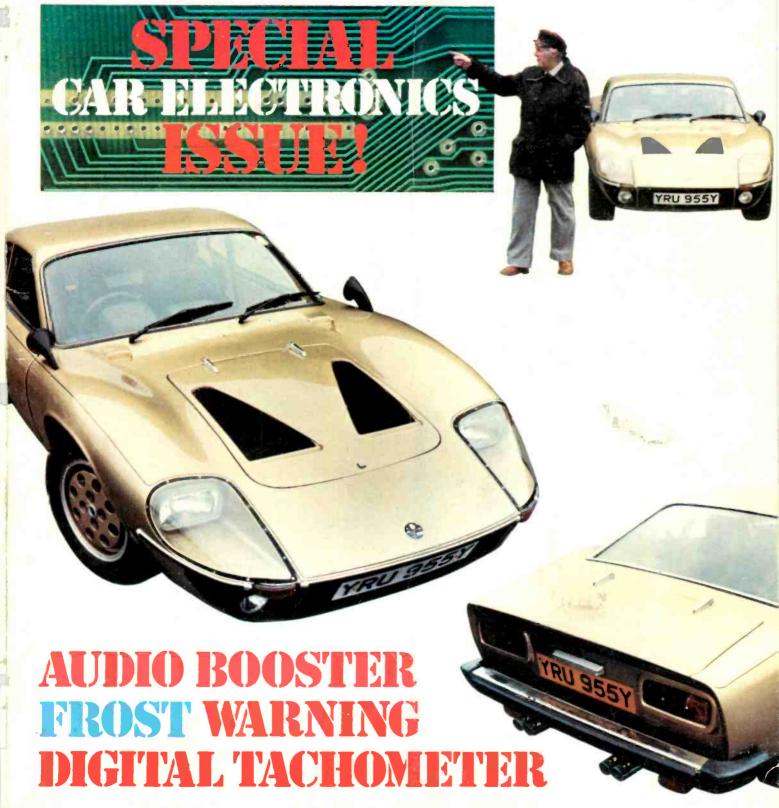
PRACTICAL

# ELECTRONICS

JANUARY 1983

85p



Also... DATA PULL OUT - PE MICROFILE

## New developments in UK Robotics

# ADVANCED DESIGNS FOR EDUCATION, INDUSTRY AND THE HOME CONSTRUCTOR

Robotic experience is becoming as essential a subject as computing. MICROGRASP provides the lowest cost means of acquiring that experience but despite its ultra low price the robot has considerable versatility. There are 5 axes each using a servo motor and there is feedback from each of the arm movements. Control is by any computer with an expansion bus – the ZX81 being particularly suitable. Servoing is achieved with hardware on the interface board to keep programming simple and the robot is operated under BASIC commands with no computer-specific software required. The interface board is memory mapped using only 64 bytes at any of 1024 switch selectable locations.

MICROGRASP robot kit with power supply Universal computer interface board kit 23 way edge connector ZX81 peripheral/RAM Pack splitter board

HEBOT II is a turtle-type robot which takes programming out of the two dimensional world of the VDU into the real three dimensional world. Given a DC supply of 9-15V it can perform a bewildering number of moves under computer control — forwards, backwards, left and right — with each wheel independently controlled. It has blinking eyes, bleeps with a choice of two tones and has a solenoid operated pen to chart its progress. Touch sensor soupled to its shell return data, about its environment, to the computer for it to calculate evasive or exploratory action. Hebot II connects directly to an I/O port or alternatively with the universal interface board to the expansion bus of a ZX81 or other computer.

Hebot II kit Universal computer interface board 23 way edge connector ZX81 peripheral/RAM Pack splitter board

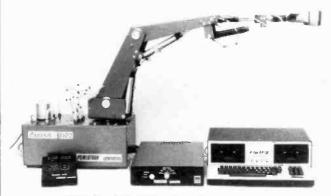


£75.00 £10.00 £2.50 £3.00

£48.50

£2.50

£3.00



GENESIS P102 PROCESSOR BOX, HAND HELD CONTROLLER AND CORTEX COMPUTER

Top of the range is the Genesis P102 which has dual speed control, continuous servo operation and double acting cylinders for increased torque on the wrist and arm rotation joints. The microprocessor based control system has additional memory, position interrogation via the RS232C interface increasing the versatility of computer control and inputs are provided for machine tool interfacing.

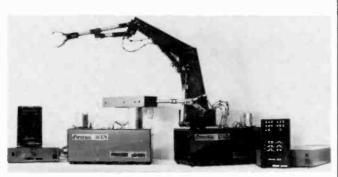
6 axis system READY BUILT
Powertran CORTEX 16 bit 64K computer Kit £295.00; READY BUILT £395.00
(Electronics Today International December issue on CORTEX)

# **POWERTRAN**cybernetics



MICROGRASP, INTERFACE BOARD AND ZX81

#### 'HIGH-TECH' FROM HANTS .



GENESIS \$101 AND GENESIS P101 WITH PROCESSOR BOXES AND HAND-HELD CONTROLLERS

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

#### Example prices and specifications

#### Genesis S101

Base: 19.5" × 11" × 7.5" Lifting capacity: 1500gm Arm lift: 6.6" Weight: 29Kg

4 axis model in kit form £390 5 axis model in kit forh £445 5 axis model READY BUILT £790

#### Genesis P101

Base: 19.5" × 11" × 7.5"
Lifting capacity: 2000gm
Arm lengths between axles: 14.0"
Weight: 34Kg

4 axis model in kit form £495 6 axis model in kit form £595 6 axis model READY BUILT £950

COMPLETE SYSTEMS AS SHOWN IN PHOTOGRAPH ABOVE

#### Genesis S101

4 axis system in kit form £635.50 5 axis system in kit form £695.00 5 axis system READY BUILT £1355.00 Genesis P101
4 axis system in kit form £742,00
6 axis system in kit form £852,00
6 axis system READY BUILT £1525,00

As featured in this journal November '81–April '82 issues.

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#### PRACTICAL

# **ELECTRONICS**

**VOLUME 19** 

No. 1

**JANUARY 1983** 

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FRONT COVER: We would like to thank ACM Ltd. of Poole and Mr R. C. Cradock for the use of the Bonito car shown on

between pages 38 and 39

the front cover.

**OUR FEBRUARY ISSUE WILL BE ON SALE FRIDAY, JANUARY 14th, 1983** 

(for details of contents see page 3/6 of Micro-file)

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MICRO-FILE by R. W. Coles . .

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1544 9 15921 9 WARICAPS 6A/100V 40 6A/400V 50 8B105B 40 Noise Drode	FERRIC CHLORIDE 6x4x3 7x5x3 1 lb bag Anhydrous 8x6x3	" 150 " 180 " 210 x3" 240 3" 275	DPDT c/over 145 SPDT Biaser DPDT field BPDT C/OFI Mon Locking Push to make Push break 25p 3 pole c/over	d 105 75 88 on 185 d 145 r 205	Miniatu Pina MALE	9 15 25 way way way	3-0-3V, 12-0-12 6VA: 2x15V- 12VA:	2V 75mA; 15-0-15V 75 2x6V5A; 2x9V4A -25A 2x4V5-1-3A; 2x6V-1-	9-0-9V 75mA; imA 98p ; 2x12V-0-3A; 220p 2A; 2x12V-5A;
25J   195   TRIACS   3A/100V 48   3A/400V 56   Thyristors 0 8A-100V 32   8A/400V 69   5A/300V 38   8A/400V 69   5A/400V 48   8A/400V 15   5A/600V 48   8A/300V 60   12A/400V 82   8A/600V 95   12A/800V 135   12A/800V	Pen plus spare tip 90p 12x8x  COPPER CLAD BOARDS Fibre Single- Double- Glass sided sided 9 6'x 6' 90p 110p 6'x 12' 150p 195p  VEROBOARDS 0-1'	3" 295 SRBP 5"x8.5" 95p	ROCKER: 5A, 250V, SPST ROCKER: With neon lights red vi 10A 250V, DPST ROCKER: (White) 10A/250V DP ROTARY: Make your own in Switch. Shafting Assembly ac dates up to 6 wafers. Break before make Wafers. Silver of 1 pole/12 way; 2 pole/6 way; 4 way; 4 pole/2 way; 6 pole/2 way	85p DT 72p Aultiway commo- 90p contacts. 3 pole/	Strait FEMALE Solder Angle Strait COVERS 1	170p 160p 220p 105p 160p 200p	355p 3310p 3310p 338p 440p 420p 100VA 2:5A;2	6V-1-5A 6V-1-5A; 9V 1 1 2×6V-4A; 158A 15 2×6V-4A; 2×9V-2-5 -1-5A; 2×20V-1-2A 2×30V-0-8A 2×12V-4A; 2×15 ×30V-1-5A; 2×40V-1	58A; 20V6A 330p (60p p&p) 5A; 2x12V-2A; A; 2x25V-2A; 465p (60p p&p) V-3A; 2x20V-
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2N5064 38 2N4444 130 SOLDERCON PINS 100 70p 5T2 25	VERO WIRING PEN and Spool	350p os 6p ea.	(SPDT) 4 way 190p. THUMBWMEEL Mini front mour Decade Switch Module B.C.D. Switch Module Mounting Cheeks (pair) PROXIMITY Switch with magne	275p	32 way 95p	2x30 way 245p 2x36 way 295p		MALE RECEPTACLE Jum 20pin 26pin 3 160p 200p 2	per Leads 24" 14pin 40pin 160p 300p 180p 525p
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Superboard & UK101  VIDEO MONITORS glare display filter. 750 lines. I/P 750 o	5. Fully cased. Smoked anti- Bandwidth 12MHz. Res. or high. 240V/50Hz. en £95; Amber £98.	direc BR1 imag s u p Unde	ctional, Centronix Interf., 110-9600 Hi-res, bit ge graphics, subscript & verscript. Italics, rellning plus FREE 500 ets paper. ONLY £324 (carr. £7)	4-1943 4-4336 4-608M 4-80MH 5-0MH2 5-185M 5-2428 6-0MH2 6-144M 6-5536 7-0MH2	19M 100 1Hz 200 tz 200 t 160 1Hz 300 8M 390 t 140 1Hz 150 MHz 200	<ul><li>16K MEM</li><li>Printer Us</li><li>Complete</li><li>Disc Inter</li></ul>	IORY (8 x 48 ser I/O Port Printer Cab face Kit BB Ile Disc Driv	ole 36" C3 res see below	£18.00 £8.20 £12.00 £41.00
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18 0MHz
18 432M
19 968MHz
20 0MHz
24-0MHz
24-930MHz
24-930MHz
24-956-69M
26-670MHz
27-145M
27-145M
27-145M
27-648MHz
38-66667M
48-0MHz
55-5MHz
100-0MHz
145-8MHz

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ULTRASONIC TRANSDUCERS

Complete Upgrade Kit from Model A to B £45

Complete range of Cables & Connectors for BBC Micro available. Send SAE for list.

FLOPPY DISC DRIVES

#### **FLOPPY DISC DRIVES**

- TEAC FD-50A 5¼" 40 track SSSD Uncased £125
- TEAC FD-50A 5¼" 40 track SSSD in cabinet
- with own PSU 100K

  TEAC FD-50A 5¼" 40 track Two Drives SSSD in cabinet with PSU 200K

  TEAC FD-50E 5¼" 80 track S/S in cabinet with
- own PSU 200K £238 SIEMENS FDD100-5 Fully cased drive for
- APPLE (incl. Cable) £235 APPLE II DOS Int. Card for above drive. Gold
- plated Edge connection £42 DRIVE Connecting Cable. Single £9; Dble £12. 10 Verbatim 5¼" Diskettes S.D. £20; DD £30

WATFORD FLECTRONICS Telex. 8956095 Tel. (0923) 40588

● Teleprinter Roll (no VAT) £3.50 (P&P on some of the above items is extra) Call in at our shop for demonstration of any of the above items. Be satisfied before you buy.

• 9½" Fan fold paper (1000 sheets) (no VAT) £7

TEX EPROM ERASER with the Solid-State 30

MULTIRAIL PSU KIT. Output: +5V/5A; +12V;

Attractive Beige/Brown ABS CASE for Superboard/UK101 or Home Brew £29

4 x 4 matrix keypad (reed switch assembly) £4

C12 COMPUTER Grade BASF Cassettes in

STACK-PACK. Unique 10 section stackable Drawers rack including 10 x C12 Computer grade

15-30 min.

Library Cases

minute Electronic Timer.

+25V; -5V; -12V @ 1A.

Cassettes (BASF Tape).

5V/5A PSU Ready built and tested

Full ASC11 coded keyboard type '756'

8" Fan fold paper (1000 sheets) (no VAT)

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Soldering Irons

£33

£25

£40

£39

40p

550p

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Spare bits Iron stands **Heat Shunt** 30

ASTEC UHF MODULATORS 6MHz 280p 8MHz Wide Modulators 425p 40KHz Transmitter & Receiver 325p/pai





Due to continous improvements in components and design ILP now launch the largest and most advanced generation of modules ever.



#### **WE'RE INSTRUMENTAL** IN MAKING A LOT **OF POWER**

In keeping with ILP's tradition of entirely self-contained modules featuring, integral heatsinks, no external components and only 5 connections required, the range has been optimized for efficiency, flexibility, reliability, easy usage, outstanding performance, value for money.

With over 10 years experience in audio amplifier technology ILP are recognised as world leaders.



#### BIPOLAR MODULES

Module	Output Power Watts rms	Load Impedance 	T.H.D. Typ at 1KHz	DRITION I.M.D. 80Hz/ 7KHz 4:1	Supply Voltage Typ	Size mm	WT	Price inc. VAT
E1 7 (80)	15	4-8	0.015%	< 0.006%	1 18	76 × 68 × 40	240	€8.40
HY60	30	4.8	0.015%	< 0.006%	2 25	76 x 68 > 40	240	€9.55
H 7 BU60	30 + 30	4-8	0,015%	< 0.006%	± 25	120 x 78 x 40	420	£18,69
HV124	60	4	0,01%	< 0.006%	± 26	120 x 78 x 40	410	£20.75
HY128	(60)	8	0.01%	< 0.006%	2 35	120 x 78 x 40	410	£20.75
HY244	120	4	0.01%	< 0.006%	± 35	120 x 78 x 50	520	£25.47
HY248	120	8	0.01%	<0.006%	± 50	120 x 78 x 50	520	£25.47
HY364	1.88	- 4	0.01%	< 0.006%	1.45	120 x 78 x 100	1030	£38.41
H ₹ 36H	180	8	0,01%	<0,006%	± 60	120 x 78 x 100	1030	€38,41

Protection: Full load line, Slew Rate, 15 $\nu/ps$ , Risetime: 5 $\mu s$ , S/N ratio: 100db. Frequency response (-3dB) 15Hz=50KHz, Input sensitivity: 500mV rms, input Impedance: 100K  $\Omega$ , Damping factor: 100Hz >400,

Module Number	Module	Functions	Current Required	Price inc
нч6	Mono pre amp	Mic/Mag. Carti idge/Tuner/Tape/ Aux + Vol/Bass/Treble	10mA	€7.60
HY66	Stereo pre aniti	Mic/Mag. Cartridge/Tuner/Tape/ Aux + Vpt/Bass/Treble/Balance	20mA	£14.32
HY73	Guitar pre amp	Two Gurtar (Bass Lead) and Mic + separate Volume Bass Treble + Mix	20mA	€15.36
HY78	Stereo pre amp	As HY66 less tone controls	20mA	£14.20

Most pre-simp modules can be driven by the PSU driving the main power amp. A separate PSU 30 is available purely for pre-simp modules if required for £5.4? (Inc. VAT). Pre-simp and mixing modules in 18 different variations. Please send for details.

Mounting Boards
For ease of construction we recommend the 86 for modules HY6—HY13 £1.05 (Inc. VAT) and the 866 for modules HY66—HY78 £1.29 (inc. VAT).

#### MOSFET MODULES

Module Number	Output Power Watts rms	Load Impedance Ω	DISTO T.H.D. Typ at 1KHz	RTION I,M,D. 60Hz/ 7KHz 4:1	Supply Voltage Typ	Size mm	WT	Price inc. VAT
MOS 128	60	4-8	<0.005%	<0.006%	1.45	120 × 78 × 40	420	£30.41
MOS 248	120	4-8	<0.005%	<0.006%	1 55	120 s 78 s 80	850	£39.86
MOS 364	180	4	<0.005%	<0.006%	1.55	120 x 78 x 10k)	:025	145 54

Protection: Asset to cope with complex loads without the need for very specific protection circuitry (fuses will suffice).

Siew rate: 20v/js. Rise (fme: 3ps. S/N ratio: 100db Frequency response E-3dB): 15Hz = 100KHz, Input sensitivity. 500mV rms Input impedance: 100K M2. Damping factor: 100Hz > 400.

#### 'NEW to ILP' In Car Entertainments

C15
Mono Power Booster Amplifier to increase the output of your existing car radio or cassette player to a nominal 15 waits rms.

Very easy to use,

Mounts anywhere in car.

£9.14 (inc. VAT)

Automatic switch on.

Automatic wirtch on. Output power maximum 22w peak into 4.0. Frequency response (-3dB) 15Hz to 30KHz, T,H,D, 0,1% at 10w 1KMz S/N ratio (DNA AUDIO) 80dB, Load Impedance 3.0. Input Sensitivity and impedance (selectable) 700mV rms into 15K  $\Omega$  3V rms into 8  $\Omega$ . Size 95 x 48 x 50mm. Weight 256 gms.

version of C15. Size 95 + 40 + 80. Weight 410 gms. £17.19 (inc. VAT)

## POWER SUPPLY UNITS (Incorporating our own toroidal transformers)

Number	For Use With	VAT
	1 or 2 HY30	£11,93
	Lor 2 HY60, 1 x HY6060, 1 x HY124	£13,83
	1 + HY128	£15,90
	1 x MOS128 2 x HY128, 1 x HY244	£16.70
PSUSIA	2 1 HT 128, 1 1 HT 244	£17.07

Model Number	For Use With	Prior inc
PSU 52X	2 x HY124	[17,07
PSU 53X	2 x MOS128	£17.86
PSU 54X	1 x HY24B	£17,86
PSU 55X	1 x MOS248	£19.52
PSU 71X	2 x HY244	€21.75

Model Number	For Use With	Pripe in	
	2 x HY248	£22,54	
	1 x HY 364	±22,54	
	1 x HV368	£24.20	
PSU 75X	2 x MOS248, 1 x MOS368	. £24,20	

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

# WITH A LOT OF HELP FROM

# PROFESSIONAL HI-FI THAT EVERY ENTHUSIAST

**CAN HANDLE...** 

#### Unicase

Over the years ILP has been aware of the need for a complete packaging system for it's products, it has now developed a unique system which meets all the requirements for ease of assembly, adaptability, ruggedness, modern styling and above all price

Each Unicase kit contains all the hardware required down to the last nut and bolt to build a complete unit without the need for any special tools.

Because of ILP's modular approach, "open plan" construction is used and final assembly of the unit parts forms a compact aesthetic unit. By this method construction can be achieved in under two hours with little experience of electronic wiring and mechanical assembly.

## **Hi Fi Separates**

UC1 PRE AMP UNIT: Incorporates the HY78 to provide a "no frills", low distortion, (<0.01%), stereo control unit, providing inputs for magnetic cartridge, tuner, and tape/ monitor facilities. This unit provides the heart of the hi fi system and can be used in conjunction with any of the UP Unicase series of power amps. For ultimate hum rejection the UC1 draws its power from the power amp unit.

POWER AMPS: The UP series feature a clean line front panel incorporating on/off switch and concealed indicator. They are designed to compliment the style of the UC1 pre-amp. Performance for each unit which includes the appropriate power supply, is as specified on the facing page.

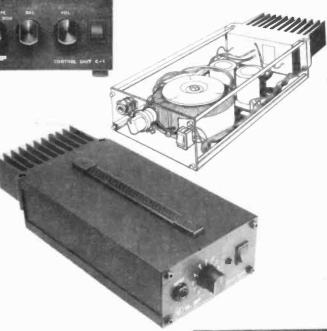
#### Power Slaves

Our power slaves, which have numerous uses i.e. instrument, discotheque, sound reinforcement, feature in addition to the hi fi series, front panel input jack, level control, and a carrying handle. Providing the smallest, lowest cost, slave on the market in this format.

U	NI	CA	S	E	S

HIFI Sep	arates				Price inc
UC1	Preamp				£29.95
UP1X	$30 + 30W/4 - 8\Omega$	Bipolar	Stereo	HiEi	£54.95
UP2X	60W/4Ω	Bipolar	Mono	HiFi	£54.95
UP3X	60W/8Ω	Bipolar	Monu	HiFi	£54.95
UP4X	120W/4 <b>Ω</b>	Bipolar	Mono	HiFi	£74.95
UP5X	120W/8Ω	Bipotar	Mono	HiEi	£74 95
UP6X	60W/4−8Ω	MOS	Mono	HiFi	£64.95
UP7X	120W/4−8Ω	MOS	Mono	HiEi	£84.95
Power Si	aves				
US1X	60W/4 <b>\O</b>	Bipolar	Power	Slave	£59.95
US2X	120W/4 Ω	Bipolar	Power	Slave	€79.95
US3X	60w/4-8n	MOS	Power	Slave	£69.96
US4X	120W/4−8Ω	MOS	Po-ver	Slave	£89.95

Please note X in part number denotes mains voltage. Please insert "O" in place of X for 110V, "1" in place of X for 220V (Europe), and "2" in place of X for 240V (U.K.) All units except UC1 incorporate our own toroidal transformers.



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Fill in the coupon as shown, or write details on a separate sheet of paper, quoting the name and date of this journal. By sending your order to our address as shown at the bottom of the page opposite, with FREEPOST clearly shown on the envelope, you need not stamp it. We pay postage for you. Cheques and money orders must be crossed and made payable to I.L.P. Electronics Ltd. If sending cash, it must be by registered post. To pay C.O.D. please add £1 to TOTAL value of order.

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Int. Money Order

# BI-PAK AUDIO PRO

HIGH QUALITY MODULES FOR STEREO MONO AND OTHER AUDIO EQUIPMENT BI PAK Audio Modules are famous for their variety, quality of design and ruggedness. For over 10 years BI PAK have been suppliers to manufacturars of high quality audio aquipment throughout the world - to date, well over 100,000 modules have been sold - this is why discerning amateur enthusiasts and professionals able insist on using 6I PAR

They know that every item is designed and tested to do the job for which it is intended before it leaves the factory. Whatever you are building there is a list or module in the BI PAK range to suit your every need

#### **AUDIO AMPLIFIERS**

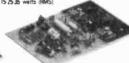
5 10 watts (RMS) ALZO 5 watt Audio Amp Module 22-30v supply £3.57 AL30A 7:10 wett Audio Amp. Module 22-324

£4 16



#### **AUDIO AMPLIFIERS**

15 25 35 wetts (RMS)



AL60 15-25 tt Audie Amp Madule 30:50e supply F5 15

ALBO 35 watt Audio Amp Module £8.07

#### **AUDIO AMPLIFIER**

Audio Amplifier, 50W R.M.S., with integral heat sink and short circuit protection.

introduced to lultil the demand for a fully protected power amp, capable to driving high quality speaker systems at up to 50w with distortion levels below .05% Ideal for domestic use Discos. P.A. systems, electronic organs, etc. The generously rated components ensure continuous operation at high

output levels. AL120 50 watt Audio Amp Module 50 70v supply

#### **AUDIO AMPLIFIER**

125 watts (RMS) AL250.

A power amplifier providing an RMS into a 4 ohm land. Four 115w transistors in the output stage makes it extremely rugged while damage from incorrect or short circuit lands is grevented by a four transistor protection pircuit. For use in many applications such as disco units, sound re-inforcement systems, background music players etc. £19.60.

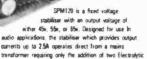
Module 50-80v



#### POWER SUPPLIES

PS12 24v Supply Suit: 2 x AL10 2 x AL20 2 x AL30 6 PA12/S453 £1.66. SPM80 33v Stabilised supply Suit 2 x ALBO PA100 to 15 wests £4.84. SPM120/45 45v Stabilised supply Suit: 2 x AL60 PA100 to 25

warts EB.38. SPM12055 55v Stabilised supply Suit: 2 x ALBO PA200 EB.38. SPM120/65 65v Stabilisad supply Suit: 2 x AL120 PA200 1 x AL250 EB.30. SG30 150-15 Stabilised nower supply for 2 x GE100 MKII E3.00





#### **STEREO** PRE-AMPLIFIERS

PA12 Supply voltage 22-32v input sensifivity 300mv Suit: AL10/AL20/AL30 CR.55. PA100 Supply voltage 30 55v inputs. Tape Tuner Mag P.U. Suit: AL60/AL60 E17.65. PA20D Supply voltage 35-70v inputs. Tage Tuner Mag P.U. Sun ALBOYAL 120/AL250 ETR.24



The PA200 is basically our popular PA100, modifications being made to make it compatible with the higher output amplifiers i.e. AL120 & AL250. The unit boasts six push button selectors giving a choice of 3 inputs, 2 filters, for both high and low frequencies and a stereo or mono button, all combining to give a top quality stereo pre-amplifier and tone control.

#### MINIATURE FM TRANSMITTER

Freq: 95-106MHz. Range: 1 mile ONLY Size: 45×20mm. Add: 9v batt. 
Not licenced in U.K. 
Ideal for: 007-MI5-FBI-CIA-KGB etc.

#### MAGNETIC CARTRIDGE PRE-AMPLIFIER

Enjoy the quality of a magnetic cartridge with your caramic equipment using the MPA30 which is a quality pre-ump, enabling magnetic cartridges to be used whe facilities exist for ceramic carbidges only. With a input socket & full, easy to follow instruction MPA30 Stereo Mag Cartridge, Pre-amp. -- input 15mv Dutput 100mv £3.27.

#### MONO PRE-AMPLIFIERS

MM100 suitable for disco mixer. MM100G suital guitar pre-amp mixer.
The MM100 and MM100G mono pre-ampid

compatible with the ALGO ALGO AL120 and AL250 power amplifiers and their associated power supp MM100 Supply voltage 40.65v inputs. Tape Mag P.U. Vicrophone Max output 500mv £12.43. MM100G Supply voltage 40-65v inputs: 2 Guitars, Microphones Max output



#### GE100 MKII

Monographic

Only 155mm x 65mm x 50mm including the 10 x 10K 45mm sider potentiometers and knobs which are mount on a board above the circultry. In the range of 31Hz to 18KHz you can cut and boost ±12dB with the 10 sliders. with frequency marked on the circuit board. The GE100 uses include mixers, P.A. systems and discos. It will also improve the sound reproduction of your existing audio equipment. Power supply for GE100 old SG30. with Transformer no: 2043. GE100 MKII 10 Channel mono graphic Equaliser with siders & Knobs

£20.00.

#### PUSH BUTTON STEREO FM THNER

Fitted with Phase locked loop decoder

S453 Provides instant programme selection at the touch of a button ensuring accurate tuning of 4 pre-selected stations, any of which may be aftered as often as you choose, simply by changing the settings of the preset controls. Features include FET input stage Varican dinde

£19.00.

#### Transformers are not included with power supplies SPM120 Range also require reservoir and output capacitors

#### **TRANSFORMERS**

2034 1.7 amp 35v suit SPM80 E4.90, 2035 2 amp 55v £6.65, 2036 750mA 17v Suit PS12 £2.65, 2040 1.5 amp 0-45v-55v Suit SPM120/45 SPM120/55v £8.45. 2041 2 amo 0-55v 65v Suit SPM12055 SPM12065v 68.46. 2029 1 amp 0-20v Suit Stereo 30 E3.50. 2043 150mA 15.0 15v Suit SG30 E1.60.

