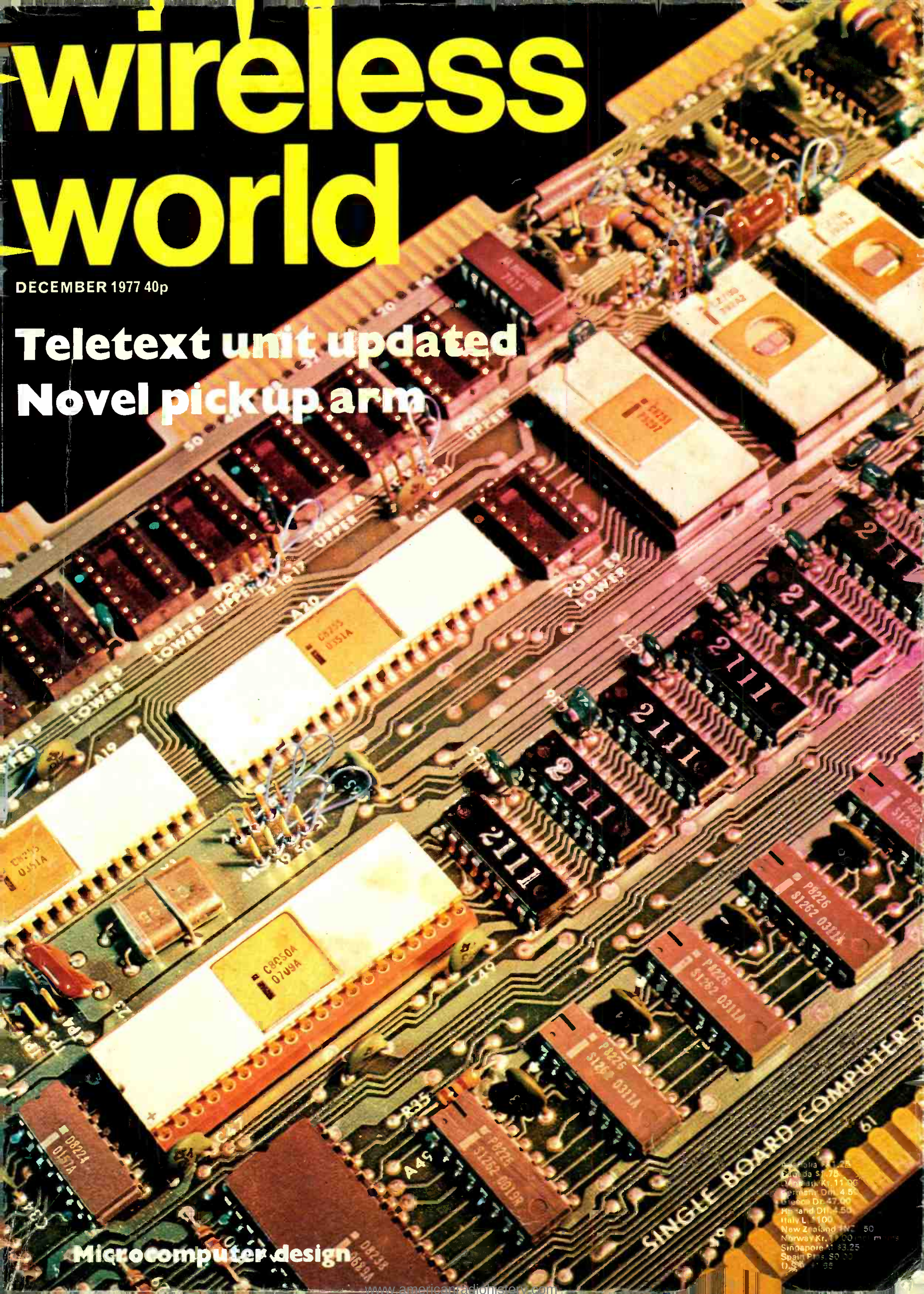
wireless world

DECEMBER 1977 40p

Teletext unit updated
Novel pickup arm



Microcomputer design

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Canada $1.75
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Greece Dr. 47.00
Holland Dfl. [illegible]
Italy L. [illegible]100
New Zealand [illegible] 50
Norway Kr. [illegible]00 [illegible]
Singapore [illegible] $3.25
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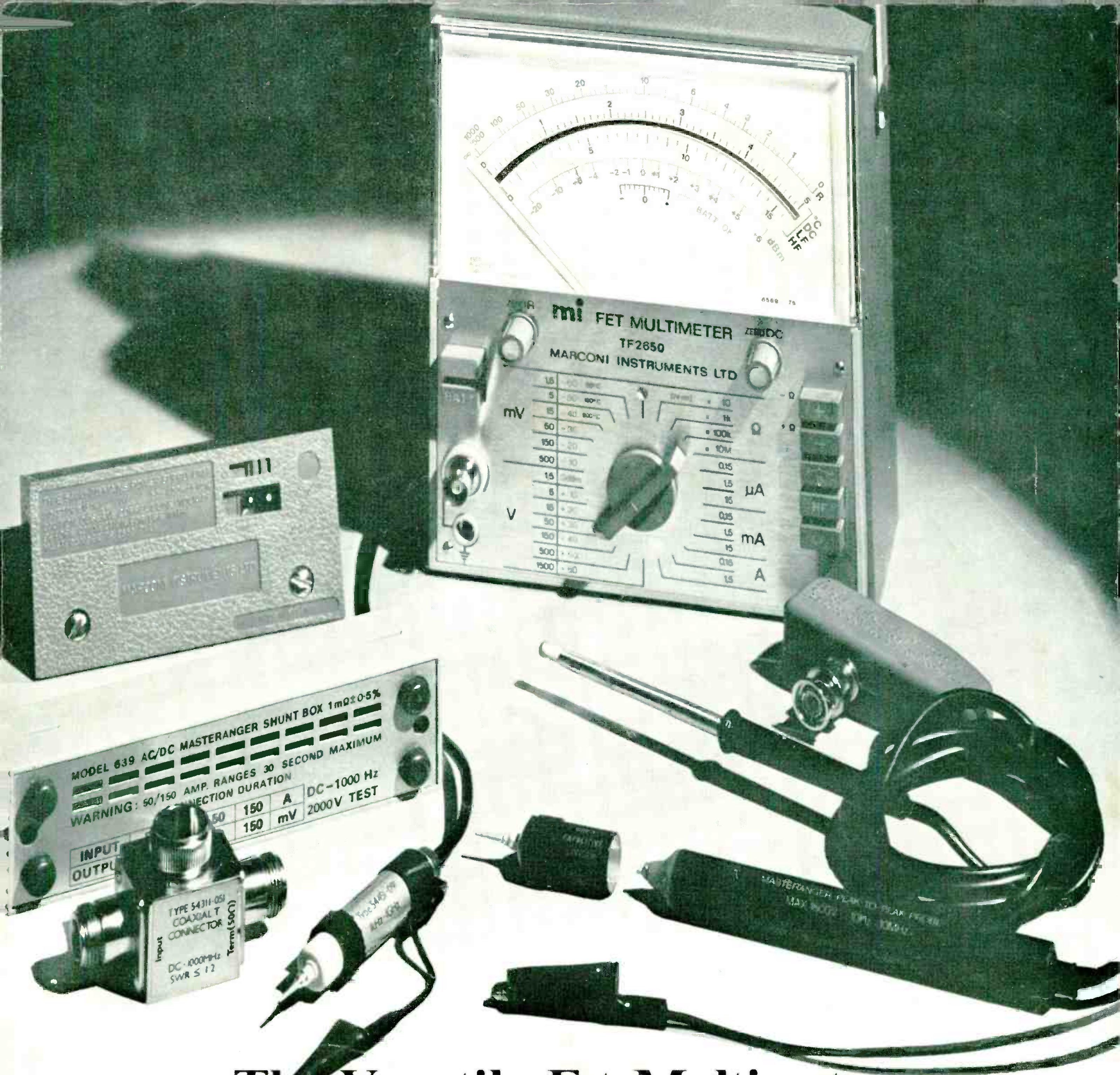

The Versatile Fet Multimeter

Eight optional accessories including an r.f. probe, a peak-to-peak probe, a temperature probe, and a co-axial T-connector, make the TF 2650 Solid State FET Multimeter one of the most comprehensive general purpose multimeters available. Such versatility makes the TF 2650 ideal for use in servicing, production, technical education, research, design and many other applications, while the battery/mains option makes it equally suitable for field, laboratory or workshop.

Accuracy is ±1·5% on most ranges and the f.e.t. input amplifier gives an output resistance of typically 100 MΩ with good overload protection. Scales cover from 1·5 mV and 0·15 mA f.s. to 1500 V and 1·5 A a.c. and d.c. The accessories extend the ranges up to 30 kV and 150 A, r.f. up to 1 GHz and temperatures up to 500°C. Resistances can be measured from 100 Ω to 100 MΩ mid-scale with a facility to make in-circuit measurements on solid-state devices. A centre-zero facility is available on most ranges.

The basic instrument is supplied complete with co-axial leads, crocodile grips, test prods and a leather carrying case.

For further information write or phone:

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WW—001 FOR FURT DETAILS

A GEC-Marconi Electronics Company

wireless world

Electronics, Television, Radio, Audio

DECEMBER 1977 Vol 83 No 1504

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Current issue price 40p, back issues (if available) 50p, at Retail and Trade Counter, Paris Garden, London SE1. By post, current issue 55p, back issues (if available) 50p, order and payments to Room 11, Dorset House, London SE1 9LU.
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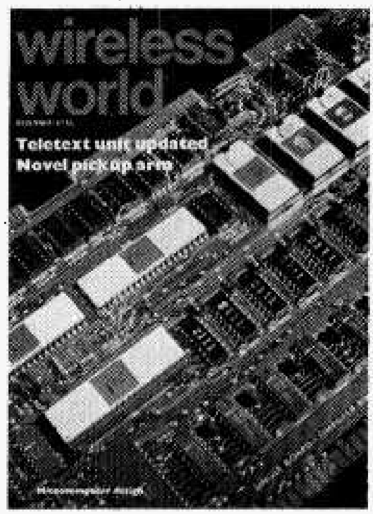


Front cover, showing a micro-computer using Intel devices on a single p.c. board, introduces our second article on microcomputer design in this issue.
Photographer Paul Brierley

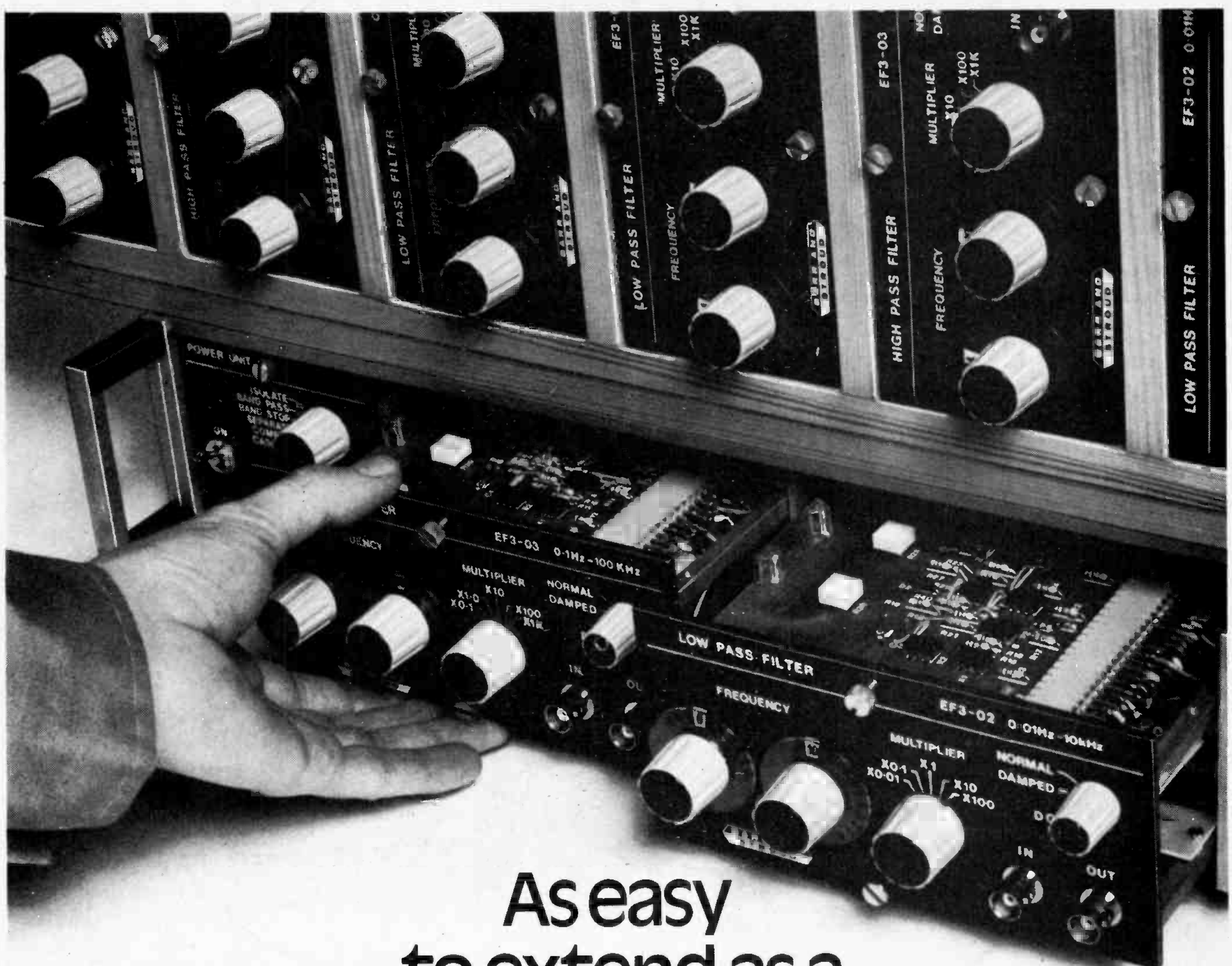
IN OUR NEXT ISSUE

Traffic information broadcasting. Latest developments in the BBC's proposed system using a multiplicity of low power m.f. transmitters on a single frequency.

Fuses — their physical functioning, design and characteristics. A detailed look at a somewhat neglected component.

Power into loads: why we don't apply the maximum power transfer theorem to active devices in linear circuits.

ISSN 0043 6062



As easy to extend as a cassette library... EF3 Modular Filtering System from Barr & Stroud

When dealing with a variety of projects, electronic filtering requirements change rapidly and need to be met with minimum fuss and maximum flexibility. The Barr & Stroud EF3 Modular Filtering System is designed around the most compact of basic main frames containing the power unit and function switching with capacity for two slide-in filter units. The modular concept allows you to begin with the minimum of a mainframe and one filter unit. Thereafter you can extend your *'library'* of filter capability as requirements dictate and budgets make possible.

The EF3 is a system that grows with every plug-in module and constantly expands as new modules are developed and introduced. Current modules give a pass band capability from d.c. to 10MHz and within this spectrum filter units can be operated individually or in a combination to give low-pass, high-pass, band-stop, band-separate or band-combine modes.

The EF3 system is a part of the comprehensive Barr & Stroud range of electronic filters that could well meet all your filtering requirements. If not, Barr & Stroud welcome the opportunity to study your problem and come up with a custom-built solution. The full spectrum of Barr & Stroud capability in electronic filtering is covered in a range of literature available on request.

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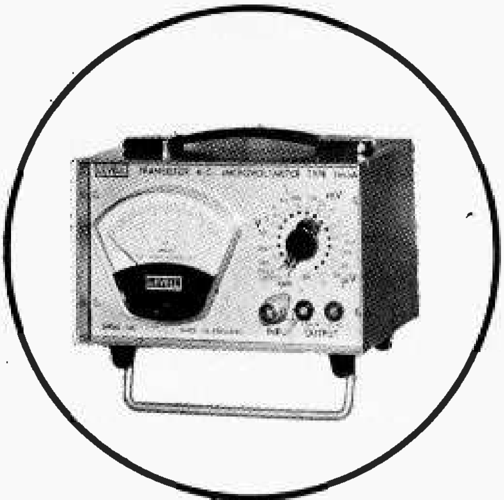

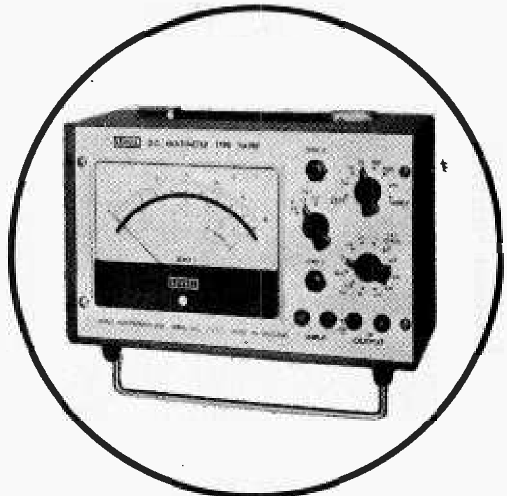

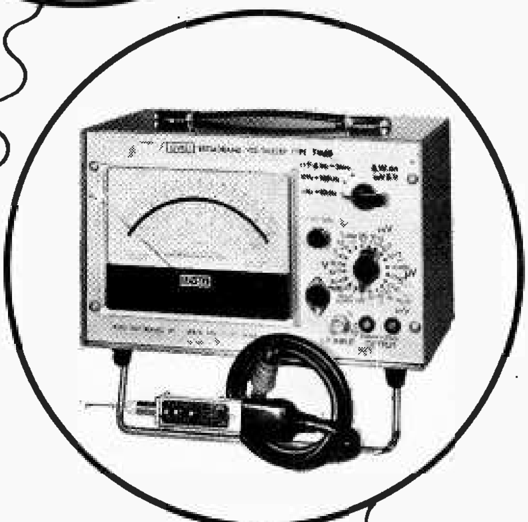

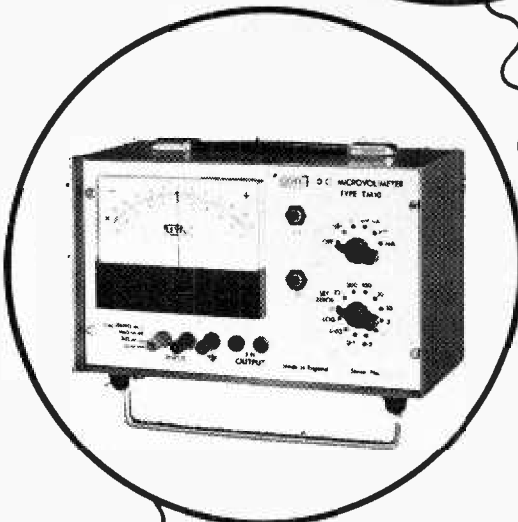

A.C. MICROVOLTMETERS

VOLTAGE & dB RANGES: 15µV, 50µV, 150µV . . . 500V
Acc. ± 1% ± 1% f.s.d. ± 1µV at 1kHz — 100, — 90 . . . +50dB
Scale — 20dB/ + 6dB rel. to 1mW/600Ω.
RESPONSE: ± 3dB from 1 Hz to 3MHz, ± 0.3dB from 4Hz to 1MHz above 500µV. Type TM3B can be set to a restricted B.W. of 10Hz to 10kHz or 100 kHz.
INPUT IMPEDANCE: Above 50mV >4 3MΩ<20pf
On 50µV to 50mV : > 5MΩ < 50pf.
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type TM3A **£89** type TM3B **£99**

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CURRENT RANGES: 3pA, 10pA, 30pA . . . 1mA (1A for TM9BP).
Acc. ±2% ±1% f.s.d. ±0.3pA. LZ & CZ scales.
RESISTANCE RANGES: 3Ω, 10Ω, 30Ω . . . 1 GΩ linear Acc. ±1% ±1% f.s.d. up to 100MΩ.
RECORDER OUTPUT: 1V at f.s.d. into > 1kΩ on LZ ranges.

type TM9A **£130** type TM9BP **£140**

BROADBAND VOLTMETERS

H.F. VOLTAGE & dB RANGES: 1mV, 3mV, 10mV . . . 3V.
Acc. ±4%±1% f.s.d. at 30MHz. — 50dB, — 40dB, — 30dB to + 20dB. Scale — 10dB/ + 3dB rel. to 1mW/50 Ω ± 0.7dB from 1MHz to 50MHz, ± 3dB from 300kHz to 400MHz.
L.F.RANGES: As TM3 except for the omission of 15µV and 150µV.
AMPLIFIER OUTPUT: Square wave at 20Hz on H.F. with amplitude proportional to square of input. As TM3 on L.F.

type TM6A **£140** type TM6B **£150**

D.C. MICROVOLTMETERS

VOLTAGE RANGES: 30µV, 100µV, 300µV . . . 300V.
Acc. ± 1%, ± 2% f.s.d., ± 1µV. CZ scale.
CURRENT RANGES: 30pA, 100pA, 300pA . . . 300mA.
Acc. ± 2%, ± 2% f.s.d., ± 2pA. CZ scale.
LOGARITHMIC RANGE:
± 5µV at ± 10% f.s.d., ± 5mV at ± 50% f.s.d., ± 500mV at f.s.d.
RECORDER OUTPUT: ±1V at f.s.d. into >1kΩ.

type TM10 **£77**

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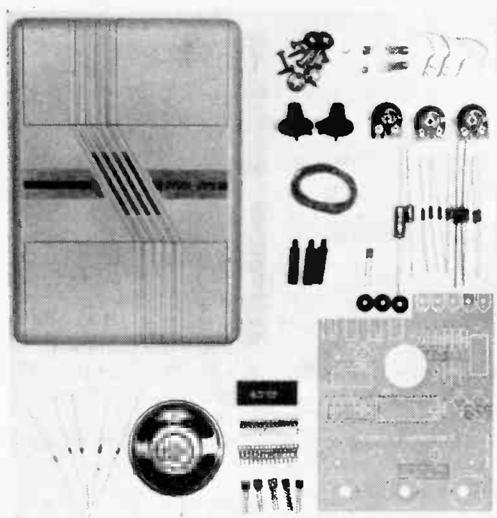
Build a microprocessor electronic musical door chime which can play 24 different tunes!

A complete Chroma-Chime *Kit for only £18 inc. p.&p. & VAT.*



Plays:

Greensleeves	Cook House Door
God Save the Queen	The Stars & Stripes*
Rule Britannia*	Beethoven's Ode to Joy
Land of Hope and Glory	William Tell Overture
Oh Come All Ye Faithful	Soldier's Chorus
Oranges and Lemons	Twinkle, Twinkle Little Star
Westminster Chimes*	Great Gate of Kiev
Sailor's Hornpipe	Maryland
Beethoven's "Fate Knocking"	Deutschland uber Alles
The Marseillaise	Bach
Mozart	Colonel Bogie
Wedding March	The Lorallie

*These tunes play longer if the push button is kept pressed.

* Handsome purpose built ABS cabinet
* Easy to build and install
* Uses Texas Instruments TMS1000 microcomputer
* Absolutely all parts supplied including I.C. socket
* Ready drilled and legended PCB included
* Comprehensive kit manual with full circuit details
* No previous microcomputer experience necessary
* All programming permanently retained is on chip ROM
* Can be built in about 3 hours!
* Runs off 2 PP3 type batteries.
* Fully Guaranteed

*
A great introduction to the fascinating world of microcomputers.

* *Save pounds on normal retail price by building yourself.*

The Chroma-Chime is the world's first electronic musical door chime which uses a pre-programmed microcomputer chip to generate tunes. Instead of boring old buzzes, dings or dongs, the Chroma-Chime will play one of its 24 well known tunes from its memory using its tiny 'brain' to all the music synthesizing! Since everything is done by precise mathematics, it cannot play the notes out of tune.

The unit has comprehensive built-in controls so that you can not only select the 'tune of the day' but the volume, tempo and envelope decay rate to change the sound according to taste.

Not only visitors to the front door will be amazed, if you like you can connect an additional push button for a back door which plays a different tune!

This kit has been carefully prepared so that practically anyone capable of neat soldering will have complete success in building it. The kit manual contains step by step constructional details together with a fault finding guide, circuit description, installation details and operational instructions all well illustrated with numerous figures and diagrams.

To CHROMATRONICS, River Way, Harlow, Essex, U.K.

Please send ☐ Chroma-Chime Kits at £18·00 each including VAT and post and packing

PLEASE USE BLOCK CAPITALS

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Address ______________________

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Signature ______________________

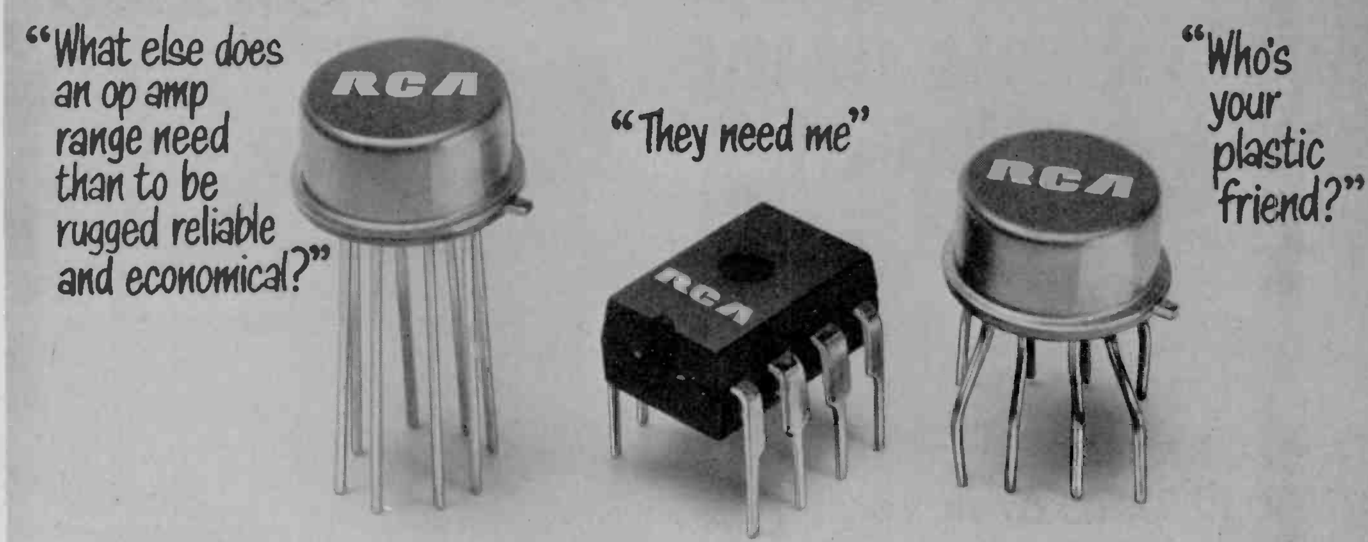
N.B. The CHROMA-CHIME is also available, fully assembled, price £24·95 inc VAT and post and packing.

Please allow 7-21 days for delivery.

The CHROMA-CHIME is exclusively designed by

CHROMATRONICS

River Way, Harlow, Essex.



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The table gives an indication of just what you can expect from a simplified range that covers virtually every application.

The BiMOS philosophy is in step with the trend towards standardising on fewer components that can do more jobs. It can help reduce costs all along the line – from design, manufacture and purchasing, to inventory control and incoming inspection.

And now the BiMOS range is available in plastic packaging. At a lower price of course. Good news for those concerned about profitability today.

Whether you're a systems designer, an engineer or in management, BiMOS gives you something to think about. And act upon.

Op amp category	What BiMOS contributes	RCA device
General purpose	Wide applicability. Low cost	CA3160 CA3140 CA3130
FET Input	Lower device cost Reduced circuit cost	CA3160 CA3140 CA3130
Wideband 4·5 to 70 MHz	High slew rate with low ringing	CA3160 CA3140 CA3130 CA3100
Micropower down to 1·5 mW	Strobability.	CA3160 CA3130
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(incorporating ECS and GDS Sales)

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RCA

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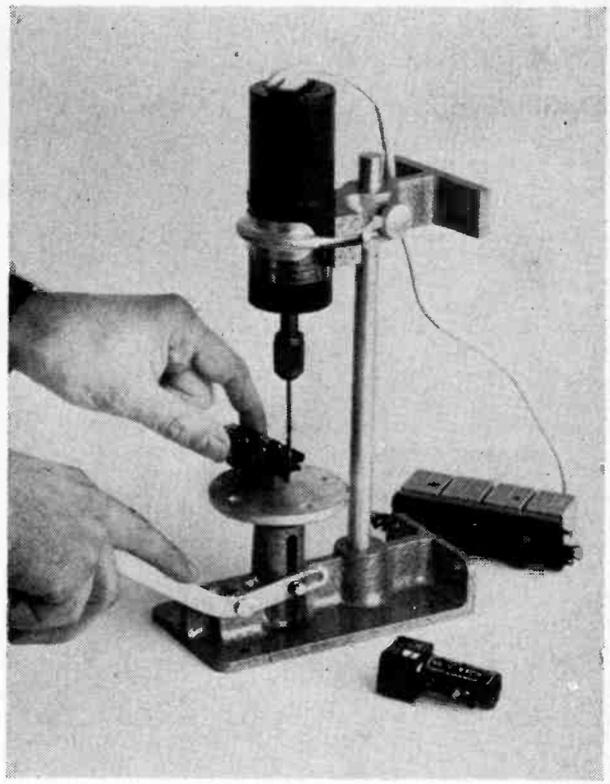

Behind this name there's a lot of real POWER!

Illustrated right is a **TITAN DRILL**

Mounted in a multi-purpose stand. This drill is a powerful tool running on 12v DC at approx. 9000 rpm with a torque of 350 grm. cm. Chuck capacity 3.00 m/m.
The multi-purpose stand is robustly constructed of steel and aluminium. The base and bracket are finished in hammer blue.
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These are examples of the extensive range of power tools designed to meet the needs of development engineers, laboratory workers, model makers and others requiring small precision production aids.
To back up the power tools, Expo offer a comprehensive selection of Drills, Grinding Points and other tools.
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Stockists: Richards Electric, Worcester and Gloucester; Hoopers of Ledbury; Hobbs of Ledbury; D&D Models, Hereford; Bertella, Gloucester.

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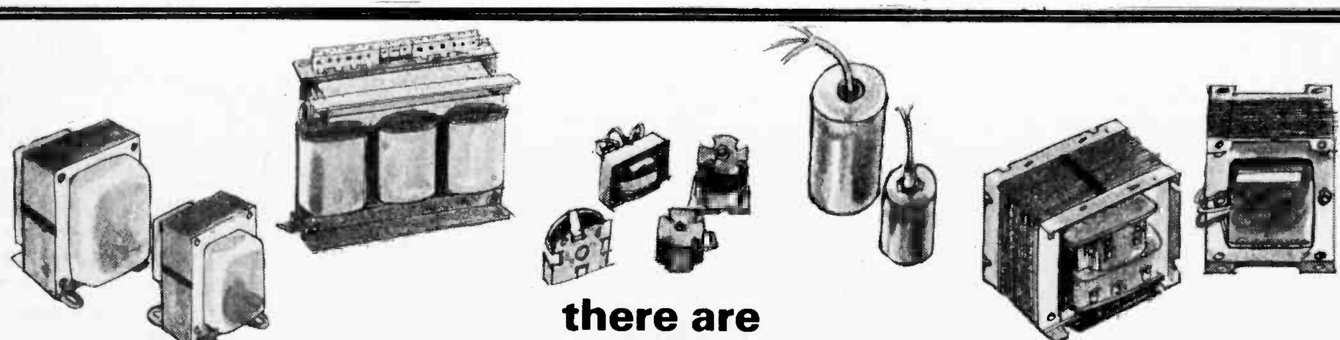
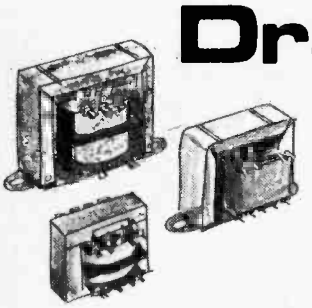
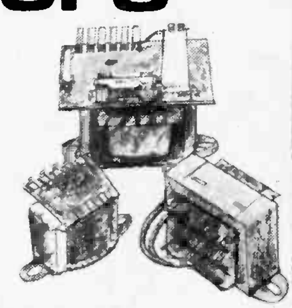


there are *transformers* and

Drake Transformers



A wide range of transformers manufactured in production quantities to customers' own requirements; prompt design and prototype service.



