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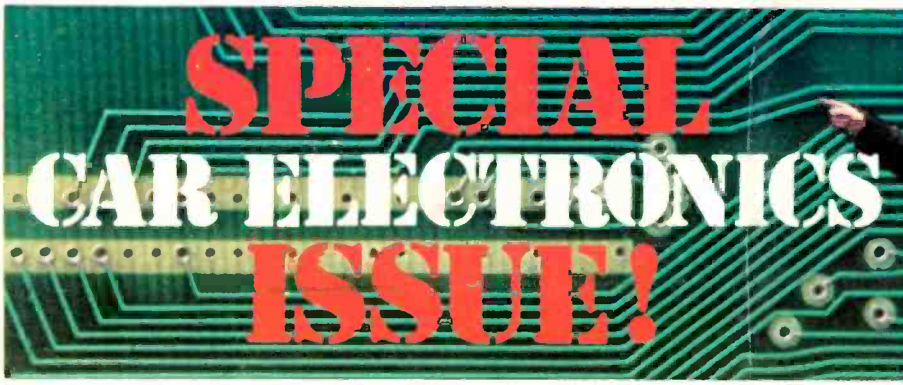
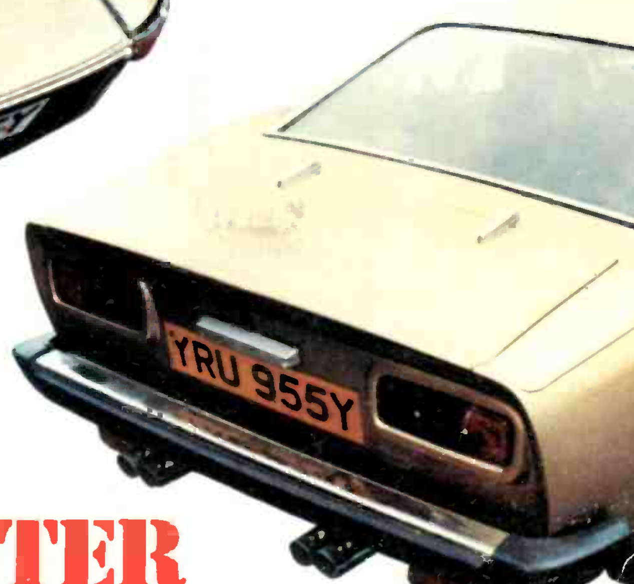
PRACTICAL ELECTRONICS

JANUARY 1983

85p





AUDIO BOOSTER
FROST WARNING
DIGITAL TACHOMETER

Also... DATA PULL-OUT – PE MICROFILE

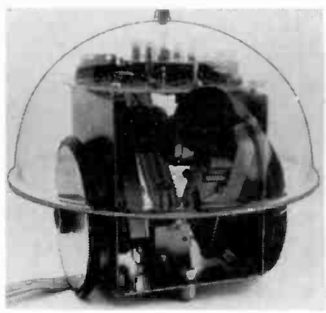
New developments in UK Robotics

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	£125.00
Universal computer interface board kit	£48.50
23 way edge connector	£2.50
ZX81 peripheral/RAM Pack splitter board	£3.00

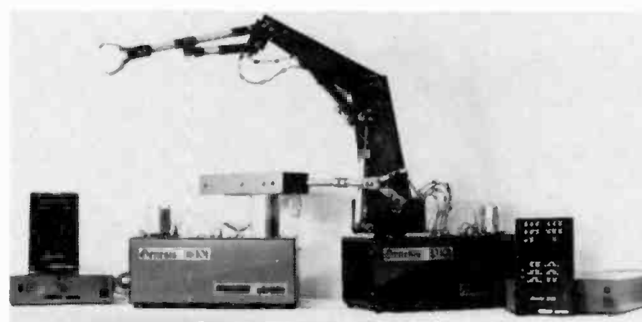
MICROGRASP, INTERFACE BOARD AND ZX81



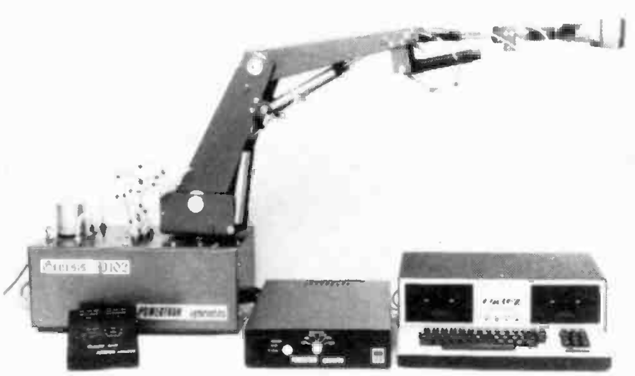
HEBOT II is a turtle-type robot which takes programming out of the two dimensional world of the VDU into the real three dimensional world. Given a DC supply of 9-15V it can perform a bewildering number of moves under computer control – forwards, backwards, left and right – with each wheel independently controlled. It has blinking eyes, bleeps with a choice of two tones and has a solenoid operated pen to chart its progress. Touch sensors coupled 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	£75.00
Universal computer interface board	£10.00
23 way edge connector	£2.50
ZX81 peripheral/RAM Pack splitter board	£3.00

'HIGH-TECH' FROM HANTS . . .



GENESIS S101 AND GENESIS P101 WITH PROCESSOR BOXES AND HAND-HELD CONTROLLERS



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 £1950.00
Powertran CORTEX 16 bit 64K computer Kit £295.00; READY BUILT £395.00
(Electronics Today International December issue on CORTEX)

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.

POWERTRAN cybernetics

ALL PRICES EXCLUSIVE OF VAT

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PRACTICAL
ELECTRONICS

VOLUME 19 No. 1 JANUARY 1983

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

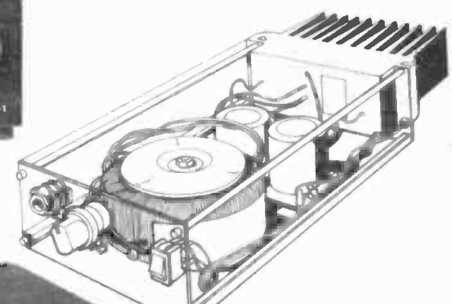
SPECIAL SUPPLEMENT

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 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)

WITH A LOT OF HELP FROM ILP ELECTRONICS LTD

PROFESSIONAL HI-FI THAT EVERY ENTHUSIAST CAN HANDLE...

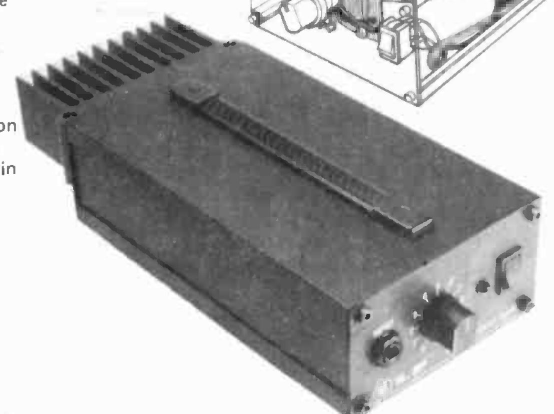


Unicase

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.

UNICASES

HIFI Separates					Price Inc. VAT
UC1	Preamp				£29.95
UP1X	30 + 30W/4–8Ω	Bipolar	Stereo	HiFi	£54.95
UP2X	60W/4Ω	Bipolar	Mono	HiFi	£54.95
UP3X	60W/8Ω	Bipolar	Mono	HiFi	£54.95
UP4X	120W/4Ω	Bipolar	Mono	HiFi	£74.95
UP5X	120W/8Ω	Bipolar	Mono	HiFi	£74.95
UP6X	60W/4–8Ω	MOS	Mono	HiFi	£64.95
UP7X	120W/4–8Ω	MOS	Mono	HiFi	£84.95
Power Slaves					
US1X	60W/4Ω	Bipolar	Power	Slave	£59.95
US2X	120W/4Ω	Bipolar	Power	Slave	£79.95
US3X	60W/4–8Ω	MOS	Power	Slave	£69.96
US4X	120W/4–8Ω	MOS	Power	Slave	£89.95

Please note X in part number denotes mains voltage. Please insert '0' 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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BI-PAK AUDIO
THE PROFESSIONAL APPROACH
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 manufacturers of high quality audio equipment throughout the world – to date, well over 100,000 modules have been sold – this is why discerning amateur enthusiasts and professionals alike insist on using BI PAK modules in their equipment.
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 kit or module in the BI PAK range to suit your every need.
AUDIO AMPLIFIERS
5-10 watts (RMS)
AL20 5 watt Audio Amp Module 22-30v supply £3.57
AL30A 7-10 watt Audio Amp. Module 22-32v supply
£4.16.
AUDIO AMPLIFIERS
15-25-35 watts (RMS)
AL60 15-25 watt Audio Amp Module 30-50v supply £5.15.
AL80 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 fulfil 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
£13.14.
AUDIO AMPLIFIER
125 watts (RMS). AL250
A power amplifier providing an output of up to 125w RMS, into a 4 ohm load. Four 115w transistors in the output stage makes it extremely rugged while damage from incorrect or short circuit loads is prevented by a four transistor protection circuit. For use in many applications such as disco units, sound re-inforcement systems, background music players etc.
AL250 125 watt Audio Amp Module 50-80v supply
£19.60.
POWER SUPPLIES
SPM120 is a fixed voltage stabiliser with an output voltage of either 45v, 55v, or 65v. Designed for use in audio applications, the stabiliser which provides output currents up to 2.5A operates direct from a mains transformer requiring only the addition of two Electrolytic capacitors to complete the power supply.
PS12 24v Supply Suit: 2 x AL10 2 x AL20 2 x AL30 & PA12/S453 £1.65. SPM80 33v Stabilised supply Suit: 2 x AL60 PA100 to 15 watts £4.84. SPM120/45 45v Stabilised supply Suit: 2 x AL60 PA100 to 25 watts £8.38. SPM120/56 56v Stabilised supply Suit: 2 x AL80 PA200 £8.38. SPM120/65 65v Stabilised supply Suit: 2 x AL120 PA200 1 x AL250 £8.38. SG30 15-0-15 Stabilised power supply for 2 x GE100 MKII £3.80.
STEREO PRE-AMPLIFIERS
PA12 Supply voltage 22-32v input sensitivity 300mv Suit: AL10/AL20/AL30 £8.55. PA100 Supply voltage 30-55v inputs. Tape Tuner Mag P.U. Suit: AL60/AL80 £17.65. PA200 Supply voltage 35-70v inputs. Tape Tuner Mag P.U. Suit: AL80/AL120/AL250 £18.24.
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: ¼ mile Size: 45×20mm. Add: 9v batt. Not licenced in U.K.
ONLY £5.50
Ideal for: 007-MI5-FBI-CIA-KGB etc.
MAGNETIC CARTRIDGE PRE-AMPLIFIER
Enjoy the quality of a magnetic cartridge with your ceramic equipment using the MPA30 which is a quality pre-amp. enabling magnetic cartridges to be used where facilities exist for ceramic cartridges only. With a DIN input socket & full, easy to follow instructions.
MPA30 Stereo Mag Cartridge. Pre-amp. – input 3.5mv Output 100mv £3.27.
MONO PRE-AMPLIFIERS
MM100 suitable for disco mixer. MM100G suitable for guitar pre-amp mixer.
The MM100 and MM100G mono pre-amplifiers are compatible with the AL60, AL80, AL120 and AL250 power amplifiers and their associated power supplies.
MM100 Supply voltage 40-65v inputs. Tape Mag P.U. Microphone Max output 500mv £12.43. MM100G Supply voltage 40-65v inputs: 2 Guitars, Microphones Max output 500mv
£12.43.
GE100 MKII
10 Channel. Monographic Equaliser.
Only 156mm x 65mm x 50mm including the 10 x 10K 45mm slider potentiometers and knobs which are mounted on a board above the circuitry. In the range of 31Hz to 16KHz you can cut and boost ±12dB with the 10 sliders, each 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. Together with Transformer no: 2043.
GE100 MKII 10 Channel mono-graphic Equaliser with sliders & Knobs £20.00.
PUSH BUTTON STEREO FM TUNER
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 altered as often as you choose, simply by changing the settings of the preset controls. Features include FET input stage. Vari-cap diode tuning.
£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 £4.90. 2035 2 amp 55v £6.65. 2036 750mA 17v Suit PS12 £2.85. 2040 1.5 amp 0-45v-55v Suit SPM120/45 SPM120/55v £6.45. 2041 2 amp 0-55v 65v Suit SPM120/55 SPM120/65v £8.08. 2039 1 amp 0-20v Suit Stereo 30 £3.50. 2043 150mA 15-0-15v Suit SG30 £1.60.
ACCESSORIES
139 Teak Cabinet Suit Stereo 30 320 x 235 x 81mm £7.00. 140 Teak Cabinet Suit STA15 425 x 290 x 95mm £9.50. FP100 Front Panel for PA100 & PA200 £1.80. BP100 Back Panel for PA100 & PA200 £1.60. GE100FP Front Panel for one GE100MKII £1.75. TC60 Kit of Parts including Teak Cabinet chassis, sockets & knobs etc to house STA15 Amplifier) £17.50. PS250 Consists – 1 capacitor & 4 diodes for constructing unstabilised power supply for AL250 to 125 watts £2.90.
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Variable from 2-30 volts and 0-2 Amps. Kit includes –
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SIREN ALARM MODULE
American Police type screamer powered from any 12 volt supply into 4 or 8 ohm speaker. Ideal for car burglar alarm, freezer break-down and other security purposes. BP124 5 watt 12v max – Siren Alarm Module £3.85.
BI-KITS
STA5 5 watts per channel Stereo Amplifier Kit consisting of 2 x AL20 amplifiers 1 x PA12 pre-amplifier 1 x PS12 power supply 1 x 2036 transformer and necessary wiring diagram £19.52. STA10 10 watts per channel Stereo Amplifier Kit consisting of 2 x AL30 amplifiers 1 x PA12 pre-amplifier 1 x PS12 power supply 1 x 2036 transformer and necessary wiring diagrams £20.63. STA15 15 watts per channel Stereo Amplifier Kit consisting of 2 x AL60 amplifiers 1 x PA100 pre-amplifier 1 x SPM80 power supply 1 x 2034 transformer 2 x coupling capacitors for 8 ohms 470 mfd 50v and necessary wiring diagrams £36.78. STA25 25 watts per channel Stereo Amplifier Kit consisting of 2 x AL60 amplifiers 1 x PA100 pre-amplifier 1 x SPM120/45 power supply 1 x 2040 transformer 2 x coupling capacitors for 8 ohms 470 mfd 45v 1 x reservoir capacitor 2200 mfd 100v and necessary wiring diagram £45.76. STA35 35 watts per channel Stereo Amplifier Kit consisting of 2 x AL80 amplifiers 1 x SPM120/55 power supply 1 x PA200 pre-amplifier 1 x 2035 transformer 2 x coupling capacitors 470 mfd at 50v for 8 ohms 1 x reservoir capacitor 2200 mfd 100v and necessary wiring diagram £45.76.
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6 precision screwdrivers in hinged plastic case Sizes – 0 8 1 4 2 2.4 2 9 and 3 8mm **£1.75**

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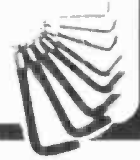

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Paks SX12-15 contain a range of Carbon Film Resistors of assorted values from 22 ohms to 2 2 meg Save pounds on these resistor paks and have a full range to cover your projects.
*Quantities approximate, count by weigh

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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 & CONSTRUCTORS. Order No. ASD/1 £3.50 each

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SX17	200	Ceramic Capacitors Miniature Mixed	□
SX18	100	Mixed Ceramics 1pf-56pf	□
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SX20	100	Assorted Polyester/Polystyrene Capacitors	□
SX21	60	Mixed C280 type capacitors metal foil	□
SX22	100	Electrolytics, all sorts	□
SX23	50	Quality Electrolytics 50-1000mf	□
SX24	20	Tantalum Beads, mixed	□

*Quantities approximate, count by weigh

BARGAINS

SX91	20 x Large .2" RED LED	£1
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SX43	10 Rectangular Green LED's .2	£1
SX46	30 Assorted Zener Diodes 250mw-2 watt mixed voltages, all coded. New	£1
SX47	4 Black Instrument Knobs—winged with pointer ¼" Standard screw Fit size 29 x 20mm	50p
SX49	20 Assorted Slider Knobs Black/Chrome, etc.	£1
SX80	12 Neons and Filament Lamps Low voltage and mains – various types and colours – some panel mounting	£1

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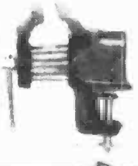
RE 188m
LCD 10 MEGOHM INPUT IMPEDANCE
*3½ digit *16 ranges plus hFE test facility for PNP and NPN transistors *Auto zero, auto polarity *Single-handed pushbutton operation *Over range indication *12 5mm (½-inch) large LCD readout *Diode check *Fust circuit protection *Test leads, battery and instructions included

Max indication	1999 or – 1999
Polarity 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
Power Supply	1 x PP3 or equivalent 9V battery
Consumption	20mW
Size	155 x 88 x 31mm

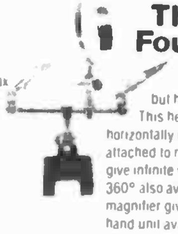
RANGES
DC Voltage 0-200mV
0-2-20-200-1000V Acc 0 8%
AC Voltage 0-200-1000V
Acc 1 2% DC Current 0-200uA
0-2-20-200mA 0-10 A Acc 1 2%
Resistance 0-2-20-200K ohms
0-2 Megohms Acc 1%
BI-PAK VERY LOWEST POSS PRICE
£35.00 each

MINI VICE

This small cast iron quality made vice will clamp on to any bench or table having a max thickness of 1⅛" The 2½" jaws open to max of 1⅝" Approx size 80 x 120 x 66mm
Bi-Pak's Mini Vice at a Mini Price only
£2.50
ORDER NO SX82



The Third and Fourth Hand...



.... you always need but have never got 'until' now
This helpful unit with Rod mounted horizontally on Heavy Base Crocodile clips attached to rod ends Six ball & socket joints give infinite variation and positions through 360° also available attached to Rod a 2½ diam magnifier giving 2 5 x magnification Helping hand unit available with or without magnifier Our Price with magnifier as illustrated ORDER NO T402 **£5.50**
Without magnifier ORDER NO T400 **£4.75**

SX52 6 Black Heatsink will fit TO-3 and TO-220 Ready drilled Half price value. £1
SX53 1 Power finned Heatsink This heatsink gives the greatest possible heat dissipation in the smallest space owing to its unique staggered fin design, pre drilled
TO-3 Size 45mm square x 20mm high 40p
SX54 TO-66 size 35mm x 30mm x 12mm 35p
SX55 1 Heat Efficiency Power Finned Heatsink 90mm x 80mm x 35mm High Drilled to take up to 4 x TO-3 devices
£1.50 each

SINGLE SIDED FIBREGLASS BOARD

Order No.	Pieces	Size	Sq.Ins.	Price
FB1	4	9 x 2¾"	100	£1.50
FB2	3	11 x 3"	100	£1.50
FB3	4	13 x 3"	156	£2.00

DOUBLE SIDED FIBREGLASS BOARD

FB4	2	14 x 4"	110	£2.00

SILICON POWER TRANSISTORS – T03

NPN like 2N3055 – but not full spec
100 watts 50V min.
10 for £1.50 – Very Good Value
100s of uses – no duds
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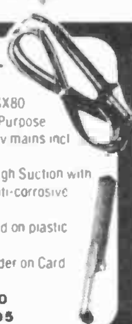

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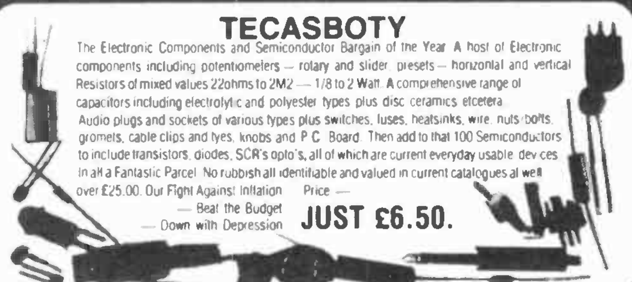

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Sinclair ZX Spectr

16K or 48K RAM... full-size moving-key keyboard... colour and sound... high-resolution graphics...

From only £125!

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.

Professional power–personal computer price!

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 high-resolution 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.

