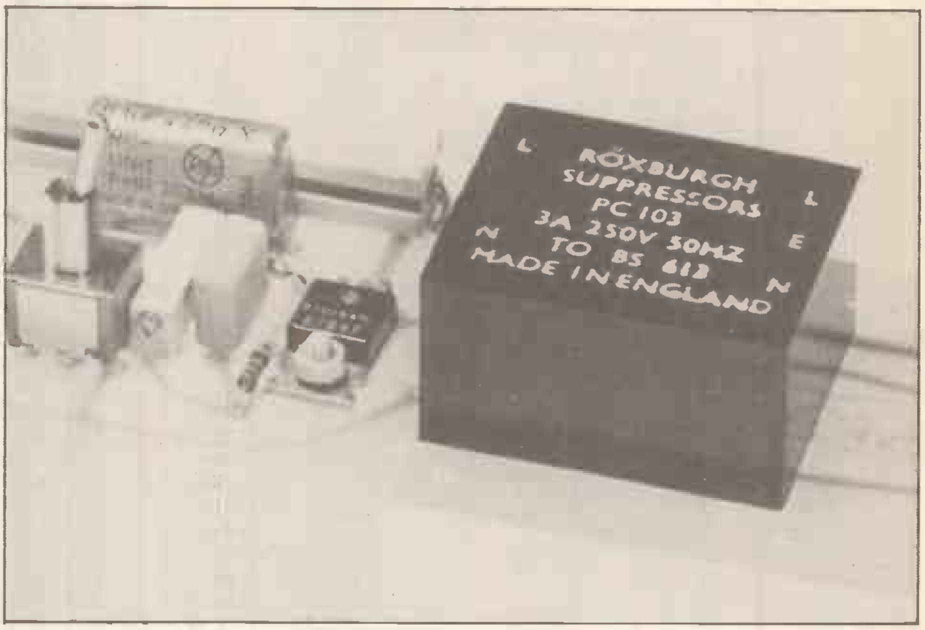
Companies In Bristol

HomeTech '83, a new computer and leisure technology exhibition, is being held at the **Bristol Exhibition Centre** on 11th, 12th and 13th November — the first major public exhibition of its kind to be held in the west of England.

The Friday is specifically for educationalists and small businessmen, while the other two days will be orientated to hobbyists, students and the rest of us.

Look for local advertising, or contact **Tomorrow's World Exhibitions, 9 Park Place, Clifton, Bristol BS8 1JP. Tel: (0272) 292156.**

PCB Protectors



The range of mains filters available from **Roxburgh Suppressors** now includes two filters designed for direct mounting onto a printed circuit board. Designated PC 103 and PC 105, they are rated at 3A and 5A respectively. The filters are suitable for protecting a wide range of equipment from mains transients and interference. Rifa self healing capacitors ensure reliability and the units are fully encapsulated for complete environmental protection. The photograph shows the PC 103 mounted on a mains input board.

For further information please contact **Rick Keens** at **Roxburgh Suppressors. Tel. (0797) 223725.**

More Meters

The **Pantec** Pan 2001, a high quality professional multimeter is currently available from **Electronic & Computer Workshop**, priced at £99.00 plus £1.00 p&p and VAT. The meter, supplied with a shock proof plastic case, will measure capacitance and features a diode test facility plus a square wave generator from 15Hz to 15kHz in four ranges.

The unit will measure DC-AC voltages from 100uV to 1000V in five ranges; DC-AC current from 1uA to 10A in six ranges; resistances from 0R1 to 20R in six ranges and capacitance from 1pF to 20uF in five ranges. An optional temperature measuring facility gives a –50°C to +150°C measuring range.

Specifications include a 3½ digit 19mm LCD, automatic polarity, overload indication and battery test, a 10Hz frequency range, with protection on all ranges up to 250VAC/DC. Power consumption is low with battery life in excess of 200 hours continuous operation. Overall dimensions are 130 x 125 x 400mm.

The **Velleman** Universal four digit up/down counter with memory is a CMOS alternative to conventional TTL counters. In kit form, it is priced at £38.99 plus £1.00 p&p and VAT.

The counter incorporates four multiplexed displays, with a maximum display of 9999 and a maximum count frequency of 2MHz, together with the benefit of low current consumption from a 5V supply.

Able to add or subtract (up or down), the counter has an 'Auto-Reset' facility, which halts the counter at zero producing a signal simultaneously with that of the counter passing through zero. BCD switches allow the counter and/or register to be loaded, and enables a number to be preset for continuous comparison with the content of the counter.

Further features allow the selection and display of any value, as a starting point for the counter, and the ability to hold a display value, whilst allowing the internal counter to run. Counter input is via an integrated Schmitt trigger and the display control has facilities for die out, normal operation, or the compression of conducting zeros.

The **Steinel** Master Check 3 is a versatile voltage tester. Of handy pocket size, the Master Check 3 will test supply voltages, various AC and DC voltages, and battery operated appliances with applications ranging from testing batteries to three-phase AC motors. It operates in the 6 to 380VAC/DC range (with line voltages of either 110, 240, or 415V) and is surge voltage proof to 6kV. Input resistance is 2 to 5kR (PTC controlled) and frequency ranges from 0 to 100Hz, with an operating temperature range of –10°C to +50°C. Maximum peak current at 380V rms is 180mA, with continuous current after regulation approximately 10mA. The tester, which has a maximum operating period of 30s (DC), has been tested and approved to the German VDE 0425 standard.

The Master Check 3, designed for rigorous use, is £15.49 (plus £1.00 p&p and VAT). For further information please contact **Caroline Stewart, Electronic & Computer Workshop Ltd., 171 Broomfield Rd., Chelmsford, Essex CM1 1QJ. Tel: (0245) 62149.**

Fastware

JRS software for the ZX81 will be incorporating a new system which has been developed to enable programs to be loaded at the maximum speed possible within the limitations of the ZX81 itself, without needing any additional hardware. Data is loaded at between 300 and 500 bytes per second, or ten to fifteen times faster than the normal ZX81 rate, and almost any program can therefore effectively be loaded in under a minute.

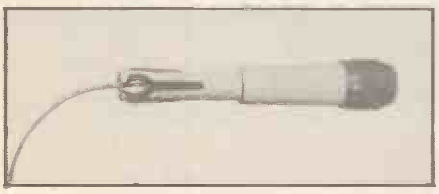
This breakthrough has been achieved by drastic modification of the input/output signals, ie altering the waveform to take fullest advantage of ZX81 circuitry characteristics. At the same time, the maximum frequency has been limited to 4kHZ, to guarantee reliable operation even when using poor quality tapes or low-cost cassette recorders (the system has been found to work perfectly within variations in normal tape speed from -10% to +12%).

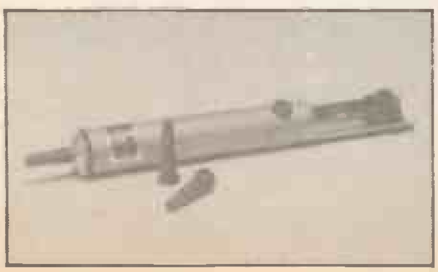
JRS's sample program, using a full 16K of RAM with 'Fast Loading' system replaces the normal loading time over six minutes, with a 'Fast Loading' time of only 36 seconds, excluding the load routine, which takes 16 seconds.

For further information contact **JRS Software Ltd., 19 Wayside Avenue, Worthing, West Sussex BN13 3JU. Tel: (0903) 65691.**

Boxes And Tools

A new brochure from **OK Industries** describes the range of PacTec enclosures. The range of moulded enclosures offers off-the-shelf prototype kits and production units, moulded-through colour for long-lasting looks and inexpensive customising. Made of impact-resistant ABS the modular enclosures are constructed from standard parts and accessories to eliminating the cost of special tooling. A range of sizes covers small-to-medium enclosure requirements, and the 22 page catalogue details exact dimensions, accessories, colours and options.





Suitable for field service, laboratory, light production or hobby use, OK's ST-400 is a micrometer-adjustable wire stripping tool which can accommodate both solid and stranded wire from 18 AWG through 30 AWG (1.0 to 0.25mm). The user simply turns the micrometer knob until the desired wire size is shown on the dial window, and this automatically adjusts the stripping blades for a precise and nick-free strip. Strip length is selected by using the moulded-in scale, and the tool can then be rotated once or twice to cut the insulation. Compatible with all common types of insulation, it has hardened steel blades for long life and is extremely compact and lightweight.

OK's 'desolder' pump has a tip made of a special bronze alloy composition designed for long life. Moreover, static discharges automatically through the hand of an earthed operator, making the DP-2 suitable for removing sensitive CMOS components. Suction is precisely regulated to prevent damage to delicate circuits.

For catalogue and prices contact **OK Industries UK Ltd., Dutton Lane, Eastleigh, Hants SO5 4AA. Tel: 0703 610944.**

Mini Robot

Colne Robotics have developed a two-wheeled mobile robot known as the Zeaker Micro-Turtle. Its movements can be controlled by any microcomputer, via a connecting umbilical ribbon cable. Software is provided which permits the movements to be memorised and reproduced — Zeaker has a learning capability. Sensors indicate when the robot touches an obstacle, and the computer instructs it to find an alternative path. Stimulation of the sensors produces one of two notes on a horn, according to the direction of Zeaker's movements.

An additional feature is the built-in, retractable pen beneath the unit, which can trace the path taken across a surface. The pen itself is controlled by the computer, and its position (lowered or retracted) is indicated by an LED on top of the robot. Two further LEDs can indicate the direction in which the unit is travelling.

The ZEAKER Micro-Turtle is aimed at the educational market in which schools wish to extend their computer teaching syllabus to cover control systems, through the use of microcomputers. Teachers are also interested in the fact that with appropriate software, ZEAKER is capable of drawing logo graphics. To keep in line with the rapid fall in microcomputer prices, the unit has deliberately been produced at a very low cost: £52.00 +VAT for the kit version and £69.50 +VAT for the assembled robot. The unit comes complete with interface, power supply, operation manual and software. It can be driven by any microcomputer which has an 8-bit bi-directional port, as well as by the ZX81 or Spectrum for which special interfaces are also available from Colne Robotics. Additional interfaces are planned for other popular micro-computers.

For further information contact **Colne Robotics Co. Ltd., Beaufort Road, Off Richmond Road, East Twickenham, Middx. TW1 2PH. Tel: 01 892 8197.**

Bet its not as cute as HEBOT!

Plug-In Power

A new range of low cost DC power supplies suitable for powering logic, microprocessor and linear circuitry is now available from **Electronart Design**.

All the units are housed within a

MONITOR

tough 13 amp plug style case, but there the similarity with calculator "AC Adaptors" and the various "Battery Eliminators" ends. These units are stabilised and well regulated with output by way of 4mm sockets, thermal fuse protection and LED output indicators. Models are available with single or twin outputs of 5, 12, 15 or 18VDC. Many extras such as crowbar overvoltage protection, power-on reset and power down signals for microprocessor and memory applications are available. The company can also supply 'specials' in any quantity.

The units should be of interest to hobbyists and educational users as well as industry. For further details and price list contact **Electronart Design, 78, Kimberley Ave., Ilford, Essex IG2 7AS. Tel. 01 590 7979.** They will send details as soon as these are available.

Chips From Ferranti

Ferranti Electronics has recently introduced the ZN411E which, with a minimum of external components, provides precise speed control for electric motors. Now generally available the circuit was originally designed for use in a professional power drill. The ZN411 will operate from the AC mains or a suitable DC supply and has an on-chip shunt regulator. The circuit has a power down reset facility and a 'soft start' capability whereby the speed builds up smoothly to the set speed.

The ZN414 tuned radio frequency (TRF) radio chip has been used in a wide range of consumer products.

In order to meet new applications requiring a higher output level. Ferranti Electronics has now introduced the ZN415E, which incorporates an output stage enabling the device to directly drive high-efficiency headphones. Like its predecessor, it operates off a single cell battery with low current consumption and is available in an eight pin DIL package. High quality AM medium and long wave reception is possible with only six external components including the ferrite aerial. Simple but effective AGC action is provided and no setting up or alignment is needed.

Full details are available from **Ferranti Electronics Ltd., Fields New Road, Chadderton, Oldham, Lancashire OL9 8NP. Tel: 061 624 0515.**

Carry On Camel

Cambridge Microelectronics, popularly known as **Camel Products,** have a new batch of micro-related products now available. The PROMER-81 is a low cost Eprom programmer for use with the ZX81. The PROMER-81 will program 2516, 2536, 2716 and 2732 Eproms and comes with full user notes suited for novices as well as experienced users. The notes include the routines for blowing Eproms for programming.

All the standard programmer functions of CHECK, SPECIFY, READ, PROGRAM and VERIFY are provided, and the control program, which is supplied on tape, includes safety features such as a check on Vpp status before executing a task.

The PROMER-81 requires four PP/ batteries to provide regulated programming voltage, and comes assembled and tested, with an extension connector at the rear. The price is £19.95 plus VAT. With the PROMER-81, pricing tables, toolkits, educational and scientific programs, assemblers, text editors etc. (to quote Camel) can be instantly and reliably called up from ROM readers like ROM-81 and DREAM-81, also by Camel (both of which have featured in these pages).

So far unfeatured by Monitor is the CRAMIC-81, a 16K memory module using special CMOS chips which need only a tiny amount of power to retain data when not in operation. The power is supplied by a ten-year-life Lithium battery in standby mode. When in use power comes from the ZX-81. The CRAMIC-81 behaves like an ordinary RAMpack, but can be powered down and removed from the micro without losing data.

It also has a rear connector so that another RAMpack can be used at the same time. While the two units occupy the same memory area, you can choose either memory via your program, without using links or switches, and actually run two separate programs with alternating screen displays.

The CRAMIC-81 comes in a moulded, low-lying ABS case with a cable connector. We don't have a price for it at present.

Last from Camel isn't a ZX-81 add-on, but a three-way PSU. This unit features maximum current ratings of +5V at 3A, +12V at 1A and -12V at .25A, with a normal maximum continuous power output rating of 25W at 40°C. The construction includes a torodial mains transformer, high CXV, high surge rating electrolytic capacitors, and linear voltage regulators LM350T, 7812 and 7912 for short circuit protection on all outputs. The front panel includes double-pole mains rocker switch and LED indicator, and the screw type connector block allows users freedom of choice in interface connectors.

We don't have a price for this one either, or a photograph, but as with all these products contact **Cambridge Microelectronics Ltd., One Milton Rd., Cambridge CV4 1UY** for details. **Tel: (0223) 314814.**

Switchable Switches

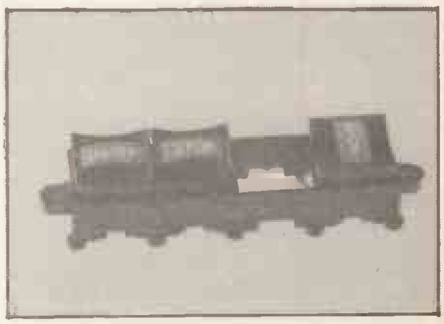
Dean Electronics have produced a compact PCB mounting switch module with an eight pin configuration, which allows designers to choose any of six different contact functions simply by selecting the appropriate pins when laying out the circuit.

The MED switch is designed for 0.1in grid PCB mounting, and is available in both momentary and push-key action.

The MED keycap system allows maximum versatility by providing buttons and bezels for the switch, which can accommodate one or two high brightness 'pinhead' or rectangular bar LEDs, or work without illumination, as desired. These allow for maximum mounting density in any configuration. The keycaps are available in ten standard colours.

The final aspect of the range is the Vario-Support, which provides a variable mounting frame which enables front panel mounting of the MEC range, removes the need for PCB mounting and consequent wear and tear on the PCB, and aids accurate alignment of the switch system to the front-panel cut-outs when assembling. Vario-Support is available in any cell combination from one times one to ten times ten matrix.

For information contact **Dean Electronics Ltd., Glendale Park, Fernbank Rd., Ascot, Berks. Tel: (0344) 885661.**



Small Business Software

A demonstration tape of three programs for the 48K Spectrum, from **Hilderbay Ltd.**, is now available for £3.95. The three programs are business software: Payroll, Stock Control and Statutory Sick Pay.

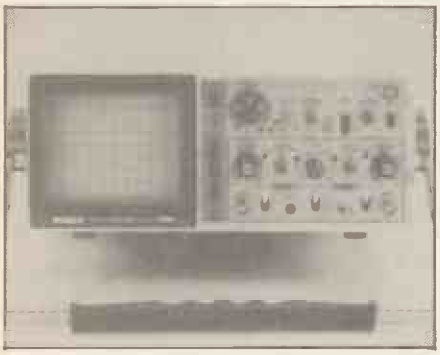
The Stock Control program can keep records on over 1000 stock lines, handling either stock changes or closing stock, with information on current stock levels and value instantly available.

Stock lines can be located by name, inserted or deleted in under two seconds.

The Payroll program can deal with up to 50 employees at a time; tax and national insurance details are built into the program; where there are no changes, a single keystroke will compute an employee's situation, and another will print a payslip. Results from the Payroll program (but not the demo tape!) are guaranteed to be correct.

The Statutory Sick Pay program will carry out all the calculations associated with SSP, so that the user only has to enter essential information. Simple cases take about 40 seconds to enter, very complex cases up to 90 seconds.

For the demo tape or more information contact **Hilderbay Ltd., 8/10 Parkway, Regent's Park, London NW1 7AA. Tel: 01 485 1059.**



Slimline Oscilloscope

The new V-222 oscilloscope from **Hitachi** is a low-cost 20MHz dual-trace model incorporating a larger six rectangular CRT in an ultra-light, slim casing. The V-222 has a number of unique features to assist in the analysis of complex waveforms: an alternative sweep magnifier enables any section of the waveform to be expanded ten times and displayed simultaneously with the un-magnified signal; a DC offset control and offset measurement socket allows a digital voltmeter to be used to monitor voltages on the screen, whilst a low impedance signal output socket enables a frequency meter or a counter-timer to be connected.

Comprehensive triggering facilities include an active sync separator for video signals, and an alternate trigger made which enables two unsynchronised signals to be displayed simultaneously. The V-222 has a sensitivity of 1mV/cm and a maximum sweep speed of 20ns/cm. Fully variable gain and sweep rate controls have uncalibrated warning lights to avoid accidental measurement errors. Full XY mode and Z modulation facilities are provided, and the large CRT has an internal parallax-free graticule with variable illumination and 0,10,90 and 100% markers for rise time meaurement.

The V-222 comes complete with two x1 and x10 switchable probes and carries a full two year warranty. Price in the UK is £340 plus VAT, a lower specification version is also available at £295 plus VAT. These new Hitachi oscilloscopes are available ex-stock from **Reltech Instruments, Coach Mews, St. Ives, Huntingdon, Cambs PE17 4BN. Tel: (0480) 63570.**

Battery Protection

A new device has been developed by **S & W Battery Charging Systems** to prevent premature battery failure and reduce the cost of battery maintenance. This unit simply be inserted between the charger and the battery.

No larger than a matchbox, the unit is designed to constantly monitor battery voltage without interrupting the system. Once the cells are full charged, the controller will pass only sufficient current to maintain the battery in a fully charged condition without overcharge. The controller may be adjusted externally to give a variety of voltages, making one unit suitable for a wide range of lead acid or nicad batteries. It is simple and quick to fit into existing charging systems, and reduces maintenance and energy costs.

Enquiries to: **S & W Battery Charging Systems Ltd., Nailsea Trading Estate, Southfield Road, Nailsea, Bristol BS19 1JL. Tel: (0272) 855161.**

Lynx Escapes

The new 96K version of **Camputers'** popular Lynx microcomputer made its first public appearance at the Earls Court Computer Fair in London from June 16-19, and is available from retailers, priced £299 including VAT.

The expanded RAM of the 96K Lynx provides 37K5 directly accessible to Basic in high resolution full colour, with up to 24K more available to programs using machine code. At 20K, the ROM is 4K larger than that of the 48K Lynx; additional ROM features on the 96K Lynx include drivers for both parallel and serial printers, a range of preformatted sound effects, CIRCLE command and commands to use the 24K of machine code assessible RAM as a data store for programs running in Basic.

Owners of the 48K Lynx will be able to have their machines upgraded to full 96K specification through their Lynx dealers, who will arrange for the machines to be returned to Camputers for upgrading. The price of the upgrade will be £89.95, including VAT.

Enquiries to: **Camputers, 33A Bridge Street, Cambridge CA3 4B. Tel: (0223) 315063.**

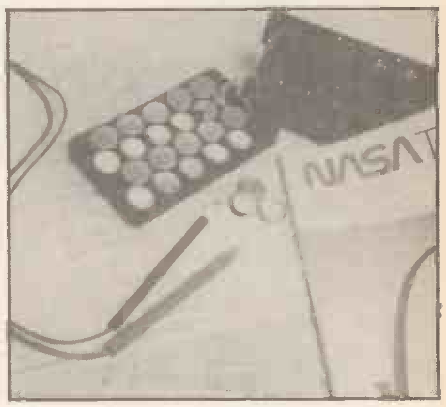
Batting Back and Forth

Gould Activair UK, who have been developing zinc-air power-cell technology from a basis of NASA research on air electrodes, have now been awarded a NASA contract to provide zinc-air power packs for use on board the Space Shuttle.

Previously, NASA used long-life lithium batteries, but zinc-air batteries are now longer-lasting (in this case, 5 to 5.5 amp-hours as opposed to 3 amp-hours). This means fewer power packs, which in turn mean less weight for the Shuttle to carry.

The Shuttle power packs will be 15V each, measuring 138.4mm x 81.28mm x 19.05mm, weighing 482g, and composed of sixty individual disc-shaped cells. They will be used to operate the in-cabin radio system which enabled the astronauts to talk to each other and to the ground.

Wonder if they listen to Radio One in between chats?



Short

The Vintage Wireless Co. have been tightening up their already tight act with new mail order procedures, the dropping of some 'time consuming' lines from their lists and — last but not least — they are moving to new premises, not far from the present ones. We don't yet have their new address, but anyone interested in old and industrial electronics and wireless equipment and VWC's regular price lists and newsletters should write as usual to **64 Broad St., Staple Hill, Bristol BS16 5NL. Tel: (0272) 565472.**

MONITOR

Computer Fair

The **Chiltern Computer Fair**, the first of its kind in that region, will be held on 22 October at the Challney Community College, Stonygate Rd., Luton, Beds. There will be about a hundred companies covering all aspects of home, business and educational computers. The site is very near to junction 11 on the M1, so is easy to get to.

Enquiries from exhibitors and, presumably, others should go to Mr. John Pinney, on Luton (0582) 56400 or 508616.

Stand And Kit

Electroni Kit whose FX-Computer was reviewed in October's HE, write to tell us that they will be at the Leisure Electronics Trade Show, Heathrow Penta, from 13th to 15th February. Anyone who wants to inspect the FX-Computer, FX-Kits or Electroni-Kit's Chip Shop Kits, can do so.

Electroni-Kit are at **388 St. John Street, London EC1V 4NN. Tel: 01 278 0109.**

Domestic Irons

Cooper Tools, who manufacture the professional-quality range of **Weller** soldering irons, have come up with the idea of marketing a set of soldering irons for home use, not restricted to conventional electronics soldering, but also for other hobby uses. The packs include operating instructions and hints on how to use the particular iron for best results.

The range comprises: A Mini Soldering Iron (WM12D) price £5.46 — a lightweight, pencil-thin, miniature soldering iron designed for hobby work (especially electronics) and household repairs, rating 12 watts; a Mini Soldering Iron Kit (WM12DK) price £7.79 — as above but including solder, tweezers and two soldering tips; a Fine Duty Soldering Iron (SI15D) priced £6.64 — ideal for the electrical repair shop or home hobbyist in audio equipment, rating 15 watts; a General Duty Soldering Iron (SI25D) price £6.46 — an all purpose iron that will deal with most household applications and yet is light and manageable enough for most intricate jobs, rating 25 watts; General Duty Soldering Iron Kit (SI25DK) price £8.32 — as above but including 1 spare soldering tip, a soldering aid tool and solder; a Medium Duty Soldering Iron (SI40D) price £7.18 — a workshop iron, recommended for jobs where a slighly higher temperature is required and where the iron is in continual use, rating 40 watts; a Heavy Duty Soldering Iron (SI75D) price £8.88 — as its name implies, this is an iron for the larger jobs such as heavy metal repairs, rating 75 watts; a Wood Burning Iron Set (WH1) price £9.50 — a specially designed tool for wood and cork burning, leather branding and candle sculpting. It comes complete with all the necessary tips from fine to blocking and patterning, rating 25 watts; a Plastic Carving Knife (WH2) price £9.50 — a hot-knife for all types of plastics including acrylic, vinyl and expanded polystyrene, rating 25 watts; a Stained Glass Iron (WH3) price £12.75 — a simple to use iron for decorative glass work around the home, rating 75 watts.

All the prices are recommended retail prices, ex. VAT. For further information contact **Cooper Tools Ltd., Sedling Rd., Wear, Washington, Tyne and Wear NE38 9BZ. Tel: 091 416 6062.**

Counting Kits

Three new **Velleman** kits are available from the company.

The Precision Timer (K2584) has four programs which can vary from one second to ninety nine minutes and ninety nine seconds. The timer counts down to zero and activates the output, which can also be manually switched on or off. Running programs can be stopped, interrupted or continued. The unit has applications such as dark room timing, process control, light control etc. and comes with housing, transformer and sheet keyboard.

The Codelock (K2585) is a unit with two memory levels, each capable of storing twenty numbers of six digits each. The memory contains a CMOS RAM which is fed by a battery in case of poor failure. All the numbers are retained even in the event of a month-long mains failure (would there still be anybody around to care after a month long mains failure??). The Codelock has a sheet keyboard as a front panel and its applications including protection of machines, entry systems for flats and offices, and anti-burglar protection in general.

The Programmable Controller Module (K2591) is designed to control measurement of temperature, humidity acid and chlorine levels etc. It has a 24 hour clock, four programmable registers and a display for the input signal, which can be made up of an analogue voltage from 0 to 99mVDC. The module compares the input signal with the values programmed in the memory and switches on an output relay. Switching precision is 10mV to the input signal.

For full technical details and prices contact **Velleman (UK) Ltd., PO Box 30, Leonards On Sea, East Sussex TN37 7NL. Tel: (0424) 753246.**

Circuits To Build

Two new books of electronics circuits come from **Elektor Books.**

33 Electronic Games gives a selection of circuits which can be played once they've been built. The games don't need a TV screen, either, and are said not to be complex or to involve complicated software.

Following the same theme, *301 Circuits* gives a selection of circuits from the very simple to more complex. It can be used as a source book for construction projects and general ideas.

The books cost £4.50 and £5.50 respectively, in paperback, and are both full illustrated with diagrams.