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4K STATIC RAM
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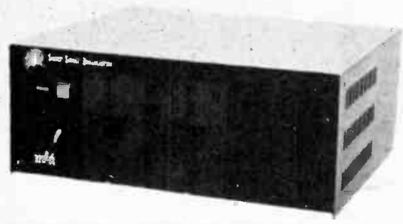

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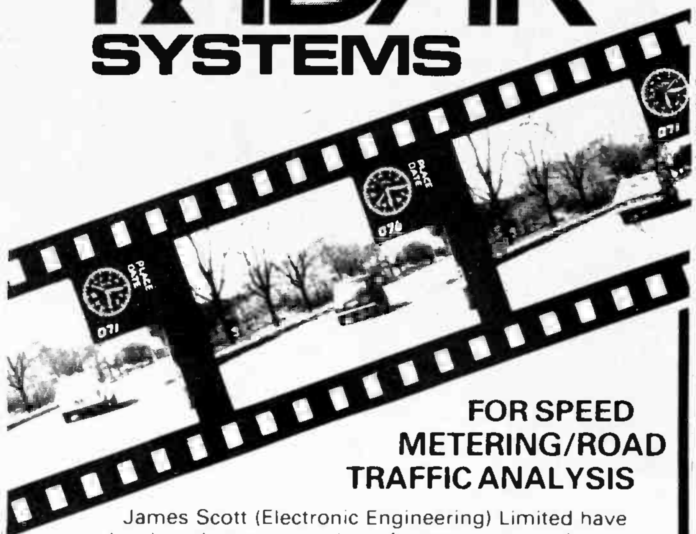
JAMES SCOTT TRAFFIC RADAR SYSTEMS

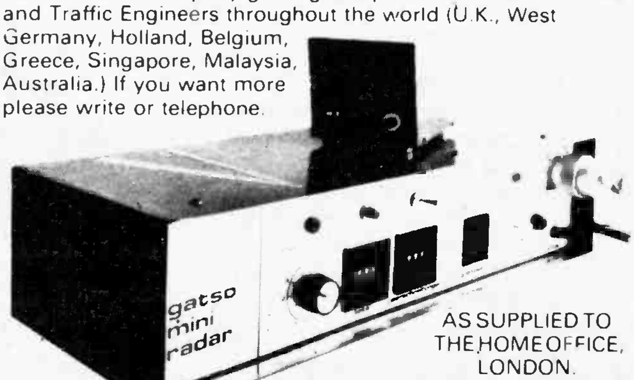


FOR SPEED METERING/ROAD TRAFFIC ANALYSIS

James Scott (Electronic Engineering) Limited have developed, over a number of years, a range of miniature traffic radar systems of advanced design for law enforcement and traffic analysis applications.

● Digital speed presentation ● Suitable for LH/RH traffic systems ● Alarm speed selectable in the range 21 to 99 mph or kph in unit steps ● Can be used tripod mounted or from inside a parked vehicle
● Compact, lightweight design with solid state circuitry except for digital display tubes ● Facility to operate camera/flash unit (available as optional extra) ● Test oscillator incorporated ● BCD output available for data-logging.

These are some of the reasons why the James Scott Gatso Mini Radars are rapidly gaining acceptance with Police Forces and Traffic Engineers throughout the world (U.K., West Germany, Holland, Belgium, Greece, Singapore, Malaysia, Australia.) If you want more please write or telephone.



AS SUPPLIED TO THE HOME OFFICE, LONDON.

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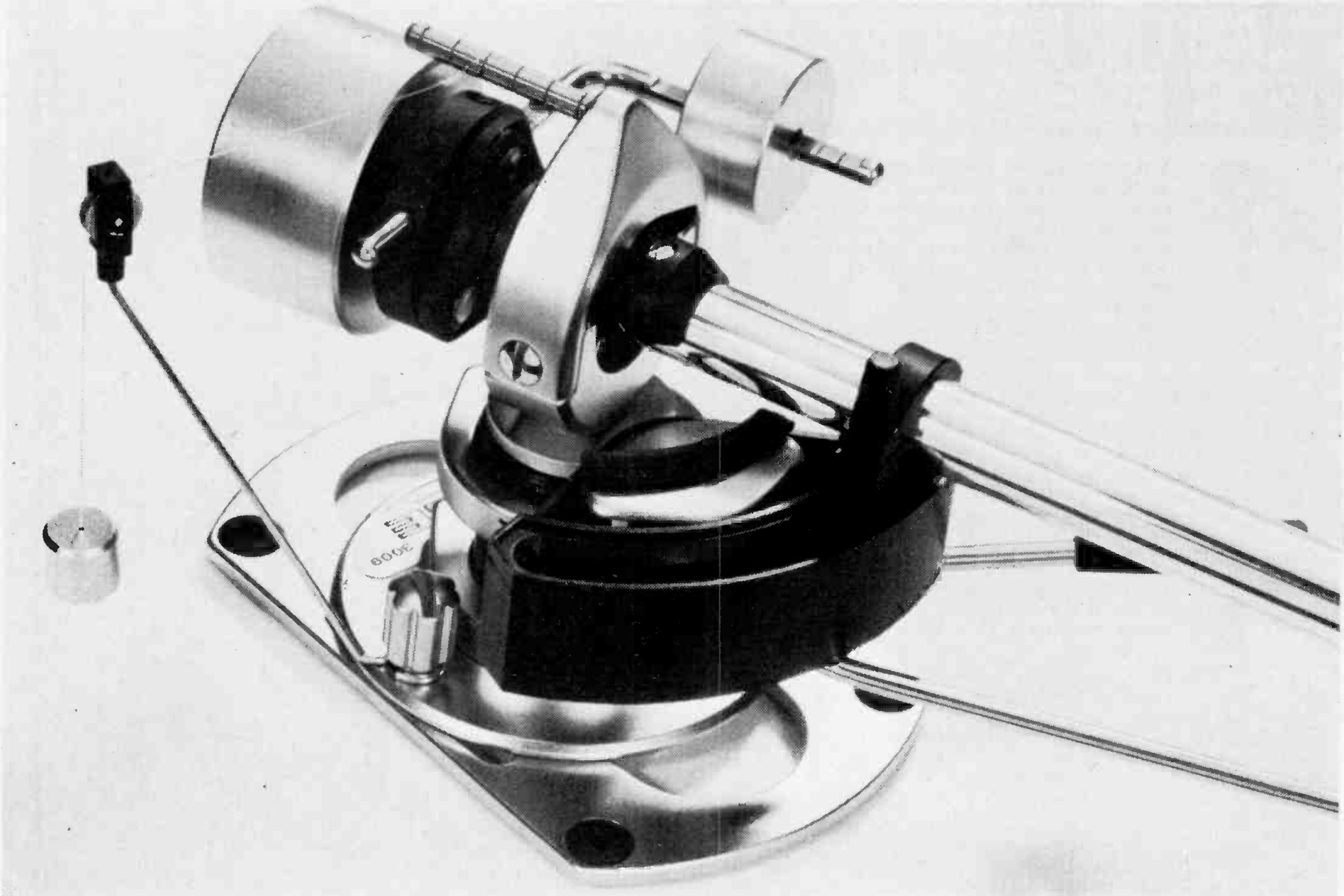


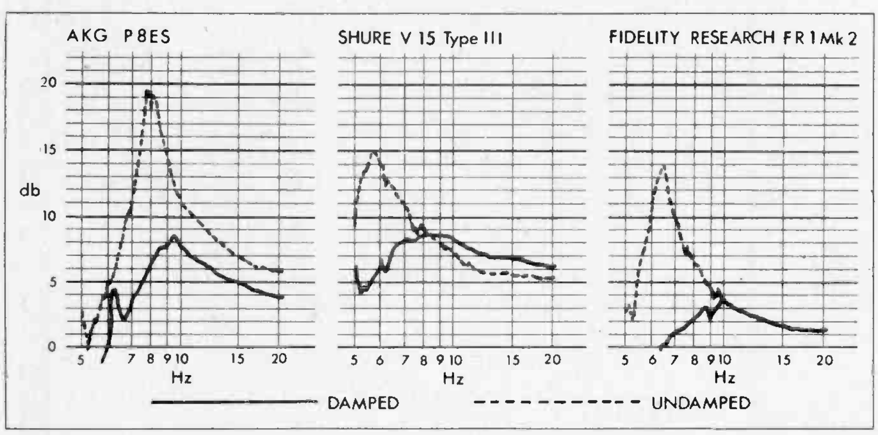
3009 + FD200

The FD200 fluid damper renders the pick-up arm less lively. In this respect it performs a similar function to the shock absorber of a motorcar. The damper does not resist the normal slow passage of the arm across the record, but any influence which would tend to produce rapid arm motion is resisted because of the flow characteristic of the fluid.

The benefits are smoother bass, resistance to external shock and reduction of spurious low frequencies. The prior art has been to apply damping at the bearings but this method is inherently inefficient and liable to migration of the damping fluid. The FD200 overcomes these problems as it is applied at a radius of 1.45 inches (36.8mm) making it several times more effective.

It is suitable for use with all Series II and Series II Improved arms and offers a choice of three damping rates to suit all cartridge compliances.

The attractively presented kit includes all parts necessary for the conversion which is easily carried out by the user following the explicitly illustrated instruction booklet. It is recommended for all cartridges, particularly those of relatively low compliance which might otherwise require a more massive arm.



The illustrations show typical extreme low frequency response characteristics of three cartridges in the Series II Improved arm.

Note the substantial reduction in the Q of the low frequency resonance. Although these frequencies are themselves outside the range of human hearing they give rise to undesirable side-effects which are audible.

Write to Dept 0643B · SME Limited
Steyning · Sussex · BN4 3GY

SME

The best pick-up arm in the world

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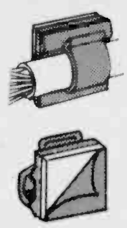
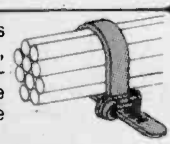
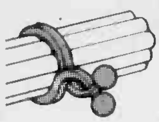
PLASTIC FASTENERS FOR ELECTRONICS



SELF-ADHESIVE CABLE CLIPS are a quick and simple means of securing cables, cords and small looms to flat surfaces. No drilling or fixing screws necessary. The peel-off backing is removed immediately before placing the clip. The coating adheres to most clean, flat surfaces and withstands a wide range of humidity and temperature. Cable clips are moulded in natural nylon and have rounded edges to prevent damage to the cables.

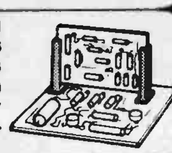
CABLE STRAPS are semi-permanent fasteners for strapping wires and cables into tight, compact looms. The ratchet fastener is adjustable and can be released by pinching-in the sides of the fastener head. Cable straps are made from black nylon.

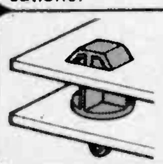




WIRE TIES are a flexible means of fastening wires and small cables into orderly, compact looms. They are quick and easy to fit and can be re-used, greatly reducing re-looming times. Wire ties are made from nylon and are available in various sizes each determined by a different colour.

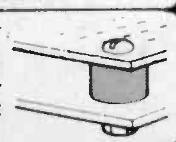
The **P.C. BOARD GUIDE** is a self-retaining edge support for printed circuit boards. It has good panel retention and grips p.c. boards firmly and securely. The guide is available in two types of material - yellow acetal or grey Noryl, for high temperature and voltage applications.

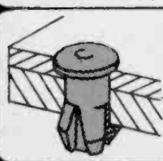




P.C. BOARD SPACERS are simple to fit, one-piece mouldings for use with p.c. boards. They have a self retaining shank for fastening into panels and a T-shaped anchor for securing p.c. boards of 0.062" thickness. They have good resistance to vibration and are suitable for board-to-board or board-tochassis use.

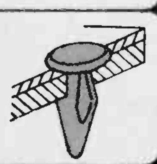
P.C. BOARD STAND-OFFS are quickly assembled, self-retaining panel supports for p.c. boards. Made from natural (off white) nylon and have good resistance to vibration. Suitable for panels up to 0.079" thickness. Stand-Offs accept a No. 4 self-tapping screw.

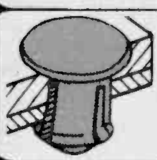




PLASTIC RIVETS fasten panels, fittings and name plates to metal plastic and wood. Resilient enough to fix into brittle materials like fibreglass, hardboard and glass. Shank, head and pin are one piece. Fixing is by driving the pin through the head into the space between the legs, gripping the work.

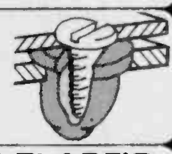
DRIVE FASTENERS hold two or more panels together. Easily fixed, normally by thumb pressure. No special tools required. Boat-shaped DRIVE Fasteners are for panels of thin and medium thickness and are removable. Ribbed Drive Fasteners are used in blind holes where hole length exceeds length of shank.





PLASTIC HOLE PLUGS are quick, inexpensive means of plugging unwanted holes. Hole Plugs keep out dust, dirt and moisture. Attractively shaped heads give a neat finish. The snap action grip of the Hole Plug makes a vibration resistant seal. Hole Plugs are made from nylon and are non-corrosive.

LOKUT ANCHORS are used to strengthen holes by providing additional screw thread engagement in materials where self-tapping screws would be unsatisfactory. Made from high strength nylon and used in insulation, and electrical chassis work. Easily fitted by hand.



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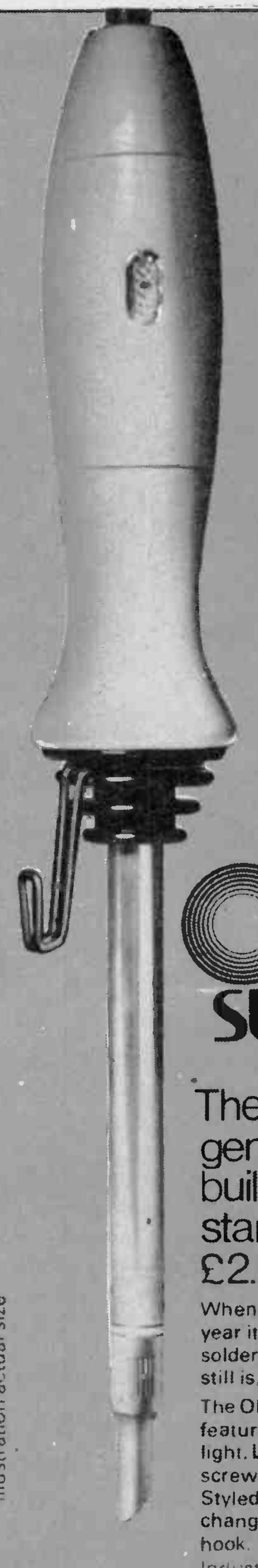

Illustration actual size

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Telephone 0734-596844. Telex 848659

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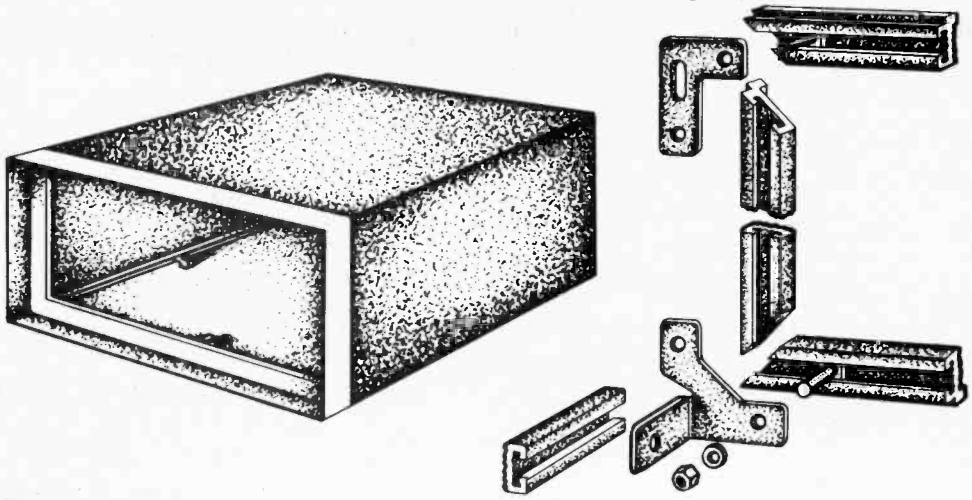
when is a box not a box?

Instrument boxes are often sold in standard sizes— not always the most practical sizes for your needs. When bought they take up a lot of storage space.



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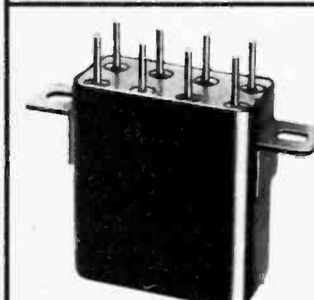

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They're here! For PAL.

Yes, actually available in Britain! It took a year due to unprecedented demand for NTSC. But the outstanding ¾" U-format colour video cassette recorders from JVC have now arrived.
Six brilliantly versatile models with the name that's known for innovation. You've heard about them. You've talked about them. Now see for yourself what's behind their global reputation. Whatever the brief – for boardroom or classroom, oil-rig or top-flight recording studio – there's a model that's right… flexible in operation… reliable in the extreme.

From JVC – the name worth its wait.

And for all U-format systems – famous for colour clarity, the Fuji video cassette, Beridox, is also available from Bell & Howell.

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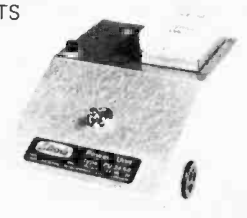

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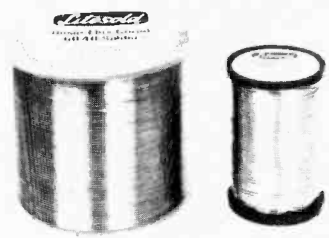

SOLDER Resin cored wire and chips for solder pots

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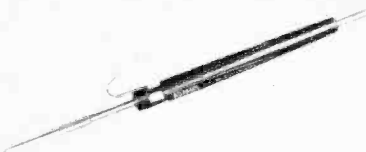

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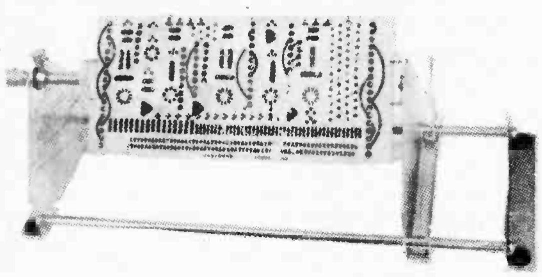
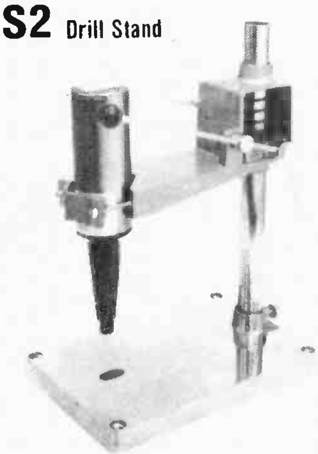


Invaluable for holding P.C.B.s and other panels when inserting and soldering components. Can be adjusted to suit work up to 280mm, rotating to gain access to reverse side and locks in any position. All metal.

Price **£10** inc. VAT. P&P £1

Write or phone for full details

S2 Drill Stand



Robust, all metal with ample throat dimensions. Adjustable height canti-lever with lever actuated feed. Spring return. Will accept both P1 & P2 drills.
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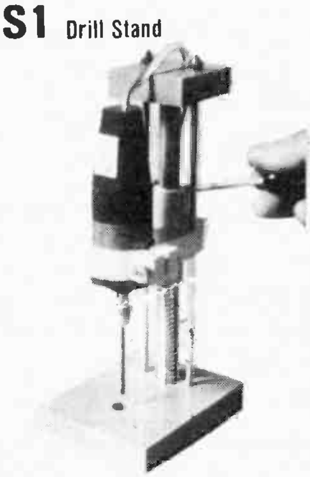
P2 Drill **£16.50** inc. VAT. P&P 86p

S1 Drill Stand



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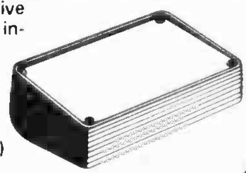
BIMCONSOLES
BIMBOXES
BIMBOARDS
BIMDRILLS
BIMDICATORS

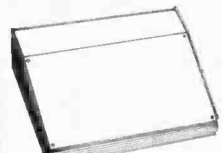
MINI DESK BIMCONSOLES

Moulded in Orange, Blue, Black or Grey ABS and incorporating guides on all sides for holding 1.5mm thick pcb's. 1mm Grey Aluminium panel sits recessed into front of console and held by screws running into integral brass bushes. Stand-off bosses in base for supporting small sub-assemblies etc. 4 self adhesive rubber feet also included.



BIM1005 (161x96x58mm) £1.97*
BIM1006 (215x130x75mm) £2.70*

LOW PROFILE BIMCONSOLES

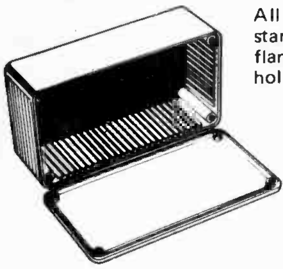


1mm Grey Aluminium panel sits recessed into front of console base, which is moulded in Orange, Blue, Black or Grey ABS and sits on 4 self adhesive rubber feet. Incorporating guides for holding 1.5mm thick pcb, the base also has stand-off bosses for supporting small sub-assemblies etc. and ventilation slots. Front panel is held by 4 screws which run into integral brass bushes.

BIM6005 (143x105x55.5[31.5] mm) £2.14*
BIM6006 (143x170x55.5[31.5] mm) £2.73*
BIM6007 (214x170x82[31.5] mm) £3.75*

ABS & DIECAST BIMBOXES

5 sizes, in either ABS or Diecast Aluminium
ABS moulded in Orange, Blue, Grey or Black
Diecast Aluminium available in Grey Hammertone or Natural



All boxes incorporate guides on all sides for holding 1.5mm thick pcb's and stand-off bosses in base for supporting small sub-assemblies etc. Close fitting flanged lids held by screws running into integral brass bushes (ABS) or tapped holes (Diecast).

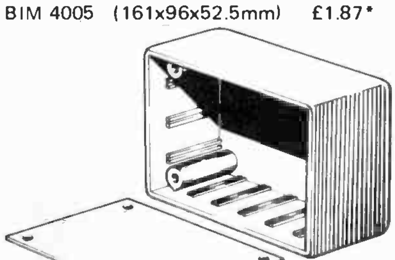
	ABS		Diecast	Hammertone	Natural
(100x50x25mm)	BIM2002/12	£0.87*	BIM5002/12	£1.20*	£0.97*
(112x62x31mm)	BIM2003/13	£0.97*	BIM5003/13	£1.50*	£1.20*
(120x65x40mm)	BIM2004/14	£1.05*	BIM5004/14	£1.86*	£1.49*
(150x80x50mm)	BIM2005/15	£1.18*	BIM5005/15	£2.38*	£1.91*
(190x110x60mm)	BIM2006/16	£1.84*	BIM5006/16	£3.41*	£2.85*

Also available in Grey Polystyrene (112x61x31mm) with no slots and self tapping screws BIM2007/17 £0.82*

MULTI-PURPOSE BIMBOXES

Moulded in Orange, Blue, Black or Grey ABS with 1mm thick Grey aluminium recessed front cover which is retained by 4 screws running into integral brass bushes. 1.5mm pcb guides are incorporated on all sides and as with all ABS boxes they are 85°C rated. 4 self adhesive rubber feet also included.

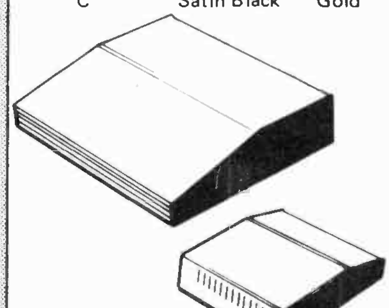
BIM 4003	(85x56x28.5mm)	£1.13*
BIM 4004	(111x71x41.5mm)	£1.42*
BIM 4005	(161x96x52.5mm)	£1.87*



ALL METAL BIMCONSOLES

All aluminium, 2 piece desk consoles with either 15° or 30° sloping fronts, sit on 4 self-adhesive non slip rubber feet. Ventilation slots in base and rear panels permit efficient cooling.

Colour Code	Top Panel	Base
A	Off White	Blue
B	Sand	Green
C	Satin Black	Gold



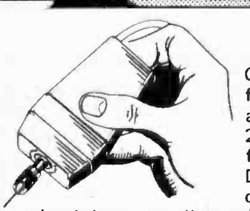
15° Sloping Panel

BIM7151	(102x140x51[28] mm)	£ 7.66*
BIM7152	(165x140x51[28] mm)	£ 8.51*
BIM7153	(165x216x51[28] mm)	£ 9.35*
BIM7154	(165x211x76[33] mm)	£10.21*
BIM7155	(254x211x76[33] mm)	£11.05*
BIM7156	(254x287x76[33] mm)	£11.92*
BIM7157	(356x211x76[33] mm)	£12.76*
BIM7158	(356x287x76[33] mm)	£13.60*

30° Sloping Panel

BIM7301	(102x140x76[28] mm)	£ 7.66*
BIM7302	(165x140x76[28] mm)	£ 8.51*
BIM7303	(165x183x102[28] mm)	£ 9.35*
BIM7304	(254x140x76[28] mm)	£10.21*
BIM7305	(254x183x102[28] mm)	£11.05*
BIM7306	(254x259x102[28] mm)	£11.92*
BIM7307	(356x183x102[28] mm)	£12.76*
BIM7308	(356x259x102[28] mm)	£13.60*

MAINS BIMDRILL



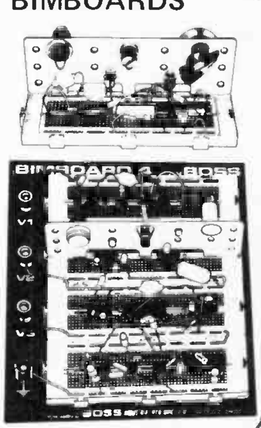
Operates directly from 220-240Vac and supplied with 2 metres long cable fitted with 2 pin DIN plug. Will drill brass, steel and aluminium as well as pcb's etc. Has integral biased-off switch and accepts tools with 1,2 and 3.2mm dia shanks £9.72*
Accessory Kit including 1mm, 2mm, .125" twist drills, 5 burrs and 2.4mm collet £2.20*

DIL COMPATIBLE BIMBOARDS

Bimboards accept all sizes of DIL packages as well as resistors, diodes, capacitors and LED's etc. They have integral Bus Strips running up each side for carrying Vcc and ground as well as Component Support Brackets for holding lamps, fuses and switches etc. Available as either single or multiple units, the latter mounted on 1.5mm thick, matt black aluminium back plates which stand on non slip rubber feet and have 4 screw terminals for incoming power.

Bimboard 1 contains 500 individual sockets whereas the multiple units containing 2, 3 or 4 Bimboards incorporate 1,100, 1,650 or 2,200 individual sockets, all arranged on a 2.5mm(0.1") matrix.

Bimboard 1 £ 9.72* Bimboard 2 £22.68*
Bimboard 3 £32.40* Bimboard 4 £42.12*



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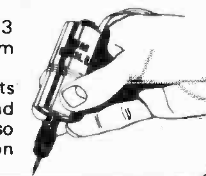
Mains to 12 Volts adaptor, lathe, stand and accessory kits also available, details on request.



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the impact of electronics

A major international conference organised by Electronics Weekly.

Hilton Hotel, Park Lane, London. Thursday, December 8th, 1977

An opportunity to discover how developments in electronics will bring far-reaching changes to industry, commerce, leisure and society.

This major international conference is an attempt to create an awareness of what is happening in terms of the social and economic effects of the electronics revolution, which can only be minimised and turned to good account if all those concerned understand what is involved.

In a series of papers, leading figures in electronics from Britain and other countries will explain that while new technology may be disruptive, this can be lessened if long-term plans based on sound knowledge are made.

This conference can be your first step towards acquiring this knowledge—the key to choosing the right way ahead.

Subjects and speakers will include:

The Impact of Electronics—Past, Present and Future, by Jack Akerman (Managing Director of Mullard Ltd., Chairman of the Electronic Component Industry Federation, and member of Electronics EDC).

The Impact of New Technology in Telecommunications, by Kenneth Corfield (Deputy Chairman and Managing Director of Standard Telephone and Cables Ltd., and Senior Officer of ITT in the United Kingdom).

The Microprocessor in the Home, by Dr Steve Forte (Managing Director of General Instrument Microelectronics Ltd since 1971 and has many years experience of the Semiconductor industry).

The Microcomputer in Industry and Commerce, by Alex d'Agapeyeff, OBE, (Chairman of Computer Analysts and Programmers Ltd).

The Impact of Microelectronics on Employment, by Dr Alfred Prommer (Vice President of Siemens AG, West Germany, and head of sales and marketing in the company's components group).

Lord Orr-Ewing, OBE, C.Eng. (Chairman of Ultra Electronics Ltd); Sir Ieuan Maddock, CB, OBE, FRS (Deputy Chairman of the National Electronics Council) and Lord Thorneycroft (Chairman of Pye of Cambridge Ltd) have all agreed to chair the sessions.

The concluding **Open Forum** will feature a panel of experts which will include William C Hittinger (Executive Vice President, research and engineering, RCA Corporation USA); Gerrit Jeelof (Chairman and Managing Director of Philips Industries UK); Derek Roberts (Managing Director of Plessey Microsystems Division) and Frank Chorley (Managing Director, Plessey Electronic Systems Ltd).

The conference commences at 9.00am and closes at 5.30pm.

The fee is £60 plus 8% VAT (£4.80) per delegate.

To be sure of reserving your seat for this occasion please complete the form on right:


Kenneth Corfield


Jack Akerman


Dr. Steve Forte


Gerrit Jeelof


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Alex d'Agapeyeff


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Please complete in CAPITALS and send to: Conference Administrator, IPC Business and Industrial Training Ltd., Surrey House, Throwley Way, Sutton, Surrey SM1 4QQ. Telephone: 01-643 8040.

Please reserve..........places for *The Impact of Electronics* conference to be held at the London Hilton on Thursday December 8th 1977.

The fee is £60 plus 8% VAT (£4.80) per delegate.