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MJE3055	69p
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MP8111	1.00
MP8112	1.39
MP8121	1.35
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OC28	1.70
OC29	2.35
OC35	2.36
OC41	80p
OC43	70p
OC44	82p
OC70	50p
OC71	50p
OC72	50p
OC82	50p
OC82D	70p
OC83	75p
P346A	58p
R2008B	2.13
R2010B	1.88
SC107	27p
SC108	27p
SC109	27p
TIP29A	32p
TIP29C	38p
TIP30A	35p
TIP30C	38p
TIP31A	38p
TIP31C	38p
TIP32A	39p
TIP32C	42p
TIP33A	65p
TIP33C	78p
TIP34A	74p
TIP34C	88p
TIP35A	1.09
TIP35C	1.28
TIP36A	1.29
TIP36C	1.39
TIP41A	49p
TIP41C	55p
TIP42A	55p
TIP42C	65p
TIP49	1.20
TIP50	1.40
TIP53	1.57
TIP54	1.59
TIP110	74p
TIP112	90p
TIP115	81p
TIP117	96p
TIP120	69p
TIP122	73p
TIP125	1.20
TIP127	1.27
TIP130	1.50
TIP132	1.60
TIP135	1.60
TIP137	1.60
TIP140	1.04
TIP142	1.04
TIP145	1.19
TIP147	1.19
TIP2955	77p
TIP3055	70p
TIS37	62p
TIS43	40p
VN10KM	60p
VN46AF	84p
VN66AF	85p
ZTX107	10p
ZTX108	10p
ZTX109	10p
ZTX300	13p
ZTX301	15p
ZTX302	15p
ZTX303	23p
ZTX304	15p
ZTX310	35p
ZTX311	32p
ZTX312	35p
ZTX313	36p
ZTX314	24p
ZTX320	35p
ZTX330	35p
ZTX341	28p
ZTX500	14p
ZTX501	14p
ZTX502	14p
ZTX503	17p
ZTX504	24p
ZTX510	34p
ZTX530	24p
ZTX531	25p

LINEAR ICs

AN103	2.20
AY1-0212	6.80
AY3-0215	7.95
AY1-1320	2.20
AY1-5050	95p
AY1-1270	7.26
AY3-8910	5.39
AY3-8912	5.59
AYS-2376	5.89
CA3000	4.80
CA3001	4.95
CA3002	4.60
CA3005	3.15
CA3007	4.82
CA3010	1.30
CA3012	1.75
CA3013	4.12
CA3014	2.35
CA3015	2.62
CA3018	75p
CA3018A	2.00
CA3020	2.00
CA3020A	3.90
CA3021	3.20
CA3022	3.12
CA3026	1.52
CA3028A	1.21
CA3028B	2.53
CA3029	1.44
CA3030A	2.97
CA3033	5.44
CA3034	5.18
CA3035	2.75
CA3039	1.50
CA3041	3.47
CA3042	3.47
CA3043	3.92
CA3046	69p
CA3047	4.60
CA3048	2.98
CA3049	3.21
CA3050	4.11
CA3051	3.80
CA3052	2.82
CA3053	1.00
CA3054	1.66
CA3059	2.80
CA3060	4.09
CA3062	13.84
CA3065E	4.62
CA3068	4.23
CA3070	3.20
CA3071	3.30
CA3075	2.25
CA3076	3.42
CA3078T	2.25
CA3080	1.89
CA3080A	3.95
CA3080E	70p
CA3081	1.90
CA3085	1.35
CA3086	56p
CA3088E	2.35
CA3089E	1.95
CA3090AQ	3.70
CA3130E	87p
CA3130T	1.80
CA3140E	46p
CA3140T	85p
HA1166W	2.40
HA1388	2.54
ICL7106	7.40
ICL7107	9.50
ICL8038	2.99
ICM7555	80p
LC7120	3.20
LC7130	3.20
LF351	47p
LF353	82p
LF355	83p
LF356	92p
LF357	1.00
LF13201	2.98
LF13331	3.30
LF13741H	68p
LF13641N	58p
LM10CH	4.25
LM11CH	4.50
LM114	6.75
LM137K	11.52
LM301AH	1.00
LM301AN	25p
LM305AH	2.90
LM305H	88p
LM307H	1.05
LM307N	55p
LM308AH	3.16
LM308AN	2.14
LM308H	95p
LM308N	88p
LM309K	2.80
LM310H	1.95
LM310N	1.89
LM311H	1.04
LM311N	70p
LM317K	2.80
LM317MP	1.04
LM318H	2.40
LM318N	1.49
LM319H	2.46
LM319N	2.10
LM320 – See 79XX Series Volt Regulators	
LM324N	29p
LM337K	4.75
LM337MP	1.65
LM337T	1.99
LM339AN	1.60
LM339N	47p
LM340 – See 78XX Series Volt Regulators	
LM345K	8.60
LM348N	62p
LM349N	1.15
LM350K	4.00
LM359N	1.44
LM360N	3.88
LM376N	65p
LM377N	1.69
LM378N	3.40
LM379S	4.79
LM380N14	75p
LM380N8	1.50

LM381AN	2.28
LM381N	1.40
LM382N	1.12
LM383T	3.40
LM384N	1.40
LM386N1	85p
LM386N4	1.20
LM388N	2.43
LM391N60	1.70
LM391N80	1.83
LM392N	75p
LM393N	94p
LM394H	3.80
LM396K	13.52
LM709N8	64p
LM709CH	1.00
LM710CH	89p
LM710CN	52p
LM711CH	1.38
LM711CN	70p
LM723CH	1.21
LM723CN	40p
LM725CH	3.40
LM725CN	3.19
LM733CN	77p
LM741CH	94p
LM741CN	15p
LM741CN14	80p
LM747CN	69p
LM748CH	1.00
LM748CN	35p
LM1303N	1.20
LM1304N	2.50
LM1305N	3.10
LM1307N	2.75
LM1310N	1.45
LM1330N	2.25
LM1458	44p
LM1496	1.08
LM1800	3.24
LM1801	2.99
LM1812	8.00
LM1818	2.99
LM1820	2.15
LM1828	4.79
LM1830	2.44
LM1845	4.12
LM1848	2.89
LM1850	2.75
LM1871	4.39
LM1872	4.39
LM1886	7.44
LM1889	3.77
LM2907N	2.75
LM2907N8	2.60
LM2917N	1.89
LM2917N8	1.89
LM3524	6.77
LM3301	1.00
LM3302	74p
LM3401	85p
LM3403	75p
LM3405	1.45
LM3900	48p
LM3905	1.25
LM3909	79p
LM3911	1.20
LM3914	1.79
LM3915	1.99
LM3916	2.19
LM4250CH	2.63
LM4250N	2.39
LM13600	1.09
MB3712	1.99
MB3756	3.80
MB8719	7.95
MC1352	1.75
MC1456	1.80
MC3340	1.46
MOST MC Prefix = LM Prefix	
NE531N	1.36
NE543N	2.50
NE544N	1.50
NE555	16p
NE556	46p
NE558	1.89
NE560	3.25
NE562	4.09
NE565	1.18
NE566	1.49
NE567	1.37
NE570	3.75
NE571	3.75
NE5534	1.49
PLL02A	4.85
PLL03A	12.75
RC4136	59p
S566B	2.59
SAD1024	11.99
SAS560	2.59
SAS570	2.59
SAS580	2.59
SAS590	2.59
SFF96364	7.99
SL610C	4.00
SL611C	4.00
SL612C	4.00
SL620C	6.00
SL621C	6.00
SL623C	10.00
SL630C	6.00
SL640C	6.00
SL641C	6.00
SN76001N	2.80
SN76008	3.80
SN76477	4.49
SN76488	4.49
SN76550	80p
SN76666	2.90
SO41P	1.60
SO42P	1.60
TA7210	1.49
TA7204	1.95
TA7205	89p
TA7222	1.45
TA7310	1.49
TAA263	1.50
TAA300	3.95
TAA320	2.05
TAA350	3.60
TAA521	1.50
TAA522	2.47
TAA550	73p
TAA560	2.35
TAA570	2.35
TAA621AX1	2.75
TAA661A	1.50

TAA661B	1.70
TAA700	2.00
TAA930	2.50
TAA930B	2.63
TAA970	2.45
TAA991D	2.45
TAD100	2.00
TBA120AS	75p
TBA331	1.50
TBA341	2.05
TBA395	1.65
TBA396	1.50
TBA450	1.95
TBA460	1.53
TBA500	2.87
TBA500Q	3.11
TBA510	2.96
TBA510Q	3.06
TBA520	2.57
TBA520Q	2.75
TBA530	2.56
TBA530Q	2.76
TBA540	2.72
TBA540Q	2.74
TBA550	3.25
TBA550Q	3.27
TBA560Q	2.87
TBA570	2.37
TBA570Q	2.48
TBA581	3.11
TBA641	3.00
TBA651	1.90
TBA673	4.15
TBA700	2.38
TBA700Q	2.47
TBA720AQ	2.60
TBA750	2.25
TBA750Q	2.46
TBA790A	2.11
TBA800	78p
TBA810	95p
TBA820	75p
TBA820M	75p
TBA920	1.95
TBA920Q	1.97
TBA950	2.25
TBA990	2.65
TBA990Q	2.74
TCA105	3.00
TCA160C	2.87
TCA220	3.44
TCA270	2.44
TCA440	2.20
TCA450	2.68
TCA640	4.15
TCA650	4.15
TCA660B	4.15
TCA730	4.80
TCA740	4.80
TCA750	4.85
TCA760	2.75
TCA800	3.50
TCA800Q	3.60
TCA830S	1.90
TCA910	2.19
TCA940	1.69
TDA1002	3.39
TDA1003	3.94
TDA1004	2.87
TDA1005	3.94
TDA1010A	2.25
TDA1022	4.95
TDA1024	1.19
TDA1034	3.20
TDA2020	2.99
TDA2030	2.85
TDA2522	4.20
TDA2530	3.30
TDA2540	4.10
TDA2541	4.10
TDA2560	4.10
TDA2571	4.40
TDA2581	3.75
TDA2590	5.20
TDA2591	4.73
TDA2600	6.15
TDA2610	3.90
TDA2611A	2.50
TDA2640	3.64
TDA3000	2.76
TL061	40p
TL062	80p
TL064	99p
TL071	36p
TL072	50p
TL074	1.30
TL081	50p
TL082	75p
TL083	85p
TL084	89p
TL170	49p
TL430	69p
UAA170	1.69
UAA180	1.69
ULN2003	85p
UPC575C2	2.65
UPC1156	2.76
UPC1181	8.75
UPC1182	2.99
UPC1185	6.45
XR2206	2.92
XR2207	3.75
XR4212	1.83
ZN414	79p
ZN418	2.25
ZN1034	1.99
ZN1040	6.69
ZTX22	85p
ZTX33	85p

TTL

7400	10½p
7401	11p
7402	11p
7403	12p
7404	12p
7405	12p
7406	16p
7407	16p
7408	14p
7409	14p
7410	14p
7411	16p
7412	16p
7413	16p
7414	17p
7416	17p
7417	17p
7420	15p
7421	20p
7422	20p
7423	20p
7425	18p
7426	18p
7427	18p
7428	18p
7430	14p
7432	17p
7433	21p
7437	19p
7438	19p
7440	15p
7441	65p
7442	27p
7443	65p
7444	65p
7445	46p
7446	50p
7447	35p
7448	40p
7450	15p
7451	15p
7453	15p
7454	14p
7460	15p
7470	30p
7472	25p
7473	23p
7474	18p
7475	22p
7476	24p
7480	40p
7481	1.19
7482	63p
7483	38p
7484	63p
7485	60p
7486	18p
7489	1.70
7490	20p
7491	35p
7492	25p
7493	34p
7494	34p
7495	34p
7496	34p
7497	85p
74100	80p
74104	50p
74105	55p
74107	20p
74109	25p
74110	29p
74116	50p
74118	53p
74119	57p
74120	59p
74121	25p
74122	30p
74123	34p
74125	30p
74126	29p
74128	25p
74132	29p
74136	27p
74141	55p
74142	1.75
74143	1.95
74144	1.95
74145	38p
74147	80p
74148	55p
74150	49p
74151	35p
74153	35p
74154	45p
74155	35p
74156	40p
74157	30p
74159	75p
74160	40p
74161	40p
74162	40p
74163	40p
74164	40p
74165	44p
74166	48p
74170	1.17
74172	2.50
74173	48p
74174	54p
74175	49p
74176	39p
74177	45p
74178	68p
74180	40p
74181	1.15
74182	55p
74184	90p
74185	90p
74186	4.69
74188	2.50
74190	45p
74191	45p
74192	45p
74193	45p
74194	40p
74195	40p
74196	40p
74197	40p
74198	77p
74199	77p
74221	53p

74LS TTL

74LS00	11p
74LS01	11p
74LS02	11p
74LS03	12p
74LS04	12p
74LS05	12p
74LS08	12p
74LS10	12p
74LS11	12p
74LS12	12p
74LS13	18p
74LS14	22p
74LS15	12p
74LS20	12p
74LS21	12p
74LS22	12p
74LS27	12p
74LS28	14p
74LS30	12p
74LS32	13p
74LS33	14p
74LS37	14p
74LS38	14p
74LS40	12p
74LS42	28p
74LS47	35p
74LS51	14p
74LS54	14p
74LS56	14p
74LS73	18p
74LS74	18p
74LS75	18p
74LS76	18p
74LS78	18p
74LS80	1.20
74LS83	33p
74LS85	39p
74LS86	16p
74LS90	22p
74LS92	25p
74LS93	24p
74LS95	36p
74LS96	50p
74LS107	20p
74LS109	23p
74LS112	20p
74LS113	22p
74LS114	22p
74LS122	25p
74LS123	34p
74LS124	89p
74LS125	24p
74LS126	25p
74LS132	33p
74LS136	24p
74LS138	24p
74LS139	27p
74LS145	70p
74LS147	99p
74LS148	69p
74LS151	39p
74LS153	39p
74LS154	79p
74LS155	29p
74LS156	36p
74LS157	27p
74LS158	28p
74LS160	32p
74LS161	35p
74LS162	35p
74LS163	35p
74LS164	40p
74LS165	50p
74LS168	84p
74LS169	85p
74LS170	70p
74LS173	55p
74LS174	39p
74LS175	39p
74LS181	88p
74LS183	1.20
74LS190	36p
74LS191	36p
74LS192	36p
74LS193	37p
74LS194	32p
74LS195	32p
74LS196	45p
74LS197	48p
74LS221	50p
74LS240	55p
74LS241	55p
74LS242	55p
74LS243	55p
74LS244	55p
74LS245	70p
74LS247	50p
74LS248	55p
74LS249	55p
74LS251	30p
74LS253	32p
74LS257	29p
74LS258	33p
74LS259	55p
74LS261	99p
74LS266	18p
74LS273	53p
74LS275	1.25
74LS279	30p
74LS280	95p
74LS283	40p
74LS289	4.70
74LS290	45p
74LS293	40p
74LS295	75p
74LS298	79p
74LS299	1.55
74LS323	1.55
74LS324	1.45
74LS325	2.96
74LS326	2.36
74LS327	2.30
74LS347	95p
74LS348	88p
74LS352	59p
74LS353	59p
74LS362	7.25
74LS365	27p
74LS366	27p
74LS367	27p
74LS368	27p
74LS373	54p
74LS378	80p
74LS386	1.14
74LS390	46p
74LS393	42p
74LS395	87p
74LS395	1.90
74LS398	2.70
74LS399	1.50
74LS445	1.30
74LS490	1.95
74LS540	88p
74LS541	88p
74LS640	99p
74LS641	99p
74LS643	99p
74LS644	99p
74LS668	1.18
74LS669	99p
74LS670	99p
74LS673	5.50
74LS674	9.99

74C CMOS/TTL

74C00	27p
74C04	29p
74C10	28p
74C14	89p
74C20	28p
74C30	35p
74C42	96p
74C48	1.40
74C73	64p
74C76	57p
74C83	1.74
74C85	1.34
74C86	1.10
74C89	5.95
74C90	1.05
74C93	1.44
74C95	1.00
74C107	60p
74C151	2.55
74C154	4.95
74C157	2.20
74C160	1.54
74C161	1.15
74C162	1.16
74C163	65p
74C164	1.15
74C165	2.00
74C173	90p
74C174	65p
74C175	75p
74C192	89p
74C193	68p
74C194	89p
74C195	70p
74C200	10.00
74C221	1.20
74C901	1.91
74C902	71p
74C903	2.30
74C904	1.84
74C905	10.88
74C907	1.91
74C908	1.87
74C911	9.59
74C912	8.00
74C914	2.88
74C915	1.99
74C918	2.50
74C920D	8.50
74C922	4.50
74C923	5.00
74C925	6.00
74C926	6.58
74C928	5.00
74C929	5.20
74C930J	7.80
74C932	3.12

COMPUTER ICs

CPUs

1802	6.50
2650A	11.98
6502	3.24
6800	2.74
6802	2.69
6809	6.50
8036	3.49
8060	10.50
8080A	2.60
8085A	3.49
8900	57.75
8980	21.00
SCMP1	17.60
Z80A	3.15

MEMORIES

2101	4.00
2102AL2	1.35
2111-1	3.00
2114 (200ns)	85p
2532	3.60
2708	2.25
2716 (5V)	2.11
4027	3.00
4044	4.50
4060	9.50
4116 (200ns)	75p
4118-3	3.25
4164	4.50
5204	7.80
6116	4.40
6514	3.30
6810	1.15
7489	4.20
74189	4.00
74LS288	1.50
74S188	1.50
74S287	3.05
74S288	2.25

40 CMOS

4000	10p	4044	41p
4001	10p	4045	99p
4002	11p	4046	44p
4006	40p	4047	39p
4007	15p	4048	39p
4008	32p	4049	22p
4009	24p	4050	23p
4010	24p	4051	44p
4011	10p	4052	49p
4012	15p	4053	49p
4013	20p	4054	83p
4014	46p	4055	83p
4015	39p	4056	83p
4016	20p	4059	4.35
4017	32p	4060	42p
4018	44p	4063	79p
4019	26p	4066	22p
4020	44p	4067	2.22
4021	39p	4068	14p
4022	39p	4069	13p
4023	12p	4070	13p
4024	32p	4071	13p
4025	12p	4072	13p
4026	77p	4073	13p
4027	20p	4075	13p
4028	37p	4076	44p
4029	43p	4077	13p
4030	14p	4078	13p
4031	1.19	4081	12p
4032	80p	4082	12p
4033	1.20	4085	49p
4034	1.29	4086	53p
4035	50p	4089	1.20
4036	2.40	4093	20p
4037	1.30	4094	69p
4038	99p	4095	75p
4039	2.80	4096	70p
4040	40p	4097	2.88
4041	40p	4098	74p
4042	39p	4099	90p
4043	46p		

For higher numbers in 40 Series, substitute 74C for 40 prefix, e.g. 40107=74C107

45 CMOS

4502	59p
4503	29p
4507	33p
4508	1.19
4510	45p
4511	48p
4512	39p
4514	1.10
4515	1.10
4516	55p
4518	39p
4519	29p
4520	45p
4521	90p
4526	59p
4527	59p
4528	46p
4532	69p
4534	4.29
4536	2.59
4538	65p
4539	99p
4543	65p
4553	2.25
4555	35p
4556	35p
4560	1.49
4566	1.49
4569	1.59
4584	39p
4585	79p

ZERO INSERTION DIL SOCKETS

24 pin	4.80
40 pin	5.20

LOGIC ICs including COMPUTER SUPPORT

ADC0800	22.50	81LS95	90p
ADC0816	14.90	81LS96	1.20
ADC0817	10.06	81LS97	90p
AYS-2376	6.90	81LS98	1.20
ICM7555	80p	6522	3.19
INS1671	20.00	6532	8.85
INS1771	20.00	6821	1.12
INS1791	20.00	6845	10.00
MC1466L	6.50	6847	10.00
MC1488	85p	6850	1.35
MC1489	85p	6852	2.48
MC4024	3.25	6875	4.85
MC4044	3.25	8131	3.75
MK50250	30.00	8154	8.42
MK50398	8.95	8155	3.50
MM5303	6.25	8212	1.10
MM5307	12.75	8216	1.00
MM5357	22.50	8223	1.90
MM57106	14.00	8224	1.10
MM57109	12.00	8226	2.80
MM57160	9.00	8228	2.50
MM57161	9.00	8238	6.75
MM58174	11.80	8243	4.88
RO2513LC	5.99	8250	8.65
RO2513UC	7.50	8251	3.15
SAA5000	3.00	8253	7.95
SAA5010	7.10	8254	10.00
SAA5012	7.10	8255	2.48
SAA5020	5.50	8257	4.00
SAA5030	9.00	8258	4.00
SAA5040	15.00	8278	4.40
SAA5041	15.00	8304	4.50
SAA5050	8.50	8544	1.50
SAA5052	8.80	8601	1.20
TMS6011	3.65	8678CABN	19.50
ULN2003A	85p	8832	2.90
8T26	1.36	8833	2.25
8T28	1.36	9097	3.00
8T95	1.36	9099	3.00
8T97	1.36	9601	5.50
		9602	2.50
		Z80ACTC	2.65
		Z80ADART	8.00
		Z80ADMA	10.00

PE VOLUME 19 NO. 1 JANUARY 1983

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!