For more information, contact **E P Publishing Ltd., East Ardsley, Wakefield, W. Yorks WF3 2JN. Tel: (0924) 823971.**

HE

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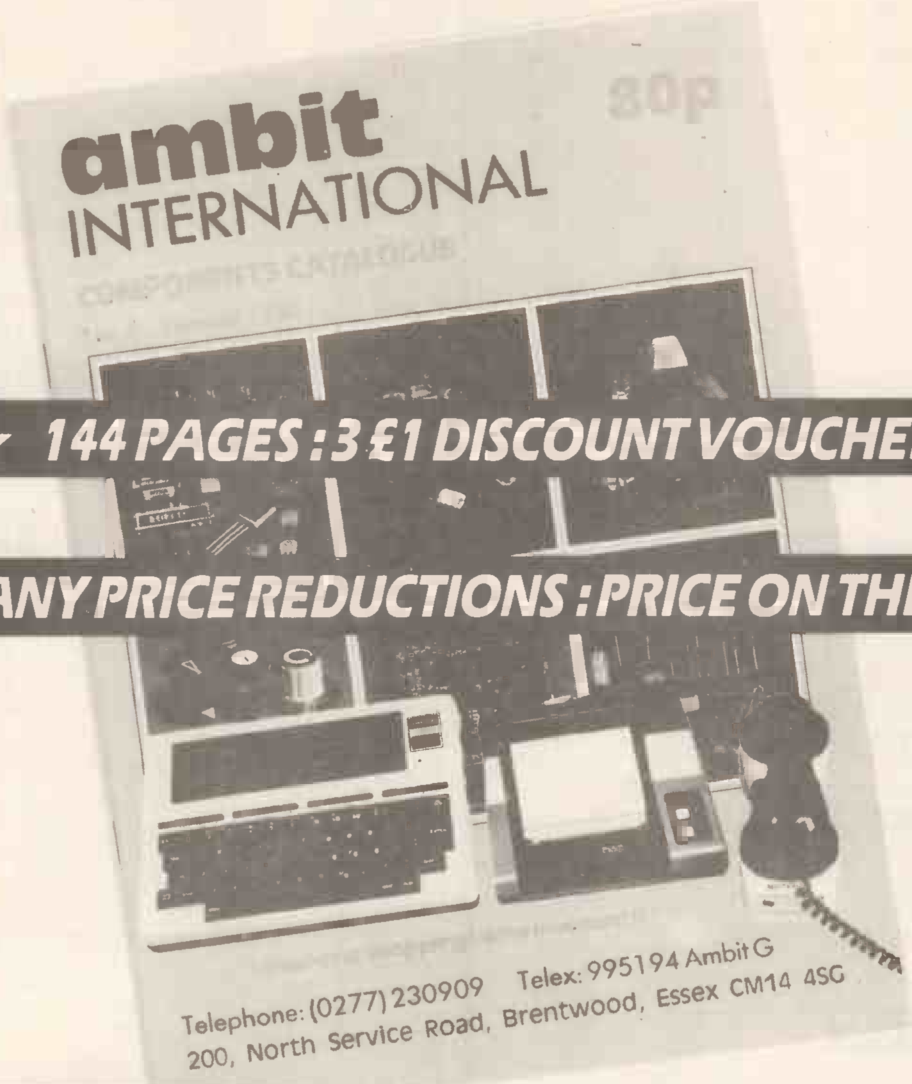

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				LM358	50	LM3915	195	▶NE570	370	TL072	50
555CMOS	80	ICL7106	790	LM377	170	LM13600	105	NE571	370	TL074	95
556CMOS	150	ICL7611	95	▶LM380	65	MC1496	68	▶RC4136	55	▶TL081	25
709	25	ICL7621	180	▶LM381	120	MC3340	135	▶RC4558	60	TL082	45
▶741	14	ICL7622	180	LM382	120	▶MF10CN	350	SL480	170	TL084	95
748	35	ICL8038	295	LM384	130	ML922	400	SL490	250	TL170	50
9400CJ	350	ICL8211A	200	LM386	65	ML924	195	SL76018	150	UA2240	120
AY-3-1270	720	ICM7224	785	LM387	120	ML926	210	▶SN76477	380	ULN2003	85
AY-3-8910	370	ICM7555	80	LM393	100	ML926	140	SP8629	250	ULN2004	90
AY-3-8912	540	▶LF351	45	LM709	25	ML927	140	TBA120S	70	XR2206	290
CA3046	60	LF353	85	LM711	60	ML928	140	TBA800	75	ZN414	100
▶CA3080	65	LF356	90	LM725	350	ML929	140	TBA810	96	ZN423	135
CA3089	190	LM10	360	LM733	75	MM5387A	465	TBA820	70	ZN424	135
CA3090AO	375	LM301A	25	LM741	14	NE529	225	TBA950	220	ZN425E	350
CA3130E	85	LM311	70	LM747	60	NE531	150	TDA1008	320	ZN426E	330
▶CA3140E	36	LM318	120	LM1458	40	NE544	205	▶TDA1022	490	ZN427E	650
CA3161E	100	LM324	40	LM2917	200	▶NE555	16	TDA1024	125	ZN428E	480
CA3189	290	LM334Z	100	LM3900	45	▶NE556	45	TL061	40	ZN459	285
▶CA3240E	110	LM335Z	125	▶LM3909	70	NE565	110	TL062	60	ZN1034E	200

TRANSISTORS

				BC517	40	BF337	40	MPSU56	60	ZTX108	8	2N3055	50
				BC547	7	BFR40	23	TIP29A	30	ZTX109	12	2N3442	120
				BC548	10	BFR80	23	TIP29B	55	ZTX300	14	▶2N3702	6
AC125	35	BC149	9	BC549	10	▶BFR81	20	TIP29C	37	ZTX301	16	2N3703	9
AC126	25	BC157	8	BC558	10	BFX29	25	TIP30A	35	ZTX302	15	▶2N3704	6
AC127	25	BC158	10	BCY70	18	BFX84	25	TIP30B	50	ZTX304	17	2N3705	9
▶AC128	20	BC159	8	BCY71	18	BFX85	25	TIP30C	37	ZTX341	30	2N3706	9
AC176	25	BC160	45	BCY72	18	BFX86	28	TIP31A	35	ZTX500	15	2N3707	10
AC187	22	BC168C	10	BD115	55	BFX87	25	TIP31C	37	ZTX501	15	2N3708	10
AC188	22	BC169C	10	BD131	35	BFX88	25	TIP32A	35	ZTX502	15	2N3709	10
AD142	120	BC170	8	BD132	35	BFY50	23	TIP32C	37	ZTX503	18	2N3772	170
AD149	80	BC171	10	BD133	50	BFY51	20	TIP33A	50	ZTX504	25	▶2N3773	195
AD161	40	BC172	8	BD135	40	BFY52	23	TIP33C	75	2N697	20	▶2N3819	18
AD162	40	BC177	18	BD136	30	BFY53	32	TIP34A	60	2N698	40	2N3820	40
AF124	60	BC178	18	BD137	30	BFY55	32	TIP34C	85	2N706A	20	2N3823	65
AF126	50	BC179	18	BD138	30	BFY56	32	TIP35A	105	2N708	20	2N3866	90
AF139	40	BC182	10	▶BD139	35	BRY39	40	TIP35C	125	2N918	35	2N3903	10
AF186	70	▶BC182L	8	▶BD140	35	BSX20	20	TIP36A	125	2N1132	22	2N3904	10
AF239	75	BC183	10	BD204	110	BSX29	35	TIP36C	135	2N1613	30	2N3905	6
BC107	10	BC183L	10	BD206	110	BSY95A	25	TIP41A	45	2N2218A	45	2N3906	10
BC107B	12	BC184	10	BD222	85	BU205	160	TIP42A	45	2N2219A	25	2N4037	45
▶BC108	10	BC184L	7	BF180	35	BU206	180	TIP120	90	2N2221A	25	2N4058	10
BC108B	12	BC212	10	BF182	35	BU208	170	TIP121	90	2N2222A	20	2N4060	10
BC108C	12	BC212L	10	BF184	25	MJ2955	99	TIP122	90	2N2368	25	2N4061	10
▶BC109	10	BC213	10	BF185	25	MJE340	50	TIP141	98	2N2369	16	2N4062	10
BC109C	12	BC213L	10	BF194	12	MJE520	65	TIP142	98	2N2484	25	2N5457	36
BC114	18	BC214	10	BF195	12	MJE521	95	TIP147	110	2N2646	45	2N5458	36
BC115	22	▶BC214L	8	BF196	12	MJE3055	70	TIP2955	60	2N2904	20	2N5459	30
BC117	18	BC237	8	BF197	12	MPF102	40	TIP3055	55	2N2904A	20	2N5485	36
BC119	35	BC238	14	BF198	10	MPF104	40	TIS43	40	2N2905	22	2N5777	45
BC137	40	BC308	12	BF199	18	MPSA05	22	TIS44	45	2N2905A	22	2N6027	30
BC139	40	BC327	14	BF200	30	MPSA06	25	TIS90	30	2N2906	25	40360	40
BC140	28	BC328	14	▶BF244B	22	MPSA12	30	TIS91	30	2N2906A	25	40361	50
BC141	30	BC337	14	BF245	30	MPSA55	30	VN10KM	45	2N2907	25	40362	50
BC142	25	BC338	14	BF256B	45	MPSA56	30	VN46AF	75	2N2907A	25	40408	70
BC143	25	BC477	30	BF257	32	MPSU05	55	VN66AF	85	2N2926	9		
BC147	8	BC478	30	BF258	25	MPSU06	55	VN88AF	95	▶2N3053	23		
BC148	8	BC479	30	BF259	35	MPSU55	60	ZTX107	8	2N3054	55		

CABLES

20 metre pack single core connecting cable ten different colours 65p
Speaker cable . . . 10p/m
Standard screened . . . 16p/m
Twin screened . . . 24p/m
2.5A 3 core mains . . . 23p/m
10 way rainbow ribbon . . . 65p/m
20 way rainbow ribbon . . . 120p/m
10 way grey ribbon . . . 38p/m
20 way grey ribbon . . . 80p/m

HARDWARE

PP3 battery clips . . . 6
Red or black crocodile clips . . . 6
Black pointer control knob . . . 15
Pr Ultrasonic transducers . . . 350
▶6V Electronic buzzer . . . 65
▶12V Electronic buzzer . . . 65
▶PB2720 Piezo transducer . . . 75
▶64mm 64 ohm speaker . . . 70
▶64mm 8 ohm speaker . . . 70
20mm panel fuseholder . . . 25

CAPACITORS

Polyester, radial leads, 250v, C280 type: 0.01, 0.015, 0.022, 0.033 - 6p; 0.047, 0.068, 0.1 - 7p; 0.15, 0.22 - 9p; 0.33, 0.47 - 13p; 0.68 - 20p; 1u - 23p.
Electrolytic, radial or axial leads: 0.47/63V, 1/63V, 2.2/63V, 4.7/63V, 10/25V - 7p; 22/25V, 47/25V - 8p; 100/25V - 9p; 220/25V - 14p; 470/25V - 22p; 1000/25V - 30p; 2200/25V - 50p.
Tag end power supply electrolytics: 2200/40V - 110p; 4700/40V - 160p 2200/63V - 140p; 4700/63V - 230p
Polyester, miniature Siemens PCB: 1n, 2n2, 3n3, 4n7, 6n8, 10n, 15n, 7p; 22n, 33n, 47n, 68n, 8p; 100n, 9p; 150n, 11p; 220n, 13p; 330n, 20p; 470n 26p; 680n, 29p; 1u 33p; 2u2, 50p.
Tantalum bead: 0.1, 0.22, 0.33, 0.47, 1.0 @ 35V - 12p. 2.2, 4.7, 10 @ 25V - 20p; 15/16V - 30p; 22/16V - 27p; 33/16V - 45p; 47/6V - 27p; 47/16V - 70p; 68/6V - 40p; 100/10V - 90p.
Cer. disc. 22p-0.01u 50V, 3p each.
Mullard miniature ceramic plate: 1.8pF to 100pF 6p each.
Polystyrene, 5% tol: 10p-1000p, 6p; 1500-4700, 8p; 6800 0.012u, 10p.
Trimmers. Mullard 808 series: 2-10 pF, 22p; 2-22pF, 30p; 5.5-65pF, 35p

REGULATORS

78L05	30	79L05	65
78L12	30	79L12	65
78L15	30	79L15	65
7805	35	7905	40
7812	35	7912	40
7815	35	7915	40
LM309K	130	LM723	35
LM317K	270	SPECIAL OFFER!	
LM317T	120	78PD5 10A +5V	
LM323K	350	only 390p each.	

POTENTIOMETERS

Rotary, Carbon track Log or Lin 1K - 2M2, Single 32p, Stereo 85p. Single switched 80p. Slide 60mm travel single Log or Lin 5K - 500K 63p each.
Preset submin. hor. 100 ohms - 1M 7p each.
Cermet precision multiturn, 0.75W ¾" 100 ohms to 100K - 88p each.

TRIACS

		400V 8A	65
		400V 16A	95
400V 4A	50	BR100	25

DIODES

BY127	12	▶1N4001	3
OA47	10	1N4002	5
OA90	8	1N4006	7
OA91	7	1N4007	7
OA200	8	1N5401	12
OA202	8	1N5404	16
1N914	4	1N5406	17
▶1N4148	3	400mW zen	6

JUMPER LEADS

Length	14pin	16pin	24pin	40pin
Sgle ended DIP (header plug) jumper				
24 ins.	145	165	240	380
Dble ended DIP (header plug) jumper				
6 ins.	185	205	300	465
12 ins.	195	215	315	490
24 ins.	210	235	345	540
36ins.	230	250	375	595

25 way D Connector jumpers
18ins. long single ended male 495p.
18ins. long single ended f/male 525p.

BRIDGE RECTIFIERS

		2A 200V	40
		2A 400V	45
		6A 100V	80
		6A 400V	95
1A 50V	20	VM18 DIL 0.9A	
1A 400V	35	200V	50

OPTO

▶3mm red	7	▶5mm red	7
▶3mm green	10	▶5mm green	10
▶3mm yellow	10	▶5mm yellow	10

Clips to suit - 3p each.

Rectangular		TIL32	40
▶red	12	TIL78	40
green	17	▶TIL111	60
yellow	17	ORP12	85
▶TIL38	40	TIL100	90
2N5777	45	Dual colour	60

Seven segment displays:

Com cathode		Com anode	
DL704 0.3"	95	DL707 0.3"	95
▶FND500 0.5"	100	FND507 0.5"	100
TIL313 0.3"	115	TIL312 0.3"	115
TIL322 0.5"	115	TIL321 0.5"	115

LCD: 3½ digit 580p. 4 digit 620p.

COMPUTER CONNECTORS

ZX81 2 x 23 way edge connector wire wrap suitable for ZX81 add-ons . . . 150
SPECTRUM 2 x 28 way edge connector wire-wrap suitable for SPECTRUM add-ons . . . 200

RIBBON CABLE

Grey Ribbon cable. Price per metre

10 way	38	34 way	150
16 way	55	40 way	170
20 way	80	50 way	198
24 way	110	60 way	260

IDC CONNECTORS

	PCB Plug Straight	Socket	Edge Conn.
10 way	90	85	120
16 way	130	110	175
20 way	145	125	195
26 way	175	150	240
34 way	205	170	320
40 way	220	190	340
50 way	235	20C	395
60 way	330	230	495

MIN D CONNECTORS

	9 way	15 way	25 way	37 way
Plugs solder lugs	60p	85p	125p	170p
Right angle	120p	180p	240p	350p
Sockets lugs	90p	130p	195p	290p
Right angle	160p	210p	290p	440p
Covers	100p	90p	100p	110p

SOLDERING IRONS

Antex CS 17W Soldering iron . . . 495
2.3 and 4.7mm bits to suit . . . 85
CS 17W or XS 25W element . . . 210
Antex XS 25W . . . 525
3.3 and 4.7mm bits to suit . . . 85
Solder pump desoldering tool . . . 480
Spare nozzle for above . . . 70
10 metres 22swg solder . . . 100

RESISTORS

¼W 5% Carbon film E12 series 4.7 ohm - 10M . . . 1p each.
½W 5% Carbon film E12 series 4.7 ohm to 4M7 . . . 2p each.
¼W 1% metal film E24 series 10 ohm - 1M . . . 6p each.

PCB MATERIALS

Alfac transfer sheets — please state type (e.g. DIL pads etc.) . . . 45
Dalo etch resistant pen . . . 100
Fibre glass board 3.75 x 8" . . . 80
Fibre glass board 8 x 12" . . . 200
Ferric Chloride crystals . . . 100

BOXES

Plastic with lid & screws		Aluminium	
		3 x 2 x 1"	65
		4 x 2¾ x 1½"	95
		4 x 2½ x 2"	95
3 x 2 x 1"	55	6 x 4 x 2"	120
4½ x 3 x 1½"	88	7 x 5 x 2½"	165
7 x 4 x 2"	160	8 x 6 x 3"	205

CONNECTORS

DIN	Plug	Skt	Jack	Plug	Skt
2 pin	9p	9p	2.5mm	10p	10p
3 pin	12p	10p	3.5mm	9p	9p
5 pin	13p	11p	Standard	16p	20p
Phono	10p	12p	Stereo	24p	25p
1mm	12p	13p	4mm	18p	17p

UHF (CB) Connectors:
PL259 Plug 40p. Reducer 14p.
SO239 square chassis skt 38p.
SO239S round chassis skt 40p.
IEC 3 pin 250V/6A.
Plug chassis mounting . . . 38p
Socket free hanging . . . 60p
Socket with 2m lead . . . 120p

SCRs

▶C106D	30
400V 8A	70
400V 12A	95

VOICE SYNTHESISER!

Now your computer can talk. The GI SP0256 speech processor is able through stored program to synthesize speech. Allophone (extended phoneme) system gives unlimited vocabulary.
Easily interfaced with any digital system; ten TTL compatible signals are used to select the allophones.
SP0256 925p. Data: 50p.

VERO

VEROBLOC◄ . . . 350
Size 0.1 matrix:
2.5 x 1 . . . 22
2.5 x 3.75 . . . 75
2.5 x 5 . . . 85
3.75 x 5 . . . 95
VQ board . . . 160
Veropins per 100:
Single sided . . . 50
Double sided . . . 60
Spot face cutter . . . 105
Pin insertion tool . . . 162
Wiring pen and spool . . . 310
Spare spool 75p Combs . . . 6

SWITCHES

Submin toggle:
SPST 55p, SPDT 60p, DPDT 65p.
Miniature toggle:
SPDT 80p, SPDT centre off 90p, DPDT 90p, DPDT centre off 100p.
Standard toggle:
SPST 35p, DPDT48p
Miniature DPDT slide 12p.
Push to make 14p.
Push to break 22p.
Rotary type adjustable stop, 1P12W, 2P6W, 3P4W all 55p each.
DIL switches:
4SPST 80p 6 SPST 80p, 8SPST 100p.

MICRO

		6116P3	320	6852	240	8228	220
		6502 CPU	325	6875	495	8251	250
		6522 VIA	295	6880	100	8253	390
		6532	570	81LS95	85	8255	225
		6551 ACIA	650	81LS96	85	8259	390
2114L2	99	6800 CPU	220	81LS97	85	MC1488	55
2716	225	6802 CPU	250	8080A	250	MC1489	55
2532	290	6809 CPU	620	8085AC	340	Z80A CPU	290
2732	290	6810 RAM	115	8156	350	Z80A PIO	260
2764	425	6821 PIA	110	8212	110	Z80A CTC	260
4116P20	85	6840	360	8216	100	Z80A SIO	900
5101L-1	220	6850	110	8224	120	Z80A DMA	1150

SOCKETS

	Low profile	Wire-wrap
8 pin	6p	25p
14 pin	8p	35p
16 pin	9p	42p
18 pin	12p	52p
20 pin	13p	60p
22 pin	16p	70p
24 pin	18p	70p
28 pin	23p	80p
40 pin	25p	98p

Soldercon pins 60P/100

COMPONENT KITS

An ideal opportunity for the beginner or the experienced constructor to obtain a wide range of components at greatly reduced prices. ¼W 5% Resistor kit. Contains 10 of each value from 4.7 ohms to 1M (total of 650 resistors) . . . 530
Ceramic Cap. kit. 5 of each value - 22p to 0.01u (135 caps) . . . 370
Polyester Cap. kit. 5 of each value from 0.01 to 1uF (65 caps) . . . 575
Preset kit. Contains 5 of each value from 100 ohms to 1M (total 65 presets . . . 425
Nut and Bolt kit (total 300 items): 180p

25 6BA ¼" bolts	50 6BA washers	50 6BA nuts
25 6BA ½" bolts	25 4BA ¼" bolts	50 6BA washers
50 6BA nuts	25 6BA ½" bolts	

CMOS

		4016	20	4034	140	4054	78	4081	12	40193	65	4528	45
		4017	30	4036	249	4055	80	4082	12	4502	60	4529	150
		4018	45	4039	280	4059	430	4085	48	4503	32	4532	60
4000	10	4019	25	4040	40	4060	42	4086	50	4507	35	4534	400
4001	10	4020	42	4041	40	4063	80	4089	125	4508	110	4538	60
4002	12	4021	40	4042	38	4066	22	4093	18	4510	45	4543	50
4006	50	4022	45	4043	40	4067	225	4094	68	4511	40	4549	360
4007	14	4023	16	4044	40	4068	14	4095	65	4512	40	4553	215
4008	36	4024	33	4046	40	4069	13	4097	290	4514	115	4555	35
4009	24	4025	12	4047	35	4070	13	4098	70	4515	115	4556	35
4010	24	4026	75	4048	38	4071	13	4099	70	4516	55	4559	390
4011	10	4027	20	4049	21	4072	13	40106	40	4518	40	4560	140
4012	15	4028	40	4050	21	4073	13	40109	110	4520	50	4584	35
4013	20	4029	45	4051	42	4075	13	40163	60	4521	130	4585	60
4014	45	4030	14	4052	48	4076	45	40173	100	4526	60	4724	140
4015	40	4031	125	4053	48	4077	14	40175	75	4527	50		

LS TTL

		LS20	12	LS75	20	LS123	42	LS160	35	LS197	45	LS353	60
		LS21	12	LS76	17	LS125	24	LS161	35	LS221	50	LS365	28
		LS22	12	LS78	17	LS126	25	LS162	35	LS240	60	LS366	28
LS00	11	LS26	14	LS83	35	LS132	35	LS163	35	LS241	55	LS367	28
LS01	11	LS27	12	LS85	48	LS136	26	LS164	40	LS242	55	LS368	29
LS02	12	LS30	15	LS86	20	LS138	60	LS165	56	LS243	56	LS373	58
LS03	12	LS32	18	LS90	24	LS139	30	LS166	60	LS244	100	LS374	60
LS04	14	LS37	14	LS92	25	LS145	70	LS170	75	LS245	70	LS375	43
LS05	12	LS38	15	LS93	24	LS147	150	LS173	60	LS247	48	LS377	60
LS08	14	LS40	13	LS95	38	LS148	75	LS174	45	LS251	28	LS378	57
LS09	12	LS42	28	LS96	95	LS151	38	LS175	45	LS257	32	LS390	45
LS10	14	LS47	35	LS107	40	LS153	38	LS190	35	LS258	32	LS393	40
LS11	12	LS48	45	LS109	21	LS154	75	LS191	35	LS259	55	LS399	156
LS12	12	LS51	14	LS112	21	LS155	33	LS192	35	LS266	20	LS541	78
LS13	19	LS55	14	LS113	21	LS156	36	LS193	36	LS273	58	LS670	135
LS14	30	LS73	20	LS114	22	LS157	30	LS195	32	LS279	30		
LS15	12	LS74	20	LS122	35	LS158	29	LS196	45	LS283	38		

TTL

		7413	17	7444	85	7483	30	74122	38	74161	46	74190	40
		7414	23	7446	58	7485	60	74123	38	74162	46	74191	40
		7416	19	7447	36	7486	19	74125	33	74163	46	74192	40
7400	11	7417	19	7448	43	7489	180	74126	33	74164	46	74193	40
7401	11	7420	14	7450	14	7490	19	74132	30	74165	46	74194	40
7402	11	7421	19	7451	14	7491	34	74141	54	74167	150	74195	40
7403	12	7422	19	7453	14	7492	24	74145	48	74170	115	74196	40
7404	12	7427	18	7454	14	7493	24	74147	75	74173	58	74197	40
7405	14	7428	25	7460	14	7494	33	74148	60	74174	53	74198	80
7406	19	7430	13	7472	22	7495	33	74150	48	74175	45	74199	80
7407	19	7432	20	7473	24	7496	38	74153	38	74176	35		
7408	13	7433	20	7474	19	7497	86	74154	47	74177	42		
7409	13	7437	23	7475	26	74100	78	74155	36	74179	75		
7410	13	7438	24	7476	25	74107	22	74156	36	74180	38		
7411	15	7440	14	7480	45	74109	24	74157	28	74181	100		
7412	17	7442	30	7482	65	74121	24	74160	55	74182	55		

The Rapid Guarantee

★ Same day despatch ★ Competitive prices
★ Top quality components ★ In-depth stocks

ORDERING INFO. All components brand new and full specification. All prices exclude VAT. Please add to total order. Please add 50p carriage to all orders under £15 in value. Send cheque/ P.O. or Access/Visa number with order. Our detailed catalogue costs 45p (free with orders over £10). Callers most welcome. Telephone orders welcome with Access or Visa. Official orders accepted from colleges, Schools, etc. . . Callers most welcome, we are open Monday to Friday.

Para-Q

Charles Blakey

A stereo parametric amplifier that can be used with hi-fi systems, in semi-pro recording studios, for music synthesis or for any other audio signal processing application.

MOST READERS will be familiar with the graphic equaliser and its impressive array of slider potentiometers. Such a device consists of a number of frequency selective filters which allow the sound level to be boosted or cut at specific frequencies. The 'graphic' part originates from the fact that the knobs of the slider pots give a graphical display of the way its frequency response has been set up. It is intriguing to notice how such units have been set up by their users and one of the most interesting seen recently had a 'V' shape on each channel which attenuated those frequencies to which the ear responds best and so effectively reduced 'loudness': the unit was connected to a tape recorder providing background music!

While a graphic equaliser can be useful, especially if it has a large number of filters, it does have two main deficiencies. In the first place one of its objectives is to correct for deviations from a flat audio response but nowadays even a modest hifi system will give good results, with the main deviations being caused by location of the sound system. That is, a comfortable living room will often result in absorption or boosting of certain frequencies in the sound emanating from the speakers. The usual effect is a frequency response curve displaying just two or three peaks or troughs, at least over the range 50Hz to 15kHz (the fall off outside this range is invariably due to the speakers). The first difficulty with a graphic equaliser which has relatively few bands is that the centre frequency of the filters will not correspond with one of the peaks or troughs you wish to correct. In these circumstances attempted correction may make matters worse.

The second difficulty is that the peaks and/or troughs are often very sharp, that is, the defect in the response only occurs over a fairly narrow band of frequencies, whereas a graphic equaliser generally boosts, or cuts, a wide range of frequencies. The latter is due to the need to set the 'Q' (quality factor) of the filters so that the gain of adjacent channels overlap. Trying to eliminate a sharp peak with a wideband filter can easily result in two troughs in the frequency response — again worsening matters.

A parametric equaliser overcomes the above deficiencies since it has the capability for adjusting both the frequency and Q over a large range, as well as having the gain control. Furthermore in most situations the performance of a sophisticated graphic equaliser may be exceeded by two or three parametric equalisers per channel and even the stereo unit described in this article will yield very useful results.