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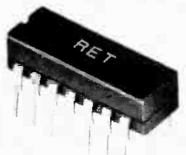

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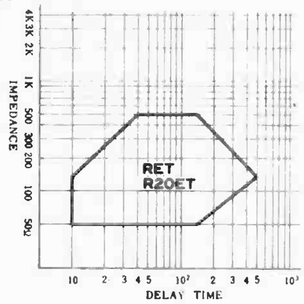

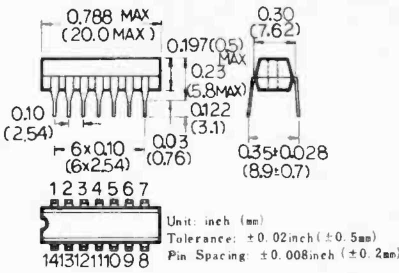

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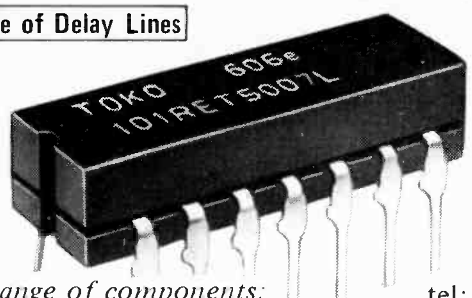

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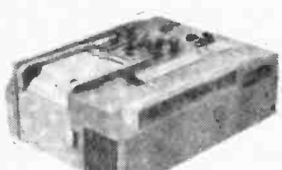

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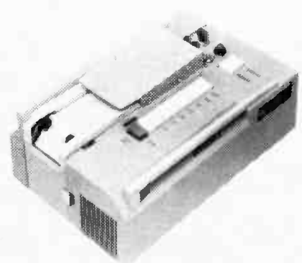

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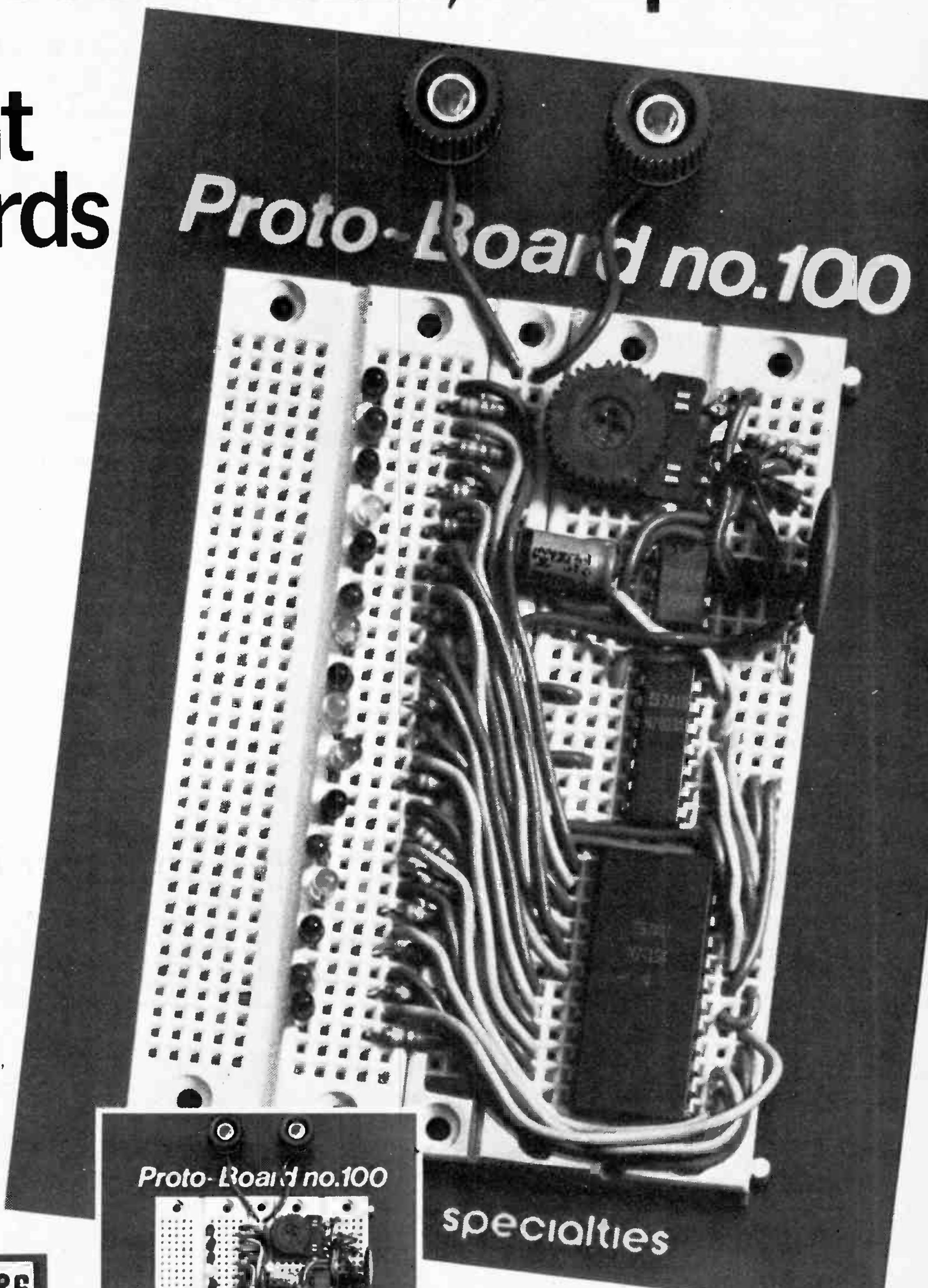

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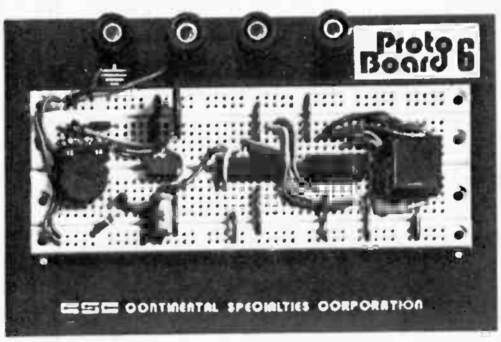

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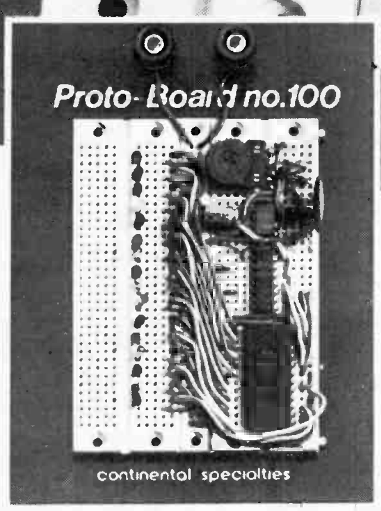

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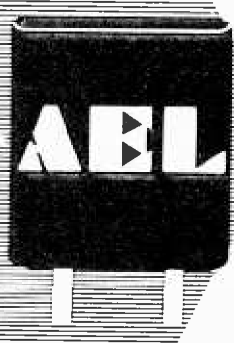

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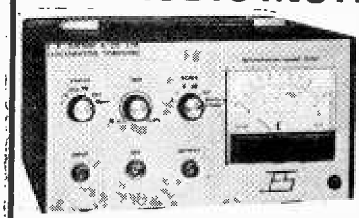

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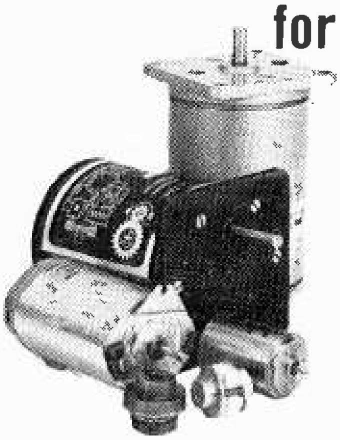

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Technical Editor:
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Frequencies, technology and society

To judge from all the preliminary discussions about WARC 1979 one would think that radio systems began and ended with frequency space. Of course, when there's a shortage of it the various users making their claims and counter-claims become preoccupied with the subject and develop an almost pathological concern for spectral *lebensraum*. But if we are going to need more communication, broadcasting and other radio systems in the future we can't afford to ignore the other, equally important, dimensions of a communication channel: space, time and signal-to-noise ratio. And to make use of these, our traditional thinking and methods of transmission and reception will have to be supplemented by fresh ideas and new technology.

By "space" is meant simply the physical volume occupied by a radio transmission. If you physically confine transmissions you can have many using the same frequencies without interference. Furthermore, signals can be kept within coaxial cables, waveguides, leaky feeders and optical fibres, and it makes sense to use such methods when transmitters and receivers are fixed. There are people, for example, who maintain that broadcasting is a misuse of the radio spectrum because the transmitters and many receivers can be connected by cables. The dimension of time can be used in a variety of ways. For example, where pauses occur in a message, as between spoken phrases, the gaps can be occupied by portions of other messages automatically switched into them. Redundancy in certain signals can be used to reduce the maximum information rate and hence the bandwidth required. Television broadcasting is a notorious consumer of time and bandwidth. Since many tv programmes are little more than homogenised pap dished out of cans, why not send them out at night, to be recorded on video tape machines fitted in receivers, so that the spectrum space could be used by other services during the day? Signal-to-noise ratio can be "traded" by modulation and encoding methods so that channels are utilized more efficiently. Spread spectrum techniques are one possibility and more attention could be given to determining human tolerance to noise-type background interference from pseudo-randomized signals as against background interference from intelligible signals.

But all this assumes a continuation of present trends in society. A fundamental question affecting all communication technology is what will happen in the future. Can the present process of industrialization and economic growth continue indefinitely in a finite environment, or shall we be forced into a state of "global equilibrium" at a lower level of activity as predicted by the famous MIT study "The Limits to Growth"? The well-known economist the late Dr E. F. Schumacher thought that our present system could collapse as a result of three impending crises: a revulsion of human nature against "1984" technological, organizational and political patterns; a breakdown of the living environment which supports human life; and exhaustion of the world's non-renewable resources, in particular, the fossil fuels. Energy, on which depends all industrialization and economic growth, could indeed be a decisive factor. Ichiro Miura, the director of communications policy in Japan's ministry of posts and telecommunications, thinks that because of this the widely predicted "information-oriented society" will not in fact succeed industrial society and that we may well revert to the "resources society" which preceded industrialization (*Telecommunication Journal*, September 1977).

If the natural limits of the environment do restrict economic growth and as a result the structure of society is modified, then obviously the requirements for electrical communication – both in amount and pattern – will be greatly changed.

Teletext decoder modifications

New circuits to take advantage of the latest facilities

by Richard T. Russell

Since the original articles on the *Wireless World* Teletext decoder appeared (November 1975 to June 1976 issues), a new teletext specification has been published[1] which describes a number of extra facilities and allocates some of the hitherto unused control characters for use with four new display modes. These are: graphics hold, double height, separated graphics and background colour, and were described in the February 1977 issue of *Wireless World*, p. 61. These new facilities are intended to enhance the appearance of teletext pages and remove some of the limitations imposed by the original specification. The photographs show typical examples of their use.

Another facility not provided by the original design, although present in an earlier specification and used by both Ceefax and Oracle, is the "concealed-display" mode. This allows, by the action of a control character, selected characters to be displayed as spaces until "revealed" by the viewer, and is useful in a question and answer situation. All these new facilities are provided by the additional circuitry to be described.

At the time of writing, Oracle (the IBA's teletext service) makes extensive use of these facilities on test pages with some use on normal information pages, whilst Ceefax (BBC) is just beginning to use some of the new facilities on an experimental basis.

New board

The new circuitry comprises 25 t.t.l. integrated circuits, which decode the apropriate control characters and implement the new display modes. These i.cs have been numbered 101 to 125 to avoid confusion with i.cs 1 to 90 used in the original decoder design. There is sufficient room in a decoder using the cabinet and printed boards described in the original articles to mount an extra board containing the new circuitry, and the number of connexions between this board and the rest of the decoder has been kept to a minimum to simplify installation. In a decoder of this sort, the new board mounts above digital board 1 in the area between the analogue board and the left-hand end of the cabinet. The new board, which will be referred to as digital board 3, is principally intended to work with a decoder using the 74S262 (X887) character generator r.o.m., which provides the full upper and lower case teletext character set. A small modification will allow the board to be used with a decoder using the 2513 r.o.m., although since it occupies the area used by the add-on lower-case board, an alternative location for this will have to be found if the new board is to be fitted into a decoder of this sort.

Most of the connexions to the new board are to the existing edge contacts linking digital boards one and two, and therefore installation is particularly simple in a decoder using these boards. The only external modification required is the provision of a push-button "reveal" switch on the front panel.

Fig. 1. Control character codes.

Bits	b_7 b_6 b_5	0 0 0	0 0 1
$b_4 b_3 b_2 b_1$		0	1
0 0 0 0	0		
0 0 0 1	1	Alpha^n red	Graphics red
0 0 1 0	2	Alpha^n green	Graphics green
0 0 1 1	3	Alpha^n yellow	Graphics yellow
0 1 0 0	4	Alpha^n blue	Graphics blue
0 1 0 1	5	Alpha^n magenta	Graphics magenta
0 1 1 0	6	Alpha^n cyan	Graphics cyan
0 1 1 1	7	Alpha^n white	Graphics white
1 0 0 0	8	Flash	CONCEAL DISPLAY
1 0 0 1	9	Steady	CONTIGUOUS GRAPHICS
1 0 1 0	10	End box	SEPARATED GRAPHICS
1 0 1 1	11	Start box	
1 1 0 0	12	NORMAL HEIGHT	BLACK BACKGROUND
1 1 0 1	13	DOUBLE HEIGHT	NEW BACKGROUND
1 1 1 0	14		HOLD GRAPHICS
1 1 1 1	15		RELEASE GRAPHICS

Control codes

The latest list of control characters, showing their binary equivalents, is given in Fig. 1. The control codes which are detected and implemented by digital board 3 are shown in capitals. There are nine of these in all. Usually these control codes are allocated in pairs, one of each pair to establish the specified mode and the other to end it. The exception is the conceal mode. There is no reveal control character; instead the normal revealed condition is established on the occurrence of any character in the shaded portion of the table (i.e. characters 0/1 to 0/7 and 1/1 to 1/7 inclusive).

A significant point, which has considerable importance in the detail of the circuitry adopted, is that before the advent of graphics hold, all control characters were displayed as spaces. This meant that the transition between two display modes was invisible, and could take place anywhere within the control character rectangle. Now that the control character rectangle may be filled with a "held" graphics character, it is important that a change in display mode (e.g. a colour change) takes place at the boundary of the character rectangle, not part way across the character. Certain of the display modes are said to be "set at" the occurrence of the control character, meaning that the mode changes at the left-hand boundary of the control character rectangle. Others are "set after" the control character, meaning that the mode does not change until the right-hand edge of the character rectangle.

Circuit description

As mentioned, it is required to change certain of the modes at the left-hand edge of the control character rectangle. To achieve this, it is necessary that the data at the output of the page store have been stable for a period sufficient to decode the control character. In the original design the left-hand edge of the character rectangles corresponded to the point at which the data latches on the outputs of the page store were clocked. This does not provide the necessary period, so with the new board the character rectangle is redefined as being one clock-pulse later than before. Conveniently this means that the rectangle edges correspond to the negative edge of the signal on IC_1, pin 8 (January, 1976 issue), and all mode changes are made synchronous with this edge. For simplicity, the alphanumeric characters are not moved by a corresponding amount, and this means that these characters are displaced slightly to the left with respect to the character rectangles. This is of no consequence, however, as there is still a gap between the character and each edge of the rectangle.

As can be seen from Fig. 1, all the control codes of interest have bits b6 and b7 at logic 0, and bit b4 at logic 1. These bits are gated together by (106,13) and (101,3), and gated additionally with a mixed blanking signal at IC_{101}, pin 6, giving a logic 1 at IC_{106}, pin 10 for valid control characters (Fig. 2). This leaves bits b1, b2, b3 and b5 to be decoded into a separate signal for each control code. A 4-line-to-16-line decoder could have been used for this purpose but, since only nine of the control codes are of interest a saving can be made by inverting bits b3 and b5 and using a 4-line-to-10-line decoder IC_{113}, (7442). Bits b3 and b5 are inverted so that the inputs to IC_{113} corresponding to the wanted control codes are in the range 0000 to 1001 (0 to 9). Binary inputs in the range 1010 to 1111 result in none of the outputs being enabled.

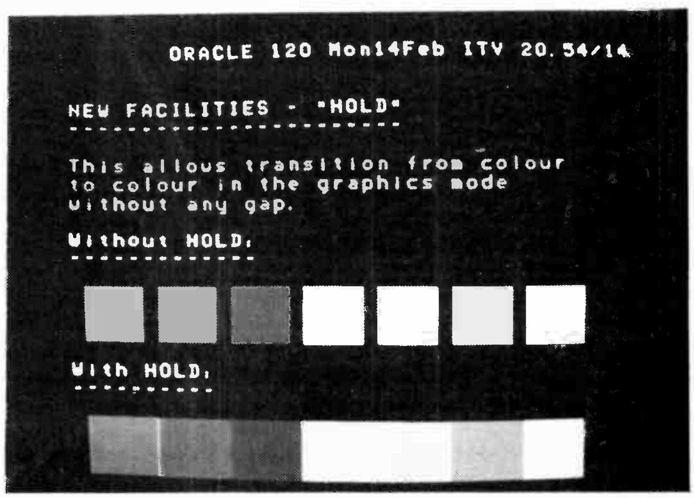
As explained, the display modes must change at the edge of the display rectangle. This is achieved by feeding the inputs to IC_{113} from a D-type latch IC_{112}, clocked by the signal from IC_1, pin 8 inverted in (118,8). Bits b1 and b2 are fed directly to the inputs of this latch from the page store output latch IC_{28} on digital board 1 (February 1976 issue). Bits b3 and b5 are fed to IC_{112} via NAND gates (101,8) and (101,11) which perform the dual function of inverting them, and gating them with the valid character signal at IC_{106}, pin 10. If this signal is at logic 0 (i.e. "invalid") pins 12 and 13 of IC_{113} are clocked to a logic 1, thereby disabling all its outputs.

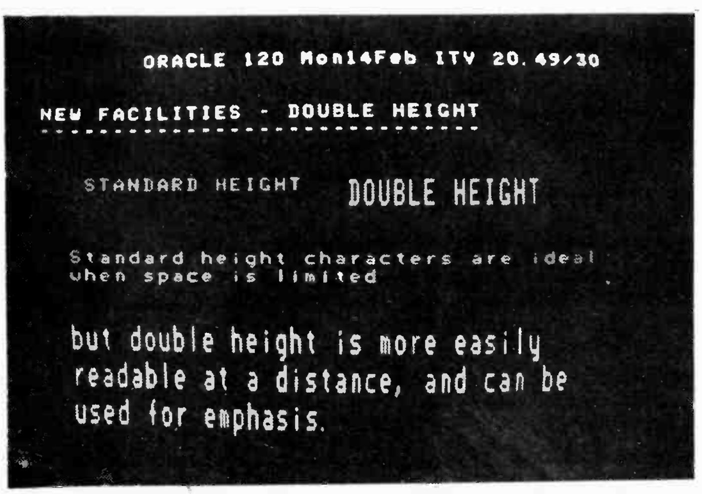
There remains the reveal signal to be generated, which as mentioned corresponds to codes 0/1 to 0/7 and 1/1 to 1/7 inclusive. Gates (106,1), (118,2), (111,3), (116,11) and (116,8) provide this signal, which is synchronised with the character rectangles by D-type latch (117,15).

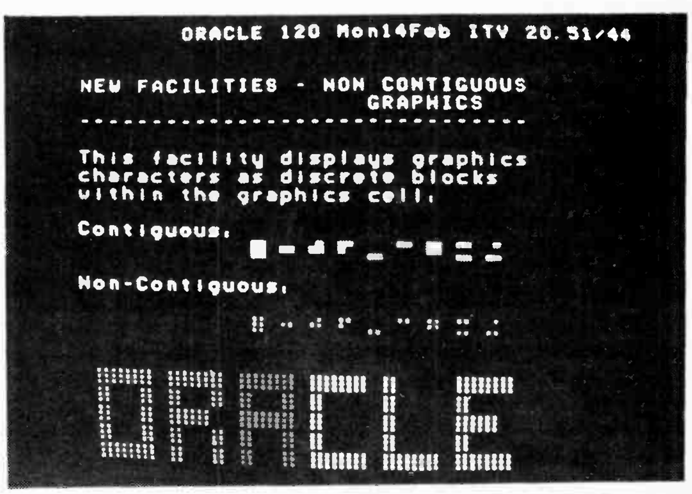
Graphics generator. A completely new graphics generator is included on board 3, the original on digital board 2 being made redundant. The reason for this is twofold. Firstly, the necessity to provide the held graphics function means that the graphics character has to be stored in a latch so it can replace a control character when required. Secondly, the separated (or "non-contiguous") graphics facility requires a more complex graphics generator. To have incorporated the original graphics generator circuit would have entailed an excessive number of interconnexions.

The graphics generator operates as follows. The six-bit latch IC_{102} contains the held graphics character. This is defined as the last character having bit b6 at logic 1, so the clock (pin 9) is gated with b6 in (116,3). This latch also synchronizes the graphics character with the character rectangle. Data selector IC_{107} selects either bits b1, b3, b5 or bits b2, b4, b7 according to the state of pin 1, which is a logic 0 for the left-hand half of the character and a logic 1 for the right-hand half. On the outputs of IC_{107}, therefore, are the three bits corresponding to the three vertical cells in that part of the graphics character (Fig. 3). IC_{104} is a 16-line to 4-line data selector (multiplexer), the address inputs of which (pins 11 to 15) are driven from a vertical (line) address which runs from 15 at the top of the

Examples of the new facilities, obtained using the modified decoder.







character rectangle, through 0, to 8 at the bottom (10 lines in all, or 20 counting both fields). This is the same address which feeds the character generator r.o.m. on digital board 2. Assuming $IC_{\overline{121}}$, pin 9 is at logic 1, the gates in IC_{109} act simply as non-inverting buffers. The inputs to IC_{104} are connected to the appropriate outputs of IC_{107} to give the correct allocation of lines to the three graphics cells – 3 to the top cell, 4 to the middle cell and 3 to the bottom cell. This symmetrical arrangement gives a slightly better appearance than the 4-3-3 scheme adopted in the original decoder.

The decoded control signals for contiguous and separated graphics at the outputs of IC_{113} are fed to a latch comprising (120,8) and (119,8). This latch is additionally set to the contiguous condition by the inverted mixed blanking signal at IC_{124}, pin 8 as all rows start in the contiguous state. The specification states that the contiguous/separated graphics mode shall be part of the structure of the held graphics character, so the contiguous/separated signal is fed to D-type flip-flop IC_{121}, clocked by the signal at IC_{102}, pin 9.

When separated graphics are in use there are gaps between the graphics cells in both the vertical and horizontal directions. In the vertical direction this is achieved by IC_{109}, the outputs of which are held at 0 in the separated mode thereby inhibiting the graphics on lines 1, 4, 7 and 10 of the character rectangle (counting from top to bottom). When separated graphics characters are vertically adjacent this gives a larger gap between the rows (2 lines) than between the cells within a character (1 line) but this is unavoidable.

In the separated-graphics mode IC_{106}, pin 6 goes to a logic 0, thereby allowing the signal on (124,6) to be fed to the strobe input of IC_{104}, pin 9. This signal provides the gaps between the graphics cells in the horizontal direction (Fig. 3).

Display colour. To simplify the background colour circuitry, and to arrange that the display colour changes at the boundary of the character rectangle, a new display-colour selection circuit is included on the new board. For convenience the aphanumerics /

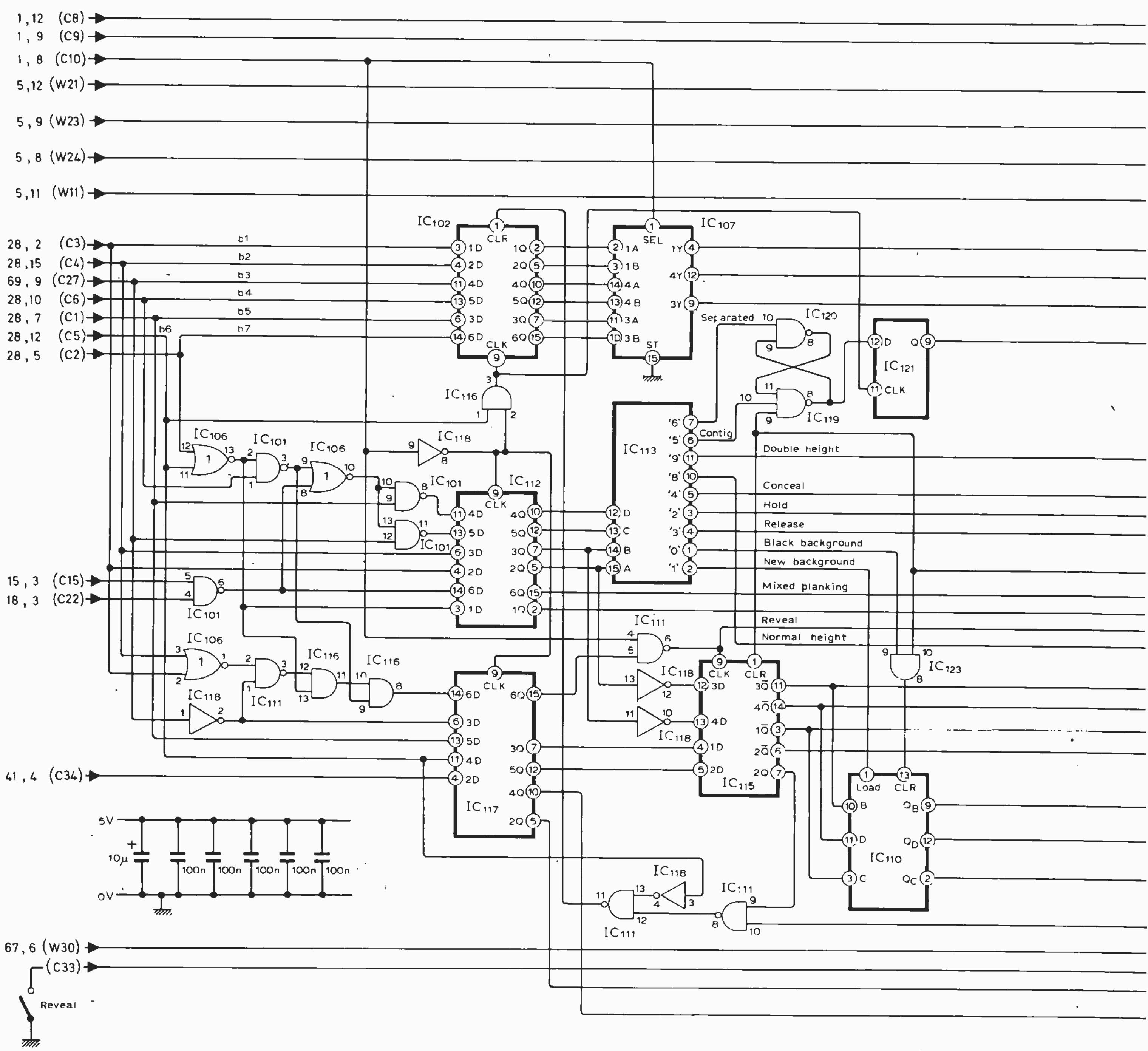


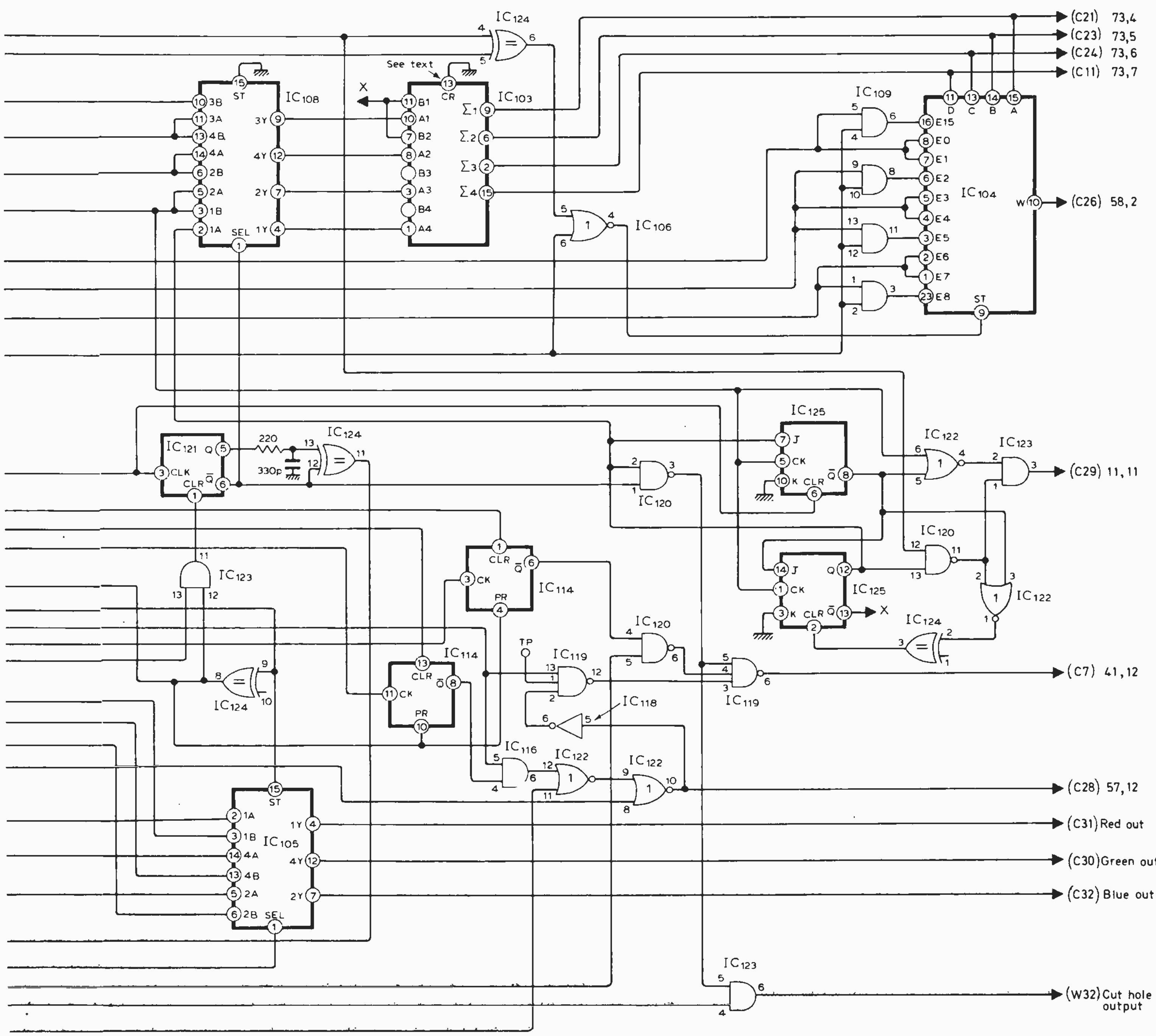
Fig. 2. Circuit diagram of the new digital board 3.

graphics selection is also included. The circuits on digital board 2 which originally performed these functions are no longer used.

If any control character in the shaded portion of Fig. 1 occurs, then the red, green and blue components of the display colour obtaining for the next and subsequent characters (display colour is a "set after" display mode) correspond directly to bits b1, b2 and b3 respectively. For example, if bit b1 is 1 then the colour includes red. It will be remembered that this group of control characters is the same as that defining the reveal condition, and a corresponding signal is available at IC_{117}, pin 15. By gating this signal with the character-rate square wave in (111,6) a suitable signal is obtained for clocking the display colour latch IC_{115}. To the D-inputs of this latch are applied bits b1, b2 and b3, all delayed by one character and inverted. By inverting the inputs and using the $\overline{Q}$ outputs of the latch, the clear input (pin 1) may be used to set the display colour to white at the beginning of each row. the fourth latch in IC_{115} is used to store the alphanumerics / graphics signal (which is a function of the state of b5) in the same way.

Background colours. It may be helpful at this point to explain how the set at and set after requirements are met. The occurrence of a control code of interest causes one output of IC_{113} to go low for exactly one character period (or more if two or more identical control characters occur in succession). Both edges of this signal are synchronised to the edges of the character rectangle. If a set at function is required, the signal is fed to a logic-0 sensitive preset, clear or enable input, causing a change to take place immediately it goes low. Examples of this are hold and conceal. For the set after function, the signal at the output of IC_{113} is fed to a positive-edge sensitive input causing the mode to change on the trailing edge of the signal. Examples of this are double height and release which are fed to the clock inputs of D-type flip-flops.

On the occurrence of a new background control character the current display colour is adopted as the new background colour. Both new background and black background are "set at" modes, so what is required is a 3-bit latch to store the background colour with level-operated preset and clear inputs. One device which meets this



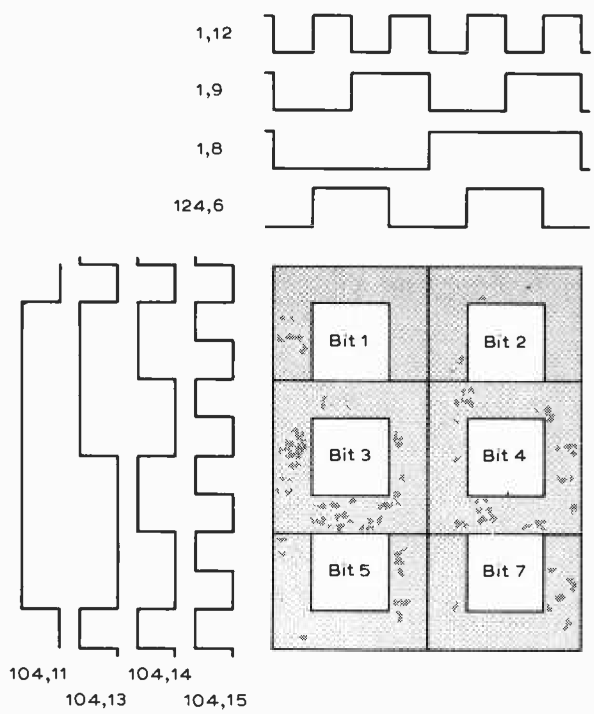


Fig. 3. Waveforms in the graphics generator. In the separated-graphics mode, only the small squares are illuminated.

requirement is the four-bit counter 74177, and this is used as IC_{110}. It is used simply in its parallel load mode and the clock inputs are disregarded. The black background signal is combined with inverted mixed blanking in (123,8) to ensure that all rows start with a black background.

The data selector IC_{105} switches between the background colour on its A inputs (in r,g,b form) and the display colour on its B inputs according to the white output signal from digital board 2 (IC_{67}, pin 6). Mixed blanking is fed to the strobe input, pin 15.

Concealed display. Conceal is a set at mode and reveal a set after mode. Consequently, the conceal signal is fed to the clear input of a D-type flip-flop (114,1) and the reveal signal to its clock input, pin 3. Inverted mixed blanking is fed to the preset input (pin 4) to ensure all rows start revealed. The signal at pin 6, which is logic 1 for conceal, is gated with the signal from the manual reveal switch in (120,6) and fed via (119,6) as a blanking signal to digital board 2.