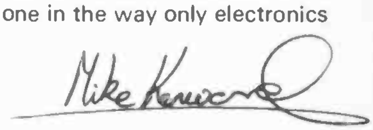
The 1982 Motor Show proved yet again how slow things move in this field. Many readers will have seen demonstrations of speech recognition systems and synthesised speech warnings but we are still some years away from such devices being part of the popular motoring scene. Even the solid state dashboard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



Technical and Editorial queries and letters (see note below) to:
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Westover House,
West Quay Road, Poole,
Dorset BH15 1JG
Phone: *Editorial* Poole 671191

We regret that lengthy technical enquiries cannot be answered over the telephone

Queries and letters concerning advertisements to:
Practical Electronics Advertisements,
King's Reach Tower,
King's Reach, Stamford Street, SE1 9LS
Telex: 915748 MAGDIV-G

Letters and Queries

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

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 0PF, at £1 each including Inland/Overseas p&p. Please state month and year of issue required.

Binders

Binders for PE are available from the same address as back numbers at £4·60 each to UK or overseas addresses, including postage and packing, and VAT where appropriate. Orders should state the year and volume required.

Subscriptions

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.

Digital Disc System

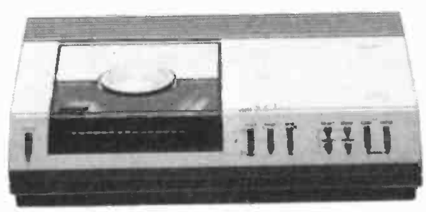
This Spring will see the launch of the much heralded audio revolution with Philips releasing a digital audio system, called the Compact Disc. The Compact Disc player has been designed to connect into any existing hi-fi system in the same way as other sound sources such as tape decks, turntables etc.

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%.



SOLAR POWER GAME

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.)

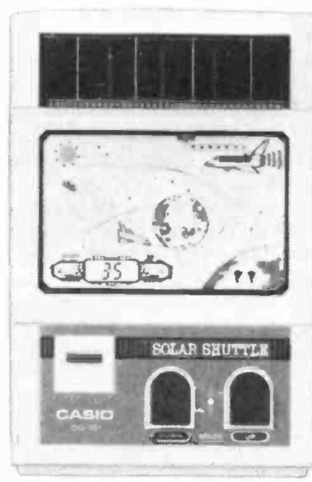
By controlling speed increase and decrease buttons, the object is to achieve shuttle lift off from earth, enter lunar orbit, and then to escape from orbit to dock with a space station.

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.

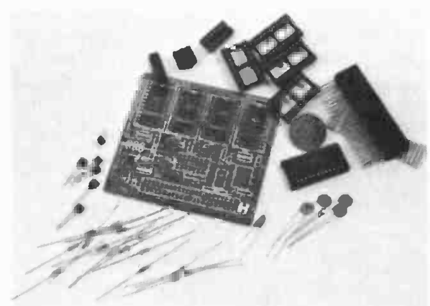


NOT TO BE FORGOTTEN

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 non-volatile. The RAM retains its memory even when the ZX81 is switched off or reset.



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.

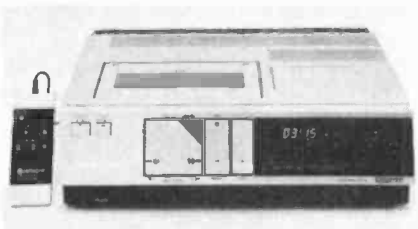
The kit priced at £19·95 plus £1·95 p&p or just the p.c.b. with instruction manual is £10 post paid supplied by Hunter Electronics, P.O. BOX 5, Axminster, Devon EX13 5AS.

MARKET PLACE

NEW HITACHI VIDEO

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 rewind 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 audio-visual 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 3½ 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 possiblities 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.

...NEWS & MARKET 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, 1½kg 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.

Briefly...

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 Instruments.

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 used.

● ● ● ●

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 294393)

Countdown...

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. **Z1**
BEX Bournemouth Feb. 9–10 1983. The Pavillion. **K**
Microsystems Feb. 23–25 1983. West Cntr. Hotel, Fulham, London. **Z1**
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 St. **E**
Brighton Electronics March 1983. **T**
BEX Leeds Mar. 16–17 1983. Dragonara Hotel. **K**
INSPEX Mar. 21–25 1983. National Exhibition Cntr. Birmingham International. **Z1**
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, London. **O**
Compec North June 21–23 1983. Belle Vue, Manchester. **Z1**

A8	Holographic Exhibitons ✆01-836 6423
E	Evan Steadman ✆0799 22612
I	Industrial Trade Fairs ✆021 705 6707
K	Douglas Temple Studios ✆0202 20533
O	Online ✆09274 28211
Q	Exhibitions For Industry ✆08833 4371
T	Trident ✆0822 4671
Z	BETA Exhibitions ✆01-405 6233
Z1	IPC Exhibitions ✆01-643 8040

FROM THE OPEN UNIVERSITY

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

Whether 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.

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- HEKTOR - a fully assembled micro-computer development system to give engineers "hands-on" experience while they learn.
- An experiment book containing practical work to develop skills.
- Five specially-prepared manuals for self-paced learning.
- A file of specimen manufacturers' data sheets and brochures.
- The course is completely self-contained and not linked to any broadcasts, correspondence tuition or seminars.

How the Course helps Engineers:

Engineers completing this course will gain more than a theorectical knowledge of microprocessor-based design. They will be better able to put theory into practice, designing more advanced, highly functional and marketable products using the most up-to-date technology currently available.

- The course can be studied without losing time from work. Colleagues can share the course thereby saving on the cost (£395 complete).
- 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.
- Grants may be available from the Engineering Industry Training Board (further details in our leaflet).
- If you are unemployed and want to develop new job skills, the course is available at a reduced rate. (Tick box B in coupon).

Find out more about the course by filling in the coupon and sending it to The Open University, FREEPOST, PO Box 188, Sherwood House, Milton Keynes MK3 6HH. No stamp required. Or phone 0908-79058 (24 hour answering service).

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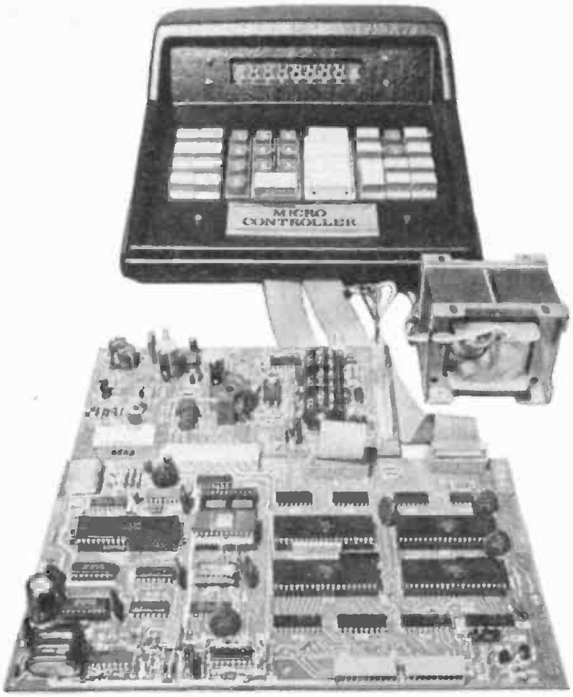


MICRO CONTROLLER

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

PART THREE

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 0V of 1kΩ or less to assume the 'low' state. The logic low/high levels are: <1·4V and >1·6V for A, and <0·7V and >3·0V 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. 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	ORA/ DDRA	ORB/ DDRB	CRA	CRB
14	User	1000	1000	1001	1002	1003
13	User	1400	1400	1401	1402	1403
12	Display	1800	1800	1801	1802	1803
11	Keyboard	1C00	1C00	1C01	1C02	1C03

Table 1. Microcontroller PIA register addresses

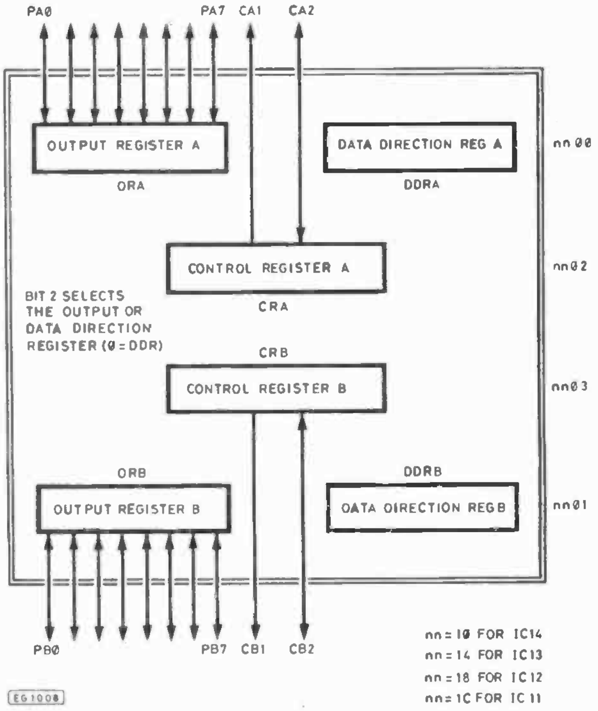


Fig. 1. Programming model for the 6821 PIA

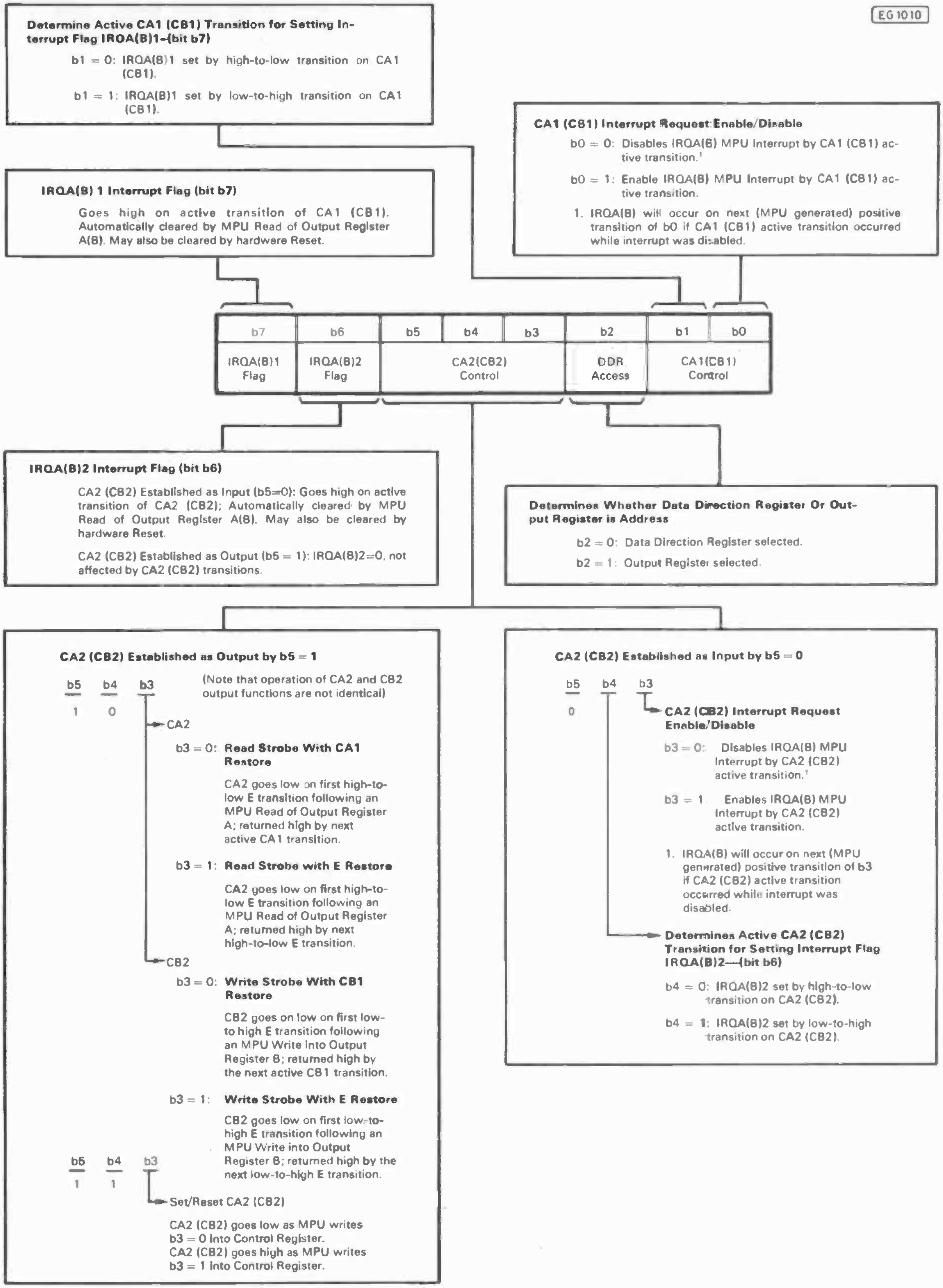


Fig. 2. Format of the PIA control word

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

At the end of this routine, any data written to locations 18ØØ and 18Ø1 (ORA and ORB, respectively) will be output on PA0 to PA7 and PB0 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 DISBUG the IRQ service routine starts at FF9Ø; 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 op code 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 l.e.d.s are connected to the 'B' side of IC14. These l.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 l.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

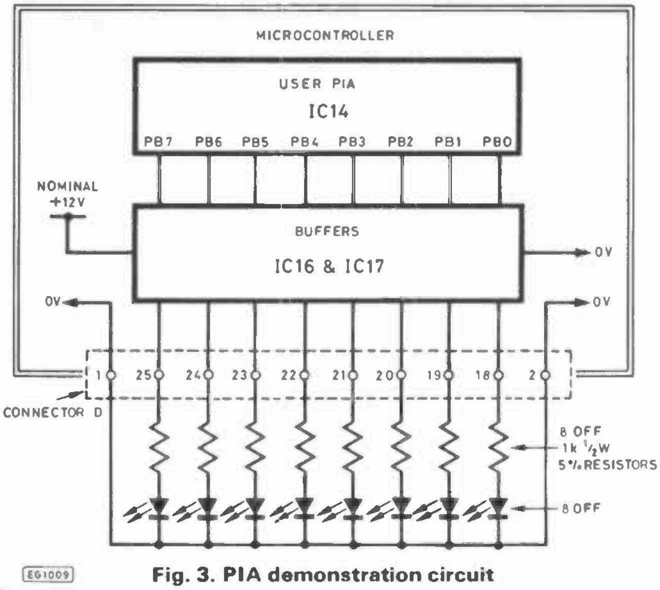


Fig. 3. PIA demonstration circuit

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 'ØØ' to location 1ØØ3 (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 PB0 to PB3 as inputs, and PB4 to PB7 as outputs, the DDRB value would have been 'FØ' (equivalent to '1111ØØØØ' in binary). Bit 2 of CRB is currently set to 'Ø', so setting up DDRB is simply a matter of writing 'FF' to location 1ØØ1 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 1ØØ1. Thus a value of 'FF' written to location 1ØØ3 will turn on all eight l.e.d.s, whereas '8Ø' will only turn on l.e.d. number 7 ('8Ø' is equivalent to '1ØØØØØØØ' 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 1ØØ2 (CRA) and 1ØØØ (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 0V with a wire link, and the value of ORA is re-read from location 1ØØØ, the result should now be 'EF'; this is because PA4 is now 'Ø', while the other lines are still pulled up to '1' ('EF' is equivalent to '111Ø1111' 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 ØØØØ, 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	ØØØ1	7F 1Ø Ø3	CLR UPIACRB	Set all user PIA
3	ØØØ4	86 FF	LDAA #FF	B I/O lines to be
4	ØØØ6	B7 1Ø Ø1	STAA UPIADRB	outputs
5	ØØØ9	86 Ø4	LDAA #Ø4	Select the PIA
6	ØØØB	B7 1Ø Ø3	STAA UPIACRB	output register
7	ØØØE	7F 1Ø Ø1	CLR UPIAORB	Set all outputs to 'Ø'
8	ØØ11	Ø1	NOP	To be replaced later
9	ØØ12	86 55	LDAA #55	Output '55'
A	ØØ14	B7 1Ø Ø1	STAA UPIAORB	to PB0 to PB7
B	ØØ17	Ø1	NOP	To be replaced later
C	ØØ18	86 AA	LDAA #AA	Output 'AA'
D	ØØ1A	B7 1Ø Ø1	STAA UPIAORB	to PB0 to PB7
E	ØØ1D	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 'Ø1Ø1Ø1Ø1' to be output, thereby turning on l.e.d.s 0, 2, 4 and 6. Lines C and D reverse this pattern to turn on l.e.d.s 1, 3, 5, and 7 instead. The software interrupt returns control to DISBUG. Running the whole program will cause l.e.d.s 1, 3, 5 and 7 to start in the off state and then go on, while l.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 ØØØØ, 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 l.e.d.s 0, 2, 4, and 6 will be illuminated. After a further one second delay, these l.e.d.s will go out, and l.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!)