#### **ACCESSORIES**

139 Teak Cabinet Suit Stereo 30 320 z 235 z 81mm £7.00, 140 Teak Cabinet Suit \$7A15 425 z 290 z 95mm £3.50, FP100 Front Panel for PA100 & PAZOD £1.80. BP100 Back Panel for PA100 6 PAZOD E1.50. GE100FP Front Panel for one GE100MKI1 E1.75. TC60 IG1 of Parts including Teak Cabinet chassis, societs & linobs etc ito house STA15 Amplifier) £17.50. PS250 Consists 1 capacitor & 4 diades for constructing unstabilised power supply for AL250 to 125 watts £2.90

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Completely re-designed. Full of the type of components you require, plus so very interesting ones you will soon be using and of course, the largest range of nconductors for the Amateur and Professional you could hope to find

There are no wasted pages of useless information so often included in Catalogues published nowadays. Just solid facts i.e. price, description and individual features of what we have available. But remember. Bi Pak's police has always been to self quality components at competitive prices and THAT

BLPAK'S COMPLETELY NEW CATALOGUE is now available to you. You will be a Bi Pak Catalogue. Have one by one all the time-of case to boy RLPAK

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#### BI-KITS!

of 2 s AL20 amplifiers 1 s PA12 pre-amplifier 1 x PS12 power supply 1 x 2036 transformer and necessary wiring: 1 x SPM80 power supply 1 x 2034 transformer 2 x dagram E19.52. STA10 10 waits per channel Ste Ampilier Kit consisting of 2 a AL30 ampiliers 1 x PA12 pre amplifier 1 x PS12 power supply 1 x 2036 transformer and necessary wiring diagrams £28.63.

STA5 5 walts per channel Stereo Amplifier Kit consisting. STA15 15 walts per channel Stereo Amplifier Kit consisting of 2 x AL60 amplifiers 1 x PA100 pre-anylities coupling capacitors for 8 ohms 479 mfd 50v and necessary wiring diagrams. £36.76. STA25-25 waits per channel Stereo Amplifier füt consisting of 2 x AL60 channel Stereo Amplifier füt consisting of 2 x ALSO amplifiers 1 x PA100 pre-amplifier 1 x SPM120/45 po

#### REGULATED VARIABLE STABILISED POWER SUPPLY

Variable from 2-30 volts and 0-2 Amos, Kit includes VPS30 Module, 1 — 25 volt 2 amp transformer, 0-50v 2" Panel Meter, 1 — 0-2 amp 2" Panel Meter, 470 ohm wirewound potentiometer, 1 - 4K7 ohm und potentiometer, Wiring Diagram

included VPS30 KIT £20.

#### SIREN ALARM MODULE

volt supply into 4 or 8 ohm speaker. Ideal for car burglar alarm, freezer break down and other security purposes. BP124 5 wart 12v max

Siren Alarm Module £3.85.

supply 1 x 2040 transformer 2 x coupling itors for 8 ohms 470 mtd 45v 1 z reservoir capacitor 2200 mfd 100v and necessary wring diagram

E46.76, STA35 35 warts per channel Stereo Amplither IGI consisting of 2 ALBO amplifiers 1 x SPM120/55 power supply 1 x PA200 pre-amplifier 1 g 2035 transformer 2 x coupling capacitors 470 mfd at 50v for 8 ohms 1 x reservoir capacitor 2200 mfd 100v and necessary wiring diagram E45.76



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#### 5121 SCREWDRIVER SET 6 precision screwdrivers in hinged plastic

case Sizes - 0 8 1 4. 2 2.4. 2 9 and 3 8mm £1.75

#### 5131 NUT DRIVER SET

5 precision nut drivers in hinged plastic case With furning rod Sizes -3 3 5 4 4 5 and 5mm £1.75

#### 5141 TOOL SET

5 precision instruments in hinged plastic case Crosspoint (Phillips) screwdrivers H O and H 1 Hex key wrenches 1 5 2 and 2 9mm £1.75

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5 precision wrenches in hinged plastic case Sizes ~ 4. 4 5. 5 5 5 and 6mm. £1.75

BUY ALL FOUR SETS 5121-5751 and get HEX KEY SET FREE HEX KEY SET ON RING

Sizes 1.5, 2, 2, 5, 3, 4. 5. 5 5 and 6mm Made of hardened steel HY/1 £1.25

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Pak No.	Qty."	Description	Price
SX10	400	Mixed "All Type" Resistors	- £1
SX11	400	Pre-formed %-19 watt Carbo	ne
		Resistors	£1
SX12	200	watt Carbon Resistors	£1
SX13	200	% watt Carbon Resistors	- 61
SX14	150	14 watt Resistors 22 chm	
		2m2 Mixed	- 61
SX15	100	1 and 2 walt Resistors 22	
		ohm 2m2 Mixed	€1

Paks SX [2-15 contain a range of Carbon Film Resistors of assorted values from 22 ohms to 2.2 meg. Save pounds on these resistor paks and have a full range to cover your projects

Quantities approximate, count by weigh

#### GUARANTEED TO SAVE YOU

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Type 9500 Series PPD	£1.00
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Accorded values 1 ohm 12K	£1.00

AUTO SCREWDRIVERIDRILL Automatic spiral ratchet. Complete with 2 screwdriver blades, 5 & 65mm. 1 screwdriver cross point No. 1 & three drills - 2, 2,8 and 3.65mm - A MUST FOR ALL HOBBY-BUILDERS & ONSTRUCTORS, Order No. ASD/1 £3.50 each

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SX16	250	Capacitors Mixed Types	0
SX17	200	Ceramic Capacitors Ininiature	
		Mixed	0
SX18	100	Mixed Ceramics Ipt- a6pt	•
SX19	100	Mixed Ceramics 68pf 0.5mf	0
SX20	100	Assorted Polyester / Palystyrer	16
		Capacitors	0
SX21.	60	Mixed C280 type capacitors	
		metal foil	0
SX22	100	Electrolytics, all sorts	0
SX23	50	Quality Electrolytics	
		50-1000 mf	0
SX24	20	Tantalum Beads, mixed	0
*Quantite	es appro	imate, count by weigh.	

BARGAINS

10 Rectangular Green LED's .2 30 Assorted Zener Diodes 250mw-2 watt mixed voltages, all coded. New

Knobs—winged with pointer In Standard screw. Fit size 29 x

12 Neons and Filament Lamps Low

voltage and mains — various types and colours — some panel mounting £1

20 Assorted Slider Knobs

61

£1

£1

£1

20 x Large .2" REO LED 20 small 125 Red LED's

4 Black Instrument

Black/Chrome, etc.

#### BRAND NEW LCD DISPLAY MULTITESTER.

LCD 10 MEGOHM INPUT IMPEDANCE \*3% digit \*16 ranges plus hFE test facility for PNP and NPN transistors \*Auto zero. auto polarity \*Single-handed, pushbulton operation 'Over range indication '12 5mm 1/2 -inch) large LCD readout \* Oroce check Fust circuit protection "Test leads, battery and instructions included 1999 or - 1999 Max indication

Polarily indication. Negative only. Positive readings appear without + sign

Input impedance 10 Megohms Zero adjust Automatic Sampling time 250 milliseconds Temperature range - 5°C to 50°C

1 x PP3 or equivalent 9V Power Supply battery Consumption 20mW

155 x 88 x 3 tmm RANGES OC Voltage 0-200mV 0-2-20-200-1000V Acc 0.8%

AC Voltage 0-200-1000V AC Voltage 0-200-1000V Acc 1 2% DC Current 0-290uA 0-2-20-200mA.0-10 A Acc 1 2% Resistance 0-2-20-200K ohms 0-2 Menohyms Acc 1 1%

0-2 Megohms, Acc. 1% 0-2 Megohms Acc 1%
BI-PAK VERY LOWEST POSS PRICE £35.00 each

#### MINI VICE

is small cast iron quality made vice will amp on to any bench or table having a max tickness of 1 % The 2 1/2" jaws open to max of 1% Approx size 80 x 120 x 66mm Mini Price only

BI-PAK SOLDER

**DESOLDER KIT** 

3/16" (4.7mm) bit

dispenser

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Heat Shunt Iool tweezer Type

Total Retail Value over £12.00

OLIR SPECIAL KIT PRICE C8.95

Kit comprises ORDER NO SX80 1 High Quality 40 watt General Purpose

Lightweight Soldering fron 240v mains inc

automatic ejection. Knurled, anti-corrosive

5 metres of De-soldering braid on plastic

yds (1 83m) Resin Cored Solder on Card

1 Quality Desoldering pump. High Suction with



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#### The Third and Fourth Hand...

.... you always need but have never got "until now This helpful unit with Rod mounted horizontally on Heavy Base. Crocodite clips attached to rod ends. Six ball & socket joints give infinite variation and positions through 360° also available attached to Rod a 21/2 diam magnifier giving 2.5 x magnification. Helping hand unit available with or without magnifier Our Price with magnitier as illustrated OROER NO 1402 CB.50 Without magnitier ORDER NO 1400 £4.75

BI-PAK PCB ETCHANT AND DRILL KIT

Expo Mini Drill 10.000RPM 12v DC incl 3

Sheet PCB Transfers 210mm x 150mm

1/2 ID Dack FERRIC CHLORIDE crystals

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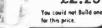
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First, there was the world-beating Sinclair ZX80. The first personal computer for under £100.

Then, the ZX81. With up to 16K RAM available, and the ZX Printer. Giving more power and more flexibility. Together, they've sold over 500,000 so far, to make Sinclair world leaders in personal computing. And the ZX81 remains the ideal low-cost introduction to computing.

Now there's the ZX Spectrum! With up to 48K of RAM. A full-size moving-key keyboard. Vivid colour and sound. High-resolution graphics. And a low price that's unrivalled.

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The ZX Spectrum incorporates all the proven features of the ZX81. But its new 16K BASIC ROM dramatically increases your computing power.

You have access to a range of 8 colours for foreground, background and border, together with a sound generator and high-resolution graphics.

You have the facility to support separate data files.

You have a choice of storage capacities (governed by the amount of RAM). 16K of RAM (which you can uprate later to 48K of RAM) or a massive 48K of RAM.

Yet the price of the Spectrum 16K is an amazing £125! Even the popular 48K version costs only £175!

You may decide to begin with the 16K version. If so, you can still return it later for an upgrade. The cost? Around £60.



## Ready to use today, easy to expand tomorrow

Your ZX Spectrum comes with a mains adaptor and all the necessary leads to connect to most cassette recorders and TVs (colour or black and white).

Employing Sinclair BASIC (now used in over 500,000 computers worldwide) the ZX Spectrum comes complete with two manuals which together represent a detailed course in BASIC programming. Whether you're a beginner or a competent programmer, you'll find them both of immense help. Depending on your computer experience, you'll quickly be moving into the colourful world of ZX Spectrum professional-level computing.

There's no need to stop there. The ZX Printer – available now – is fully compatible with the ZX Spectrum. And later this year there will be Microdrives for massive amounts of extra on-line storage, plus an RS232 / network interface board.



#### Key features of the Sinclair ZX Spectrum

- Full colour-8 colours each for foreground, background and border, plus flashing and brightness-intensity control.
- Sound BEEP command with variable pitch and duration.
- Massive RAM 16K or 48K.
- Full-size moving-key keyboard all keys at normal typewriter pitch, with repeat facility on each key.
- High-resolution 256 dots horizontally x 192 vertically, each individually addressable for true highresolution graphics.
- ASCII character set with upper- and lower-case characters.
- Teletext-compatible user software can generate 40 characters per line or other settings.
- High speed LOAD & SAVE 16K in 100 seconds via cassette, with VERIFY & MERGE for programs and separate data files.
- Sinclair 16K extended BASIC incorporating unique 'one-touch' keyword entry, syntax check, and report codes.

# 'um



## ZX Spectrum software on cassettes—available now

The first 21 software cassettes are now available directly from Sinclair. Produced by ICL and Psion, subjects include games, education, and business/household management. Galactic Invasion... Flight Simulation... Chess... History... Inventions... VU-CALC... VU-3D... 47 programs in all. There's something for everyone, and they all make full use of the Spectrum's colour, sound and graphics capabilities. You'll receive a detailed catalogue with your Spectrum.

## RS232/network interface board

This interface, available later this year, will enable you to connect your ZX Spectrum to a whole host of printers, terminals and other computers.

The potential is enormous. And the astonishingly low price of only £20 is possible only because the operating systems are already designed into the ROM.

## sinclair

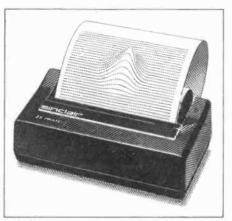
Sinclair Research Ltd, Stanhope Road, Camberley, Surrey GU15 3PS. Tel: Camberley (0276) 685311.

## The ZX Printer – available now

Designed exclusively for use with the Sinclair ZX range of computers, the printer offers ZX Spectrum owners the full ASCII character set – including lower-case characters and high-resolution graphics.

A special feature is COPY which prints out exactly what is on the whole TV screen without the need for further instructions. Printing speed is 50 characters per second, with 32 characters per line and 9 lines per vertical inch.

The ZX Printer connects to the rear of your ZX Spectrum. A roll of paper (65ft long and 4in wide) is supplied, along with full instructions. Further supplies of paper are available in packs of five rolls.



## The ZX Microdrive – coming soon

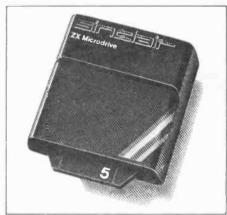
The new Microdrives, designed especially for the ZX Spectrum, are set to change the face of personal computing.

Each Microdrive is capable of holding up to 100K bytes using a single interchangeable microfloppy.

The transfer rate is 16K bytes per second, with average access time of 3.5 seconds. And you'll be able to connect up to 8 ZX Microdrives to your ZX Spectrum.

All the BASIC commands required for the Microdrives are included on the Spectrum.

A remarkable breakthrough at a remarkable price. The Microdrives are available later this year, for around £50.



#### How to order your ZX Spectrum

BY PHONE-Access, Barclaycard or Trustcard holders can call 01-200 0200 for personal attention 24 hours a day, every day. BY FREEPOST-use the no-stamp needed coupon below. You can pay by cheque, postal order, Access, Barclaycard or Trustcard.

EITHER WAY-please allow up to 28 days for delivery. And there's a 14-day money-back option, of course. We want you to be satisfied beyond doubt - and we have no doubt that you will be.

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	Sinclair ZX Spectrum - 48K RAM version	101	175.00	
	Sinclair ZX Printer	27	59.95	
	Printer paper (pack of 5 rolls)	16	11.95	
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CERAMIC Very small 1.8, 2.2, 2.7 etc. up to 1n 5p mach, 1n5, 2n2, 3n3, 4n7, 6n8 5p; 10n, 22n, 6p; 33n, 47n 7p; 100n 8p.

POLYESTER, SEMEMES LAYER TYPE 7.5mm lead spacing 100V 1n. 1n5, 2n2, 3n3 @g; 4n7, 6n8, 8n2, 10n, 12n, 15n, 18n, 22n, 2n, 33n, 39n, 47n 7g; 58n, 68n 7g; 82n, 100n @g; 120n, 15on 11g; 180n, 220n 12g; 270n, 330n, 390n, 470n 16g; 560n, 680n 24g, 10mm spacing 1<sub>2</sub>ff 25g, 15mm spacing 2µ2 38g, 22.5mm spacing 1µf 400V 56g; 33µf 100V 88g, Indepth stocks.

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2μμ 3μg; 40, 80με 59ρ; 100με 89ρ.

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12g; 100/10 19g; 10/03, 22/40, 100/16 14ρ; 22/83, 47/40, 100/25, 10/65, 22/01, 22/01, 12/01, 18ρ; 22/03, 21/01, 14/01, 10/25, 10/65, 22/01, 22/01, 22/01, 18ρ; 22/05, 21/01, 21/01, 47/015, 47/07, 1000/10 3p; 47/04, 0.100/16 27p; 1000/25, 28p; 10/00/40, 22/01/16 44p; 10/00/63, 78p; 22/01/40, 47/01/16, 73p.

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220/25 13p; 47/0/63 15p; 47/0/10 18p; 47/0/16 18p; 47/0/25 22p; 47/0/40 25p;
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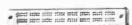


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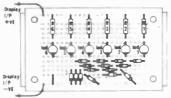
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LS TTL  LS00 11 LS01 11 LS02 11 LS03 12 LS04 12 LS05 12 LS06 12 LS09 12 LS09 12 LS09 12 LS10 12 LS10 12 LS11 12 LS11 12 LS12 13 LS12 13 LS12 13 LS14 30 LS15 12	LS20 LS21 LS26 LS27 LS36 LS37 LS38 LS40 LS42 LS47 LS48 LS41 LS55 LS73 LS74	12 12 12 14 12 13 14 15 13 28 35 45 45 14 18 17	L\$75 L\$76 L\$78 L\$85 L\$86 L\$90 L\$92 L\$93 L\$95 L\$95 L\$107 L\$109 L\$112 L\$113 L\$114 L\$114 L\$122	20 17 17 35 48 16 24 25 24 38 95 40 21 21 21 22 35	LS123 LS125 LS126 LS136 LS138 LS139 LS145 LS147 LS148 LS151 LS155 LS156 LS157 LS158	34 24 25 35 26 30 30 70 150 75 38 38 75 33 36 26 29	LS160 LS161 LS162 LS163 LS164 LS165 LS166 LS170 LS173 LS174 LS175 LS190 LS191 LS192 LS193 LS196	35 35 35 40 55 60 75 60 45 35 35 35 36 32 46	LS197 LS221 LS240 LS241 LS242 LS243 LS244 LS245 LS251 LS257 LS255 LS258 LS259 LS266 LS259 LS266 LS279 LS283	45 50 60 55 55 55 55 70 48 28 32 32 32 55 20 58 30 38	LS353 LS365 LS366 LS367 LS368 LS373 LS374 LS375 LS377 LS378 LS393 LS399 LS541 LS670	60 28 28 28 29 58 60 43 60 57 45 40 156 78 135

	7414	23	7446	58	7485	60	74123	38	74162	46	74191	4
	7416	19	7447	36	7486	19	74125	33	74163	46	74192	4
11	7417	19	7448	43	7489	180	74126	33	74164	46	74193	4
11	7420	14		14	7490	19	74132	30	74165	46	74194	4
1.1	7421	19		14	7491	34	74141	54	74167	150	74195	6
12	7422	19	7453	14	7492	24	74145	48	74170	115	74196	6
12	7427	18	7454	14	7493	24	74147	75	74173	58	74197	4
14	7428	25	7460	14	7494	33	74148	60	74174	53	74198	6
19	7430	13	7472	22	7495	33	74150	48	74175	45	74199	- 8
19	7432	20	7473	24	7496	38	74153	38	74176	35		
13	7433	20	7474	19	7497	86	74154	47	74177	42		
13	7437	23	7475	26	74100	78	74155	36	74179	75		
13	7438	24	7476	25	74107	22	74156	36	74180	38		
15	7440	14	7480	45	74109	24	74157	28	74181	100		
17	7442	30	7482	65	74121	24	74160	55	74182	55		
	11 11 12 12 14 19 19 13 13 13	7414 7416 11 7417 11 7420 11 7421 12 7422 12 7427 14 7428 19 7430 19 7432 13 7433 13 7437 13 7438 15 7440	7414 23 7416 19 11 7417 19 11 7420 14 11 7421 19 12 7422 19 12 7422 18 14 728 25 19 7430 13 19 7432 20 13 7437 23 13 7437 23 13 7438 24 15 7440 14	7414 23 7446 7416 19 7447 11 7417 19 7448 11 7420 14 7450 11 7421 19 7451 12 7422 19 7451 12 7422 19 7451 14 7428 25 7460 19 7430 13 7472 19 7430 20 7473 13 7432 20 7473 13 7437 23 7475 13 7437 23 7475 13 7438 24 7476 15 7440 14 7480	7414 23 7446 58 7416 19 7447 36 111 7417 19 7448 43 111 7420 14 7450 14 112 7422 19 7451 14 12 7422 19 7451 14 12 7422 19 7453 14 14 7428 25 7460 14 19 7430 13 7472 22 19 7430 20 7474 19 13 7437 23 7474 24 13 7437 23 7476 25 13 7480 44 7476 25 15 7440 14 7480 45	7414 23 7446 58 7485 7416 19 7447 36 7485 11 7417 19 7448 43 7489 11 7420 14 7450 14 7490 11 7421 19 7451 14 7491 12 7422 19 7451 14 7491 12 7422 19 7451 14 7491 12 7422 18 7454 14 7493 14 7428 25 7460 14 7493 19 7430 13 7472 22 7495 19 7432 20 7473 24 7496 13 7437 23 7475 25 74100 13 7437 23 7475 25 74100 13 7438 24 7476 25 74107 15 7440 14 7480 45 74109	7414 23 7446 58 7485 60 7416 19 7447 36 7486 19 11 7417 19 7448 43 7489 180 11 7420 14 7450 14 7490 19 11 7420 19 7451 14 7491 34 12 7422 19 7453 14 7491 34 12 7422 19 7453 14 7492 24 14 7428 25 7460 14 7493 24 14 7428 25 7460 14 7494 33 19 7430 13 7472 22 7495 33 19 7432 20 7474 19 7496 38 13 7437 23 7475 26 74100 78 13 7438 24 7476 25 74100 72 13 7438 24 7476 25 74107 22 15 7440 14 7480 45 74109 24	7418 23 7446 58 7485 60 74123 7416 19 7447 36 7486 19 74125 11 7417 19 7486 19 7448 43 7486 19 74125 11 7421 19 7450 14 7490 19 74132 11 7421 19 7451 14 7490 19 74132 11 7421 19 7453 14 7491 34 74141 12 7422 19 7453 14 7492 24 24145 12 7427 18 7453 14 7492 24 24145 12 7427 18 7450 14 7493 24 74147 19 7430 13 7472 22 7495 33 74150 19 7430 13 7472 22 7495 33 74150 19 7432 20 7473 24 7496 38 74153 13 7433 20 7474 19 7497 86 74154 13 7437 23 7475 26 74107 8 74155 13 7438 24 7476 25 74107 22 74156 15 7440 14 7480 45 74109 24 74157 74157 15 7440 14 7480 45 74109 24 74157	7414 23 7446 58 7485 60 74123 38 7415 11 7417 19 7448 43 7486 19 74125 33 11 7417 19 7448 43 7489 180 74126 33 11 7420 14 7450 14 7490 19 74125 33 11 7420 14 7450 14 7490 19 74132 33 11 7421 19 7451 14 7491 34 74141 54 12 7427 18 7453 14 7492 24 74145 54 12 7427 18 7454 14 7493 24 74147 75 14 7428 25 7460 14 7493 24 74147 75 19 7430 13 7472 22 7495 33 74150 48 19 7430 13 7472 22 7495 33 74150 48 13 7433 20 7473 24 7496 38 74153 48 13 7433 20 7474 19 7497 86 74154 47 13 7437 23 7475 25 74100 78 74156 36 13 7438 24 7476 25 74100 78 74156 36 13 7438 24 7476 25 74107 22 74156 36 15 7440 14 7460 45 74107 22 74156 36 15 7440 14 7460 45 74107 22 74156 36 15 7440 14 7460 45 74107 22 74156 36 15 7440 14 7460 45 74107 22 74156 36 15 7440 14 7460 45 74107 22 74156 36 15 7440 14 7460 45 74107 22 74156 36 15 7440 14 7460 45 74107 24 74157 28	7414 23 7446 58 7485 60 74123 38 74162 741	7414 23 7446 58 7485 60 74123 38 74162 46 7416 19 7447 36 7486 19 74125 33 74163 46 11 7417 19 7448 43 7489 180 74125 33 74163 46 11 7417 19 7448 43 7489 180 74126 33 74164 46 11 7421 19 7451 14 7490 19 74132 30 74165 46 11 7421 19 7451 14 7490 19 74132 30 74165 10 12 7422 19 7453 14 7491 34 74141 54 74167 150 12 7422 19 7453 14 7492 24 74145 48 74170 150 12 7427 18 7454 14 7493 24 74147 75 74173 58 19 7430 13 7472 22 7495 33 74180 48 74175 45 19 7432 20 7473 24 7496 38 74150 48 74175 45 13 7433 20 7474 19 7497 86 74154 47 74177 75 13 7433 23 74375 26 74100 78 74156 36 74179 75 13 7438 24 7476 25 74100 78 74156 36 74179 75 13 7438 24 7476 25 74100 78 74156 36 74179 75 13 7438 24 7476 25 74100 78 74156 36 74179 75 13 7438 24 7476 25 74100 78 74156 36 74179 75 13 7438 24 7476 25 74100 78 74156 36 74179 75 13 7438 24 7476 25 74100 78 74156 36 74179 75 13 7438 24 7476 25 74100 78 74156 36 74179 75 13 7438 24 7476 25 74100 78 74156 36 74179 75 13 7438 24 7476 25 74100 78 74155 36 74179 75 13 7438 14 7480 45 74109 24 74157 28 74180 38	7416

CA3096 60 LE353 85 LW171 60 ML392 140 TRAILOS 72 A1206 CA3090 65 LE356 90 LW1725 350 ML392 140 TRAILOS 72 A1206 CA3090 190 LW10 360 LW1725 350 ML392 140 TRAILOS 72 A1206 CA3090 190 LW10 360 LW1725 350 ML392 140 TRAILOS 72 A1206 CA3090 A0 375 LW301A 25 LW1725 350 ML392 465 TRAILOS 72 A1206 CA3090 A0 375 LW301A 25 LW1725 350 ML392 465 TRAILOS 72 A1206 CA3090 A0 375 LW301A 25 LW1725 CA3130E 85 LW311 70 LW747 60 NE531 150 TDAI1008 320 ZW425E 3 CA31361E 100 LW324 40 LW2917 200 NE551 150 TDAI1008 320 ZW425E 3 CA31361E 100 LW324 40 LW2917 200 NE555 16 TDAI1024 125 ZW425E 40 CA3189 390 LW3342 100 LW3900 45 NE555 45 TLOGI 40 ZW4259 2	5555 5566 709 748 940 AY- AY- CAS CAS CAS CAS CAS CAS	41 14 3 35 35 36 37 37 37 37 37 37 37 37 37 37 37 37 37	LF356 LM10 LM301A LM311 LM318 LM324 LM334Z	90 360 25 70 120 40 100	LM725 LM733 LM741 LM747 LM1458 LM2917 LM3900	350 75 14 60 40 200 45	ML929 MM5387A NE529 NE531 NE544 ▶ NE555 ▶ NE556	400 195 210 140 140 140 140 465 225 150 205 16 45	TBA810 TBA820 TBA950 TDA1008 ► TDA1022 TDA1024 TL061	96 70 220 320 490 125 40	ZN423 ZN424 ZN425E ZN426E ZN427E ZN428E ZN459	96 30 50 96 28 45 90 120 85 90 138 135 350 480 285 200
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		_		DC31/	40	01.221	40	MIPSUDE	00	SULVID	ä	2149033	30
TRAN	SIST	ORS		BC547	7	BFR40	23	TIP29A	30	ZTX109	12	2N3442	120
	_			BC548	10	BFR80	23	TIP29B	55	ZTX300	14	▶ 2N3702	
AC125	35	BC149	9	BC549	10	▶8FR81	20	TIP29C	37	ZTX301	16	2N3703	9
AC126	25	BC157	8	BC558	10	BF X29	25	TIP30A	35	ZTX302	15	▶2N3704	6
AC127	25	BC158	10	8CY70	18	BF X84	25	TIP30B	50	ZTX304	17	2N3705	9
▶AC128	20	BC159	В	BCY71	18	BF X85	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	BF X87	25	TIP31C	37	ZTX501	15	2N3708	10
AC188	22	BC169C	10	BD131	35	8FX88	25	TIP32A	35	ZTX502	15	2N3709	10
AD142	120	BC170	8	BD132	35	8FY50	23	TIP32C	37	ZTX503	18	2N3772	170
AD149	80	BC171	to	BD133	50	BFY51	20	TIP33A	50	ZTX504		▶2N3773	
AD161	40	BC172	8	BD135	40	BFY52	23	TIP33C	75	2N697		▶ 2N3819	
AD162	40	8C177	18	BD136	30	BFY53	32	T1P34A	60	2N698	40	2N3820	40
AF 124	60	BC178	18	BD137	30	BFY55	32	TIP34C	85	2N706A	20	2N3823	65
AF126	50	BC179	18	BD138	30	BFY56	32		105	2N708	20	2N3866	90
AF139	40	BC182	10	▶BD139	35	BRY39	40	TIP35C	125	2N918	35	2N3903	10
AF 186	70	▶BC182L	. 8	▶BD140	35	BSX20	20	TIP36A	125	2N1132	22	2N3904	10
AF 239	75	BC183	10		110	8SX29	35	TIP36C	135	2N1613	30	2N3905	6
BC107	10	BC183L	10		110	BSY95A	25	TIP41A	45	2N2218A		2N3906	10
BC107B	12	BC184	10	BD222	85	BU205	160	TIP42A	45	2N 22 19 A		2N4037	45
▶BC108	9	BC184L		BF180	35	BU206	180	T1P120	90	2N2221A		2N4058	10
BC1088	12	BC212	10	BF 182	35	BU208	170	T1P121	90	2N2222A		2N4060	10
BC108C	12	BC212L	10	BF184	25	MJ2955	99	TIP122	90	2N 2368	25	2N4061	10
▶BC109	9	BC213	10	8F 185	25	MJE340	50	T1P141	98	2N2369	16	2N4062	10
BC109C	12	BC213L	10	BF194	12	MJE520	65	TIP142	98	2N2484	25	2N5457	36
BC114	18	BC214	10	BF 195	12	MJE521	95	TIP147	110	2N2646	45	2N5458	36
BC115	22	▶BC214L		BF196	12	MJE3055		TIP2955	60	2N2904	20	2N5459	30
BC117	18	BC237	В	BF197	12	MPF102	40	TIP3055	55	2N 2904A		2N 5485	36
BC119	35	BC238	14	BF198	10	MPF104	40	TIS43	40	2N 2905	22	2N5777	45
BC137	40	BC308	12	BF199	18	MP\$A05	22	TIS44	45	2N 2905 A		2N6027	30
BC139	40	BC327	14	BF 200	30	MPSA06	25	TIS90	30	2N2906	25	40360	40
BC140	28	BC328	14	▶BF244B		MPSA12	30	TIS91	30	2N2906A		40361	50
BC141	30	8C337	14	BF 245	30	MPSA55	30	VN10KN		2N2907	25	40362	50
BC142	25	BC33B	14	BF 256B	45	MPSA56	30	VN46AF		2N2907A		40408	70
BC143	25	BC477	30	BF 257	32	MPSU05	55	VN66AF	85	2N2926	9		
BC147	8	BC478	30	BF258	25	MPSU06	55	VN88AF	95	▶2N3053	23		

#### CAPACITORS

Polyester, radfal 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.