The parametric equaliser described is a high performance unit suitable for use with even the most exotic hifi system. The prototype had a boost and

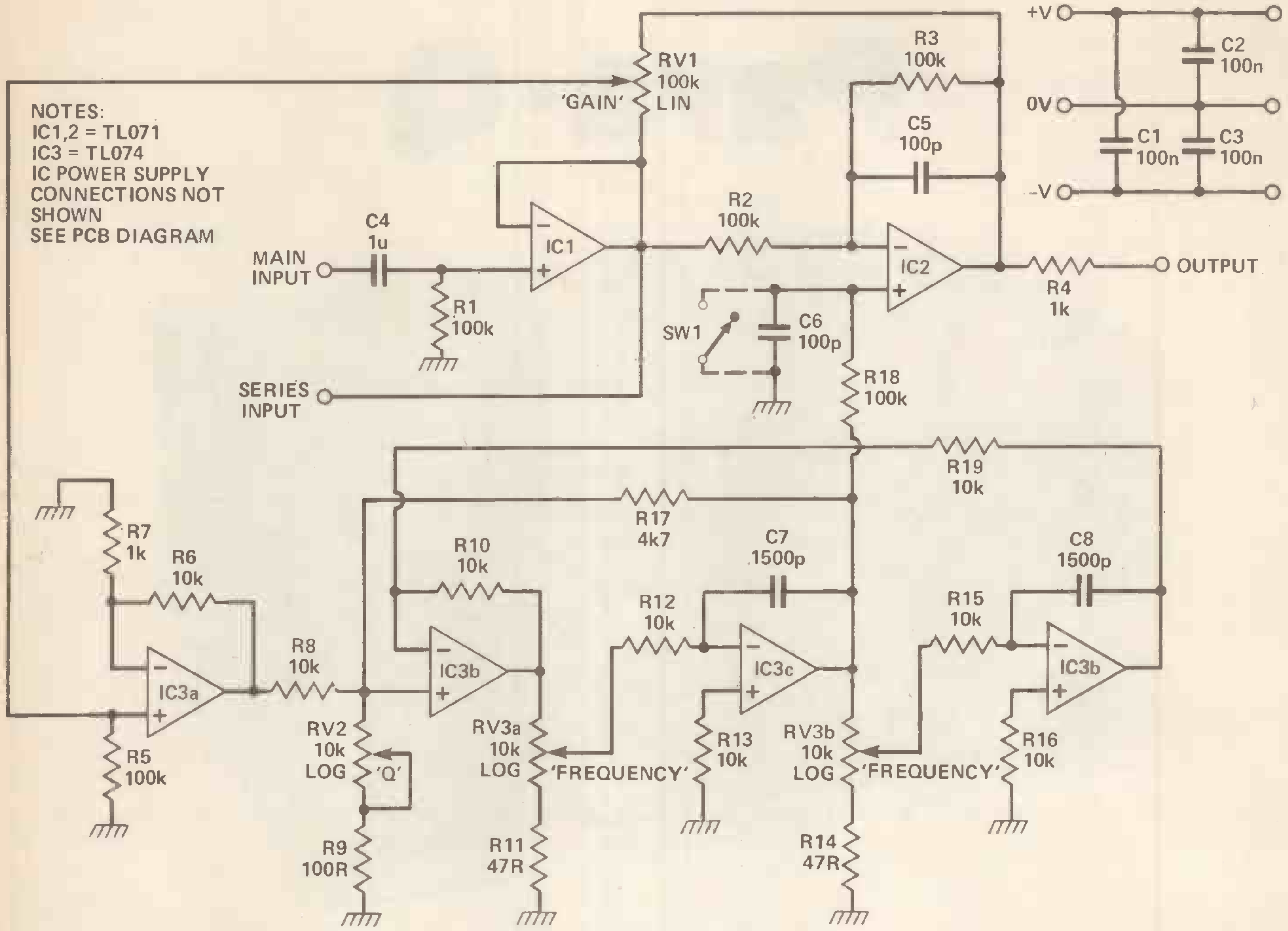


Figure 1. The circuit shown above is for one channel of the stereo pair. Switch SW1 is an optional bypass for the channel; several other modifications which alter the characteristics of the equaliser are described in the text.

cut range from zero to just over ±20dB; a Q variable from 1 to 25; and a frequency range of 50Hz to 11kHz. The Gain and Q measurements were made at 1kHz but uniformity of response is good over the full frequency range. The latter range is ideal for most audio applications since one rarely wishes to treat frequencies below 50Hz, and a 11kHz top level reduces the risk of damaging tweeters if the equaliser is set to a high boost at high frequencies (unless it is correcting for a trough in the response). The frequency range may, however, be easily altered as described later.

A high gain, high-Q parametric equaliser is particularly useful for 'correcting' recordings and the most common alterations are boosting frequencies deficient in the original and cutting out an unwanted frequency, eg a noise originating from one of the instruments.

Such equalisers are also ideal for electronic music applications. Firstly, for imitative synthesis it may be used as a so-called formant filter; that is, to boost a band, or bands, of frequencies which are characteristic of the instrument being simulated. These equalisers are now often used as an effects unit since the tone changes they can introduce are quite dramatic, especially at high gain levels.

Circuit

The complete circuit diagram for one channel of the parametric equaliser is shown in **Figure 1**. The key feature of the equaliser is a band pass filter which is constructed around ICs 3a, 3b and 3c, arranged in what is known as a 'state variable' configuration. The band pass output is available at the output of IC3c and the centre frequency of the filter is governed by the integrating capacitors C7 and C8, plus the resistance provided by the ganged potentiometer RV3. With 1n5 capacitors the frequency range is 50Hz to 11kHz and this range may be altered by changing both C7 and C8. For example, if they are substituted by 1n the frequency range would be 75Hz to 16.5kHz, while 2n capacitors would give a range of 35Hz to 7.5kHz.

Reverting to the input stage, the main input is AC coupled to IC1, which is simply a buffer stage primarily to provide a low impedance to the gain control, RV1; R1 sets the input impedance of the circuit. The signal then passes to the output via the unity gain amplifier IC2 and, if switch SW1 is closed so as to ground the non-inverting input of IC2, the filter section will not have any effect.

The input to the filter is via RV1, one end of which is connected to the original non-inverted signal at the output of IC1 while the other end of the potentiometer connects to the inverted signal at the output of IC2. The signal input to the band pass filter comes from the wiper of RV1 while RV3 determines which frequency components are passed by the filter and fed back into the non-inverting input of IC2. Thus if the wiper of RV1 is closer to the output of IC1 (the original signal) more of the selected frequency band of the original signal becomes added (boosted) onto the original signal at IC2. Likewise when RV1 wiper is close to the output of IC2 the effect will be to subtract (cut) the original signal in IC2. The effect is the same as a conventional graphics equaliser

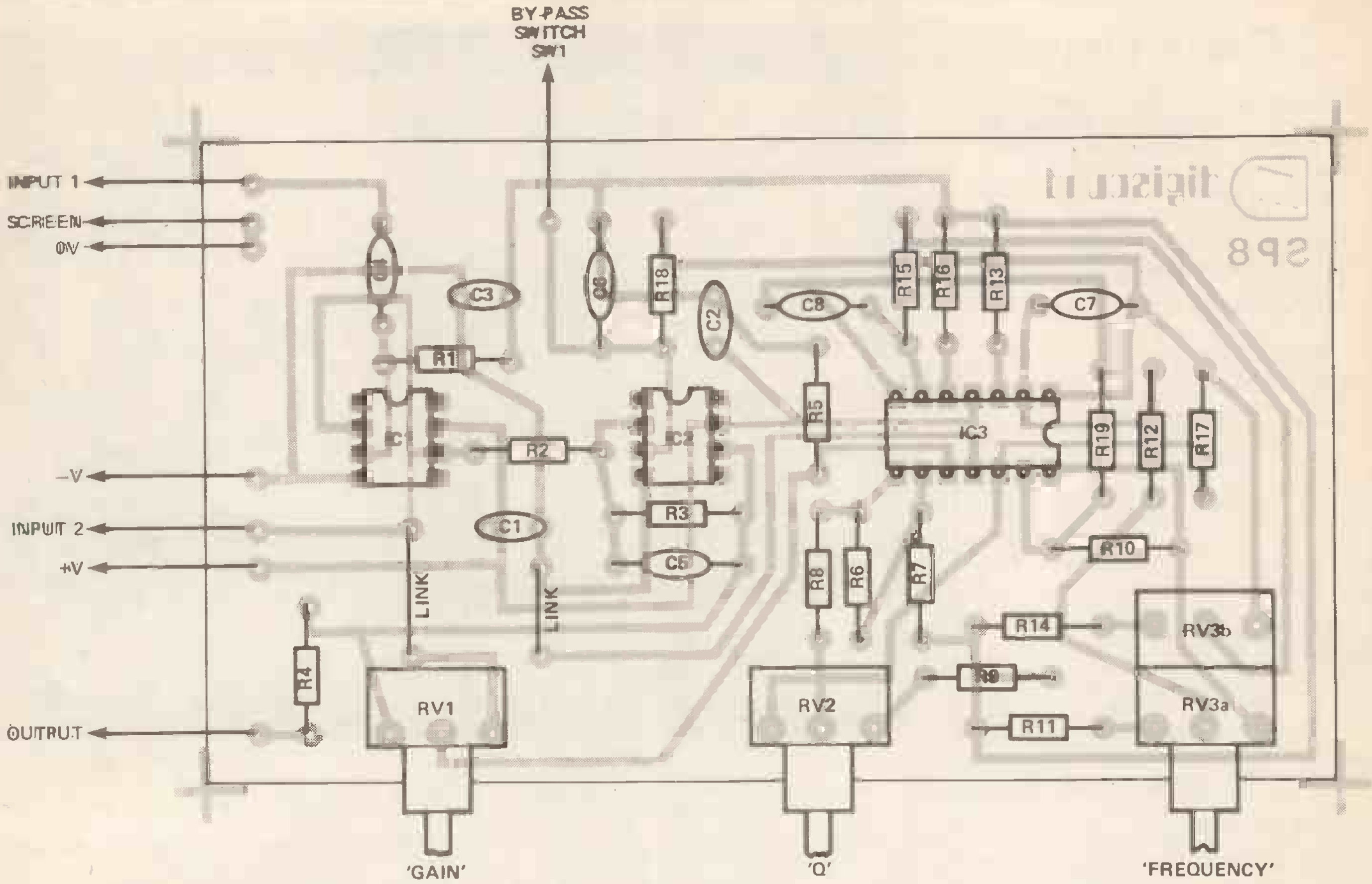


Figure 2. The printed circuit board accommodates the components for a single channel of equalisation. Two boards are required for the full stereo facility (see internal picture, next page) or any number can be connected in series using the series input (labelled input 2 in the diagram above).

but the ability to adjust the frequency over the full range is a major advantage. Typical outputs with boost and cut are shown in **Figure 3**.

The other feature that has to be incorporated into a parametric equaliser is a variable Q; the higher the Q the more peaked the response from the filter. Increasing Q is obtained by increasing the amount of feedback and one of the main reasons for choosing a state variable filter is to obtain a high Q without causing the filter to oscillate. In the absence of RV2/R the Q of the circuit would be determined by the ratio of R8 and R17 but altering these resistors would also alter the gain of the circuit unless the design is altered and dual potentiometers are incorporated to alter both resistor values. This problem is overcome by increasing the gain prior to R8 and then varying Q by attenuating the feedback signal using RV2.

Construction

All components, including the potentiometers, are mounted onto a printed circuit board and the component overlay is shown in **Figure 2**. The latter makes assembly about as simple as one can get for such a project, but there are several options available to the user which are discussed below.

Power Supplies. The parametric equaliser requires dual power supplies and these can be anything from ±9V to ±15V. At ±15 volts the power consumption is about 12mA per rail per unit, and so the project would be suitable for battery operation. In the latter event a power switch should be fitted to conserve battery power when not in use and one should also put a reservoir capacitor, say 47uF, across the supply lines. For a single, or stereo unit, an alternative is to pick up dual supplies from some other equipment. Lastly, one could incorporate a mains derived supply into the case but if this option is used then carefully check the siting of the transformer before finalising the lay-out since filters may pick up and amplify the 'hum' being radiated from the transformer.

By-Pass Switch. A single pole, single throw switch may be connected from the points in **Figure 2** marked 'by-pass switch, SW1' and 'OV'. When the switch is closed the non-inverting input of IC2 is grounded and the original signal will pass through the equaliser unaffected by the settings of any potentiometers. This facility may be useful when using the unit in a hifi chain, since the effect of the settings may then be rapidly checked by switching SW1. The by-pass arrangement is also useful when the parametric

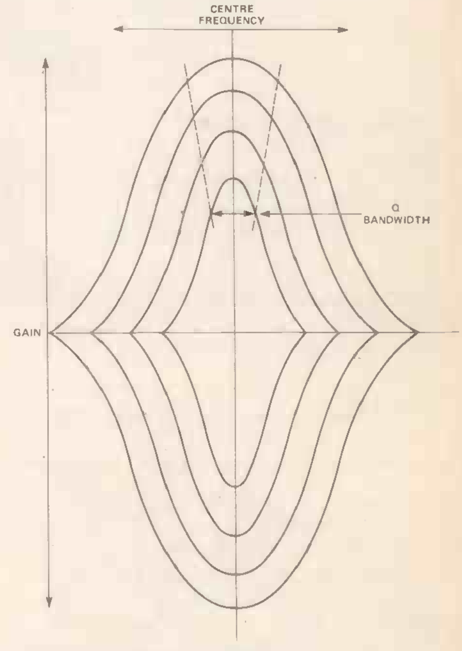


Figure 3. This graph shows a few of the infinite variety of response curves that the Para-Q can generate. There are three variables: the centre frequency can be positioned anywhere between 50Hz and 11kHz; the gain at that frequency can be varied by ±20dB; and the Q or bandwidth of frequencies effected can range from 1 to 25, giving boost or cut over a very narrow range or over a wide band of frequencies.

Parts List

Although a stereo parametric equaliser is illustrated, the reader may wish to use only one unit as an effects unit, or several for a hifi system. In view of this we show the basic set of components for a single unit and the choice of connectors and control knobs is left to the constructor.

RESISTORS

¼ watt, 5% carbon film

R1, 2, 3, 5, 18 .... 100k
R4, 7 .... 1k0
R6, 8, 10, 12, 13, 15, 16, 19. 10k
R9 .... 100R
R11, 14 .... 47R
R17 .... 4k7

POTENTIOMETERS

RV1 .... 100k
lin carbon, PCB mount
RV2 .... 10k
log carbon, PCB mount
RV3 .... 10k+10k
dual log carbon, PCB mount

CAPACITORS

C1, 2, 3 .... 100n
min polyester
C4 .... 1u0
MkH polyester
C5, 6 .... 100p
polystyrene
C7, 8 .... 1n5
polycarbonate

SEMICONDUCTORS

IC1, 2 .... TL 071
JFET low noise op-amp
IC3 .... TL 074
JFET low noise quad op-amp

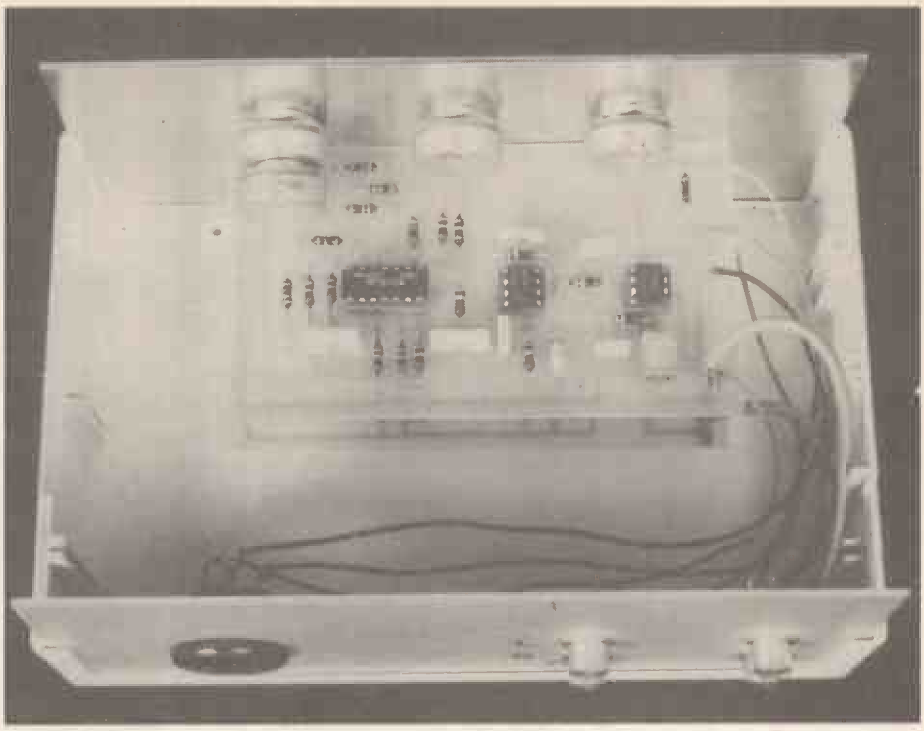
MISCELLANEOUS

8-pin DIL sockets (2); 14-pin DIL socket; PCB, wire, solder, etc.

BUYLINES .... **page 34**

equaliser is used as an effects unit for music. One switch may be used for several equalisers housed within the same case or the user may use a switch for each unit so that the effect of single units may be rapidly checked.

Number of Equalisers and Connecting Up. If a single equaliser is used in each signal path then the channel input connects to the point on **Figure 2** marked 'Main Input'; screened cable is preferred, with the screen going to the point marked 'screen' on the PCB overlay. The input socket(s) may be of any type to suit the user, for example, phono sockets, DIN socket, or jack sockets. The output is of low impedance and need not be screened within the housing of the equaliser, ie from the point marked 'output' on the overlay to the output socket.



As already mentioned, three parametric equalisers will usually be more effective in a hifi system than a ten, or more, channel graphic equaliser. If more than one unit is connected up per channel then they are connected in series. The signal to the first unit connects with 'Main Input', as described above, but the 'output' of unit 1 goes to the 'Series Input' of unit 2 ('output' of unit 2 to 'series input' of unit 3 and so on) and the 'output' from the last unit goes to the output socket of the particular channel. The second and following units do not require components IC1, C4 and R1 and if the latter have already been installed then the unit will not work until IC1 has been removed from these additional equalisers.

When several equalisers are employed then the most convenient method of housing them will be with the PCBs arranged vertically. The distance between PCBs should be 33mm or greater and, for information, the distance between potentiometer centres is 38mm.

In Use

With the gain control in the mid position, or the by-pass point connected to ground, the parametric equaliser has unity gain, that is, the level of the signal out is the same as the level of the signal in. The input signal should, therefore, be pre-amplified and with many audio amplifiers the monitor output is the appropriate point to use. Alternatively, when the equaliser is used for tape/cassette recording it may be installed in the signal line to the recorder.

Table 1

Power Supply	Max Signal Input
±9V	400mV
±12V	530mV
±15V	700mV

The signal level which can be used is partly governed by the power supply and partly by application. For hifi and many recording situations, the cut and boost control is only set to a level which will compensate for deficiencies in frequency response so as to ensure a nominally flat response. In these circumstances the unit will cope with signal levels likely to be encountered in such systems irrespective of the power supply used. If, however, the equaliser is used for special effects and gain is set at either extreme then the maximum signal levels shown in **Table 1** are recommended in order to avoid clipping.

As regards setting of the controls, without having access to audio analysing equipment, you will have to start off by using an equaliser channel in much the same way as you use tone controls at present, that is, adjusting them by ear. Start with the Q control at, or near, minimum and then adjust gain gradually either way from the centre position and then slowly rotate the frequency control clockwise. You will be amazed by the results and will soon learn the best settings for your system. Note that when Q is increased the effect of the gain control is generally less marked since the band of frequencies being boosted or cut is much narrower and therefore not so noticeable to the ear unless it is centred on some constant frequency in the sound.

HE

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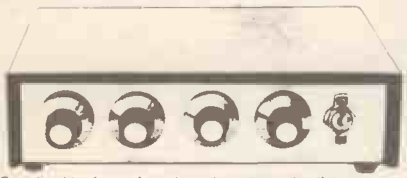
(plus postage for transformer)	£3.00

3 CHANNEL SOUND TO LIGHT KIT



Complete kit of parts for a three channel sound to light unit controlling over 2000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for disco work. The unit is housed in an attractive two tone metal case and has controls for each channel, and a master on/off. The audio input and output are by ¼" sockets and three panel mounting fuse holders provide thyristor protection. A four pin plug and socket facilitate ease of connecting lamps. Special price is £14.95 in kit form or £25.00 assembled and tested.

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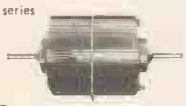

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Ditto, but double ended £4.25.
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	12 pole 3 way	18 pole 2 way

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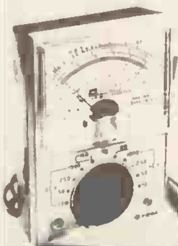

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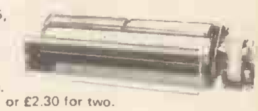

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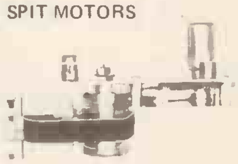

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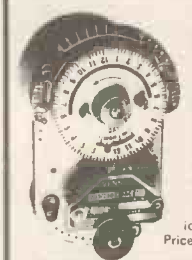

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Although these articles are being prepared for the next issue, circumstances may alter the final content.

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Fantastic In-Car Entertainment Offer for Hobby Electronics readers.

Your choice from two Hitachi Auto Reverse Stereo Cassette players* with LW/MW/FM stereo radio – at LESS THAN TRADE PRICE!

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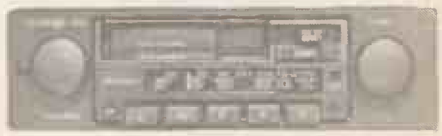

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SEND TO:
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POINTS OF VIEW

Feel like sounding off? Then write to the Editor stating your Point of View!

Power To The Housepersons!

Dear HE,
Good try for printing articles on the human side of electronics, but your writer John Biggin (Power In The House, HE June '83) presented an overoptimistic and one sided view of the impact of electricity in the home.

This is the other side.

1) Statistics show that women are spending as many hours as their mothers did on housework.

2) Phrases like 'working housewives' suggest that the tasks done in the home are not work. Homemaking is work - not to mention the job of bringing up children, which is done in the home and which can't be made automatic or mass produced.

3) Far from liberating women, the signs are that women are losing status in society because what is done in the home is under-valued. Don't forget, before the industrial revolution everyone worked at home and running that home was an important job.

I think it is a good thing that magazines like HE print articles about the impact of technology because people, men and women, could do with giving it a bit more thought. By the way, there are a number of women electronic hobbyists, including myself, who would prefer not to be referred to as 'The Ladies' - I have enough trouble with shop assistants talking to my husband about components I am buying!
Hilary Pegg,
Roundhay,
Leeds.

At last! One of our wimmin readers (apart from the One who filled in her Reader Survey in 1982) comes out of the woodwork. Your comments are much appreciated, and I don't think we can blame John Biggins for any bias in his article, as the idea that electrical gadgets don't actually save any time seems to be a fairly new one (and, I think, a mistaken one, but I'll come back to that).

Actually, the reference in the intro to 'The Ladies' was intended to draw to the attention of The Gents that this article was not directly relevant *only* to persons of the non-masculine gender (but I couldn't get that onto one line). Now some brief flurries of response:

1) Women may be spending as much time on housework as their mothers did, but I bet they don't spend as much time as their grannies (or their grannies' housekeepers) did. After that, Parkinson's Law comes into operation. I have heard tell that some ladies (and probably gents as well) clean the grouting between their bathroom tiles with old toothbrushes, and iron their teatowels. Well, it's a free country.

2) Couldn't agree more about 'working housewife' — it reflects the attitude which accepts that a woman with a job must still have housework as her main occupation. The mass of men who also do a full-time job and cook and hoover in the evenings don't get called 'working househusbands' do they?

3)Yes, but housework has always been undervalued because men have always tended to hold the reins of the Media and therefore (a normal human trait) have given their ròles the best press. Women, for instance, have tended to do the budgeting in every age and clime, but get precious little credit (no pun intended . . .) for it. However, the people who have denigrated the rôle of the housewife in these latter days have frequently been other women who have taken the selfrighteous attitude that people who don't have 'careers' are inferior. Women have more control over the media these days, and some of them glamourize their ròles at the expense of others.

There has always been talk about how technology has not made our lives any happier — as a medieval historian my only reply to this is (*language - Ed.*) The choice everyone has now about what to do with their time is an extraordinary gift which it is up to us to handle.
True, it can make life very complicated, and it's more fun if you're wealthy and have an interesting job, but everyone has benefitted to some extent and nobody actually *has* to iron their teatowels, or wash their cars every Sunday. Let's enjoy it while we've got it!

OK, back to your workbenches, the lot of you, heads down and get soldering. And next time a shop assistant addresses your husband/dad/larger friend about your purchases, have them trained to say "I haven't a clue — ask the one who's doing the work."

But Can You Bend The Strings?

Dear Sir,
Many of us musicians have quite good pianos which were built say thirty or so years ago, which can go on playing for a good many more years, they were built so well, but they do lack the tone and sound of a Steinway. I am sure other musicians will agree with me when I say that there is really nothing to compare with the feeling of playing the piano, as against that of an electronic one, especially as it applies to players who were taught from an early age to play piano. I have tried several electronic pianos, but there is not the same feeling in playing.

Discussing this with some musician friends, it was decided to carry out a small experiment, by placing a stereo mic in the bottom of one of our pianos, then running a lead to a hifi amplifier, which was connected to six hifi loudspeakers, 70 watt each channel, we were all agreeably impressed with the overall improvement, bearing in mind we had overcome our aversion to the feel or key response, which is inherent in electronic pianos.

All had the idea that it would be best to have the mic, amplifier and speaker incorported in the piano, or else in a combo alongside, so that the player would immediately hear what was being played, the piano's normal acoustics being audible, but on the combo there would be controls to alter or adjust the electonic sound, or switch them off altogether.

We also agreed, that it would be best to put the whole project to some electronic wizards, who undoubtedly would be in a better position to advise the type of components to use, that would ensure the best results that could be achieved.

We would be very pleased to hear from you if you would consider taking up this challenging project, which I am sure would be of considerable interest to thousands of piano owners.
Yours truly,
R H Briggs,
Ringwood,
Hants.

We racked our brains for seconds to think of an answer to this one, and at last we found the elusive clue. About two decades ago (well, nearly) famous guitar person Dave Davies of The Kinks appeared on BBC TV playing a guitar which was adorned with the words: "THIS IS A PIANO". Natually, at the time, we thought that he had overestimated our gullibility, but now we see that this was a time-encapsulated message planted to aid musicians who already had pianos and would one day wish to bring them under the aegis of electricity.

To put it briefly, what you are looking for is a guitar amplifier. Consult your nearest electric guitar dealer, and when he has recovered from the idea that you want the amp for a piano, he will probably be able to advise you. The age of the Guitar Hero is over, and the age of the Piano Hero has dawned! You may even find you can play it with your teeth . . .

Airmail Abroad

Dear Sir,
I am interested in obtaining some of your projects for construction and back numbers of your magazine.

However, while you give the costs and postage, I feel sure that this does not cover postage to South Africa. May I suggest that you adopt the method used by the British Philatelic Bureau whereby they give postage rates to about three world zones. This would assist greatly in ensuring no delay of delivery to us. I have been receiving your magazine for a few years now, and am very pleased that you include a number of articles that start from the basics. This in fact is the main attraction of your magazine to me.
Yours faithfully,
R. B. Macgillivray,
Marshalltown,
South Africa.

I have consulted with our subscription department, and the reason that we don't quote in postal zones is quite simply that postal charges rise too frequently, and it is annoying and expensive for both us and our customers if they send enough money to cover an obsolete postal rate and we have to ask them for more — there are currency charges on each separate transaction, for example.

Our Backnumbers price of £1.50 a copy provides a basic postal charge for inland or surface mail to anywhere in the world. It also includes packing and handling charges. Airmail postage is very much more expensive.