1. 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.
2. 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

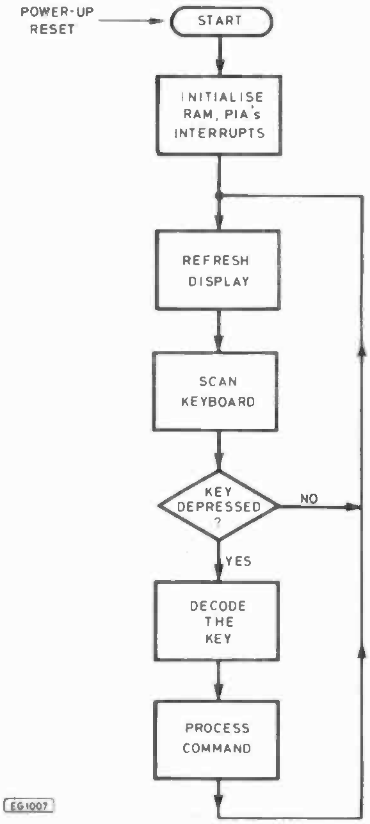


Fig. 4. Infinite loop control program—DISBUG top level routine

KEY : OP CODE MNEMONIC
NUMBER OF BYTES = N° OF ✱'S
ADDRESSING MODE

2nd OP CODE DIGIT \ 1st OP CODE DIGIT	Ø	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
F	SEI • INHERENT		BLE •• RELATIVE	SWI • INHERENT	CLRA • INHERENT	CLRB • INHERENT	CLR •• INDEXED	CLR ••• EXTD		STS •• DIRECT	STS •• INDEXED	STS ••• EXTD		STX •• DIRECT	STX •• INDEXED	STX ••• EXTD
E	CLI • INHERENT		BGT •• RELATIVE	WAI • INHERENT			JMP •• INDEXED	JMP ••• EXTD	LDS ••• IMMED	LDS •• DIRECT	LDS •• INDEXED	LDS ••• EXTD	LDX ••• IMMED	LDX •• DIRECT	LDX •• INDEXED	LDX ••• EXTD
D	SEC • INHERENT		BLT •• RELATIVE		TSTA • INHERENT	TSTB • INHERENT	TST •• INDEXED	TST ••• EXTD	BSR •• RELATIVE		JSR •• INDEXED	JSR ••• EXTD				
C	CLC • INHERENT		BGE •• RELATIVE		INCA • INHERENT	INCB • INHERENT	INC •• INDEXED	INC ••• EXTD	CPX ••• IMMED	CPX •• DIRECT	CPX •• INDEXED	CPX ••• EXTD				
B	SEV • INHERENT	ABA • INHERENT	BMI •• RELATIVE	RTI • INHERENT					ADDA •• IMMED	ADDA •• DIRECT	ADDA •• INDEXED	ADDA ••• EXTD	ADDB •• IMMED	ADDB •• DIRECT	ADDB •• INDEXED	ADDB ••• EXTD
A	CLV • INHERENT		BPL •• RELATIVE		DECA • INHERENT	DECB • INHERENT	DEC •• INDEXED	DEC ••• EXTD	ORAA •• IMMED	ORAA •• DIRECT	ORAA •• INDEXED	ORAA ••• EXTD	ORAB •• IMMED	ORAB •• DIRECT	ORAB •• INDEXED	ORAB ••• EXTD
9	DEX • INHERENT	DAA • INHERENT	BVS •• RELATIVE	RTS • INHERENT	ROLA • INHERENT	ROLB • INHERENT	ROL •• INDEXED	ROL ••• EXTD	ADCA •• IMMED	ADCA •• DIRECT	ADCA •• INDEXED	ADCA ••• EXTD	ADCB •• IMMED	ADCB •• DIRECT	ADCB •• INDEXED	ADCB ••• EXTD
8	INX • INHERENT		BVC •• RELATIVE		ASLA • INHERENT	ASLB • INHERENT	ASL •• INDEXED	ASL ••• EXTD	EORA •• IMMED	EORA •• DIRECT	EORA •• INDEXED	EORA ••• EXTD	EORB •• IMMED	EORB •• DIRECT	EORB •• INDEXED	EORB ••• EXTD
7	TPA • INHERENT	TBA • INHERENT	BEQ •• RELATIVE	PSHB • INHERENT	ASRA • INHERENT	ASRB • INHERENT	ASR •• INDEXED	ASR ••• EXTD		STAA •• DIRECT	STAA •• INDEXED	STAA ••• EXTD		STAB •• DIRECT	STAB •• INDEXED	STAB ••• EXTD
6	TAP • INHERENT	TAB • INHERENT	BNE •• RELATIVE	PSHA • INHERENT	RORA • INHERENT	RORB • INHERENT	ROR •• INDEXED	ROR ••• EXTD	LDAA •• IMMED	LDAA •• DIRECT	LDAA •• INDEXED	LDAA ••• EXTD	LDAB •• IMMED	LDAB •• DIRECT	LDAB •• INDEXED	LDAB ••• EXTD
5			BCS •• RELATIVE	TXS • INHERENT					BITA •• IMMED	BITA •• DIRECT	BITA •• INDEXED	BITA ••• EXTD	BITB •• IMMED	BITB •• DIRECT	BITB •• INDEXED	BITB ••• EXTD
4			BCC •• RELATIVE	DES • INHERENT	LSRA • INHERENT	LSRB • INHERENT	LSR •• INDEXED	LSR ••• EXTD	ANDA •• IMMED	ANDA •• DIRECT	ANDA •• INDEXED	ANDA ••• EXTD	ANDB •• IMMED	ANDB •• DIRECT	ANDB •• INDEXED	ANDB ••• EXTD
3			BLS •• RELATIVE	PULB • INHERENT	COMA • INHERENT	COMB • INHERENT	COM •• INDEXED	COM ••• EXTD								
2			BHI •• RELATIVE	PULA • INHERENT					SBCA •• IMMED	SBCA •• DIRECT	SBCA •• INDEXED	SBCA ••• EXTD	SBCB •• IMMED	SBCB •• DIRECT	SBCB •• INDEXED	SBCB ••• EXTD
1	NOP • INHERENT	CBA • INHERENT		INS • INHERENT					CMPA •• IMMED	CMPA •• DIRECT	CMPA •• INDEXED	CMPA ••• EXTD	CMPB •• IMMED	CMPB •• DIRECT	CMPB •• INDEXED	CMPB ••• EXTD
Ø		SBA • INHERENT	BRA •• RELATIVE	TSX • INHERENT	NEGA • INHERENT	NEGB • INHERENT	NEG •• INDEXED	NEG ••• EXTD	SUBA •• IMMED	SUBA •• DIRECT	SUBA •• INDEXED	SUBA ••• EXTD	SUBB •• IMMED	SUBB •• DIRECT	SUBB •• INDEXED	SUBB ••• EXTD

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 executed 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 F8ØØ 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:

1. 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.
2. 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!
4. 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 'Ø', 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. ★

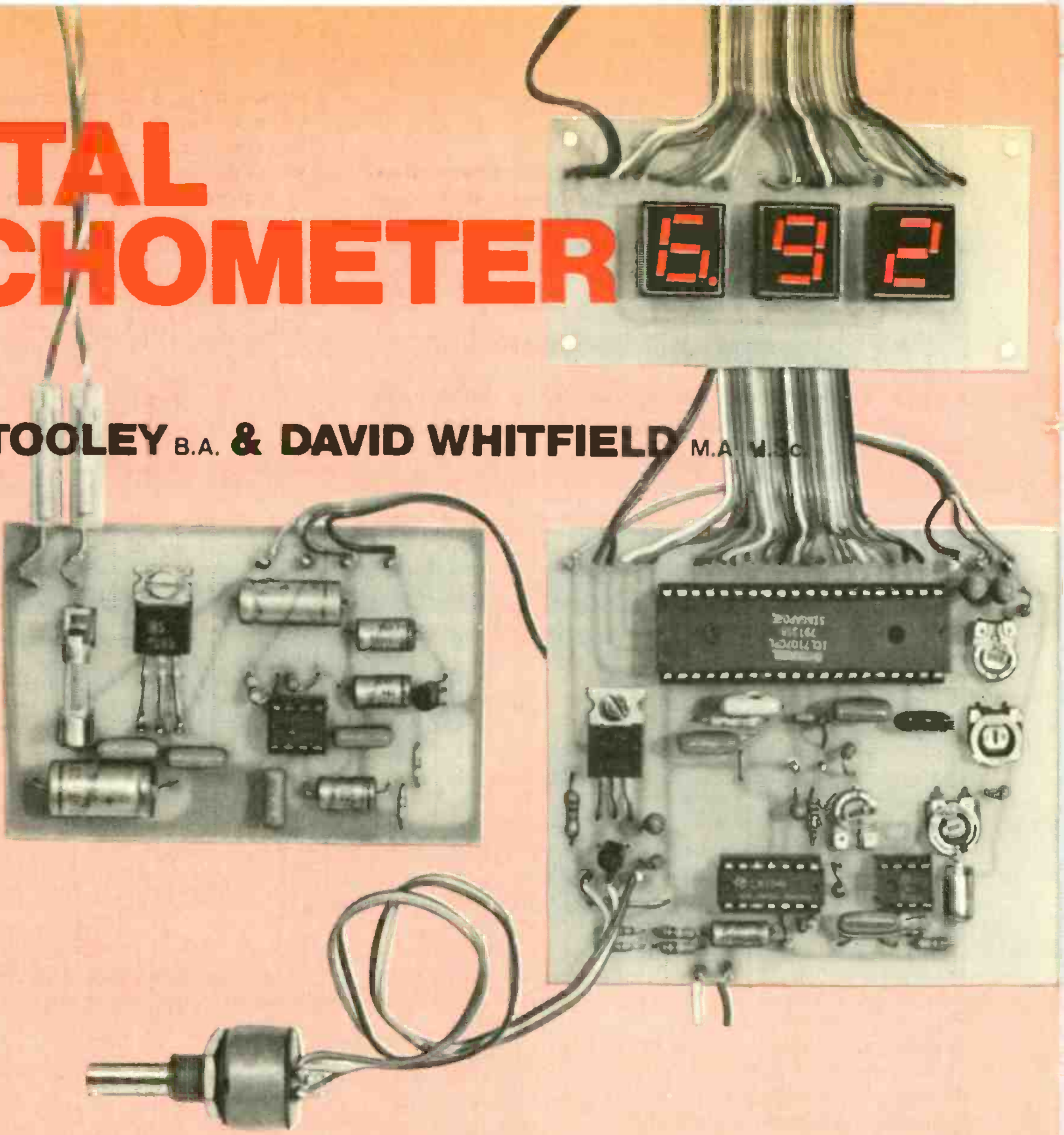
Competition

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).**

DIGITAL TACHOMETER



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

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 over-bright 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:

$$N = 0{\cdot}5 \times (\text{engine r.p.m.}) \times (\text{number of cylinders})$$

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.

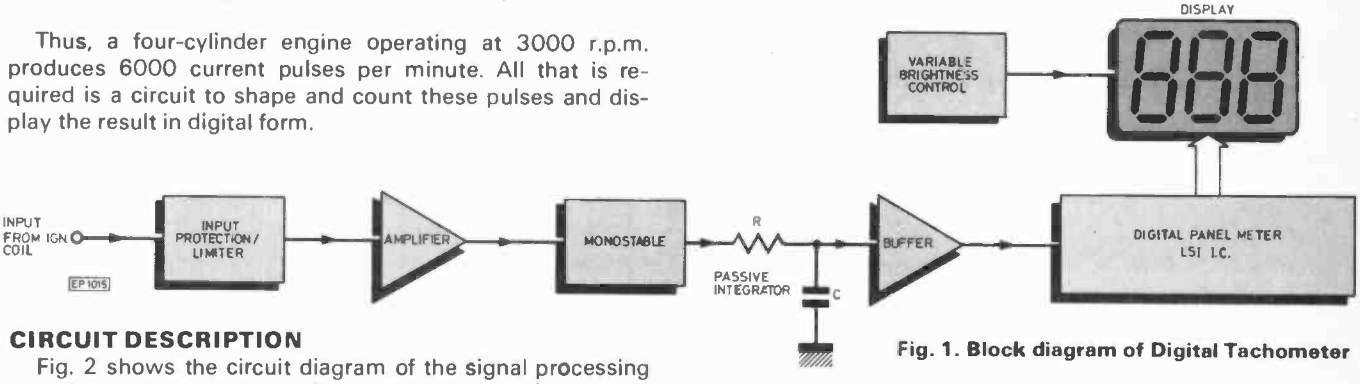


Fig. 1. Block diagram of Digital Tachometer

CIRCUIT DESCRIPTION

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 IClb 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 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 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 0·5in. 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 22-way 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 0V. The signal input on the signal processing board is derived from the contact breaker terminal on the ignition coil. A separate 0V (earth) connection may also be made if desired. The power input from the vehicle consists of two wires, +12V and 0V, 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

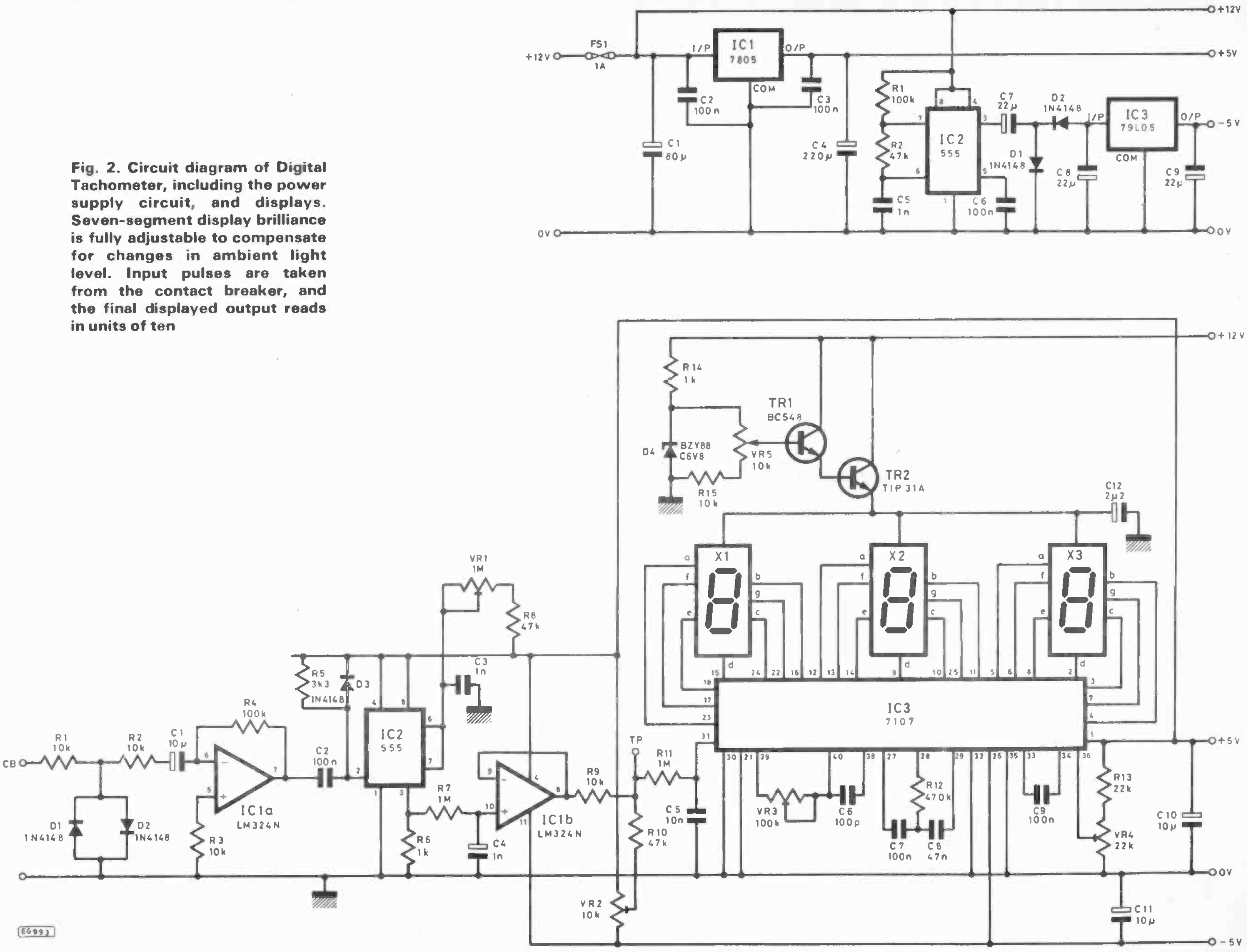


Fig. 2. Circuit diagram of Digital Tachometer, including the power supply circuit, and displays. Seven-segment display brilliance is fully adjustable to compensate for changes in ambient light level. Input pulses are taken from the contact breaker, and the final displayed output reads in units of ten

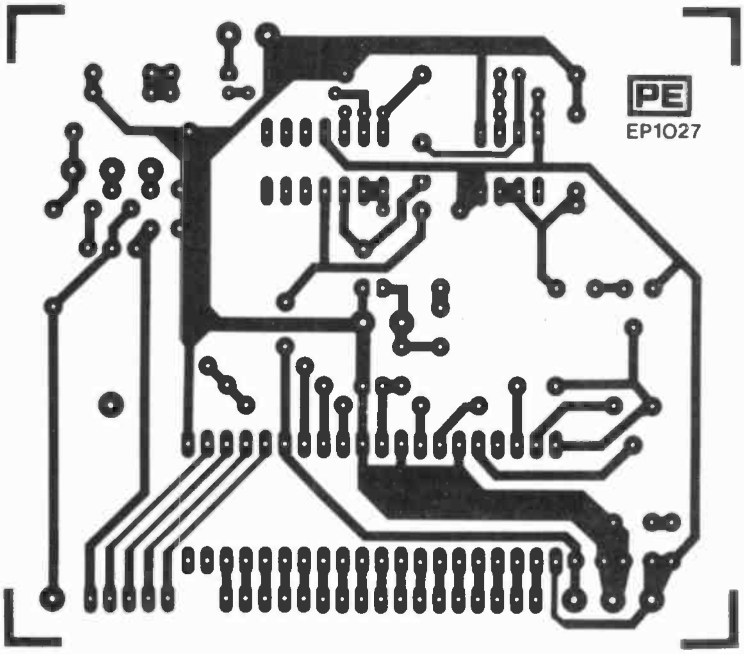


Fig. 3. Printed circuit board layout (actual size) of the Tacho's main processing board

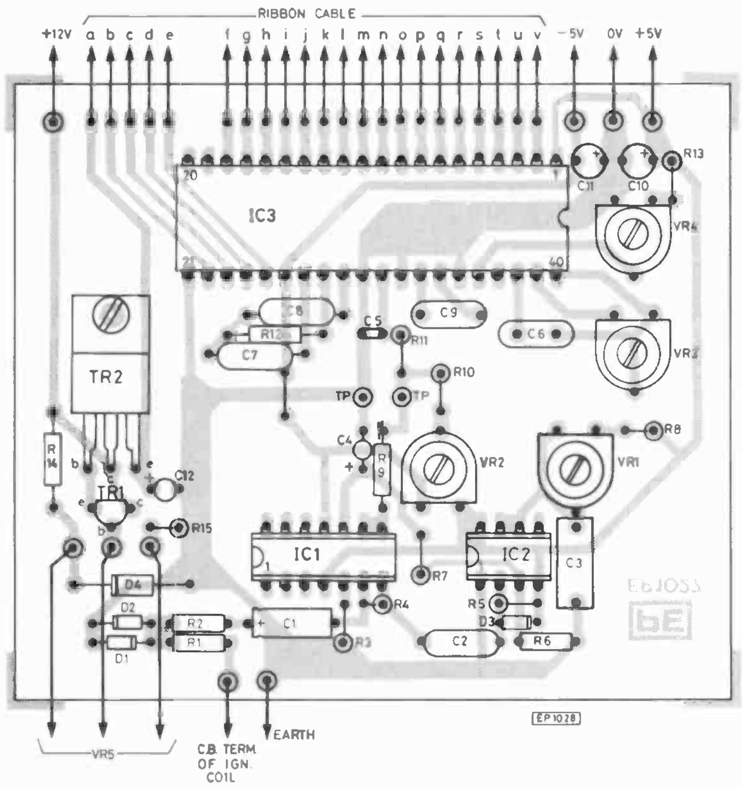


Fig. 4. Component layout of the main processing board

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	1M 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
C10, C11	10µ	35V tantalum (2 off)
C12	2µ2	35V tantalum

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
IC3	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 (22 way)
P.c.b. (2 off)
Display filter

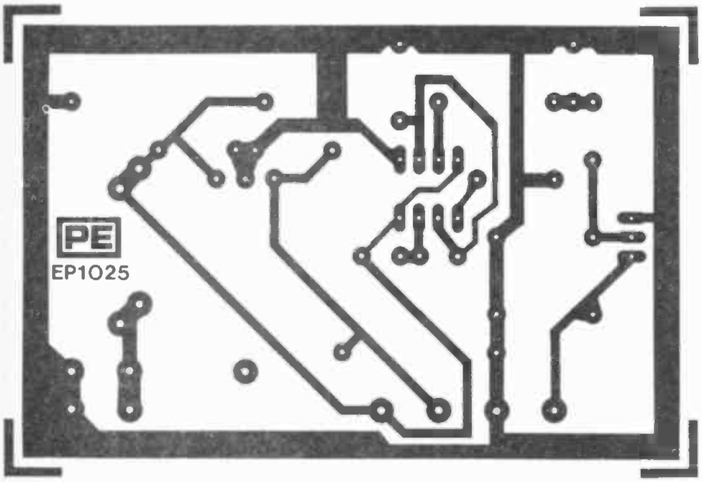
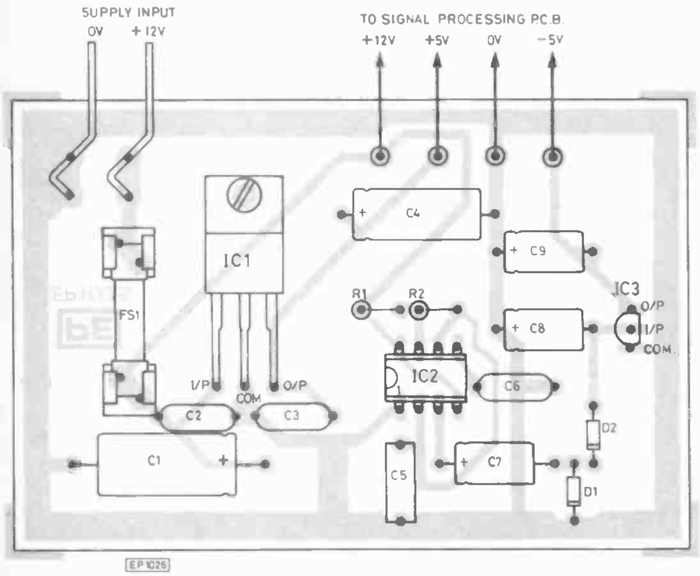


Fig. 5. Printed circuit board layout (actual size) of the PSU



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
IC2	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