20p: 1u · 23p.
Electrolytic, radial or axial leads;
0.47/63 V, 1/63 V, 2.2/63 V, 4.7/63 V,
10/25 V · 7p; 22/25 V, 47/25 V · 8p;
10/25 V · 7p; 22/25 V, 47/25 V · 8p;
10/25 V · 2p; 220/25 V · 14p;
470/25 V · 22p; 1000/25 V · 30p;
2200/25 V · 50p.
Tag and power supply electrolytics;
2200/40 V · 110p; 4700/40 V · 160p
2200/63 V · 140p; 4700/63 V · 230p
Polyester, ministure Siemens PCB;

Polyester, miniature Siemens PC8: 1n, 2n2, 3n3, 4n7, 6n8, 10n, 15n, 7p 22n, 33n, 47n, 88n, 8p; 100n, 3p; 150n, 11p; 220n, 13p; 330n, 20p; 470n 26p; 680n, 29p; 1u 33p; 2u2,

4 70n 26p; 589n, 29p; 1u 33p; 2u 2, 50p.

Tantalum bead:
12p. 22, 4.7, 10 @ 35 V - 12p. 2; 2, 4.7, 10 @ 25 V - 20p.
15/16V - 30p. 22/16V - 27p; 37/16V - 45p; 47/6V - 27p; 47/16V - 70p; 68/6V - 40p; 100/10V - 90p.

Cer. disc. 22p - 0.01u 50 V, 3p each.

Williard mighatuse caregories .er. oisc. 22p-0.01u 50V, sp each. Mullard ministure ceramic plaie: 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, 35g

#### RESISTORS

%W 5% Carbon film Et2 series 4.7 ohm - 1M. . . . . 1p each, 
%W 5% Carbon film E12 series 4.7 ohm to 4M7 . . . 2p each, 20 each. 20 each.

SOCKETS	Law	Wire
8 pin	6р	25p
14 pin	80	350
16 pm	9p	420
18 pin	120	520
20 pin	130	60p
22 pin	16p	70p
24 pin	18p	70p
28 pin	230	800
40 pin	25p	980
Soldercon pi	ns 60P/100	

#### SWITCHES

Submin toggle: SPST 55p. SPDT 60p. DPDT 65p. Winisture toggle: SPDT 80p, SPDT centre off 90p, SPDT 90p, DPDT centre off 100p tandard toggle: PST 35p. DPDT48p Uninture DPDT slide 12p Push to make 12p. Push to break 22p Rotary type adjustable stop. IP12W, 2P6W, 3P4W all 55p each

DIL switches: 4SPST 80p 6 SPST 80p. 8SPST 100p.

## VERO

VEROBLOC	4				350
Size 0.1 matri	bet				
2.5 x 1 .					22
2.5 x 3.75					75
2.5 x 5 .					85
3.75 × 5 .					95
VQ board					160
Veropins per	100	):			
Single sided					50
Double sided					60
Spot lace cut	ter				105
Pin Insertion	too	ŀ			162
Wiring pen an	d s	000	4		310
Spare epopl 7	5n		Cn	no bu	6

#### DIODES

BY127	12	▶1N4001	3
DA47	10	1N4002	5
OA90	8	1N4006	7
OA91	7	1N4007	7
QA 200	8	1N5401	12
OA202	8	1N5404	16
1N914	4	1N5406	17
▶ 1N4148	2	400mWzen	6

#### CABLES

20 metre pack single core connect-

Speaker cable .		10p/m
Standard screened		16p/m
Twin screened .		24p/m
2.5A 3 core mains		23p m
10 way rainbow ribb		85p/m
20 way rainbow ribb	001	120p/m

#### POTENTIOMETERS

Rotary, Carbon track Log or Lin 1K - 2M2, Single 32p, Stereo 85p, Single switched 80p. SIIde 60mm travel single Log or Lin 5K - 500K

63p each. Preset submin, hor, 100 ohms -1M 7p each. Cermet precision multiturn, 0,75W %" 100 ohms to 100K - 88p each.

#### REGULATORS

78L05	30	79L05	65
78L12	30	79L12	65
78L15	30	79L15	65
7805	35	7905	40
7812	35	79 t 2	40
7815	35	7915	40
LM309K	130	LM723	35
LM317K	270	LM338K	475
LM317T	120	78H05 5A	
LM323K	350	▶5V .	550

#### SOLDERING IRONS

SOLDERING INONS	
Antex C\$ 17W Soldering iron	460
2.3 and 4.7mm bits to sult .	65
	450
Antex XS 25W	480
3.3 and 4.7mm bits to suit .	65
Solder pump desoldering tool.	480
Spare nozzle for above	70
10 metres 22swg solder .	100

#### PCB MATERIALS

Alfac transfer sheets - please s	tate
type (e.g. DIL pads etc.) .	45
Dalo etch resist pen	100
Fibre glass board 3.75"x8"	80
Ferric chloride 250ml bottle.	100

#### TOOLS

		- 1							
Small trimming tool		22							
Small pocket screwdriver		16							
Large pocket screwdriver		13							
6 piece precision screwdriver set									
In plastic case		170							
Low cost side cutters		160							
High quality side cutters		650							
Low cost pilers		160							
High quality pilers		650							
Wire strippers		120							
Expo reliant drill .		695							
Expo Titan drill		1025							
Drill stand		1200							
Reduced shank drill bits li	OF.								
above 0.8mm,		60							
above o.dimin,	-	60							

	OPTO			
	▶3mm red	7	▶5mm red	7
	▶ 3mm green	10	▶5mm green	10
	▶3mm yellor	W10	▶ 5mm yellor	~10
	Clips to suit -	3p e	ach.	
	Rectangular		TIL32	40
	▶red	12	T1L78	40
	green	17	▶TIL111	60
	yellow	17	ORP12	85
	▶TIL38	40	TIL100	90
١	2N5777	45	Dual colour	60
	Seven segmen	nt dis	plays;	
	Com cathode		Com anode	
	DL704 0.3"	95	DL707 0.3"	95
	▶FND500		FND507	
	0.5"	100	0.5"	100
	TIL3130.3"	115	TIL3120.3"	115
	TIL3220.5"	115	TIL3210.5"	115
	LCD: 3½ dig	It 58	Op. 4 digit 62	Op.

TRIACS	ī	400 V 8A 400 V 16A	65
400V 4A	50	BR100	25

#### COMPONENT KITS

An ideal opportunity for the beginner or the experienced construct to obtain a wide range of components at greatly reduced prices. AW 75 of 500 relation kit. Contains 10 of each value from 4.7 ohms to 1M (total of 500 relations). Ceramic Cap. kit. 5 of each value - 22p to 0.01u (135 caps). Polyster Cap., kit. 5 of each value from 0.01 to 1uf [65 caps]. Preset kit. Contains 5 of each value from 100 ohms to 1M (total 65 caps). 425

#### TRANSFORMERS

Please add carriage charges to our normal post charges Miniature mains: 606 V, 909 V, 12012 V all @ 100 mA 100 p each.

PCB mounting, Ministure: 3VA 0-6, 0-6 @ 0.25A; 0-9, 0-9 @ 0.15A; 0-12, 0-12 @ 0.12A 200o each 6VA 0-6, 0-6 @ 0.5A; 0-9, 0-9 @ 0.3A; 0-12, 0.12 @ 0.25A 270p each.

High quality. Split bobbin construction 5VA 0.6, 0.6 @ 0.54; 0.9, 0.9 @ 0.4A; 0.12, 0.12V @ 0.3A 220p each, 12VA 0.6, 0.6 @ 1.4; 0.9, 0.9 @ 0.8A, 0.12, 0.12 @ 0.5A, 0.15, 0.15 @ 0.4A, 295p (plus 40p carriage), @ 0.4A 295p (plus 40p carriage), 25VA 0-6, 0-6 @ 1,5A; 0-9, 0-9 @ 1,2A; 0-12, 0-12 @ 1A; 0 15, 0-15 @

0.8A 330p each (plus 60p carriage) 50 VA 0-12, 0-12 @ 2A, 0-15, 0-15 @ 1,5A, 440p each (plus 75p carriage

PP3 battery clips	
Red or black crocodile clips	
Black pointer control knob	
Pr Ultrasonic transducers	3
▶6V Electronic buzzer	
▶12V Electronic buzzer	
▶PB2720 Piezo transducer .	
▶64mm 64 ohm speaker .	
▶64mm 8 ohm speaker	
20mm panel fuseholder	

#### BOXES 6x3x1%\* 88 160

\$CRs	► C106D 400V 8A 400V 12A	30 70 91
20.00	2A 200V	40

BRIDGE RECTIF	2A 2A 6A	40	0 V	40 45
1A 50V 1A 400V	6A VN 200	118		0.9A 50

#### CONNECTORS

		5			
DIN	Plug	Skt	Jac k	Plug	Skt
2 pin	9p	9p	2.5mm	10p	100
3 pin	12p	10p	3.5mm	9p	9p
			Standar		
			Stereo		
			4mm	18p	17p
UHF (	CB)	Conn	ectors:		
PL259	Plug	40p	Reduce	er 14g	٥.
SO239	squa	are ch	lassis skt	38p.	
50238	S ro	and c	hassis sh	1 400	
IEC 3	pin 2	50 V	6A.		
Plug cl	hassis	mou	nting .		38p
Socke	t free	hang	ing		60p
Socke	t with	2m	lead .		120p

#### MULTIMETERS

MULTIMETERS
HT-120 4,000 opv
A smart looking 11 range pocket
stade multimeter with an impressive
spec, Complete with bettery, etc.
650 each
HT-320 20,000 opv.
Holly sensitive 19 range multimeter including transistor tester.
Overload protection. DC volts1000, AC volts—1000; DC current
0,25A. 4 restanceranges, Complete
with batteries, leads, etc. 1395p

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#### SLOW CARS

For many years PE has been critical of the slow approach to electronics of the motoring industry. Knowledgeable motorists have been adding various bits of circuitry to their "Ford Populars" for many years but it is only comparatively recently that the need for economy, and the challenge of the Japanese, has resulted in the car giants pushing back the barriers.

As far back as 1966 (yes 17 years ago) PE published a Solid State Ignition. It was a capacitive discharge system and, according to the memory of our Assistant Editor, gave readers many a problem with reliability. However, in the ensuing seventeen years technology has taken great strides and we now have semiconductors with a rather better specification than the OC20's used in the original PE circuit. It seems that it is the problem of reliability that has held back many electronic innovations in this field; the car engine compartment being one of the most hostile areas imagineable for electronics. Even so we feel much blame for this tardyness must lie with the conservative motor giants. It is only in recent years that electronic ignition has become the norm and only now that the trip computer is achieving such status. By the way, we have seen

nothing to match the PE Car Computer and that was published two years ago!

The 1982 Motor Show proved yet again how slow things move in this field. Many readers will have seen demonstrations of speech recognition systems and synthesised speech warnings but we are still some years away from such devices being part of the popular motoring scene. Even the solid state dashboard is only just beginning to make an appearance.

#### **PE CONTRIBUTION**

In all these areas PE has made contributions over the years and many long standing regular readers will have enjoyed the benefits of added electronics for some time. A range of designs for solid state analogue instruments, first published in '78, proved so popular they were reprinted in PE Popular Projects (which is still available for £1.25 from our Post Sales Department). The highly acclaimed PE Scorpio Ignition, first published in 1970 and subsequently updated twice, has probably been fitted to more cars than any other published design. The latest Miniature Scorpio follows the original circuitry and once again proved the need for such a system with its popularity, following publication last year.

In this issue we continue to provide useful additions for the motorist. They are all relatively simple in terms of construction but each can bring added benefits or facilities to the popular saloon. Having said that, we should qualify it, because we have reservations on the usefulness of the Digital Tachometer. The design is excellent and will work beautifully, but we feel an analogue display is better for a tacho. However, we have had so many requests for a digital version that we decided we had better comply. A solid state analogue unit is described in PE Popular Projects!

If you can afford a 1983 vehicle no doubt you will not be requiring some of the projects in this and subsequent issues but we bet they won't all be fitted. Over the next few months we will also be describing a Radio Booster, 12V d.c. to 240V a.c. Inverter, Twilight Warning, Wiper Delay, Accessory P.S.U and an Automobile Test Set, plus one or two others. None of them are particularly complex but all provide a useful extra function or enhance an existing one in the way only electronics

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We are unable to offer any advice on the use or purchase of commercial equipment or the incorporation or modification of designs published in PE. All letters requiring a reply should be accompanied by a stamped, self addressed envelope, or addressed envelope and international reply coupons, and each letter should relate to one published project only.

Components and p.c.b.s are usually available from advertisers; where we anticipate difficulties a source will be suggested.

**Back Numbers** 

CLASSIFIED SUPERVISOR Barbara Blake 01-261 5897

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

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

# BUSS &

# Digital Disc System | NOT TO BE FORGOTTEN

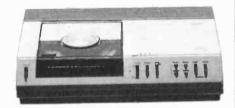
This Spring will see the launch of the much heralded audio revolution with Philips releasing a digital audio system, called the Compact Disc. The Compact Disc player has been designed to connect into any existing hi-fi system in the same way as other sound sources such as tape decks, turntables etc.

The system uses 120mm diameter single sided discs which have up to an hour's continous playing time. The disc has no grooves; the digitally coded recording lies under the surface of the disc, invulnerable to dirt, with the recording being read by a laser beam which causes no damage or wear to the disc.

Inside the disc player a precision electric motor spins the disc whilst a point focused laser beam reads the digitally recorded information splitting the audio information from the servo control information. A decoding system is used to convert the digital information into conventional audio waveforms for the left and right channels. The clocking signal from the servo information is compared with a quartz crystal controlled frequency oscillator and any discrepancy generates a correction signal for the disc motor speed control. Because the scan speed of the laser across the disc is constant the disc speed must be changed progressively from 500 to 200 r.p.m. as the beam tracks from the inside to the outside of the disc

The disc is produced in the same way as a conventional record, by compression or injection moulding. It goes through the same stages of pre-mastering, mastering and replication but the production process is different in many respects because the technological level of the end product is much higher.

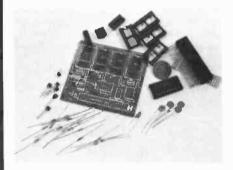
The Compact Disc system features extremely low distortion figures, both harmonic and intermodulation, it does not require a noise reduction system, there is no rumble or wow and flutter. The dynamic range, the signal to noise ratio and the channel separation are all >90 dB whilst the T.H.D. (including noise) is <0.005%.



A new addition to the range of ZX81 options will enable constructors to double their present memory facility.

This memory board is designed to fill the transparent 8K block of memory (from 8K to 16K) in a ZX81 - 16K system. This area of memory is an ideal place to store, either permanently or temporarily, machine language routines or data which are to be used by the basic system. Indeed with this board it is no longer necessary to place your machine language routines in REM statements, in string variables, or beyond RAM TOP. You can build up a resident library of machine utilities for use by your basic system.

The use of HM 6116P 2K CMOS RAM memory i.c.'s with their own reserve power supply means that routines stored in the RAM are nonvolatile. The RAM retains its memory even when the ZX81 is switched off or



The Lithium cell supplied with the board will maintain sufficient reserve power for about ten months for 2K or about two months for a fully populated board. A connector is made available for an alternative external supply.

Complete step by step instructions in a 16 page manual makes assembly of the board easy with construction taking between 1 and 2 hours. It should be noted, however, that the kit is supplied with only one 2K CMOS 6116P - 3 RAM i.c. and the separate purchase of a further three would be required to facilitate the maximum 8K capability of this board.

The kit priced at £19.95 plus £1.95 p&p or just the p.c.b. with instruction manual is £10 post paid supplied by Hunter Electronics, P.O. BOX 5, Axminster, Devon EX13 5AS.

For a change here's a Casio electronic game without an attached calculator. The CG10 is a solar shuttle game which is appropriately solar powered. (No batteries to wear out.)

By controlling speed increase and decrease buttons, the object is to achieve shuttle lift off from earth, enter lunar orbit, and then to escape from orbit to dock with a space station.

Inadequate power means a failure to lift off, a failure to escape lunar orbit or perhaps a crash on the moon. Too high a speed at various points, on the other hand. means overshoot and disappearance into space.

Acceleration and deceleration consume power, and although close approach to the sun during orbit attracts added solar energy, it is still possible to fail from lack of fuel, or from running over a time limit. And just to complicate matters as you get more practised, higher game levels introduce the prospect of collision with UFO's.

As with all Casio games, the CG10

automatically keeps score, and awards bonus points as appropriate.

The CG10 is priced at £12.95 including p&p and is available from Tempus, 38 Burleigh Street, Cambridge CB1 1DG.

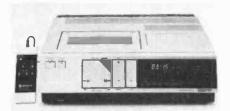


# MARKEZ PLACE

# NEW HITACHI VIDEO LIGHTWEIGHT

Hitachi are extending their range of video recorders with the launch of the VT11E. With a retail price of around £399 it has been specifically designed to provide top quality performance at a realistic price.

The unit has a streamlined fascia with large control buttons for the principal functions which include a single multi-function button for play, record, fast forward, fast re-



wind and 4x visual search in both directions, an electronic fluorescent digital tape counter and control buttons for setting the clock and microprocessor programme timer to enable a recording to be made over a 10 day period.

Although the VT11E sells at a low price it still has all the important features including a test signal generator for setting the video channel on the TV monitor, automatic tape stop at the end of the tape and automatic shut off. In addition there is an automatic output change without the need for a TV/VTR switch, a heater for protection against moisture condensation damage, an auto or colour mode selector, tracking control, freeze frame, built in aerial booster and a full function remote control.

# LIGHTWEIGHT CAMERA

Yet another gem of technological miniaturisation from the East. This much reduced video camera, due to be launched in the UK in the Spring, overturns conventional notions of the size and weight requirements for portable video cameras.

Manufactured by the Konishiroku company, under the Konica brand name and weighing in at just 690 grams (including cable) it will be compatible with all video deck systems. The camera which has a 10–30mm 200m lens and an optional electronic view finder, will be available with a black or silver body and measures 58mm × 199mm × 106-5mm.



An important element in the camera is its energy saving design; power consumption being 10–20 per cent less than conventional portable video cameras. This is a decisive factor in extending total recording time. The company in their 110 years of experience have been in the forefront of innovation in cameras and film, and now this latest introduction extends the policy into the audio-visual market.

This move follows the recent news that Konishiroku Japan in partnership with Ampex, have moved into the audiovisual area and will be introducing into the UK the Konica range of high quality audio and video cassettes.

# 'DIGI CHECK'

The Steinal multi-tester has  $3\frac{1}{2}$  digit display and is a development of their very successful range of hand held Voltage Testers.



Both the point of the probe and the display can be seen together and as the readout is stored it remains visible even when the probe is removed from the test point.

The 'Digi Check' is priced at £92.66 excluding VAT and p&p from Toolrange Limited, Upton Road, Reading, Berkshire. (0734 22245)

## Cabletext...

With the introduction of cable TV there will be many applications for teletext in the UK and Mr. Geoffrey Hughes, Chief Executive of Oracle Teletext Ltd. has made the following statement; 'In general, we welcome the Hunt report and the prospect of cable TV in the UK. However, until firm rules are established, which will preserve existing broadcasting standards, I would prefer not to comment further!

'As far as teletext is concerned, we see real possibilities of development of our services and in fact we are already co-operating with Rediffusion in experimental tests of Cabletext, their advanced switched star cable system, which will demonstrate the potential of teletext on cable services.'

## ...Teletext

The British Teletext standard is fast becoming the de facto world standard according to Junior Industry Minister John Butcher. He noted at the launch of the London Oracle system that over 95 per cent of teletext sets throughout the world are based on the British system and that working services operating to the British standard are now up and running in 13 different countries.

Last month the Australian Government announced its acceptance of the UK teletext as the approved broadcast standard after two years of trial operations involving all the available systems.

Also in the USA, UK technology has provided the only system to be effectively sold with the inauguration of the 'Keyfax' national magazine, the first large scale consumer operation for teletext in the USA.

# ... HEUS & MARKEZ PLACE

## PHILIPS CTV

Philips have reduced the components in their conventional colour TV to produce a new range of sets for the 1990's-the CTX family:

The CTX models will all share a common



chassis, a single, compact board with a third less components than previous sets which means increased reliability and cheaper running costs for the consumer.

This radical new chassis, developed at Philips's research and development headquarters in Eindhoven, Holland is only a little larger than this page. The component count is just 386 compared with the previous models 564. The CTX has been tailored to meet the growing requirement for a simple low cost TV.

The first CTX model available in the UK is the 14" CT2006, a compact set measuring (310mm×450mm×360mm), and weighing 12kg, 14kg less than its predecessor, normal power consumption is just 39 watts. The picture tube is the tried and tested 570×90° in line, quick start.

Up to twelve channels can be pre-set and selected via light action push buttons, there are rotary controls for volume, brightness and colour, and a headphones socket is provided. A 16" set will appear shortly with remote control versions and 20" models to follow soon. CTX production will initially be abroad, but UK manufacture starts in 1983.

Finished in a robust, contemporary styled silver cabinet the CT2006 (14") comes complete with its own loop aerial and a main aerial socket for use in weak signal areas. Price around £170 inc. VAT.

For those of you who would like to hear the very latest in digitised synthetic speech just phone 0234 223377 and listen. The number will connect you directly to the new range of speech synthesis chips from Texas

According to Electronics Times the BBC, presently experimenting with stereo sound for BBC2, are keeping "mum" about the possibility of stereo broadcasting becoming a regular feature. Initial tests from the modified Crystal Palace transmitter to assess signal interference with existing transmissions are apparently first on the agenda. A modified German system is to be

 $\bullet$ 

Drawing upon the experience of an already well established Users Group, Proton Acceleration aims to provide full independent system support for a variety of 6502, 6509 CPU based machines including the BBC, Apple, Acorn and Microtan systems.

Their priorities will be in the design, production and distribution of hardware products for members at favourable user group prices. Proton also aim to establish a comprehensive software library compiled from users' own contributions and professional packages commissioned by them for specific applications.

Membership of the group is for a period of 12 months and will include a copy of the monthly newsletter the 'Accelerator'.

Proton Acceleration, 16 Iddesleigh Road, Charminster, Bournemouth, Dorset. (0202

# 

Please check dates before setting out, as we cannot guarantee the accuracy of the information presented below. Note: some exhibitions may be trade only. If you are organising any electrical/electronics, radio or scientific event, big or small, we shall be glad to include it here. Address details to Mike Abbott.

Christmas Holography (+ items for sale) Dec. 2-Mar. (1983) Light Fantastic Gallery, London. A8

ElectroNORTH Dec. 7-9. Harrogate Supercenter. Q IT82 (Information Technology Year Conf.) Dec. 8-9. Barbican. O

Continuous events at the National Microprocessor & Electronics Cntr. Peripherals Feb.2-4 1983. Cunard Int. Hotel, Hammersmith, London. ZI

BEX Bournemouth Feb. 9-10 1983. The Pavillion. K

Microsystems Feb. 23-25 1983. West Cntr. Hotel, Fulham, London.

CAD North Mar. 1-3 1983. Belle Vue Ex. Cntr., Manchester. Z1 Mailing Efficiency Mar. 1-3 1983. Bloomsbury Cntr. Hotel, London. Z Local Networks Mar. 8-10 1983. Royal Lancaster Hotel, London O Laboratory Edinburgh Mar. 16-17 1983. Assembly Rooms, George

Brighton Electronics March 1983. T

BEX Leeds Mar. 16-17 1983. Dragonara Hotel. K

INSPEX Mar. 21-25 1983. National Exhibition Cntr. Birmingham In-

Sensors & Systems Mar. 22-24 1983. The Forum, Wythenshawe. T Compec Wales Mar. 22-24 1983. Cardiff University. Z1

ETM (Electronic Test/Measurement) Mar. 22-24 1983. The Forum, Wythenshawe, Manchester. T

Laboratory Manchester Mar. 23-24 1983. New Century Hall, Corporation St. E

American Holography Mar.-June inc. Light Fantastic Gallery, Covent Garden, London. A8

All Electronics Show April 19-21 1983. Barbican Cntr. London. E Fibre Optics April 19-21 1983. Porter Tun Rooms, The Brewery (!), Chiswell St., London EC1. E

International Materials Handling April 19-26 1983. Earls Court. I International Packaging Exhibition April 25-29 1983. NEC B/ham. I HEVAC (Heating, Ventilation & Air Cond.) Apr. 26-28 1983. Barbican. I

Biotech May 4-6 1983. Wembley. O

The Business Computer Show May 10-12 1983. Wembley. O

Defence Components Expo May 10-12 1983. Metropole, Brighton. I Computers In The City (conf. & ex.) May 24-26 1983. Barbican. O Business Telecom May 24-26 1983. Barbican. O

International Wood Processing May 24-27 1983. Wembley Conf. Cntr. Z.