However, extrapolating from our overseas air mail subscription rates, I would say that if you were to enclose an extra £1.00 per copy ordered and ask for air mail delivery, you would not be denied. This only makes sense for readers outside Europe, as the extra speed gained within the European postal area just ain't worth the extra cash.

More Rodents

Dear HE,
Please would you send me information on the Micromouse Association? I am writing to you as you made some mention of a micromouse at the beginning of your Hebot II article in HE November '82.

I would be extremely grateful if you would oblige. I am designing one for my electronics project, at A level.
Yours sincerely,
Roy Freeman,
Welbeck College,
Worksop.

Unfortunately, we lost contact with the micromouse species in about 1939. The people most likely to know are the **Computer Users' Club, c/o Tony Latham, 72 Sidmouth Rd., Willing, Kent DA16 1DS**.

Missed The Program

Dear Sir,
I am writing in connection with the ZX81 HRG article which appeared in your July edition.

After a careful study of the entire magazine I cannot find the program 4 listing, referred to in the text. As I intend constructing the project I would be most grateful if you could supply me with the omitted program. Unfortunately I will be out of the country for the next couple of months, so I will miss the August issue, should it appear there.

Many thanks in anticipation.
Yours,
I. Jauncey,
Weston Favell,
Northampton.

The references to Program 4 were supposed to have been deleted from the text when we dropped the listing because of space limitations. Unfortunately we cannot supply the listing now (because of time limitations — I hope Einstein isn't listening) but if you want the listing (and it's only an example) you can send Cambridge Computing £4.50 at the address in the July issue and they will supply a cassette containing all four programs, which will save you the trouble of typing them in.

Miss the August issue? MISS THE AUGUST ISSUE??? Haven't you heard of the Hobby Electronics Backnumbers service?? What is the world coming to?

Prestel Kits

Dear Sirs,
With regard to the letter from C. V. Parker in HE June '83 enquiring about Teletext/Prestel kits. The following company supplies two teletext kits, the MK I at £170.20 inc. VAT and the MK II at £227.70 inc. VAT. P&P is extra: **Manor Supplies, 172 West End Lane, London NW6. Tel: 01 794 8751/7346.** *I hope this will be of some help.*
Yours,
R. J. Ford,
Croydon,
Surrey.

Theory And Practice

Dear Ed.,
Perhaps you could provide me with some information concerning your projects section.

Even though I have good theoretical knowledge by passing the ONC test the only practical work I have done has been on operating simple circuits on breadboards.

This is a common problem facing college leavers who are then refused employment due to unfamiliarity with PCB techniques and development.

A feature in HE August '82 called "Beginners Guide To Construction" was quite informative.

As I now wish to start constructing circuits, similar to those in HE but at a lower starting-off level, how should I go about it? Where can I find these practical circuits?

Having been a student until recently I do have a fairly small budget but what are the essential items that I should purchase to begin with? (eg PCBs, soldering iron, meters, testing equipment, crocodile clips, power supply etc., the list seems endless!)

Any advice that you would offer would be much appreciated.
Yours faithfully,
David O'Donnell,
S. Tottenham,
London.

This sort of problem faces school and college leavers at all levels, including graduates, and as you are showing good sense in trying to get round it by your own efforts. As you may have gathered from reading the Careers In Electronics series, employers look for practical ability as well as theoretical ability, and evidence of a personal interest in practical things can make the difference between getting a good job and not getting it.

Projects: get Hobby Electronics regularly. We run projects at all sorts of levels, most of them within the scope of a virtual beginner, and quite a few of our projects can be built from kits (or at least with a PCB Service circuit board) which takes some of the sweat out of the early stages of learning.

More projects: readers may have noticed our symbiotic relationship with **Bernard Babani (publishers) Ltd.**, of **The Grampians, Shepherds Bush Rd., London W6 7NF**, who will send you a catalogue if you write and ask. This is because Babani publish a large number of small, inexpensive volumes of projects and on specific subjects, many of which are ideal for beginners, and require only a small investment. Some of these are on offer through our regular HE Bookshelf Service, for people who don't want to go to the trouble of getting in a catalogue.

Equipment: the most basic equipment will comprise a soldering iron, a small multimeter, a small pair of fine, long-nosed wiring pliers, a small, sharp pair of wire cutters, a small screwdriver (for casings, especially), and a sharp modeller's knife for wire-stripping, track cutting etc.

Choose a soldering iron with a fairly fine tip, and which is compact enough to be wieldy in a small space. For a multimeter, choose one with 20 kilohms per volt and as many ranges as possible. A cheap, useful meter should cost about £20; the cost of irons varies. You will eventually find you need two irons, one about 15W and one of 30 to 50W. You can start as cheap as possible and up grade as you discover the limitations of your tools, but you get what you pay for. Our technical department mentions Tandy meters and Antex soldering irons as fair value for money.

You will discover what else you need as you go along. A soldering station is a luxury which could be classed as a necessity for the amount of irritation it can save!

Making PCBs is a specialisation which you will want to move on to, but steer clear of it till you have overcome the more basic tricks of construction.

We've said it before, we'll say it again: there is no foolproof way of ensuring that electronics constructions work properly first time, short of having a perfect design, perfect construction and using Military Spec. components. On top of the good grasp of theory needed by a pro., patience, careful method and intuition are essential. It's the ability to overcome the frustration of not knowing what's gone wrong (or failed to go right) and test, estimate and calculate your way to a solution that employers are looking for.

Synthesiser Request

Dear Sir,
Could you please tell me if you have ever published a Synthesiser project (not a minisynth)?
Thank you,
N. Simister,
Eccles,
Manchester.

Not yet; keep watching, it could happen.

Athletics Counter

Dear Sir,
Having read your magazine since February 1979 I would like to congratulate you on an all-round excellent magazine.

Now comes the request. I would be grateful if you could supply me with any information on track event counters. The system envisaged would start when the gun fires and finish when a runner crosses the line. Having seen commercial equivalents, perhaps it's time a hobbyist (ie cheap) version arrived. Below I give the characteristics of the device as proposed to me by a 100m sprinter.

1. Portable; 2. Battery operated; 3. Stop input, Start input, Reset control and 4-digit capability.
Yours,
David O'Sullivan,
Baldonnel,
Ireland.

An interesting idea, indeed one that crops up around the office from time to time. Unfortunately, it has never progressed beyond the "bright ideas" stage, so we can't help you with further information.

However we'll schedule it for development and see what happens, so keep in touch. Be warned, though: this is a "marathon" project, so don't expect results too "fast"!

Old Advertisers

Dear Sir,
Whatever happened to T. Powell? I saw his adverts in old issues of HE and his prices are very competitive.
Yours sincerely,
Ben Chaston,
Enfield,
Middlesex.

T. Powell appeared in the Directory of Electronic Components and Hardware Suppliers in HE J October '82 at the address of Advance Works, 44 Wallace Rd., London N1, Tel: 01 226 1489; hopefully, we'll have them in this year's survey when it appears in December.

However — a general warning — don't order straight away from suppliers advertising in issues more than two or three months old; people move, they mutate, prices go up, lines get dis-continued, anything can happen; write and/or phone them first and make sure they are where you think you are and have what you want.

Getting Into Radio

Dear Sir,
I am interested in radio electronics, and I have been experimenting with small, very low power transmitters with a range of about thirty feet, using circuits which our school electronics club has got.

I would now like to get into CB but I can not afford a shop bought rig, so I was wondering if you had got some circuits for CB radios and if so could you send me details.
Yours sincerely,
Simon Phillip,
Devizes,
Wilts.

Sorry, but radio transmission is very strictly controlled, so that those people who can or must use radio communications can do so without interference from 'pirate' transmitters.

All radio transmitters used in the UK must meet certain standards and with the exception of equipment used by licensed radio amateurs, must be approved by the Department of Trade and Industry. All CB equipment included.

If you are serious about wanting to experiment with radio circuits your best bet is to sit for the Radio Amateurs' Examination. Contact the **Radio Society of Great Britain, Alma House, Cranbourne Rd., Potters Bar, Herts EN6 3JW** for more information.

In Short Supply

Dear Sir,
Please could you send me information on your Sound To Light Unit, HE January '81, because when I purchased the kit from Magenta, they did not enclose any technical information. And I found a few mistakes in your wiring diagram. And also could you let me know whether John Bull Electrical have closed down?
Yours faithfully,
Peter G. Rees,
Weyland,
Dyfed.

This depends on what information you want! We can tell you, for example, that there were two errors in the article: the Verobard track should be broken at co-ordinate B25, and that pins 6 and 7 of IC1 should be linked together.

As for J. Bull — they're still alive and well, as testified by any recent copy of HE, where they advertise their services regularly.

Seek The 'Speaker

Dear Sirs,
Please could you help me in obtaining a two and three way crossover unit for use in two loudspeaker systems. Each must be rated at about 100W. For the three-way crossover unit, the crossover frequencies must be between 1) 2500Hz and 3500Hz 2) 6500Hz and 7500Hz. For the two way unit, the crossover frequency must be between 5000Hz and 6000Hz.

If you could recommend any companies which produce such units I would be much obliged.
Yours faithfully,
R. J. Coleman,
Newark,
Notts.

Crossover units are designed for specific speaker systems, so it's unlikely you'll find one to exactly fit your requirements — but it's always worth a try. Wilmslow Audio make a variety of crossover units for their range of hifi speaker kits and may have one that will suit your design. Their address is **35/39 Church St., Wilmslow, Cheshire SK7 1AS.** HE

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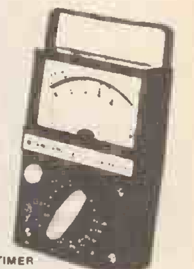

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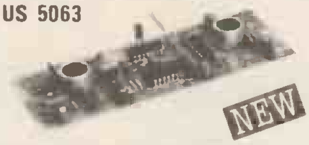

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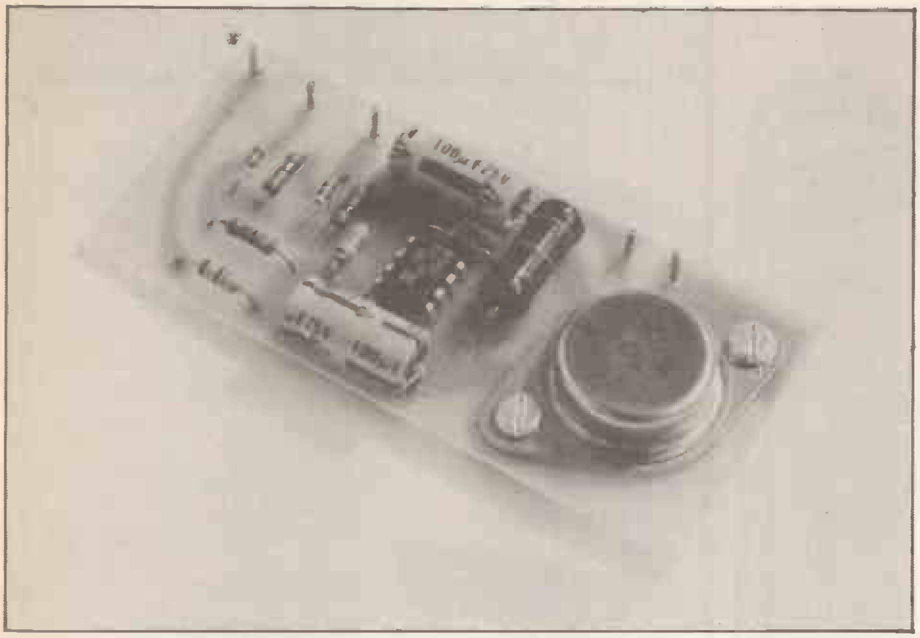


INTERIOR LIGHT DELAY

Tony Scragg

Lead, kindly light . . .

DO YOU want to improve the specification of your car to Cortina Crusader or even Jaguar XJ6 specification? With this circuit you can — at least in the interior light department. The circuit described here is suitable for all negative earth cars fitted with door switches to operate the interior light.

The function of the circuit is to keep the interior light on after the car door is closed, allowing time to find keys or the way out of the garage etc. The delay can be set to any value and with the component values given, this is about 30 seconds. Switching on the ignition over-rides the delay, allowing the car to be driven away safely at night before the 30 seconds are over. Opening the doors with the ignition on causes the interior light to operate "normally", ie with no delay.

Installation of the circuit involves interrupting the connection between the light and the switches and making connections to battery, earth and ignition.

Circuit Description

The heart of the circuit is the 555 timer IC which is used as a comparator, in this application; its internal divider chain and good output drive capability simplify the circuit considerably.

Basically there are two states of interest here. When the trigger and threshold inputs are *less* than 1/3Vcc the output is high, turning on the output stage, Q1. When inputs are *greater* than 2/3Vcc the output stage is turned off.

Referring to the circuit diagram, when the doors have been closed for some time (switch contacts open) C1 will be charged up to 2/3Vcc + 0V7; this voltage is clamped by diode D3 and the internal divider chain, to protect the 555 inputs.

In this stage the light is off, but opening the door causes C1 to be discharged through R2 and D2 (R2 limits the current through D2). Hence the inputs go below 1/3Vcc and the light is turned on. Closing the door, D2 is reversed biased by R1, and C1 charges up through R4 — this defines the delay time. If the ignition is switched on during this time, C1 rapidly charges up through D1 and R3, hence the light goes off immediately. C2, ZD1 and R6 form a simple power supply filter and protection from high battery voltages.

Construction Details

Construction of the interior light delay unit is fairly straightforward, being simply a matter of soldering the components to the PCB as per **Figure 2**. Ensure that the IC, diodes and electrolytic capacitors are of the correct polarity and also note that the 2N3055 must be bolted down using metal bolts, as one of these forms the electrical connection to the transistor collector. It is also advisable to solder the nuts down to the PCB as this gives a more reliable joint and helps to stop the screws loosening!

Once the PCB is assembed, flying leads are attached to the five connections to the board and the board then mounted in any small plastic enclosure at hand (as the unit will be mounted out of sight behind the dashboard appearance is not of upmost importance). A piece of foam rubber is used to locate the board in the enclosure and the flying leads brought out to "chocolate block" connectors.

Installation

The first stage of the installation is to locate the interior light wiring, as the unit is most conveniently mounted near to this wiring. The wire of interest is that between the light and the door switches. In the case of roof mounted lights this wire runs up one of the windscreen or door pillars, so is quite easily traced where it emerges under the dash or carpet. Generally, both front doors and sometimes the rear doors have switches installed and it is important that all these have merged into one conductor to the light at the point that the connections are made, otherwise not all the doors will have delayed operation.

Once this wire has been located it

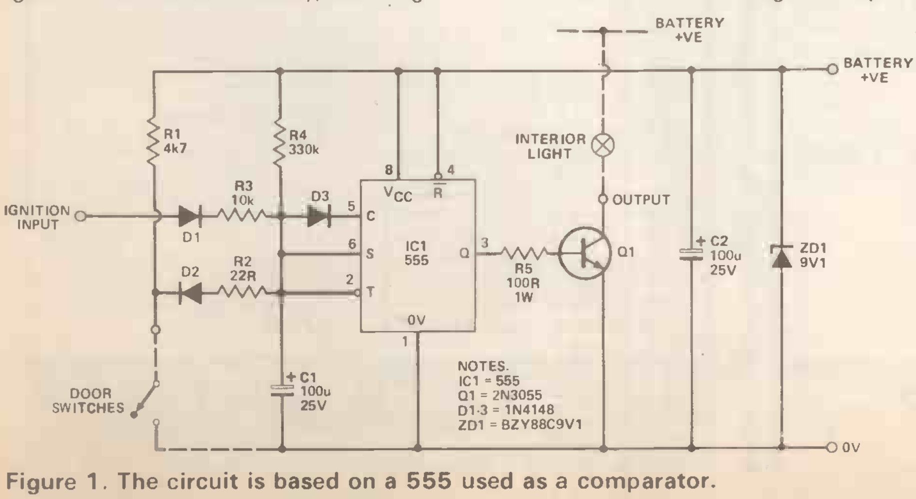


Figure 1. The circuit is based on a 555 used as a comparator.

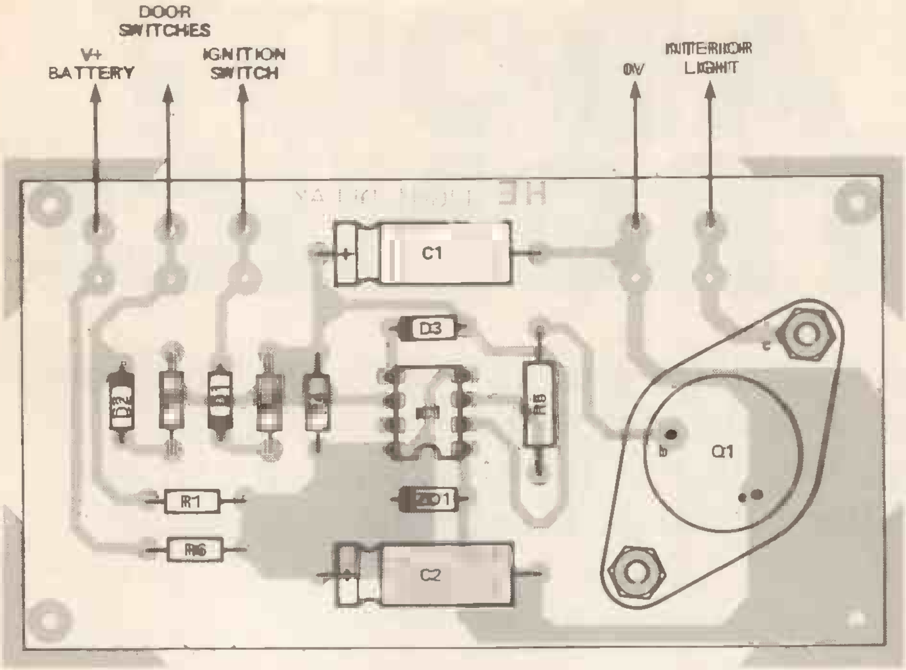


Figure 2. The PCB is compact, for easy installation.

Parts List

RESISTORS
(All ¼ watt 5% carbon unless noted)
R1 .... 4k7
R2 .... 22R
R3 .... 10k
R4 .... 330k
R5 .... 100R
2.5W wirewound
R6 .... 47R

CAPACITORS
C1, 2 .... 100u 25V
axial electro

SEMICONDUCTORS
IC1 555
Q1 .... 2N3055
D1, 2, 3 .... 1N916
ZD1 .... BZ788C9V1

MISCELLANEOUS
PCB; optional case; wire, solder, nuts and bolts etc.

BUYLINES .... page 34

is cut to generate two connections to the light delay unit — the door switches to the input and the light connection to the unit output. A permanent source of 12V is also required — this can be taken from the interior light supply or the clock supply, for example. Any convenient earth connection can be used and the final connection is to the ignition circuit, which can be taken from the back of the ignition switch.

The unit requires no setting up and should be completely operational once connected. HE

ALL ABOUT ELECTRONICS

Our new Beginner's Series tells you all you'd like to know about electronics. From start to finish. All about components and circuits, all the theory you need to get started in the world of electronics.

Keith Brindley

IN OUR FIRST LOOK at semiconductors, in last month's All About Electronics, we saw there were two basic ways of using transistors — in circuits where an electronic switch was required to turn on or off electrical equipment, and in circuits which required amplification of electrical current.

The first type of circuit — the transistor as a switch — is broadly classified as *digital*. In the electronic sense, this means that the circuits have fixed output states. We can further classify digital circuits as *binary digital*, ie, any circuit has only two logic states: *on* and *off*. These states are generally indicated by a voltage change at the output of the circuit, a typical voltage change being from 0V when the output is off, to 5V when on. Other circuits may have voltage level states of, say -5V, and +12V. The voltage levels are irrelevant; the important factor is the identification of two distinct logic states. In this way, the output state of one transistor stage can be used to apply the input state of the following transistor stage, so that complex and automatic electronic equipment can be built up. As a general rule, the numbers 0 and 1 are used to distinguish between the logic states — whatever the voltages used.

Simply Logical

We saw the simplest of these logic circuits last month if you remember. **Figure 1** shows it — no more than the basic NPN transistor with a collector resistor and a base resistor. Let's take a look at its action to see what happens. With no voltage applied at point A (ie, logic 0) no base current flows so the transistor is off ie, no collector current flows and the transistor resistance is extremely high. A circuit equivalent to this condition is shown in **Figure 2**. The base resistor is effectively connected to the same voltage at both ends (0V) and so no current flows through it. The transistor resistance (R_{tr}) is shown as 20M (a typical value for a transistor in the off mode). Resistors R_{tr} and R1 form a voltage divider, the output voltage of which follows the formula:

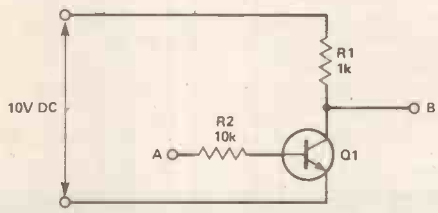


Figure 1. A single transistor used as an inverter logic gate.

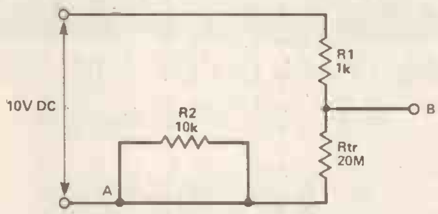


Figure 2. Equivalent diagram of a single transistor inverter with logic 0 at point A.

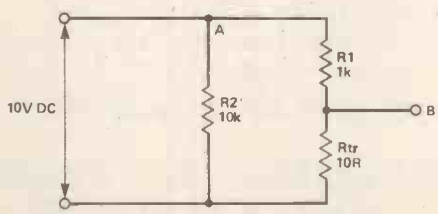


Figure 3. Equivalent diagram of a single transistor inverter, this time with logic 1 at point A.

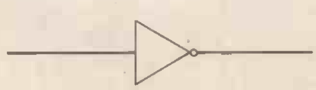


Figure 4. Symbol of an inverter gate.

$$V_B = \frac{R_{tr}}{R_{tr} + R1} \times V_A$$

$$= \frac{20M}{20M + 1k} \times 10$$

which is close enough to being 10V ie, logic 1, to make no difference. *The output of our circuit is of the opposite logic state to the input.*

If we now consider the transistor with a base current — the equivalent circuit is shown in **Figure 3** — we know that the transistor resistance is low (shown as 10R by R_{tr} in **Figure 3**), hence the output voltage at point B is:

$$V_B = \frac{10}{1k + 10} \times 10$$

which is close to 0V (logic 0) as we'll ever get. So, in this mode the transistor output state is always the opposite of the input state. So whatever the input logic state, the output is the reverse. We call this simple digital circuit — you guessed it — an inverter.

Every Picture Tells A Story

To make it easy and convenient to design complex circuits using such transistor switches, symbols can be used instead of having to draw the whole transistor circuit. The symbol for an inverter is shown in **Figure 4** and is fairly self-explanatory. The triangle represents the fact that the circuit acts

IN	OUT
1	0
0	1

Figure 5. Truth table of an inverter gate.

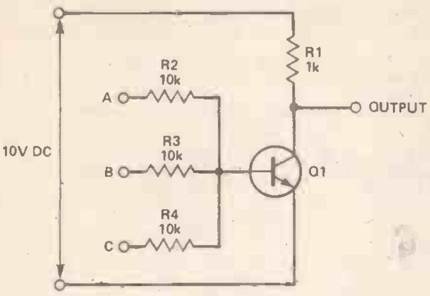


Figure 6. A single transistor, three-input NOR gate.

A	B	C	OUTPUT
1	1	1	0
0	1	1	0
1	0	1	0
0	0	1	0
1	1	0	0
0	1	0	0
1	0	0	0
0	0	0	1

Figure 7. Truth table of a three-input NOR gate.

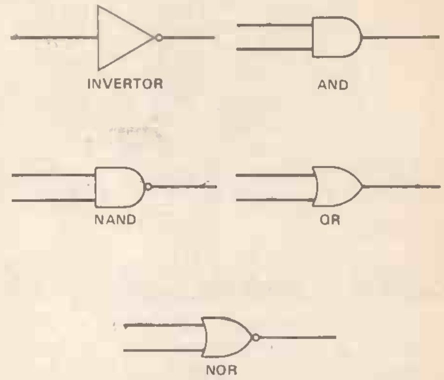


Figure 8. A selection of available logic gate.

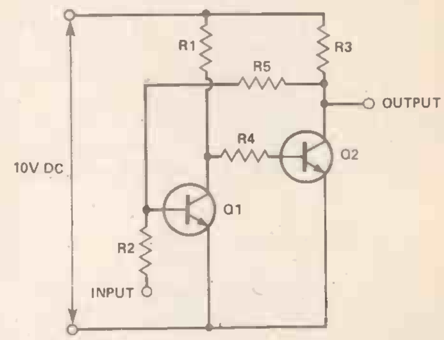


Figure 9. A two-transistor bistable formed by connecting the output of the first to the input of the second.

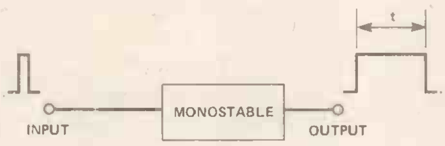


Figure 10. Block diagram of a monostable

as what is called a buffer ie, connecting the input to the output of a preceeding stage does not affect or dampen the preceding stage in any way. The dot on the output tells us that an inverting action has taken place and so the output state is the opposite to the input state in terms of logic level.

To aid our understanding of digital logic circuits, input and output states are often drawn up in a table — known as a truth table. The truth table for an inverter is shown in **Figure 5**.

Another transistor circuit used in digital logic is shown in **Figure 6**. Before I tell you what this circuit is called let's see if we can calculate how it works. Incidentally, circuits like the inverter and this one — and others which you will see over the coming months — are termed *gates*. The gate in **Figure 6** looks similar to the inverter gate, doesn't it? But it has three inputs and three base resistors. If inputs A, B and C are at logic 0, then no base current flows, the transistor resistance is high, and so the output state is logic 1. However, if any one or more of the inputs is high (ie, at logic 1) then the output changes to a low (logic 0) state.

The operation of the gate can be summarised if we say that the only case in which the output state is high is when neither input A, nor input B, nor input C is high. Would you believe, this gate is known as a NOR gate. Its truth table is shown in **Figure 7**.

Figure 8 summarises a number of the symbols of the more common digital logic gates, all of which can be constructed using transistors. Their actual construction is unimportant, however, only the symbols need be learned. Binary digital logic is a fascinating topic in its own right really, and I'm not going to spend too much time talking about it now, but I will discuss it next month when All About Electronics will be dedicated to it.

The next digital circuit we must study is known as the *bistable*. It is the first of a group of three circuits which is probably the most important group of digital circuits there is. Each of the three circuits can be formed by using two transistors and the bistable is shown in **Figure 9**.

Shutting The 'Stable Gate

A bistable is formed simply by connecting the output of one inverter gate to the input of a second. The output of the second is then connected back to the input of the first. In this way the overall output, at point B in **Figure 9**, is held at either state (high or low; logic 1 or logic 0) for an indefinite period. When the input state is changed so does the output: the output then remains stable in its new state indefinitely. The circuit is therefore stable in both logic states — hence the name 'bi-stable'! Bistables are given the nickname *flip-flop* which describes their operation in a more graphic (but no less accurate) way.

The next circuit in the group is the *monostable* — yes, you're right, it has only one stable state. Operation is best described by considering the block diagram in **Figure 10**. When an input pulse ie, a short variation of input voltage from logic 0 to logic 1 and back to logic 0 again occurs, the output varies as shown. The time, t, during which the output is high is fixed, so no matter what length the input pulse is, the output will be high for time t. Time, t, could be as short or as long as required. The circuit could form the basis of a controller for, say, an electric fire, where a single press of a push-button turns the fire on for a fixed time of twenty minutes, and then automatically turns it off again.