Held graphics. Graphics hold is a set at and graphics release a set after mode. The other half of IC_{114} is used as the hold/release latch with the hold signal from (113,3) fed to pin 13 and release from (113,4) to pin 11. The connexion to pin 10 presets the latch to the release condition at the start of each row.

the signal at (119,13) is a logic 1 during a control character and logic 0 otherwise. This signal, fed via (119,12) and (119,6) normally blanks control characters. However, if graphics have been selected (and during a control character this can only occur in the held graphics mode) the blanking is disabled by the signal at (118,6).

The select graphics signal at (122,10) can only go to a logic 1 under the following circumstances. Gate input (122,8) must be at logic 0, that is, the display must be in the graphics mode, and neither a 'blast-through' alphabetic character (122,11) nor a control character in the graphics release mode (122,12) must be selected. Blast-through characters are identified by b6 being 0 and b7 being 1. During a control character in the graphics hold mode (116,4) and (116,5) are both at logic 1. Output (116,6) is therefore also at logic 1 and (122,13) is forced to logic 0. If in graphics rather than alphanumerics mode, (122,8) is at logic 0 and (122,10) goes to a logic 1 to select the held graphics character for display. At the same time the normal control character blanking is inhibited by (118,6) as mentioned.

Earthing the test-point (119,1) disables the control character blanking so that all control characters are displayed (except when hidden by being in the same colour as the background). This can be useful for fault diagnosis, especially with the 74S262 character generator which includes special characters for all the control codes (Fig. 4). With the 2513 character generator the control characters will appear as various alphanumeric symbols.

Double height. This is the most complex of the new display modes as it involves two distinct processes. The first is the switching between single and double height characters across a particular row, and the second is arranging that any row containing double-height characters is read from the page store twice in succession, the row which would normally occupy the position of the second of the pair of rows being ignored, i.e. not read from the store. Additionally, on the second row of the pair any characters which are not double-height characters must be displayed as unboxed spaces.

Double height is a set after mode and the signal at (113,11) is fed to the D-type clock input (121,3). Normal height is a set at mode and, gated with inverted mixed blanking in (123,11), the signal at (113,10) is fed to the clear input (121,1). The data selector IC_{108} switches the vertical (line) address of a character from the normal 0,1,2,3.. to one changing at half the rate (i.e. 0,0,1,1..) thereby expanding the top-half of the character to fill the whole row height. On the first of a pair of double-height rows, and on all normal rows, the only purpose of IC_{103} is to subtract 1 (add 15)

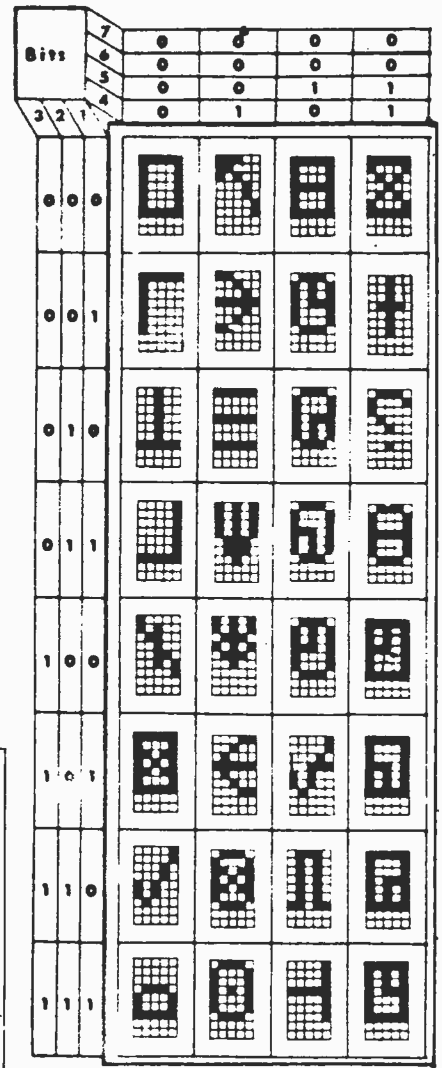


Fig. 4. Symbols generated by the Texas 74S262 character generator.

from the vertical address in order to move the alphanumeric characters down one line. If this is not done, characters (from the 74S262 r.o.m.) can run into graphics in the row above. This does not apply to the 2513 r.o.m.s and a small modification of this part of the circuit to inhibit the subtract 1 function will be described later.

The section of the double-height circuitry described so far results in the first row of the pair being displayed correctly — normal height characters being displayed conventionally and double-height characters having their upper-half stretched to fill the rectangle.

The function of IC_{125} and the associated gates is as follows. If there are no double-height characters in a row, (125,8) and (125,12) remain at logic 0. Although both flip-flops are clocked after every row, their J and K inputs are at logic 0 in each case, and in this condition the outputs remain unchanged (Table 1.). Pin 1 of IC_{123} is therefore at logic 1 and the most significant bit of the line address is fed, inverted by (122,4), to IC_{11}, pin 11 on digital board 1. The positive-going edge of this signal clocks the row address once per row in the normal way.

If a double-height character is present, IC_{125}, pin 6 will pulse to a logic 0, thereby changing (125,8) to a logic 1. This has no immediate effect but at the end of the last line in the row, when the signal at (122,6) goes low, this is prevented from reaching IC_{11}, pin 11 and the row address is not incremented. Instead, as (125,14) is now at logic 1, pin 12 of IC_{125} changes from logic 0 to logic 1. This signal feeds (108,2) and, when a double-height character is selected, it becomes the most significant bit of the vertical character address. That is, instead of the address counting 0,1,2,3.. it counts 8,9,10,11... What is required, however, is for the address to count 5,6,7,8 to display the lower half of the character correctly. This is achieved by (103,7) and (103,11) going to logic 0, thereby subtracting a further three from the vertical address. The double-height characters are now displayed correctly.

The signal at (125,12) is also gated with the output of the normal/double-height latch to give a signal (120,3) which is zero for all normal-height characters in the second row of a double-height pair. This blanks the display via (119,5) and also inhibits the cut-hole signal at (123,6).

CLK	J	K	Q	$\bar{Q}$
⎍	0	0	Q_0	$\bar{Q}_0$
⎍	0	1	0	1
⎍	1	0	1	0
⎍	1	1	$\bar{Q}_0$	Q_0

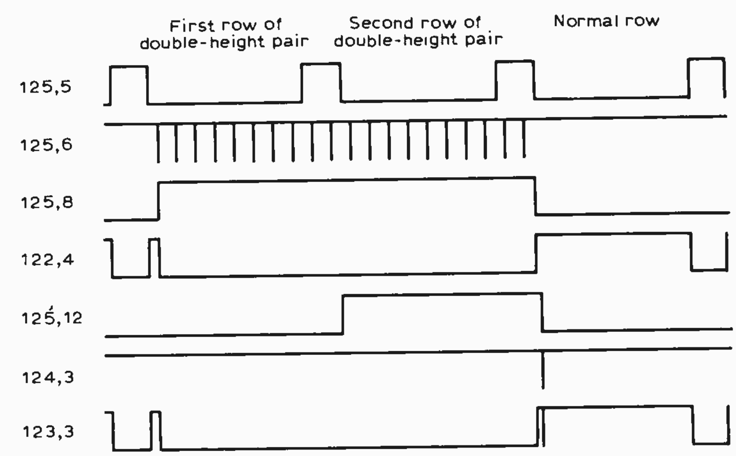


Fig. 5. Waveforms for the double-height mode.

At the end of the last line in the second double-height row IC_{125} is again clocked. This time (125,7) is at logic 1 as is (125,14). (125,8) changes back to a logic 0 but (125,12) remains unchanged. At this point (120,12) is at logic 0 so (123,3) changes to a logic 1, thereby clocking the row address. Shortly afterwards (120,12) goes to logic 1. This causes (120,11) to go to 0 and (123,3) to return to 0. At the same time (122,1) goes to 1, (124,3) goes to 0 and (125,12) is cleared back to a zero via. (120,11) this causes (123,3) to go back to 1. In this way a narrow negative-going pulse appears at (123,3) of a duration equal to the total delay around the loop (120,11), 122,1), (124,3) plus the clear-to-Q delay of IC_{125}. This narrow pulse is sufficient to clock the row address again, for the second time in quick succession. In this way the hidden row is skipped as required. Figure 5 shows the waveforms associated with the double-height circuitry.

The teletext specification states that after a change in either the alphanumerics/graphics or the normal/double-height modes the held graphics character should be taken to be a space. This is arranged as follows. When in the alphanumerics mode, IC_{115}, pin 7 is at logic 0. If (118,3) is at logic 0, i.e. the next character is not a valid held graphics character, IC_{111}, pin 11 goes low and the held graphics character is cleared to a space character. On a change from double to normal-height, or from normal to double-height, pins 12 and 13 of IC_{124} will be momentarily at the same logic level due to the delay through the RC network. A short negative-going pulse will occur at (124,11) which will similarly clear the held graphics character via (111,8) and (111,11).

Reference
1. Broadcast Teletext Specification, September 1976. Published jointly by the B.B.C., I.B.A. and B.R.E.M.A.

Notes on installation and testing will appear next month

Literature Received

Two programme reference guides, published by Rapid Recall, list the assembly language in both mnemonic and hex. machine language form for the 8085 and 8048 microcomputers. There is also a table of the ASCII character set and controls with hex. values. Rapid Recall Ltd, 9 Betterton Street, Drury Lane, London WC2H 9BS WW401

Static, uninterruptible power supplies for use with electronic equipment whose performance must not be affected by transients, voltage fluctuations or power failures are produced by Chloride Transipack. A brochure describes the systems, which rectify mains a.c., charge batteries and convert back to a.c. by means of inverters. Chloride Transipack Ltd, Stanley Road, Bromley, Kent BR2 9JF WW402

A chart illustrating many varieties of audio and power connector is obtainable from Beacon Audio Components, 282 Hatfield Road, St. Albans, Herts AL1 4UN .. WW403

More than 3000 components for use at r.f., including connectors, adaptors, leads and probes, are completely specified in a catalogue from Greenpar Engineering Ltd, P.O. Box 15, Station Works, Harlow, Essex WW404

Microprocessors and i.cs for use in telecommunications are described in a booklet from National. Other equipment mentioned includes tone receivers, modems, touch-tone dialling, companders, filters and memories. National Semiconductors (UK) Ltd, 19 Goldington Road, Bedford MK40 3LF WW406

News of the Month

Hall effect heads

A new type of tape recorder head has been developed which will give higher output, better signal to noise ratio and improved distortion figures, say the makers, Hitachi. The head uses the Hall effect principle, whereby a current flowing through a material along the y axis and subjected to a magnetic field acting along the z axis will produce a potential difference across the x axis. The effect is most marked in a semiconductor. The induced x axis Hall electric field, if the current along the y axis is constant, is proportional to the magnetic field strength. If the magnetic field strength is varying, as when a recorded tape passes over the head, then the electric field appearing across the semiconductor will vary accordingly.

In the Hitachi stereo cassette head there are four sections, enabling simultaneous stereo recording and playback. In other words, cassette users will be able to monitor off tape as they record, as reel to reel machines have allowed for years. According the provisional specification the record and playback heads, with casing, are only 10mm wide along the direction of tape travel, and the distance between record and playback heads is a mere 2.6mm.

According to a *New Scientist* report the head is the subject of over a hundred patent applications round the world. The improvement in signal-to-noise ratio is 3dB over conventional inductance coilheads. The semiconductor used is a thin film of indium-antimony. Hitachi's provisional specification says that at a flux level of −20dB ref. 250nWb/m the output level at 1kHz would be around 280μV.

Hall effect devices are frequently used in measurement but it is only recently that they have been applied to domestic equipment. Matsushita, for example, have developed linear and switch-type silicon monolithic Hall i.c.s with a Hall element and amplifier on a single chip. This can be used for keyboard switches, microswitches, rotation detectors for tachometers, tape recorders and so on, and for position detectors for movie cameras and sewing machines.

Can you hear the picture?

Another spectacular tape recording development, again from Japan, is the use of video recorders to tape high quality sound. Sony are about to sell in Japan a black box for attachment to their Betamax video cassette recorder which will encode sound signals serially and put them on the half-inch video tape. Pre-recorded cassettes will be available which, when decoded through the playback section of the circuit, will give a dynamic range of 95dB. The dynamic range for self-recorded material will be about 85dB, say Sony. Other measurements are: distortion 0.03% from 2Hz to 20kHz; unmeasurable wow and flutter (because of storage and time-base correction); and frequency response 2Hz to 20kHz ±¼dB. The sampling rate is 44.1kHz and, for the domestic version of the device, three words are put into each line, each word having two 13-bit information portions and six parity bits. The box accepts line-level audio inputs on the record side. The selling price of the equipment, which can be attached to any conventional helical-scan recorder, will be around the same as the player, around £800.

It is reported that the Japanese broadcasters may transmit high quality sound signals after normal transmission hours. These will be received by the television set and decoded to the amplifier and speakers through the black box. Sony expect that the Betamax will now attract a great deal of professional attention since, although it would not normally be good enough for professional video use, the new technique will make it one of the best sound machines available, and one which offers a three-hour playing time. It was first introduced in Japan in May 1975. In November 1964 Sony introduced what they say was the world's first home use video recorder, the CV2000, and in October 1969 they announced the first video cassette system, the U-matic.

● The IBA announces that its director of engineering since 1966, Mr Howard Steele, is leaving to join Sony Broadcast at the beginning of 1978.

Electronics takes two prizes

Two of the four prizes awarded this year by Technical Development Capital Ltd, a funding organisation, for outstanding innovation went to electronics companies. BSH Electronics (Manchester) Ltd shared the runner-up prize with two other firms, one of them SEMA Electronics Ltd of Dundonald, Ayrshire.

BSH's development was of a device for turning a rear windscreen-heater into a car aerial. The inventor, Mr J. J. Kropielnicki, got the idea for his Bi-Fi aerial when he was having trouble with his own, conventional, car aerial. His wife came and asked why he didn't use "the aerial in the back window," and he set about designing a system that would allow him to do just that. The device has the advantage that it cannot be torn off the car, like conventional whip or rod aerials, though we have no information about its efficiency with a variety of rear windscreen-heaters.

SEMA's prize was for developing a light, portable gas detector. According to its inventor, Mr R. L. Dries, the idea for this came to him when he had taken the top off a transistor 12 years ago, and found that the air contaminated it.

The first devices he made which used this phenomenon were too heavy to carry and consumed too much current, he said. He had to wait until the i.c. arrived before he could make the device as portable as he wanted. So far he had tested about 400 gases and it had worked on all of them. Each detector will only respond to one kind of toxic or inflammable gas, so the customer has to say what he wants the device to do. The detector and the electronics are then made to suit.

The detector and electronics can be in the same case, or a remote sensor can be fitted. "You can put half a mile of cable on the detector, it makes no difference." He could not say anything about the detector other than that it was a p-n p-n p-n multiple sandwich. The detector reverted back to normal after the gas went away, so there was no ageing effect. Full scale deflection was a contamination of one part per million. "It will detect the unburnt combustibles in smoke. It will work in an inert atmosphere and doesn't require oxygen to make it work."

At the presentation of the awards Lord Seebohm, chairman of Technical Development Capital Ltd, a subsidiary of Industrial and Commercial Finance Corporation Ltd, said that 155 people had made submissions. "Before introducing the prizewinners I want to stress that the TDC award is not for the innovation itself. The new products are important ingredients ... but they are far from being the whole story ... In choosing the winners of our competition we have taken all aspects of the business into account." The winner, who showed a method of injecting concrete blocks with insulation, received £10,000 and each of the runners-up received £1,667.

Ferrograph swap

The impending closure of the Ferrograph factory in South Shields has forced the National Enterprise Board to arrange a marriage between Ferrograph and North-East Audio Ltd (NEAL). Wilmot Breeden, who have owned Ferrograph since 1968, sold the company for nearly £½ million. The announcement came in mid-October.

Ferrograph had been struggling for some time. Although the old Ferrograph Series 7 tape recorder had been well thought of, the BBC, for example, using it extensively, successors to the machine, the Super 7 and Logic 7, had met with a less than enthusiastic response. Had Wilmot Breeden closed the South Shields factory, moving production down to Bognor Regis, only the Ferrograph test set and the Studio 8 tape recorder would have remained in production. There were also long lines of communication between South Shields, Bognor and Wilmot Breeden's Birmingham headquarters.

Ferrograph's difficulties were compounded by problems elsewhere in the electronic division of Wilmot Breeden: the Wayne Kerr factory at Bognor Regis, for example, went on a three-day week last January "due to a run down in orders." The electronics division made losses of £1½ million last year attributable partly to Rendar and partly to Ferrograph.

The Bognor factory went back to full-time working after 12 weeks, and a spokesman told *Wireless World*, performance had now improved in other parts of the division.

The National Enterprise Board was anxious that Ferrograph's South Shields factory should not close. Its 140 or so employees live in an area which is suffering from even worse unemployment than other parts of the UK. The NEB approached NEAL with an offer to take a 49% stake in NEAL if they would take on the factory. The NEB holding means a new injection of £400,000 into NEAL, whose founder and managing director, Alan Helliwell, was chief engineer or chief executive at Ferrograph for the four years to 1972.

As well as audio tape recorders, Ferrograph make audio test equipment and marine echo sounders. NEAL will take over the whole range except for the ARA1 cathode ray tube response unit, though this may be supplied in future under an o.e.m. arrangement with Wayne Kerr. The Studio 8 recorder is a professional machine designed to compete with the £3,000-plus Studer machines. It was developed in Bognor Regis and is now made under subcontract. All other Ferrograph manufacture, NEAL's own factory in Newcastle, and the sales office in London will be moved to South Shields.

Mr Helliwell told *Wireless World* that after a slow start the sales of the Studio 8 were doing "very well." As for the rest of the company: "We have quite a long job in front of us. We're not going to do it overnight. Our aim is to try to get it back to what it was ten years ago within three to five years, though if it takes five years I shall be disappointed." One of his first tasks would be to make the existing product range more attractive.

He expected that, at the end of next year, NEAL would contribute half of the company's turnover. His approach would be to attack several markets from the base of the same technology rather than, as the Japanese had done, attacking one market with several technologies. The latter course was, in any case, rather expensive. It would be little more expensive to market Ferrograph and NEAL combined than NEAL alone since, for example, they only had to buy space for one exhibition stand to show both products.

Light on records

Teac showed a record player that used a laser beam instead of a stylus at the recent All-Japan Audio Fair in Tokyo. Production won't begin for five years but the price is expected to be around £320 a unit. The development is expected to result in a large reduction in record wear.

BBC's Wood commended

The Society of Motion Picture and Television Engineers (SMPTE) has awarded Mr C. B. B. Wood, head of engineering information at the BBC, a special commendation award for "his many outstanding contributions to motion pictures and television." Wood worked at the BBC research department for 26 years, during which time he had worked on television film recording. After the introduction of colour tv he was awarded the MBE in 1971. In 1968 he received the Geoffrey Parr award of the Royal Television Society for his physics group's work in improving tv reproduction of colour films. In 1972 he won the Pye Travelling Scholarship for work on the standardisation of reproduction chromacities. He is a fellow of the SMPTE, an honorary fellow of the BKSTS, and a fellow of the Royal Television Society.

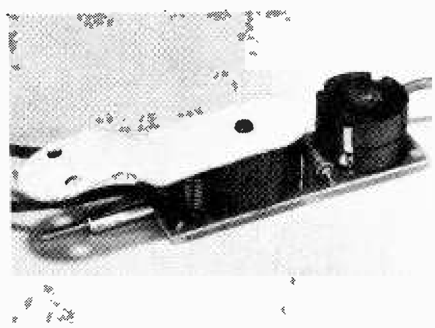
Radio and the danger of explosions

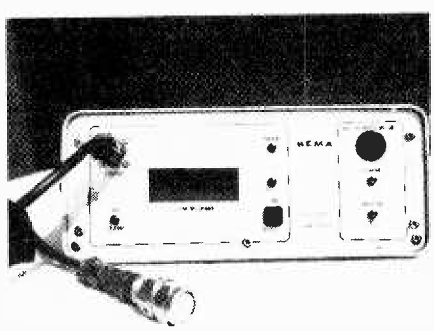
A gas terminal receiving supplies from the Frigg field is so close to a new Royal Navy communications base that the radio waves from the base might cause a serious explosion, according to the British Gas Corporation. Yet the Admiralty, who decided to go ahead with the project, for which they have received a Nato grant, in 1969, before the St Fergus gas terminal three miles away was even contemplated, say they have no intention of closing the base down. The terminal will eventually supply 40% of Britain's gas.

The Navy's plans for the base at Crimond, Grampian, according to the Ministry of Defence, were known to Total and the British Gas Corporation before they went ahead with the terminal. The base is due to open formally next January, but test transmissions have been carried out and are continuing, though at reduced power while an investigation is carried out.

The Navy told *Wireless World* that although the frequencies and powers to be used were not publicly available, this information had been given to the parties concerned with the building of the gas terminal when planning permission for the base was going through.

It has now been well established that radio waves, particularly those received near to a powerful transmitter, can cause the explosion of inflammable gases. Currents induced in metal pipes by the waves can cause a dangerous spark, and a British Standard, BS4992, has been published on the subject.





The two winners of the TDC award – see "Electronics takes two prizes." Top: the inside of the Bi-Fi car aerial device, and (below) the SEMA gas monitor.

That standard places the onus for the protection of flammable gases on the user of the material so hazarded, and that is one reason why the Navy feel the British Gas Corporation should carry out any necessary protective work themselves.

British Gas say that when they first thought of building the terminal the hazards of radio waves were not much known or thought about by the scientific community. It was only after construction began in 1972 that enough work on the subject had been done to make it clear that it could be a hazard, and this was long after the Navy had sought planning permission, in 1970. The British Standard was published in April, 1974. Ironically, when British Gas sought a site for their terminal they investigated Crimond, and discovered the Navy had already got it.

Since "hundreds of millions of pounds," according to BGC, have already been spent on St Fergus, and Shell and Esso will also build terminals there for passing products on from the Brent field, there is no question of closing that down either. A committee of representatives from the Energy Department, Defence Ministry, British Gas and Total will now have talks and safety measures will be agreed, though it is not known how long this will take.

Sinclair pushing tv

Production problems at the beginning of the year caused Sinclair to depart from the target dates they announced for the pocket television set when it was launched at the beginning of January. (See *WW* March, p.37.) Although Clive Sinclair had said that the sets would be in the shops in February, that did not happen until June, four months later.

The delay was partly attributable to faults in the case moulding, each one of the first batch of which had to be altered by hand. There is also some doubt about the quantities now in production. By August they were making about 800 a month, and 1,000 a month after that. During September they had hoped to make 1,500 a month but the failure of delivery of tuner circuits cut that figure by a third. At an October press conference to launch a new calculator range and pocket multimeter, Clive Sinclair announced that production was "now 2,000 a month," and he expected it to reach 4,000 a month within two months.

Even allowing, however, for a little hyperbole in these figures the assertion that "demand exceeds supply" is probably correct. All the sales are being made either here or in the United States, roughly half each, and Sinclair expects the tv to account for half the company's turnover eventually.

The calculator market which built the company up is now very competitive, and Sinclair executives were finding this year's going a bit hard, which is why they welcome the success of the television and are keen to get production up to its (as yet undisclosed) maximum. There are immediate plans to increase capacity to about double the present figure.

There were reports that there had been some difficulty in the supply of the AEG Telefunken tube, which the German company are contracted to supply only to Sinclair for this application. Clive Sinclair denied this, and there do not at the present appear to be any plans to find second sourcing for the tube, though this may change next year if, as Sinclair hopes, the production of the sets goes well ahead and the market opens up. After Christmas test marketing of the set will start in Europe.

Sinclair said at the October press conference that the investment by both the NEB and the company, which now totals over £2 million, had resulted in large increases in turnover; in November, he said, turnover would be "at least double" that for the same month last year. And profits were also "increasing very rapidly."

The cost of producing a colour version of the set may be prohibitive, at least for the present, but, in view of Sinclair's growing interest in the instrument market, it would not be all that surprising to see a pocket oscilloscope being launched at some future date.

Beeb's light drama to be lighter

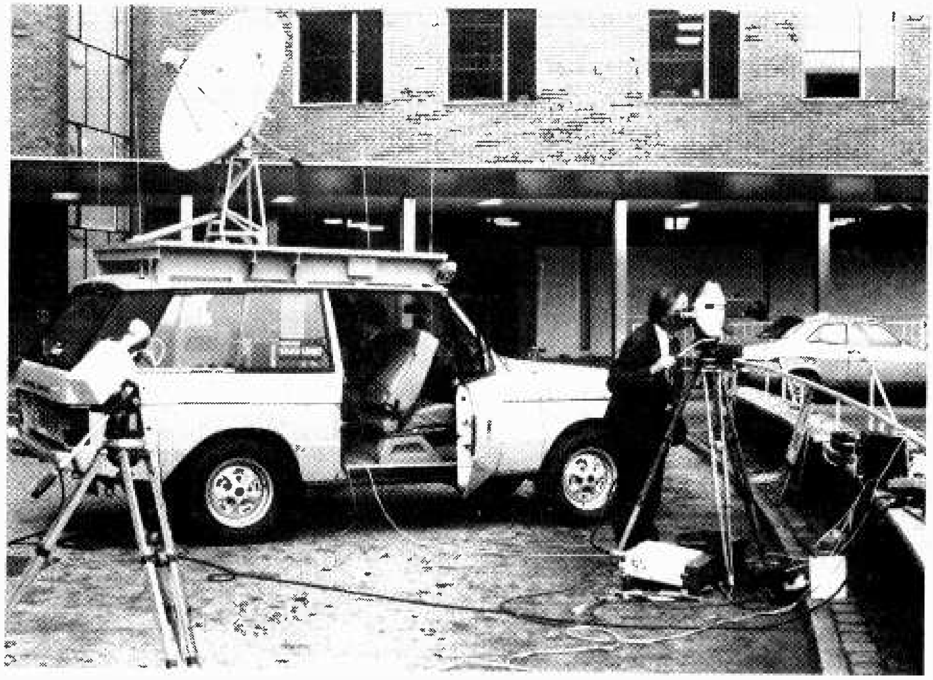
The BBC is conducting a one-year experiment in electronic news gathering. The first use of the new equipment was for an interview with Mrs Margaret Thatcher on October 10, just before the Conservative party conference and it now averages two or three stories a day.

A Range Rover has been equipped with a Philips LDK11 camera, Sony 3800 ¾in U-matic cassette video recorder and Sony Trinitron monitor, radio telephone, and transmission links. An intermediate Microwave Associates 13GHz "window" link, with a range of about ½ mile, will be able to transmit to the e.n.g. unit. From there a more powerful 2½GHz link will carry the signals to the top of London's Millbank Tower, and cable takes them to Television Centre. Other base stations, which have already been tested, will be used when necessary. Where a cable link already exists for outside broadcasts, at such places as Downing Street or Heathrow Airport, the video cassette can be played straight down the cable. Another choice is to send the cassette to the Centre by dispatch rider, as already happens for cans of exposed film.

The BBC plan to do live inserts into television news broadcasts. This has been done in the past with the o.b. units, sending signals back over temporary links.

The BBC have been carrying out tests with various types of equipment for the past two years, and talks with the unions have been going on for the past 18 months. Film camera crews have been retrained to operate the electronic equipment. The Range Rover will have a crew of two, plus a reporter who will travel separately and the despatch rider, if needed. The LDK11 camera is rather larger than the latest cameras available for such uses. Nevertheless its weight compares well with that of a 16mm camera. Crews can either connect the camera to the recorder on the van, or carry the recorder with them for playing back later from the vehicle. The reporter can play back the whole tape and send cues and editing instructions to Television Centre via the radiotelephone. Cue numbers are visible on an elapsed-time readout, and are generated by an SMPTE code on the tape.

The BBC are not giving any figures for the cost of the experiment, though it is believed that the equipment of the van cost about £70,000, and another £30,000 was spent on associated equipment at the centre. This total of £100,000 will be written off over five years. A film unit costs about £20,000 to put on the road, but the operating costs of the electronic unit are believed to compare favourably with those of film units, since there are no processing costs and the "stock" can be re-used almost indefinitely. Ten minutes of film cost about £20. All in all the comparative total costs of e.n.g. as against film are about the same over the five-year period.



The BBC's experimental e.n.g. unit. See "Beeb's light drama to the lighter."

The small new cameras have other advantages besides being easily carried. According to BBC engineers the ⅔in. tubes are more sensitive than those of larger cameras, giving a picture even in bad light. In this respect they perform about as well as film cameras, but they have the added advantage of giving a better colour balance. Editing is all-electronic, and will take about the same time as film editing does now, though no time has to be spent on film processing, which can take from 40 minutes to an hour.

The Corporation is doing a great deal more lightweight production for drama and current affairs than on news, which represents only about 9% of output. According to a BBC spokesman, 67% of tv output was now being produced electronically, and they aimed to enable drama producers, for example, to use locations as easily as they now did the studio.

This can have important benefits on productivity. Whereas a production unit might only shoot four minutes of film a day because there might be doubt about the light conditions, for instance, with electronic production this can be increased to 12 minutes a day or more because the results can be seen immediately without processing. Two-camera units using 1in tubes have been operating in drama for about three years. The next step would be electronic field production using 1in helical scan tape recorders instead of the heavy 2in tape machines now in use, which do not offer still-framing.

The BBC has just bought three Ampex VPR1 recorders for news and current affairs in Newcastle and Manchester, and these and other machines may be bought for drama.

Solar power nearer

Bell labs are developing solar cells made from liquids and solids which may be more economical than all-solid cells. They are also easier to make and may last longer, say Bell.

Efficient but expensive solar cells may be made from joining two single crystal solids, and less expensive but less efficient cells can be made from the junction of polycrystalline materials. The latest liquid junction Bell cells also use polycrystalline materials but are cheaper to make: "Junctions in all-solid cells are difficult to form since layers of crystals must be aligned precisely," say Bell. "Liquids conform to solids easily."

The new cells comprise two electrodes in a water-based solution. One of the electrodes is a semiconductor, the other carbon or any of a number of common metals. When light falls on the semiconductor current flows from one electrode to the other via the liquid. The solution is of sulfide polysulfides in water, and it remains relatively unaffected by the process. This accounts, say Bell, for the long life of the cell, up to four years in one case. In one experiment using cadmium selenide as the semiconductor electrode over a twentieth of the incident light was converted into electricity, about two-thirds the efficiency of the equivalent crystal cell.

An 8% efficient solar cell is reported to have been made by annealing with a single 30ns laser pulse, according to a report from the 1977 Photovoltaic Solar Energy conference in Luxembourg. The result is a silicon ion-implanted solar cell. Another cell, a 50mm thick silicon cell uniformly thinned by etching in sodium hydroxide has a claimed efficiency of 14%.

A Rugby engineer, Mr A. T. Freeman, has built a solar powered car which does not store the energy in conventional batteries. The solar cells, made by Ferranti, are mounted in a canopy above the vehicle's seat and produce a maximum of 35W. Eventually he wants to produce a commuter vehicle which will have a roof area of 50ft², producing 250W, and a maximum speed of 15 m.p.h. The cost at the moment would be £5,000 for the panels but he is hoping this will eventually come down to £50.

The electronic arm of the law

Suffolk Police have installed over £100,000 worth of computer equipment at their headquarters at Martlesham, near Ipswich. The equipment, to control the force's more than 200 vehicles, to record incidents, to switch messages between teleprinters in a communications network, and to hold local criminal, firearm, and stolen property records, was commissioned in November 1975 and installed beginning in the summer of the following year.

Currently 96 of the police vehicles are fitted with terminals which link them with the computer. Fourteen v.d.u.s are in divisional control rooms at Ipswich, Bury St Edmunds and Lowestoft, and at force headquarters. The message switcher controls 18 teleprinters distributed among the 13 sub-divisions and force HQ, and also a journal printer. The processor used is the GEC 4080, supported by 256 kbytes of core store, two 35 Mbyte discs, magnetic tape, line and logging printers, and communications interfaces operating at 2,400 baud to the v.d.u.s. and 75 baud to the teleprinters.

The Suffolk police regard the installation as one of the most advanced of its type, even though they are aware that computer technology has advanced some way since the system was commissioned. The force serves a community whose industry is expanding rapidly and includes the port of Felixstowe. The new police headquarters, housing 250 police and civilian workers, is a showpiece, and, like the computer system, has been designed to meet Suffolk's needs well into the future.

Suffolk is one of the latest forces to embrace the computer. Recent reports in the specialist and daily press have mentioned the growing police use of computers in Glasgow, Staffordshire, the West Midlands, Devon and Cornwall, Lincolnshire, Tayside, the Thames Valley, and, of course, Scotland Yard. Many more of the country's 43 police forces are taking advantage of the computer, and there is no doubt that one day they will all be computerised. Those not already so may be using their local authority's computer for the same purposes.