Russian Holography June-Sept. inc. 1983. Light Fantastic Gallery. A8 Semlab June 1983. Olympia. I

IBM Productivity (conf. & small ex.) June 14-16 1983. Tara Hotel,

Compec North June 21-23 1983. Belle Vue, Manchester. Z1

- Holographic Exhibitons & 01-836 6423
- Evan Steadman \$ 0799 22612
- Industrial Trade Fairs & 021 705 6707
- K Douglas Temple Studios & 0202 20533
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## FROM THE OPEN UNIVERSITY

# The State-of-the-Art Course on Microprocessors for Engineers



Thether you are already using microelectronics in product engineering or are only thinking about it, you will be well aware of the scarcity of engineers equipped with a sound, up-to-date knowledge of microprocessor technology

Now, the Open University has brought out a new self-study course on Microprocessors, combining state-of-the-art knowledge with the OU's highly successful teaching methods.

#### Microprocessors and Product Design. A self-study course for engineers:

Provides a complete, thorough and convenient introduction to the incorporation of microprocessor technology in product design. Although the course is primarily designed for self-study, it can also be used as the basis of an in-house training scheme.

 The course covers systems design, hardware and software development, prototype evaluation and final production.

It has been developed by the Open University with the backing of the Department of Industry as part of the Microprocessor Application Project.

 No previous knowledge of electronics or computing is assumed.

#### What the Course includes:

 HEKTOR - a fully assembled microcomputer development system to give engineers "hands-on" experience while they learn.

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for self-paced learning.

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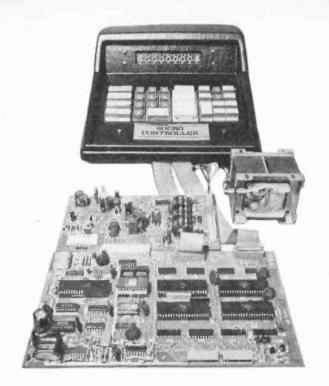
 Thousands of OU microprocessor courses are already being used by industry, by private individuals, and by colleges and polytechnics. Many have been incorporated into company training programmes.

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THIS is the final part of the series on the Microcontroller, and it concentrates on those aspects of the system which relate to its use in controlling practical external hardware. A detailed description of the workings of the 6821 PIA is given. Examples are included to demonstrate how peripheral circuitry may be driven from the keyboard (via DISBUG), and also under programmed control. Finally a set of notes and guidelines to assist with writing and debugging of control programs are included to help with the development of working programs for the Microcontroller.

#### THE 6821 PERIPHERAL INTERFACE ADAPTER

The 6821 Peripheral Interface Adapter (PIA) provides a flexible method of connecting peripherals to the CPU. The PIA is a programmable device designed to assist the CPU in controlling external hardware. Each PIA appears to the CPU as four memory locations, which may be manipulated with the full range of instructions. Internally, however, the PIA is a complex device and a full description of its capabilities is beyond the scope of a brief article. What follows, therefore, is a summary of those features of the PIA which are used most frequently in control applications.

A basic programming model for the 6821 PIA is shown in Fig. 1. As seen in previous issues, the PIA is essentially divided into 2 independent sections, A and B. Each section may be controlled separately by the CPU, and is provided with three registers for this purpose. Although the registers of sections A and B are addressed in an identical fashion, they differ electrically in certain respects. Both sides of the PIA have a drive capability of two TTL loads, but they behave differently on input. The output circuitry of the B side adopts a tri-state condition on input, whereas the A side inputs are taken high by internal pull-up resistors, and require a resistance to OV of  $1k\Omega$  or less to assume the 'low' state. The logic low/high levels are: <1.4 V and >1.6 V for A, and <0.7 V and >3.0 V for B. The A and B sides of the PIA are otherwise identical.

Each half of the PIA has three main elements: an Output Register, a Control Register, and a Data Direction Register.

# MIGRO CONTROLLER

MICHAEL TOOLEY, B.A. DAVID WHITFIELD M.A. M.Sc.

#### PART THREE

These registers appear to the CPU as if they are read/write memory locations, which may be written to or read from using standard instructions. Each group of three registers however, appear to the 6800 as if they are only two memory addresses. This is achieved by using part of the Control Register to determine whether the Output or Data Direction Register is selected by the second memory address. Table 1

IC Number	PIA	Base Address		ORB/ DDRB		CRB
14	User	1000	1ØØØ	1001	1002	1003
13	User	1400	1400	14Ø1	1402	14Ø3
12	Display	1800	1800	18Ø1	1802	18Ø3
11	Keyboard	1 CØØ	1 CØØ	1 CØ1	1 CØ2	1 CØ3

Table 1. Microcontroller PIA register addresses

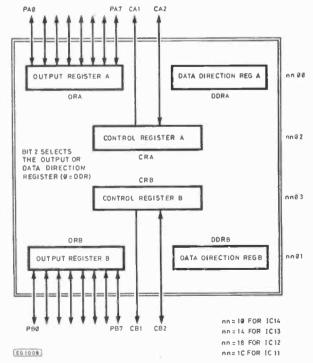


Fig. 1. Programming model for the 6821 PIA

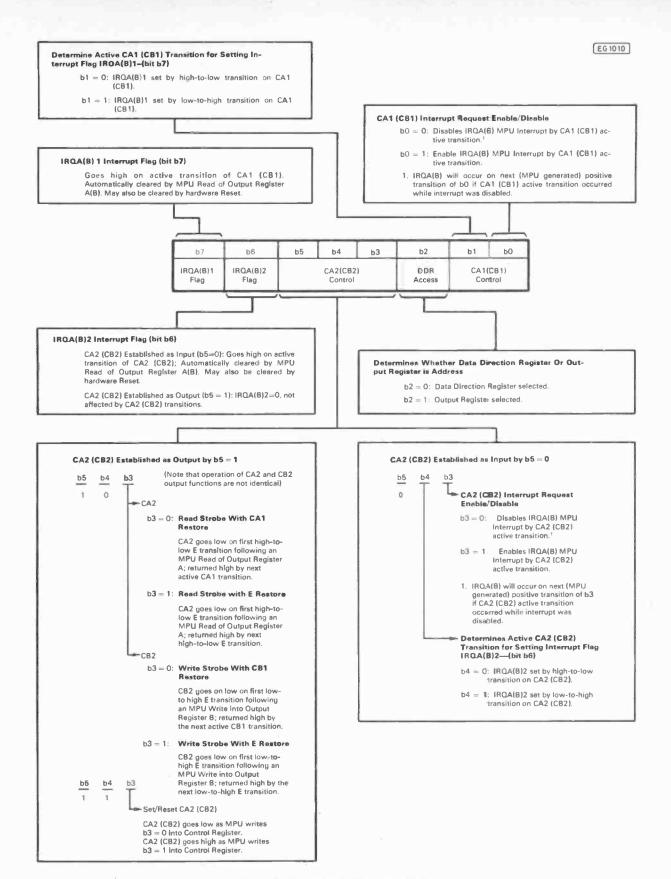


Fig. 2. Format of the PIA control word

shows the memory addresses which correspond to all of the PIA registers in the Microcontroller.

The Data Direction Register (DDR) is used to establish each of the eight peripheral lines associated with the half of

the PIA as either an input or an output. Each line may be programmed separately, an output is established by setting the appropriate bit in the DDR to a 'one', and an input by setting the bit to a 'zero'. The CPU sets up all eight lines at

once by writing an eight-bit value into the DDR. The Direction Register is selected whenever bit 2 of the associated Control Register is set to 'zero'. Whenever bit 2 is set to a 'one', the Output Register is selected instead.

The Output Register, when addressed, stores the data present on the CPU data bus during a write operation. This data will also appear on those peripheral line that have been programmed as outputs. Lines configured and used as inputs are unaffected by writing to the Output Register; unused inputs will float 'high'.

When the CPU reads an Output Register, the data present on the peripheral lines is transferred to the data bus. Lines which have been configured as inputs will assume their true corresponding bit states. However, lines designated as outputs will reflect the current state of the output rather than the current state stored in the Output Register. To avoid confusion when using a mixture of inputs and outputs in the same half of a PIA, it is suggested that a logical 'AND' be used to mask off the unwanted bits. For example, if the top four bits are used as inputs and the bottom four as outputs, any read operation should be followed by 'AND'ing the read value with FØ.

The Control Register allows the CPU to select whether the second of the pair of addresses associated with the half of the PIA relates to the Output Register or to the Data Direction Register. Bit 2 of the Control Register is dedicated to this function; Ø selects the DDR, and 1 selects the Output Register.

The remainder of the PIA Control Register is used to establish and control the operating modes of the peripheral control lines, CA1 and CA2/CB1 and CB2, respectively. These lines are used to allow control information to be passed between the CPU and the peripherals. In particular, all four lines may be configured to cause user interrupt requests (IRQs) when the state of the selected line(s) change(s) in the selected direction.

The format of the control word written to the Control Register is shown in Fig. 2; it should be noted that there are slight differences between the operation of the CA2 and CB2 output lines. A full discussion of the ways in which the Control Register may be set up to realise the full potential of the PIA could, and does, occupy tens of pages. Readers are, therefore, referred to a standard text for full details; for more straightforward applications, however, an example is given below. The routine listed is taken from the DISBUG monitor itself, and shows how the real time clock is configured to cause one second interrupts. These interrupts are subsequently serviced by another routine in DISBUG to update a running 16-bit count of seconds in locations Ø3E2 and Ø3E3; this can be very useful in user applications!

Code	Mnemonics	Comments
7F 18 Ø2 7F 18 Ø3 86 FF B7 18 ØØ B7 18 Ø1 86 34 B7 18 Ø2 86 35 B7 18 Ø3 ØE	CLR DPIACRA CLR DPIACRB LDAA #FF STAA DPIADRA STAA DPIADRB LDAA #34 STAA DPIACRA LDAA #35 STAA DPIACRB CLI	Select the two DDR Display PIA Registers Configure all lines as outputs Set CA2 as output l and select ORA Set CB2 as output, set CB1 interrupt, select ORB Enable user interrupts

At the end of this routine, any data written to locations 1800 and 1801 (ORA and ORB, respectively) will be output on PAO to PA7 and PBO to PB7, respectively. The B side of the display PIA has been configured so that a HIGH-to-LOW

transition on the signal applied to the CB1 line will cause a user interrupt request (IRQ). This will be recognised by the CPU because the interrupt mask has been cleared by the CLI instruction; the real time clock signal from IC2 is a 1Hz square wave connected to the CB1 line of IC12. When a HIGH-to-LOW transition occurs, the CPU will execute the user interrupt service routine; on the 6800 the start address of the user interrupt service routine is defined by the manufacturer to be held in locations FFF8 and FFF9. In DIS-BUG the IRQ service routine starts at FF90; readers are invited to use the memory editor to try and work out how this routine maintains the seconds count mentioned earlier! A disassembly table is included later to allow conversion of hex op codes back to understandable instruction mnemonics. The use of such a table is essential in debugging, and is vastly quicker than searching the assembly opcode table each time an unrecognised code is encountered.

#### **THE USER PIAs**

The Microcontroller has four PIAs; one primarily for the keyboard, a second for the display, and two free for user applications. There are a number of peripheral I/O lines on the keyboard and display PIAs which are not used by DISBUG, and these are thus also available to the user. The discussion which follows will refer to the two user PIAs, but many of the comments will also be true for the keyboard and display PIAs.

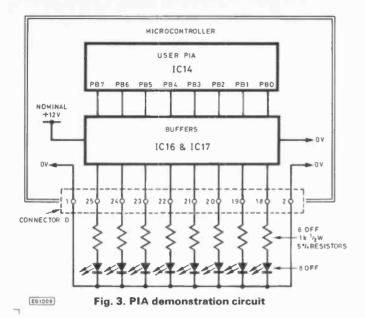
The original configuration for the Microcontroller was such that the majority of the peripheral lines were configured as outputs. These output lines were provided with high current drivers suitable for sourcing current at a nominal +12V. Readers should, however, note that this nominal supply may rise to approximately 17V in the absence of a load. These drivers will be ideal for many applications, especially those involving relay driving and lamp control; the power supply will provide load currents of up to 2A. Applications which require a significant number of input lines may necessitate some changes to the board; the simplest change is to remove the appropriate number of driver i.c.s and replace them with wire links to complete the circuit between the PIA(s) and the user peripheral connector D. Alternatively, the driver i.c.s may be re-fitted in sockets to allow the user to cater for a range of applications.

The simplest way to learn to use the two free PIAs is to drive them directly from the keyboard with DISBUG. This can be done because the PIA registers behave as standard read/write memory locations, and therefore all of DISBUG's memory examination and change facilities may be used. A simple example will be used to show how to set up and use one of the spare PIAs using DISBUG; later on we will show how to drive the same circuit from a control program residing in user RAM.

Fig. 3 shows a simple test circuit which may be attached to the Microcontroller via connector D. The eight I.e.d.s are connected to the 'B' side of IC14. These I.e.d.s will be used to indicate the logic state of any of the peripheral lines, PB0 to PB7, which are configured as outputs; in a real application the I.e.d.s could be replaced by relays, lamps, etc.

When the Microcontroller is first switched on, the clock generator i.c. outputs a reset signal to ensure that all of the PIAs are initialised to a known state. This state sets all of the PIA registers to zero, and hence the l.e.d.s will all be off. In a control situation, however, it is usual to make no such assumptions regarding the state of the PIAs, and the following example will show how to set up the selected PIA from an unknown state. The method described is therefore appropriate for use anywhere in a control program.

The first step in setting up the PIA is to set the contents of



the Control Register (CRB) to the value of 'ØØ'. This will have the effect of turning off the user interrupts, and of selecting the Data Direction Register (DDRB) instead of the Output Register. The memory editor is used to write '00' to location 1003 (i.e. CRB). The next step is to decide which of the I/O lines are to be inputs and which are to be outputs. In this example all of the I/O lines are to be used as outputs, and to accomplish this it is necessary to set each bit in DDRB to a '1'; setting all eight bits to a '1' is equivalent to setting the contents of DDRB to 'FF'. If it had been desired to set up PBO to PB3 as inputs, and PB4 to PB7 as outputs, the DDRB value would have been 'FØ' (equivalent to '11110000' in binary). Bit 2 of CRB is currently set to 'Ø', so setting up DDRB is simply a matter of writing 'FF' to location 1001 using the memory editor. The final step, before the PIA may actually be used to output data to the l.e.d.s, is to select ORB instead of DDRB. This is accomplished by setting bit 2 of CRB to '1' instead of 'Ø'; writing 'Ø4' to location 1ØØ3 will effect this change.

The l.e.d.s will now reflect any value which is written to ORB at location 1001. Thus a value of 'FF' written to location 1003 will turn on all eight l.e.d.s, whereas '80' will only turn on l.e.d. number 7 ('80' is equivalent to '10000000' in binary); 'AA' and '55' will produce complementary alternating on/off patterns.

Readers may now like to try setting up the A side of user PIA IC14 in an all-inputs configuration. The two register addresses are 1002 (CRA) and 1000 (DDRA and ORA). With nothing attached to connector D, the value read from ORA should be 'FF', due to the pull-up resistors R16 to R23. If pin 9 of connector D is now connected to OV with a wire link, and the value of ORA is re-read from location 1000, the result should now be 'EF'; this is because PA4 is now '0', while the other lines are still pulled up to '1' ('EF' is equivalent to '1110/1111' in binary).

#### **PROGRAMMED CONTROL OF PIAS**

Once the basic principles of using PIAs have been understood, the next step is to drive them from within control programs rather than from DISBUG. The following section will describe further examples based around the test circuit shown in Fig. 3. The role of DISBUG in these examples will now be to allow the control programs to be written into user RAM, and then to control their execution; all PIA operations will take place under programmed control.

The sample program shown below should be entered in the user RAM using DISBUG's memory editor. The suggested start address is 0000, but in fact the code is position independent, and could start anywhere in the user region. The line numbers are included for ease of reference, although they would be produced anyway by most computer-based (rather than hand-based!) assemblers.

Line	Address	Code	Mnemonics	Comments
1	ØØØØ	Ø1	NOP	To be replaced later
2	0001	7F 1Ø Ø3	CLR UPIACRB	Set all user PIA
3	0004	86 FF	LDAA #FF	B I/O lines to be
4	0006	B7 10 01	STAA UPIADRB	outputs
5	ØØØ9	86 Ø4	LDAA #Ø4	(Select the PIA
6	ØØØB	B7 10 03	STAA ÜPIACRB	Loutput register
7	ØØØE	7F 1Ø Ø1	CLR UPIAORB	Set all outputs to '0'
8	ØØ11	Ø1	NOP	To be replaced later
9	ØØ12	86 5 <b>5</b>	LDAA #55	(Output '55'
Α	ØØ 14	B7 10 01	STAA UPIAORB	to PBO to PB7
В	ØØ 17	Ø1	NOP	To be replaced later
С	ØØ18	86 AA	LDAA #AA	COutput 'AA'
D	ØØ1A	B7 1001	STAA UPIAORB	to PBO to PB7
Е	ØØ 1D	3F	SWI	Return to DISBUG

There are a number of points to be noted about this sample program. The first is that a simple way of returning from the program to DISBUG is shown in line E. Using a software interrupt instruction causes control to pass back to DISBUG, and since it will be indistinguishable from a breakpoint, DISBUG will dispay the address of the instruction (the display will be "E-001d-bP"). Unlike a real breakpoint, DISBUG will not remove the SWI op code and replace it with the original code because the breakpoint editor will not know of its existence; all 'real' breakpoints will be removed in the usual fashion.

The second point concerns the NOP instructions on lines 1, 8 and B. These will not have any effect on the operation of the program, other than slowing it down by approximately 6 microseconds. The purpose of these instructions is to allow them to be replaced by other op codes in the next example without having to re-enter the whole program from scratch.

Lines 2 to 7 of the program set up the B side of IC14 to be all outputs, with all lines initially set to 'Ø'. Lines 9 and A cause a pattern of 'Ø10101010' to be output, thereby turning on I.e.d.s 0, 2, 4 and 6. Lines C and D reverse this pattern to turn on I.e.d.s 1, 3, 5, and 7 instead. The software interrupt returns control to DISBUG. Running the whole program will cause I.e.d.s 1, 3, 5 and 7 to start in the off state and then go on, while I.e.d.s 0, 2, 4, and 6 will start in the on state and then go off.

The program is run using the GO function in DISBUG, and specifying a start address of  $\emptyset\emptyset\emptyset\emptyset$ , followed by ENTER. After a delay of up to 1 second caused by DISBUG, l.e.d.s 1, 3, 5, and 7 will light up. After a further delay of a second, also caused by DISBUG, control will return to the monitor with a display of "E–001d–bP", indicating that the SWI instruction at line E has been reached.

At this point readers are probably wondering why l.e.d.s 0, 2, 4, and 6 were never illuminated. The answer is that they were, but only for the time taken to execute lines B to D of the program, i.e. for approximately ten microseconds. This is a good example of the difference between real time and machine time!

What is required now is a way of relating machine time to real time. The table of 6800 instructions given in the last issue allows the time taken to execute particular instructions to be calculated. The use of the real time clock, however, allows a much more elegant (and usually much more efficient!) way of keeping track of elapsed time. The real time

clock (RTC) 'ticks' every second, and DISBUG arranges for each 'tick' to cause a user interrupt (IRQ), which is then serviced as described earlier. The RTC can thus be used to keep track of real time, while the CPU runs the program. All that is needed now is a way of relating the two events, execution of the program, and 'ticking' of the clock.

The 'wait for interrupt' (WAI) instruction is primarily intended to allow the interrupt response time (i.e. time taken for the CPU to get from the end of the instruction during which the interrupt was acknowledged, to the start of the interrupt service routine) to be minimised. This is only usually important when speed is critical, since all it saves is the time taken to push all of the CPU registers onto the stack. In the sample program a WAI (op code = '3E') instruction can be used to effectively force the CPU to wait until the next clock 'tick' before continuing. When the interrupt from the clock occurs, it will be serviced, and control will then return to the instruction following the WAI. This is almost all that we need to know in order to be able to synchronise the sample program to the real time clock. The additional information, required to provide repeatable performance, is that when DISBUG starts a program via GO or PROCEED, it waits until the next 'tick' of the real time clock before implementing the transfer of control. Similarly, when a software interrupt is encountered. DISBUG waits for the next 'tick' before it returns control to the keyboard. Users may therefore assume that, at the start of any program entered from DISBUG, the real time clock will have 'ticked' within the last few microseconds. It should therefore now be possible to synchronise the sample program to real time AND predict its run-time performance.

Replacing the NOP code in line B of the sample program with a WAI code, and re-running the program should now have the following results. After the ENTER following the start address, the display will go blank, there will be a delay of up to 1 second, and then I.e.d.s 0, 2, 4, and 6 will be illuminated. After a further one second delay, these I.e.d.s will go out, and I.e.d.s 1, 3, 5, and 7 will be illuminated instead. After a further one second delay, the display will show "E-001d-bP", as control returns to the keyboard.

The CPU registers may be examined using the register editor, and their contents compared with the values expected. The proceed function may be used to continue execution from a software interrupt with different register values. Alternatively, setting a breakpoint using DISBUG will allow the output pattern in the registers to be changed before being output to the PIA ORB, since breakpoints may be inserted at the start of any instruction in the program. As an exercise, readers may wish to try the effects of replacing some of the NOP codes with WAI ('3E') or SW1 ('3F') instructions, and comparing the results on the performance of the re-run program with their expectations.

#### **CONTROL FUNCTIONS**

To include even a brief discussion of all possible aspects of writing programs for control applications would more than fill an issue of PE. Rather than attempt the impossible, therefore, this necessarily short introduction to the subject will restrict itself to a few general guidelines which should prove useful in designing and writing control programs for the Microcontroller.

Not all of the suggestions which follow will be compatible with everyone's way of programming, or be suitable for every application, but they should provide some useful pointers to achieve the aim of a working program in the shortest time. In general, the principles described have been followed in the design and implementation of DISBUG itself, so if nothing else they will provide an insight into the monitor's internal workings! (The disassembly table in the next section

provides the means for obtaining the full details!)

- Decide WHAT is to be done first. Then decide HOW it is to be done. Finally write the code to implement the design. The temptation to write code as soon as possible is great, but a little thought can often save hundreds of lines of code.
- Keep it simple. It is difficult to keep in mind more than 50-100 lines of code at any time. Complex functions can usually be divided into a series of simpler operations; an added bonus is that some of these often turn out to be required by more than one function.
- 3. Keep it modular. Designing in functional units makes it simple to add to and change the overall design when the program is tried in practice. For example, DISBUG uses separate routines (implemented as subroutines) to refresh the display, scan the keyboard, decode the key, and process commands. Each module is subsequently further subdivided; for example each editor mode has a separate command processor.
- 4. Define interfaces carefully. A precise statement of what is passed (e.g. in registers or memory) to a routine, and what is assumed (e.g. interrupts are enabled), will help to minimise compatability problems. It also means that 'borrowing' routines for different applications can be done quickly and safely.
- 5. Do not sacrifice readability unless it is essential. It is almost always possible to re-code a routine to run faster and/or occupy less memory, but only usually at the expense of readability of the code. Readable code is easier to understand, especially

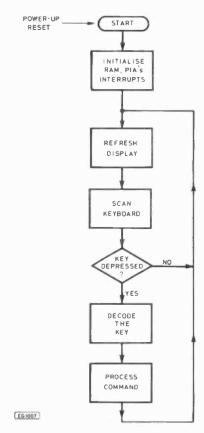


Fig. 4. Infinite loop control program—DISBUG top level routine

	Ø	1	2	3	4	5	6	7	8	9	A	В	С	D	E	F	1	
F	SE1		BLE  RELATIVE	SWI	CLRA *	CLRB • INHERENT	CLR • •	CLR * * *		STS • •	STS	STS • • •		ST X	STX 	STX • • • EXTD	F	
Е	CLI • INHERENT	/	BGT • •	WAI •			JMP • •	JMP • • •	LDS • • •	LDS • • DIRECT	LDS	LDS • • • EXTD	L D X	LDX • •	L DX	LDX • • • EXTO	Ε	
D	SEC •		BLT + + RELATIVE		TSTA .	TSTB .	TST	TST • • • EXTO	BSR • • RELATIVE	1	JSR • •	JSR • • • EXTD				1	D	
С	C L C		BGE • • RELATIVE		IN CA	IN CB	INC	INC • • • EXTD	CPX •••	CPX • •	CPX • •	СРХ • • • • Ехта					С	
В	SEV INHERENT	ABA	BMI + + RELATIVE	RTI • •NHERENT					ADDA • •	ADDA  DIRECT	ADDA  INDEXED	ADDA exto	ADDB • •	ADDB  DIRECT	A DOB	ADDB	В	
A	CLV • INHERENT		BPL • • RELATIVE		DECA • INHERENT	DECB • INHERENT	DEC	DEC • • • EXTD	ORAA • •	ORAA • • DIRECT	ORAA • •	ORAA • • • EXTD	ORAB 	ORAB 	ORAB 	ORAB • • • EXTD	А	
9	DE X	DAA •	BVS • • RELATIVE	RTS *	ROLA • INHERENT	ROLB • INNERENT	ROL 	ROL * * *	ADCA • • IMMED	ADCA * * DIRECT	ADCA 	ADCA ••• €xtD	ADCB	ADCB  DIRECT	ADCB INDEXED	ADCB extD	9	
8	INX • INHERENT		BVC • • RELATIVE		AS LA	ASLB .	ASL	ASL • • • EXTD	EORA • • IMMED	EO RA	EDRA  INDEXED	EORA ••• EXTD	EORB	EORB  DIRECT	EORB	EORB ••• EXTD	8	2 m
7	TPA • (NHERENT	TBA .	BEQ	PSHB • INHERENT	ASRA • INHERENT	ASRB "INHERENT	ASR • • • NDEXED	ASR • • • EXTD		STAA • • DIRECT	STAA + + INDEXED	STAA • • • EXTD		STAB  DIRECT	STAB 	STAB • • • ExtD	7	
6	TAP	TAB +	BNE  RELATIVE	PSHA *	RORA • INHERENT	RORB	R OR • • INDEXED	ROR • • • EXTD	LDAA • • IMMED	LOAA • • DIRECT	LDAA * *	LDAA * * * EXTD	LDAB • •	LO AB	LOAB 	LDAB • • • EXTD	6	
5			BCS • • RELATIVE	TXS • INHERENT					BITA • • IMMED	BITA • • DIRECT	BITA • • INDEXED	BITA • • • EXTO	BITB + + IMMED	BITB  DIRECT	BITB • • INDEXED	BITB  EXTD	5	
4			BCC  RELATIVE	DES • INHERENT	L SRA	LSRB • INHERENT	LSR • • INDEXED	LSR • • • EXTD	ANDA • • IMMED	ANDA + + DIRECT	ANDA • •	ANDA • • • EXTO	ANDB • • IMMED	ANDB + + DIRECT	ANDB	ANDB • • • EXTO	4	
3			BLS • • RELATIVE	PULB • INHERENT	COMA • INHERENT	COMB • INHERENT	COM • •	COM • • • EXTO									3	
2	/		BH I RELATIVE	PULA • INHERENT	1		1	1	SBCA • •	SBCA	SBCA • • INDEXED	SBCA • • • EXTD	SBCB • • IMMED	SBCB	SBCB • • INDEXED	SBCB • • • • xT0	2	
1	NOP # INMERENT	CBA • INHERENT		INS • INHERENT	1			1	CMPA • • IM MED	CMPA + + DIRECT	C MPA • •	CMPA • • • EXTO	CMPB + •	CMPB  DIRECT	CMPB  INDEXED	CMPB * * * EXID	1	
0	/	SBA *	BRA  RELATIVE	TSX *	NEGA #	NEGB *	NEG • •	NEG • • • •×TO	SUBA • •	SUBA * * DIRECT	SUBA • •	SUBA • • • EXTO	SUBB * *	SUBB • • DIRECT	SUBB • •	SUBB • • • ExtD	Ø	
	Ø	1	2	3	4	5	6	7	8	9	Α	В	С	D	Ε	F		

IST OF CODE DIGIT

Table 2. Disassembly table for 6800 instructions

some time after it has been written, and is usually easier to modify. Optimise only when and where necessary.