Again, as in the bistable, two transistors are used to build this circuit in **Figure 11**. Again the first transistor switches the second, which in turn switches the first. But this time a capacitor has been placed between transistors TR1 and TR2. So, how and why does this affect the operation of the original bistable to form this monostable?

To understand that, we have to take a closer look at capacitors. A couple of months ago we saw initially how capacitors worked, but to simplify things I did not discuss their operation in DC circuits. Well, now is the time to do so! Firstly, let's consider the capacitor in **Figure 12a**. The capacitor is connected to 0V at its lower end (hence the connection to the earth symbol). If we allow a constant current to flow into the top of the capacitor then obviously, the voltage across the capacitor will increase at a constant rate. This is shown by the voltage on the graph in **Figure 12b**. Now, we should remember that the capacitor will hold a charge, so if the constant current is now removed the voltage across the capacitor will be held constant. This is shown by the level voltage on the graph in **Figure 12b**.

Resistors And Capacitors

This whole process of applying a constant current then removing it can be approximated quite simply by connecting a series resistor to the capacitor, then applying a DC voltage, as in **Figure 13a**. It is not possible with such a simple circuit to produce a truly constant current, as you will see, but the following explanation of circuit operation will show you that the overall effect is close enough. Take, for example, the instant the DC voltage is applied to the circuit. The voltage across the capacitor plus the voltage across the resistor must equal the applied voltage ie:

$$V_{cc} = V_{cap} + V_{res}$$

Now, at this instant the voltage across the capacitor must be zero, so all the applied voltage must appear across the resistor ie:

$$V_{cc} = V_{res}$$

So, the current in the circuit is, from Ohm's Law:

$$I = V/R$$

and, because the voltage is at maximum the current is also at maximum. This is shown by the fact that the voltage across the capacitor (**Figure 13b**) begins to increase over the first part of the graph at a high rate.

After a period of time the voltage has increased across the capacitor so the voltage across the resistor must have dropped. Let's say the capacitor voltage, V_{cap} is 5V, then obviously the resistor voltage V_{res} must also be 5V. Because the current in the circuit is defined from Ohm's Law and is directly related to the resistor voltage then, if the voltage falls, so must the current. Also, because the current falls, so does the rate at which the capacitor voltage increases. You can see this on the graph in **Figure 13b** because the slope of the graph decreases as the capacitor voltage increases.

Finally, the capacitor voltage increases so much that the resistor voltage decreases to zero, and so no more current flows. At this point the capacitor voltage levels out on the graph in **Figure 13b** and remains constant.

So overall we have produced an effect similar to that in **Figure 12**. The process of gradually increasing a capacitor voltage is known as charging a capacitor and the circuit consisting of a resistor and a capacitor is known as a *resistor-capacitor (RC) circuit*. The curve of the capacitor voltage which such a circuit

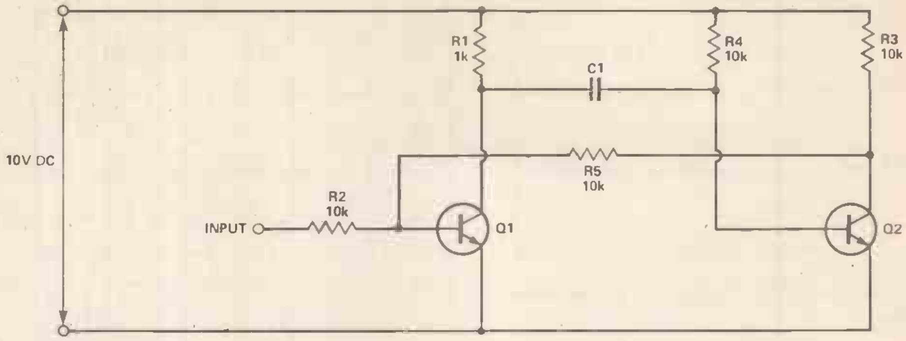


Figure 11. Monostable formed by two transistors connected by a capacitor.

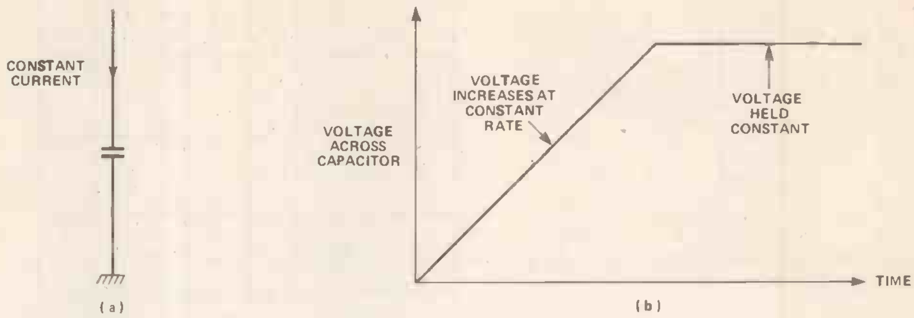


Figure 12. a) A constant current used to charge a capacitor b) Capacitor voltage when a constant current is applied then removed.

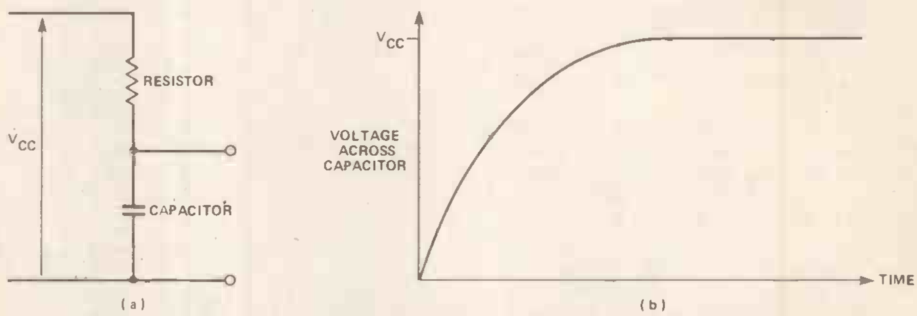


Figure 13. A practical approximation of Figure 12.

produces is known as an exponential curve and any combination of resistor/capacitor/applied voltage will produce an exponential curve of capacitor voltage — only the values of the graph areas would differ.

Likewise, we can take a charged capacitor and put a resistor in parallel with it to *discharge* the stored voltage. Of course, as current flows through the parallel resistor, the voltage across the capacitor falls, so less current will flow causing the voltage to fall at a slower rate. The curve produced and the circuit is shown in **Figure 14**. Again the curve is said to be exponential.

We've Got The Time

These two simple circuits are particularly useful because they both produce a time delay where their outputs occur a period of time after their inputs. And, the period of time is directly related to the charging (or discharging) current and the voltage across the capacitor: so increasing the value of either the resistor or the capacitor increases the time delay; and decreasing the resistor or capacitor value decreases the time delay.

The product of the resistor and the capacitor value is known as the time constant, t, and has units of seconds ie:

$$t = C \times R \text{ (in seconds)}$$

So, if a capacitor has a value of, say, 1uF and a resistor has a value of 1M then the time constant:

$$t = 1 \times 10^{-6} \times 1 \times 10^{6} = 1\text{s}$$

I have reproduced the graph of an exponential curve in **Figure 15** and marked some important points on the curve relating to the time constant. These are:

- at a time equal to 0.69t the capacitor voltage is at a voltage of 0.5 of its final voltage.
- at a time t, the capacitor voltage is 0.63 of its final voltage.
- at time 3f, the capacitor voltage is 0.95 its final voltage.

Although I have shown these values on an exponential charging curve, they are the same for an exponential discharge curve, just upside-down.

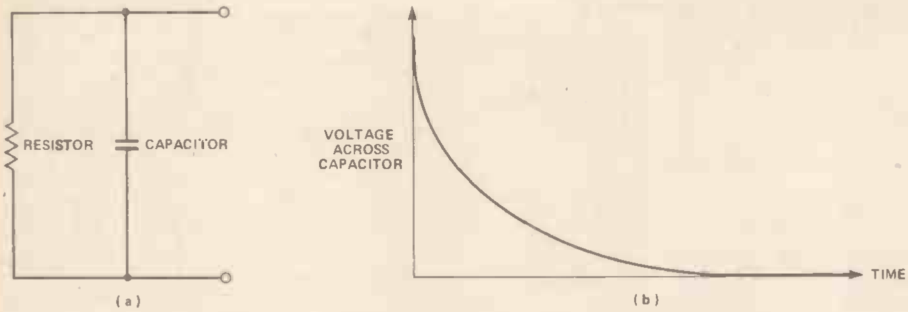


Figure 14. Discharging a charged capacitor through a parallel resistor.

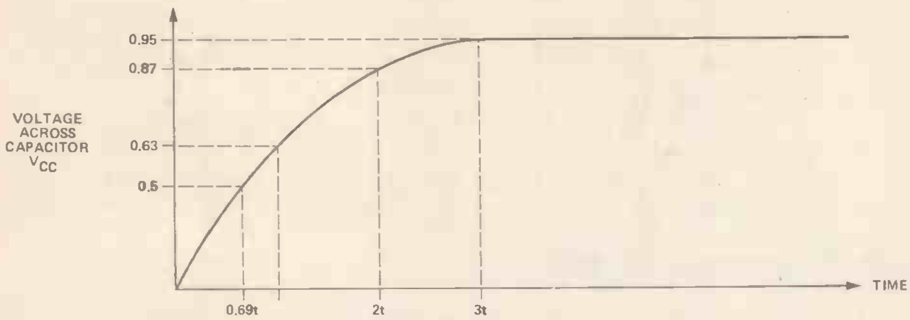


Figure 15. Important points on the exponential curve of a charging capacitor.

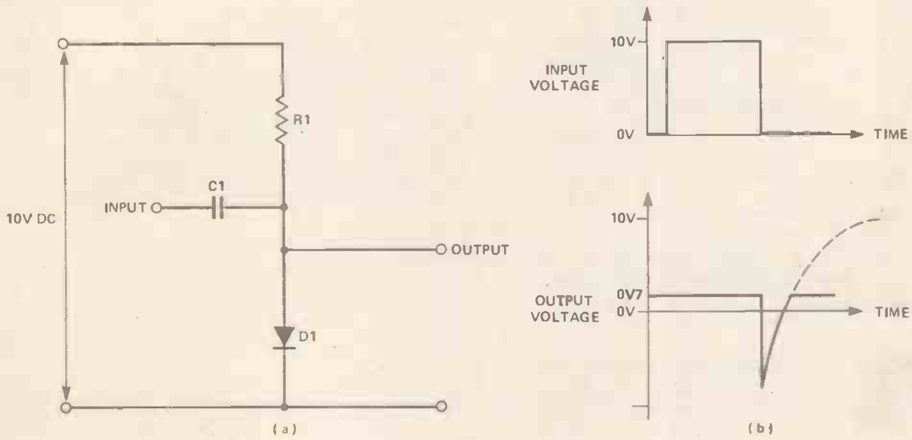


Figure 16a) Resistor/capacitor/diode (RCD) circuit b) Operating voltages of the RCD circuit.

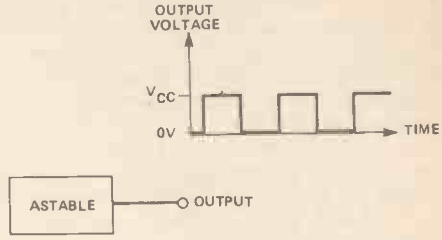


Figure 17. Block diagram of an astable.

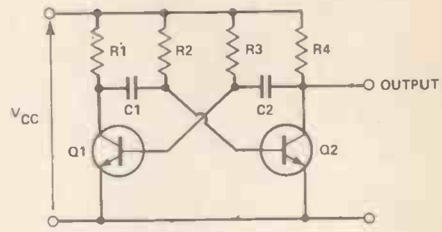


Figure 18. Astable formed by two transistors and two RCD circuits. The diodes of each RCD circuit are formed by the base-emitter junction of the transistors.

Now, before we go back to the monostable we have to add a further component to the RC circuit — a diode. **Figure 16a** shows this RCD circuit and **Figure 16b** shows the input and resultant output waveforms. Normally the diode conducts, holding the output voltage at 0V7. When a positive going pulse is applied at the input the diode current is increased by the amount of the capacitor charging current, but the output voltage remains constant at 0V7. However, when the input voltage falls from a positive value to zero the output voltage also falls (because there is nowhere a large discharge current can flow) from 0V7 to -9V3. A discharge current now flows through R1 and the output voltage follows an exponential curve towards the supply voltage; however when the voltage reaches 0V7 the diode once again holds the voltage constant.

Monostable Circuit

At last we are now in a position to understand the operation of the monostable circuit of **Figure 11**. Capacitor C1, resistor R4, and the base-emitter diode junction of transistor TR2 form an RCD circuit identical to **Figure 16a**. Normally therefore, transistor TR1 is held on by the base current through R4. The output of transistor TR2 is low, which holds transistor TR1 initially off. The collector of transistor TR1 is therefore high (ie, 10 volts) so the initial voltage across capacitor C1 is 9V3 (ie, 10V - 0V7).

When an input pulse is applied, transistor TR1 turns on taking the collector low. The base of transistor TR2 goes low by the same amount (because of the action of the RCD circuit), turning transistor TR2 off. As transistor TR2 turns off, its collector goes high and the loop (via resistor R5) holds transistor TR1 on. Once this occurs the original input pulse can be removed and transistor TR1 stays on until transistor TR2 turns on again. This will happen when the capacitor, discharging through resistor R4 allows the base voltage to rise high enough to gain turn on transistor TR2. The circuit will then return to its initial state.

You should be able to see that the length of time the circuit remains in its unstable state (ie, with transistor TR2 off) is totally dependent on the values of resistor R4 and capacitor C1.

The final circuit in this group of three is the *astable*: it has no stable states and constantly oscillates ie, changes, between the two logic states 0 and 1. The block diagram of **Figure 17** shows the basic action, and **Figure 18** shows how the circuit can be made using two transistors and two RCD time delay circuits. Each transistor turns on the next after the time delay of its RCD circuit and the whole process repeats itself indefinitely. The frequency of oscillation depends upon the time constants of the two RCD time delays so by varying resistor or capacitor values we can make the circuit switch as fast or as slow as we wish.

Linear Circuits

The other main group of semiconductor circuits consists of transistors operating only in their linear range ie, all input and output voltages are somewhere in between the two extremes of logic 0 and logic 1, so we call them linear circuits.

Simplest of these circuits was the final circuit of last month's All About Electronics: the inverting AC current amplifier — reproduced in **Figure 19**. If you remember (if not — why not?) the transistor amplifies an input current with a gain of β, up to a maximum collector current determined by the collector resistor R1.

As the emitter of the transistor is connected to the 0V supply rail (which is sometimes known as the common rail) the circuit is often called a *common emitter amplifier*.

Now, this circuit is very clever and useful but it does have one major drawback. Consider the case of a stereo high fidelity amplifier for example. Each channel of the amplifier is formed by such a circuit — obviously, I've oversimplified things somewhat here; no amplifier consists of a single stage but the effect is the same. Unless the transistor β of each channel is identical, one channel is always going to be louder than the other. And, even if two transistors with identical β could be found, it often happens that a transistor's β varies with time. Obviously this simple circuit is not acceptable as it stands. So what can we do to make it acceptable? Well, one simple way to to add a resistor between the emitter and common rail, as in **Figure 20**. In this way the emitter current, I_e, which equals the base current plus the collector current, flows through the emitter resistor, setting up a voltage across the resistor ie:

$$I_e = I_b + I_c$$

and,

$$V_{R4} = I_e \times R4$$

If we assume (because I_b can be neglected with respect to I_c) that $I_e = I_c$ and that $V_{R4} = V_{in}$ (actually there is 0V7 differance but that is close enough to show the principle!) then we can see that:

$$V_{out} = V_{cc} - I_c \times R1$$

and,

$$I_c = \frac{V_{in}}{R_4}$$

So,

$$V_{out} = V_{cc} - V_{in}\frac{R^1}{R_4}$$

Now, before going any further, let's consider the voltage terms here. V_{out} and V_{in} are the output and input AC voltages concerned with the circuit. But V_{cc} is the DC power supply voltage. We don't want to have to worry about this DC voltage and so to eliminate it from the calculation we add a component at the input and output which will block (ie prevent) all DC terms, but pass all AC ones. You will remember from earlier on in this series such a component is a capacitor (**Figure 21**).

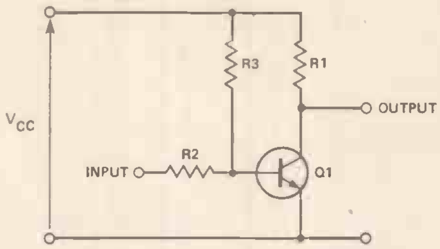


Figure 19. AC current amplifier formed by a single transistor.

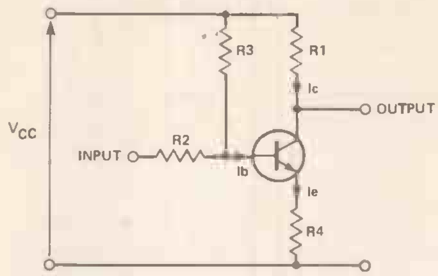


Figure 20. Common emitter amplifier with feedback.

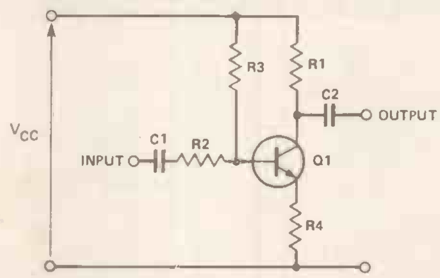


Figure 21. Common emitter amplifier with feedback and DB blocking capacitors.

Blocking the DC term, our relationship between input and output reduces to:

$$V_{out} = -V_{in}\frac{R1}{R4}$$

so the gain of the circuit,

$$\frac{V_{out}}{V_{in}} = -\frac{R1}{R4}$$

the minus sign indicates an investing function. That is, *the gain of the circuit now no longer depends on the transistor β, but on the simple ration between two resistors*. Thus, we can set the gain of the amplifier to whatever value we like (as long as the transistor operates within its linear range) simply by changing resistor value.

Feedback

Adding a resistor into the circuit so that the gain of the amplifier is related to the resistor value is known as adding feedback. Remember the term because you'll see a lot of it over the coming months. Feedback is one of the most important concepts in linear electronics and different methods of applying it in the various circuits we look at and discuss, allow the circuits to function in varied ways — not just as straightforward amplifiers for high fidelity amplifiers etc.

Another single transistor linear circuit is shown in **Figure 22**. Instead of the emitter being common to a power supply rail, this time the collector is, so we call this circuit a common collector amplifier.

The voltage at the emitter of the transistor, V_e, is the voltage at the base, V_b, minus the base-emitter junction voltage ie:

$$V_e = V_b - 0V7$$

The DC blocking capacitors remove all DC voltage terms, leaving us with the simple relationship:

$$V_e = V_b$$

in other words:

$$V_{out} = V_{in}$$

In this circuit, the transistor is a non-inverting, unity gain amplifier. The emitter voltage is said to follow the base voltage and so the circuit is often called an emitter follower. The current gain is however, similar to the common emitter amplifier. Emitter current is equal to the base current plus the collector current:

$$I_e = I_b + I_c$$

But

$$I_c = \beta \times I_b$$

so,

$$I_c = I_b + \beta \times I_b$$

$$= I_b(\beta + 1)$$

so the current gain:

$$= \frac{I_e}{I_b} = \beta + 1$$

As β is normally large (ie 50), the current gain can be considered to be β.

The resistance of the circuit's input (ie input voltage over input current) is obviously β times the output resistance. Actually, when dealing with transistors we normally are considering AC input and output voltages so instead of talking about input and output resistances we use impedances (remember from the August issue of Hobby Electronics, impedance can be thought of as AC resistance).

For these reasons, emitter follower circuits are often used as buffers, where a large current is required when only a small current output is available from a preceding circuit. The high impedance input ensures that the preceding circuit is not affected, or dampened, in any way by the low impedance output of the emitter follower.

All This And Many More

There are many, many more transistor circuits, digital and linear, logic and amplifiers — far too many to discuss in any more detail than we've covered so far — and far too many to be able to discuss them all. But, being transistor based, their functions and operations are similar to the circuits we've already looked at. One or two more such circuits will crop up, no doubt, over the next few months, but even then we won't be considering them in any depth. We know as much about the basics of semiconductors as we need to know and any more circuits we look at will only be considered in terms of the job they perform rather than the way they perform it.

In this way we can look at very complex circuits and yet know how to use them without having to calculate how every part of the circuit works before being able to use it. From now on we will consider the action of circuits in block diagram form only, without going down to component level. We have already seen an example of this in the logic gate symbols of **Figures 4 and 8**. Although we know that transistors and other components form the actual circuits of say a NOR gate, we don't have to know what families of components are involved at all to understand circuit action: the block diagram (ie, circuit

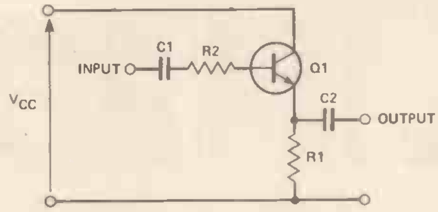


Figure 22. Common collector amplifier (emitter follower) formed by a single transistor.

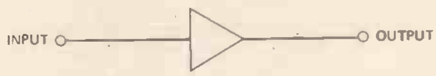


Figure 23. Symbol of a non-inverting amplifier.

symbol) is all we used. Another example is shown in **Figure 23** of a non-inverting amplifier. The symbol is similar to the inverter of **Figure 4** but of course without the inverting ring on the output. Both circuits are, in fact, buffers — hence the triangular shape which is used in both digital and linear circuits.

This method of using block diagrams to stand for a complex circuit is enhanced by the use in electronics of integrated circuits (ICs). ICs are simply a collection of individual components formed in a circuit in a single body. Often, the circuit within the body is not complete and a few separate components — perhaps a couple of resistors or capacitors need to be connected to it to make it work. In this way the IC can be a general purpose but the addition of a few specific components can define the exact operation of the complete circuit.

Most ICs are constructed so that all connections to and from the circuit are made via legs on each side of the body, in two rows. For this reason the shape is classified as being dual-in-line (DIL). The individual legs of each row are 0.1 in (2.5mm) apart and the rows of the legs are 0.3in (7.5mm) apart. These dimensions are standard for most ICs with up to about twenty legs: above that the body size increases so that the rows of legs are 0.6in (15mm) apart.

With present miniaturisation techniques the circuits involved, (linear or digital), in some types of IC can be very complex. For example it is common to have an IC with a hundred or so transistors within its body. Some of the more recently introduced ICs have thousands, and in fact, some ICs have as many as 100,000 transistors in the one body.

Will it ever end?

HE

BUYLINES

Para-Q

A full kit of parts for the Para-Q parametric amplifier is available from **Digisound Limited,** 14/16 Queen Street, Blackpool, Lancs FY1 1PQ, priced at £8.50 for a single unit and £8.15 for additional units ordered at the same time.

The price includes postage, packaging and VAT, and the kit includes the PCB and all the components shown in the Parts List.

A case for the Para-Q has not been specified, since the system is expandable to as many boards as are needed for a particular application. For most situations a standard ABS plastic box would be suitable, but a metal box should be used if noise or hum is a problem, eg if a mains power supply is used and located close to the Para-Q unit.

Dual PSU

All the components for the unit are easily obtained and shouldn't pose any great problems. The case for the prototype, a plain aluminium box, was from **Greenweld Electronics,** who can also supply most of the other components. The transformer, however, can be had from either **Ambit, Rapid** or **Watford Electronics.**

Interior Light Delay

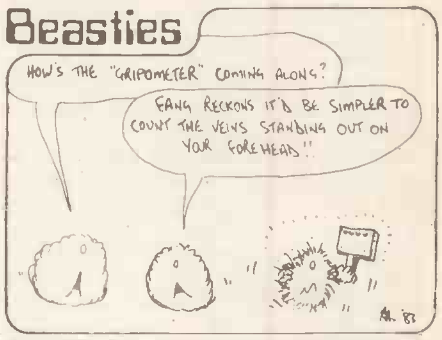
A little persistence, possibly even some ingenuity, might be needed to obtain the low value resistors used in this project. The only other unfamiliar component is the 1N916 diode, a low capacitance version of the better known 1N914. It should be used for preference, and is stocked by **Maplin Electronics,** who can also supply the hard-to-find resistors. Note that although R5 is listed as 100 ohms, 2.5 watts wirewound, any type of 100R resistor rated at better than 2.5W will suit, though the higher wattage types may not fit neatly on the printed circuit board.

Windscreen Wiper Delay

Several unusual type numbers are in the parts list for this project, but most of them are stocked by major retailers.

The exception is D3, the MR751 diode; no direct equivalent for this device has been found however a similar type, the MR752 can be ordered from RS components through your local supplier. Alternatively type R250B, stocked by **Watford Electronics,** meets the required specification of 6A forward current and 100V maximum reverse voltage, and is a PCB mounting type. Other 6A diodes are available, but most are stud mounting and therefore not suitable for the PCB design.

All other components are also available from Watford.



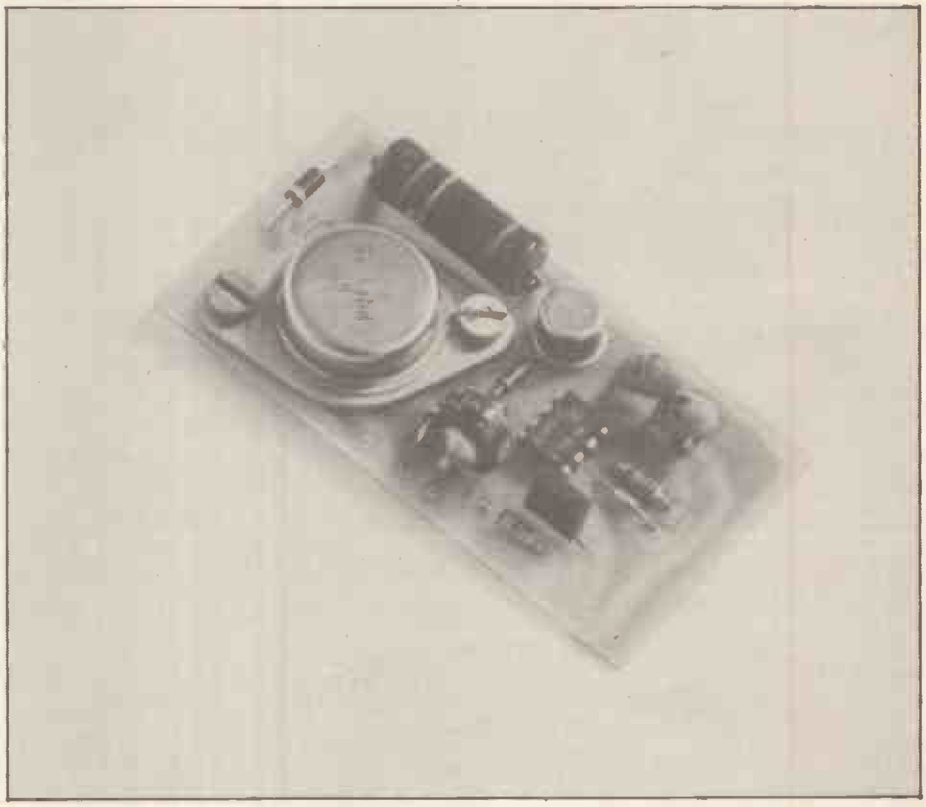
THIS UNIT is suitable for all negative earth single or dual speed wipers. It is designed to replace the slow speed with a delayed-action wipe of between zero and 30 seconds. The delay is controlled with a potentiometer either on the dash or steering column, and the unit is switched on using the existing wiper switch. The fast and single shot functions (if fitted) are not affected by this circuit.