Stations linked

The arrival of the blue serge computer is mainly attributable to the shortage of police manpower, and to the related switch in emphasis in recent years from crime detection to crime prevention, or, as the bobbies inimitably put it, "pre-emptive policing." But while this is a desirable end, serious doubts have been raised by the means.

There is nothing a computer can store that could not be stored on paper. The difference is in the amount of storage and the ease with which it can be made available. Data banks can hold enormous amounts of information with very little trouble, and when what was previously held in paper files is so easy to store there is an overwhelming temptation to add all sorts of other details as well.

All of the 800 police stations in England and Wales are linked to a national police computer, based on a Burroughs main frame, at Hendon. This project went ahead in 1969 and began to operate in 1974. According to the Government white paper on computers and privacy, "its purpose is to automate the storage and retrieval of certain of the records held by the central and regional criminal record offices and by police forces: these comprise indices to records of persons convicted of serious offences, wanted and missing persons, stolen vehicles, disqualified drivers and persons with suspended sentences."

In addition, each day a new tape is carried from the vehicle registration computer at Swansea to Hendon for feeding into the computer. This is necessary because the Swansea computer works on tape and that at Hendon on disc, for speedy access. This transfer means that, by 1979, the names of 26 million people owning licensed vehicles will be on the file, along with address, date of birth, details of the vehicle and other codes saying whether, for example, the car is "of long term interest to the police." The total number of entries will be over 36 million.

This contradicts a government assurance that the information used for one purpose would not be transferred for use in another. There are some 220 central government administrative tasks which are computer-based. The public sector has around 3,500 computers at its disposal, roughly a quarter of the private and public sectors' combined total. The Home Office and Metropolitan Police joint automatic data processing unit, for example, has five central processors, 500 staff and a capacity of 768 kwords. The Home Office has spent £14 million on computers in the last ten years. In January, 1973, *Computer Weekly* reported that detectives on a murder enquiry had searched the memory banks of a Department of Health and Social Security computer, looking for a letter. Also, the Balcombe Street bombers were partly tracked down by tracing a computer dating form from a *Time Out* advertisement which one of the bombers had filled in as a joke.

The police national computer also has a fingerprint file for those convicted and sentenced over the last 40 years (the Rehabilitation of Offenders Act, 1974, is supposed to ensure that a conviction vanishes from the record after five years) as well as those awaiting trial, a total of 2.25 million people. Those detained under the Prevention of Terrorism Act also had their fingerprints taken and stored even though 19 out of 20 of them were acquitted. (See *Wireless World*, September 1975, p.406.) A *Police Review* editorial once described the information in police files as "frequently libellous".

BBC

This is why the government white paper stresses that the disclosure of criminal and other records from the computer is not "given to anyone, however responsible, unless considerations of public interest justify it." Yet the number of people with authorised access includes public bodies or authorities about to employ doctors, dentists, nurses, youth leaders or teachers, civil servants, atomic energy and Post Office temporary or permanent staff, magistrates, justices of the peace, barristers, solicitors and their clerks. Astonishingly the paper also admits that "the police also maintain the practice, *which does not have specific statutory authority*, of helping social services departments in considering applications from adoptive and foster parents." Anyone who applies to join the police, or for an award under the Criminal Injuries compensation legislation, or for a gaming licence, is also checked.

In addition, a recent book* by Patricia Hewitt of the National Council for Civil Liberties points out that criminal records are also available to anyone who knows how to work the system. For this reason the practice, not confined to security firms, of hiring ex-policemen has become widespread. The most outstanding example must be the BBC's appointment of Robert Huntley, former head of the bomb squad, as security adviser. Anyone applying for a BBC post might therefore expect the corporation to have access to a great deal of information which would otherwide be closed to them. Yet when the police computer was being set up, in 1971, the then Home Secretary, Mr Reginald Maudling, told the Commons that access to it would be restricted to the police.

Passport details

Scotland Yard's computer provides a good example of the dangers computers may present. In February this year *The Times* revealed that nearly 1.5 million names of criminals "and their associates" will have been fed into the computer by 1985. Stewart Tendler wrote that Scotland Yard refused to say whether this would include the names of those suspected of subversion. A £900,000 contract for the computer was announced last year but no other details, including the name of the winner of the contract, for which 25 companies competed, have been released. However, *Computer Weekly* revealed in December last year that the contract had gone to Computer Technology Ltd, one of their biggest ever orders.

Notably, the records include passport details and details of bankruptcies. "By 1985," said *The Times*, the computer could be storing information equivalent to one-fifth of the population in the area of the Metropolitan Police's jurisdiction." Although the kind of information stored is supposed to be subject to the guidelines in the white paper, and therefore not secret, Scotland Yard refused to say why the information was classified, or whether it was true that an astonishing two-thirds of the names on the biggest section of the records was of suspects and associates rather than people with criminal records.

A further report in September said that the names of tens of thousands of those suspected by the special branch "for reasons of national security" were to be fed in. The special branch was allocated up to 600,000 of the total capacity of 1,300,000 names for such purposes.

No one doubts that the tracing of bombers and murderers after the event, still more the prevention of their atrocities beforehand, is of benefit to the community, though more often the beginning of the spiral is the mere tracing of stolen cars. But, the objectors say, these worthy objects may become the excuse for producing just the kind of peephole society the bombers would resort to if they ever found themselves in control. Be it noted that, after nine years' work, the FBI has abandoned a national police computer it was to set up in the United States, largely because of the privacy issue.

**Privacy: the information gatherers. Patricia Hewitt, National Council for Civil Liberties. £1.25.*

The Bizarrm

Low-cost pickup arm using mono-filament suspension needs no special tools

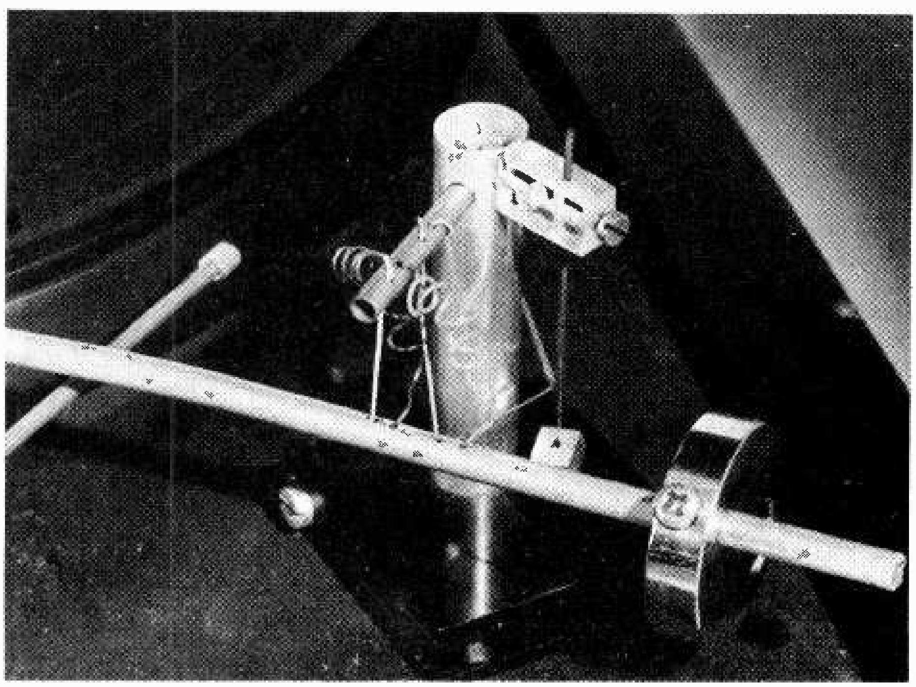
by Ernie Lowinger

Many pick-up arm designs for home manufacture have already been described in the journals. Most very beautiful, all very sophisticated and requiring the use of a lathe and appropriate precision. For some time I have sought the design for an arm that could be made with a minimum amount of costly precision tools.

My aim has been to produce an arm with performance as good as there is, with a reasonable appearance, from inexpensive materials which are easily found, using tools I have to hand: electric drill, drilling stand, assorted drill bits and a few BA taps.

I have tried miniature ball races and found them too temperamental. A unipivot is out, hydraulics and knife edges, too. For some time I toyed with the idea of a thread or wire suspension. The idea finally took form when I saw two mentions of a thread-suspended bias compensation device in some old *WW* and *HFN & RR* copies[1]. This was not my first acquaintance with this form of thread suspension. It defeated me the first time I met it as an A-level maths problem years ago. This time I derived the equation $M=Wa^2/h$, where M is the moment, W the total mass of the arm, 2a the distance between the threads, and h the suspension height (see Appendix 1). The principle is simple enough; the arm is supported by only two threads, Fig. 1. The resulting friction is due only to the torsional hysteresis of the threads and the lead-out wires. I have made two arms utilising this principle. One uses fine nylon fishing line for suspension. The other uses the signal wires themselves to support the arm.

In addition to having low inherent friction the principle also offers automatic bias compensation. The moment on the arm is proportional to the sine of the angle of rotation of the arm, i.e. $M \propto \sin\theta$. If θ is centred on 90° then for a sweep of 23° of the 9-inch arm there is only 4% variation in M.



First design, in whch the arm is carried by the signal wires.

Bias compensation

To arrive at some concrete dimensions for the threads and the values of a, h and W it is necessary to look into this bias business.

If a cartridge is offset ϕ degrees in a pick-up arm, Fig. 2, but is tracking a groove tangentially, there will be a force F due to friction along the cartridge's longitudinal axis. This force can be resolved into a pull along the arm P from the pivot, and a pull S at right angles to the arm which tends to make the stylus ride the inner wall of the groove harder than the outer

$$S=F\sin\Phi \quad P=F\cos\Phi \quad \text{(see Appendix II)}$$

Now F is proportional to the tracking weight and it has been shown[2] that the constant of proportionality can be anything between 0.2 and 0.9, depending on the record and this can be increased by 80% more on highly modulated grooves in the case of certain cartridges. It is quite likely that a resulting variation of 10:1 can occur across one record. One might well ask, is it worth the bother?

Anyway, to start somewhere the equation has become

$$S=kG\sin\phi$$

where G is the tracking weight and k a constant. Taking a mean value for k of 0.5, a 9-inch arm with an offset angle of 23° and a range for G between 1 and 3 grams, S ranges between 0.2 and 0.6 grams. This means a moment at the pivot of a 9-inch arm of between 1.8 and 5.4 gram-inches, if you will forgive the mixed units. This is the range of the values for M in the equation $M=Wa^2/h$.

The crunch

The effective mass M_e of a pick-up arm (moment of inertia divided by the square of its length) and the compliance C of the cartridge combine to give a resonant frequency f of bounce on the stylus suspension, according to

$$f=\frac{1}{2\pi\sqrt{M_eC}}$$

I have read[3] that f should be kept between 6 and 14Hz and to achieve this with the range of cartridge compliances likely to be met, the arm less cartridge should have an effective mass of 7 to

Fig.1

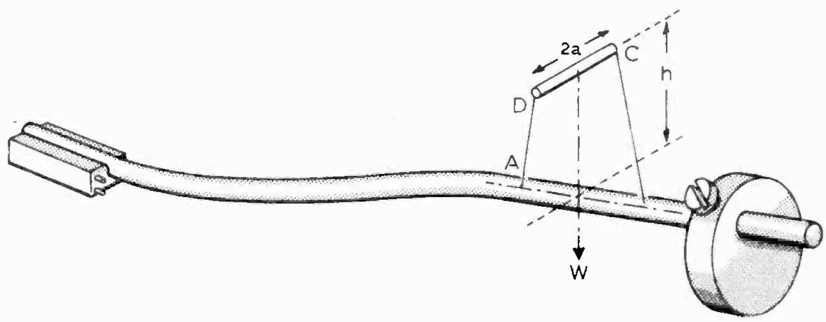


Fig.2

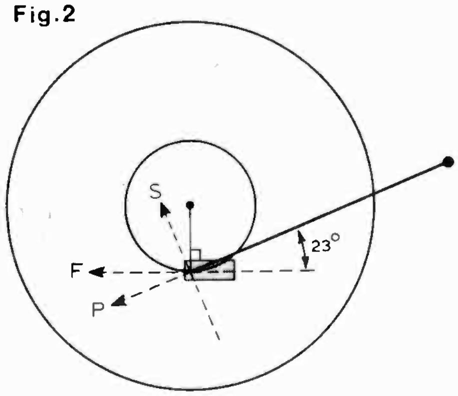


Fig.3

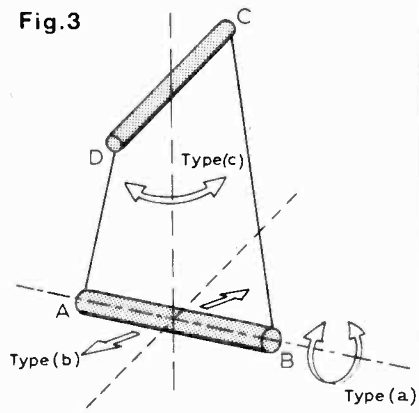


Fig.4

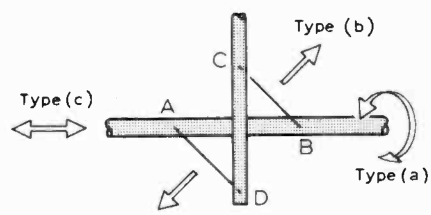


Fig.5

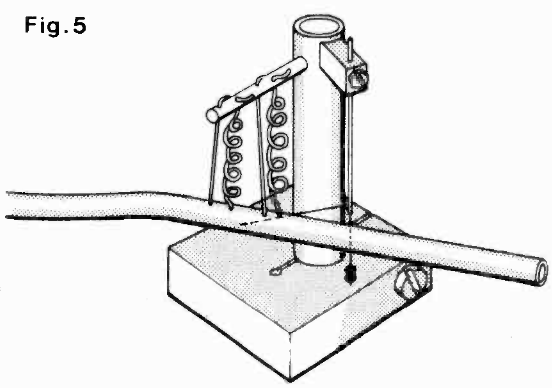


Fig.6

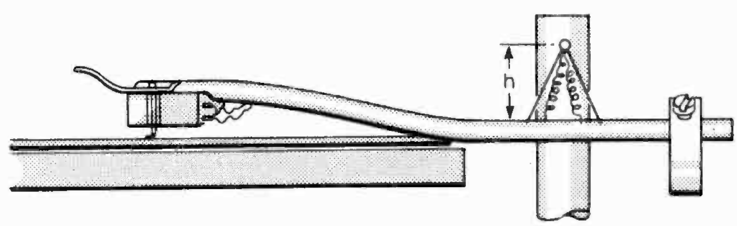


Fig.7

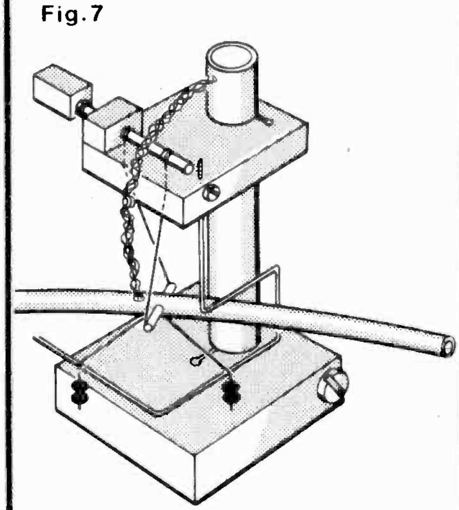


Fig.8

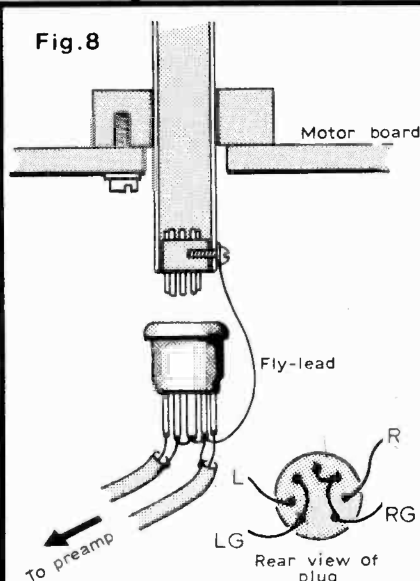
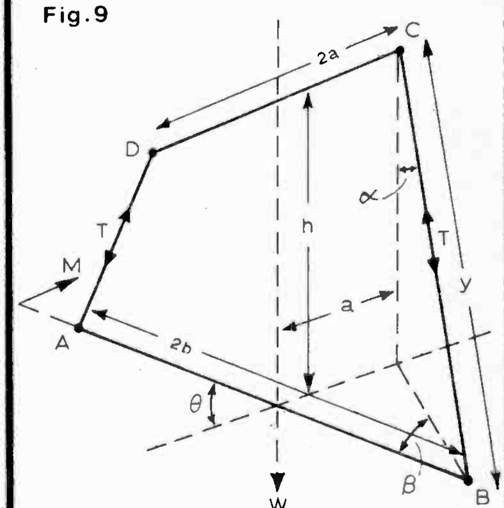
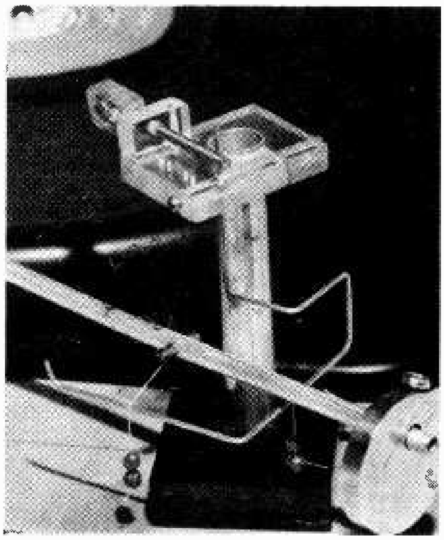


Fig.9



10gm. Generally speaking, this implies a fairly massive counterweight kept close to the pivot point. This is because inertial moment and therefore effective mass is proportional to the mass of the counterweight but the square of its distance from the pivot.

There is, however, a counter constraint. If $M = Wa^2/h$, we may have to keep W down to keep a and h convenient and still have the right M. In the event, it has been quite easy to keep the effective mass in the 7gm region with an all-up W of 58gm, and if we take a as 3/16 in (i.e. the threads are ⅜in apart), then h becomes about half an inch. This can be increased to 1in for a value of 1.8 for M. However, if you want to increase M, I think it would be better to increase 'a' than reduce h much more, otherwise the stress on the wire may be excessive (see Appendix 3).



Second arm has its own cross-member and uses nylon threads.

It wobbles

You might think that, dangling there on the end of its thread, the arm would be rather unstable. You are right. However, analysis shows that the wobbles are predictable and amenable to control.

Going back to the first principle, there are three modes of oscillation in the system that cause trouble, Fig. 3.

A – The lower rod AB can rotate about its own longitudinal axis.

B – The lower rod AB can swing at the end of the two threads moving in tandem about an axis at right angles to the projection of the two threads in plan, Fig. 4.

C – The lower rod AB can swing about the upper rod CD and its longitudinal axis.

Not sure which would be the best orientation for the threads, I made two arms. In the first, Fig. 5, the lower rod AB forms a part of the rod itself. The four signal wires emerge from small holes in the arm tube. Two of the wires actually carry the arm. The remaining two are loosely coiled to contribute as little torsion as possible. The wires are held firm in the arm by simply tying a large knot which jams in the hole, just behind the cartridge, through which the wires enter the arm. At the other end the wires are 'knitted' into a tubular hollow cross tree. The suspension height can be varied by tweaking the wires in and out of the holes. This cross tree is now the upper rod CD. It acts as the pivot axis for vertical movement of the arm. So we have no trouble from the type (c) wobbles. Type (a) wobbles do happen. This is because the centre of mass has to be below the line joining the stylus tip and the support point on the arm, to stop it falling over. So you end up with a sort of compound pendulum. This wobble is difficult to eliminate. By keeping the centre of mass quite low down the period of oscillation is kept long and partially damped by the sogginess of the support wires. The method used for damping type (b) wobbles helps a little too, but I found that jolts on the turntable can set it wobbling. However, the movement only lasts a second or so and, more important, does not cause any audible modulations. Wow.

Type (b) wobbles are the worst. I found the easiest way to control them was to drape some cotton thread over a piece of wire and fix one end to the pivot point of the arm. The other carries a small weight. The two or three ⅛in lead split shot do quite well. The friction of the thread running over the wire seems to be enough to damp them out completely. As the arm is only free to wobble in one direction, one thread and weight is enough.

The disadvantages of this arm are that the vertical pivot point can be rather high above the surface of the record for low tracking weights and small anti-skating forces, Fig. 6. Also bias adjustment is rather fiddly and so rarely undertaken. On the other hand it is simple and neat and performs well with a G820SE tracking at 1¼ gm, 2a ⅜in and h 1in.

In the case of arm number two, the suspension is turned through 90° about a vertical axis, Fig. 7. The arm itself has to have a cross tree to take the ends of the support threads. These threads are 1½-lb breaking strain nylon monofilament. This has very little inherent damping property so I had to be a bit more careful. The cross tree acts as the axis for vertical movement of the cartridge, and so type (a) oscillations do not happen. Both types (b) and (c) occur in this arrangement, the last-mentioned taking the form of the whole arm swinging about a line joining the stylus tip and the upper end of the support threads. These wobbles caused considerable wow and flutter when left undamped and required two threads of the type already described, at right angles to each other, to damp all tendency to movement in the horizontal plane. They are completely effective but the wire frame to carry them is a bit of a contorted shape. With its easily adjusted suspension, height and therefore bias compensation, very low friction and complete lack of wobbles this arm is magnificent but looks very Heath-Robinson-esque. I use it at present with an ADC Q36 tracking at 1¼ gm again.

Both arms were simple to make but incredibly fiddly to assemble and set up. The horizontal pivot point does not stay in one place as the arms move across the record, variation in the friction component P along the arm causes some change. This, however, is not a problem as long as the arm is set up to give zero tracking error at the end-of-side, as is usually the case.

Friction

To keep friction low the important thing is to use sufficiently fine lead out wire, and finding it was a bit of a job. Writing to SME for a free sample would be admitting defeat so I kept looking. For arm number one I found some four-way screened and sleeved wire supposedly for pickups, but stiff as a salami. However, when you strip off the sleeving and screening, you get four pretty coloured p.v.c. covers each containing 10 strands of 47-gauge copper wire, untinned, and these are quite flexible.

For the second arm I used 3 × 48g Litz wire, enamelled and silk covered. This is about as fine as one would wish to use, somewhat fragile and a trifle tricky to solder. Four pieces are cut to length and then given different colours with fibre tip pens.

Measuring lateral and vertical friction is a bit of a problem because of the constant lateral moment. However, I must confess to not having seriously tried. Inspection of the only sources of friction, the lead-out wires and nylon support threads, would I am sure convince the reader as it did me that in the case of arm number one the friction at the stylus is approximately sweet F.A. and with arm number two, even less.

Materials

Arm: You can buy 12-inch lengths of 10-gauge fine-wall aluminium tube from any good model shop for about 10 pence. It weighs about 5 gm and can be bent with bare hands. It is quite strong, too. It is 3/16-in o.d. and nine-inches serves for the arm, the remaining three inches take the counterweight.

Counterweight: I used about ¼in of 1¼in brass bar. Aim for about 1½oz weight.

Support pillar: ½in aluminium tube from Band I TV aerial.

Cartridge retaining clip and finger lift: 16-gauge aluminium sheet.

Support base: I happen to have some green perspex ⅛in thick and some clear ¼in.

Arm 1
Cross tree: 12-gauge brass tube from model shop.

Arm 2
Thread carrying platform: ¼in clear perspex and 6BA threaded brass rod.

Cross tree in arm: 10-gauge welding rod.

Damping frame: 18-gauge steel wire.

Various 8, 6 and 4 BA screws and nuts, and that is about it.

Construction

I can say nothing that will improve on the constructional information published by *HFN & RR* and *WW* in the past[4] and construction of this arm is clearly much indebted to the work of Bickerstaffe. The March and April 1971 articles are particularly useful as regards the arm itself and I will not try and improve on them. Suffice it to say that the arm must be bent to give a 23° offset angle and the pivot region should be on the same horizontal plane as the stylus tip. As cartridges tend to vary a bit in dimensions it will have to be set up for the individual case. The head is undercut, and various holes are started off with a sharp metal spike. The tube wall is very thin; once it is penetrated the actual-size hole can be made with an appropriate drill worked between finger and thumb. In the case of very small drills, wrap the shank in scotch masking tape to a thickness of ¼in. I found this the most accurate and least damaging way to cut holes in fragile tubing.

A hand vice is required for drilling all the other components. Brass and perspex both tend to snatch when being drilled. Low revs and a very slow feed rate are essential. Even so I frequently saw the hand vice whirling round the drill shank at 900 rev/min. The drill would be well and truly bent and the vice and workpiece then hurled through the window, or worse into one's guts.

Threading the signal wires into the arm is fairly straightforward if one uses nylon thread or 5-amp fuse wire to pull through. Similarly the hollow cross tree in arm number one. In arm two, the solid cross tree is glued into the arm with Araldite.

The support platform in arm two is fiendishly hard to set up the first time but easier when you know how. Assemble the height-adjustment screw in the platform. Take a good foot of nylon line. (You only need a foot but you have to buy a hundred yards; still, it's cheap enough.) Form a blob at one end, about ¹⁄₁₆ in diameter, by holding the end near a gas flame. This is a finnicky task and you burn through a few foot lengths of line before you get a good secure blob. Now pass the unblobbed end down through one hole in the screw, a hole in the perspex platform immediately below, then up through the adjacent hole ⅜ in away and up through the appropriate hole in the screw. Now form another ¹⁄₁₆in blob at the other end of the line. Carefully turn the adjustment screw and the nylon line should fit neatly in the grooves in the screw. Three full turns gives about an inch adjustment.

Fit the platform to the support pillar and pass the nylon loop under the cross tree in the arm. The arm will already have its signal wires inserted. The wire can now be threaded through the support pillar.

It would be nice to terminate the wires in a smart plug-socket arrangement at the bottom of the support pillar. After a long search I found a miniature seven-pin plug/socket that does reasonably well, Fig. 8. I filed the threads of the plug part and soldered the arm wires to it. It just fits in, and is retained in the bottom of the pillar by an 8BA screw. The screw also carried a fly lead to earth the pillar itself. (The arm is earthed by a fly lead from one of the cartridge earth tags.) The socket part is soldered to the twin screened lead which leads to the amplifier.

There is a lot of unscreened signal wire floating about. I was worried about this and made up some screening cans from aluminium film canisters. However, during use I found that they made absolutely no difference and with the cartridges I use and 68-kΩ input impedance at the preamp there is no hum at full volume. So I threw the screens away.

The pillar base is a sandwich of green perspex top and bottom and clear in the middle. Total thickness ½in. The whole is solvent welded with chloroform. You can get this from your chemist but you will have to sign the poisons book.

Drill the ⅝in mounting hole 8⅜in from the record spindle.

Further development

The pick-up arm can be suspended by any number of threads. If their upper ends are regularly spaced about the circumference of a circle of radius a centred on the upper support, and the lower ends of the threads similarly fixed about a circle centred on the pivot point of the arm, then the couple on the arm, *ceteris paribus*, remains Wa^2/h.

The theoretical pivot for both lateral and vertical movement of the arm, is a point halfway between the centres of the upper and lower circles.

With regard to stability, there will always be one direction in which such an arm would be free to wobble. It will therefore require one stabilizing thread arranged as in the Type I arm. The lateral stability will be enhanced however.

A simple way of making such an arm will be to use a modified Type I arm with all four signal wires doing the supporting. The stress on the wires, and their slight tendency to creep will be correspondingly reduced.

Conclusion

They might not require a lathe, but instead require extensive wrestling with almost invisible bits of wire and thread. However, they work, and better than I had ever hoped. They are not beautiful, but they have a certain rustic charm. They are certainly cheap.

References

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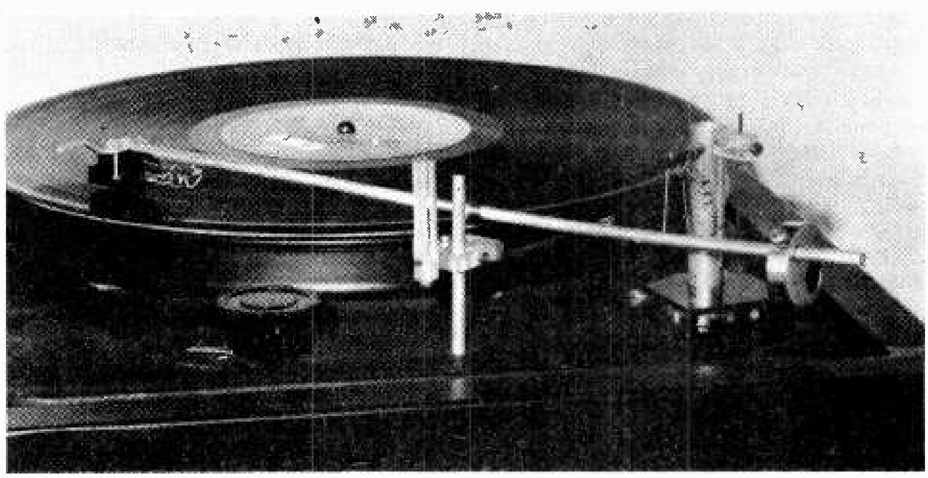
continued on page 64

Type 1 arm in use.



World of Amateur Radio

The power game

The power race that has taken such a firm grip on m.f. and h.f. broadcasting in so many countries (appropriately enough Babel, Iran now has a 2MW m.f. station) has not left British amateurs unaffected. Without wishing to be a spoil-sport one cannot help feeling that the authorities never foresaw the power levels that have been made possible by exploitation of (or misunderstanding of?) the Post Office ruling some years ago that British s.s.b. stations could use up to 400 watts p.e.p. output, although this was clearly *meant* to be directly comparable with the 150W d.c. input for a.m., f.m. and c.w. modes.

Today some British amateurs are using power amplifiers that for any mode other than s.s.b. would be rated at over 1kW d.c. input; for example the Heathkit SB220 which is usually listed as 2kW p.e.p. and the popular K2RIW design of a 432MHz stripline amplifier with two ceramic tetrodes, considered in the United States as a "kilowatt" amplifier. Such amplifiers often have two 4CX250B or 8930 valves for u.h.f. or two 3-500Z or similarly rated valves for h.f., with power supplies built to provide over 2.5kV at up to 800-1000mA on peaks, occasionally with heavy r.f. speech clipping to increase significantly the duty cycle of the transmissions.

While such equipment *may* be operated under legal conditions for s.s.b. it must be extraordinarily difficult to get them down to anywhere near 150W d.c. input when used for other modes. On u.h.f. such equipment, combined with high-gain aerials, can provide effective radiated powers as high as 50-100kW, without taking into account the clipping "gain".

Again, the more stringent power limits imposed by our licences for 1.8MHz (10W d.c. input and on s.s.b. 26.67W p.e.p. output) do not appear to prevent many amateurs using on that band medium power h.f. transceivers that have no facility for reducing power and which, I am assured, often cannot readily be operated within the authorised power levels. An American 1.8MHz enthusiast, recently visiting the UK, was prepared to identify certain Top Band signals he hears regularly and is convinced do *not* emanate from 10-watt transmitters.

If only to sort out the current confusion, and if the Home Office have no objection to the use of high-power transmitters for s.s.b., should they not authorise at least a similar legal 400W p.e.p. *output* for c.w., f.s.k., and n.b.f.m.? Or is this a case where it is left to "self-regulation"?

Many amateurs believe that our radio and tv set makers could do more to make receivers, broad-band mast-head amplifiers and audio equipment far less susceptible to high r.f. fields – but it is asking a lot for domestic equipment to be capable of operating directly in a 100kW e.r.p. beam of a nearby transmitter.

At the other end of the scale, David Johnson, G4DHF, recently made more than 40 contacts on the 144MHz band during a low-power contest at distances up to 300km: he was using a home-made transceiver based on the SL600 series of integrated circuits with an r.f. output of about 25mW.

Scanning the bands

The British Amateur Radio Teleprinter Group reports a membership increase of 40 per cent during the past year to over 550. John Jones, GW3IGG, suggests that the advent of visual display units for "teleprinter" display has brought many new operators to r.t.t.y., even though most stations are currently still using hard copy machines for two-way contacts, and he wonders if the increasing interest in such display units and microprocessors is beginning to make the very term "radio teleprinting" seem too restrictive for moden usage. Reginald Wigg, G6JF, has worked some 136 different countries on r.t.t.y. and is the top British station in BARTG's "quarter century award" listings. Leading station is the Belgian ON4BX with 154 countries. Brian Hodgson, G3YKB, has taken over the editorship of the group's newsletter (now appearing in an attractive new format) in succession to Dennis Goacher, G3LLZ who has produced the newsletter for eight years.