6. Write it down. Documentation is often seen as a chore, until it comes to debugging or modification. Write down design notes to accompany the code, and at least you will know what the program was supposed to do when it doesn't!

The final suggestion is a way of organising a control program which is suitable for continuous situations, i.e. where something is to be monitored, and action taken depending on the result. Such a program will generally include an initialisation procedure; this will usually only be ex-

ecuted when the program starts and will, for example, configure the PIAs as appropriate. The program will then enter an infinite loop of the form shown in Fig. 4, and will continuously monitor the selected events, check against some conditions, and take appropriate action. The whole process then repeats. The example of Fig. 4 is actually the top level design of DISBUG; there are up to five levels of subroutine below the one shown. For enthusiastic disassemblers, this routine starts at address F800 in the DISBUG EPROM!

#### **DEBUGGING**

The point arrives sooner or later when a program has been designed and coded, and is now residing in user RAM, ready

to run. When the program is first run, however, the chances are that, no matter how carefully the coding has been done, not everything will go quite as expected. Be assured, this is not a new problem! On the contrary, the first-time success rate for real programs is low enough to be used as a good example of the difference between the theory and practice of programming. The problem now is to find the 'bugs' which are preventing the program from running properly, a process which has become known as debugging.

In general, debugging is concerned with the removal of four types of error from a program. These are:

- Errors in the design of the program. Typically this type of error is the result of making an assumption which is not valid, e.g. waiting for an interrupt which the PIAs have not been set up to generate.
- Errors in the coding of the design. Typically this will be using the wrong instruction to perform the function required, or using an instruction to perform a function which it does not, e.g. expecting an INC to increment a value AND expecting it to set the Carry flag.
- 3. Errors in implementing the code. Typically, this will result from mis-remembering or mis-reading the op code from the table, e.g. 38 instead of 3B for a RTI. This is probably the most frequent type of error!
- Errors in locating the program. This will cause jumps and data storage to relate to the wrong addresses.

In many cases, what the program actually does, rather than what it should do, will provide some useful hints as to the source of the problem. The next step is to narrow down the area of search for the error using breakpoints. At each breakpoint the contents of the registers should be examined, along with any significant memory locations, and the contents compared with the values expected. If the values do not appear to agree with expectations, a search back in the code may well reveal the cause of the problem. Backtracking in the code requires a disassembly table to allow the opcodes to be converted back to instruction mnemonics in order to ensure that the correct code has been generated. A disassembly table for the 6800 instruction set is provided in Table 2.

Breakpoints in loops in the program should take note of the fact that, when a breakpoint is encountered, the proceed function will continue execution from the breakpoint, but with that breakpoint removed. This means that, when debugging loops of code, it is a good idea to put in two breakpoints, one at each end of the loop. This will ensure that if the program is in fact looping continuously, it will still hit a breakpoint!

In general it is a good idea to test all routines as thoroughly as possible since it will usually save a great deal of time when they are assembled together into a complete program. If the component parts have been tested, the fault can then usually (but not always!) be traced to the overall control loop or to the interfaces between the routines. The aim always is perfection, but reality is that it is impossible to test every combination of inputs and outputs in a program which is of any significant length. Thorough testing, however, is the soundest approach to building up complex programs which will be robust in use.

#### CONCLUSION

This part concludes the series of articles describing the Microcontroller system. The information which has been provided should be enough to allow the development of control systems for practical hardware applications, and in this sense the ball is now in the reader's court! The uses to which

the system can be put are a challenge to the imagination and ingenuity, with the possibility of tangible recognition in the competition organised by Display Electronics Ltd.

The descriptions of the 6800 CPU and 6821 PIA have necessarily concentrated on the basic and most frequently used facilities. Users are therefore referred to a standard 6800 reference manual for the fine details of some of the more involved operations.

Further information regarding some of the practical problems which are often encountered in relating microprocessors to the real world will be covered in a new short series starting soon in PE. This will discuss how to convert from the purely digital 'clean' world of the microprocessor, where everything is expressed as a TTL '1' or '0', to the real world of noise and continuously varying levels. This series will be especially relevant to the Microcontroller since many of the examples given will be based around the 6821.

#### Competition

A competition is being run by Display Electronics to find the most practical application for the Microcontroller system. The winning entry which will be considered for publication in PE will receive £300 in cash or goods from Display Electronics to the value of £400. Full details from Display Electronics.

#### Prices

The complete Microcontroller system (excluding the case) is priced at £32.95 plus VAT and £2.00 p&p. The case is priced at £19.00 plus VAT and £1.00 p&p. Display Electronics, 64–66 Melfort Road, Thornton Heath, Surrey (01-689 7702).

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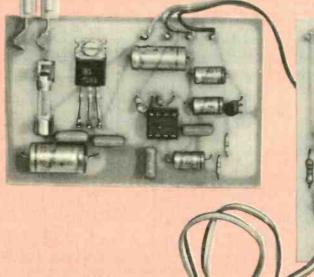


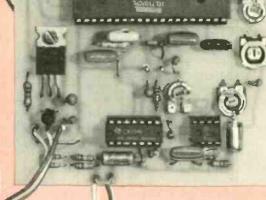
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# DIGITAL TACHOMETER ESE

MICHAELTOOLEY B.A. & DAVID WHITFIELD





THE TORQUE produced by an engine tends to fall off at high, and low engine speeds, and thus an indication of the rate at which an engine turns over can be a very useful facility in everyday driving situations.

The average saloon car performs best at approximately 2000 to 3000 r.p.m. and consistent driving at this angular velocity will help ensure optimum performance in terms of both acceleration and fuel consumption for the particular gear selected. Furthermore, since the forces exerted on the engine unit vary with the square of the engine revs, it is important that the maximum r.p.m. for a particular engine is not exceeded, irrespective of the actual road speed.

The Digital Tachometer described provides a digital display of the engine r.p.m. The maximum resolution of the display is 10 r.p.m. and the unit may be calibrated for four, six or eight-cylinder engines. The calibration procedure is carried out before the tacho is installed in the vehicle, and only requires the use of an a.f. signal generator. The display uses conventional seven-segment l.e.d.s and the brilliance is fully adjustable so that the driver can compensate for the effect of changes in ambient light level. This is particularly important when driving in darkness since the glare of an overbright l.e.d. display can act as a considerable distraction. Alternative layouts are given for 0.5in. and 1in. l.e.d.s to suit the individual constructor's preference.

#### SYSTEM DESCRIPTION

The simplified block schematic of the Digital Tacho is shown in Fig. 1. Input pulses derived from the contact breaker terminal of the ignition coil are taken, via an input protection and shaping circuit, to a high gain amplifier. The output of the amplifier is a rectangular waveform at the same frequency as that of the contact breaker pulses. This signal is applied to a monostable circuit which generates a pulse of fixed duration whenever a falling edge input is encountered. Unlike the signal derived from the contact breaker, the rectangular pulses generated by the monostable are noise free, of constant amplitude, and have consistent pulse width.

The clean monostable pulse train output is then applied to a passive integrator circuit, the output voltage of which is a linear function of the input pulse repetition frequency. To prevent the effects of integrator loading, which would otherwise cause non-linearity, a high-impedance unity gain buffer amplifier follows the integrator stage. The output of the buffer amplifier is an analogue representation of the input pulse repetition frequency. This voltage is then applied to a digital panel meter i.c. and associated seven-segment l.e.d. display.

The unit has a separate power supply for operation from a nominal 12V d.c. input. This provides the various supply rails

and is not shown in Fig. 1.

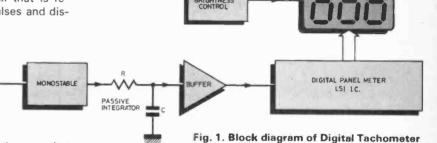
#### **RPM MEASUREMENT**

The distributor shaft of a four-stroke engine rotates at exactly half the speed of the engine crankshaft and is responsible for opening and closing the contact breaker points. The contact breaker interrupts the current flowing in the primary of the ignition coil and the number of current pulses per minute, N, in the winding is given by:

 $N = 0.5 \times \text{(engine r.p.m.)} \times \text{(number of cylinders)}$ 

Thus, a four-cylinder engine operating at 3000 r.p.m. produces 6000 current pulses per minute. All that is required is a circuit to shape and count these pulses and display the result in digital form.

shown in Fig. 3 and the corresponding component layout is given in Fig. 4. Sockets should be used for all three integrated circuits and components should be fitted in the following order; terminal pins, i.c. holders, resistors, capacitors, pre-sets, diodes and transistors. Care should be taken to ensure that all polarised components, such as capacitors and diodes, are correctly orientated. When assembly of the p.c.b. is complete it should be carefully inspected for dry joints and solder bridges between tracks. A length of 22-way ribbon cable is used to interconnect the



#### CIRCUIT DESCRIPTION

EP 1015

Fig. 2 shows the circuit diagram of the signal processing and display sections of the Digital Tacho. A voltage limiter, consisting of R1 and anti-parallel silicon diodes D1 and D2, provides simple but effective input protection. The signal voltage at the junction of R1 and R2 is thus limited to approximately 1.2V peak-peak. ICla forms a simple inverting amplifier with a fixed gain of 10. This provides an output voltage at C2 of approximately 10V peak-peak.

A 555 timer, IC2, is connected in conventional monostable mode and the monostable pulse duration is set by means of VR1. The output of the monostable is developed across R6 and the integrator circuit is formed by R7 and C4. The component values used exhibit a time constant of 1 second. The integrator output is buffered by ICIb which is then followed by a second passive integrator of time constant 10 ms. This removes any noise present on the analogue signal which is fed to the digital meter, IC3. This device is a 7107 digital voltmeter. VR3 sets the internal clock frequency at around 50kHz (in vehicle applications the clock frequency is not critical) whilst VR4 provides adjustment of the reference voltage.

A discrete Darlington pair, TR1 and TR2, form a simple variable voltage source which is adjustable, by means of VR5. over the approximate range 2·2V to 5·6V. The voltage is applied to the common anodes of the three seven-segment displays, X1, X2, and X3. Decoupling of the +5V and -5V rails is provided by C10 and C11 respectively.

The circuit diagram of the power supply is also shown in Fig. 2. This provides output rails of +12V. +5V, and -5V. The +5V rail is derived from a conventional monolithic voltage regulator, IC1. Another 555, IC2, connected in astable mode generates a square wave at approximately 7kHz. This square wave is applied to the negative going voltage doubler formed by D1 and D2. The unregulated negative output voltage is developed across C8 and then applied to a low-power negative monolithic voltage regulator, IC3.

#### CONSTRUCTION

The Digital Tacho uses three separate printed circuit boards and is thus built in three separate sections; signal processing, display, and power supply. The constructional details will therefore deal with each section in turn. The p.c.b. copper foil layout of the signal processing section is

signal processing and display p.c.b. and this is terminated along one edge.

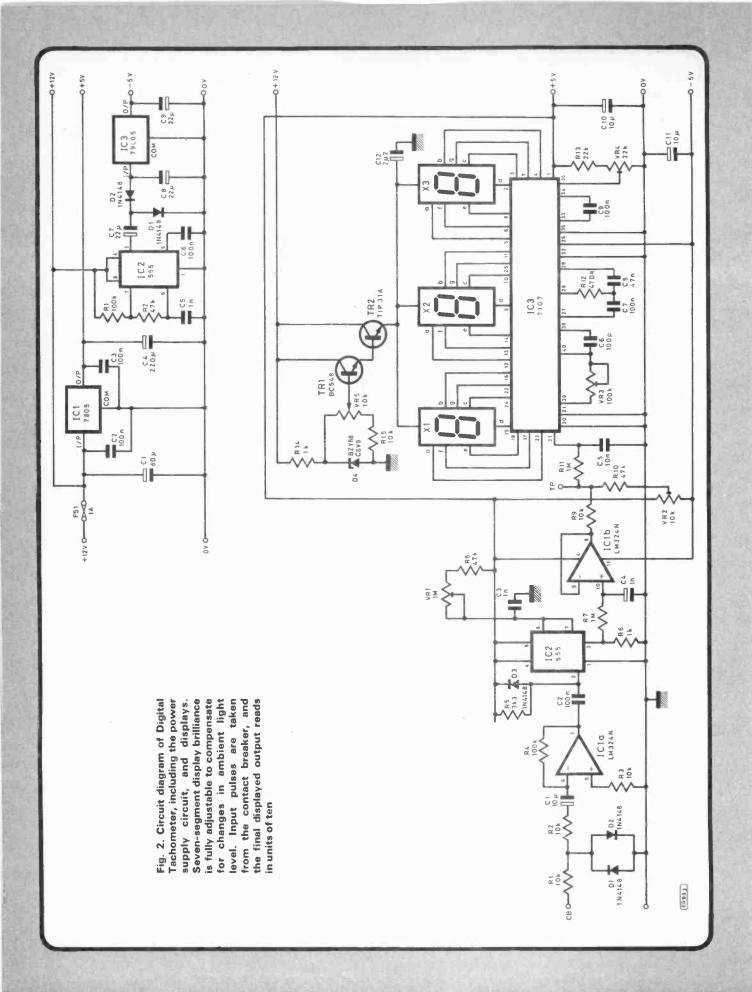
The copper foil layout for the power supply p.c.b. is shown in Fig. 5 together with the corresponding component layout in Fig. 6. The i.c.'s on this board do not require holders and, furthermore, a heat sink will not normally be required by IC1. Component assembly should follow the sequence; terminal pins, fuse clips, blade connectors, resistors, capacitors, diodes and i.c.'s. As with the signal processing board, care should be taken to ensure the correct orientation of all polarised components. When complete, the board should be similarly inspected for dry joints and solder bridges between tracks.

The copper foil layout for the O.5in. display p.c.b. is shown in Fig. 7 whilst that for 1in. displays is shown in Fig. 8. The corresponding component layouts are provided in Fig. 9 and 10 respectively. Note that, in either case, the 22-way ribbon cable from the signal processing board terminates along the *top* edge of the board. Little further comment is required, save that of repeating the need to carefully inspect the completed p.c.b.

The three completed p.c.b.s are connected according to the wiring diagram shown in Fig. 11. A short length of 22way ribbon cable interconnects the display and signal processing boards. Care must be taken to ensure the correct orientation of this cable. Note that letters are used to identify each individual wire on the component layout diagrams. The power supply p.c.b. is connected to the signal processing p.c.b. by four wires carrying +12V, +5V, -5V and OV. The signal input on the signal processing board is derived from the contact breaker terminal on the ignition coil. A separate OV (earth) connection may also be made if desired. The power input from the vehicle consists of two wires, +12V and OV, which are terminated on the power supply p.c.b. A further three wires connect the display brightness control, VR5, to the signal processing p.c.b. To avoid confusion, the use of appropriately colour coded wire is highly recommended.

#### INITIAL TESTS AND CALIBRATION

Functional tests and calibration should be carried out before wiring into the vehicle. The power source should



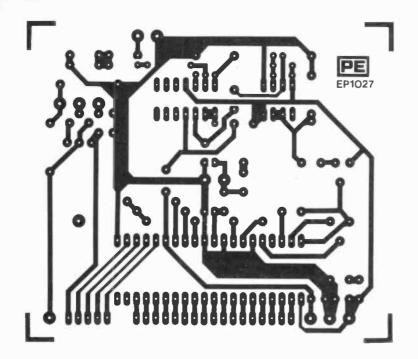


Fig. 3. Printed circuit board layout (actual size) of the Tacho's main processing board

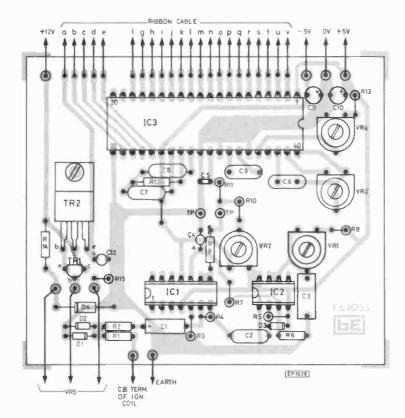


Fig. 4. Component layout of the main processing board

#### COMPONENTS ...

### SIGNAL PROCESSING AND DISPLAY BOARDS

#### Resistors

R1-3, R9, R15	10k (5 off)
R4	100k
R5	3k3
R6, R14	1k (2 off)
R7, R11	1M (2 off)
R8, R10	47k (2 off)
R12	470k
R13	22k

All fixed resistors, except where otherwise stated, are 0.25W 5% carbon

#### **Potentiometers**

VR1	1 M min. horizontal skeleton pre-set
VR2	10k min. horizontal skeleton pre-set
VR3	100k min. horizontal skeleton pre-set
VR4	22k min. horizontal skeleton pre-set
VR5	10k lin. wirewound potentiometer

#### Capacitors

C1, C2, C7, C9	100n	polyester (4 off)
C3	1n	polystyrene
C4	1μ	35V tantalum
C5	10n	polyester

C6 100p silver mica C8 47n polyester

 $\begin{array}{ccc} \text{C10, C11} & & 10 \mu & & 35 \text{V tantalum (2 off)} \\ \text{C12} & & 2 \mu 2 & & 35 \text{V tantalum} \end{array}$ 

#### Semiconductors

D1-3	1N4148 (3 off)
D4	BZY88 C6V8
TR1	BC548
TR2	TIP31A

#### **Displays**

X1-X3 0.5" or 1" common anode seven-segment l.e.d. display (3 off)

#### Integrated circuits

IC1	LM324N
IC2	555
1C3	7107

#### Miscellaneous

8-pin d.i.l. socket (1 off)
14-pin d.i.l. socket (1 off)
40-pin d.i.l. socket (1 off)
Terminal pins (11 off)
Short length of ribbon cable

Short length of ribbon cable (22 way)

P.c.b. (2 off) Display filter

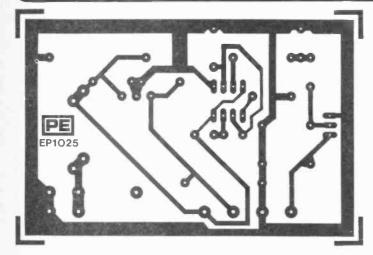


Fig. 5. Printed circuit board layout (actual size) of the PSU

#### COMPONENTS ...

#### POWER SUPPLY BOARD

#### Resistors

R1 100k R2 47k

#### Capacitors

C1	80µ	25V tubular electrolytic
C2-3, C6	100n	polyester (3 off)
C4	220μ	10V tubular electrolytic
C5	1n	ceramic
C7-9	22µ	25V tubular electrolytic (3 off)

#### Semiconductors

D1, D2	1N4148 (2 off)
IC1	7805
1C2	555
IC3	79L05

#### Miscellaneous

P.c.b.
P.c.b. fuse clips (2 off)
1A 20mm fuse
Terminal pins (4 off)
Blade connectors (2 off)

Fig. 6. Component layout of the PSU

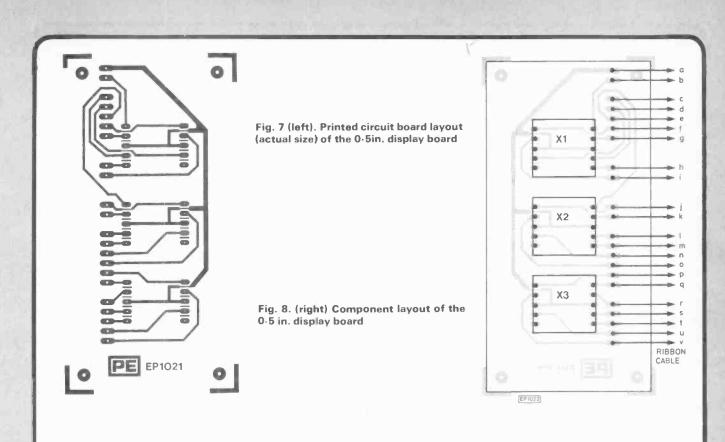


Fig. 9 Printed circuit board layout (actual size) of the 1 in. display board

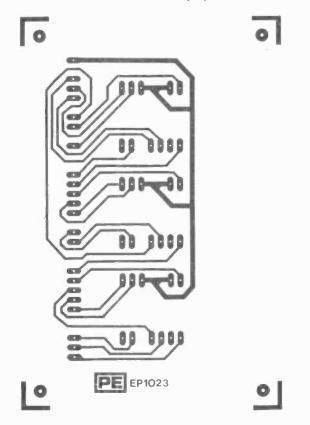
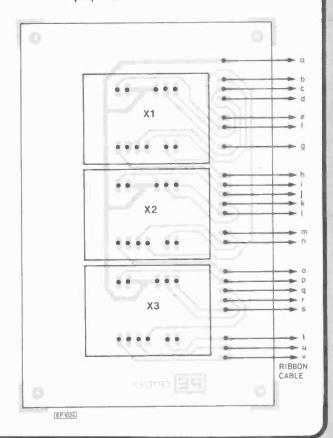


Fig. 10. Component layout of the 1 in. display board



33

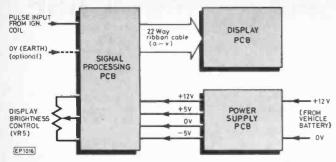


Fig. 11. Wiring arrangement between the separate boards

ideally be a well regulated 12V d.c. power supply which incorporates some form of electronic over-current protection. If a current trip is not fitted to the power source, the 1A fuse in the positive supply input should, at least, offer some measure of protection against catastrophic faults!

Adjust the controls as follows; VR1 fully clockwise, VR2, VR3, VR4 and VR5 all set to mid-position. Temporarily insert a d.c. milliammeter on the 1A d.c. range in the positive supply lead. The power supply should then be switched on and the supply current noted. This should be in the range 50mA to 150mA and the display should be illuminated, though it will not necessarily read zero. If the current is in excess of 200mA, or much less than 50mA, carefully check the p.c.b. interconnections, supply voltage rails, and then each board in turn. As a guide, typical test voltages are given in Table 1.

With the signal input left disconnected, adjust VR2 to obtain a display of "000". With the aid of an electronic or digital voltmeter adjust VR4 for a reading of exactly 1V at pin 36 of IC3 on the signal processing board. Re-adjust VR2, if necessary, to maintain a display of "000". Now connect an a.f. signal generator to the signal input leads. The signal generator should be set to provide a 12V p—p square wave output at 200Hz. Adjust VR1 for a display reading of "600". This corresponds to an indication of 6000 r.p.m. with a four-cylinder engine. For six and eight-cylinder engines, VR1 should be set to display "600" with input frequencies of 300Hz and 400Hz respectively.

The operation of the brightness control should now be checked. The display brilliance should vary reasonably smoothly, from almost completely dark to very bright, over the full range of adjustment. This completes the initial checks and calibration and the unit is now ready for installation in the vehicle.

	TABLE 1. Tes	st voltages
IC100	input	+12V
	output	+5V
IC101	pin 4	+12V
	pin 8	+12V
IC102	input	-8·5V
	output	−5V
IC1	pin 4	+5V
	pin 7	OV
	pin 8	OV
	pin 11	-5V
IC2	pin 2	+5V
	pin 3	OV
	pin 4	+5V
100	pin 8	+5V
IC3	pin 1	+5V
	pin 26	_5V
	pin 36	+1V
TR1	collector	+12V
	base	+6.8V
	emitter	+6·1V
TR2	collector	+12V
	base	+6·1V
	emitter	+5·3V
Test point		OV
		using a multimeter of 20k control is set to 'maximum',

#### INSTALLATION

The three p.c.b.s may be located within the passenger compartment to suit the individual constructor's preference and the constraints of the vehicle. The display p.c.b., in particular, may be situated either behind the existing dashboard or in a separate surface mounting "pod". Similarly, the display brightness control can either be positioned so that it harmonises with the existing dashboard controls or it can be tucked away on a small bracket beneath the dash. The use of a polarised red display filter is highly recommended since this considerably improves the appearance and visibility of the display. The +12V supply for the unit can be taken from any suitable point, including the rear of the ignition switch. The power should, of course, only be present when the ignition is switched on.

no input connected, and the display indication is "000".

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## FROST WARNING

#### MICHAEL TOOLEY B.A. & DAVID WHITFIELD M.A. M.Sc.

Severe damage can be caused to a car engine when its operating temperature is allowed to exceed a safe working limit. Such a condition usually results from the loss of engine coolant or from a circulation failure within the system. Few modern vehicles are fitted with a comprehensive temperature gauge and most manufacturers seem content to rely solely on the provision of a temperature warning light which is often 'lost' amidst a maze of other indicator lamps. Unfortunately, the driver who fails to notice such a warning is almost certainly destined to incur some hefty bills for the repair of damage to the vehicle's engine.

Very low temperatures experienced when a car is left stationary and without the protection of a suitable 'antifreeze' mixture can have equally disastrous results. In this case the driver is provided with no warning until the temperature light operates to alert him to the fact that the majority of the coolant has escaped through cracks in the engine block!

Obviously what is required is a reliable warning indication of abnormal engine temperatures which may preferably be programmed for either under or over temperature conditions. Such a device should provide both audible and visual alarm signals and reset automatically when the temperature returns to a normal state.

The unit described provides exactly this function and furthermore uses a minimum of readily available low-cost components. It may be easily fitted to the vehicle and calibration requires little more than a kettle, some ice, and a thermometer!

#### CIRCUIT DESCRIPTION

1000

The temperature sensitive transducer, TR1, produces a base emitter voltage which is a function of the junction temperature. The transistor forms part of one arm of a bridge with R1, R2 + VR1, and R3 as the other arms. The output voltage of the bridge (which is also a function of the junction temperature of TR1) appears between A and C.

The operational amplifier, IC1, is sonnected as a comparator which responds to the polarity of the voltage present at its input, B and D. When the potential at B exceeds that at D, the output of IC1 falls to approximately OV. When the potential at D exceeds that at B, the output of IC1 rises to almost the full supply voltage. The output voltage of the comparator is inverted by means of TR1 and D1 is included to improve the witching action of the overall arrangement. The output from TR2 is then applied to a 555 timer, IC2, connected in an astable configuration.

The astable provides an output at approximately 1Hz and this is applied to the I.e.d., D2, via an appropriate series resistor, R9. The low frequency square wave output is also connected to a second 555 astable, IC3. This stage operates at approximately 1.2kHz and its output is taken via coupling capacitor, C4, to a miniature loudspeaker.

The unit is protected against inadvertent reverse connection of the supply by means of D3. C5 provides de-coupling of the supply voltage rail.

#### CONSTRUCTION

The components are assembled on a small piece of 0·1in matrix Veroboard measuring approximately 80mm x 43mm. Construction is not at all critical and a suggested layout is provided in Fig. 2. To permit removal of the integrated circuits, the use of low-profile DIL i.c. sockets are highly recommended. Terminal pins should be employed to facilitate interconnection of the circuit board with the case mounted components. The recommended sequence of assembly is as follows: terminal pins, i.c. sockets, resistors, capacitors, transistors, diodes and links.

When assembly is complete, a careful check should be made; the top side of the board should be examined for correct placement and orientation of components whilst the underside should be inspected for dry joints and solder bridges between tracks. Breaks in the tracks should be made using either a proprietary spot face cutter or with the aid of a small sharp drill.

The circuit board should be mounted in the base of the plastic case using two small stand-off pillars. On order to avoid inadvertent short circuits, care should be taken to lear the tracks on the underside of the board in the vicinity of the pillars. This precaution will, of course, be unnecessary when insulating pillars are used. Interconnections from the board to the case mounted components are made using short lengths of insulated wire.