Connection of the unit is quite simple, involving only the breaking of the original slow speed connection to the motor and making connections to each side of the break, to the park switch and a suitable ground. This is all shown in the circuit diagram

WINDSCREEN WIPER DELAY

Tony Scragg

A minimum modification accessory for motors, this unit suits all negative earth cars and provides wiper delay times of between zero and thirty seconds.



Wiped Out

In order to understand how the delay circuit works it will be helpful to describe the normal function of the wiper circuit. A dual speed circuit is described, as fitted to almost all modern cars. However single speed wipers are functionally the same; just ignore the fast speed circuitry. Single wipe facilities are provided by biased switch action to the slow speed setting.

Figure 1 shows the circuit diagram of the wipers. It can be seen that there are three electrical components: the motor itself; the park switch, which is enclosed inside the motor casing; and the control switch on the dashboard or stalk on the steering column.

The motor has three connections: common connected to ground, and two power connections, one for each speed. The park switch is also part of the motor assembly and its function is to ensure that the wiper blades stop (park) in the correct position. The contacts are changeover type; the centre contact is grounded at the correct park position, but otherwise is connected to the supply.

Overall control of the wipers is produced by the driver operated switch. Initially this is in the park position and the wipers are also parked and in this state the motor is shortcircuited to ground. When either operating speed is selected the motor is powered directly through the switch and operates continuously. When the switch is returned to the park position, power is supplied via the 'run' contact until the park position is reached; then the motor is again shorted out and the wipers stop. By shorting the motor, its back EMF causes dynamic braking of the wipers so there is less overshoot.

When delayed wipers are installed the slow continuous running connection is interrupted and replaced by a momentary action switch — in this case a transistor switch. A simple timing circuit generates a pulse to drive this switch, providing current until the park switch contacts change over and the 'run' contact then provides the current. A diode is required in this supply path to stop the switching transistor initially shorting to ground through the park switch (D3, in the complete circuit diagram). Both the switching transistor and the diode must have high power ratings because the transistor must handle the motor starting surge current while the diode carries the motor current for most of the "wipe".

The original wiper connection is used to provide power for the delay circuit, as can be seen from the circuit diagram.

Circuit Description

The circuit is based on the 555 timer IC, connected in the astable mode. The timing capacitor, C2, is charged through R1 and discharged through RV1, giving the variable rate. The output of the 555 drives Q1 and Q2

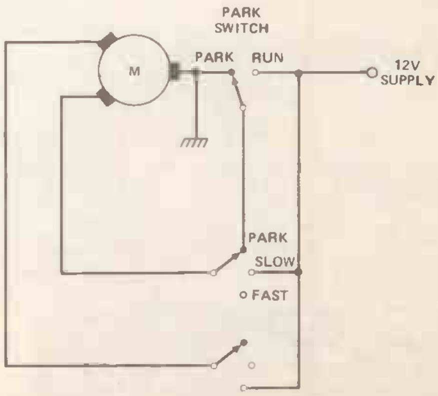


Figure 1. The wiper control circuit shown is conventional on most makes. The Delay unit is installed in the 'slow speed' circuit, but slow wipe is still possible by turning the delay to zero.

Parts List

RESISTORS
R1 .... 10k
¼ watt
R2 .... 100R
½ watt
R3 .... 330R
½ watt
R4 20R
2.5 watt wirewound

POTENTIOMETERS
RV1 .... 1MR
linear carbon

CAPACITORS
C1, 2 .... 47u 16V
tantalum
C3 .... 100n
ceramic

SEMICONDUCTORS
IC1 555
Q1 .... BFY51
Q2 .... MJ2995
ZD1 .... BZY88C9V1
D1 .... 1N916
D2, 4 .... 1N5401
D3 .... MR751

MISCELLANEOUS
PCB; optional case; wire, solder, nuts and bolts etc.

BUYLINES .... page 34

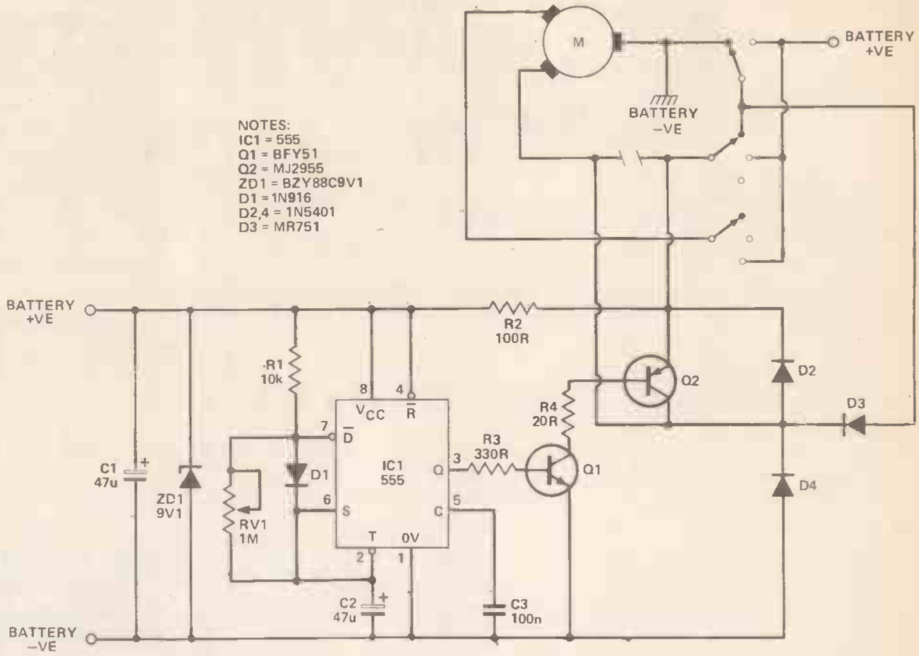


Figure 2. The circuit uses a 555 timer in the astable mode to provide the delay function. The unit is connected into the slow speed wiper circuit at the points indicated by the breaks.

which effectively perform the function of wiper on/off switch. The 555 output pulse is just long enough to move the wiper motor, causing the park switch to change over. The motor current then passes through D4 until the wipers are again in the park position. The armature is then shorted out by D3.

Diodes D2 and D4 provide clamping to protect the output from the inductive motor load. R1, D1 and C1 provide a simple regulated power supply for the 555, giving protection against the noise on the car battery and possible high voltages — above the maximum for the 555 — under faulty charging conditions.

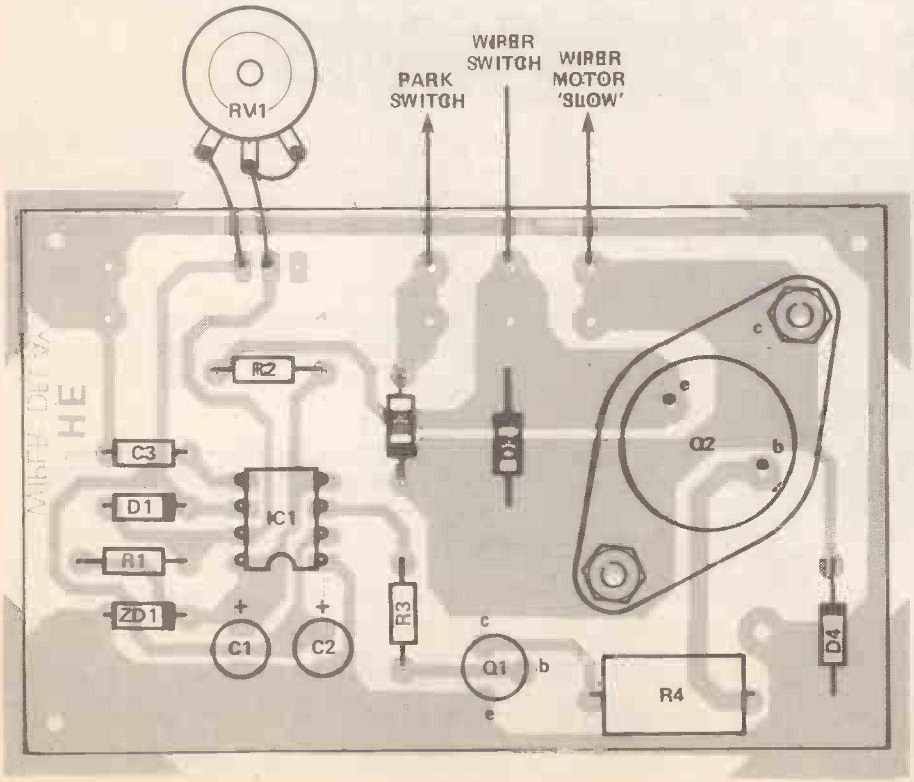


Figure 3. All components are mounted on the PCB except the control potentiometer, which can be mounted on the dashboard or steering column.

Construction and Installation

Construction is fairly straightforward as all components are mounted onto the PCB. The power transistor must be bolted down using metal nuts and bolts as this forms the electrical connection. Once assembled the board is enclosed in any small box — as the unit will be housed out of sight appearance is not too critical — with flying leads used to make connections with "chocolate block" type connectors. Three connections are required to the wiper circuit: the first step is to locate the wires concerned, either by consulting the workshop manual and comparing the circuit diagrams, or with a multimeter. If the latter approach is chosen set the multimeter to measure 12V and with the ignition on, operate the wipers. The slow speed connection will be at 12V as long as the wipers are operating; the park switch connection will have momentary 0V pulses in the level at the park position. Having located the correct wires, connections are made a per the circuit diagram; additional connection is required to a convenient grounding point. The potentiometer speed control connections are then made, having first found a convenient place to mount it within easy reach when driving!

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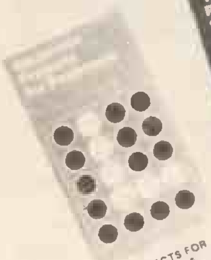

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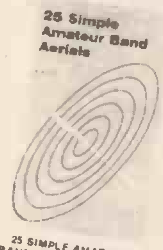

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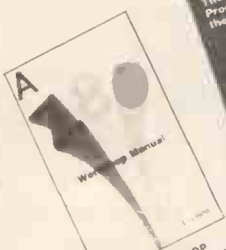

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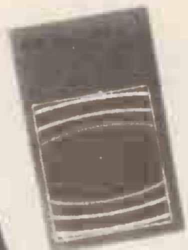

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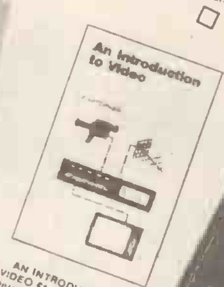

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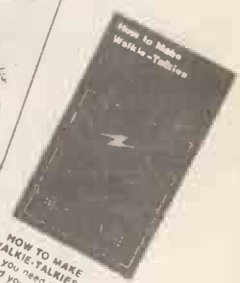

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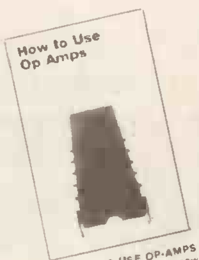

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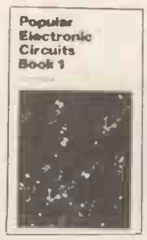

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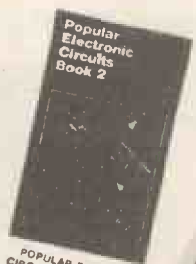

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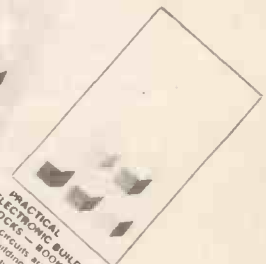

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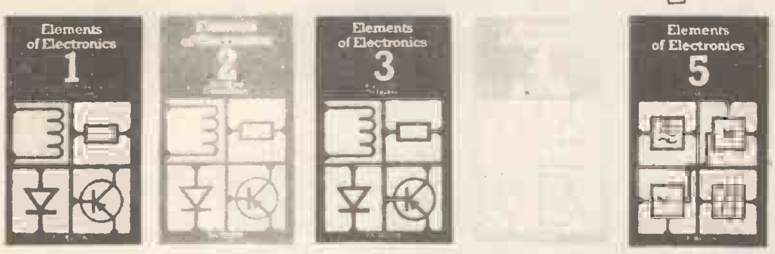

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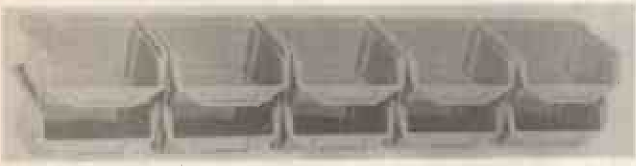

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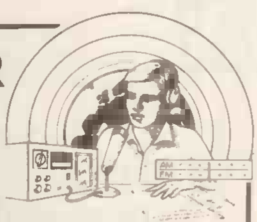

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FORWARD BIAS

Questions, answers and errata from readers and writers.

HE Auto-Tester

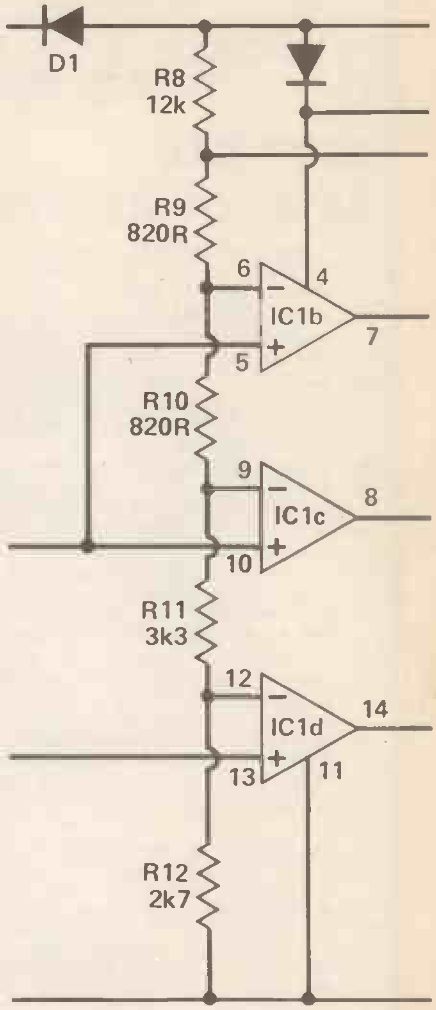
A number of errors have come to light in the circuit diagrams and in the PCB component overlay for this project, which was published in May, 1983.

On page 29 in **Figure 1**, the main circuit diagram, "R8" should read "R9" and "R9" should read "R8". R12, 2k7 was omitted from the circuit; it should have been shown connected between pin 12 and IC1d and the OV rail.

In **Figure 3** on the same page, "LED4" should read "LED3", and in the text, the voltage referred to on the last line of the second paragraph under the heading "Resistance" should be 1V2, not 1V3.

On the PCB overlay, **Figure 6** on page 30, "LED2" should read "LED4" and "LED4" should read "LED2". The polarity of the LEDs were not indicated, but are shown below along with the ocrrected diagrams of **Figure 1** and **3**.

The printed circuit board is otherwise correct and there should be no further difficulty experienced by constructors of this versatile project for the motorist.



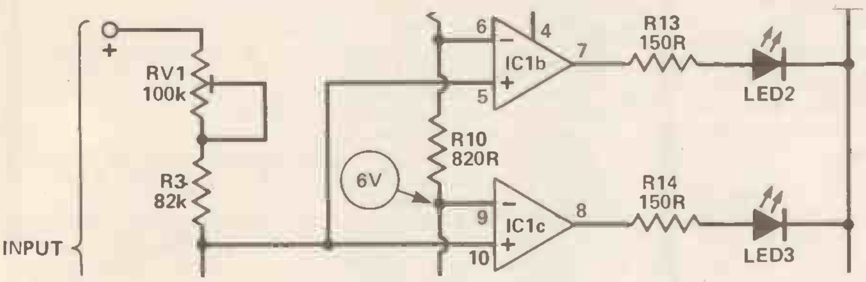


Figure 3

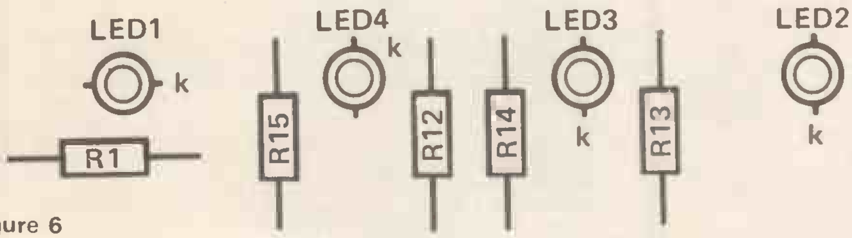


Figure 6

COLLECTED BOOBS

Continuing excerpts from the Hobby Electronics Errata Box

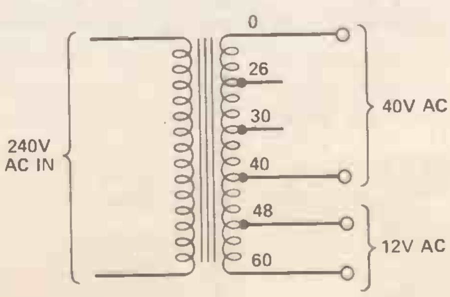
Infra Red Remote Control
(HE February '80)

On page 32, the last paragraph of the second column of text should read: "(1) The EARTHS of the main input and output cables . . .", NOT the neutrals as this would be very dangerous.

Figure 2: R4 should be 1k0, not 1M0. The **Parts List** is correct.

5080 PSU Module
(HE March '80)

Buylines (page 20) the transformer in our offer is now sold out. However, the Marshalls catalogue (1979/80) had a transformer type no. MT126FT which was suitable, using the 0-40 secondaries for the high voltage supply and the 48-60 secondaries for the low voltage supply as shown here.



Another solution is to use two transformers: one 0-12V @ 100mA and one 20-0-20V @ 1A or 2A as required.

Electronic Ignition
(HE April '80)

In **Figure 1**, on the secondary of T1, the OV tapping should be connected to the +V line immediately below.

In **Parts List**, the high voltage capacitors used have proved difficult to obtain in some places. Two replacements are suggested: the B32562 470n and B32562 1u0.

Rv1 should be 100k.

Speed Controller
(HE April '80)

In the **Parts List**, 3BR should read 33R, C1, 8 should be 100n and not 100u, and C2 should also be 100n.

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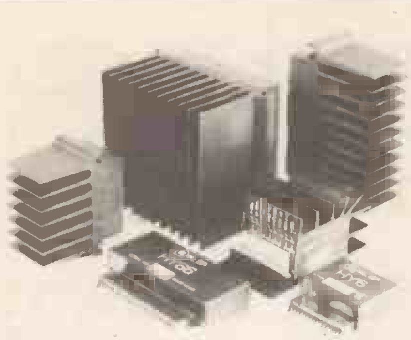

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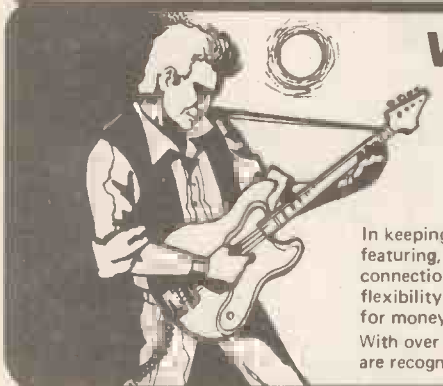

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HY368	180	8	0.01%	<0.006%	± 60	120 x 78 x 100	1030	£38.41

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HY73	Guitar pre amp	Two Guitar (Bass Lead) and Mic + separate Volume Bass Treble + Mix	20mA	£15.36
HY78	Stereo pre amp	As HY66 less tone controls	20mA	£14.20

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MOS 248	120	4-8	<0.005%	<0.006%	± 55	120 x 78 x 80	850	£39.86
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Slew rate: 20v/μs. Rise time: 3μs. S/N ratio: 100db
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Very easy to use.

Robust construction. **£9.14 (inc. VAT)**

Mounts anywhere in car.

Automatic switch on.

Output power maximum 22w peak into 4Ω
Frequency response (−3dB) 15Hz to 30KHz, T.H.D. 0.1% at 10w 1KHz
S/N ratio (DIN AUDIO) 80dB, Load Impedance 3Ω
Input Sensitivity and impedance (selectable) 700mV rms into 15KΩ 3V rms into 8Ω.
Size 95 x 48 x 50mm. Weight 256 gms.

C1515
Stereo version of C15. **£17.19 (inc. VAT)**

Size 95 x 40 x 80. Weight 410 gms.

POWER SUPPLY UNITS (Incorporating our own toroidal transformers)

Model Number	For Use With	Price inc. VAT
PSU 21X	1 or 2 HY30	£11.93
PSU 41X	1 or 2 HY60, 1 x HY6060, 1 x HY124	£13.83
PSU 42X	1 x HY128	£15.90
PSU 43X	1 x MOS128	£16.70
PSU 51X	2 x HY128, 1 x HY244	£17.07

Model Number	For Use With	Price inc. VAT
PSU 52X	2 x HY124	£17.07
PSU 53X	2 x MOS128	£17.86
PSU 54X	1 x HY248	£17.86
PSU 55X	1 x MOS248	£19.52
PSU 71X	2 x HY244	£21.75

Model Number	For Use With	Price inc. VAT
PSU 72X	2 x HY248	£22.54
PSU 73X	1 x HY364	£22.54
PSU 74X	1 x HY368	£24.20
PSU 75X	2 x MOS248, 1 x MOS368	£24.20

Please note: X in part no. indicates primary voltage. Please insert "0" in place of X for 110V, "1" in place of X for 220V, and "2" in place of X for 240V.

ILP Electronics Ltd., DEPT 5 Graham Bell House, Roper Close, Canterbury CT2 7EP, Kent, England.
Telephone: (0227) 54778 Technical (0227) 64723. Telex: 965780.

This is the Great Hobby Electronics Computer-Controlled Model Railway COMPETITION

Sponsored by Oric Products International Ltd., Beatties of London Limited and ASP Software (a division of Argus Specialist Publications Ltd.).

WHEN it was proposed that there should be a Grand Computer Controlled Model Railway Competition for the 1983 Breadboard exhibition, we rapidly became bogged down with seemingly endless complications. We spent most of the time during discussions simply explaining jargon: what, to a computer hardware man, is a "dead frog"? Something unpleasant by the roadside, was the popular answer! On the other hand our modelling consultant was somewhat bemused by the many acronyms that punctuate conversations between computer buffs: who, or what is a PIA? Bits of what? What is a multiplexer, and so on, and on, and on . . . !

In the end we were all quite bewildered — but this confusion ultimately gave us the clue to our Computer Controlled Model Rail Competition: no one, it seems, truly knows how best to marry a computer to a complex model rail layout or what it should do and, particularly, how it should be done.

We decided, finally, that the simplest and best approach would be to throw the thing wide open, with only a few essential restrictions. The only rule of the competition, then, is that the winning entry will be that which demonstrates the most ingenuity, usefulness and practicality in adapting a modern home computer to control a model railway layout — the what, how and why we quite happily leave to our readers!

The essential limitation we felt obliged to impose is that the layout should measure no more than 6ft by 2ft — in other words, something that can be transported to the Breadboard exhibition in Hammersmith in late November this year.

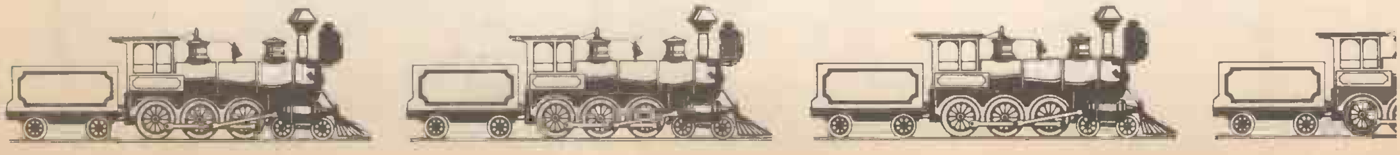
We anticipate that most of the entries will be from constructors who have an existing computer interfaced layout, but the competition is open to all comers so anyone who wants to "have a go" will be welcome in the lists. For the benefit of those who fancy their chances at the Grand Prize, here are a few ideas that resulted from the meeting of the minds in Hobby's editorial offices (we won't mention the ideas that evolved later, down at the Royal George!).

- A fairly simple software application would be to write a program for storing and modifying timetables and operating schedules; an extension of this idea would be an interface to position sensing circuits so that an operator would know not only when the next train was due to leave, but also when it was safe to start down the track.

- One of the most obvious ideas proposed was to program a mimic board which could show not only the track layout but the condition of signal lights and with 'train in section' indication: colour would be necessary for user-friendliness!

- Ways to adapt microprocessor technology to model train control: one option that might be easily constructed would be to computer-control sections of track rather than individual trains. However completely automatic running is not the goal of most railway modellers, so any system should allow lots of room for the operator to control the layout himself.

And that is about the limit of the ideas we came up with before brain fog set in. We'll leave it to the inventiveness and competitive spirit of our readers to stun the judges with brilliant projects we should have thought of . . . but didn't!



1 FIRST PRIZE

Hot off the production line, an Oric 48K colour computer, donated by Oric Products International Ltd.

2 SECOND PRIZE

Gift vouchers to the value of £50, redeemable on model rail products at any Beatties of London shop.

3 THIRD PRIZE

£25 worth of games and utility program tapes from ASP Software.

Entry forms, together with an entrance fee of £1.00 (cheque or money orders only, please) should be sent to: **The Exhibition Manager, BB83, ASP Exhibitions, 145 Charing Cross Road, London WC2H 0EE.** Closing date is 31st October 1983. Judging will take place at Breadboard '83, Cunard Hotel, Hammersmith, London W6, on either Wednesday 23rd or Thursday 24th November 1983. Entrants will be informed of the day on which they will be required to present their layouts at the exhibition. Finalists will be asked to demonstrate their layouts at some time(s) during the open days of Breadboard '83 (25, 26, 27th November) and layouts will be available for collection between 1600 and 1800 hours on Sunday 27th November. **The judges decision will be final and no correspondence will be entered into.**

Entry Form

PLEASE USE BLOCK CAPS

NAME: ....

ADDRESS: ....

....

TEL NO: .... AGE ON 30TH NOV. 1983: ....

BRIEF DESCRIPTION OF LAYOUT AND FUNCTIONS: ....

....

....

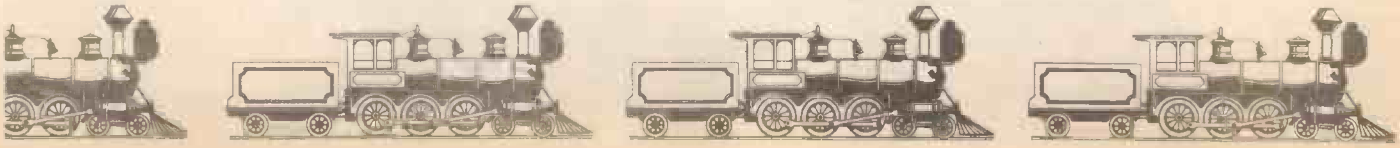
....