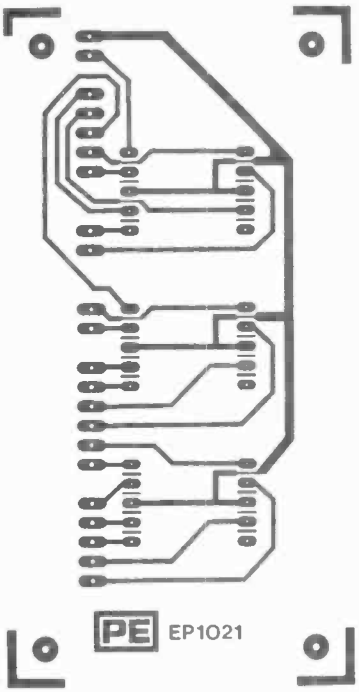


Fig. 7 (left). Printed circuit board layout (actual size) of the 0·5in. display board

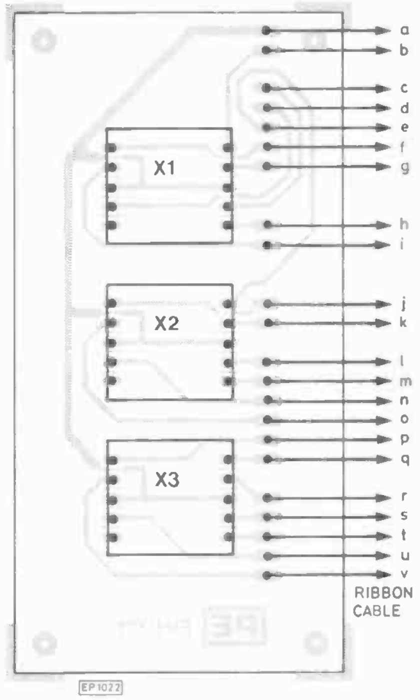


Fig. 8. (right) Component layout of the 0·5 in. display board

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

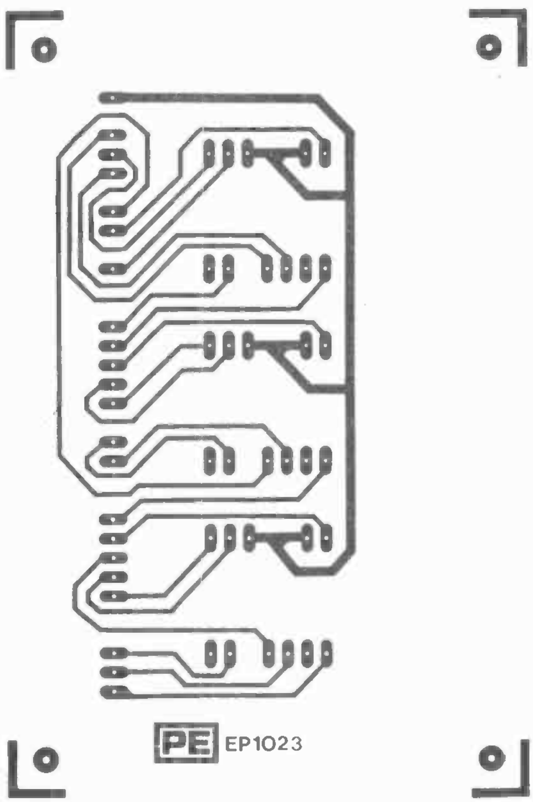
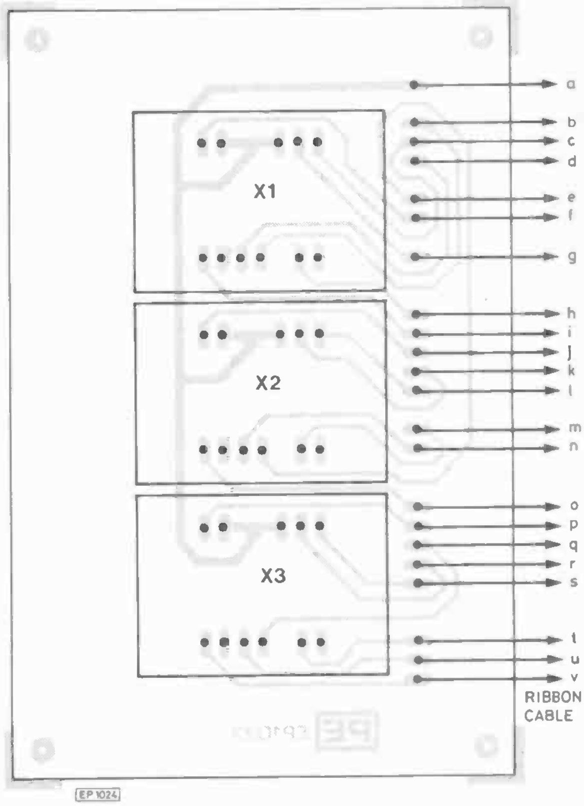


Fig. 10. Component layout of the 1 in. display board



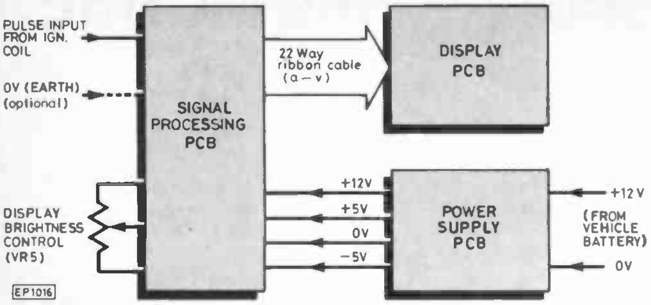


Fig. 11. Wiring arrangement between the separate boards

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. Test 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	0V
	pin 8	0V
	pin 11	–5V
IC2	pin 2	+5V
	pin 3	0V
	pin 4	+5V
	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		0V

All voltages are measured using a multimeter of 20k ohm/V. Display brightness control is set to 'maximum', no input connected, and the display indication is "000".

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. ★

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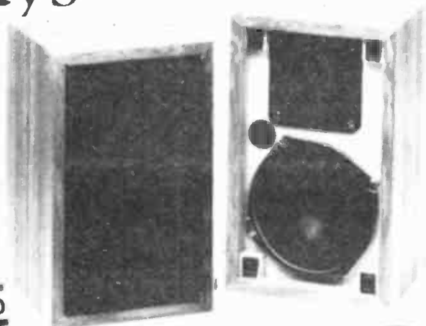

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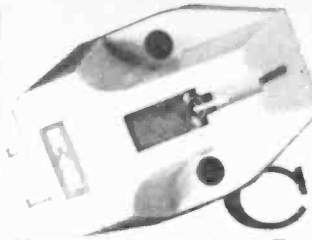

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FROST WARNING

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 'anti-freeze' 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

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 connected 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 0V. 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 switching 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 l.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. In order to avoid inadvertent short circuits, care should be taken to clear 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.

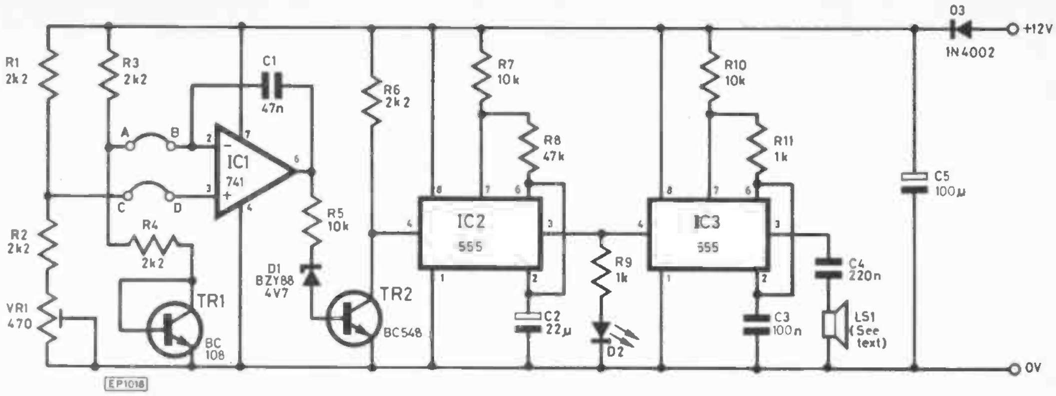


Fig. 1. Circuit of Frost Warning.

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.

COMPONENTS

Resistors

R1	2k2
R2	2k2
R3	2k2
R4	2k2
R5	10k
R6	2k2
R7	10k
R8	47k
R9	1k
R10	10k
R11	1k

All fixed resistors are 0·25W 5% carbon

Capacitors

C1	47n polyester
C2	22µ 25V axial electrolytic
C3	100n polyester
C4	220n polyester
C5	100µ 16V p.c. electrolytic

Semiconductors

TR1	BC108
TR2	BC548
D1	BZY88C4V7
D2	Red l.e.d.
D3	1N4002
IC1	741
IC2	555
IC3	555

Potentiometer

VR1 470R min. horizontal skeleton preset

Miscellaneous

Miniature loudspeaker or earpiece (see text)
Case
8-pin DIL i.c. sockets
0·1in matrix Veroboard
Terminal pins
L.e.d. mounting clip
Grommet

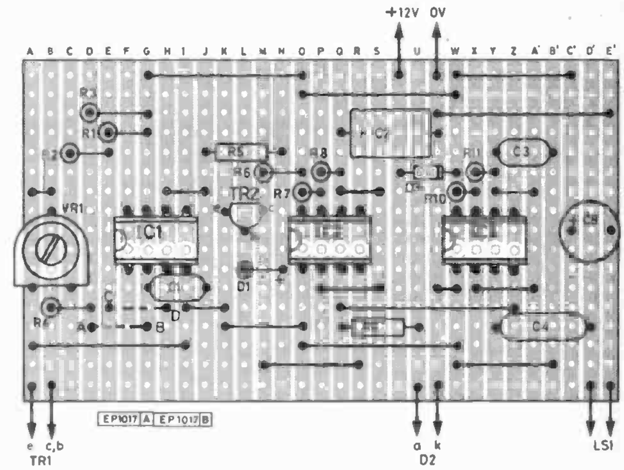


Fig. 2. Veroboard assembly details.

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.

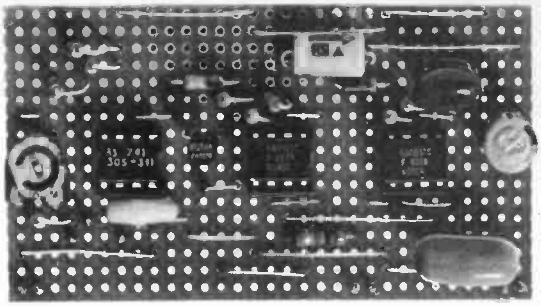
Boiling water from the kettle should be carefully poured into a heatproof measuring jug. The thermometer is placed in the jug together with the temperature transducer, TR1. Care should be taken to ensure that the transistor leads do not become immersed in the water. The links on the circuit board should 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 resistant cable should be used to interconnect the transducer to the alarm module. ★



The completed Frost Warning unit

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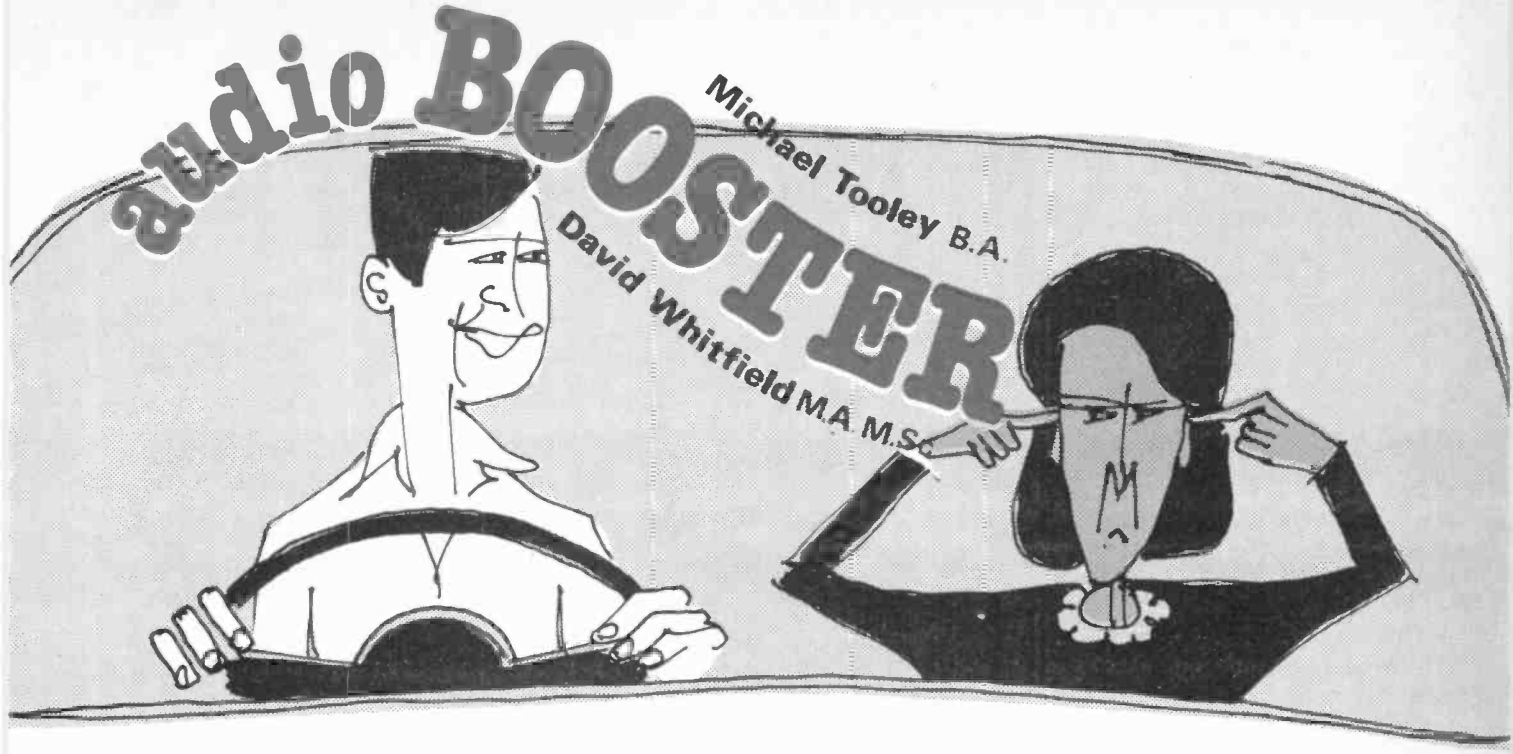
PE BAZAAR JANUARY '83



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

$$P_{out(max)} \simeq \frac{V^2_{CC}}{8\,R_L}$$

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 4ohm loudspeaker system the maximum theoretical r.m.s. output power will be:

$$P_{out(max)} \simeq \frac{12^2}{8 \times 4} = \frac{144}{32} = 4{\cdot}5\text{W}$$

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:

$$P_{out(max)} \simeq \frac{13{\cdot}5^2}{8 \times 4} = \frac{182}{32} = 5{\cdot}7\text{W}$$

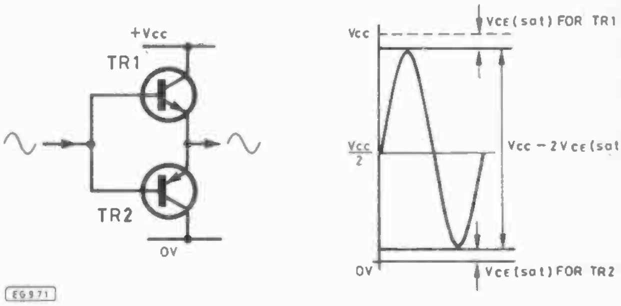
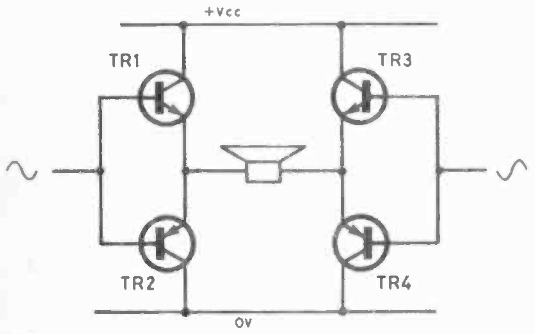


Fig. 1. Simplified complementary symmetrical output stage and corresponding maximum undistorted output voltage swing.

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-to-noise ratio during the quieter 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



EG969

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 4ohm 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 l.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.

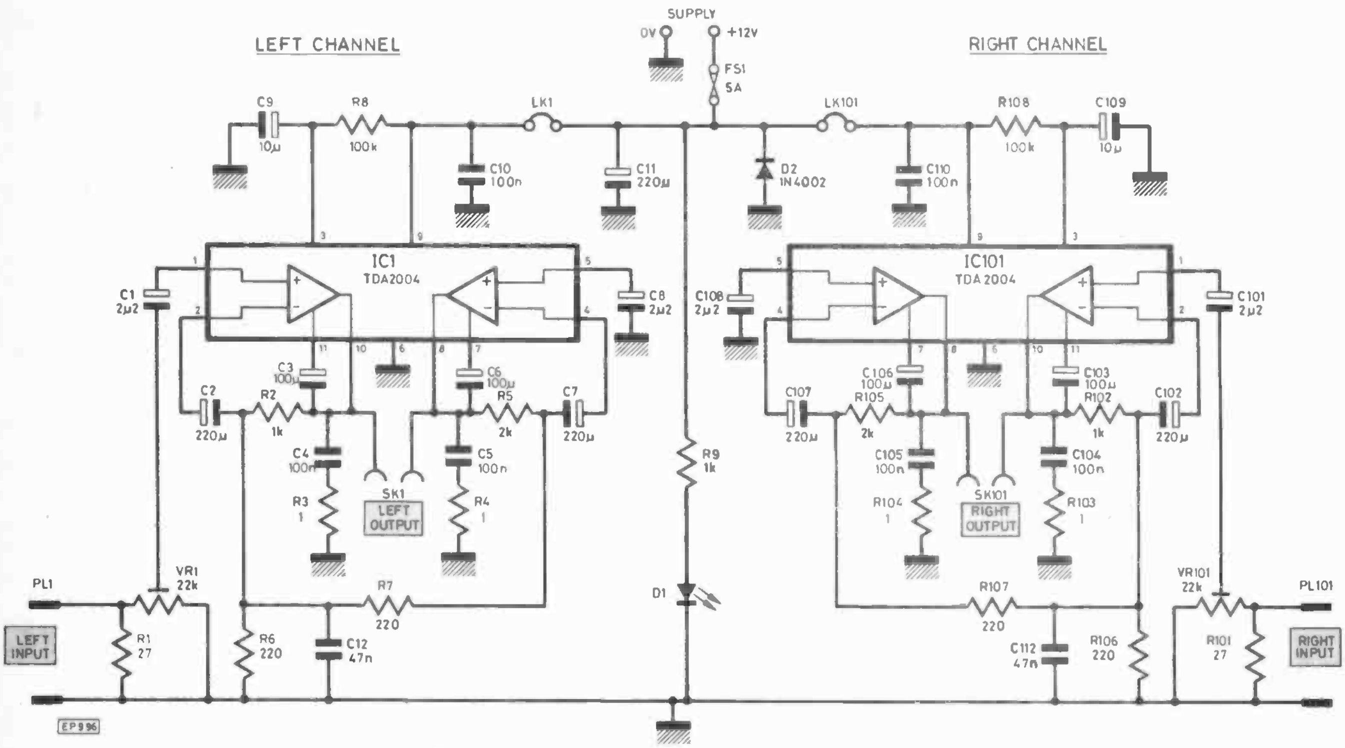


Fig. 3. Complete circuit diagram of the Audio Booster.