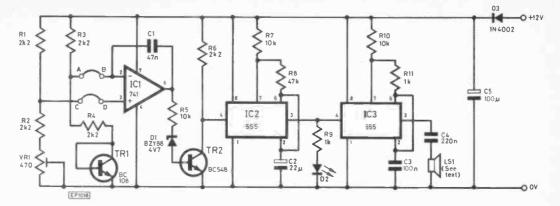
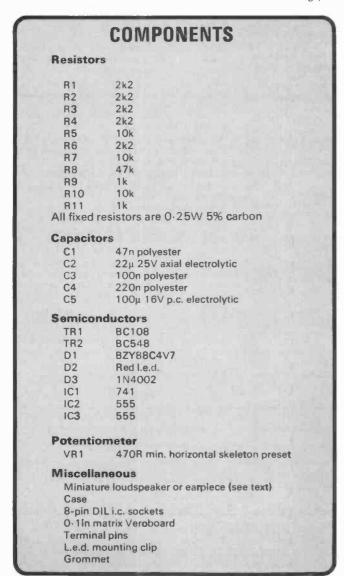


Fig. 1. Circuit of Frost Warning.

The transducer used for the audible output of the alarm may be a conventional loudspeaker, an earpiece, or even a standard telephone insert. The nominal impedance of such a unit can be anywhere in the range 8 ohm to 10 kilohm however the sound intensity produced is likely to vary widely according to the type of transducer employed. Most small transistor radio loudspeakers will produce more than ample volume and the value of the coupling capacitor, C4, may be altered to increase or decrease the sound level accordingly.



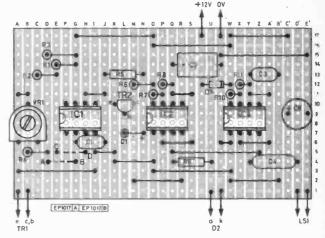


Fig. 2. Veroboard assembly details.

#### ADJUSTMENT AND INSTALLATION

Calibration can most easily be carried out before fitting the unit to the vehicle. Where the device is to be used for the provision of over-temperature indication, a kettle of boiling water will be required together with a reliable thermometer which can be read to an accuracy of 1 or 2 degrees Celsius.

Boiling water from the kettle should be carefully poured into a heatproof measuring jug. The thermometer is placed in the jug together with the temperature transducer, TR1. Care should be taken to ensure that the transistor leads do not become immersed in the water. The links on the circuit board should be connected A to D and C to B. The threshold control, VR1, should be adjusted so that the alarm operates above 98 degrees Celsius and ceases to operate below this value.

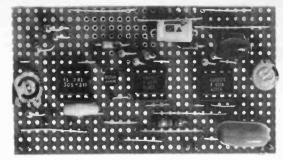
The optimum working temperature for a car engine, regardless of road speed, is one which raises the coolant in the vicinity of the thermostat housing to a temperature of approximately 85 degrees Celsius. Note, however, that since the coolant operates under pressure, its boiling point is greater than 100 degrees Celsius. Typical values, depending upon the pressure cap setting and height above mean sea level, are in the range 110 to 114 degrees Celsius.

Under-temperature calibration, with the links connected A to B and C to D, should be carried out using a mixture of crushed ice and salt. The threshold control being adjusted so that the alarm operates below -2 degrees Celsius and ceases to operate above this value.

The finished alarm module can be installed at any convenient point within the passenger compartment. The loudspeaker should, if possible, be located so that its output is directed upwards towards the driver. Power for the unit can be derived from any convenient point after the ignition

switch. The unit should thus only receive its supply when the ignition is 'on'.

The temperature transducer, TR1, should be mounted on the engine block well away from the exhaust manifold. Ideally, a small hole should be drilled into the block into which the transistor is tightly fitted. This arrrangement is, however, not recommended since not only may damage result to the block if the hole is improperly located but, as the metal case of the transistor is connected to its collector, a short circuit to the vehicle's 'earth' may result. A better method is to use a small metal clip insulated from the transistor's case and bonded to the engine block in the vicinity of the thermostat housing with a suitable heat and moisture resistant epoxy resin. The transistor leads should be sleeved using silicon rubber sleeving and a substantial flexible heat



The completed Frost Warning unit

resistant cable should be used to interconnect the transducer to the alarm module.

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ARP POLYSYNTH, perfect condition, must sell. Bargain £285 o.n.o. Tejinderpal Sidhu, Amity, Strafford Road, Hounslow, Middlesex TW3 3EN. Tel: 01-570 7975.

UK101 8K 300, 600 Baud 12MHz MON 02 BASIC 5. Uncased £100 o.n.o. Mr. 8rant, 5 Deben Close, Walton. Chesterfield, Derby. Tel: (0246) 36021.

ACÓRN ATOM 12K RAM, 8K ROM, new keyboard, colour board, p.s.u., literature and software £200. Mr. R. Hizzey, 43 Bouncers Lane, Prestbury, Cheltenham, Glos. Tel: Cheltenham 75714.

MULTIMETER v.g.c. £15. No offers, incl. postage. Tel: 01-554 2913, 6-9p.m. Shaft.

OKI CP110 upper case matrix printer. RS232 + parallel interfaces suitable for UK101, Video Genie etc. £100 o.n.o. Peter Vince, 19 Links Road, Ashtead, Surrey KT21 2HB. Tel: 03722 72713.

**PHILIPS** 1700 v.c.r. with tapes, needs new head £100, must collect. Personal Hi-Fi £15 + £1 postage. Essex. L. A. Privett, Barking, Essex. 01-591 4248.

P.E. JOANNA electric piano. Assembled kit and case, interwiring to complete. Offers. Tel: 061 980 2620. Mr. S. C. Walsh.

**OLIVETT!** TE300 has anyone any information on this terminal for sale or loan? Phone: Alsager 6513. A. J. Cartwright.

T159 CALCULATOR £75 PC100C printer £80, pair Coles 4001G unused £10 + p.&p. T1L311 £2.50 each + p.&p. I. C. Bannister, 4 Lucas Way, Shefford, Beds. SG17 5DT. After 6p.m. (0462) Hitchin 814748.

**ZX80 FOR SALE.** 1K RAM. 4K ROM. Manual and adaptor. Fully operational. Ideal for beginners. Duncan Martin, 17 Congreve Way, 8ardsey, Nr. Leeds LS17 9BG. Tel: Collingham Bridge 72791.

ATOM 12 + 13K, power supply, 3 utility EPROMS, 26 program cassettes, EPROM burner, books, joysticks, interface £290. John Crombie, 16 Plantation Avenue, Lisburn, Co. Antrim B.T27 5QB. Tel: (08462) 4351.

PAIR AUDIOM 61 bass 12" 40 watts high efficiency speakers £20 pair. Boxed. Mr. D. Smith, Hornchurch 49 47344.

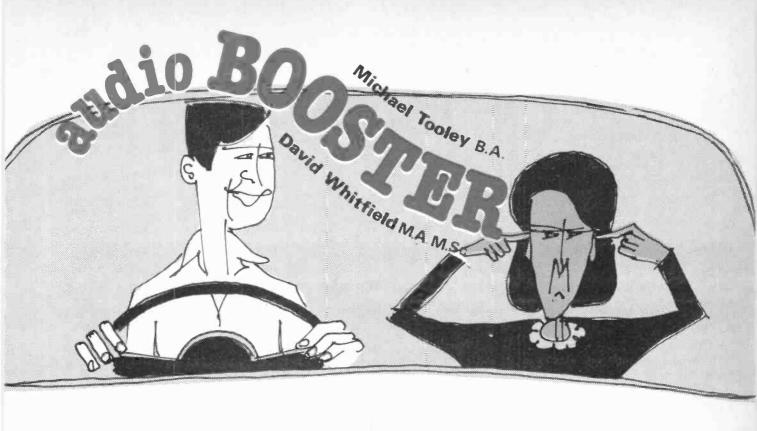
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MANY drivers find "in-car entertainment" essential for relaxation on a long car journey. Units currently available include radio receivers, both AM and FM, and cassette tape players. For the serious audiophile, however, such units are generally somewhat lacking in output power and this can, to some extent, mar the enjoyment of a system.

The unit described offers a solution to this problem by providing a simple means of effecting a four-fold increase in the audio power output of most car radios and cassette players. The unit is simple to construct, uses commonly available components, and requires no internal modification whatsoever to the user's existing in-car entertainment system.

#### **OUTPUT POWER CONSIDERATIONS**

The output power of most in-car entertainment units is limited to about 4W per channel. The reason for this is that a conventional complementary symmetry output arrangement can only provide a maximum peak-peak output voltage swing equal to the d.c. supply voltage. A simplified arrangement is shown in Fig. 1 and the maximum theoretical r.m.s. output power can be calculated using the formula:

$$P_{out(max)} = \frac{(V_{CC} - 2V_{CE(sat)})^2}{8 R_L}$$

where  $V_{\text{CC}}$  is the d.c. supply voltage,  $R_L$  the load impedance, and  $V_{\text{CE}(sat)}$  the collector-emitter saturation voltage. If the transistors are assumed to be perfect  $V_{\text{CE}(sat)}$  will be zero. Hence an approximate relationship for the maximum r.m.s. output power is:

$$P_{out(max)} \simeq \frac{V_{CC}^2}{8 R_1}$$

To put this into context let us assume that the car is stationary and the battery voltage is 12V. If the equipment is used with a 40hm loudspeaker system the maximum theoretical r.m.s. output power will be:

$$P_{out(max)} \simeq \frac{12^2}{8 \times 4} = \frac{144}{32} = 4.5W$$

With the engine running and the battery under charge the supply voltage can be expected to increase from 12V to around 13.5V. In this condition:

$$P_{out(max)} \simeq \frac{13 \cdot 5^2}{8 \times 4} = \frac{182}{32} = 5.7W$$

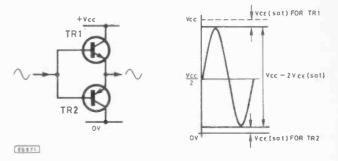


Fig. 1. Simplified complementary symmetrical output stage and corresponding maximum undistorted output voltage swing.

Whilst this power level will be considered by most to be more than adequate, hi-fi purists would disagree. An output of 10W to 20W is commonly accepted to be the minimum required for acceptable dynamic range reproduction in a domestic listening environment. The relatively high level of background noise in a car (10-20dB greater than most domestic situations) necessitates an increased average listening level in order to maintain an adequate signal-tonoise ratio during the guieter passages. Thus, even allowing for the restricted space inside a vehicle, there is a need for a power level comparable to that required for a domestic situation in order to ensure faithful reproduction. Furthermore, the type of loudspeaker system commonly used in vehicles is the totally enclosed infinite baffle. Enclosures of this type are relatively inefficient and this fact further reinforces the argument for a greater level of output power.

#### **BRIDGE OUTPUT CONFIGURATIONS**

A simplified form of bridge output stage is shown in Fig. 2. The two complementary stages are driven in anti-phase and the load connected between their outputs. Depending upon the polarity of the input signal, TR1 and TR4 turn 'on' whilst

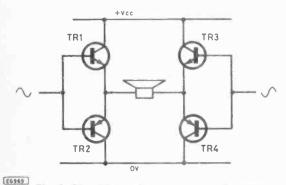


Fig. 2. Simplified bridge output configuration.

TR3 and TR4 turn 'off', and vice-versa. The peak-peak voltage swing across the load is thus approximately equal to twice the supply voltage and, since the power developed in the load is proportional to the square of the voltage, the maximum undistorted power output is increased by a factor of four. Thus powers of around 16 to 20W can be achieved from a bridge output stage operating from a nominal 12V d.c. supply.

#### **CIRCUIT DESCRIPTION**

The complete circuit diagram of the Audio Power Booster is shown in Fig. 3. The 'right' and 'left' channels are identical and each employs a single integrated circuit. This device, a TDA2004, can be configured for either 'stereo' or 'mono' (bridge) operation; the power rating being respectively 5W and 20W at 0.2% total harmonic distortion into a 40hm load. In this application the bridge configuration is, of course,

employed and the necessary phase shift is obtained by appropriate use of the inverting and non-inverting inputs of the two individual internal power amplifiers of each integrated circuit. The voltage gain of each amplifier is set by means of external resistors, R2/R6 for the non-inverting stage and R5 (R7 + R6) for the inverting stage. Since the input voltage will normally be in the region of 1V to 5V peak-peak, the voltage gain of each stage is set to a modest 4-5 approximately.

Zobel networks, C4/R3 and C5/R4, are connected from each side of the balanced load to the common rail, and links are provided so that the quiescent current of each channel can be monitored. The input signal is terminated by R1 while VR1 provides individual channel gain adjustment. Reverse supply protection is incorporated by means of D2 and FS1. The I.e.d., D1, is included to warn the user that the amplifier is "active". C10 and C12 ensure unconditional stability of the amplifiers at high frequencies whilst C11 provides supply de-coupling at low frequencies and helps to reduce the effects of supply borne noise, including ignition pulses and alternator whine.

#### CONSTRUCTION

All components, with the exception of the connectors and l.e.d. are mounted on a single sided p.c.b. measuring approximately 128mm x 78mm. Printed circuit mounting electrolytic capacitors are used and the supply fuse is retained by means of two p.c. fuse-clips. The copper foil layout of the p.c.b. is shown in Fig. 4 and the corresponding component layout is shown in Fig. 5. Care should be taken to ensure the correct location and orientation of components, with particular emphasis on the polarity of the diodes and electrolytic capacitors. Components should be assembled on the p.c.b. in the following sequence; terminal pins, fuseholder, resistors, capacitors, diode, and integrated circuits. Note that the two supply links should not be fitted at this stage since an initial check of the supply current to each stage is essential.

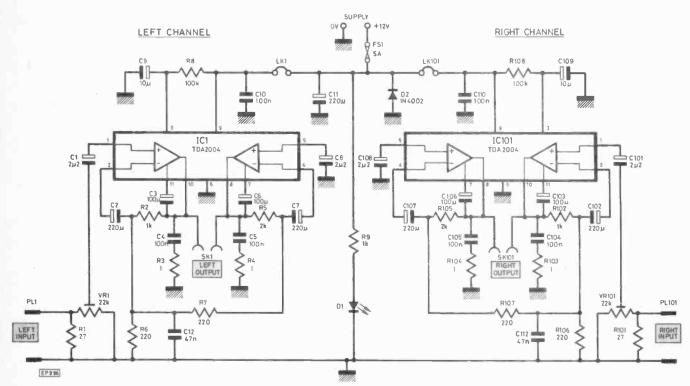


Fig. 3. Complete circuit diagram of the Audio Booster.

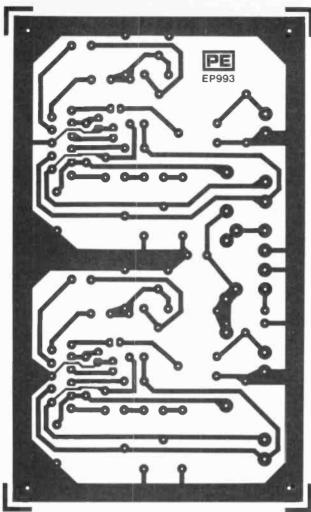


Fig. 4. P.c.b. design.

The completed p.c.b. should be carefully checked before fitting the heatsink, which consists of 16 s.w.g. brass or copper sheet measuring 40mmx110mm approximately, and mounting the p.c.b. into its diedast box. The layout and internal wiring of the complete unit is shown in Fig. 6. The use of screened input leads is highly recommended and the outer braid connection should, of course, be taken to the common OV rail. The supply wiring, OV and +12V, should be capable of carrying a current of at least 5A and, if desired an additional 5A in-line fuse may be fitted in the positive supply lead.

#### INITIAL TESTS

For initial checking the Audio Power Booster should be connected to a regulated 12V d.c. supply capable of delivering at least 2A. Ideally, the supply should have some form of electronic overcurrent protection. However, the p.c.b. mounted fuse will offer a measure of protection against inadvertent short circuits and wiring faults. The two links, L1 and L101, if fitted, should be temporarily removed. An ammeter on 1A d.c. range should be inserted in place of Link 1, whilst Link 101 is left open circuit. A loudspeaker of between 40hms and 160hms impedance should be connected to SK1 and the input plugs (PL1 and PL101) should be left disconnected. VR1 and VR101 should be set to mid-position. The 12V d.c. supply should then be switched 'on' and the supply indicator, D1, should become illuminated. The supply current to the left hand channel should then be monitored. In normal 'quiescent' operation this should be between 50mA and

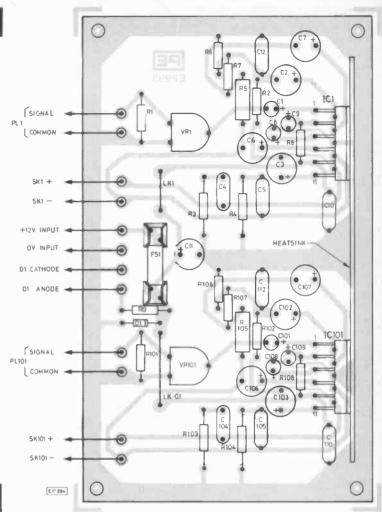


Fig. 5. Component layout.

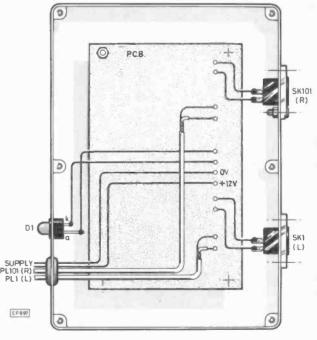


Fig. 6. Wiring diagram.

#### COMPONENTS ... Resistors \*R1 27 ½W 5% \*R2 1k 1W 5% \*R3. R4 1 ½W 10% (2 off) \*R5 2k 1W 5% 220 1W 5% (2 off) \*R6, R7 \*RB 100k \ W 5% 1k +W 5% R9 \*VR1 22k min skeleton pre-set Capacitors 2µ2 47V \*C2, C7, C11 220µ 16V (3 off) \*C3, C6 100µ 16V (2 off) \*C4, C5, C10 100n polyester (3 off) \*C8 2µ2 63V \*C9 10µ 16V \*C12 47n polyester All capacitors are p.c. mounting electrolytics unless otherwise stated. Semiconductors \*IC1 **TDA 2004** Red I.e.d. with mounting set D1 D2 IN4002 Miscellaneous 5A 20mm fuse P.C. fuseclips (2 off) P.c.b. \*SK1 DIN loudspeaker socket PL1 DIN loudspeaker plug Diecast case \*All components marked with an asterisk should be duplicated for stereo operation. All second channel components in the circuit diagrams and text are prefixed by '100'. Constructor's Note

90mA, and under no circumstances should it be greater than 200mA. If the d.c. current is in excess of 2A and either the fuse blows or the electronic protection operates this indicates the presence of a short circuit or wiring error. An inspection of the underside of the p.c.b. and wiring is then essential. If the d.c. current is in the range 100mA to 500mA this usually indicates the presence of high frequency oscillation, which can normally be cured either by increasing the value of C12 or by minimising stray feedback due to untidy wiring. Having established the correct 'quiescent' current in the left hand channel it is simply a matter of repeating the same checks for the right hand channel. Finally, replace the two links, L1 and L101, by short circuits.

Components and p.c.b. are available from Howard Associates, 59 Oatlands Avenue, Weybridge, Surrey

KT13 9SU. Please send s.a.e. for details.

When both channels appear to be operating normally under no-signal conditions the two input plugs can be connected to the cassette player, radjo or combined radio/cassette unit. Signals should then be heard from both loudspeakers and these should be quite loud at even fairly low settings of the volume control of the cassette player/radio. Advancing the volume control should produce ample volume from the Audio Power Booster. However, if necessary, adjustment can be made by VR1 and VR101 in order to produce a satisfactory range of volume adjustment.

A careful check for distortion should be carried out using a 'known' programme source and, finally, the lid of the en-

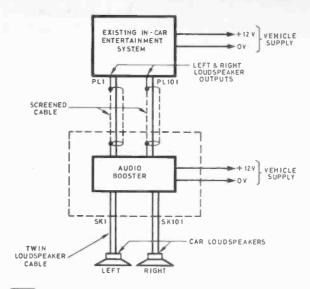
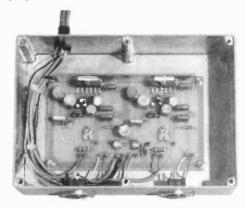


Fig. 7. Installation diagram.

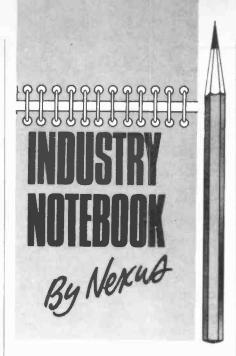
closure should be retained using the six countersunk screws. If desired the temperature of the heatsink may be checked after about thirty minutes of operation. This will feel hot to the touch (particularly if the unit has been used at high volume levels) but its temperature should not be excessive. In the latter case, a cure should be attempted by reinforcing or enlarging the heatsink.



#### INSTALLATION

The Audio Power Booster may be installed in any convenient position within the passenger compartment. It should not, however, be placed close to a heater duct or in any position where the ambient temperature is excessive. This includes the rear parcel shelf where the unit may be exposed to sunlight for long periods of time. Fig. 7 shows the basic interconnecting arrangement. The output speaker leads should be substantial and rated at 5A or more. The length of the leads should be kept as short as possible and the total length of the cable run should be the same for each channel. The positive and negative supply leads should also be substantial and rated at 5A or more. Colour coding should be employed and power can be taken from any convenient source. In many cases this can be derived from the ignition switch or from a separate accessory block, where available. A good earth (OV) connection is essential and the total length of the supply leads should not exceed 1.5 metres.

Once the unit is in operation the volume level should be more than sufficient to satisfy any 'hi-fi' enthusiast in the noisiest of vehicles.



#### IT 82

Information Technology Year is almost over, a year of unremitting propaganda on immediate and future benefits to be expected from widespread, if not universal, application of IT.

My first reaction when IT 82 was in the proposal stages was doubt that government promotion could achieve any more than a dynamic electronics industry would not have achieved unaided. In practical terms of equipment purchased and installed the full impact of the campaign will not be seen until later this decade. But already it is apparent that I underestimated the power and quality of the public relations exercise and also the determination, dedication and enthusiasm of the Minister of State for Industry and Information Technology, Mr Kenneth Baker.

The campaign slogan "There's no future without it" cunningly threatened us and encouraged us simultaneously. Far more effective than "There's a future with it". In this context the word future is a code name for prosperity which in modern life is generally equated with happiness although not always true.

The electronics industry itself, being naturally enthusiastic in the cause, needed no instruction. But did the message come across to the user industries and the general public?

To influence and change attitudes, particularly those of the insular and conservative British, is an uphill task. Kenneth Baker described the objective of his IT campaign as awareness. In this I believe he has succeeded. There can be few industrial or commercial potential users who remain unaware of possible, indeed probable, benefits to be squeezed from intelligent application of IT. The pity is that as with other great technical advances this century, reactionary elements will obstruct its introduction or impose such financial penalties as to nullify benefits obtained.

#### Freedom

When earlier this year Mr Eric Sharp, Chairman of Cable & Wireless, presented his annual statement to staff it was bannerheadlined in the staff newspaper as "The Year we Gained our Freedom" and was full of good news, not least that staff who invested in preferential shares at the time of privatisation had already seen a 70 per cent gain in value.

Cable & Wireless, even while a fully nationalised company, had a good and steady profit record. That the company was wholly government owned was not exactly a secret. On the other hand it was hardly ever mentioned because of the nature of the business, all of it overseas and largely in association with other governments although on a strictly commercial non-political basis.

The government retained over half the shares, just, the remainder being sold on the open market and snapped up by those who knew a good thing when it came along. For Cable & Wireless it meant freedom from bureaucratic restraint, Mr Sharp's phrase, not mine. For, as Sharp pointed out, the company could now operate completely commercially and freely in an industry in which opportunities for new enterprises proliferate and that "Now we have achieved our commercial freedom we can react to these opportunities with greater speed and resolution".

Fighting words indeed and not only words. Action too, including technical leadersnip in Mercury Communications Ltd, the C & W, British Petroleum and Barclays Merchant Bank consortium operating in the UK and for the first time breaking the British Telecom monopoly. Another company, Cable & Wireless UK Services Ltd, will be offering a range of new services to UK business enterprises if licences can be obtained. The company is also expanding rapidly in the USA and Europe, two areas where it has not before been prominent.

But opportunities also bring problems. In the UK Mercury is facing opposition from the BT unions who feel theatened by this thrusting newcomer. And the company's huge investment in Hong Kong, from where it virtually runs the hub of the Far Eastern international communications network and beyond, is overshadowed by the threat of eventual Chinese sovreignty. But expertise is everything and it's a fair bet that C & W will remain whatever the political outcome.

#### Go-getter

Alan Sugar's Amstrad has hit the jackpot again with doubled sales and profits up to £4.77 million. All in consumer electronics which surely shows that a tightly run company can still prosper in a difficult market. Amstrad shares coming to the market in April 1980 at 85p have now reached 400p. Sugar plans to make CTV and VTR. He may find this even tougher than hi-fi, but we wish him and Amstrad every success.

#### Semantics

The national economy and its management, its effect on employment, investment

and in economic growth or decline, affects us all. It is also an emotional topic which demands careful choice of words according to the audience addressed.

All the political parties, for example, know that economic survival depends on an incomes policy, on how big a slice of the national income is to be distributed in wages and salaries. The Liberals, for years without hope of office, could afford to be completely honest and talk of an incomes policy quite plainly. The Conservatives were quite happy to concede the principle of free collective bargaining, meaning unlimited pay demands, but only in private industry in practice because market forces automatically ensure a measure of control with people pricing themselves into or out of employment.

But where the government is paymaster the Conservatives set cash limits on what the nation can afford to spend. In this they followed the example of their Labour predecessors who imposed cash limits but called it a Social Contract. This phrase, now out of favour since the policy is alleged to have lost Labour the last election, has been replaced by a National Economic Assessment promised by Labour if they succeed at the ballot box next time. Does a NEA embrace an incomes policy? Well, yes and no is the answer we get, meaning yes if Labour wins as they, like any other government of any complexion, will have no option other than national bankruptcy.

It is not only words that are confusing or downright deceiving. Numbers are equally so and capable of many interpretations according to angle of view, especially in terms of remuneration and by this I include pay plus fringe benefits.

Last May I reported that British Telecom pay went up 31 per cent in the financial year against a mere 4.6 per cent increase in business. In consequence I received an unfriendly letter from a BT employee who contested the figure because his pay increase in two years only totalled 27.6 per cent. Perhaps I should have made it clear that the total pay bill for all BT employment was up 31 per cent, not individual basic pay, but I should have thought that my correspondent, who appeared to be a comprehending and reasonable man, would have accepted the figure in the context of comparison with business achievement.

Basic pay, gross pay and take-home pay are all different as is the pensioners' nine percent less than the nurses' eight percent. Good luck to miners for free coal and railway workers for free transport, to students for many concessions, all never mentioned in pay bargaining.

#### **Overseas**

Old timers may remember the Stromberg-Carlson radios of 50 years ago. This US company is now in digital telephone exchanges and has been bought by Plessey for £33 million and will expand Plessey's business in the USA and elsewhere overseas. The deal could result in some of Plessey's UK equipment being built in the USA for their domestic market.



N this final part the order of assembly is detailed together with testing and calibration procedures.

#### **ASSEMBLY**

Construction of the robot is very easy but the order of assembly is fairly important particularly when putting the arms together. Also if it is not to tear apart its wiring then the recommended wiring scheme should be followed.

To assist with this, holes are provided at strategic points for anchoring the wiring with cable ties.

A good starting point is the base plate on which are fitted the power supply and the rotation position sensing potentiometer (Fig. 8). Next take off the cover of one of the gear-boxes, turn round the exit side of the drive shaft, fit on it the smaller gear together with its mounting bush and nut, fit the motor loosely on the top plate, screw the side panels onto the base and fit the top plate. Special screws which roll threads in the steel in which they engage are used on all the panels. The shoulder rotation shaft and the larger gear can now be fitted and the motor tightened in position keeping the gears firmly enmeshed.