SCALE: .... SIZE OF LAYOUT: (MAX 6FT X 2FT): ....

COMPUTER USED: ....

COMMERCIAL PERIPHERALS USED: ....

....



READER'S PROJECT

Simple, untested circuits straight from Hobby readers.

STEREO PREAMPLIFIER

P. R. Pullin

THIS CIRCUIT was designed for a friend who recently up-graded his stereo cartridge from ceramic to a magnetic type — with disastrous results! He could get no more than a whisper from his amp.

What he needed was a simple stereo preamp to boost the 5mV output from his magnetic cartridge up to the 100mV input that the amplifier expected to see.

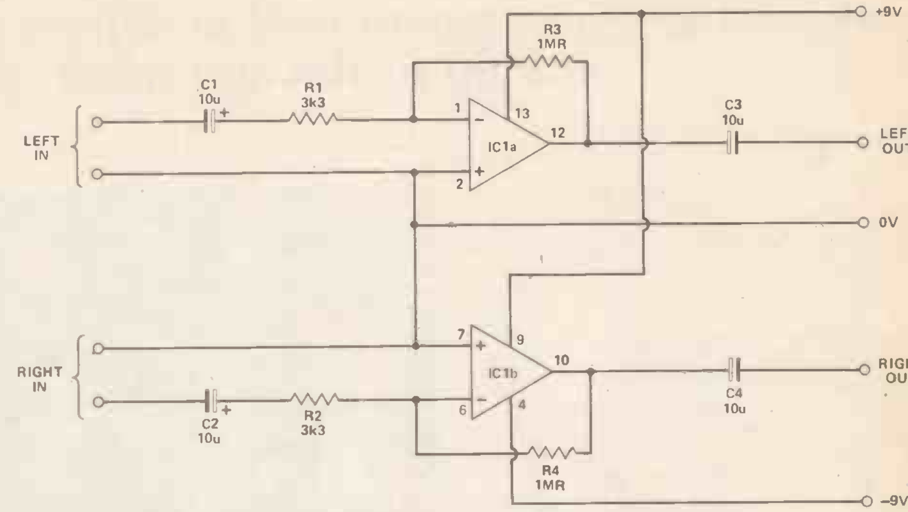


Figure 1. The circuit: a simple stereo preamp used for boosting a magnetic cartridge.

The Circuit

The ever-faithful 747 op-amp (a dual 741) proved well suited to the task. Each input is buffered with a 3k3 resistor, as the magnetic cartridge impedance is approximately 47k. The negative feedback provided by a 1MR resistor gives each channel a gain of around 20.

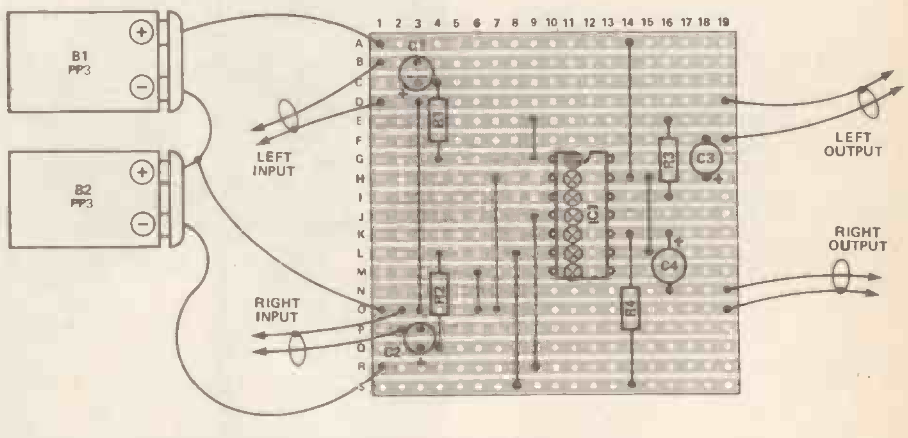


Figure 2. Careful use of screened cables for all inputs and outputs when constructing the Veroboard will keep undue noise out of the system.

Construction

Veroboard was chosen for this project because of its simplicity, and the layout was arranged so that there are no track breaks other than those between the IC pins. Axial electrolytic capacitors are used and fit quite snugly across the input. Screened cable must be used for all signal connections to reduce the noise to acceptable levels.

The original unit is in daily use, and performs quite satisfactorily. It is also suitable for other situations which require a low level signals to be boosted.

Parts List

RESISTORS
(All ¼ 5% carbon)
R1, 2 .... 3k3
R3, 4 .... 1MR

CAPACITORS
(All axial electro)
C1, 2, 3, 4 .... 10u 35V

SEMICONDUCTORS
IC1 747
dual 741 op-amps

MISCELLANEOUS
Veroboard, 2 x PP3 batteries; screened cable; wire, solder etc.

BUYLINES ....**page 34**

CAREERS IN ELECTRONICS '83

Hooked by home computers, many enthusiasts want to make microcomputers their career. Here, an expert looks at the employment field and finds that the micro is only the tip of the computer iceberg

Angela Sharp

THE MICROCOMPUTER is perhaps the most obvious manifestation of the electronics revolution. It can be bought by anyone with £50 — or less — to spare; it appears in businesses large and small, and games and business applications can be programmed by anyone with logical ability and a knowledge of BASIC. It is therefore not surprising that many people express a desire to 'work with micros'.

Perhaps you've started to think about getting a job which combines your interest in electronics and in micros. What opportunities lie open to you, and what are the relevant courses?

For those of you who want courses which train you in basic electronic theory and practical assembly/repairing skills, there is

- CSE/O or A level electronics, preferably with those highly desirable additional subjects, maths and physics;
- City and Guilds 224, 225 or 232;
- TEC qualifications up to Level III
- A Youth Training Scheme, perhaps with a manufacturer or dealer handling computers or electronic office equipment;
- an ITEC (Information Technology Centre).

Flexibility

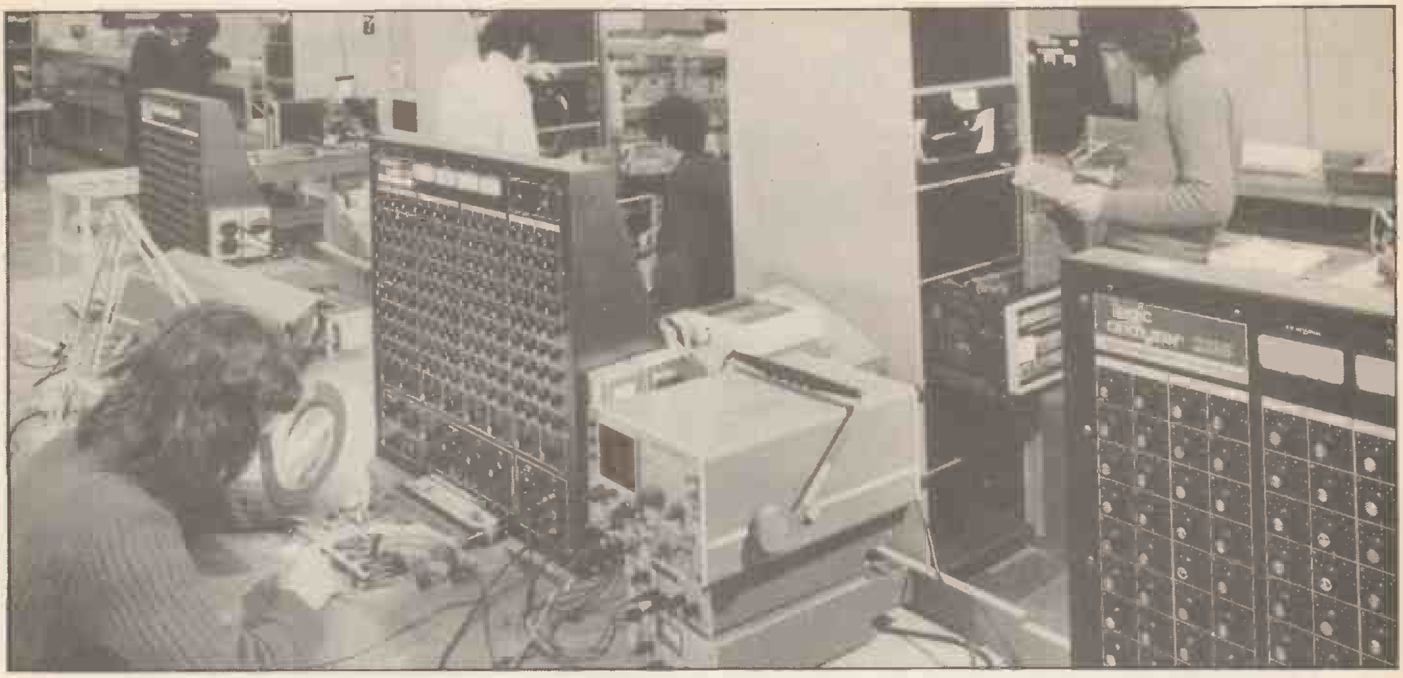
Youth Training schemes and ITECs are very new, and not much information is yet available about what happens to people when they leave and seek electronics work. However it seems likely that they will face the same problems as people with the other qualifications listed above:

- automation, which is affecting the more basic hardware jobs, especially in computer manufacture, but also in testing and repair. And some of the most successful computer manufacturers are the most highly-automated, with computerised assembly systems and cheap, easily-replaceable components and lots of diagnostic software to speed up and simplify fault identification:
- transferability from other areas of electronics, sometimes for the same reasons listed above.

Therefore, to get your own foot in the door, your keyword will have to be flexibility. You will have to be flexible in three ways:

- by considering electronics jobs other than those concerned with microcomputers. This is especially true if you are a 100% hardware person, happier repairing something behind the scenes than coping with a problem out front with a customer;
- by considering other jobs with micro computers. These are interesting to people whose prime interest is micros, and who have a broader range of talents and skills, notably in dealing with people and in programming;
- by facing the fact that you may have a period of unemployment between the end of your course and finding the job of your choice. Employers now accept this — and they are interested in how you have used your enforced leisure. Therefore you should be making contingency plans for good use of your time, and hopefully offer further relevant training or experience leading to your real goal.

Looking at jobs with micros, microcomputer manufacture is the smallest



For anyone with electronics qualifications or experience, the testing, installation and repair of computers is a field with varied opportunities.

area of employment. Many micros are manufactured abroad, or by highly automated methods. Assembly jobs in the routine sense are nowadays few and far between; there may be testing and quality control jobs, but, again, at the routine, mass-production level these have been automated, and the larger manufacturers are likely to require just a small number of more highly qualified people. Perhaps the brightest hopes in this area lie with the small, specialist manufacturer, producing one-off jobs to order — for example, computerised typesetting keyboards for use in the printing industry.

More Opportunities

Things get better at the installation and repair stage because the number of microcomputer suppliers and dealers, who are the main employers of installation/repair people, far exceeds the number of manufacturers. The main problem here is that of competition from people who gained their training in other electronics areas. However, because of the "all-round" nature of many micro jobs, many employers are also seeking to establish a team with a good mix of backgrounds so don't give up hope!

Perhaps the best chance of a first job here lies with your high street computer shop — it is easy to spot, and is likely to sell the domestic micros and smaller business micros. The more up-market micro suppliers, selling larger, more expensive business micros and operating out of prestige office premises, are more likely to recruit installation/repair people at a higher level, or with relevant experience.

A micro dealer/supplier may sell its own product and associated software, but it is more likely to have franchises for the sale and post-sales support of one or several other micros. (When you are being interviewed for a job, the dealers should be able to tell you immediately which products they handle, and the extent to which indepth or only basic hardware and/or software support is offered.)

If, as is likely, the dealer is a small company, employing for example less than twelve staff, this will have four basic effects on your working conditions:

- pay is likely to be lower than starting rates with larger micro dealers. It may not even be stated in advance, since the employer may prefer to look at different levels of people available before deciding;
- qualifications are likely to be flexible, ie the employer is open to consider anyone with the basic interest, knowledge and experience in electronics. This could be through any one of the courses listed above, or through related experience.
- varied work, including everything from packing and unpacking micros, delivering them and carrying them up the stairs, to loading software and checking it through. The employer is above all looking for someone willing to do the basic jobs, with the potential to pick up quickly, and largely through your own efforts, the hardware and software product knowledge.
- a probationary period. Since the employer has no way of knowing in advance whether you are quite as willing to carry heavy crates and make the tea as you claimed you were at the interview, and since (having asked only for a general and pretty basic electronics background) he/she has no way of telling whether you really can take it in and apply it, this probationary period is of crucial importance.

  Smaller employers tend to take people on after a fairly cursory glance at the interview, and to fire them equally quickly after the first few weeks if they do not appear to 'have what it takes'. So don't be too depressed if this happens to you — regard it as a learning-experience which will help you to redefine your own aims.
- and finally, training: the smaller the company, the more your training will depend on your ability to pick things up from other people as you go along, and to find things out for yourself. Only the larger micro suppliers can afford off-the-job courses, or self-instruction packages.

Extra Strengths

The variety which is an essential part of micro-installation/repair jobs means that employers are looking for people with strengths in two areas besides electronics: social skills and software.

You need a pleasant manner and the ability to explain things, because you will have to keep a customer informed about what has gone wrong, what you are doing about it and the likely time he/she will have to wait before the computer is up and running. You may also find yourself training the customer in how to use the software packages that you have loaded.

Some employers can actually foresee ways in which you would be expected to do some programming. Others express a preference for programming knowledge (ideally in high level and assembler languages) so that you have a good general appreciation of the computer and how things can go wrong.

And one final essential for installation/repair work is a current driving licence. Ideally, you should have one before you start to look for jobs, because it will increase the range of possible employers. Otherwise, as soon as you are employed, get one as soon as you can. Without it, you will always be dependent on colleagues, and small companies cannot, quite literally, afford passengers!

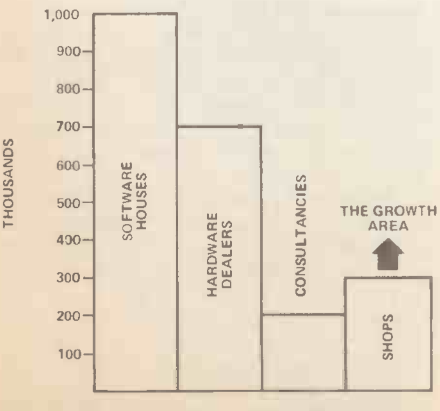
Saleing Away

If you do not get into installation and repair, but if this is your ultimate ambition, then micro sales is the next best choice. Hardware knowledge is always useful when selling micros (especially when selling components to home built-it-yourself enthusiasts).

The graph, below, shows the approximate number of employers in the UK which in various ways sell micros. A software house lays the greatest emphasis on writing programs, but also supplies hardware; a hardware dealer lays greatest emphasis on fast sales of business micros to companies, accompanied by software packages, but offering less support than a consultancy.

However, the greatest growth area is the shops, where retail groups of all descriptions are getting in on the micro scene — starting with home micros but usually with plans to sell business micros eventually. Selling domestic micros while working as a sales assistant for a well-known chain of chemists or stationery shops may not sound very exciting — but it is always worth asking what their long-term plans are. These could include the opening up of quite separate computer sales centres, and they could be recruiting their basic sales staff with a view to transfer and training in this specialist area.

Sales support includes pre-sales support and post-sales support. Pre-sales support comprises everything that has to be done up to the time the sale takes place — from helping to organise advertising, answering enquiries coming in as a result of advertising, and arranging demonstrations. It is essentially an office job, holding the fort while sales staff are visiting customers. You need a very clear, confident telephone manner for everything from straightforward booking of appointments, to giving out detailed product information and even 'cold canvassing'



Graph: Approximate numbers of micro suppliers in the UK in 1981.

Microcomputer wares in a large electronics store which also deals in hi-fi and other home entertainment equipment.

Setting up and running demonstrations may be part of the job of selling microcomputers.

— telephoning companies out of the blue and interesting them in your products. Pre-sales support leads usually to sales work.

Post-sales support includes everything that has to be done to deliver the product and get the customer up and running. It really means the most basic tasks in the installation work already described and can lead to full installation/repair.

"Hands On"

The two final areas of work with micro computers are as a user and a programmer. Both would require a considerable switch of interest from someone starting from the electronics side.

The essential point about micro-user jobs is that the micro is just a sophisticated aide or tool in a job which already existed before. Scientists, office workers, professional people and technicians of all kinds from lawyers to architects all have micros and relevant software available for their specific needs.

Some users do, however, do their own programming — either extensively, or carrying out simple amendments. Nevertheless the first-entry job is nearly always as a user. Therefore you will need qualifications which realte to that user-job, plus a course of computer studies which has included some programming, typically in BASIC.

There are sometimes programming vacancies with software houses or micro suppliers which are appropriate for younger people who have again done a computer studies course including BASIC. However, micro

software houses tend to want good; highly productive programmers but they do not offer extensive training. Therefore you must either offer very good programming and business experience (almost impossible for a college leaver), or you must take a course of computer studies and be prepared to start with basic office work while at the same time teaching yourself about your employer's products.

A Higher Level

However, in the electronics world one simple fact predominates: the more highly-qualified you are, the greater will be the range of opportunities open to you. If you are qualified to degree, HND or TEC III level, you will be less limited to one area of the industry. You will regard yourself as an electronics engineer who happens to work with micros. You will be more likely to go into a design/development job, instead of being limited to the production, testing/quality control and repair jobs which are themselves being overtaken by automation.

Up to a point, there is no difference to employers in the acceptability of degrees or HNDs, especially in development, production, test and maintenance jobs. It is only at the most advanced levels of original research that employers demand good honours degrees and research PhDs.

Design and research: above, planning the layout of a microprocessor; below, laying out a large PCB mask.

Microprocessors and peripherals also have to be sold, and they are usually sold as components to computer manufacturers. These are known as OEMs (original equipment manufacturers), and they are only likely to be impressed by a salesperson with a sound knowledge of the product and the customer's needs. It is a quite different type of work from selling commercial micros to business users.

In considering the OEMs who buy the microprocessors and components we are finally drawing closer to the microcomputer with which we started — a desk-top piece of hardware made up of all the bits and pieces lovingly designed, developed and sold by others. A micro may be a stand-alone item or it may be part of a larger system, linked for example to a mainframe computer, or playing its part in a LAN (local area network) of several micros linked up for data processing, storage and transmission.

So once more, as at the microprocessor end of the market, it becomes apparent that 'working with micros' is a false distinction. It is being overtaken by the convergence of different aspects of electronic information technology into 'total systems' combining traditional data processing, word processing, telex, facsimile transfer, electronic mail and intelligent copiers.

A Program In Electronics

When it comes to programming, the electronics person is likely to find work relevant to his/her course in two areas:

- in micro-processor research and development, helping to produce firmware — chips with a built-in program which defines their function, for example as a storage device.
- in designing operating systems software, ie programs which control the overall running of a computer instead of the applications programs which do specific jobs.

Regarding applications programs you would make best use of your knowledge by writing programs which have a scientific, and ideally, an electronic application, rather than a commercial one such as a stock control or payroll program. There are plenty of other people wanting programming jobs in those areas! In any case, starting salaries in commercial programming are about £2,000 a year lower than those for technical specialists, including electronic engineers.

Micro computers have to be installed and maintained, and this offers the main employment field where graduates, HND people and holders of TEC III can compete on equal terms.

These jobs do not only require hardware knowledge and hardware repair skills. In fact diagnostic skills are more important, ie a good knowledge of electronics theory and of diagnostic software. The diagnosis, and not the repair, is where the real skill lies.

Carrying The Responsibility

You may also require knowledge of applications programs. This is because many employers are small, young companies looking for one 'all-rounder' rather than several specialists. Despite your high qualifications, you should still be prepared to do everything: arranging delivery date, carrying the micro up the stairs and unpacking it, loading and checking the applications software, debugging where necessary and training the user. This will sometimes involve working 'after hours' to sort out a problem.

The final choice is whether to take a job at all, or a postgraduate course.

If you are thinking of a highly specialist postgraduate course, check first that it is not likely to prove a blind alley. Look at graduate vacancy lists, and ask a few pertinent questions of the course organisers. However, if your first degree is in pure science subject, then a postgraduate course in electronic engineering or computer studies could be extremely useful. There are also TOPS TEC conversion courses for science graduates based at Trent, Newcastle, Hatfield, Middlesex & Wales Polytechnics. The Middlesex course has the strongest computing bias, and they start in January 1984.

Courses which aim to broaden your horizons include new 'Information Technology Conversion Courses' funded by the Science and Engineering Research Council and open to people with a wide range of backgrounds. They aim to give students a broad and up-to-date understanding of the issues involved in the people/systems interface, and a grasp of hardware, software, storage and communications components of an IT system.

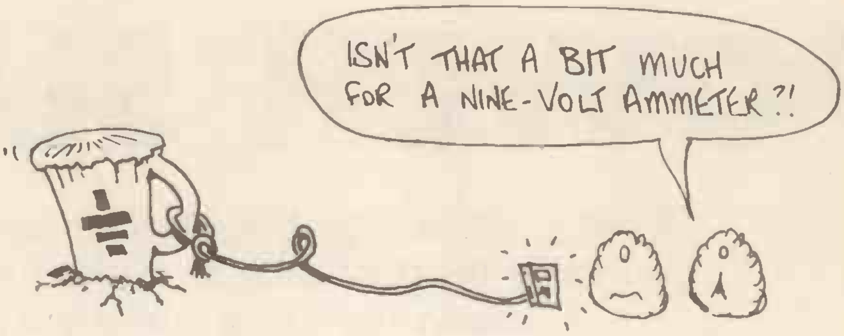
Finally if you want a longer and more research-based postgraduate training, which at the same time is geared to employers' needs, the SERC is also funding a new, 'total technology' approach to PhDs. These aim, in three years, to train engineers in all the stages of producing a product as discussed in this article, together with the management skills needed to weld the process together. This is perhaps particularly relevant to the smaller employers which cannot afford to carve each stage up into discrete departments. Several universities offer 'total technology' PhDs in electronic engineering, and you can get further details from the **SERC, Total Technology Office, Polaris House, North Star Avenue, Swindon SN2 1ET.**

Angela Sharp is the author of *Working with Computers* published by Batsford (1982), £5.95.

HE

READERS' SERVICES

Feeling stumped? Looking for the right connection? It must be time to reach for HOBBY ELECTRONICS! Here's how . . .



Letters

While we are always happy to receive correspondence from readers, it is simply not possible for the editorial staff to reply to every letter. Because of staff limitations and the fact that producing the monthly editions of HE must take precedence, *we cannot even guarantee to answer letters accompanied by an SAE.* Hopefully this situation will prove temporary and we can shortly resume a full service to readers.

In the meantime, to reduce the amount of mail to which we attempt a reply, certain guidelines have had to be imposed:

● Letters from readers who have been unable to successfully build a Hobby project will receive first claim on our attention. But we urge readers to first make sure they understand the problem, and to read all parts of the article thoroughly: it is wasting our time (which is better spent ensuring that current projects are error free) to reply (to pick a common case) that the supplier of certain components is given in Buylines, on page 34.

● Many enquiries are concerned with drafting errors in circuit diagrams or component overlays; corrections for most errors have been published in subsequent issues, so please check your back numbers before writing to us — the information may already be in your hands.

● Where there is a definite problem, we ask that readers first try to solve the problem themselves: again, reading the article carefully will often resolve what appears to be a contradiction between, say a Veroboard layout and the circuit diagram.

● If it is necessary to write, please try to supply useful information: it is impossible to give constructive advice to the reader who says "My project doesn't work. Can you help?". The short answer, and the only one possible, is *no*!

● We would like to hear from any reader who has had difficulty with a Hobby project and who has come up with a solution, but we cannot advise when a project has been modified and fails to work: if you decide to make changes you will have to live with the consequences. Similarly, we are pleased to take readers suggestions for projects they would like to see in the magazine, or for modifications to improve a published project, but we cannot design circuits on request or re-design a project to suit the requirements of a single reader.

● We will try to answer any readers' questions on electronics in general, to suggest sources for components for old projects or to offer whatever advice we can when circumstances permit; however, we cannot advise on the purchase, use or modification of commercial equipment.

● We are unable to advise on the purchase of components in foreign countries; overseas readers are advised to read carefully the advertisements placed in HE by mail-order component suppliers and to write to them directly (this advice also applies to many UK readers wishing to obtain components for projects!).

● Unless specifically requested to the contrary, any letter to Hobby Electronics may be selected for publication in the magazine, including letters with an SAE if they are sufficiently interesting; in such a case a copy of the editorial comment will be returned to the reader prior to publication.

● Letters not accompanied by a stamped, self-addressed envelope may be selected for publication but will not receive a personal reply. We will attempt to reply to all enquiries backed by an SAE (if writing from outside the UK please include the correct number of International Reply Coupons, available from Post Offices) but we cannot guarantee a reply, nor can the publishers, Argus Specialist Publications, be held legally responsible for the accuracy of the information supplied.

Writing For HE

● Hobby Electronics' editor is continually looking for good projects, ideas for projects and designers to develop an idea into working project.

However unless you are already a seasoned contributor, it is unlikely that your first effort will reach the standard required for publication in the magazine. So if you have an idea or a design and you personally think it would be suitable as a Hobby project, write and tell us about it — and please include a telephone number (night or day, we're open all hours here) where you can be contacted.

Similarly if you are a designer, perhaps with time to develop someone else's ideas, please write or phone the editor!

Any Old Rope?

We will also undertake to publish any suitable but undeveloped ideas as experimental "Reader's Projects". The article will generally fill one page when published and should include a circuit diagram and description, parts list, component overlay (the projects should generally be on Veroboard) and some brief suggestions as to how the device might be constructed by the adventurous reader! A working prototype will not be needed, and the flat rate for Reader's Projects will be £20.

Simple circuits are also needed for publication as "Short Circuits"; no constructional information is needed, and contributors of "Shorts" will be rewarded with £10 per idea.

The Back-Log

The above guidelines for writing to Hobby Electronics have had to be drawn up in response to the growing pile of yet un-answered letters from readers.

We apologise to all those still awaiting a reply; we are doing everything possible to clear the jam, but to enable us to do so in reasonable time we are retrospectively imposing the above restrictions on the type of enquiry with which we will deal. Therefore, any letter or question not relating to a Hobby Electronics project or a general electronics enquiry will be returned, with the SAE, to the reader. HE

DUAL PURPOSE POWER SUPPLY

William Leung

A nifty device to boost your batteries before you take them walkies, and to save your cells when listening quietly at home

FOR THOSE of you who are fed up having to purchase new batteries everytime the ones in your personal stereo cassette player run flat, here is a power supply which can provide a regulated 4.5 volts output for your player, and as an added bonus, it can also double as a recharger for Ni-Cad battery cells.

Although the circuit was designed to cater for the majority of cassette players which require three cells for operation, **Table 1** give the necessary modifications for players which use two or four cells.

Power Circuit

From **Figure 1**, the mains voltage is stepped down by transformer T1 to around 6 volts at 250mA per secondary winding. Connecting both windings in parallel increases the current capability to 500mA RMS. This is then fed into the bridge rectifier BR1 which converts the AC into a pulsating DC voltage. Electrolytic capacitor C1 smoothes out the pulses to give a nominal voltage of 8.5 volts DC with a low ripple content.

With switch SW1 in the 'B' position, we have a conventional series regulator using a Zener diode. By the emitter follower action, the voltage at the emitter of Q1 will be approximately 0.6 volts less than that at its base. Therefore:

$$\text{Vout} = \text{VZDI} - \text{Vbe(Q1)}$$

So that if VZDI = 5.1 volts, then the output voltage will be 4.5 volts (5.1 – 0.6 = 4.5) relative to the negative output terminal (ie the anode of ZD1). C2 removes any noise that is generated by the zener diode.