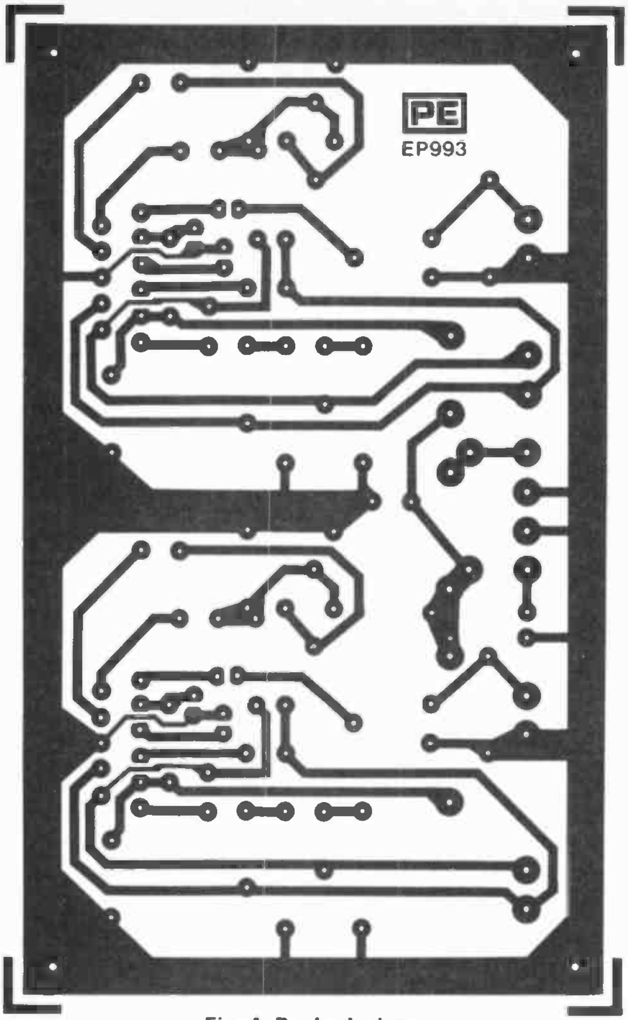


Fig. 4. P.c.b. design.

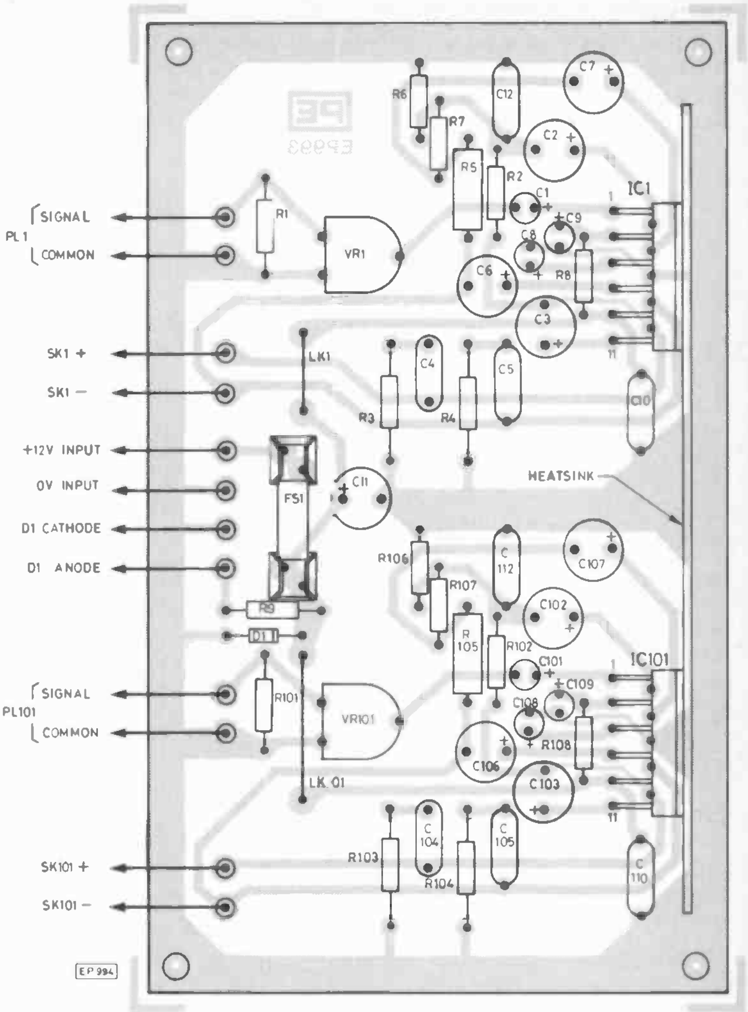


Fig. 5. Component layout.

The completed p.c.b. should be carefully checkec 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 diecast 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 0V rail. The supply wiring, 0V 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 4ohms and 16ohms 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

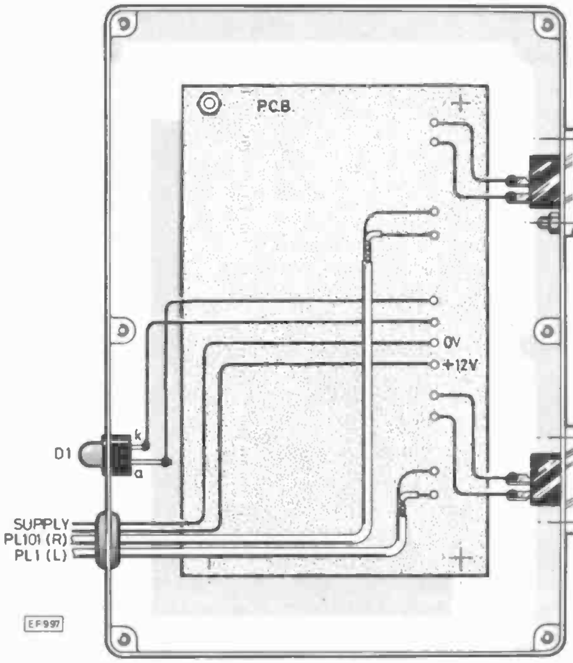


Fig. 6. Wiring diagram.

COMPONENTS . . .

Resistors

*R1	27 ½W 5%
*R2	1k ¼W 5%
*R3, R4	1 ½W 10% (2 off)
*R5	2k ¼W 5%
*R6, R7	220 ¼W 5% (2 off)
*R8	100k ¼W 5%
R9	1k ½W 5%
*VR1	22k min skeleton pre-set

Capacitors

*C1	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
D1	Red l.e.d. with mounting set
D2	IN4002

Miscellaneous

FS1	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

Components and p.c.b. are available from **Howard Associates, 59 Oatlands Avenue, Weybridge, Surrey KT13 9SU.** Please send s.a.e. for details.

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.

When both channels appear to be operating normally under no-signal conditions the two input plugs can be connected to the cassette player, radio 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 enclosure 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.

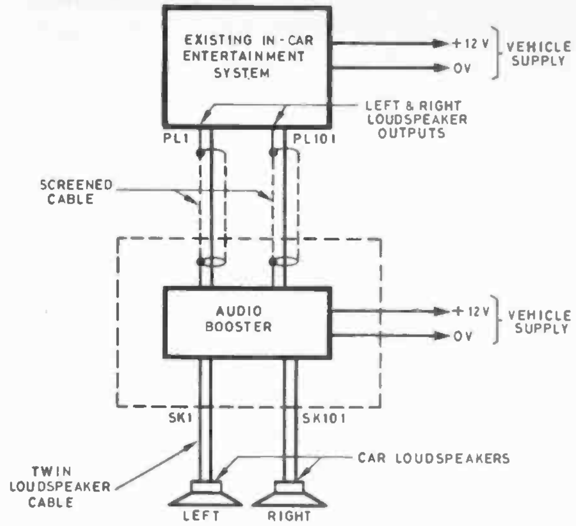
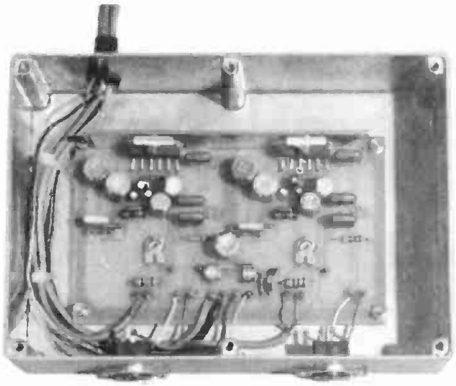


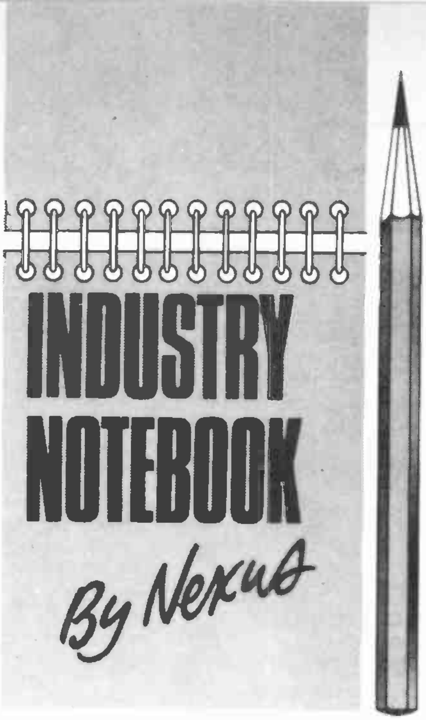
Fig. 7. Installation diagram.



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 (0V) 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 banner-headlined 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.

PE MICROGRASP

PART 2

RICHARD BECKER

IN 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 gearboxes, 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.