The arms are constructed in a sandwich arrangement with the lower arm sides fitting round the upper arm and the shoulder support bracket. First assemble the gripper components i.e. the jaws, gripper mounting plate, motor etc. as shown in Fig. 4. On one of the upper arm side pieces fit the wrist motor and a shaft securing bush and on the other side piece fit the wrist position sensing potentiometer. The two sides can now be brought together sandwiching the counterbalance weight and the gripper assembly. Next fit the shoulder support bracket, screw on it the other shaft securing bush and fit to the lower arm side pieces the motors, counterbalance weights and potentiometers.

The side pieces can now be brought together round the upper arm assembly and the shoulder support bracket, holding them together with a stud through them at what will be the rear end of the machine. The wrist motor is on the right hand side. Secure the gear box drive shafts but not the potentiometer shafts and move each axis to the centre of its travel—gripper, upper arm and lower arm all in line about 60° above the horizontal with the arm pointing forwards.

Set each potentiometer to its centre position i.e. equal resistance between the centre tag and each of the outer ones by use of a screwdriver in the adjustment slot and secure the shafts.

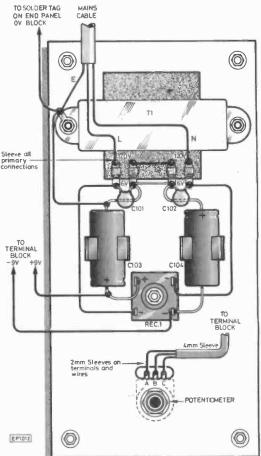
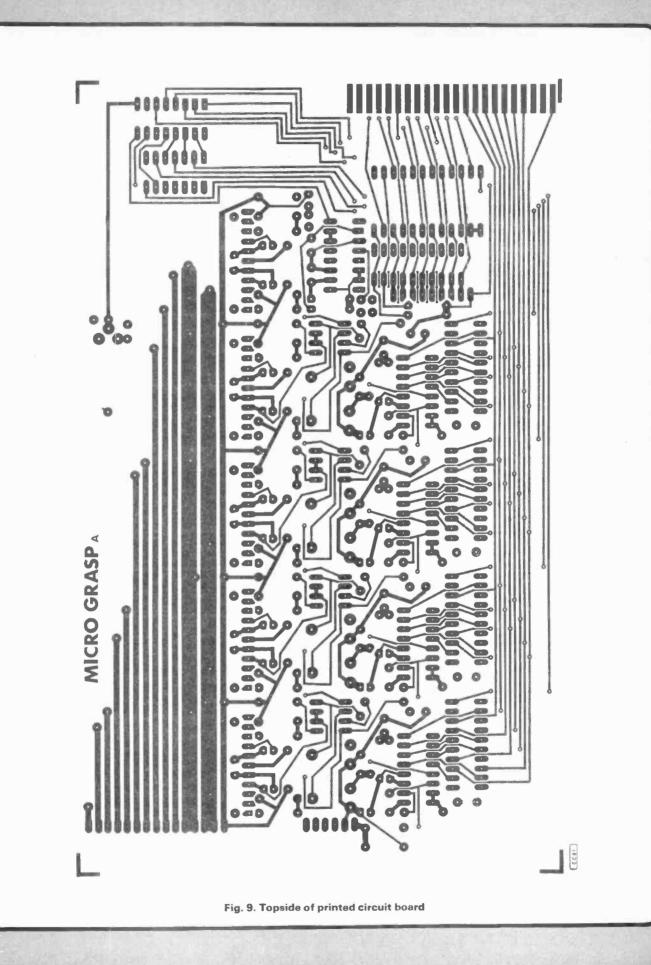
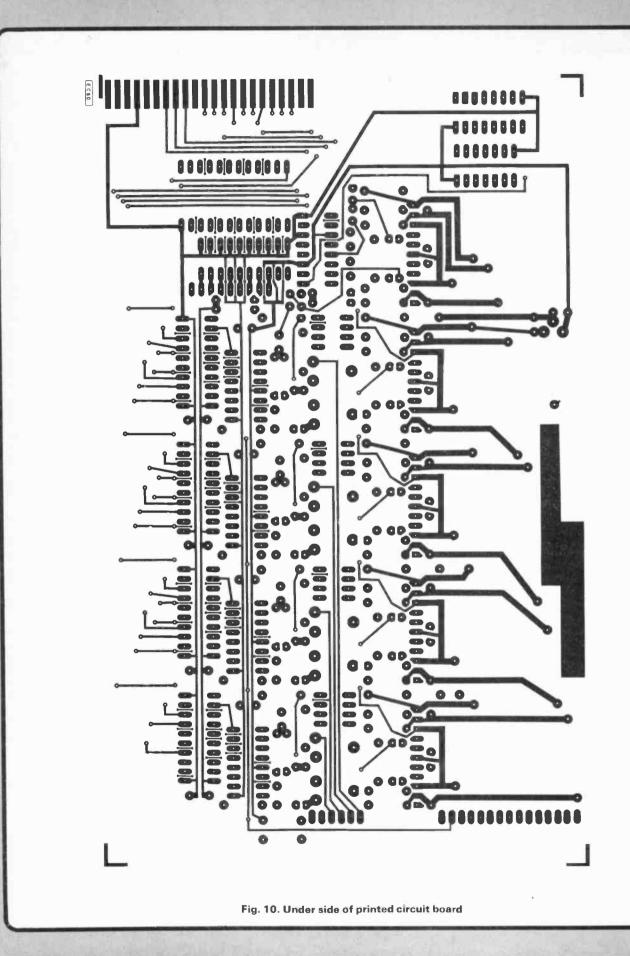


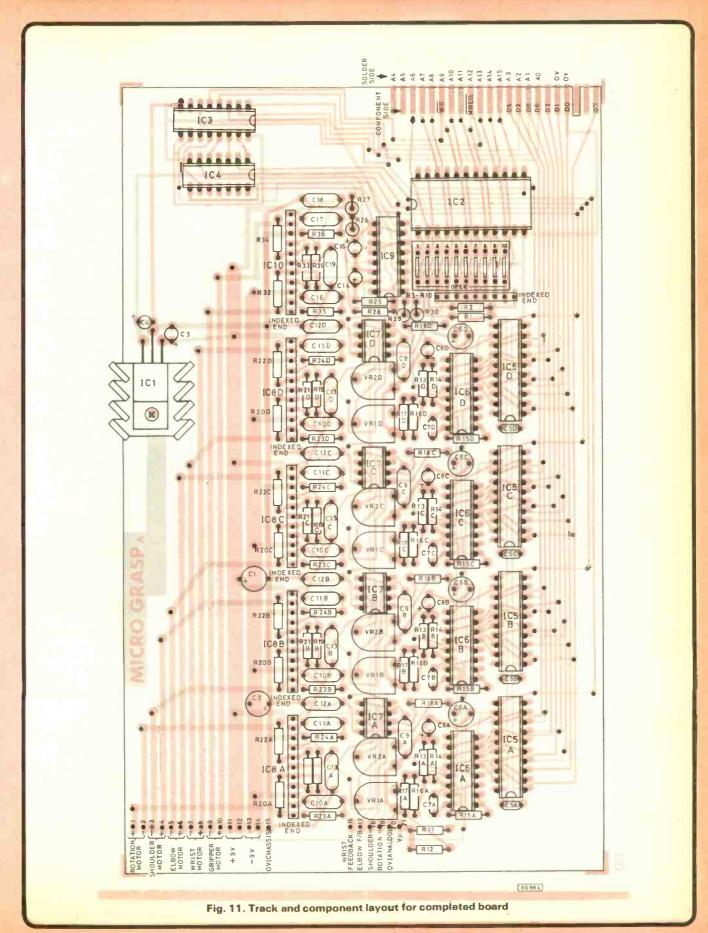
Fig. 8. Power supply component assembly and wiring on base plate

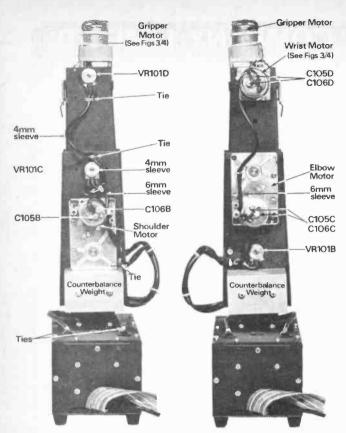
The robot can now be wired up to terminal blocks fitted to the rear end panel following the diagrams in Figs. 11, 12 and the wiring table below. The wires in the 6mm sleeve pass through holes in the bottom of the shoulder support bracket before passing through grommets in the top plate. Sufficient slack must be allowed for 180° of movement of the arm.

Assembly of the interface board (Fig. 11) requires little comment except to say that it is plated-through i.e. both sides of the board carry tracks with connections between the two sides being made by the conductive coating in the holes

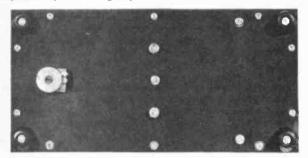








Component assembly and wiring of left and right sides respectively of Micrograsp



Underside of base with VR101A visible

so that no link-through pins are required. The board is wired in with 23 way (24 or 25 way reduced) ribbon cable to the terminal block leaving temporarily free connectors 2, 4, 6, 8, 10.

#### **TESTING AND CALIBRATION**

Power up the robot and interface board without the computer connected and with all the i.c.s unplugged and check the power rails for  $\pm 9V$  approximately and  $\pm 5V$  from the regulator. Assuming all is well, switch off and plug in the i.c.s. Check again and switch off.

Connect to the computer, switch on the robot followed by the computer and check the computer's operation is unaffected by the interface board. If it is, then there is probably a short across the address or data lines on the board.

Set all the switches to open, rotate each VR1 fully anticlockwise and enter POKE 65472,0. Each output of IC5a will now be low and IC7a pin 1 will be close to OV. Enter POKE 65472,255 and each output will change to high and pin 1 will change to close to +1V. Enter POKE 65472,128 and pin 1 will change to O-5V. Similar results will be obtained on servo circuits B, C, D using addresses 65473, 65474, 65475 respectively. Address the monostables with

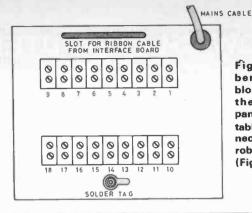
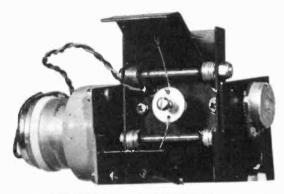


Fig. 12. Numbered terminal blocks fitted to the rear end panel. The wiring table shows connections from the robot to the p.c.b. (Fig. 11)

TERMINAL BLOCK	DESTINATION	WIRE COLOUR	PCB CONNECTION POINT
1	ROTATION MOTOR RED	GREY	1
2	ROTATION MOTOR BLACK	ORANGE	2
3	SHOULDER MOTOR BLACK	BLUE (LEFT)	3
4	SHOULDER MOTOR RED	BLACK (LEFT)	4
5	ELBOW MOTOR BLACK	ORANGE (RIGHT)	5
6	ELBOW MOTOR RED	GREY (RIGHT)	6
7	WRIST MOTOR BLACK	BROWN (RIGHT)	7
8	WRIST MOTOR RED	GREEN (RIGHT)	8
9	GRIPPER MOTOR BLACK	BL ACK (RIGHT)	. 9
10	GRIPPER MOTOR RED	BLUE (RIGHT)	10
11	+ VE OF POWER SUPPLY	RED	11,12
12	- VE OF POWER SUPPLY	BLUE	13,14
SOLDER TAG	SOLOER TAG ON BASE PLATE	BLACK	15
13	VR101 O TAG B	WHITE (LEFT)	16
14	VR 101 C TAG B	YELLOW (LEFT )	17
15	VR 101 B TAG B	VIOLET (RIGHT)	18
16	VR 101 A TAG B	GREEN/YELLOW	19
17	OV(analog) VR101A TAG C	PINK	
	WRIOIB TAG A	PINK(RIGHT)	20
	VR101C TAGA	PINK (LEFT)	1 40
	W PRIOID TAGA	PINK (LEFT)	
18	VP VR101A TAGA	RED	
	Vp VR101B TAGC	RED (RIGHT)	21
	VP VR101C TAG C	RED (LEFT)	41
	Vp VR101D TAGC	REO (LEFT)	



Showing the jaws of the gripper fully expanded

POKE 65477,0 and POKE 65478,0 and IC9 pins 13 and 5 respectively will go high for about 2 seconds and then return to low

Connect the rotation motor (connector 2) whilst the robot is switched off, turn each preset to its midway position and switch on. The arm will move to some extent and come to rest peaceably i.e. without being held back by its cables. Turning VR1A will result in the arm changing its position, Return VR1A to its midway position, successively enter data of 0 and 255 i.e. minimum, and maximum codes and adjust VR1A, VR2A for 180° of movement symmetrical about the forward facing position.

Repeat this procedure one axis at a time for the other three servo controlled axes adjusting for the shoulder to move between almost touching the end stop and about 10° below horizontal and for the elbow and wrist joints to have 180° movement. Finally connect and check the gripper motor circuit and after fitting the end panels the robot is ready for use.

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Printer cable inc Amphenoi plug (not assembled) (BBC21) 13.00	Z80CPU 2.95 Z80ACPU 3.45 Z80CTC 2.84	BP8304 4.50 MC1488 0.55	4025 <b>0.16</b> 4026 <b>1.29</b>	49 060 51 0.14	20 14 35 80 22 17 40 70 24 19 42 70	Z80CTC 0.90 Z80ADART 0.80
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#### THE UNITED STATES AND HALLEY'S COMET

The mission to look at Halley's comet was aborted by lack of funds and the European Space Agency were forced to "go it alone". The details of this situation were outlined in a previous issue of Spacewatch together with an alternative suggestion from America to divert an existing spacecraft so that at least something would be contributed. The suggestion was that first the Giacobini-Zinner Comet should be the next target and then follow-on to an approach to Halley's Comet. This was hailed as an excellent idea and at least a try to carry out the original plan. However it was not really like this at all. Funding was allowed to provide for the existing spacecraft to be diverted but the reason for it was that America wished to be the FIRST to intercept a comet. The benefit to knowledge is without a doubt a great stride forward and the world of science will acquire vital information about comets which will help to provide data to make the best use of the Halley encounter. The cost will not be more than about five million dollars. This includes the funding already provided for this spacecraft to carry out its original programme which will be completed a few months after the Halley encounter, The procedure will follow these lines:

Early in October 1982 the Goddard controllers operated the Hydrazine propulsion system to send the spacecraft back toward the Earth. This was to effect the intersection of the Moon's orbit so that the Earth's gravity could send the spacecraft outward behind the Earth passing across the Earth's tail. This means that the spacecraft will be able to examine the particles and fields that are known to exist across the tail. This took place around the 19th and 25th October, when the spacecraft was 317,000 miles from the Earth. The vehicle then continued outward until it reached about a million miles from the Earth, then the Earth's gravity pulled it back down the tail toward the Earth. Again the spacecraft will move away till it reaches some 820,000 miles gathering further data which will be unique.

About February 6th 1983 the hydrazine system will be activated again to provide a

thrust of 100 to 115 feet per second to change the orbit of the spacecraft to a swing past the Moon by some 12,400 miles. After this there will be three options at or about the 30th March 1983. After which the further changes of orbit will be decided. There are some changes to be expected on 22 December 1983 the last Lunar swing-by will take place and the spacecraft will then be about 60 miles from the surface of the Moon. For precise directional control base stations will be needed.

As there is a limited amount of propellant available the target acquisition must be precise. There will be little latitude for correction of the trajectory so the situation needs very careful calculation and execution. If all this is successful then the spacecraft will attain a closing velocity of some 13 miles per second. The spacecraft will pass behind the nucleus of the Giacobini-Zinner comet and through several thousand miles of the tail.

This spacecraft does not carry any imaging facilities but its instruments will be able to measure plasma densities, temperatures and flow speeds. It will also be possible to assess the character of the heavy ions. It is expected that the distance of the spacecraft from the nucleus of the comet will be 1,864 miles.

After the encounter with the comet the spacecraft will pass on to take part in the Halley observations. On or about October 30th 1985 the spacecraft will be on a line between the Sun and Halley's comet and will attempt to check the nature of the solar wind before it reaches the comet. At that time the spacecraft will be one astronomical unit from the comet, 94 million miles, and some 47 million miles from the Earth. Finally on March 28, 1986 the spacecraft will be 21 million miles from Halley's comet and 60 million miles from the Earth.

#### **EUROSPACE PROGRAMME**

The European Spacelab 1 mission is scheduled for September 1983, and the first flight of the Eureca recoverable carrier in April 1987. The mission slot for Spacelab 1 is assigned for the shuttle Columbia to take the Spacelab into orbit. The shuttle will be modified to enable the mission to be extended to 9 days. This mission is a cooperative one, with ESA responsible for the Spacelab itself and NASA for the operational programme. Two mission specialists from NASA will be on the Spacelab 1.

One complication arises out of this mission, this is that the recovery of the orbiter will be at Edwards AFB in California and not at the Kennedy Space centre in Florida. New planning will now be necessary to handle this situation. One of the reasons for the decision is that the return of the Orbiter from the mission will be without the "head-up" systems and will also be carrying one of its heaviest payloads. It is considered that in the light of previous missions the Edwards facility offers the maximum safety factor.

This mission will carry its specialists and the equipment in the long module unit which includes a pallet section. There will be 36 different instruments on this mission. These will include a metric camera, microwave remote sensing equipment and a fluid physics module. The disciplines to be covered on this flight are plasma physics, solar physics, astrophysics, Earth observations, material sciences and life

sciences. This mission will also involve the carrying of the total payload throughout the flight. However as part of the follow on programme for Spacelab, a small unit which will be unmanned is being developed by ESA. This will be released from the orbiter, left to carry out its tasks and then some six months later recovered by the Shuttle.

The carrier vehicle, EURECA, is scheduled for a first flight in April 1987. This will be aboard the Shuttle Orbiter Challenger. It will be recovered in the following September by the orbiter Aquarius. A number of configurations have been suggested and projects evaluated such as a mirror furnace solution growth (protein) and also automatic gradient heating. Several contracts are under consideration such as the British Aerospace design of half pallet size of unit derived from the original concept by BA for basic Spacelab missions. Another is from Messerschmitt-Boelko-Blohm. This is based on a modular payload structure that has also been used for Spacelab.

Solar arrays were under consideration which include designs from British and German groups. The solar arrays would be of average size, about 90 square metres and perhaps initially deliver 5.4kW at a voltage of 28V. Provision for the charging of on-board batteries for use during the shadow periods which will result from the angle of the orbits, when at 28.5 degrees. Other contracts will be considered for stabilisation equipment for the free flight missions.

The European Space Agency has declared its intention to make programme decisions for the next ten to twenty years activities. Preliminary guide lines are centred round follow-on launch vehicles and Earth orbiting space stations. These deliberations are being carried on at both industrial and political levels. The Agency is a multi-national body and there are therefore many points of view to be considered. In the main there are three categories of activity.

The Agency seeks at the moment agreement from the members to spend about £6 million to study the categories in depth. The broad area involved includes space launchers, where there is support for launchers capable of carrying manned vehicles into orbit. Another part of the area of study is participation with the NASA organisation in America for joint manned missions. The third area of consideration deals with the development of a European "in-orbit infrastructure" so that Europe may develop independant orbital facilities in case the cooperation project should fail to come into being.

#### **JAPAN AND SPACE**

Japan is studying small shuttle development as a priority. These studies are in the early decision stage. An initial evaluation deals with a vehicle capable of carrying three crew into orbit. The studies will include the use of airbreathing engines on the vehicles to provide powered flight on return to Earth.

Japan will continue to develop large launchers capable of raising vehicles to Earth orbits. More details of the parameters of the vehicles being processed will appear later.

#### Frank W. Hyde

# Ultimum Computer Interface Part 3

THE nature of ULTIMUM has stirred sufficient spontaneous interest, and queries, to bring about the decision to interpose at this point with a more detailed analysis of the memory mapping, and rather special address decoding techniques employed. Moreover, with a project which is likely to last many months, it is in deference to those with an anxious interest in the daughter cards *towards the end* of the list, that we now reveal more of the interfaces yet to be published.

#### **THE 8255**

The 8255 peripheral interface should first be understood. This device is a 24 line parallel interface. Each line may be set to an output or an input. Fig. 1 gives a schematic of the arrangement of this device, and as you can see it is made up of three ports (A,B,C) each of 8 bits. These lines go to the daughter cards, each card having three lines dedicated to it. We are using the 8255 for three functions

- \* Control
- \* Handshake
- \* Mapping

On some boards (the port boards being one example) we need to control particular devices with a line or two. In this case these lines are obtained from the 8255.

The handshake function is used on the two intelligent boards (the terminal board and the disk controller). These boards have to tell the system processor when an operation (like disk formatting or display scrolling) has been completed. In this case the port lines are used in their input mode and can be read by the system to determine the state of operations.

The most important function is the *so called* mapping. This is simply a way of fitting respectable amounts of memory into a limited space. Normally an 8 bit processor has 16 address lines at its disposal. These will allow addressing of 64 Kbytes. High level languages and word processing packages tend to make short work of this amount of memory, so some method of expanding the available RAM/ROM is needed.

In Fig. 2 we have shown how this can be done by selecting "banks" of memory. There are two banks in this example, but you can have as many (limited only by the drive capability/slots on the motherboard) as you like. The two banks are addressed with same address lines. The 8255 port is used to switch one bank on at a time. You cannot read both banks at once (unless you move one to a different place in memory) but data can be stored in both and accessed at

different times. The system is slower in some cases, which is why the larger 16 bit processors with their megabyte or so of direct addressing are becoming more popular.

Peripherals that aren't used very often can be switched out (sometimes called "paged out") so that they don't use up memory space when they are not needed.

To give some idea of the capacity of this type of system, four 64 Kbyte RAM cards can be used together to provide  $\frac{1}{4}$  Megabyte of memory! (but see Notes).

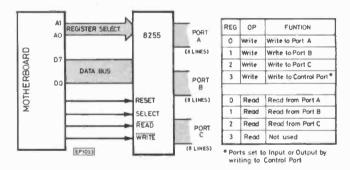


Fig. 1. The 8255 Peripheral Interface

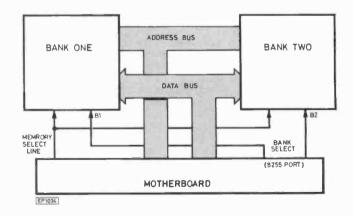


Fig. 2. Bank switching to increase usable memory

#### THE MEMORY CARDS

The dynamic RAM card and static RAM/ROM card (published already), may both use the 8255 to be paged in and out. The ability to program ROMs is covered by a programmer card (Fig. 3) which allows you to program 2716/2516/2732/2532/2764 ROMs. As Fig. 3 shows, we have provided a couple of nice features; current limiting to protect the i.c. being programmed, and hardware control of the programming pulse to make programming easy.

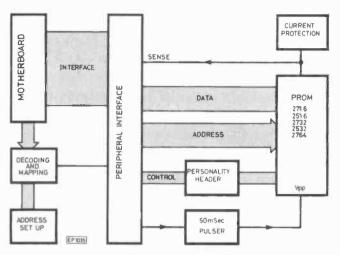


Fig. 3. The ROM Card

A departure from the standard cards for an expansion board is a Romulator card which is shown in Fig. 4. This card can emulate 2716/2516/2732/2532 ROMs. The board looks just like 4K of standard memory which can be used for programs or data. By switching a line of the 8255 on the motherboard, the memory can be made available on an external 24 pin header and plugged into another system. This makes your home computer into a powerful development system at a fraction of the cost of the stand alone emulators. With an assembler, your system can be used to develop control programs which may be burned into PROM using the programmer.

#### **DISK CONTROLLER CARD**

A very different approach in the design of this card was necessary to suit several systems. The single most important feature of this card is that it is intelligent, ie. it has its own processor which controls the disks and handshakes (see motherboard) with the main processor. The disk processor has its own disk operating system (WeeDOS) which provides formatting, directory control, and functions such as READ/WRITE and DELETE. Fig. 5 shows the block diagram for this board. It looks like a port to the main processor, and this makes the interface to the disk simple (rather like an intelligent cassette). The card was originally designed as a single density controller, but will be upgraded to a double density version, which means a capacity of about 4 megabytes using double density 5.25 in. floppies.

#### SPEAK

The speech card is based around a single chip *phoneme* generator, as opposed to the fixed vocabulary type. Limited vocabularies are never useful enough. The schematic for this card is given in Fig. 6 which also shows how it interfaces to the nine channel fully programmable sound generator. The sound generator can also be used on its own, but the two together provide a very powerful programmable sound source.

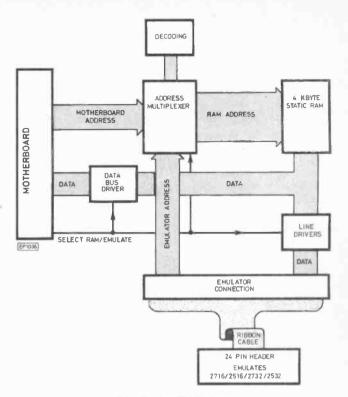


Fig. 4. The ROMulator

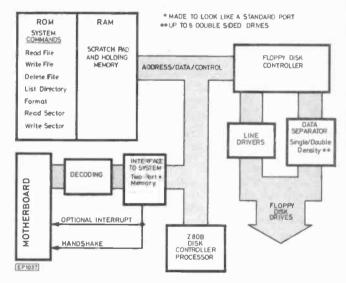
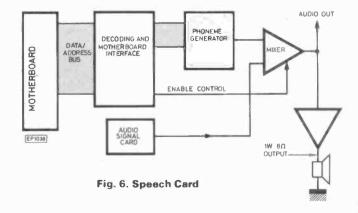


Fig. 5. Disk Controller Card



#### DISPLAYS

The more recent home computers have limited character displays, with graphics which are great for games; but just try using 32 character lines for text editing or high level languages where you need to indent the text to make it readable. Fig. 7 shows the solution to this problem. The card is another in the intelligent series of cards, having *its own* processor, and display memory. You can set the card up for a range of character widths (up to 80 characters × 24 lines) because it uses a programmable display controller (the 6545). Several high level functions such as Line Insert, Clear Screen and Scroll are provided as single byte commands. Teletext format is easily selected and you may program your own PROM character set if desired. As Fig. 7 illustrates, the card looks like a port, so that it is easy to interface to the main system.

#### INTERFACES

There are two interface cards, these being an analogue card and a port card. The port card (Fig. 8) provides a real-time clock (with a battery to keep it ticking when you switch off) an RS-232 interface (for terminals etc.) a Centronics interface (for printers) and parallel lines (16) which can be used to control peripherals.

The analogue interface provides a 12 bit D to A converter, a 12 bit A to D converter and a very fast 8 bit A to D converter (Fig. 9). Between them, they provide the resolution and speed for most applications (digital scopes and measurement being two popular ones).

#### THE LAST ONE

The final card in the series is a second processor card. Two designs are in the offing, an 8 bit (6809) and a 16 bit processor. The card will interface with all the other daughter cards and the main processor. It will be provided with a monitor program in ROM so that it can be set up and programmed from the system. Reset facilities will make the design of a stand alone system possible.

#### NOTES

The dynamic RAM card requires good quality signals from the main system. Timing is very tight. Some boards (eg. the Superboard and the UK101) are totally un-buffered and the signals coming off the expansion socket have to be seen to be believed. If your computer has adopted the dubious economy of omitting buffers, you may have problems with the dynamic RAM card. We suggest that you stick to static devices on these cheaper systems. Watford Electronics will be supplying special buffered connectors to overcome this problem.

That covers the range of cards. **NEXT MONTH** we continue with the PROM programmer.