The Home Office has now resumed licensing the additional amateur repeater stations forming "Phase 2" of the RSGB's current plans but has stated that it is not prepared to consider any applications beyond this present phase for the time being. It has expressed concern at the high sites being chosen for some of the repeater stations. However, preliminary planning for Phase 3 is continuing. With London now served by three u.h.f. repeaters, the UK FM Group is considering closing down the GB3LO v.h.f. repeater which continues to be subject to many abuses by a group apparently wishing to bring repeater operation into disrepute.

French beacon stations have been allocated the prefix "FX" and will include: FX3TEN on 28.227MHz; FX3VHF on 50.1MHz; FX0THF on 144.741MHz; FX3THF on 144.905MHz; FX7THF on 144.985MHz; FX9UHF on 432.5MHz; FX4UHF on 432.83MHz; and FX6UHF on 432.870MHz. French v.h.f. activity generally appears to continue to increase rapidly as indicated by the recent story of 200 stations on 144MHz, 36 on 432MHz and 3 on 10GHz for their 1977 National VHF Contest.

A novel constructors' contest has been announced by the East London RSGB Group. This is for home-constructed items of audio, electronic or radio equipment "totally enclosed by a 2oz tobacco tin with lid." Optionally the power supply need not be enclosed in the tin.

H.F. transmitting aerials

Bob Haviland, W4MB, recently analysed the aerials used by 500 stations contacted on 21MHz. Just over half were using Yagi beams (80% of them 3-element, 5% 2-element); second most popular group were the verticals (mostly multiband types using traps); just under 15% were various forms of "quad" loop arrays (nearly all of them 2-element); dipoles (including inverted-vees) formed 12% of the total; "long wires" only 1.8%. Height of the elements varied from 10ft to over 120ft (12% over 80ft, average 10ft). In Europe the simpler aerials form a higher percentage of the total. A check on 100 stations on 14MHz and above showed 38 using ground-planes and other "verticals"; 31 were using various types of dipole (including W3DZZ trapped dipoles and G5RV multi-band dipoles); only 13 were using 3-element Yagi arrays; 7 were using 2-element "quads".

In brief

The 1978 president of the RSGB will be Dr Dain S. Evans, G3RPE, who for a number of years has been one of the leaders of the "more activity on microwave bands" group that has done much to popularise 10GHz in the United Kingdom .... By August 31, the number of UK amateur licences had risen to over 22,750 (Class A 16,205; Class B 6559) .... ITU international prefixes now include J3 for Grenada and H4 for the Solomon Isles .... The Braun SE401 series of 144MHz multi-mode transceivers is believed to be the first commercially-built amateur equipment to use a v.f.o. which used a 64μs PAL-type delay line as a integral part of a stable phase-locked-loop system .... It was exactly 50 years ago, at the Washington Radio Conference of October-November 1927, that 350 delegates of 74 countries first defined internationally the harmonically related amateur bands from 1.7 to 56MHz.

PAT HAWKER G3VA

Letters to the Editor

CONTROL OF SOLAR HEATING

Congratulations to Mr K. D. C. Passey (Letters, October issue) for highlighting the importance of an electronic control system for solar energy pre-heating of domestic water. However, it is also important that the complexity of any control/recording system be kept within practical limits, so that the extra cost of the control/recording system and its maintenance does not exceed the extra saving over a less sophisticated electronic control.

The necessity for limiting pressure drop due to lime deposition may of course be avoided completely by using an indirect solar heating system.

We are at present conducting tests on a prototype electronic control system specifically designed for solar applications, which uses a true double differential technique, where the pump "turn-off" condition is determined completely by the pump requirement and the selected flow rate. It would be quite possible to monitor various functions by connections to points within the circuitry and to have a display panel some distance from the control proper.

We plan to start work in the near future on a control system based on microprocessor techniques which should certainly afford the user the kind of assistance advocated by Mr Passey.

F. B. McKee
McKee Solaronics Ltd.
Southminster
Essex.

MATRIX H SURROUND SOUND DECODING

In commenting upon certain statements in Michael Gerzon's multisystem and J matrix decoder (July issue), might I point out that not everyone can afford room-space or expenditure for two stereo speakers, let alone the four or six proposed for the J matrix. Popularly, stereo listening is being accomplished on headphones (two or four channel).

Since the phase-shift between left and right channels does not significantly widen the subjective "stereo-head-phone" stage width in the same way as when listening on conventional stereo loudspeakers, it is thus important that the encoding locus should pass through left-only and right-only if only to achieve good compatibility for the many thousands who listen to f.m. stereo (H "quad") on headphones. It is thus not an "unnecessary design restriction" as Mr Gerzon seems to suppose. At least SQ and (in theory) RM, QS and BMX (Nippon Columbia UD4) also give full headphone separation in stereo at least for pop-surround and dramatic programme material, some broadcasts of which have been surprisingly impressive on "binaural" listening.

Secondly, the deliberate curvature of the H matrix locus allows non-conjugate decoding or at least some measure of compatability when using decoders of other systems, e.g. even a simple "10-40" blend SQ decoder may be used if the connections to speakers are rearranged. Connections are: SQ-L_B becomes approximately equal to H front, SQ-R_B becomes H centre-back (two speakers in series in the left-back and right-back positions can be fed with this "ambience" signal, which in theory contains little matrix H centre-front since SQ (blend) right-rear is almost 160° from the front on the phase-amplitude sphere), SQ-L_F becomes H due left, and SQ-R_F becomes H due right.

The deliberate curvature of the H-matrix locus is by no means caused by a departure from "optimal" three-information-channel source encoding. For instance, the bent locus is produced by the matrix below from only three microphones: (i) omni-directional plus (ii) figure-of-eight oriented left-right plus (iii) another figure-of-eight oriented front-back, approximately as below, θ measured clockwise from centre-front.

$$\begin{bmatrix} L \\ R \end{bmatrix} = \begin{bmatrix} 0.53\,e^{-j7.5},\ 0.36\,e^{+j73},\ -0.53\,e^{j7.5} \\ 0.53\,e^{+j7.5},\ 0.36e^{j73},\ 0.53e^{+j7.5} \end{bmatrix} \begin{bmatrix} 1 = \text{omni} \\ \cos\theta = \text{fig. 8 (iii)} \\ \sin\theta = \text{fig.8 (ii)} \end{bmatrix}$$

(The equation is covered by the BBC patent.) Thus it follows that since H does not have to be produced from pairwise-panpot four-channel sources, the "third-matrixed (narrowband) channel" technique to restore most of the 3→2 channel matrix "lost" information is as applicable to H as to J; and is not therefore a function of locus-straightness as has been suggested by Mr Gerzon *et al.*

Finally, the difference in rate-of-change of curvature (phasebending) between the front-half H locus and the rear, could well be the reason that stereo headphone listeners can get some impression of front-back stereo perspective.

T. W. J. Crompton,
Crawley,
Sussex.

RADIO AND AIR SAFETY

Letters printed in your August, October and November issues brought to my attention the editorial in your June issue "Radio and air safety." As an experienced broadcast engineer with direct involvement in v.h.f. broadcasting and as an experienced and active airplane pilot, I tend to agree with the letters which you published. Your editorial is based on an inadequate knowledge of aeronautical voice communications systems and equipment and the role of voice communications in air traffic control.

There is nothing inherently wrong with a.m. mode or with 2.7kHz bandwidth. My experience with audio quality on 747 class civil airliners and all the control towers that I hear is that audio quality is quite good and background noise level is low. There may be problems with aircrews whose command of the English language may be less than is desirable. There may be faults in the system, i.e. the architecture of the communications system, which is a "party line" – no control on "access" to the communications channel. Basic aeronautical transmitters and receivers are OK. We may not be using them properly all the time.

I suspect the final Tenerife accident report will show that the reception of one of the control instructions was partially "blocked" by another aircraft transmitting at the same time. This is not a fault of the equipment but rather one of "system architecture." The Tenerife communications channel was not noisy or significantly bandwidth limited.

I. Switzer
Switzer Engineering Services Ltd
Mississauga
Ontario, Canada

USING A MICRO-PROCESSOR

There are some difficulties in using the 8080-based microcomputer discussed in J. Skinner's article, "Using a Microprocessor" (June and September issues).

The interrupt input to the 8080 is wired to a switch (START) which is used to allow the 8080 to get past the halt instruction (HLT) at address 5. For this to operate properly it is necessary to have an interrupt instruction port wired to input a single-byte, eight-bit instruction to the 8080 during the interrupt acknowledge cycle. This is not shown. It is readily accomplished with another 8212 integrated-circuit. A no-operation (NOP = 00_{16} = 000_8) should be the instruction hard-wired at the interrupt instruction port.

Mr Skinner's 8080 configuration may be useful in some applications, but it eliminates the use of the interrupt for other, more sophisticated tasks. Perhaps there will be further articles which cover this important topic. If interrupts are to be preserved a sense flag could be used to replace the interrupt connection. In this way a single bit is input and tested under software control. This requires the use of a spare bit position at an input port. If this is not available, a single input port is quickly constructed. Mr Skinner's circuit is simple and just what may be needed for a simple application where thousands are to be manufactured without further changes or add-ons. Readers should be aware, however, that there are other uses of interrupts.

After providing the register codes in three-bit octal (base eight) notation it is sad to see that the programme is encoded in hexadecimal (base sixteen) format. This is not Mr Skinner's fault, but rather the fault of all 8080 manufacturers. The octal format is much easier to encode and understand.

As per the information in Table I in the article, each of the 8080's registers is given a three-bit binary code which is easily translated into an octal equivalent, $A = 111 = 7_8$, $D = 010 = 2_8$, etc. The data transfer instructions provided in the article are good examples of the use of octal notations.

The data transfer between registers is broken down as follows:

0 1 d d d s s s

where the *ddd* is the binary code of the destination register and the *sss* is the binary code of the source register. Each of the three groups shown above is then translated into an equivalent octal code:

MOVAD = $01111010_2 = 172_8$
MOVHA = 01100111 = 147
MOVLA = 01101111 = 157
MOVAE = 01111011 = 173
MOVEA = 01011111 = 137

It seems much easier to code the instructions in octal than in hexadecimal. The last two examples prove the point by showing that when destination and source registers are interchanges, the octal digits representing the registers are interchanged in the instruction code. This is not apparent in hex notation; 7B to 5F.

Memory addressing is also simple, remembering the rule that memory is treated as 256 word blocks with a high address and a low address with the same grouping of bits as shown above:

XX XXX XXX

The rule is that when the low address goes from 377 to 000 the high address is incremented by one; 001 377 to 002 000, 125 377 to 126 000, etc.

I was pleased to see that Mr Skinner's programme listing is on a line-by-line basis as opposed to other programme listings which tend to cram too much on each line.

Jonathan A. Titus
Tychon Incorporated
Blacksburg
Virginia, USA.

DIRECT SENSING OF RADIO WAVES?

For some two years I have been plagued by clearly defined environmental "noises" which I have come to believe to be of electromagnetic as opposed to acoustic origin. Advertisements in the national press have yielded dozens of letters from people all over Britain who appear to experience similar phenomena which are often attributed to medical/psychological causes. My own observations, however, indicate that my sensation of "noise" is due neither to causes within myself nor to acoustic stimulation from outside.

In order to test my theory I wish to construct a tuner-amplifier to feed a loudspeaker or cathode-ray oscilloscope but since the frequencies are in the audio band (400 to 1100 Hz) the design of a suitable tuner presents some difficulty. Since my knowledge is limited and rusty, I would be most grateful to any interested reader who could offer me technical assistance. I shall be only too pleased to answer any letters.

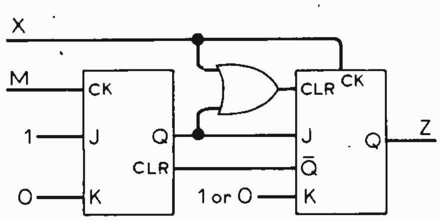
Donald Wood
Oaklands
Dorstone
Hereford

Editor's note: Mr Wood's letter was accompanied by a confidential report from a highly reputable research organization which lends some support to his belief.

MINIMISATION IN LOGIC DESIGN

I have been following your series of articles on logic design with interest, but find some of the underlying assumptions puzzling. The methods are said to be mainly for the use of inexperienced designers, although specialists may use them to improve their technique in dealing with more sophisticated assemblies. To this end a trade-off is presented where reliability, simplicity and transparency of design are won at the expense of a certain extravagance.

Minimisation is said to be relatively unimportant in the days of i.cs, where what counts is to minimise chips, not gates. However, since the sort of circuit discussed can often be part of something larger, a single gate saved here and there can quite easily lead to the elimination of a chip. Nor do the extravagances seem to be always small. Take Example 2 in the July issue (p.65), a circuit which allows a pulse on input M to gate a single pulse from a train on input X to input Z. It uses, besides a dual J-K flip-flop, a 3-input NAND, two 2-input NANDS and two inverters. These can be replaced by a single OR gate as below (assuming t.t.l. clock polarities):



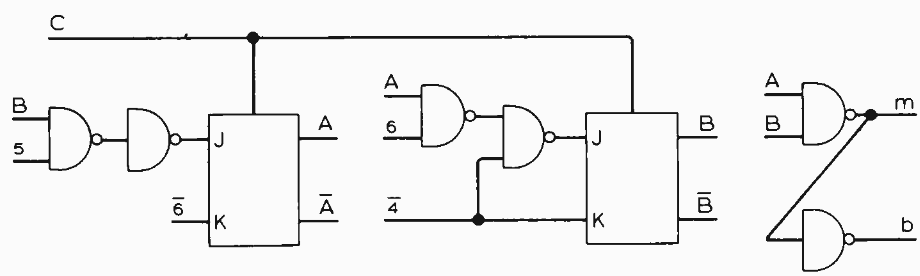
This configuration would never stem from the advocated design method for two reasons. First, it uses the Clear inputs. They were dealt with in connection with RS flip-flops but not included in the J-K equations – which hardly meets the practicalities of the t.t.l. and c.o.s.m.o.s. families. Secondly, the method *assumes* common clocking.

Example 1 is more debatable. Unless I have misunderstood the problem, state S3 is stable because its effect is to inhibit further clocking pulses. If so, the authors have demonstrated the vulnerability of their method in even the most expert hands by wasting four gates (quite possibly a chip) in providing redundant stability, since their circuit would work with $K_A=6$ and $J_B=4$. A further gate can be saved as shown below.

This is achieved by altering the assignments of A and B to the various states. The authors skate over that topic as not concerning the inexperienced designer: presumably they are not addressing themselves to their specialist readers at this point.

I imagine that in practice the inexperienced designer means the infrequent designer like myself. I have not found minimisation as unimportant as the articles suggest. On the other hand, while I agree that the mathematical steps advocated are simple enough when you are familiar with them, familiarity involves remembering a lot of highly forgettable detail. Each occasional foray into logic is likely to involve mugging the whole thing up again, which defeats part of the object of the exercise. In contrast I have found mapping methods, which are not developed at length in the series so far, easy to remember and usefully graphic and instinctive.

R. M. Hutton
London SW4



The authors reply:

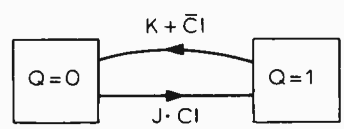
First of all we would like to point out that at no time have we suggested that minimisation of the number of gates or the number of chips used in a logic system is unimportant. Clearly, considerations of space and power consumption are two important aspects which the designer must balance against the charge for his time occupied in producing a simpler solution. However, what we are saying is that a formal method of approach to logic design is essential to the inexperienced designer and also to the student, whose difficulties we have frequently encountered.

For example, the solution presented for Example 2 seems to us to be an intuitive solution. A design method has not been presented and we can only assume therefore that there isn't one. Intuitive solutions are fine if the designer can come up with one that fits the specification, but it is very useful to have a formal method of approach available when one's intuition fails. As the logic problem becomes more complex intuition becomes more difficult to apply and it seems to us that under these circumstances a formal approach to design through the state diagram is absolutely essential. Our experience with students has been that once they have grasped the design method described in these articles they are very quickly able to develop quite complex logic systems with a minimum amount of difficulty.

Obviously we are aware that the Clear line of a JK flip-flop can be used as an additional control line. It is not possible to cover all these points in a series of articles of this nature. However it is easy to set up a truth table for the JK flip-flop incorporating the Clear signal which leads to the following equations

$$Q^{t+\delta t} = [Cl(J\bar{Q} + \bar{K}Q)]^t$$
$$\bar{Q}^{t+\delta t} = (\bar{C}l + \bar{J}\bar{Q} + KQ)^t$$

and similarly it is equally possible to draw a state diagram for the flip-flop which



incorporates the Clear signal as shown above.

B. Holdsworth and L. Zissos

PROGRAMMABLE CALCULATORS AS REACTION TIMERS

My letter in the August issue on calculators as stopwatches aroused a little interest. Here is a project which grew out of the programme for the digital clock. The question arose: what are the minimum intervals of time to which the Texas SR56 can respond? My guess was: the time required to go from one operation to the next without performing any operation (a NOP instruction). How could this be used? In a reaction timer.

A programme was written in which the calculator displayed a count-down sequence: 5, 4, 3, 2, 1, using the "pause" instruction. We then had a counting loop in order to have a pause of length different from that of the intervals between the previous digits. "0" was then displayed for about ½ second, using the "pause" instruction. The person whose reaction time is under investigation has to press the R/S key immediately he realises that the "0" has disappeared. The programme has a string of NOP instructions after the instruction to display "0." When the programme has been stopped by pressing the R/S key, to find the score it is necessary to press the LRN key. This shows the location in the programme memory at which the programme was stopped. An operator who is quick on the draw scores a low number. If he cheats, and presses the R/S key while "0" is still in the display, he reads the location after the "pause" instruction, which in my programme is stored at location 14.

Locations 15 to 94 have NOP instructions. It takes between 1 and 2 seconds to run through them; this gives an idea of the resolution of which the calculator is capable. At location 95 we have a few instructions to set up the calculator for another run. When the operator is ready for another test, it is only necessary to press the R/S key to start the count-down sequence.

In a group of students, the calculator can find the one with the best reaction time. Those with poor scores (including me) simply cannot – despite practice – bring them down to the score of a good sharpshooter. My interest was in writing the programme. I have not used it to study the effect of alcohol on my reaction. This one may be new to the wife.

The programme is entered after storing 5 in Register 0. The programme starts at location 00.

RCL; 0, PAUSE; dsz; 0; 0; 1; 0; STO; 0; dsz; 1; 0; 0; PAUSE; NOP. . . . . NOP; 5; STO; 0; R/S; RST at location 99.

If we wish to find the time necessary for a NOP instruction, we can write a programme with 95 NOP steps and a few instructions to add 1 to Register 1. We can run the programme for 60 seconds and stop it with the R/S key; we then note the contents of Register 1 (and the line at which the programme stopped). We repeat the programme with 50 NOP steps. We can then write two simultaneous equations from which we can find the time for a NOP instruction and the time required to add 1 to Register 1. In my calculator, the NOP instruction takes 0.0137 seconds.

Instead of a count-down sequence preceding the display of zero, we could arrange a slightly more demanding test. A programme is written which displays random numbers in the range 0-99. Person A controls the test: person B is tested. A quotes a certain number, e.g. 57, which he has stored at a certain register. B observes random numbers appearing and, as soon as the chosen number has appeared and disappeared, he must press the R/S key as quickly as possible. After the chosen number has appeared, the programme branches to a series of NOP instructions; B's score is found, as in the first method, by pressing the LRN key. Of course, if the random number generator is arranged to give number up to 10 digits, the test is all the more exacting. With my programme for random numbers which may have up to 10 digits, we may have 18 numbers displayed in a minute, each display lasting between ¼ and ½ second. (Part of the time, when the calculator is crunching numbers, the display is blank.) Reading a 10 digit number in the available time, and deciding that it is, or is not, the specified number, requires a certain mental speed.

T. Palmer
Acton Technical College
London, W3.

SIMULATING BIRDS' GEOMAGNETIC SENSE

With some trepidation I refer to the magnificent correspondence entitled "Electrodynamically induced e.m.f.," which spanned nearly two years from its inception in "Cathode Ray's" articles "Electricity and Magnetism?" (September and October 1974) via the spirited introduction of the aeroplane problem by Todd and Taylor of Brunel University (July 1975). May I engage the attention of those readers who would agree with C. R. Masson (Cambridge), "Cathode Ray," D. H. Preis (Harvard), B. J. C. Burrows (Culham), D. Midgley (Hull) and me! in order to help solve what seems like a very non-*Wireless World* problem – the geomagnetic sense in birds?

I have made a computer simulation of an "electrodynamic" model of bird flight. Due to wing-flapping the voltage-gradient varies, depending upon the instantaneous direction of the wing with respect to the direction of the geomagnetic field. The simulation resolves wing movement in three axes and the earth's field in two axes.

There are two effects, however, which I am unable as yet to incorporate:

1. What is the effect of the vertical electric field (≈ 100 V.m^{-1}) upon the small computed voltage gradient induced in the wing (varying between $\approx -200\,\mu$V.m^{-1} and $+100\,\mu$V.m^{-1})? A simplistic argument runs like this: the *external* electric field is confined to the bird's surface, in the manner of Faraday's ice-pail, by induced charge. This charge gives rise to a leakage current which is limited by the low conductivity of the surrounding air to $\approx 10^{-15}$A, and which varies with movement of the wings in common mode for both wings. I fancy that a more advanced treatment would suggest that movement normal to an electric field gradient invokes a magnetic field at right angles which would modify the apparent direction of the geomagnetic field.
2. A varying voltage gradient in a bird's flapping wing demands ion movement to provide a "displacement" or "polarisation" current along the wing. If one uses values for wing "external" capacitance of the order of 10pF, one is left with a value of displacement current of $\approx 10^{-14}$A which is uncomfortably low although possible. I would like to think that there is some analogous *internal* capacitance, which describes the separation of charge carriers normal to the planes of equal *internal* voltage, which might have the effect of increasing this small displacement current. At any rate, the phase of this current appears to vary with the bird's heading, at a frequency of twice the flap frequency of about 7Hz in pigeons (i.e. narrow band f.m.).

As a matter of interest *New Scientist* describes bird navigation as "a central problem of avian biology!" Any offers?

B. Whatworth,
Addlestone,
Surrey.

LOSS OF INFORMATION CONCEPT

I have noted the comments in your August issue both in the leader and in Mr Greenbank's letter.

The first point you both make is that I did not express the "loss of information" concept (Letters, June 1977) in engineering terms, i.e. those that can be objectively quantified. However, in the context of a letter to a magazine I do not feel that this was the place to expand these ideas any further. This does not mean that we do not or can not measure "loss of information" objectively. Now, as in my previous letter, I do not propose to go into great depth on the measurement of "loss of information" but perhaps if any of your readers are both interested and suitably equipped they may care to try the following test which is one of many ways of ascribing a figure to "loss of information".

Submit the equipment under test to two signals, one of large amplitude which reasonably stresses the equipment and a second which is of higher frequency and smaller amplitude. At the output of the equipment under test the large signal is filtered out so that the smaller signal may then be examined. In this test one is concerned with distortion of the small signal during and after stress conditions caused by the large signal — for example, in the case of an amplifer, driving an electromechanical load.

The difference in dynamic range between the two input signals may be as large as 90dB. This test is the basis of a range of tests which can characterise the ability of a piece of audio equipment to reproduce a given dynamic range at one instant in time. This ability is crucial to the reproduction of music. I would propose however that conducting these tests on a piece of equipment after it has been designed is rather like shutting the garage door after the car has been stolen.

I was most interested by Mr Greenbank's disclosure that during amplification "latch-up" periods of 100% intermodulation occur. Intermodulation is a term that describes what occurs when two signals modulate each other, i.e. produce input dependent intermodulation products e.g. $f_1 - f_2$, $f_1 + f_2$, $2f_1 - f_2$ etc. As far as I have been able to observe when an amplifier is "latched-up" it does not respond to input signal in any predictable way.

J. Vereker
Naim Audio Ltd
Salisbury
Wilts.

AURAL SENSITIVITY TO POLARITY

I suspect that Dr Lipshitz (October Letters) and I are getting round to dealing with apparent misunderstandings rather than real differences of opinion on the question of polarity maintenance.

The polarity effects that Dr Lipshitz described do exist and have been known to exist for some 30 years and I discussed the generally accepted explanation. The waveforms of speech are known to be asymmetrical and either by coincidence or evolution the asymmetry just about compensates for asymmetry of the opposite polarity in the ear drum system. To maintain the compensation that nature apparently intended, it is necessary that our radio transmission systems maintain this polarity relation, a positive going sound pressure wave at the studio microphone producing a positive going sound pressure wave in the listening room. Polarity changes anywhere in the system will produce a change in the quality of the reproduced sound. However, the effect is subtle and I think that it requires equipment of professional quality if it is to be detectable.

I think Dr Lipshitz will agree that the experiments that he describes only tend to support this explanation.

James Moir
James Moir & Associates
Chipperfield
Herts

ADVANCED PRE-AMPLIFIER DESIGN

I found Mr Jung's letter in the September issue most interesting; it is gratifying to encounter someone who constructs and measures the circuit under discussion before commenting on it. However, I think it is important to distinguish clearly between the two types of restriction of output swing that occur at high frequencies in the type of disc pre-amplifier being discussed. It is, I think, better to stick with the accepted nomenclature and reserve the term "slew limiting" for that effect arising from the open-loop behaviour of an amplifier, and caused by finite currents charging and discharging compensation capacitance.

The other form of output restriction, which Mr Jung deals with under the same heading, is rather different, being peculiar to closed-loop amplifiers with significant shunt capacitance in the feedback arm. This is of course precisely the situation that occurs in an RIAA equalised input stage where the gain is designed to be relatively low so that a high overload margin may be obtained (assuming that a gain control of some kind is then placed before any further voltage gain). The core of the problem is that the feedback-loop shunt capacitance falls in reactance as the frequency being handled increases, and so an increasing current demand is placed on the output section of the amplifier; if this cannot be satisfied then a form of clipping results, and the output capability (and hence the input overload performance) is restricted at the top of the audio spectrum.

The output structure of the disc input stage of the "Advanced pre-amplifier" is a simple emitter-follower; this is much better at sourcing current than sinking it, and so Mr Jung's graph shows a curtailment of output capability at full drive and high frequencies, indicated by the abrupt rise of harmonic distortion that is typical of clipping. Examination will show that deformation of the output waveform only takes place on the downward half-cycle, due to the limited current-sinking capability, and in this respect the effect is quite different from what is normally known as slew-limiting.

It is at this point important to note that "full drive" is some 40dB above the nominal operating level of the stage, so the effects discussed here are unlikely to be obtrusive in the day-to-day performance of the preamplifier. Mr Jung's graph shows that if the test signal amplitude is reduced by 12dB there are no output-restriction effects in the audio band.

Finally, I have tested the effect of Mr Jung's modification (reduction of R_e to 1kΩ), and while the graph he displays is certainly correct in its essentials*, I feel it would be more meaningful to plot maximum available output swing against frequency. If this is done, it will be seen that the modification has its maximum effect at about 6kHz, where another 3.2dB of output voltage is available, giving a corresponding increase in input overload margin. However, the improvement diminishes either side of this frequency, falling to 1.0dB at 1kHz and to 2.4dB at 10kHz. Readers must judge for themselves whether this is worth the extra 14mA drawn from the power supply; confirmed lily-gilders may care to note that the same improvement can be implemented without increase in the current drawn by replacing R_e with a constant-current source delivering 6mA.

D. R. G. Self
London E.17

*The distortion figures shown for below 3kHz seem rather high — in particular it is most suspicious that the t.h.d. at 1kHz is shown as being higher at 1.25Vr.m.s. than at 5Vr.m.s. I assume that the data shown includes the imperfections of the test equipment.

CEE22 MAINS CONNECTORS STANDARD OR FIASCO?

Do manufacturers of electrical equipment using the CEE22 mechanical size and shape connector have any requirement to use a particular pin configuration? Many of the mains leads for these equipments (if not the majority) are of the moulded variety, and consumers tend to implicitly trust these leads.

Although it is becoming less common, single pole switching is still in use and production. The danger lies in the fact that while the equipment is switched off or when the mains fuse is blown the internal circuit is still live if the live and neutral leads are reversed. God forbid the results if the earth lead is transposed!

To date I have found three different manufacturers issuing equipment with live/neutral transposed leads. Two of these put no names on the leads.

I hope more people can be made aware of the moulded lead quality control/non-standard hazard.

K. A. Yates,
Glenrothes,
Fife.

ELIMINATING ADJACENT-CHANNEL INTERFERENCE

I find the July 1977 issue article on eliminating adjacent channel interference by P. L. Taylor to be most interesting. I have been attacking the problem for some time and have also developed a system to attenuate in-band interference on double sideband transmissions. This has been demonstrated to operate well with in-band modulated carriers and numerous in-band tones. Noise is also reduced. However, I have been unable as yet to satisfactorily eliminate cross modulation between noise and the wanted signal, and, of course, depending on how noise theory is interpreted and extended, this may or may not be possible.

As the system is somewhat complex this is not the place for its description. However, I find the reactions that I have been receiving to it to be surprising and rather depressing, and unfortunately some of these reactions would also apply to Mr Taylor's design.

The first reaction from Canadian Government officials is that interference and noise do not pose any problem as current equipment provide noise-free reliable links. Next, the system only applies to double sideband transmissions. This form of radio communication is now obsolete and is being legislated out of existence to be replaced by single sideband. A reaction from Canadian industry is that it is too complex to warrant risking development money and would necessitate synchronous receiver operation which has proved unpopular in the past. From Canadian universities and research establishments comes the comment that the system cannot possibly work for noise because Shannon set the God-given limits twenty years ago and any suggestion that his theory can be developed to show more than 3dB advantage for double over single sideband transmission is rank heresy; common interference reduction is of no interest. Incidentally, the one exception here is McMaster University in Hamilton, Ontario.

Double sideband amplitude modulation produces a unique signal having a "mirror image" frequency spectrum and constant phase. Interference can be detected in very much the same way as used to be employed in old movies for a man to tell whether or not he was real. If he saw his reflection in a mirror he was real, if no reflection was there he had to conclude that he was a ghost.

There is the possibility that a double sideband signal can be lifted out of interference and noise to an extent that is an order of magnitude greater than current communications theory implies. It is not that the theory is wrong, it is that it is limited. Mr Taylor's system shows one approach, my own shows another.

L. Illingworth
German & Milne
Montreal
Quebec, Canada

Microcomputer design

2 — Practical hardware and software

by Phil Pittman, B.Sc., *in association with NASCO Ltd*

Having now looked at the various elements which constitute a microcomputer system we shall move on to examine the detailed construction and operation of a practical system. The example chosen is based on the microcomputer kit shown as a block diagram in Fig. 1 (see panel in November issue).

This system is intended as a "home" computer kit for amateur and educational use. By using commonly available domestic equipment as peripherals, for example a standard television set for a display and an audio cassette player for storing and loading programmes, a low cost system has been produced. The Z80 c.p.u. connects to the memory and the i/o components via the three bus arrangement described last month. The 1K × 8 e.p.r.o.m. is programmed with a system monitor programme. This programme automatically starts running when power is applied and allows the user to communicate with the system. Commands may be entered via the keyboard and interpreted and executed by the monitor programme. This then allows the system to function as a general purpose computer where user programmes may be keyed in to the r.a.m. memory for subsequent execution, again under control of the monitor programme. The monitor supports such functions as: entering information into memory, displaying memory contents on the tv screen, loading memory from cassette tape, storing memory contents on cassette tape, starting programme execution from any given memory address and stopping programme execution when a predetermined point is reached.