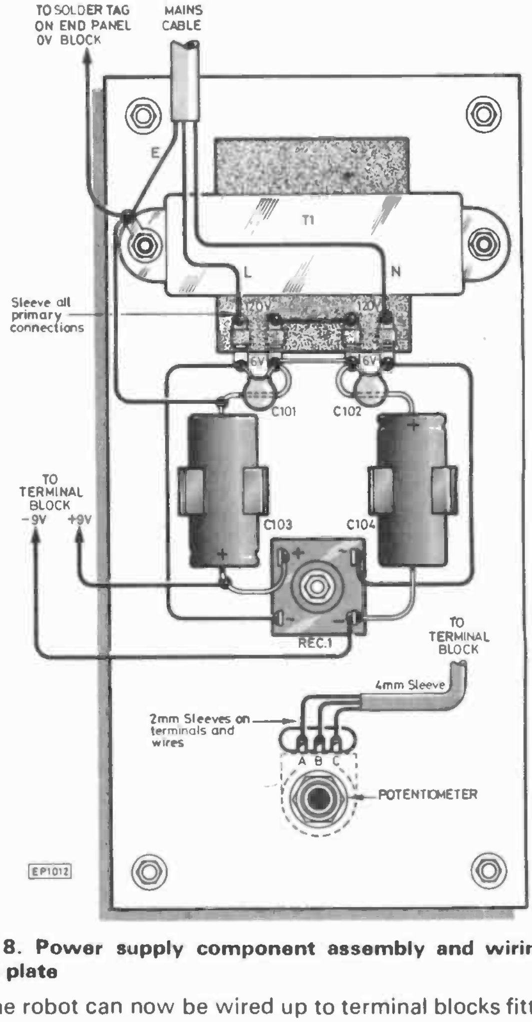


Fig. 8. Power supply component assembly and wiring on base plate

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

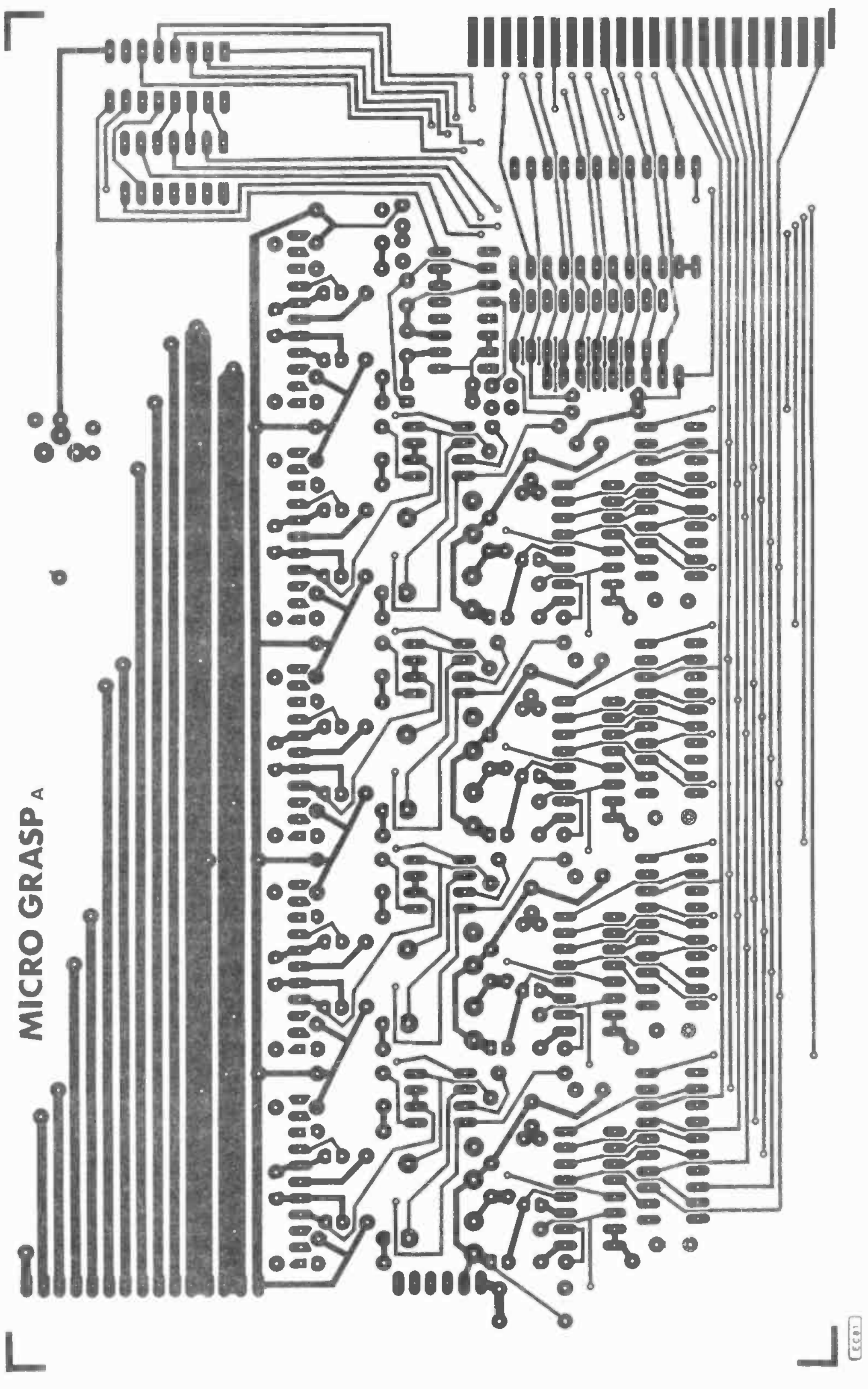


Fig. 9. Topside of printed circuit board

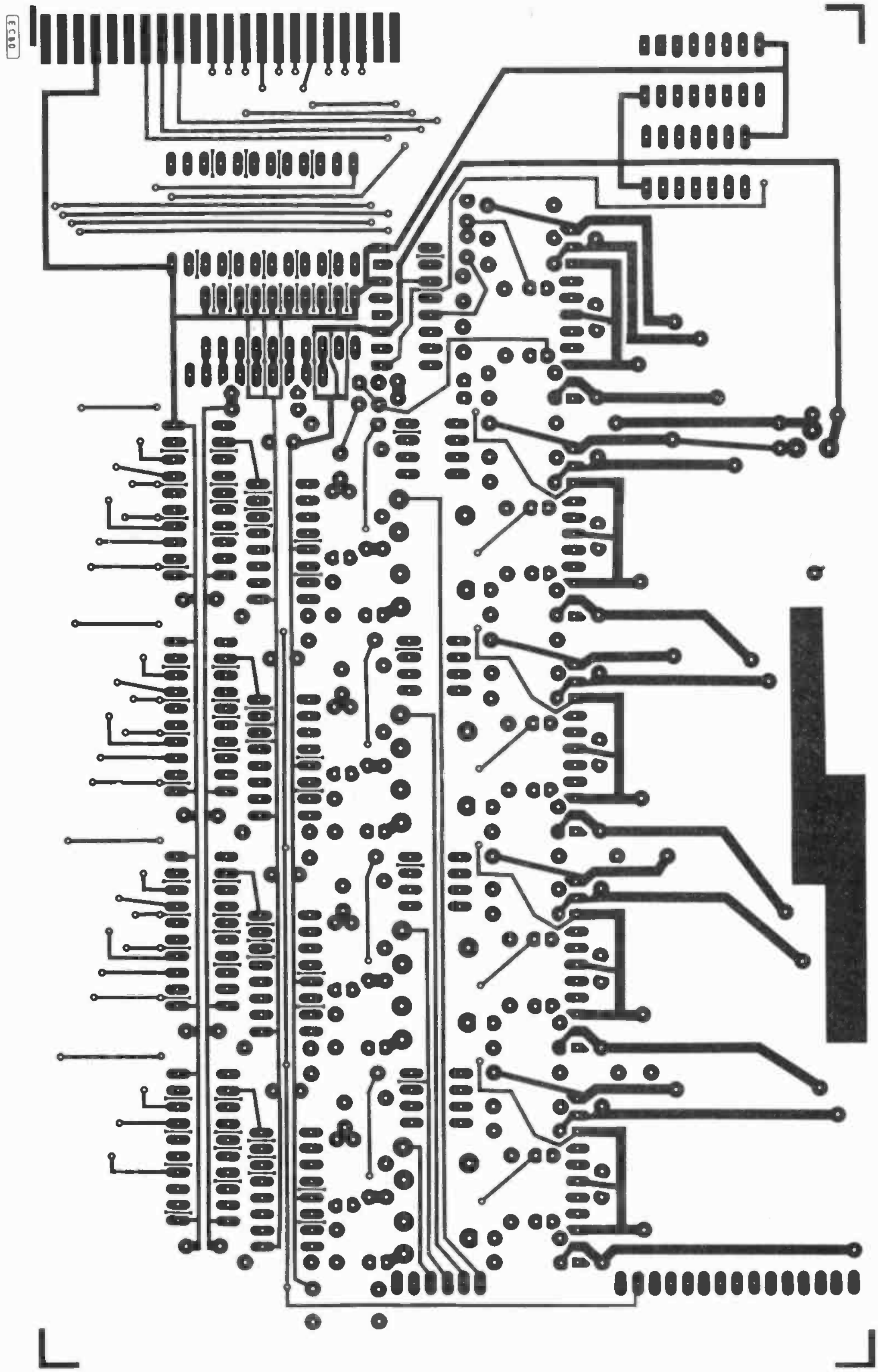


Fig. 10. Under side of printed circuit board

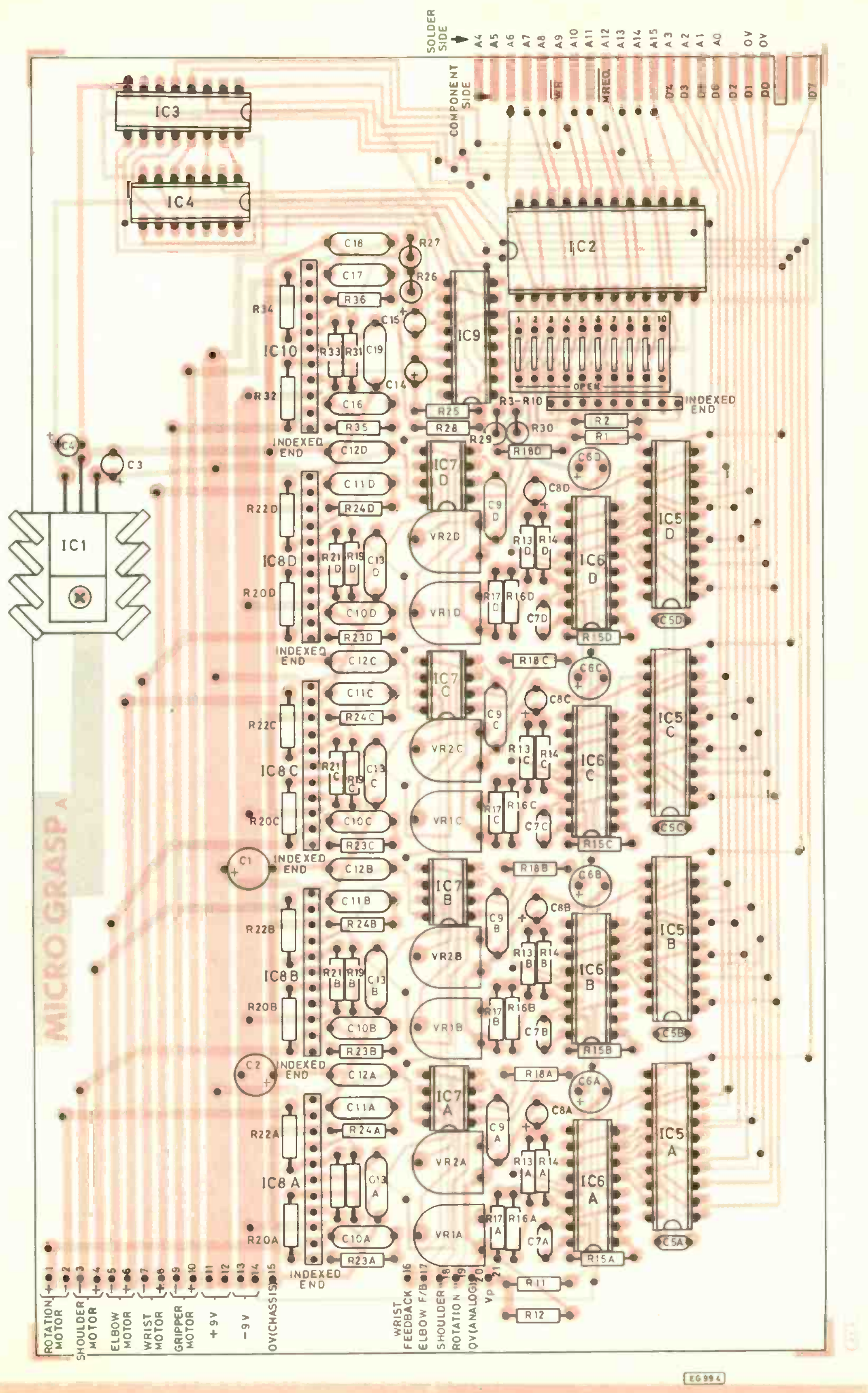
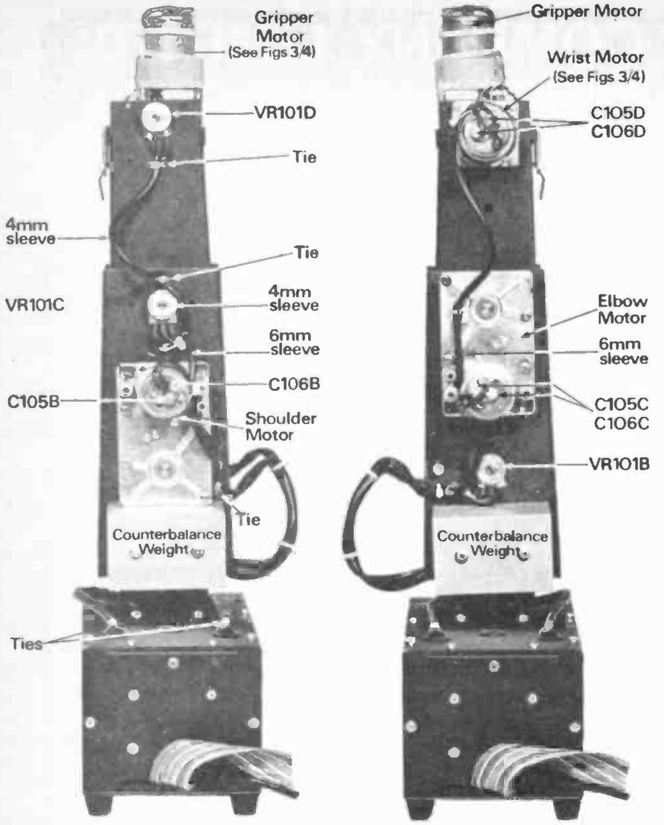
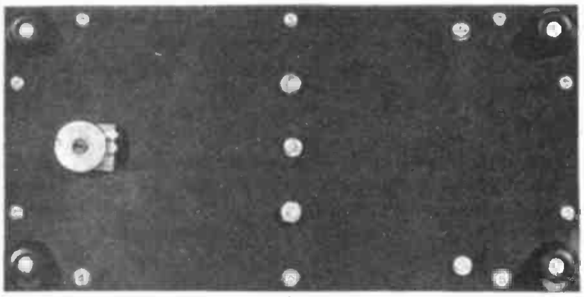


Fig. 11. Track and component layout for completed board



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 ±9V approximately and ±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 0V. 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 0·5V. Similar results will be obtained on servo circuits B, C, D using addresses 65473, 65474, 65475 respectively. Address the monostables with

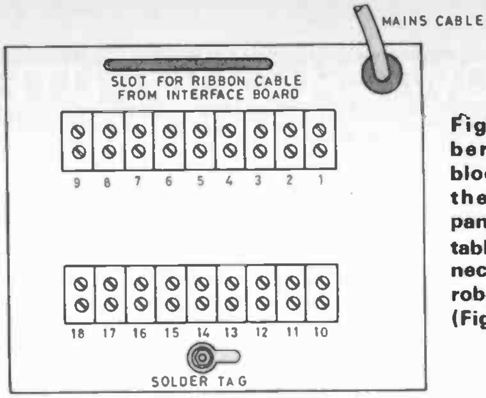
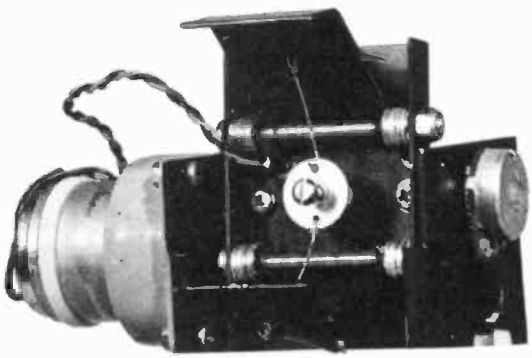


Fig. 12. Numbered terminal blocks fitted to the rear end panel. The wiring table shows connections from the robot to the p.c.b. (Fig. 11)

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	BLACK (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	SOLDER TAG ON BASE PLATE	BLACK	15
13	VR101 D TAG B	WHITE (LEFT)	16
14	VR101 C TAG B	YELLOW (LEFT)	17
15	VR101 B TAG B	VIOLET (RIGHT)	18
16	VR101 A TAG B	GREEN/YELLOW	19
17	0V(analog) VR101A TAG C " " VR101B TAG A " " VR101C TAG A " " VR101D TAG A	PINK PINK (RIGHT) PINK (LEFT) PINK (LEFT)	20
18	Vp VR101A TAG A Vp VR101B TAG C Vp VR101C TAG C Vp VR101D TAG C	RED RED (RIGHT) RED (LEFT) RED (LEFT)	21



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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4044	0.64
4045	1.69
4046	0.84
4047	0.49
4048	0.54
4049	0.24
4050	0.24
4051	0.44
4052	0.59
4053	0.77
4054	0.84
4055	0.64
4060	0.59
4063	0.98
4066	0.29
4068	0.21
4069	0.15
4070	0.14
4071	0.14
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4073	0.14
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11	0.13
12	0.11
13	0.15
14	0.29
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54	0.14
55	0.15
73	0.18
74	0.16
75	0.19
76	0.17
78	0.24
83	0.34
85	0.47
86	0.15
90	0.28
91	0.80
92	0.31
93	0.25
95	0.40
109	0.27
112	0.20
113	0.20
114	0.22
122	0.35
123	0.35
125	0.24
126	0.25
132	0.39
136	0.23
138	0.27
139	0.29
145	0.70
148	0.69
151	0.39
153	0.28
155	0.34
156	0.34
157	0.25
158	0.29
160	0.35
162	0.35
163	0.34
164	0.39
165	0.54
166	0.83
173	0.64
174	0.40
175	0.44
181	0.80
190	0.36
191	0.44
192	0.44
193	0.44
194	0.34
195	0.34
196	0.45
197	0.45
221	0.54
240	0.55
241	0.85
242	0.84
243	0.64
244	0.59
245	0.69
247	0.40
248	0.40
249	0.68
251	0.29
253	0.30
257	0.34
258	0.35
259	0.57
261	1.95
266	0.19
273	0.59
279	0.59
283	0.39
290	0.57
293	0.40
365	0.29
366	0.29
367	0.29
368	0.39
373	0.59
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Space Watch...

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 air-breathing 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.

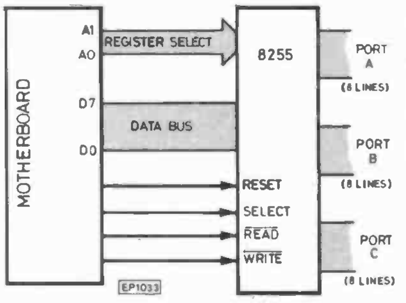
The handshake function is used on the two intelligent boards (the terminal board and the disk controller). These boards have to tell the system processor when an operation (like disk formatting or display scrolling) has been completed. In this case the port lines are used in their input mode and can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



REG	OP	FUNTION
0	Write	Write to Port A
1	Write	Write to Port B
2	Write	Write to Port C
3	Write	Write to Control Port*
0	Read	Read from Port A
1	Read	Read from Port B
2	Read	Read from Port C
3	Read	Not used

* Ports set to Input or Output by writing to Control Port

Fig. 1. The 8255 Peripheral Interface

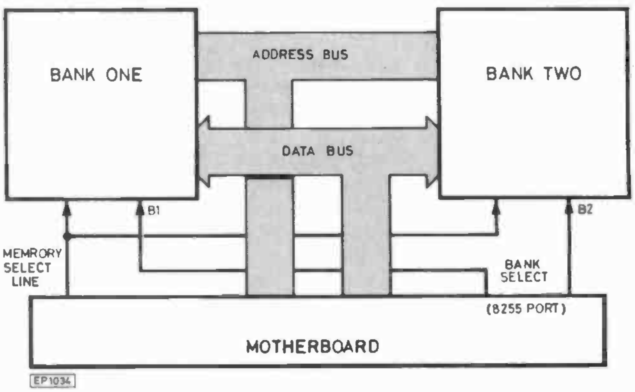


Fig. 2. Bank switching to increase usable memory

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.

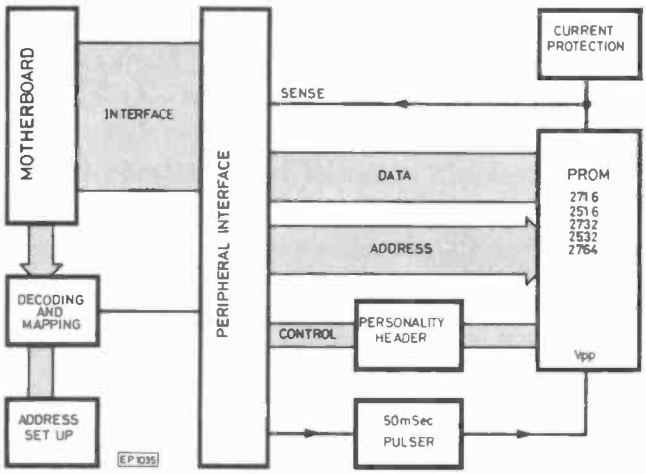


Fig. 3. The ROM Card

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.

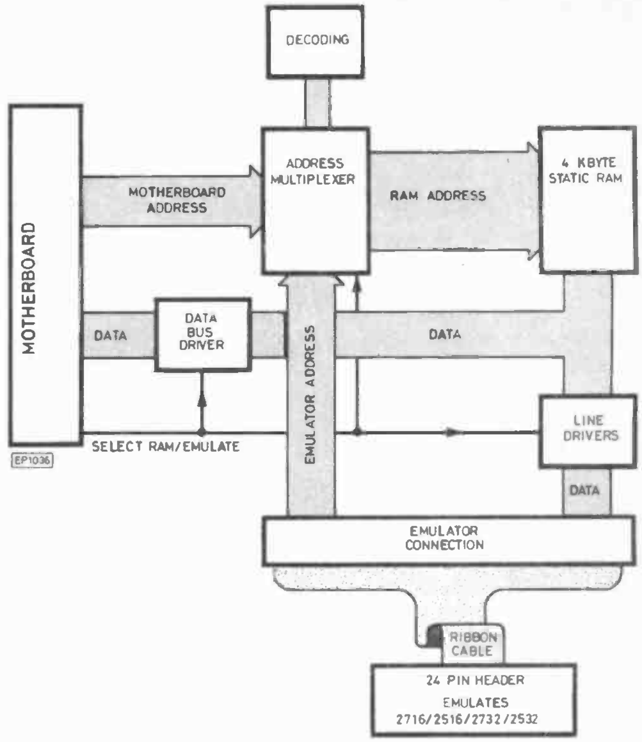


Fig. 4. The ROMulator

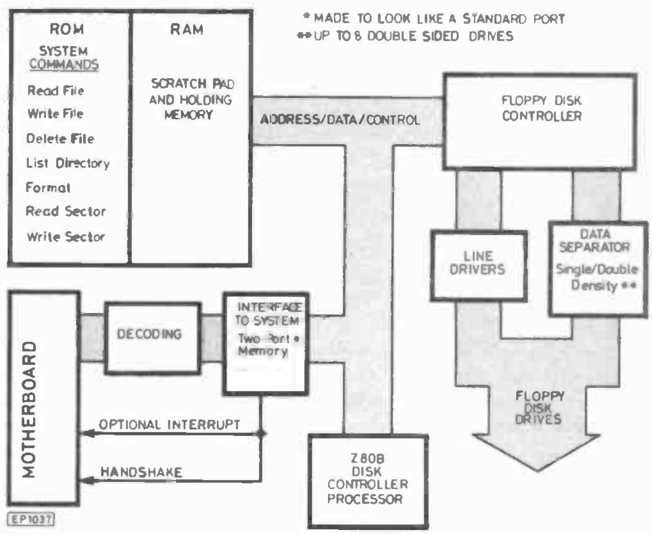


Fig. 5. Disk Controller Card

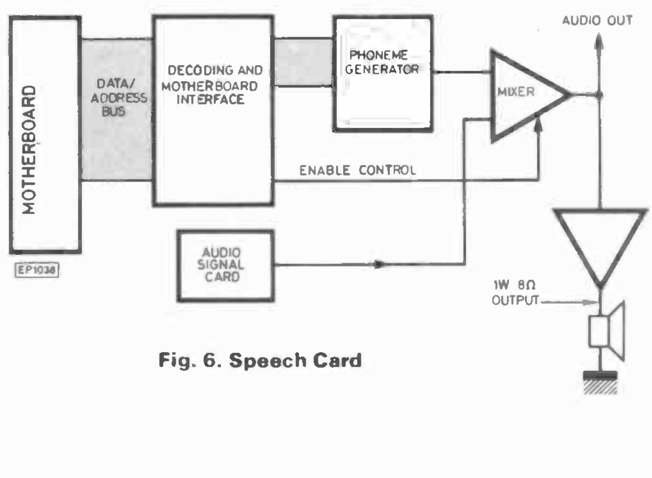


Fig. 6. Speech Card

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.

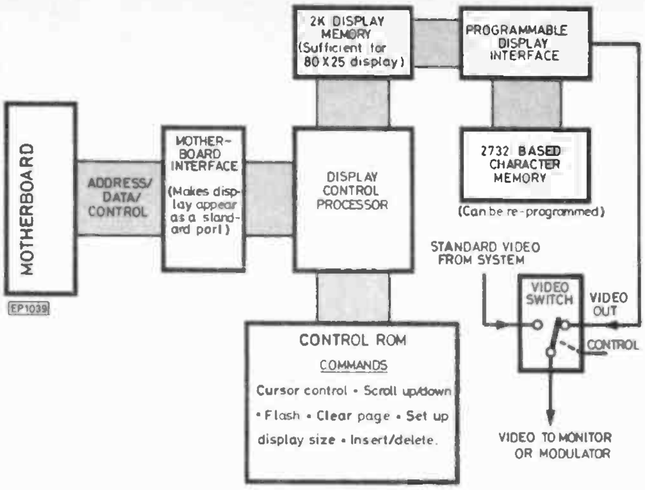


Fig. 7. Display Interface

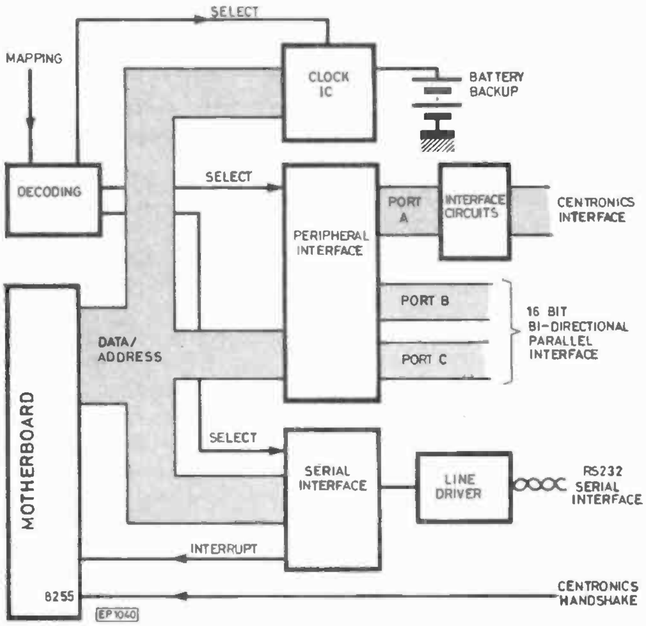


Fig. 8. Port Card

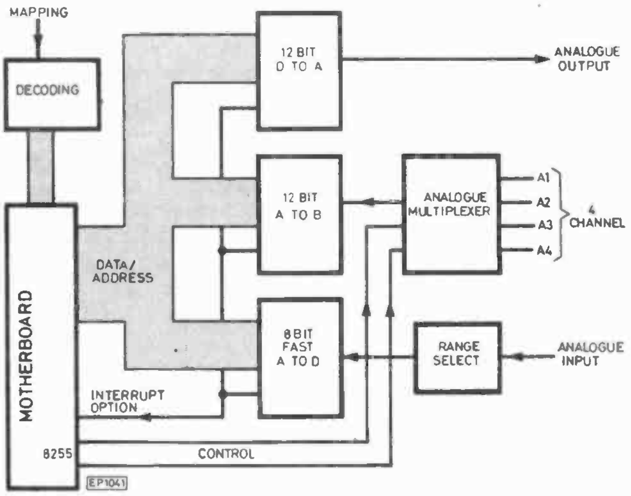


Fig. 9. Analogue Interface

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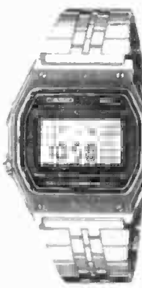

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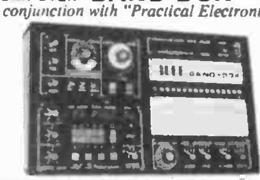

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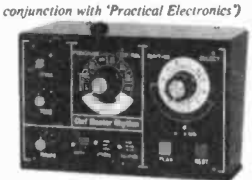

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SEMICONDUCTOR UPDATE

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 any. point. 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 $\overline{WR}$ 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, IC1, allowing the data to be read by the ZX81. 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.

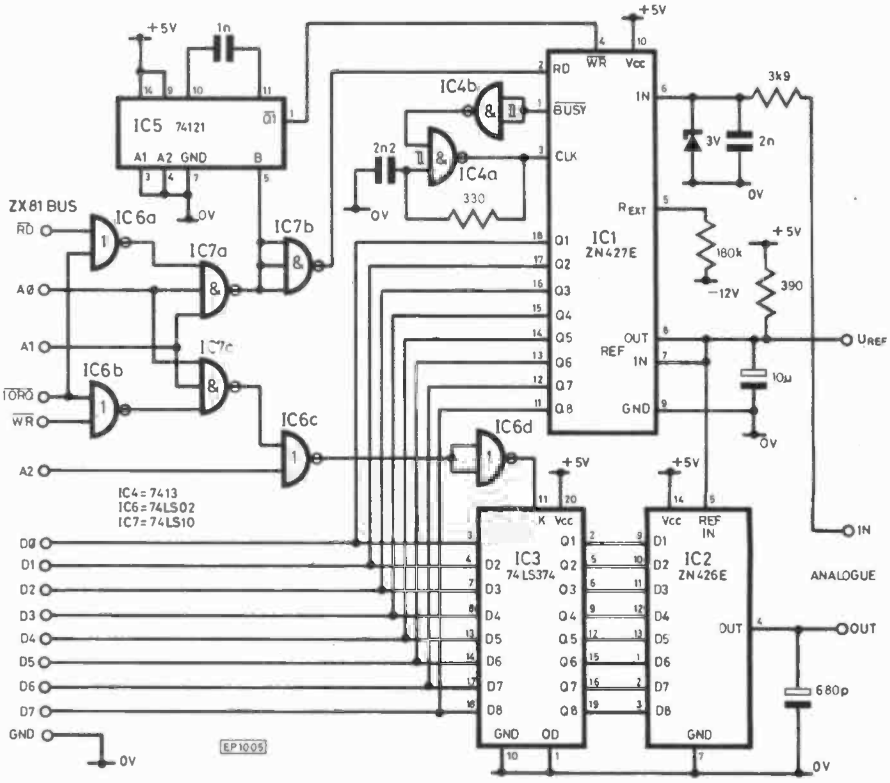


Fig. 1. Analogue input/output port circuit interfaces with ZX81

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 harmonizer 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.