Q2 and either R4 and R5 provide constant current limiting at the output so that the circuit is protected from overload. The maximum current available is equal to:

0.65 volts/Rx Ohms

Where RX is the selected current sense resistor.

The 0.65 volts mentioned is the approximate minimum base to emitter voltage of Q2. Current limiting occurs when the voltage across R4 or R5 due to load current exceeds this. Q2 then begins to conduct, pulling the base of Q1 down to a point where the corresponding lower output voltage can just maintain the maximum current (0.65 volts/Rx). At this point, ZD1 does not play any part in determining the output voltage. For example, suppose that the output was limited to 100mA and that there was a 1 Ohm resistive load, then from Ohm's Law the voltage developed across the load would be 1 volt and not 4.5 volts, due to the current limiting.

When the switch is in position 'A', the circuit operation is similar, except that the circuit is now working under current limiting continuously. This mode is used when recharging Ni-Cads.

Table 1			
ZD1	R2	T1	
3.6 volts 6.8 volts	470 Ohms 560 Ohms	6 volts 9 volts	for 2 cell operation for 4 cell operation

Table 1. Provision is made for personal cassette players operating on two or four cells.

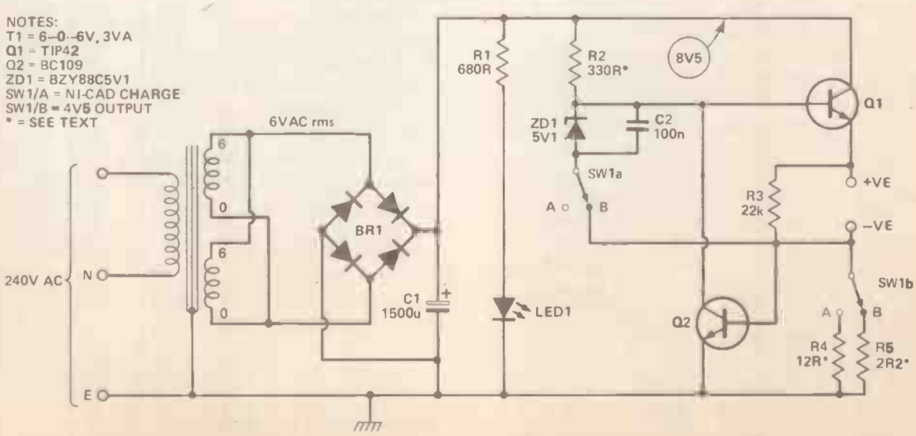
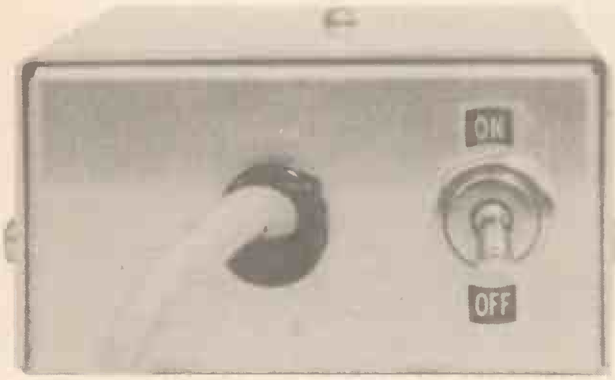
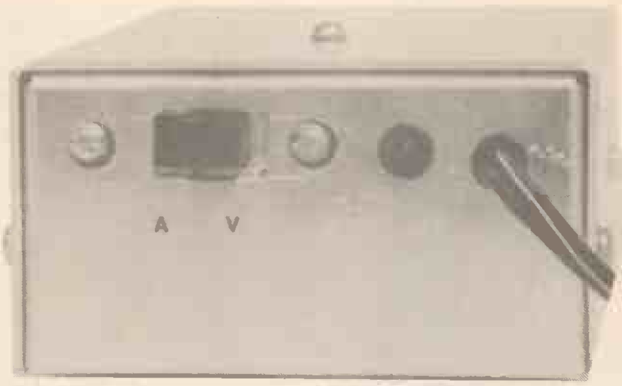


Figure 1. The values for current limiting resistors R4 and R5, must be calculated from the formula given in the text.





Finally, LED1 and its associated current limiting resistor R1 act as a simple 'Power On' indicator.

Current Sense

The value of R5 has been chosen so that the load can draw up to 250mA at the most, this being the maximum recommended DC current available from T1; it is more than enough to satisfy the needs of most stereo cassette players.

Since most players will require the use of AA sized Ni-Cad Cells, the value of R4 has been chosen to provide a 55mA charge rate for such cells over a period of 10 to 15 hours. The circuit can recharge up to three Ni-Cad Cells in series with the 6 volt transformer used. It should also be pointed out that Ni-Cads should never be recharged in parallel or, with this unit, the switch is position 'B'. For other sized cells which require different charge rates, it is only a matter of calculating the new value of R4 from the formula I_{LIMIT} = 0V65/Rx.

Construction

The Veroboard should be cut to size such that there are 20 holes in each of the 24 strips. Having done this, drill the four mounting holes and make the single break in the copper track as shown in **Figure 2**.

Then, in the usual fashion, solder in all the ten Veropins and the three wire links, followed up by the four resistors. Note that R1 is vertically mounted; the other resistors should be mounted a few millimetres off the board, since they will get rather warm in use. The capacitors should be inserted next; in the case of C1, the one used in the prototype was just small enough to fit inside the specified case.

When it comes to inserting the semiconductors, stand them a few millimetres off the board and, in particular, make sure when soldering Q2 that its clip-on heatsink does not come into contact with either ZD1 or C2. As with any semi-conductor, try and keep the soldering time as short as possible.

Next the mounting holes should be drilled into the aluminium case used to house the complete project. SW1, LED1 and the grommet for the power lead to the cassette player are mounted on the front panel of the box, as can be seen from the photographs. Note that they are positioned on the upper half of the panel and this should be borne in mind when

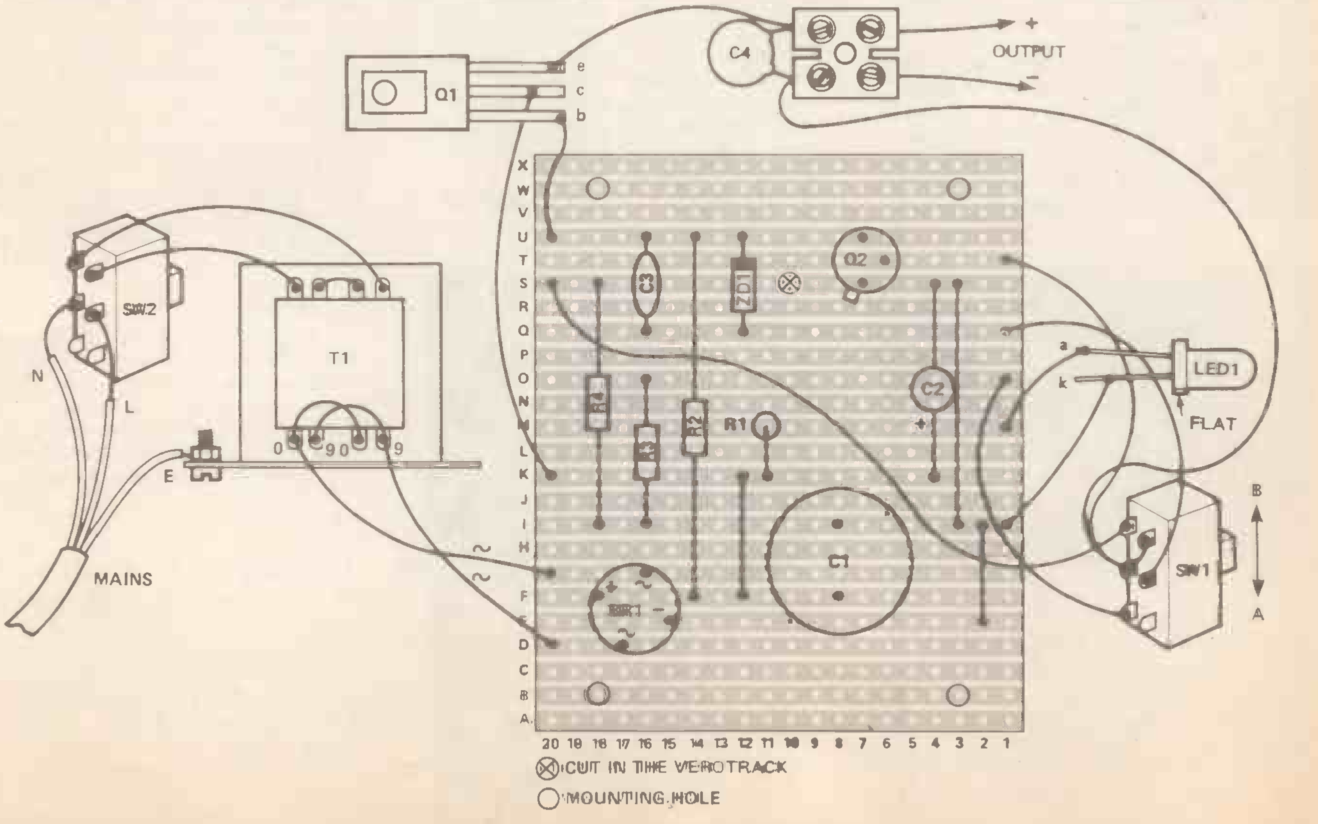
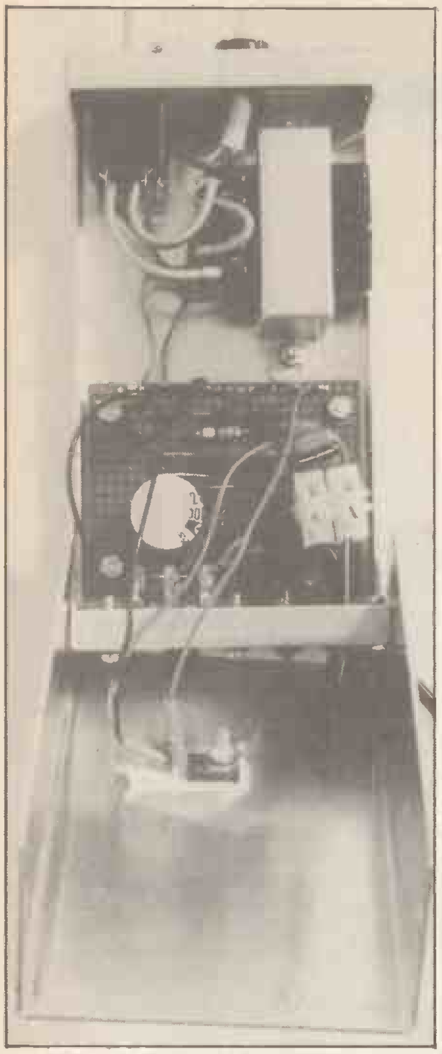


Figure 2. A small piece of Veroboard mounts most of the components, but there is a lot of off-board wiring.



Careful construction is required when working with mains voltages, as usual. The output transistor, Q1, is mounted on the lid of the plain aluminium case but isolated from it by a T0126 mounting kit; note the use of sleeves on the leads to this transistor.

Parts List

RESISTORS

(½ watt 5% carbon film unless noted)

R1 .... 1k
R2 ....220R 3W wirewound
R3 .... 12%
R4 ....2R2/3R3* 3W wirewound
* see text

CAPACITORS

C1 .... 1000u 25V radial electro
C2 .... 10u 25V axial electro
C3, 4 ....100n polyester

SEMICONDUCTORS

Q1 .... BD139 NPN transistor
Q2 .... BC142, BFY51 etc NPN transistor
ZD1 .... BZX61C5V1 5V1 Zener diode
LED1 ....3mm red LED
BR1 ....WO05 50V/1A bridge rect.

MISCELLANEOUS

T1 ....0-9V, 0-9V 6VA chassis transformer
SW1 .... DPDT slide or toggle
SW2 .... SPDT mains rated

Aluminium case, 133 x 70 x 38mm; TO5 clip-on heatsink; TO126 mounting kit; mounting ring for LED1; mains cable grommet; plug to suit cassette player; Veroboard (see text); Ni-Cad battery holders; nuts and bolts, wire, solder etc.

BUYLINES ....**page 34**

positioning the circuit board, since C1 may get in the way of SW1. On the rear panel are SW2 and the grommet for the mains cable.

From the photographs, it can be seen that Q1 is mounted on the case lid and this should be insulated from the case using the TO126 mounting kit.

Finally, it should be a straight-forward matter to wire up the project with the aid of the wiring diagram. Note that the Earth lead from the mains cable goes to the fixing bolt which holds T1 in place, and that the transistor leads of Q1 are insulated with either heatshrink sleeving or suitable insulation from some stripped wire.

The wires coming off Q1 emitter and the wiper of SW1A (the wiper with three wires coming off it) provide the output; these are soldered to the leads of C4 which are then screwed onto a two amp terminal block.

In the case of the author's proto-type, the output power lead consisted of a reasonable length of 2 core cable which was connected to this terminal block and passed through a grommet on the front panel (the grommet was in fact a mounting clip for a 3mm LED!) and onto a 2.5mm plug, tip positive.

Testing

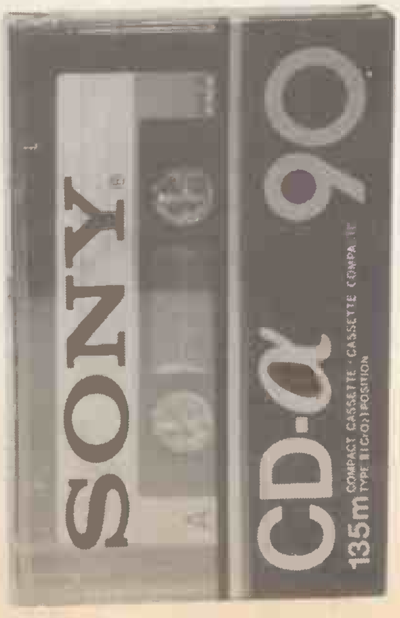
Before turning on the unit double check everything, paying particular attention to the wiring. If all seems well, turn on the power and LED1 should light up. If not, switch off immediately and check for errors.

To see that it is working properly put SW1 in position 'B' and measure the voltage at the output; this should be about 4.8 volts off load. To test the current limiting for both positions of SW1, simply connect a multimeter across the output set on a suitable current range and the meter readings should be about 55mA and 300mA (200mA if R4 has a value of 3R3) for SW1 in positions 'A' and 'B' respectively.

If all goes well at this stage, put SW1 in position 'B' and connect your personal stereo cassette player to the power supply and try a listening test. Hopefully, no problems should be experienced, however should there be any, recheck your construction.

Recharging Ni-Cads

When recharging Ni-Cads, SW1 *must* be in position 'A' and they must also be recharged in series, only. The value of R3 determines the charging current and this should be about 10% of the 'Amp-Hour' capacity of the cells (eg for AA Ni-Cads, 10% of 500mAH is 50mA), and from this, the appropriate value for R3 can be determined. At this current the charging period will be around 10-15 hours. **HE**



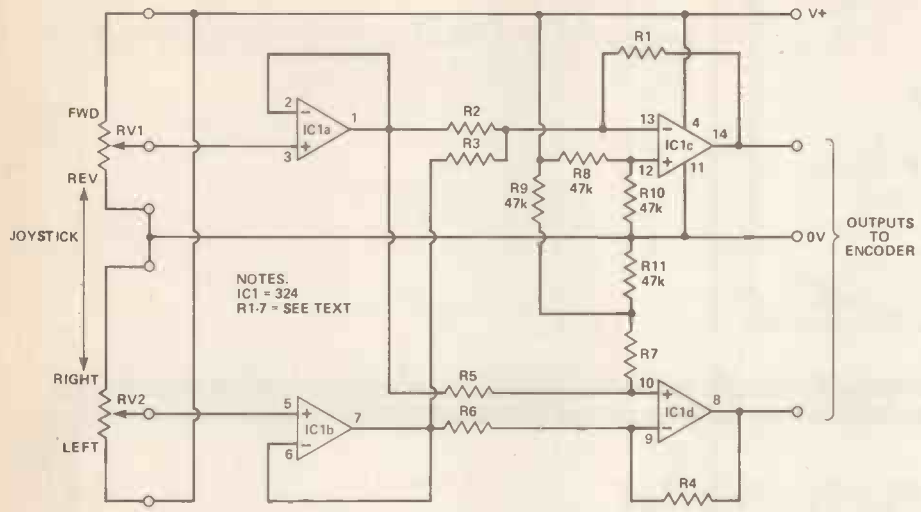
SHORT CIRCUITS

Circuit ideas from Hobby Electronics readers.

Hobby Electronics cannot undertake to answer queries on Short Circuits.

Radio Control Mixer

Over, Under, Sideways, and Around!



THIS mixer was designed to be fitted to a radio control transmitter to allow a tracked vehicle (eg a tank) to be controlled from a resistive joystick controller.

Potentiometer RV1 controls the Forward/Reverse speed, while RV2 controls the direction. The voltages from the two pots are buffered by IC1a and IC1b, and the outputs are fed to another pair of op-amps.

IC1c is connected as an inverting amplifier, while IC1d is connected as a differential amplifier. The buffered voltage from RV1 (Fwd/Rev) is fed to both IC1c and IC1d, and the voltage from RV2 is added to it at IC1c and subtracted from it at IC1d, thus producing the outputs necessary to steer a tracked vehicle.

The gain of ICs 1c, 1d are set by resistors R1 – R7. For most applications R2/R1 = R5/R4; R3/R1 = R6/R7, with R3/R1 less than R2/R1.

G. Foote,
Woodford Green, Essex.

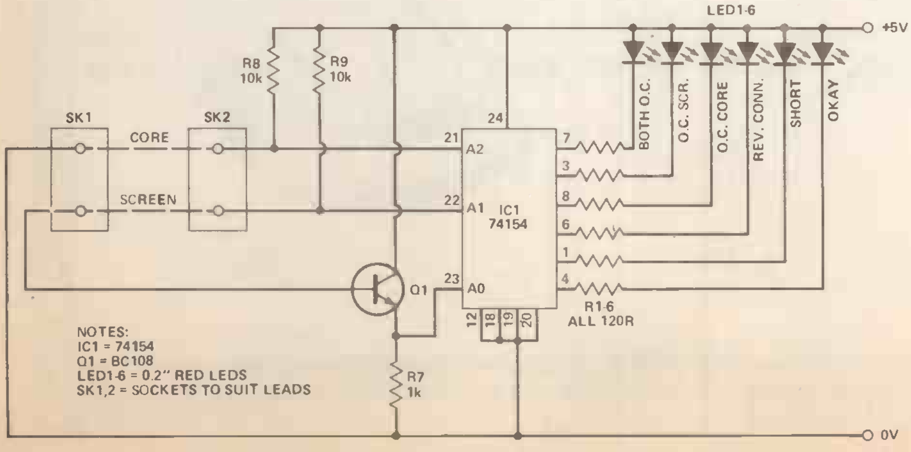
Ringing Tone Monitor

Fed up with hanging on the telephone? Then here's a circuit that indicates when your call is answered . . .

THE CIRCUIT shown was developed to monitor a telephone ringing tone and give either an audible or visual indication when the telephone is answered. It has proved very useful when calling companies with busy exchanges and has also shown its worth when I have had to contact someone the moment they arrive at their home or office!

The signal from the telephone pickup coil is amplified by a 3130 op-amp and then fed to the trigger input of a 555 monostable. This signal also provides bias for a transistor connected across the timing capacitor thus preventing it from charging up. When the ringing tone stops, the mono is allowed to time out, switching on the audible warning device or LED.

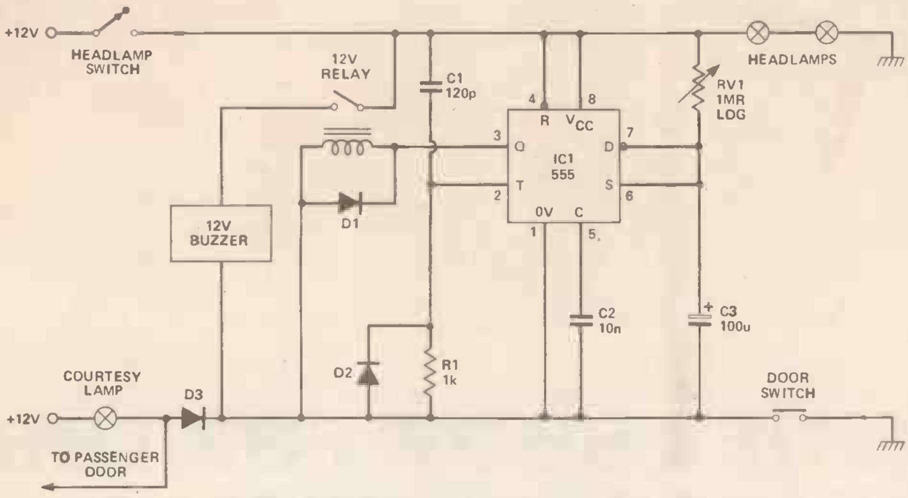
The gain of the op-amp should be set to give the best discrimination between the ringing tone and normal speech (the talking clock is a good reference) and the time constant of the 555 adjusted to hold the timer on for a period slightly longer than the pause between tone bursts.



P. Thompson
Glasgow

Headlight Warning Indicator

A handy circuit to install in your car, that warns if the headlights have been left on when a door is opened.



THIS little circuit switches on a 12V buzzer when a car's lights are accidentally left on and the door opened, but then switches it off after a predetermined time (to avoid embarrassing incidents when the Highway Patrol opens your door as you are saying Goodnight to your girlfriend!).

The circuit consists of the widely used 555 timer connected in the monostable mode, triggered by the falling waveform generated by R1 and C1. The time duration of the buzzer is set by potentiometer RV1 and C3; up to 100 secs is available with the values given for these components.

The circuit shown is for a 12V negative earth system, but can easily be adapted for almost any car.

I. Jauncey
Northampton

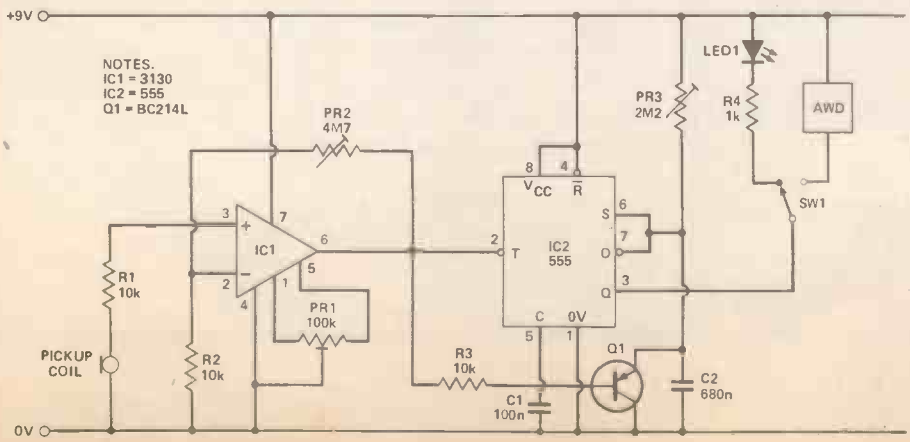
Lead Tester

Keep Snap Crackle & Pop in the packet, where they belong!

THE CIRCUIT shown may be used to check guitar or speaker leads for a number of different faults. Commercial units usually indicate three of four different faults. My design uses six LEDs to give direct indication of one of five faults, or that the lead is OK. The faults are: short circuit; open circuit core; open circuit screen; both open circuit; or reverse connection. The last is useful for checking speaker leads, where a reversed connection is a common fault and gives rise to the speakers being 'out of phase'. Double faults (for example a core open circuit and shorted to the screen) can occur, though rarely, but do not cause false indication; in fact none of the LEDs will light in such cases.

A2	A1	A0	OUTPUT PIN	LED	CONDITION
0	0	0	1	5	Short
0	0	1	x	x	x
0	1	0	3	2	o/c screen
0	1	1	4	6	OK
1	0	0	x	x	x
1	0	1	6	4	reversed
1	1	0	7	1	both o/c
1	1	1	8	3	o/c core

x = not decoded



The circuit uses a 74154 IC, which is a four-to-sixteen line decoder. For each of the 16 possible combinations of the four inputs, a single, unique output is produced. In the circuit only three inputs, A2, A1 and A0 are used, giving eight possible outputs, but only six of these are decoded to indicate one of five faults or 'OK', as shown in the truth table.

Without a lead plugged in — or if both screen and core are open circuit — inputs A2 and A1 are both held high by resistors R8 and R9 connected to the supply rail. Unconnected TTL inputs will float high, so A0 is 'pulled down' to logic 0 by resistor R7. This gives an input code of 110, which produces a low output from pin 7, lighting LED1 and indicating an open circuit condition.

With a good lead plugged into SK1 and SK2, A2 is connected to ground and therefore is at logic 0; A1 is connected to the base of Q1 and is also at logic 1; this voltage turns on Q1, so that almost the full supply voltage appears at its emitter, and A0 is also at logic 1. This combination of inputs (011) gives an output from pin 4 of the IC, turning on LED6, which is therefore marked "OK". In a similar manner all the possible fault conditions can be decoded and displayed.

A device such as this is very useful to anyone involved in electronic music or PA systems, where it is often necessary to check a large number of leads in a short time. It is certainly much faster than fiddling around with a test meter!

Brian Adams
Co. Antrim

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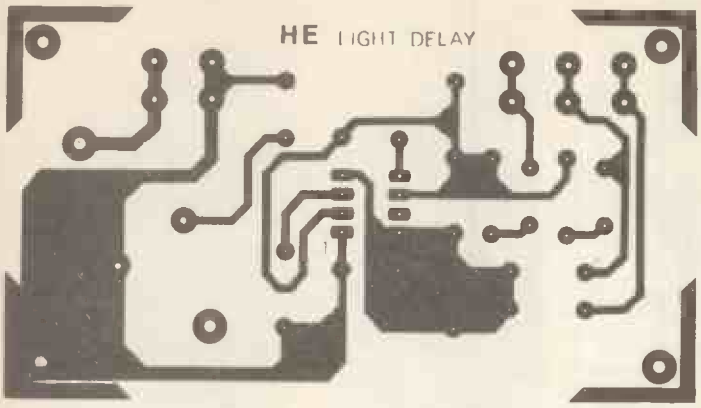

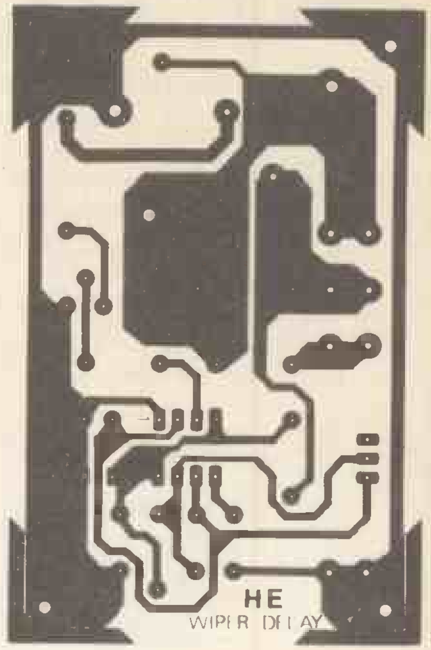

Above: Another project from the same designer: the HE windscreen wiper delay unit.

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