#### Constructor's Note

Kits for all parts of the ULTIMUM system are (or will be) available from **Watford Electronics**, 33 Cardiff Road, Watford, Hertfordshire WD1 8ED.

Send SAE for price list of boards now available.

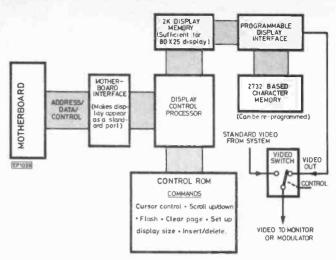


Fig. 7. Display Interface

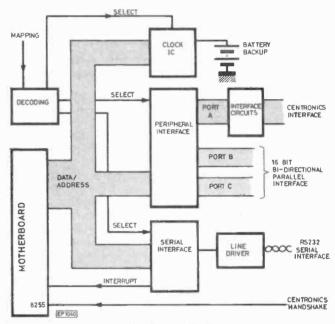


Fig. 8. Port Card

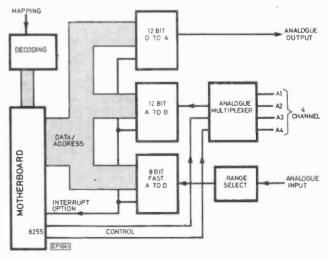
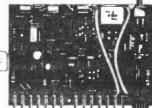


Fig. 9. Analogue Interface

Step-by-step fully illustrated assembly and fitting instructions are included together with circuit descriptions. Highest quality components are used throughout.

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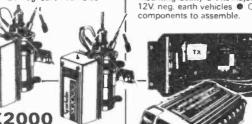






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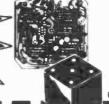
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## SEMICONDUCTOR UPDATE R.W.Coles

#### FEATURING 8001 DG221

#### **NET-WORKS**

All the buzz in computer circles at the moment is the subject of Local Area Networks or "LANs" for short. In the data processing systems of the future it will not be necessary for the hopeful, humble, user to approach the inner sanctum of the "Main-frame", clutching his carefully prepared tapes or punched cards to seek an audience with the mighty machine. Instead, 'Distributed processing" will be the name of the game, and systems will no longer live in their air-conditioned temples closely guarded by vestal virgins, but will appear on everyone's desk and in everyone's office, positively encouraging even the most casual user.

To some extent this is already happening with microcomputers of course, but a simple PET or word-processor doth not a mainframe make, because unfortunately the single autonomous keyboards and disc stores of such simple systems cannot offer either the huge memory capacity or the speed of their huge companions from IBM or ICL.

Local Area Networks are important because they will allow the friendly office micro to be hooked up to many others like itself, facilitating the exchange of programs, data, or correspondence. If the power of a mainframe is still required, it too can be hooked into the net and accessed by the microcomputers as necessary, avoiding the need for the previously necessary leg-work and temple offerings. (Pity about the vestal virgins though!)

LANs will consist of an all embracing ring using just a pair of wires or, more likely, a coaxial cable which can be "tapped" at anypoint. Office designers of the future will consider the installation of a LAN ring-main to be just as important as the 240V mains wiring, and even the older offices will be fitted out as the efficiency of such systems becomes attractive.

There are already several contenders for the coveted title of the LAN standard, and many readers will have already heard of our home-grown candidate called the "Cambridge Ring", but for my money, the LAN to look out for is the "Ethernet" standard which is supported by the powerful grouping of Intel, DEC and Xerox.

Ethernet operates over a coaxial cable ring which will transfer data at a very rapid 10 Megabits per second, but to implement this system, each terminal needs a sophisticated link controller which at the moment would cost almost as much as the microcomputer itself because it would have to be made using mainly random logic.

Needless to say, the race is on to build

cheap LSI Ethernet controller chips, and these are just starting to become available in sample quantities. One which caught my eye, because it is compatible with eight bit microprocessors and is not *too* sophisticated, is the 8001 from SEEQ Technology.

#### LINK CHIP

The 8001 consists of a CPU interface, a transmit processor, and a receive processor, made in NMOS technology and packaged in a 40 pin d.i.p. Communication with the microprocessor takes place over an 8 bit bidirectional data bus using the standard CPU control signals CS, RD, and WR which are connected within the 8001 to a transmit register, a receive register and six "Station address" registers.

In operation, the 8001 continuously monitors all data transfers occurring on the network. When the chip recognises activity on its "Carrier-sense" line, it synchronises itself to the incoming data stream during the message preamble and then examines the address field of the received message frame. If the address matches its own programmed field, the chip passes the entire frame of information to the CPU over the bus a byte at a time, but if not, it ignores the message. Ethernet messages are protected by a very discriminating error detection code called CRC, which is much better than a simple parity check. Information about the validity of a message is passed to the CPU at the end of a received frame after CRC checking so that appropriate action may be taken to request a re-transmission of the corrupted data if necessary

The 8001 also deals with some fundamental problems of serial networks by avoiding "collisions" and providing "contention" resolution. When an 8001 is ready to transmit it first checks that there is no other carrier present and then sends a preamble of bits just long enough to ensure that the first bit has had time to reach the furthest point on the network. After the preamble, the source and destination addresses, message frame, and CRC checksum are sent.

When two or more stations begin sending their preamble before they can detect the presence of each others carriers, a collision occurs which garbles the messages. When the transmitters realise that they are in conflict, they each transmit a jam signal and then wait for random time intervals before trying to re-transmit. The chances of a second collision are therefore reduced and the possibility of a "deadly

embrace" in which two stations both try to re-transmit at the same time so that they continuously garble each others messages, is avoided.

To complete an Ethernet station using the 8001 it is also necessary to add an external encoder/decoder chip to convert the serial bit stream from the chip into the return-to-zero (RZ) Manchester code required by the net, and vice-versa. Manchester coding eliminates the d.c. component introduced by conventional non-return-to-zero (NRZ) links such as RS232.

I think that we shall all be hearing a lot more about LANs before long, so watch out for further news in these pages!

#### **SWITCH CHIP**

Fingers, as everyone now realises, are designed for deftly caressing QWERTY keyboards, not for flicking nasty ugly toggle switches, so in future let your computer do the work and avoid breaking your nails, by using some Siliconix DG221s in your new microprocessor controlled Disco Console.

The DG221 consists of four solid state analogue switches controlled by a microprocessor compatible latch which can be hooked up to four lines of a data bus and strobed by a WR signal. Each switch has a typical ON resistance of 60 ohms and an OFF isolation of about 70dB and operates in the true "break-before-make" fashion that you have come to expect from those old museum-piece toggles. The switch functions are effectively isolated from the digital control latch, and can be used with separate plus and minus supplies up to a total of 44 volts with a signal voltage capability of up to 30 volts. To prevent variations of switch parameters in the face of power supply and temperature fluctuations, the chip has a built in compensating voltage regulator.

Connecting the DG221 to your microprocessor couldn't be easier since it can pretend to be either an I/O port (for 8080 or Z80 systems) or a memory location (for 6800 and 6502 systems). Since only four data bus bits are allocated to each DG221 it is also possible to have two devices at each I/O or memory address. A single byte output to the DG221s can then provide any combination of "ONs" and 'OFFs" for the eight switches to amaze and delight your friends. It is also possible to connect the various switches together to perform multi-way and multi-pole switching if required, so it can replace those old rotaries too, provided you get your program logic right!

## MICRO-BUS

#### Compiled by DJD.

Appearing every two months, Micro-Bus presents ideas, applications, and programs for the most popular microprocessors; ones that you are unlikely to find in the manufacturers' data. The most original ideas often come from readers working on their own systems; payment will be made for any contribution featured.

THE MAIN topic in this month's Micro-Bus shows how a ZX81 can be used as the heart of an audio signal processor, to give unusual audio effects; three possible applications described here are an echo unit, a harmoniser, and a digital storage oscilloscope using the computer screen for the trace display. The circuits and programs were devised by Andrew A. Szalay of Hungary, and what follows is based on his description.

#### ANALOGUE INPUT/OUTPUT PORT

The main part of the ZX81 Audio Signal Processor is the analogue input/output port which interfaces with the ZX81's bus; see Fig. 1. It can handle signals with 8-bit resolution using sample rates of up to 80kHz, which exceeds the requirements for good audio reproduction.

The circuit is based on the low-cost Ferranti ZN426E D/A and ZN 427E A/D converters. It uses the Z80's I/O port 3 to avoid conflicts with the internal I/O operations. IC6 and IC7 decode I/O operations to this port, and produce input-request and output-request signals at the outputs of gates IC7b and IC6c respectively.

The output-request pulse latches the data from the ZX81's data bus into the 8-bit latch, IC3, whose outputs are fed to the inputs of the D/A converter IC2.

The input-request pulse enables the data outputs of the A/D converter, ICI, allowing the data to be read by the ZX8I. A version of this pulse delayed by IC5 is used to reset the A/D converter, and start a new conversion. Note that the data read from the A/D converter corresponds to the previous input operations. The A/D converter clock is generated by IC4.

For maximum precision the same voltage reference is used for both converters; the analogue input/output voltage range is 0 to +2.55V, in accurate 10mV steps.

#### ANALOGUE CIRCUITS

For most analogue applications some extra amplification is desirable, and two alternative circuits are presented here. For simple applications such as data logging and the digital oscilloscope a simple interface using a buffer amplifier for both input and output can be used; see Fig. 2. The LF356 op-amp is chosen because of its high slew rate. For audio applications such as the echo unit and the har-

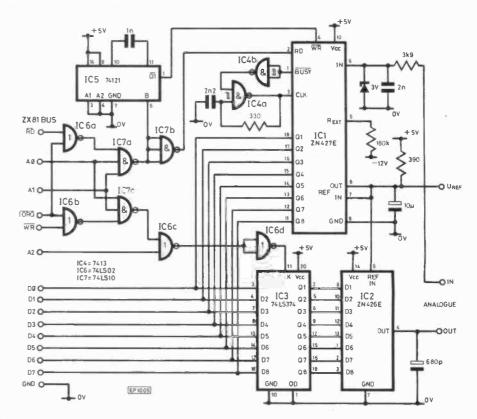


Fig. 1. Analogue input/output port circuit interfaces with ZX81

monizer additional amplification will be required as in the circuit of Fig. 3. IC1a amplifies the audio input to the required level, and the gain should be adjusted to be as large as possible without overload to minimise quantisation noise. IC1b feeds the resulting signal to the A/D stage. The output from the D/A is buffered by IC1d; the feedback control is used for the echo unit, and for multiple transpositions with the harmoniser. Finally, IC1c mixes the original input with the processed sound.

Professional analogue-to-digital systems use high-order low-pass filers to avoid aliasing, a type of distortion caused by the sampling process. In practice the simple circuits presented here work quite well without such filtering; for audio sources like an electric guitar or music from a cassette recorder none of the distortions caused by mirror frequencies can be heard.

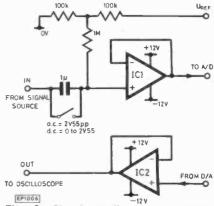


Fig. 2. Simple audio stages enable analogue I/O port to be used as a digital storage scope

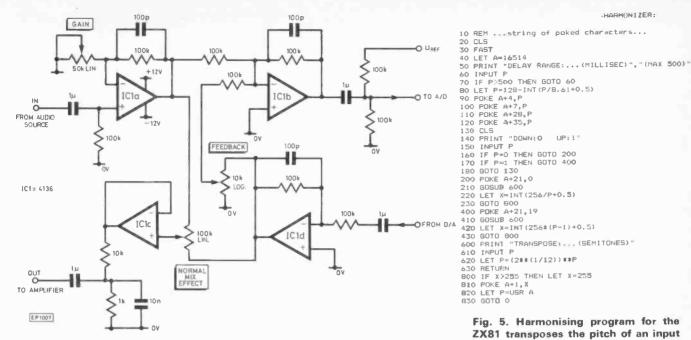


Fig. 3. Audio stage interfaces the analogue I/O port to an audio amplifier

#### Data noted by # will be changed by POKE statements

ADDRESS:	ECHO:		HARMON17E	Rt	STORAGE SC	PE:
16514	1d hl,NN	33	ld c,N	14	ld c,N	14
16515		0		171#		100#
16516		72#	ld de, NN	17	ld b,N	6
16516	ld b,N	6 3		0	di nz	16
16517 16518	14 - 4-11		la hl,NN	120# 33	0.1 HZ	-2
	1d a, (h1)	126 211	Id HI NN	0	in a.N	219
16519 16520	out N, a	3		120#	Ell dig N	217
16521	in a,N	219	in a.N	219	add c	129
17522	411 0914	3	211 0 119	3	ir no	48
16523	ld(hl.a)	119	ld(hl),a	119	31 110	-9
16524	di nz	16	inc hl	35	Id hl.NN	33
16526	-3	-2	ld a, (de)	26	,	0
16527	inc de	19	out N.a	211		70
16528	inc hl	35		3	in a.N	219
16529	dec h	37	ld a,b	120		3
16530	inc h	36	add c	129	1d(hl),a	119
16531	jp p, NN	242	ld b, a	71	inc hl	35
16532		133	jr nc	48	1d a,h	124
16533		64		1	cp N	254
16534	ld h,N	28	inc de	19		128
14535		72#	inc de	19#	jr nz	32
16536	in a,N	219	d⊕c d	21		-9
16537		2	Inc d	20	ret	201
16538	cp N	254	jp p,NN	242	ld hl, NN	33
16539	7 NIN1	119		159		0 70#
16540	jp nz,NN	133	1d d <sub>e</sub> N	22	ld a. (hl)	126
16542		64	10 0 N	120#	out N. a	211
16543	ret	201	dec h	37	Due 14, a	3
16544		201	inc h	36	inc hl	35
16545			jp p,NN	242	1d a.h	124
16546				138	cp N	254
16547				64	•	128#
16548			ld h.N	38	jr nz	32
16549				120*		-9
16550			in a,N	219	1d a,N	62
16551				2		0
16552			cp N	254	out N, a	211
16553				119		3
16554			jp nz	194	ret	201
16555				138		
16556				64		
16557			ret	201		
16558						

#### SIGNAL PROCESSING **PROGRAMS**

The following programs use the audio signal processor circuit for three different signal processing applications; they are designed for use with a ZX81 with a 16K RAM pack. The first stage for all three applications is to reserve space in memory for the machine code. Type the following:

#### 10 SAVE "SET" 20 POKE 16389, 70 **30 NEW**

Start the cassette recorder in record mode, and RUN this program; it will save itself to cassette, and delete itself. Now if this program is loaded at any time apparently nothing will remain of it, but the BASIC area will be limited to 1.5K with the area above this free for machine-code storage. Now type:

#### 10 REM 00000000 . .

and continue typing 0's until two lines have been filled. The zeros in the REM statement will be used to store the machine code. Next set up a loop for POKEing in the machinecode routines:

The numbers to type in for each application are shown in Table 1, together with the corresponding assembly language mnemonics. Once the machine-code routine has been entered, the corresponding BASIC program from Figs 4, 5, or 6 should be entered; these calculate the required parameters, POKE them into the machine-code routine, and then call the machine code. The machine-code loops can be interrupted at any time by typing "N" to return to the BASIC program

iv to return to the Bribic program.
10 REMstring of poked characters
20 CLS
30 FAST
40 LET A=16514
50 PRINT "DELAY TIME: (MILLISEC) ", " (MAX 500)
60 INPUT P
70 IF P>500 THEN GOTO 40
80 LET P= 128-INT(P/8.61+0.5)
90 PDKE A+2,F
100 PDKE A+21,P
110 LET P=USR A
120 GOTO O

Fig. 4. Program converts the ZX81 into an audio echo unit

**ECHO PROGRAM** The program to use the audio signal processor as an echo unit is shown in Fig. 4. To understand how the program works imagine the memory cells placed on the dial of a clock. The hand of the clock rotates with constant speed; when the hand points to a cell the number in that cell is first transferred to the D/A converter; the reading from the A/D converter is then placed in that cell. Each sam-

ple is thus delayed by a time that depends on

the number of cells in the loop, and on the sampling rate. The sampling rate is fixed at 30kHz, but the number of cells in the loop can be varied to give different delays of up to 500 milliseconds.

Fig. 5. Harmonising program for the

signal in real time

#### HARMONIZER PROGRAM

The Harmonizer program of Fig. 5 performs a real-time pitch transposition of the input signal, and works in a similar way to the

ADDRESS:	ECHO:		HARMON17E	ER:	STORAGE SC	DPE:
16514	1d hl,NN	33	ld c,N	14	ld c,N	14
16515		0		171#		100*
16516		72#	ld de, NN	17	ld b,N	6
16516	ld b,N	6		0		1
16517		3		120#	dji nz	16
16518	ld a, (hl)	126	la hl, NN	33		-2
16519	out N, a	211		0	in a,N	219
16520		3		120#		3
16521	in a, N	219	in a,N	219	add c	129
17522		3		2	jr no	48
16523	1d(h1,a)	119	ld(hl),a	119		-9
16524	d∫ nz	16	inc hl	35	1d hl, NN	33
16526		-2	ld a, (de)	26		0
16527	inc de	19	out N, a	211		70
16528	inc hl	35		2	in a,N	219
16529	dec h	37	ld a,b	120		3
16530	inc h	36	add c	129	ld(hl), a	119
16531	jp p, NN	242	ld b, a	71	inc hl	35
16532		133	je no	48	1d a,h	124
16533		64		1	co N	254
16534	ld h,N	38	inc de	19		128
14535		72#	inc de	19#	jr nz	32
16536	in a,N	219	d⊕c d	21		-9
16537		2	Inc d	20	ret	201
16538	cp N	254	jp p,NN	242	ld hl, NN	33
16539		119		159		0
16540	jp nz,NN	194		64		701
16541		133	1d d <sub>a</sub> N	22	ld a, (hl)	126
16542		64		120#	out N, a	211
16543	ret	201	dec h	37 36	dament da N	35
16544			inc h	242	inc hl ld a.h	124
16545			jp p,NN	138		254
16546 16547				64	cp N	128#
			3 -4 5- 61	38	ir nz	32
16548 16549			ld h,N	120#	31 112	-9
16550			in a.N	219	ld a.N	62
16551			&FI dy N	2 2	10 9914	0
16552			cp N	254	out N.a	211
			rb is	119	Out 149 6	3
16553 16554			jp nz	194	ret	201
16555			3h 115	138	1 = 1	201
16556				64		
16557			ret	201		
1000/			1.6€	201		

DIGITAL STORAGE DECILLOSCOPE

10 NEW ...string of poked characters...

0 FAST
30 PRINT "DC TRIGOGRING LEVEL...","(0 TO 2.55 VOLT)"

10 LET U-223-INT(1001U+0.5)

10 POKE 16313,U

10 OLET U-USR 16514

10 LET K-1MEY N

10 LET U-USR 16514

10 LET K-1MEY N

10 LET W-1MEY N

10 LET W-1MEY N

10 LET W-1MEY N

10 LET W-1MEY N

10 LET K-1MEY N

10 PRINT N I MEAU\*

10 LET K-1MEY N

10 LET K-

#### Fig. 6. Program converts the ZX81 into a digital storage oscilloscope

echo program. Imagine a clock with two hands which rotate at different speeds; one hand writes numbers from each cell it passes to the D/A converter, and the other hand reads numbers from the A/D converter into cells. The ratio of the two speeds determines the pitch ratio of the input to the output.

1A\$=" ( 0!8!119155": VDU&97&9A: PRINTM ID\$(A\$,RND(6)\*2,2)':Z=GET:GOTO1

#### Fig. 7. Dice-throwing program uses teletext graphics for dice faces

10WIDTH3:REPEATA=RND(6):FORB=-7TO7:C= ABSB\*4MOD8+SGR2^ABSB:IFA/C MOD(C\*2)FRINT "O";:NEXTELSEPRINTSPC1;:NEXT:UNTILGET=PA LSE

#### Fig. 8. Dice-throwing program for the BBC Micro takes 70 bytes

10 MODE2:VDU5 20 X1=RND(1278):X2=X1+RND(1279-X1) 30 Y1=RND(1022):Y2=Y1+RND(1023-Y1) 40 GCOLRND(4)-1,127+RND(8) 50 VDU24,X1;Y1;X2;Y2;16:GOTO20

#### Fig. 9. Program for the BBC Micro draws random squares in different flashing colours

#### STORAGE SCOPE PROGRAM

The last of the three applications is a digital storage scope, which allows you to read in a waveform, and then examine selected sections of it. The program, Fig. 6, allows you to select a trigger level and a "time window". When the input reaches the trigger level the sampling starts at a sampling rate of 69kHz. The available 14.5K of memory is filled up in

215ms. After this the display mode starts and the time window can be moved to give a display of any desired portion of the sample. The oscilloscope is ideal for examining audio waveforms such as speech and music.

#### DICE PUZZLE

In July's Micro-Bus a problem was posed for owners of the BBC Micro: write the shortest possible program that will print up a random dice face, in true 3 by 3 format, every time a key is pressed. The length of the original program, measured by typing: PRINT TOP-PAGE

was 96 bytes. The smallest solution, sent by John B. Murphy of Dublin, reduced this to 58 bytes; see Fig. 7. It uses teletext separated-graphics characters to give the dice faces and so is not strictly a solution to the original problem, which used the letter "o" for the spots.

The best solution to the problem as originally posed was submitted by *Richard Jozefowski* of Cambridge, and the ingenious program is shown in Fig. 8.

Richard Jozefowski included in his letter a program for the BBC Micro which may be of interest to readers; see Fig. 9. It creates a colourful display of flashing squares of different sizes. If the flashing is found too disturbing, change the RND(16) in line 40 to RND(8)!

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## STEAM TRAIN "CHUFFER"

THIS circuit simulates the "chuff chuff" sound, with background steam of a train, synchronised to the speed of the model. The principle of operation is that the voltage on the track is used to control the period of an astable, which switches the gain of a noise generator.

The voltage from the rails is smoothed by C6 (Fig. 2) and limited from exceeding 12V by D6. A minimum voltage is maintained across C6 by VR2, VR1 and D7. VR2 is also used as a manual control. The voltage across C6 is modified by IC2 (Fig. 5b) to enable the 555 astable to be controlled, by feeding the output of IC2 to pin 5 of the astable.

The timing chain on the 555 astable is fed from a 10V supply, consisting of R24 and D8, so that when the output of IC2 is greater than 10V (rail volts near zero), the 555 is gated off and no "chuffs" are heard (Fig. 3).

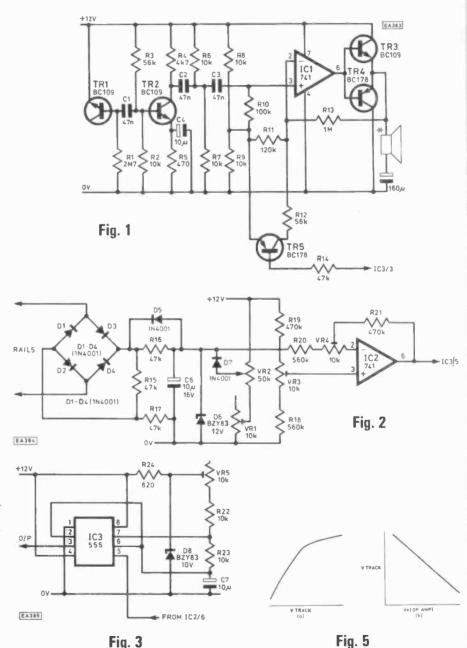
The audio circuit (Fig. 1) consists of TR1, as a noise generator due to reverse breakdown, TR2 as an amplifier and IC1 as a switched amplifier controlled by the 555 astable. TR5 switches the gain of IC1 according to the output of the 555 astable and gives a "chuff" rate which matches the speed well, as can be seen from Fig. 5.

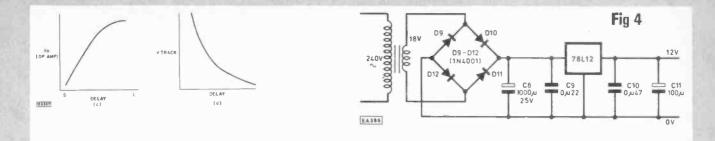
The power supply for this circuit is shown in Fig. 4 and it must be an independent 12V transformer to enable matching to any type of train controller.

VR5 (Fig. 3) sets the maximum "chuff" rate, VR1 (Fig. 2) sets the minimum voltage on C6 so that the 555 just gates off and VR3 and VR4 set the slope and level of IC2's output (i.e. Fig. 5b). The line of Fig. 5b is difficult to see correctly as VR3 and VR4 interact.

The speaker used was an 8 ohm 3 inch round type in series with 100R.

S. R. Woodall, Mangotofield, Bristol.



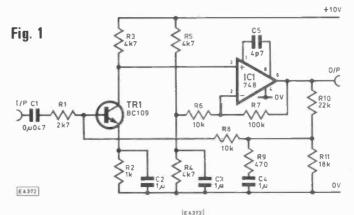


#### HIGH GAIN, HIGH FREQUENCY AMPLIFIERS

DURING experiments with a design for an induction balance metal detector, a need arose for an amplifier with a frequency response above 100kHz, a completely stable gain in excess of 100, an input impedance around 10k, and a low output impedance. In addition a sharp roll-off was required below about 20kHz, to ensure a complete lack of gain at 50Hz and thus minimise hum pick-up.

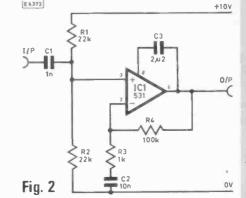
The first circuit, Fig. 1, was based on a 748 i.c. This cannot provide a gain much over 20 at the frequency required on its own, so the gain was limited to just 10 with the local feedback resistors R6 and R7. and the BC109 was used to provide the rest of the gain required, including within an overall negative feedback loop to eliminate the effects of temperature, etc. R4 and R5 set the output d.c. working point (half supply voltage), R10 and R11 act as a potential divider to provide the correct bias voltage to TR1, R1 and R8 set the input impedance, and R9 sets the overall loop gain. With the values shown the circuit provided a voltage gain of approximately 220 and was completely stable, though care should be taken with

This circuit may be of interest to some readers, as it has an extremly high gain and may be adaptable for other purposes, but after experiments with the much faster



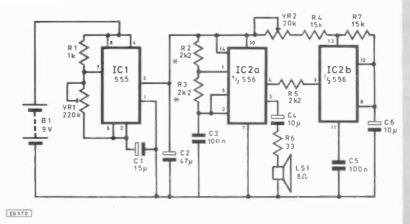
NE531V op-amp the author has replaced it with a much simpler circuit (Fig. 2). This provides a frequency response above 150kHz at a voltage gain of 100, and the low frequency response is tailored by C1 and C2 to give a very sharp roll-off at about 30kHz. At 50Hz the gain is well below unity.

A. J. Flind, Taunton, Somerset



#### TELEPHONE 'BELL'

enclose a circuit which I hope will arouse some interest. It is a circuit for a telephone 'bell'. As it stands the tone generated by IC2a is switched on and off by IC2b. IC1 switches the whole circuit on and off. The resultant sound is the characteristic 'ring-ring . . . ring-ring . . .' when adjusted properly. VR1 controls the long pause. VR2 controls the mark-space ratio between the two close rings. The controls just have to be twiddled about until it sounds right. If either VR1 or VR2 is advanced too far, the "phone" will ring three times before the long pause! In fact, due to capacitors charging up, on the first series of rings it does ring four times then starts on the "ring-ring . . ." sequence. It should be noted, however, that the frequency given out to LS1 is not 25Hz, but perhaps



2kHz.

If 25Hz is desired, the asterisked resistors should be raised in value or C1 should be raised in value. The components

asterisked change the short space between the rings.

Brian Craigie; Edinburgh

## BAZAA

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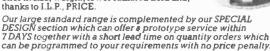
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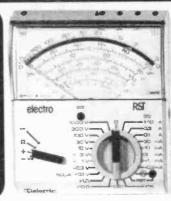




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