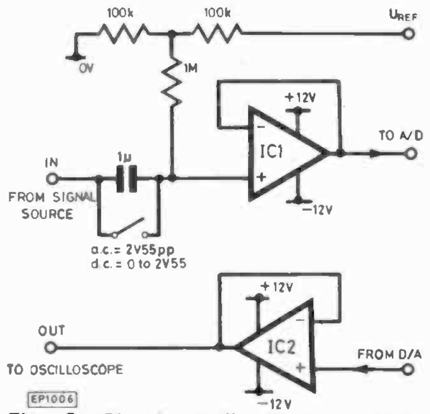


Fig. 2. Simple audio stages enable analogue I/O port to be used as a digital storage scope

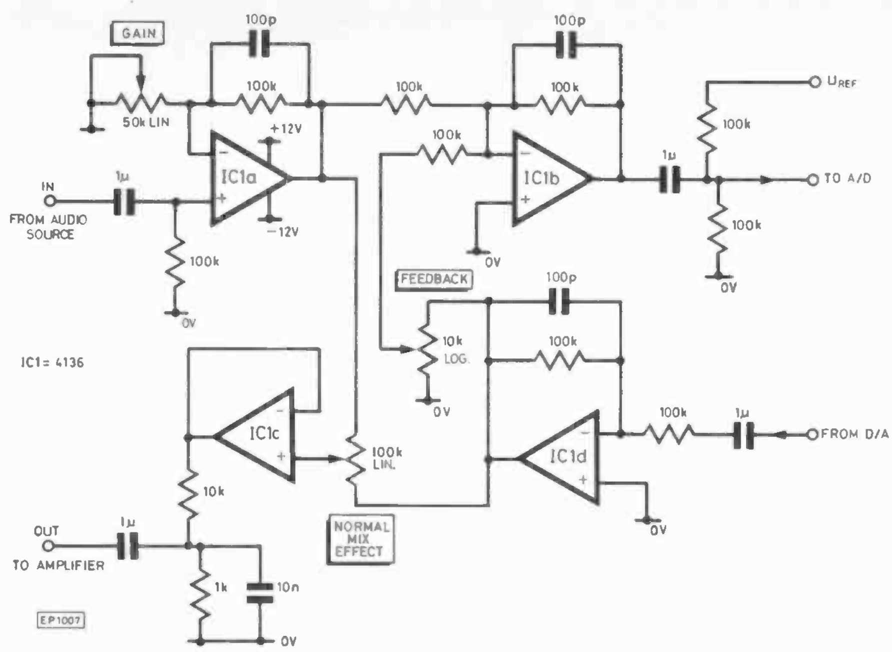


Fig. 3. Audio stage interfaces the analogue I/O port to an audio amplifier

```
                                        ·HARMONIZER:
10 REM ...string of poked characters...
20 CLS
30 FAST
40 LET A=16514
50 PRINT "DELAY RANGE:...(MILLISEC)","(MAX 500)"
60 INPUT P
70 IF P>500 THEN GOTO 60
80 LET P=128-INT(P/8.61+0.5)
90 POKE A+4,P
100 POKE A+7,P
110 POKE A+28,P
120 POKE A+35,P
130 CLS
140 PRINT "DOWN:0    UP:1"
150 INPUT P
160 IF P=0 THEN GOTO 200
170 IF P=1 THEN GOTO 400
180 GOTO 130
200 POKE A+21,0
210 GOSUB 600
220 LET X=INT(256/P+0.5)
230 GOTO 800
400 POKE A+21,19
410 GOSUB 600
420 LET X=INT(256*(P-1)+0.5)
430 GOTO 800
600 PRINT "TRANSPOSE:...(SEMITONES)"
610 INPUT P
620 LET P=(2**(1/12))**P
630 RETURN
800 IF X>255 THEN LET X=255
810 POKE A+1,X
820 LET P=USR A
830 GOTO 0
```

Fig. 5. Harmonising program for the ZX81 transposes the pitch of an input signal in real time

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 machine-code 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.

```
10 REM ...string 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 60
80 LET P= 128-INT(P/8.61+0.5)
90 POKE A+2,P
100 POKE A+21,P
110 LET P=USR A
120 GOTO 0
```

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

Data noted by * will be changed by POKE statements.

ADDRESS:	ECHO:		HARMONIZER:		STORAGE SCOPE:	
16514	ld 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*	dj nz	16
16518	ld a,(hl)	126	ld 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		3	jr nc	48
16523	ld(hl,a)	119	ld(hl),a	119		-9
16524	dj nz	16	inc hl	35	ld hl,NN	33
16526		-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	ld(hl),a	119
16531	jp p,NN	242	ld b, a	71	inc hl	35
16532		133	jr nc	48	ld a,h	124
16533		64		1	cp N	254
16534	ld h,N	38	inc de	19		128
16535		72*	inc de	19*	jr nz	32
16536	in a,N	219	dec 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		70*
16541		133	ld d,N	22	ld a,(hl)	126
16542		64		120*	out N,a	211
16543	ret	201	dec h	37		3
16544			inc h	36	inc hl	35
16545			jp p,NN	242	ld 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	ld 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						

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 sample 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.

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

```
DIGITAL STORAGE OSCILLOSCOPE

10 REM ...string of poked characters...
20 FAST
30 PRINT "DC TRIGGERING LEVEL:...","(0 TO 2.55 VOLT)"
40 INPUT U
50 LET U=255-INT(100*U+0.5)
60 POKE 16515,U
70 GOSUB 300
80 GOTO 170
90 LET L=USR 16514
100 LET L=USR 16538
110 LET K$=INKEY$
120 IF K$="" THEN GOTO 100
130 IF K$="N" THEN GOTO 170
140 IF K$="S" THEN GOSUB 400
150 IF K$="B" THEN GOSUB 500
160 GOTO 100
170 CLS
180 PRINT"MENU OPTIONS:",,"  S: SAMPLE",,"  D: DISPLAY",,"  X: EXIT"
190 PRINT"IN DISPLAY MODE:","  S: SHIFT <=",,"  B: SHIFT =>"
200 PRINT"  N: MENU"
210 PAUSE 33000
220 POKE 16437,255
230 LET I$=INKEY$
240 IF I$="S" THEN GOTO 90
250 IF I$="X" THEN STOP
260 GOSUB 300
270 GOTO 100
300 CLS
310 PRINT"SAMPLE LENGTH...(T<215 MILLISEC)"
320 INPUT T
330 LET T=INT(T/3.712+0.5)
340 LET TO=70
350 IF TO+T>128 THEN GOTO 300
360 GOSUB 600
370 RETURN
400 IF TO<=70 THEN RETURN
410 LET TO=TO-1
420 GOSUB 600
430 RETURN
500 IF TO+T>=128 THEN RETURN
510 LET TO=TO+1
520 GOSUB 600
530 RETURN
600 POKE 16540,TO
610 POKE 16547,TO+T
620 RETURN
```

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$=" ( 0181119155":VDU&97&9A:PRINTM
ID$(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+SQR2^ABSB:IFA/C MOD(C*2)PRINT
"o";:NEXTELSEPRINTSPC1;:NEXT:UNTILGET=FA
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)!

Ingenuity Unlimited

A selection of readers' original circuit ideas.
Why not submit *your* idea? Any idea published will be awarded payment according to its merits.
Each idea submitted must be accompanied by a declaration to the effect that it has been tried and tested, is the original work of the undersigned, and that it has not been offered or accepted for publication elsewhere. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.
Articles submitted for publication should conform to the usual practices of this journal, e.g. with regard to abbreviations and circuit symbols. Diagrams should be on separate sheets, not in the text.

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.

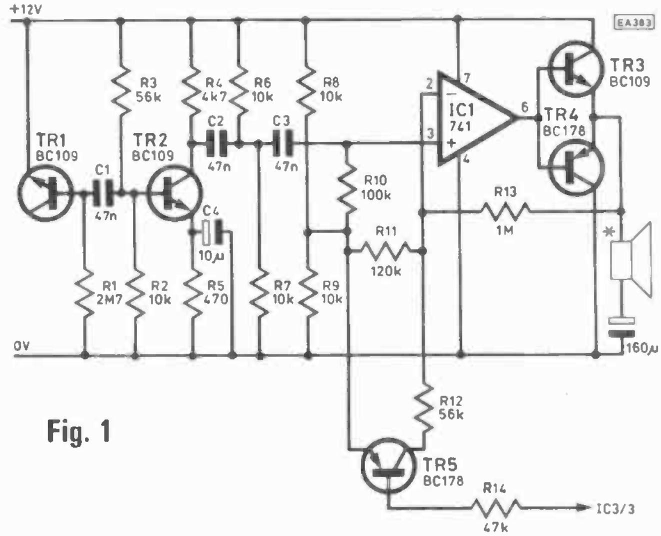


Fig. 1

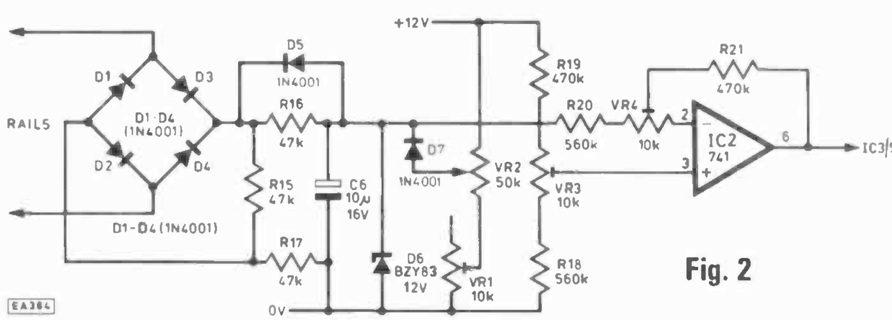


Fig. 2

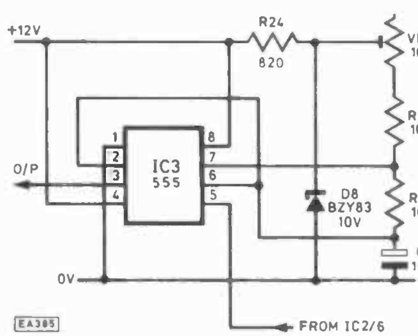


Fig. 3

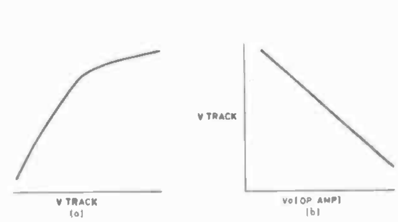
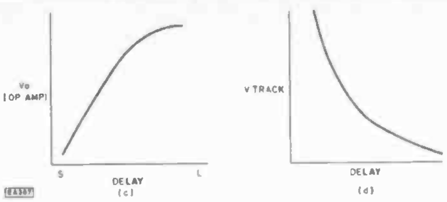


Fig. 5



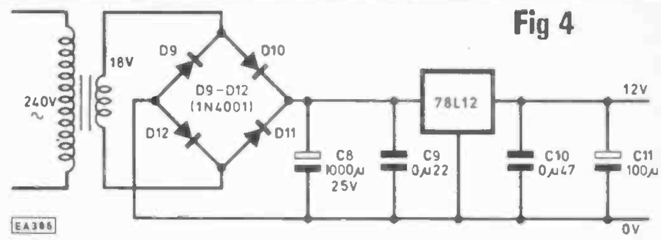


Fig 4

HIGH GAIN, HIGH FREQUENCY AMPLIFIERS

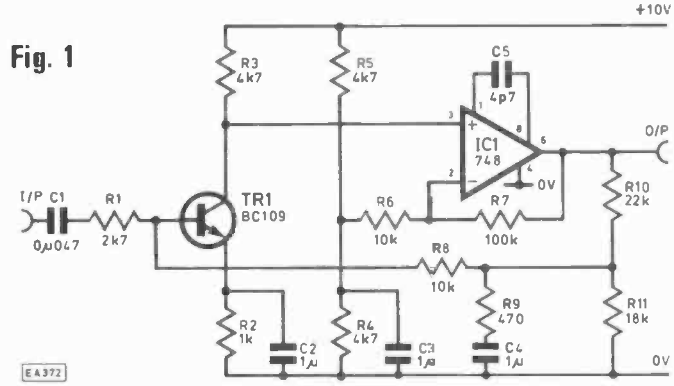
DURING experiments with a design for an induction balance metal detector, a need arose for an amplifier with a frequency response above 100kHz, a completely stable gain in excess of 100, an input impedance around 10k, and a low output impedance. In addition a sharp roll-off was required below about 20kHz, 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 layout.

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

Fig. 1



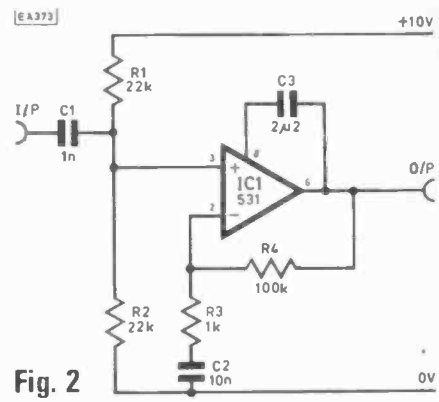
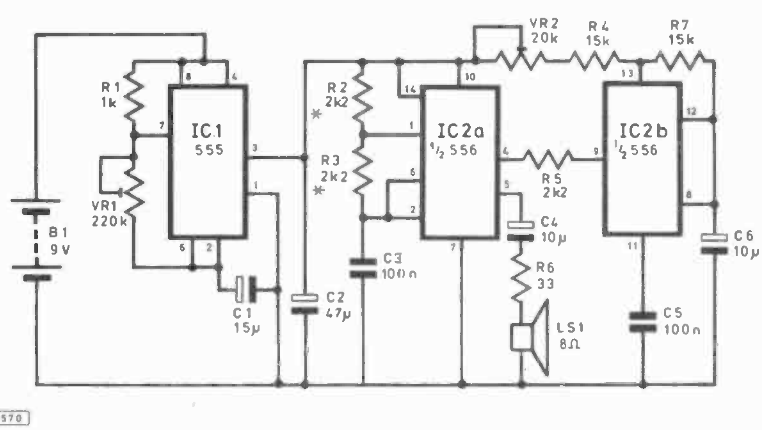


Fig. 2

TELEPHONE 'BELL'

I 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

BAZAAR

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It detects pulse widths down to 50nsec, repetition rates up to 10MHz. Separate High and Low indicating l.e.d.s driven by dual threshold window comparators. Pulse stretcher lights l.e.d. on either edge. Memory mode latches l.e.d. for catching low rep-rate and one-shot events. Switch selects logic family threshold levels. Reverse and over-voltage protected.

SPECIFICATION

Pulse detect mode: High speed pulse train or single events (+ or − transitions) activate 1/3 sec. pulse stretcher.
Memory mode: Latches pulse l.e.d. for catching low rep-events and one-shot events.
Input impedance: 100k
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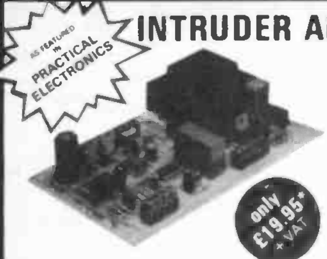
Physical size (LxWxD) 180x22x22mm (7x0.87x0.87")
Weight 70g (2.47 oz)

MODULES FOR SECURITY & MEASUREMENT

INTRUDER ALARM CONTROL UNIT CA 1250



This exciting new module offers all the possible features likely to be required when building an intruder alarm system. Whether used with only 1 or 2 magnetic switches or in conjunction with several ultrasonic alarm modules or infra-red units, a really effective system can be constructed at a fraction of the cost of comparable ready-made units. Supplied with a fully explanatory Data Sheet that makes installation straight forward, the module is fully tested and guaranteed.
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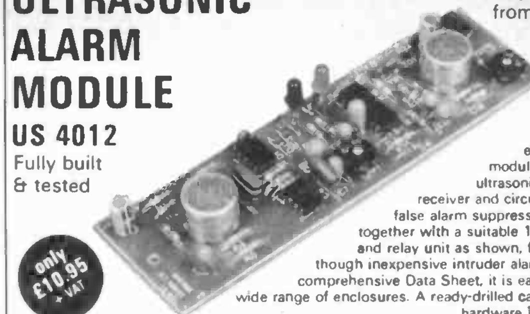
ULTRASONIC ALARM MODULE US 4012

Fully built & tested

Adjustable range from 5ft. to 25ft.



A really effective fully built module containing both ultrasonic transmitter and receiver and circuitry for providing false alarm suppression. This module, together with a suitable 12V power supply and relay unit as shown, forms an effective though inexpensive intruder alarm. Supplied with comprehensive Data Sheet, it is easily mounted in a wide range of enclosures. A ready-drilled case and necessary hardware is available below.

DIGITAL VOLTMETER MODULE DVM 314

Fully built & tested

- Positive & negative voltage with an FSD of 999mV which is easily extended
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- Large bright 0.43" LED displays
- Supplied with full applications data

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Size: 153mm x 120mm x 45mm.

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Contains an inhibit facility for use with shop lifting loops or other break to activate circuits.

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Princes Risborough (084 44) 6326
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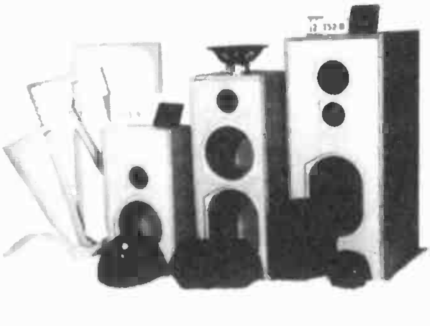

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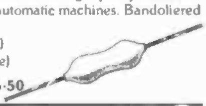

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DIL SWITCHES: Gold plated contact in fully sealed base – solve those programming problems.
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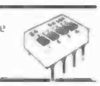

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Boost those outside octaves! Each unit has depth & range controls.
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Internal oscillator controls vocal and instrumental sounds for Wah-wah to 'Bobbley' type effect. 4 controls.
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Lots more kits in catalogue!

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Two-tone gong-like sound automatically activated at the end of transmission.
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If connectors ordered with kits in this ad, no P&P charge, else add 60p to total cost.

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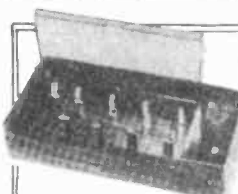

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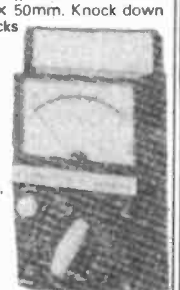

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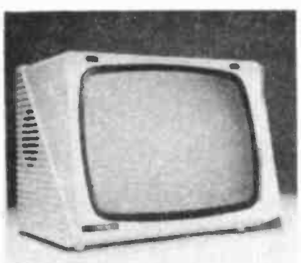

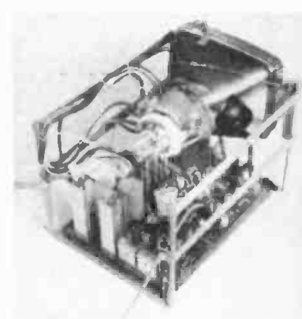

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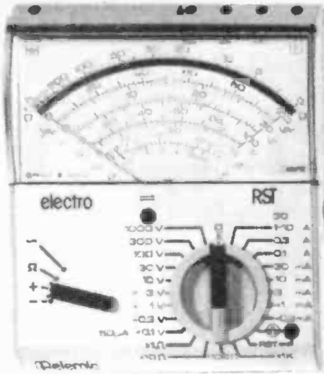

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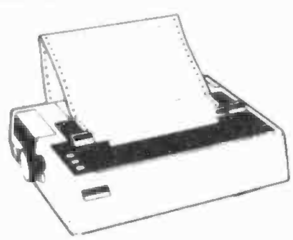

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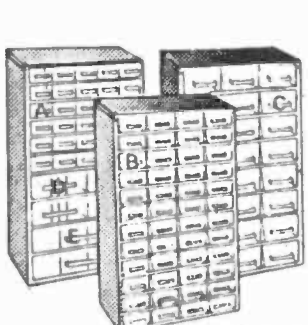

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