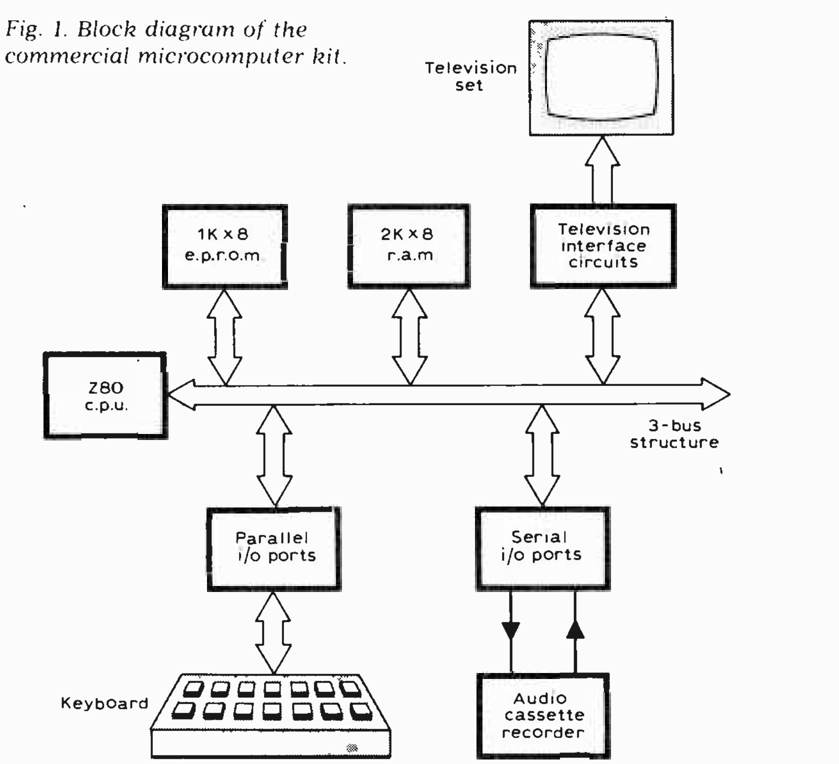
Although the entire 2K × 8 r.a.m. is available to the user of the system as a programme or data store, 1K × 8 of it is generally reserved as a character store for the tv screen information. However, because this screen memory is accessible by any programme in the system it is possible to achieve some interesting graphic effects by this conventional video interface.

A serial interface is implemented in the kit in order to provide a serial data stream to and from the cassette system. The keyboard is connected via a parallel interface controlled by the monitor software.

The essential parts of this hardware system are shown in detail in Fig. 2. Before considering the operation of the system it is useful to examine the timing of a general Z80 system. Fig. 3(a), (b) and (c) show the bus timing relationships for a programme memory access, data memory access and i/o access respectively. Note that each c.p.u. machine cycle is made up of a number of timing states. A complete instruction cycle may consist of one or more machine cycles, each consisting of at least three clock cycles, depending on the complexity of the particular instruction. The simplest Z80 instruction requires four clock cycles (or "T" states). During the T_1 state the memory or i/o address is placed on the address bus. The "memory request" or "input/output request" signal indicates whether the address is for a memory or i/o operation. T_2 is the time allowed to retrieve the memory or i/o data. The data travels on the data bus during T_3 time. The "read" and "write" signals indicate whether a read (or input) or write (or output) operation is in progress. This control structure, although described for the Mostek Z80 microprocessor, is fairly general for most processors. Other signals, more specific to the Z80 operation, will not be described here.

Referring to the circuit of Fig. 2, notice that because each bank of memory is 1K × 8, the address decoding is relatively straightforward. To address 1024 memory locations requires 10 address bits and so lines A_0-A_9 are common to all banks. In order to select

Fig. 1. Block diagram of the commercial microcomputer kit.



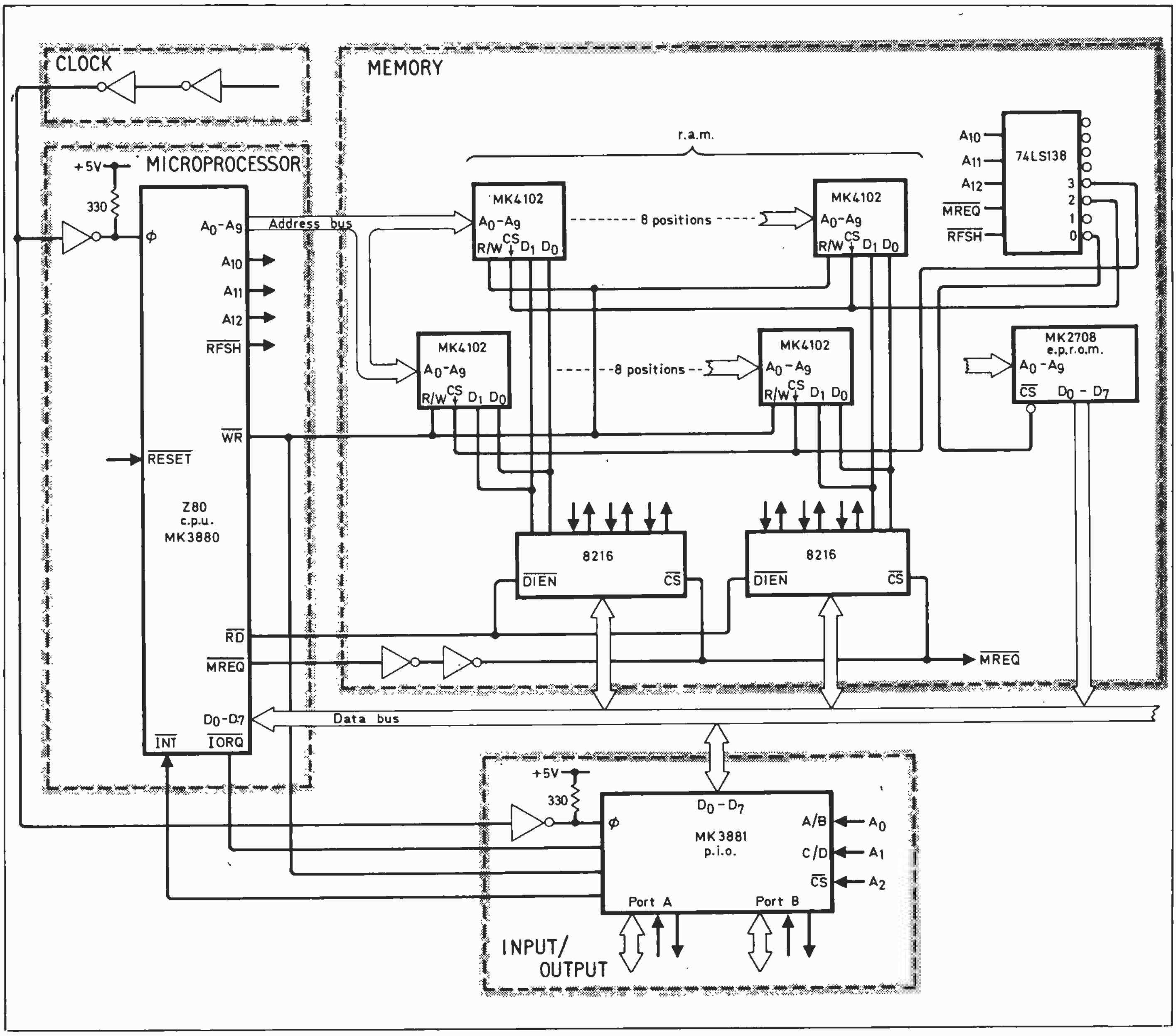


Fig. 2. Partial circuit diagram of the commercial microcomputer kit. Integrated circuits are labelled with their type numbers and other annotation corresponds to Mostek's technical literature. Negated names, e.g. MREQ indicate that the function is active when the signal is low. At this stage it is not necessary to follow the circuit in detail.

the appropriate bank, lines A_{10}-A_{12} are decoded via a 3 to 8 line decoder. The resulting memory map is shown in Fig. 4. The monitor p.r.o.m. is located in address range 0-1K because on power-up or system rest, programme execution is forced to resume at address zero. Consequently this is a convenient method to automatically begin execution of the monitor programme.

Since there very few i/o circuits in the system an address decoding scheme is not necessarily required for these, i.e. port addresses may be chosen such that individual address bus bits can select the appropriate device.

So far we have looked at the basic hardware components of a microcomputer system, showing how they relate to one another. Although one particular application has been considered, the hardware arrangement is capable of being universal. However, without software the hardware has no "personality". Software gives life to the hardware and will form the subject of the following discussions.

Stored programme concepts

The previous section has presented the hardware of the microcomputer kit after developing some of the concepts involved in its design in the previous article. In order to perform any useful function, the hardware must be given a programme to be stored in the microcomputer's memory. This then gives the system a unique "personality". In the following paragraphs some of the basic principles of programme execution and programme flow are introduced. A summary of the use of the "operations monitor" programme of the microcomputer kit is included in order to show some of the facilities available for verification of programmes, once written.

Any computer programme exists as a sequence of instructions within the main memory of the machine. These instructions are sequentially executed by the central processing unit to perform the desired task. Each instruction is represented within the memory as a binary number, which is decoded by the c.p.u. in order that the instruction may be executed. The instructions to be used are selected, by the human programmer, from what is called the "instruction set" of the c.p.u. The instruction set is the repertoire of binary codes which the c.p.u. is capable, by virtue of its design, of "recognising". The Z80 microprocessor, for example, has an instruction set consisting of 158 basic instructions.

In order to run a complete programme the c.p.u. must go through a process of repetitively fetching instructions from the memory into an internal store called an instruction register (see Fig. 5 November issue) and then decod-

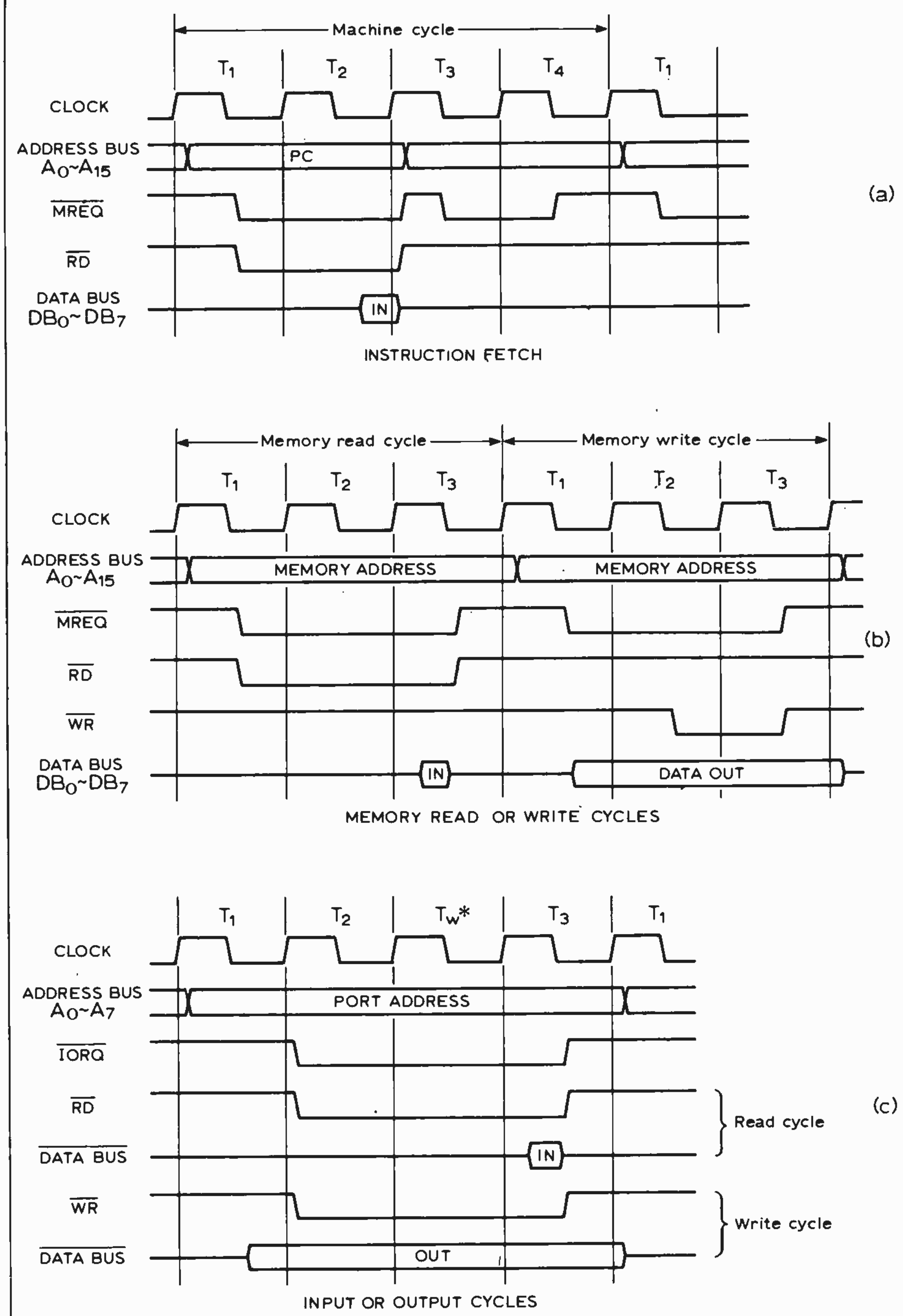


Fig. 3. System timing of the Z80 microprocessor, for (a) programme memory access, (b) data memory access and (c) i/o access.

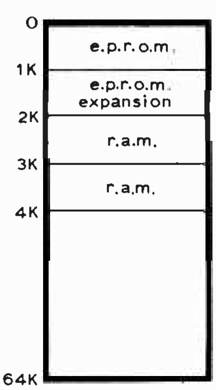


Fig. 4. Microcomputer system memory map.

ing and executing the instructions. This "fetch-execute" cycle is the basis for all programme operations.

The "fetch" part of the cycle is accomplished by the processor's placing the memory address of the next instruction in sequence on to the address bus and initiating a "memory read" operation. The instruction at this address then travels via the data bus into the processor, where it is subsequently executed. Upon completion, the next instruction must be fetched, and so on. Consequently there must be some mechanism provided within the c.p.u. for supplying sequential instruction addresses for successive fetches. This is in fact provided by the programme counter register. It is the contents of the programme counter which are placed on the address bus at the start of an instruction fetch. Then, before another fetch occurs, the programme counter is incremented so that the following instruction in sequence will be fetched next.

Once an instruction is in the c.p.u., the instruction decoding logic (Fig. 5, November) activates the appropriate internal circuits and an execution phase begins. Executing the instruction may be a completely internal operation within the c.p.u., e.g. performing an arithmetical, logical or data transfer operation on data contained in the microprocessor's registers. Alternatively, the execution of an instruction may require the movement of data in another area of system memory. If this is the case then the c.p.u. must put the new memory address on the bus for the transfer. This state of affairs may be further complicated by the fact that the data memory address may either exist in registers within the c.p.u. or may first have to be supplied to the c.p.u. from the "instruction memory", i.e. the programme memory may, in fact, consist of a mixture of instructions and data or addresses. The instruction contains a binary "operation code" which tells the c.p.u. exactly what to do during the instruction phase and whether to interpret subsequent information as data, address or a new instruction.

The following examples illustrate some of these possibilities. The c.p.u. has several internal 8-bit general purpose registers which will be referred to as A, B, C, D etc. Suppose we want to construct a programme to simply add the contents of B to A and then put the result into register C. A typical sequence of instructions could be

1. Add B to A
2. Load C from A

This simple programme requires two instructions as shown, each residing in one location of the programme memory.

Since the source and destination of the data for each instruction are contained wholly within the c.p.u.'s internal registers, no additional information need be supplied during the execution phases of the instructions.

Suppose now that it is desired to add a constant, *n*, to the contents of register A and then again put the result into register C. The programme instructions could be:

1. Add *n* to A
2. Load C from A

This programme must supply the number, *n*, to the c.p.u. from the programme memory. Consequently the programme memory would appear as follows:

Address		
p	Add	Consecutive memory locations
p + 1	*n*	
p + 2	Load	
p + 3		

This time, the number, *n* is embedded within the instruction stream and so a total of three memory locations is required for the two instructions. In the above examples the "load" instructions are identical, having the same data source and destination. However, the "add" binary instruction codes must be different in order to instruct the c.p.u. to get the data from the appropriate place. In the second example the programme sequence would be as follows: first, the programme counter contents (p) would be issued by the c.p.u. in order to fetch the "add" instruction. By decoding this the c.p.u. would then "know" that it must fetch data from the next sequential memory location. Now, during the execution of any instruction the programme counter will be advanced by one. Consequently the data address will be given by the new value in the programme counter. When this is fetched the c.p.u. completes the instruction execution and proceeds to fetch the next.

Another variation of this situation is given in the next example. Suppose it is required to add the contents of register B to those of register A and then store the result in another external memory location specified in the programme. The programme could be:
1. Add B to A
2. Load memory address *mn* from A.
The memory address *mn* may be typically a 16-bit number, therefore requiring two 8-bit memory locations. Consequently, the programme may appear as shown below:

p	Add	Memory representation
p + 1	Load	
p + 2	*m*	
p + 3	*n*	

This time the "load" instruction code instructs the c.p.u. that the destination address is contained in the next two memory locations and so the programme counter is incremented and sent out two more times before the c.p.u. has fetched all the information it requires. Now in order to complete the execution of this instruction, the address value (*mn*) must be sent out from the c.p.u., on the address bus, in order to access the required data memory location. During this cycle the data (contents of register A) is placed on the data bus so that it may be written into memory.

Table 1: Microcomputer kit software commands

T	ssss	ffff	Tabulate memory contents from address ssss to ffff
D	ssss	ffff	Dump memory to cassette from address ssss to ffff
L			Load memory from cassette
M	nnnn		Modify memory location nnnn
E	nnnn	or E	Execute programme (from address nnnn)
B	nnnn		Set a breakpoint at address nnnn
S	nnnn	or S	Single step execution (from address nnnn)

These simple examples have illustrated two important points: the way in which data and/or addresses may be included in programme instructions and how the c.p.u. is guided by the instruction operation codes into interpreting the sequence of information in the programme memory. The examples have shown how instructions are executed one by one, from start to finish of a programme. However, one of the principal features of a digital computer is its decision-making ability. In other words, the c.p.u. has the ability to select its own path through a programme depending on the results it gets from processing en-route.

In general this is achieved by certain instructions being able to examine the logical state of various bits within the a.l.u. Then, depending on these states, the c.p.u. may either continue with the next instruction in sequence or be diverted to a new area of programme memory. Diverting the c.p.u. in this manner is accomplished by loading a new value into the programme counter.

More specifically, the Z80 c.p.u. has, as part of the a.l.u., several single-bit "status registers" which remember conditions relating to the previously executed arithmetic or logical operation. These include the carry bit from the adder, an arithmetic overflow bit, an indication of a zero result, the sign (if relevant) of the a.l.u. result and an indication of the parity of the result in the a.l.u. Instructions in the c.p.u's programme "jump" group are able to interrogate any of these bits and either load the programme counter with a new value or leave it unchanged, depending on the binary state of the particular status bit.

In the programme shown below the c.p.u. tests the value stored in register A to see if it is less than 10. If so it subtracts 6 or otherwise leaves the number unchanged:

1. Compare A with 10
2. Jump if carry = 1
3. Subtract 6 from A
4. Next instruction

Here the "compare" instruction has a similar effect to that of subtracting 10 from A although the A register contents will remain unaltered. However, the carry bit of the a.l.u. (effectively a 9th a.l.u. bit) will be set to 1 if the number 10 is greater than the contents of the A register. The conditional jump instruction can examine the carry bit and thereby decide whether to continue normally or to jump out of the normal flow to another point in the programme. The programme memory would look as shown below.

When the jump instruction is fetched, all three memory bytes, i.e., including the 16-bit jump address, will be read into the c.p.u. However, if the test is true then the value (p + 7) will be put into the programme counter causing the "subtract 6" instruction to be missed.

The instructions used in the above examples are but a few of the many which are common to most microprocessors.

Before continuing to look at further programme writing techniques it is relevant to complete the discussion of the microcomputer kit facilities by

Address		
p	Compare	Compare instruction operation code
p + 1	10	Operand (10) for compare instruction
p + 2	Jump if carry	Conditional jump operation code
p + 3	p + 7	16 bit jump address to p + 7
p + 4		
p + 5	Subtract	Subtract operation code
p + 6	6	Operand (6) for subtract instruction
p + 7	Next instruction	Next instruction in sequence

Table 2: Hexadecimal number system

Hex	Decimal	Binary
0	0	0000
1	1	0001
2	2	0010
3	3	0011
4	4	0100
5	5	0101
6	6	0110
7	7	0111
8	8	1000
9	9	1001
A	10	1010
B	11	1011
C	12	1100
D	13	1101
E	14	1110
F	15	1111

examining the features offered by the kit's own software package.

A practical software system

The 1Kbyte e.p.r.o.m. programme of the kit is intended as an aid to debugging and executing programmes written by users of the kit. This software supports seven basic commands as outlined in Table 1.

Before proceeding with a description of these commands it is useful to introduce the concept of the hexadecimal number system. When working at machine code level with computers it is obviously very tedious to work in pure binary notation since the numbers are very cumbersome and difficult to visualise easily. Similarly, it is inconvenient for the computer to work with a decimal system since binary bit patterns are not readily convertible to and from decimal numbers. Consequently a suitable compromise is the hexadecimal system which works to a base of 16. Here the symbols 0 to 9 are no longer adequate by themselves and six additional symbols are required for representation of hex numbers. These are chosen to be letters A to F of the alphabet. Table 2 shows the equivalent binary and decimal values for the hex digit set. The advantage now is that numbers can be easily converted between binary and a notation which is less tedious to write because each hex digit corresponds directly to 4 bits of the binary value. Table 3 shows examples of a 16-bit and an 8-bit binary conversion to and from hex.

The software of the kit uses this number system for both displaying and entering numerical information. Each command entered via the keyboard by the user must consist of a single letter identifier followed in most cases by one or two 4-digit hex numbers. If two such parameters are required they must be separated by a space. The kit automatically generates the space between the letter identifier and the first parameter. To cause the command entered to be executed, the user must type a "carriage return" (cr) character. When the system is ready to accept a new command it "prompts" by issuing a full stop (.).

The "tabulate" (T) command allows the user to display the contents of the system's memory by specifying the upper and lower address limits concerned as part of the command. An example of this is shown in Table 4. Note that eight hexadecimal memory bytes are displayed per line, preceded by the address of the first byte on that line.

The "dump" (D) command works in a similar way but causes the information to be recorded on to the cassette tape system. As it does so, an additional item of data, called a "checksum" is calculated for each line of data. This checksum is not displayed but is recorded on tape for subsequent checking by the "load" (L) command.

The "load" command reads programmes or data from cassette and stores the relevant memory values in the system's memory at the addresses specified at the beginning of the information blocks. Checksums are again calculated by the processor and compared with those on tape. If they differ, the computer assumes that there has been a tape reading error and stops further loading. At this point the user can take whatever action is desired.

The "modify" (M) command allows memory locations to be examined or modified via the keyboard. Variations on this command enable the user to examine a single byte, replace it with a new value, delete a wrongly entered value, continue to the next consecutive memory address or terminate the command.

A programme "breakpoint," as it is called, may be set using the "B" command. A breakpoint is a very valuable facility when initially checking out a programme to see if it runs correctly. The address value given as part of the breakpoint command represents the point at which it is desired to stop a programme being executed. At this time, the kit software prints out the current contents of the c.p.u.'s programme counter and accumulator registers. Also, the remaining c.p.u. registers are automatically saved in r.a.m. so that they may be examined later with the "M" or "T" commands. In this way the programmer is able to "see inside", the c.p.u. chip at any desired stage in the programme and then modify the registers accordingly, if required, before continuing.

The "execute" (E) command is used to start execution of a programme from a desired address. If no address is specified with the command then execution will continue from the address which was in the programme counter before the previous breakpoint was encountered. Register values saved at a breakpoint will be restored automatically prior to execution.

The "single step" (S) command is similar to the "executive" command but causes only one instruction to be executed before stopping.

The above facilities enable programmes to be debugged on the kit in a way that would not be possible otherwise. The value of these will be illustrated in a more practical way in a future article on programme writing and debugging.

Table 3: Examples of binary/hexadecimal conversions

(a)	Binary	0001	1010	1110	0110
	Hex	1	A	E	6
	Decimal	(1×16^3) +	(10×16^2) +	(14×16) +	(6)
(b)	Hex	0011	← 3F →	1111	

Table 4: Typical display format from kit

(.)	T	800	813	(Entered by user)				
0800	00	11	22	33	44	55	66	77
0808	88	99	AA	BB	CC	DD	EE	FF
0810	A1	B2	C3	D4				

SPECIAL TERMINOLOGY

To access. The noun "access" used as a verb, meaning to gain access to a memory location in which binary information is already stored or can be stored. To open up a set of connections to allow reading from or writing into this location.

Instruction. An expression that defines a computer operation and identifies its operands.

Programme. A prepared list of instructions, written in a special "language" or code, to be carried out in sequence by a computer or other programmable device.

Instruction set. The total list of instructions that can be performed by a given microprocessor

Operation code. The symbols within an instruction that represent the particular operation to be performed (e.g. add).

Register. A small-capacity store intended for temporarily holding a small number of binary digits such as a word.

Jump. A departure from the normal sequence of instructions in a programme to a different part of the programme

Logic design — 10

This article is the second part of Article 7, which appeared in the September issue.

More synchronous and ripple-through counters

by B. Holdsworth* and D. Zissos†

Chelsea College, University of London †Department of Computing Science, University of Calgary, Canada

Decade binary 'up' counter. Examination of the unused states in Fig. 5(a) shows that they can be represented by the Boolean function BD + CD

The flip-flop equations are the same as for the scale-of-16 'up' counter, namely, $J_A = K_a = 1$, $J_B = K_B = A$, $J_C = K_C = AB$ and $J_D = K_D = ABC$, with the modifications shown below, which are required to inhibit the S_9 to S_{10} transition and initiate the S_9 to S_0 transition.

The transitions from S_9 to S_{10} and S_9 to S_0 are shown below:

	D	C	B	A		D	C	B	A
S_9	1	0	0	1	S_9	1	0	0	1
S_{10}	1	0	1	0	S_{10}	0	0	0	0

To inhibit the set of flip-flop B, S_h = ABS_9, where S_9 = ABCD+ (BD) + (CD). Simplifying: S_9 = AD, hence: S_B = $A\bar{B}\bar{A}\bar{D}$ = $A\bar{B}$ $(\bar{A}+\bar{D})$ = $A\bar{B}\bar{D}$. Therefore, J_B = $A\bar{D}$. To initiate the reset of flip-flop D, R_D = S_9 = AD. Therefore, K_D = A.

If the counter should assume one of the unused states due to circuit misoperation then a suitable corrective action might be to suppress the clock pulses and trip an alarm, using the Boolean function representing these states, f = BD + CD. A suitable circuit for suppressing the clock pulses is incorporated with the counter implementation in Fig.5(b).

A decade of binary 'down" counter can be designed using the same technique and the corresponding flip-flop equations are: $J_A = K_A = 1$, $J_B = \bar{A}C + \bar{A}D$, $K_B = \bar{A}$, $J_C = \bar{A}D$, $K_C = \bar{A}\bar{B}$ and $J_D = K_D = \bar{A}\bar{B}\bar{C}$. The output of a binary decade counter can be converted to a decimal number using a 4-10 line decoder as shown in Fig.6.

Consider the transition in such a counter from 0001 to 0010 and assume that flip-flop B changes faster than flip-flop A. The sequence of changes that take place are:

D	C	B	A	
0	0	0	1	
0	0	1	1	(transient state)
0	0	1	0	

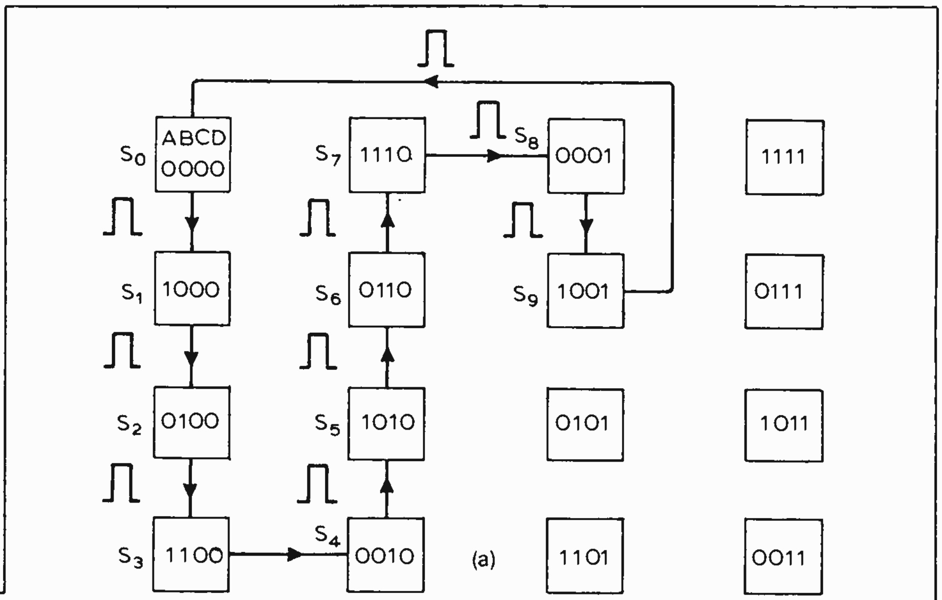
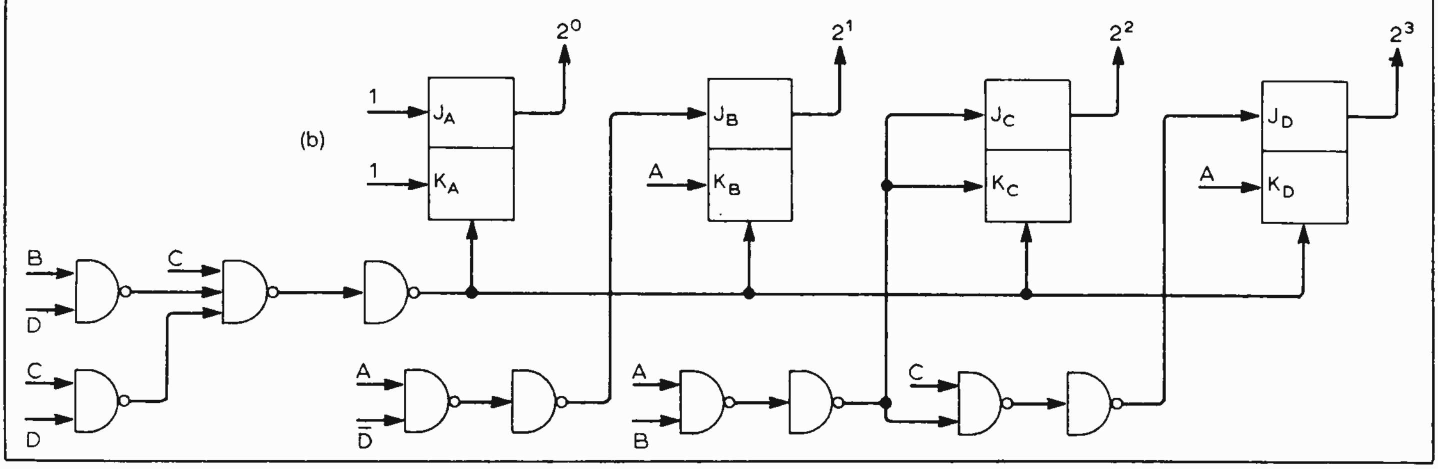


Fig. 5(a) shows the state diagram for a decode binary 'up' counter, and at (b) is the circuit implementation.



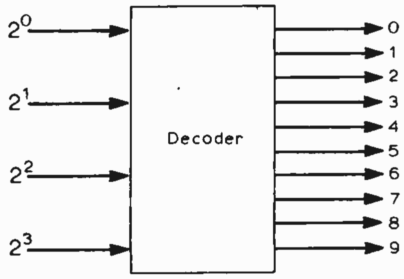


Fig. 6. A 4-10 line decoder.

D	C	B	A
0	0	1	0
0	1	1	0
0	1	1	1
0	1	0	1
0	1	0	0
1	1	0	0
1	1	0	1
1	1	1	1
1	1	1	0
1	0	1	0

Table 8. The XS-3 Gray code.

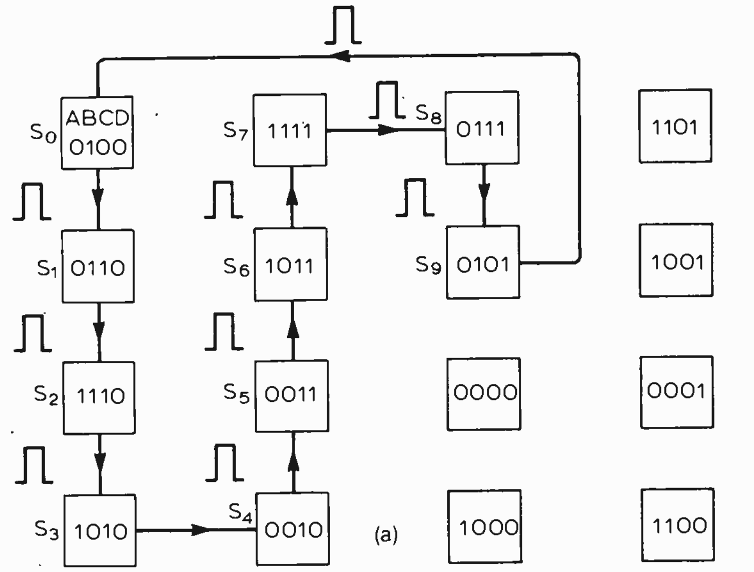
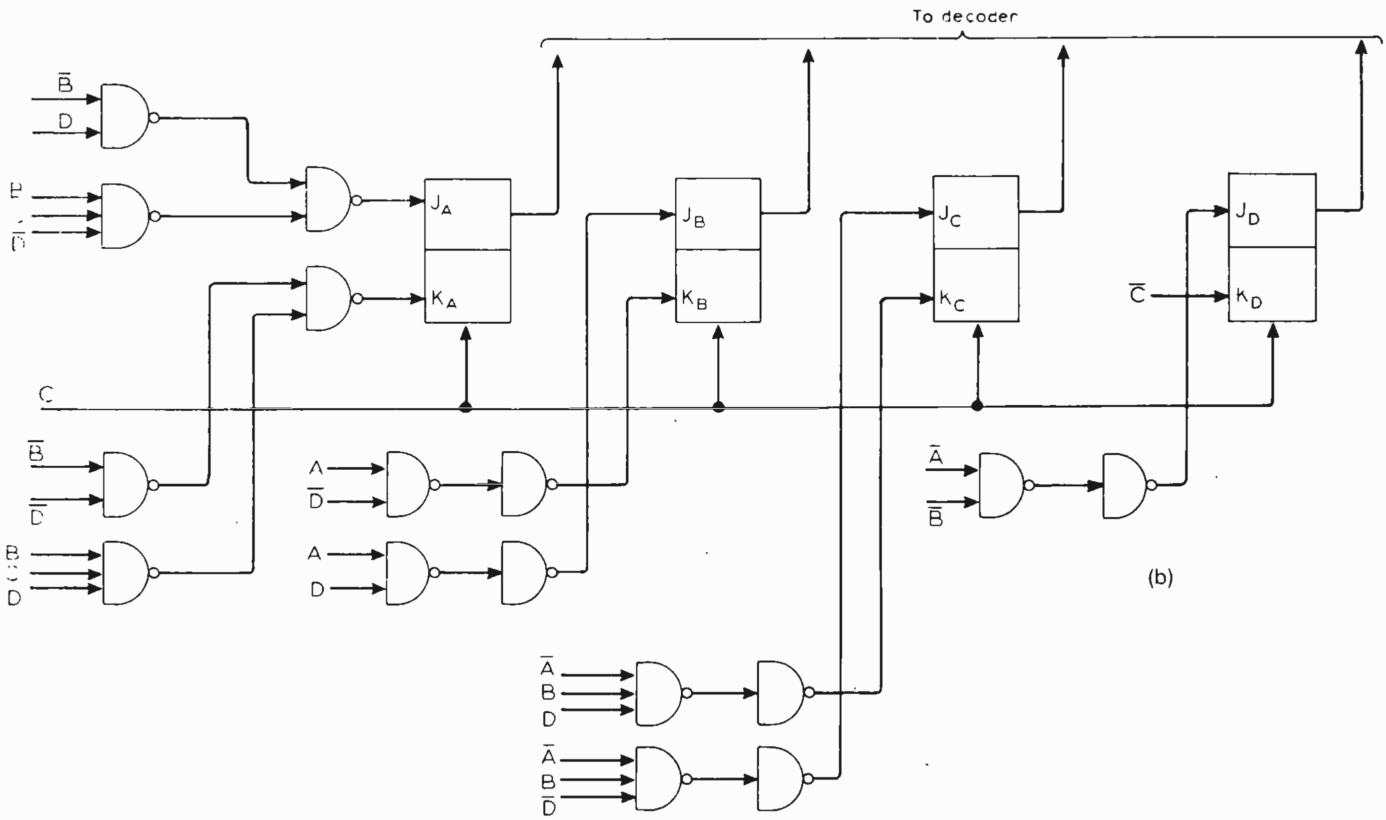


Fig. 7. State diagram for a XS-3 Gray code counter is at (a) and (b) shows the circuit.



Hence a spike will occur on the output line marked 3 during the transient state. Clearly this can occur at any point in the binary counting sequence where more than one flip-flop is required to change state during a transition. The difficulty can be eliminated by using a Gray code counter, in which only one flip-flop changes state at each transition.

Decade Gray code 'up' counter. As an example of the design of a Gray code counter, the XS3 code will be converted to a Gray code which will be used as the basis for the counter design. The conversion is carried out by obtaining the exclusive-OR sum of each pair of digits in the code starting with the two least significant digits first, as shown below. It is assumed that there are five digits in each code combination, the fifth and most significant, always being 0.

0 0 0 1 1

$\oplus$ $\oplus$ $\oplus$ $\oplus$

0 0 1 0

The complete XS3 Gray code obtained using this procedure is shown in Table 8.

A convenient procedure for designing a Gray code counter is:

(1) Determine the S and R expressions for each flip-flop and, using the equations $S_Q = J_Q\bar{Q}$ and $R_Q = K_Q Q$, obtain the corresponding expressions for J and K.

(2) Optional products defined by the unused states, (if there are any,) can now be used to reduce the J and K expressions. For the state diagram and codes, see Fig.7(a).

Examination of the unused states in Fig.7(a) shows that they can be represented by the Boolean expression $\bar{B}\bar{C} + A\bar{C}$.

The flip-flop equations are:

$$S_A = S_1 + S_5 = \bar{A}BC\bar{D} + \bar{A}\bar{B}CD$$
$$J_A = BC\bar{D} + \bar{B}CD + (\bar{B}\bar{C}) + (A\bar{C}) = \bar{B}D + BC\bar{D}$$

$R_A = S_3 + S_7 = A\bar{B}C\bar{D} + ABCD$
$K_A = \bar{B}C\bar{D} + BCD + (\bar{B}\bar{C}) + (A\bar{C})$
$= \bar{B}\bar{D} + BCD$

$S_B = S_6 = A\bar{B}CD$
$J_B = ACD + (\bar{B}\bar{C}) + (A\bar{C})$
$= AD$

$R_B = S_2 = ABC\bar{D}$
$K_B = AC\bar{D} + (\bar{B}\bar{C}) + (A\bar{C})$
$= A\bar{D}$

$S_C = S_0 = \bar{A}B\bar{C}\bar{D}$
$J_C = \bar{A}B\bar{D} + (\bar{B}\bar{C}) + (A\bar{C})$
$= \bar{A}B\bar{D}$

$R_C = S_8 = \bar{A}BCD$
$K_C = \bar{A}BD + (\bar{B}\bar{C}) + (A\bar{C})$
$= \bar{A}BD$

$S_D = S_4 = \bar{A}\bar{B}C\bar{D}$
$J_D = \bar{A}\bar{B}C + (\bar{B}\bar{C}) + (A\bar{C})$
$= \bar{A}\bar{B}$

$R_D = S_9 = \bar{A}B\bar{C}D$
$K_D = \bar{A}B\bar{C} + (\bar{B}\bar{C}) + (A\bar{C})$
$= \bar{C}$

The circuit implementation of the counter is shown in Fig.7(b).

The output of the counter can be converted directly to decimal with the aid of a 4-10 line XS3-Gray-to-decimal decoder, which is available as a chip.

If the above procedure is adopted for the design of an XS3-Gray code decade 'down' counter the following flip-flop equations are obtained:

$J_A = \bar{B}\bar{D} + BCD$, $J_B = A\bar{D}$, $J_C = \bar{A}BD$, $J_D = \bar{C}$.

$K_A = \bar{B}D + BC\bar{D}$, $K_B = AD$, $K_C = \bar{A}B\bar{D}$, $K_D = \bar{A}\bar{B}$.

The unreduced, and hence the reduced, J and K values of the flip-flops in one direction are the same as the K and J values of the flip-flops in the reverse direction, i.e. to reverse the direction of count it is only necessary to interchange the J and K inputs of each flip-flop.

It should be noted that the method of design employed does not always produce the simplest flip-flop equations but it has advantages when applied to the implementation of 'up-down' Gray code counters.

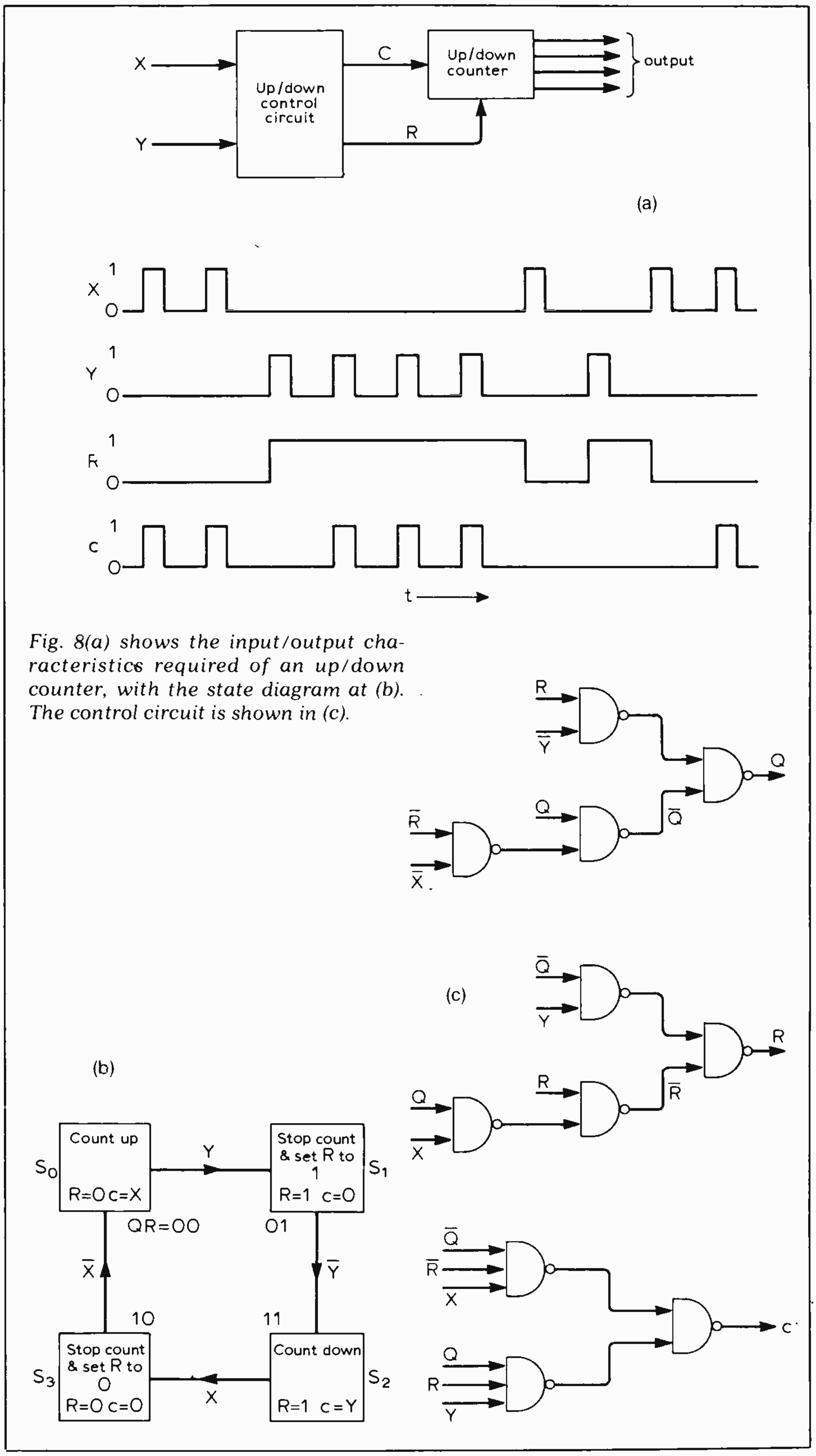


Fig. 8(a) shows the input/output characteristics required of an up/down counter, with the state diagram at (b). The control circuit is shown in (c).

'Up-down' control

'Up-down' counters are counters in which the pulse count is stepped up or stepped down by each input pulse according to whether the value of an external control signal R is 0 or 1. In practice, the input signals that step the count up or down will appear on two separate lines X and Y, as shown in Fig.8(a). The designer has to generate the clock pulses that will drive the counter flip-flops and the 'up-down' control signal R. It will be assumed that step-up and step-down signals do not appear simultaneously.

The control signal must not be allowed to change during the presence of the input data. In this case, the control signal will be generated from the input data and a race condition can be prevented by using the first pulse in each pulse train to change the value of R. Since each time the value of R is changed an input pulse is not counted this method results in a maximum count error of 1 for an odd number of changes in R and no error for an even number of changes in R.

The logic circuit used to perform the function described above is event driven and the methods used in the third article of this series will be employed in its design.

Step 1 Figure 8(a) shows the input/output characteristics.
Step 2 A suitable state diagram is shown in Fig.8(b).

Step 3 State reduction is not attempted so that clarity of design is maintained.
Step 4 Turn-on set of $Q=R\bar{Y}$
Turn-off set of $Q=\bar{R}\bar{X}$
Turn-on set of $R=\bar{Q}Y$
Turn-off set of $R=QX$

The sequential equations are:
$Q=R\bar{Y}+Q(R+X)$
$R=\bar{Q}Y+R(\bar{Q}+\bar{X})$
and $c=S_0X+S_2Y=\bar{Q}\bar{R}X+QRY$
The circuit implementation is shown in Fig.8(c).

'Up-down' XS3-GRAY code counter. Combining the flip-flop equations for 'up' counts when $R=0$ and for 'down' counts when $R=1$ the following results are obtained for the XS3-Gray code counter:

$J_A' = (\bar{B}D+BC\bar{D})\bar{R}+(\bar{B}\bar{D}+BCD)R$
$\quad = J_A\bar{R}+K_AR$
$K_A' = (\bar{B}\bar{D}+BCD)\bar{R}+(\bar{B}D+BC\bar{D})R$
$\quad = K_A\bar{R}+J_AR$
Similarly
$J_B' = J_B\bar{R}+K_BR$
$K_B' = K_B\bar{R}+J_BR$
and so on for J_C', K_C', J_D', and K_D', where J′ and K′ are used to denote the flip-flop inputs in the 'up-down' mode.

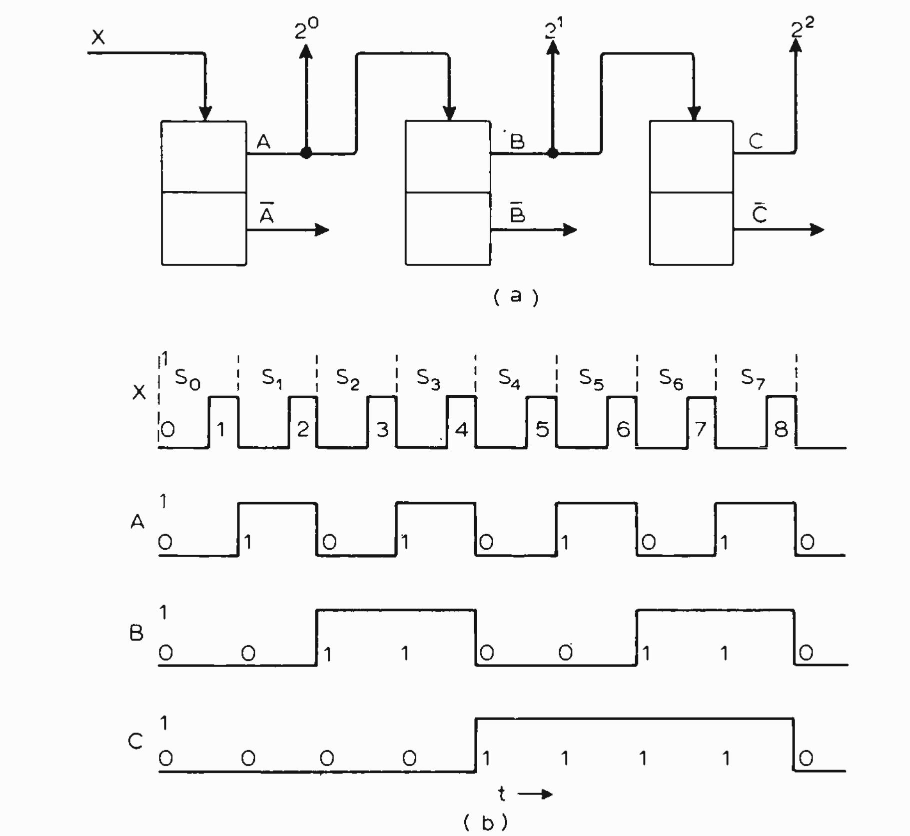


Fig. 9(a) is a 3-stage ripple-through counter, and at (b) are the timing diagrams.

Asynchronous binary counters

For counts of powers of 2 the basic arrangement consists of T flip-flops, (or alternatively JK flip-flops with J and K permanently connected to 1), connected in cascade as shown in Fig.9(a). As can be seen from the diagram the output of each flip-flop provides the clock signal for the next. The input signal X is used as the clock pulse for the first flip-flop.

The time-diagrams for a scale-of-8 (up) counter are shown in Fig.9(b), where all changes of state are assumed to take place on the trailing edge of the clock pulses. Examination of the time diagrams shows that flip-flop A changes state on each trailing edge of the input pulses X. The output of flip-flop A is used as the clock pulse for B and a change in state of this flip-flop occurs on the trailing edge of the A pulses. Similarly the output of B provides the clock pulse for C and this changes state on the trailing edge of the B pulses.

The various states of the counter are indicated on the time diagram and the binary digits associated with each state are marked on the time diagrams for the signals A, B, and C.

It is a simple matter to show that the above circuit will count down if the signals $\bar{A}$ and $\bar{B}$ are used as the clock pulses for flip-flops B and C respectively.

Scale-of-ten 'Up' Counter.

This circuit requires four flip-flops, as shown in Fig 10(a). The associated time diagrams are displayed in Fig.10(b). Starting with all the flip-flops in the 0

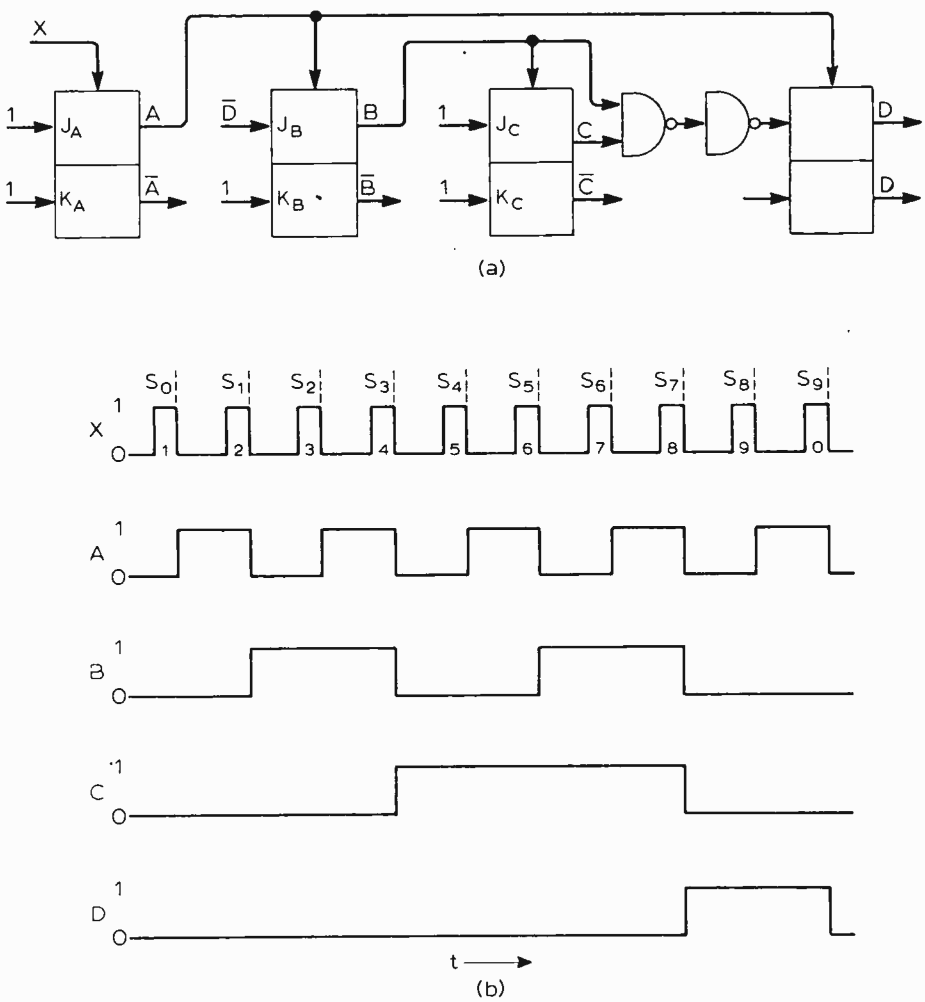


Fig. 10 is a scale-of-ten ripple-through counter. Timing diagrams are at (b).

state, the count follows the normal binary sequence up to and including the count of eight. On the trailing edge of the tenth input pulse, flip-flop A makes a transition from 1 to 0, which would normally induce a transition in flip-flop B, changing its state from 0 to 1. However $J_B = \bar{D} = 0$ at this instant and consequently flip-flop B remains in the reset condition. At the same instant it is also necessary to reset flip-flop D and it changes state from 1 to 0. All the flip-flops are now in the reset condition and are ready for the arrival of the first pulse of the next counting cycle.

Scale-of-twelve 'Up' counter

The basic circuit of a scale-of twelve asynchronous counter is shown in Fig.11(a), whilst the time diagrams describing its behaviour are shown in Fig.11(b). Flip-flops A, B, and C count from 000 to 101 inclusive. With D = 0 the counter reaches the state ABCD = 1010 (S_5), and when the next X input pulse is received it must go to the state ABCD = 0001.

Flip-flop A is controlled by the X pulses and changes state to A = 0 on the trailing edge of the sixth of these pulses. Flip-flop B remains in the B = 0 state since $J_B = C = 0$ and flip-flop C takes up the state C = 0 since $J_C = B = 0$ and $K_C = 1$. The change of C from 1 to 0 represents the trailing edge of the clock pulse for flip-flop D and hence there is a change of state for this flip-flop such that D = 1.

After another six X pulses the state of flip-flop D is restored to 0 and the counting cycle of twelve states is completed.

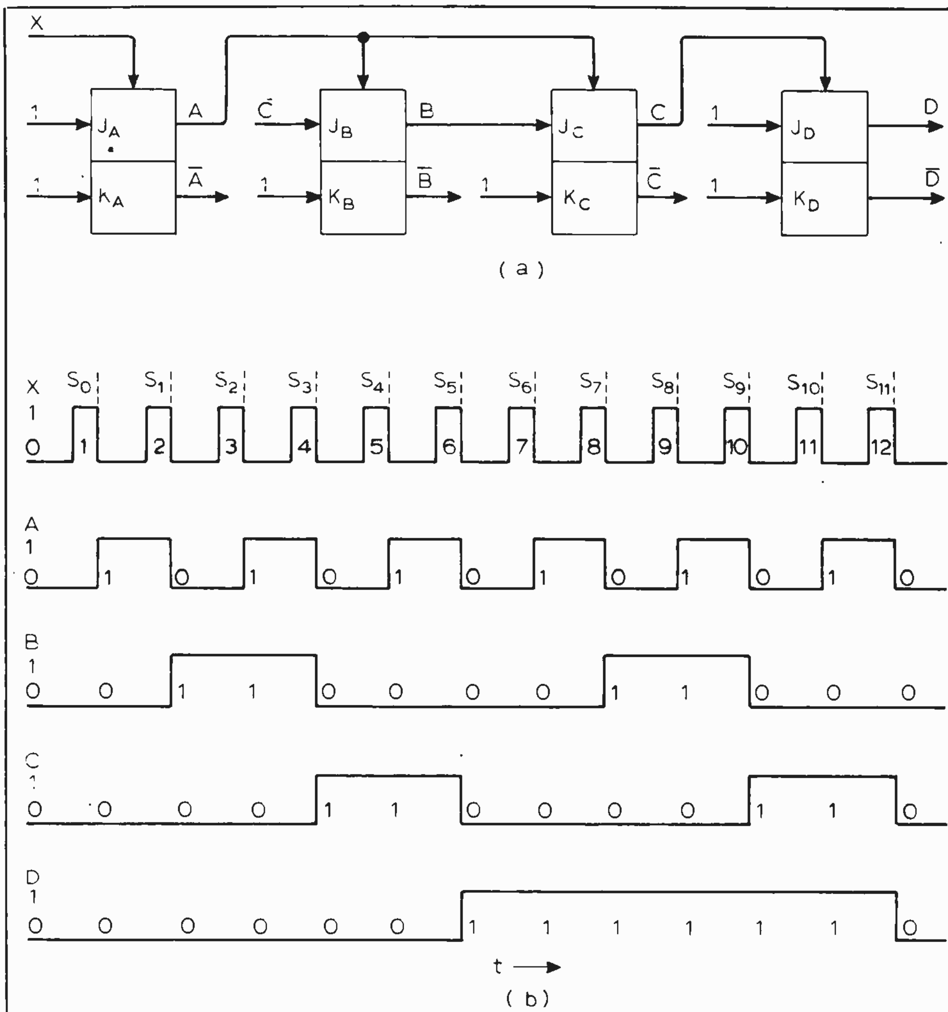


Fig. 11 shows the form and timing diagrams of a scale-of-12 asynchronous counter.

Continued from page 49

Appendix 1

To arrive at a general solution, take two threads of equal length y. By their top ends they hang from the ends, C and D of a fixed bar 2a long, Fig. 9. The lower ends are fixed to the ends of a moveable bar AB, 2b long.

The bar has a mass W and requires horizontal couple of moment M to rotate it through θ degrees about a vertical axis passing through the centres of AB and CD. There will be a tension T in the threads, which will be at an angle α to the vertical.

$$W = 2T\cos\alpha$$
$$M = 2b\,T\sin\alpha\sin\beta$$
$$M = bW\tan\alpha\sin\beta$$

Now $Y\sin\alpha\sin\beta = a\sin\theta$ and substituting for sin β

$$M = \frac{Wab\sin\theta}{y\cos\alpha}$$

This is the general case. In our case we assume $a = b < 1/3$, so $y\cos\alpha$ becomes h and constant. θ = 90°, sin θ = 1 and the equation becomes

$$M = \frac{Wa^2}{h}$$

Appendix 2

The stylus only tracks a groove tangentially at the end of a side. This is in fact how the arm is set up. At the start of a side there is a tracking error γ, which in a well-designed arm should not exceed two degrees. This decreases across the record. The equation on page becomes

$$S = F\sin(\phi + \gamma)$$

Appendix 3

–typical values, in grams

Component	*Mass–W*	*Me*
Cartridge	7	7
Arm	5	1.5
Wire	2	0.5
Clip and screws	2	2
Counterweight	42	3
	–	–
Totals	58	14

For weighing things I use ordinary kitchen scales which turn nicely at 1/16 oz. A tuppenny piece weighs ¼oz, one penny weighs ⅛ oz and ½ pence weighs 1/16 oz. And, of course, 1 oz is 28 grams. For objects weighing four grams or less, I use a stylus scale: hopelessly inaccurate but can be recalibrated.

Books Received

Tower's International Fet Selector by T. D. Towers and N. S. Towers starts with a brief introduction to f.e.ts followed by a list of about 2,600 devices together with chracteristics and ratings. Four appendices provide information on the tabulations, package outline and pin configuration, manufacturers house codes, and manufacturers address. Price £4.50 Pp.57. W. Foulsham & Co. Ltd, Yeovil Road, Slough, Bucks.

Microphones — How They Work & How to Use Them, no. 875; **The Complete Handbook of Vidocassette Recorders**, no. 811; **The Complete Handbook of Slow-Scan TV**, no 859; and **Practical Solid-State DC Power Supplies**, no. 891, are recent paperback publications from Tab Books. A hard-back book entitied **TV Lighting Handbook** is also available from the same company. For further details and UK prices contact Tab Books, Blue Ridge Summit, Pa. 17214, U.S.A.

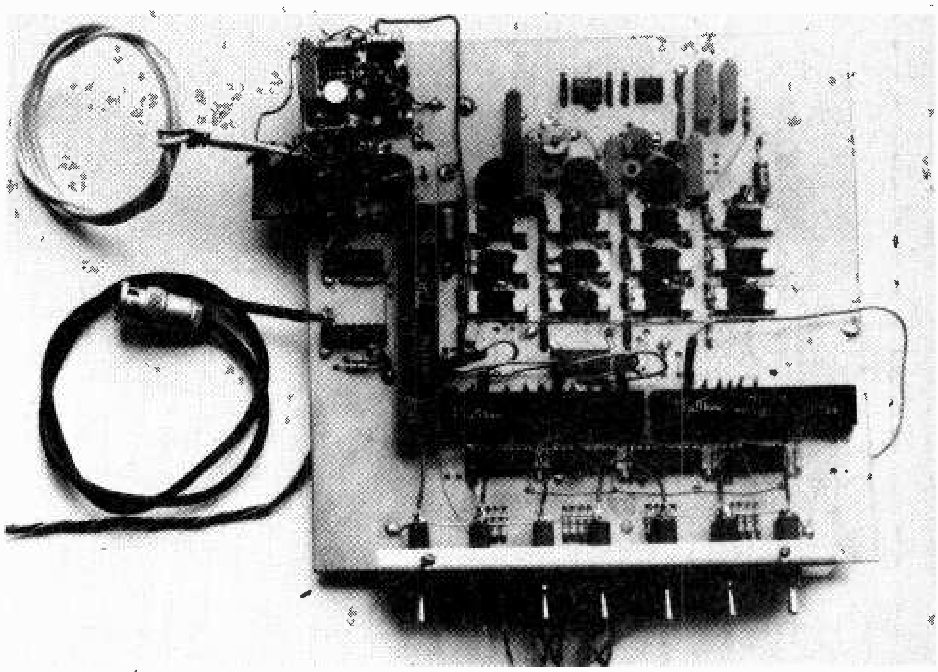
Microcircuit Device Reliability: Digital Generic Data and Linear/Interface Data are two publications which are now available from London Information. The data has been compiled from technical reports and information from various manufacturers. Each publication contains reliability details together with information of the field and test conditions. London Information (Rowse Muir) Ltd, Index House, Ascot, Berks.

High-speed analogue-to-digital conversion

Recent developments and applications

by O. J. Downing, Ph.D and P. T. Johnson, B.Tech., *University of Bradford*

Digital signal processing and data transmission, particularly for television and radar systems, have stimulated a demand for faster and more accurate analogue to digital converters. Much of the current research and development in this field has given Britain a significant technological lead. Converters capable of coding to 8-bit accuracy with sampling rates greater than 30MHz have been demonstrated and have opened up many new applications. The two authors have spent several years researching a-to-d convertors at Bradford University with the intention of producing a cheap manufacturable converter particularly suitable for tv signals. This article describes some of the most recent systems including the author's prototype 2+2+2+2 serial coder design, opposite, and suggest ways in which gross coding rates greater than 400Mb/s may shortly be achieved.



It has been said that the solution to one problem begets ten more. Certainly, in the realms of digital signal processing, the inherent attractions of digital operation have led to a steadily growing range of more demanding applications for the devices and interfaces.

One recent example of the power of digital signal processing is the television signal standards converter DICE[1] (Digital Intercontinental Conversion Equipment). In this equipment a complex and extensive sequence of operations are performed on a digitized tv signal using high-speed logic. This system has resulted in corresponding improvements in mean signal quality, in the amount of maintenance and setting up required, and in the general effectiveness of the equipment when compared with the analogue counterpart. Digital techniques are now being used in the design of television, radar and communication systems, and in the area of transient signal measurement with similar benefits.

In all of these applications, however, the major attractions of digital operation depend on speed, accuracy, stability, reliability and cost of the analogue-to-digital conversion process.

Thick-film integrated and hybrid a-to-d and d-to-a convertors have been available for some time. In these devices the conversion techniques such as ramp-counting, feedback successive approximation, and dual-slope integration require a trade-off between the rate at which input signal samples are translated into binary digits (the conversion rate), and the accuracy to which the output bits represent the instantaneous value of the input signal (the dynamic accuracy). Although developments in component technology are relieving these restrictions to some extent, the majority of existing high-speed converters use combinations of serial and parallel conversion techniques. Integration, however, does offer mainly trouble-free and stable circuit operation. The aim of many a-to-d converter designs therefore, has been to obtain higher conversion rates and dynamic accuracy using integration techniques which require few precision components and do not need a great deal of adjustment.

Pulse-code modulation

The derivation of a pulse-code-modulated output from an analogue input signal requires three basic operations. Firstly, the input is sampled, according to the Nyquist criterion, at a rate greater than twice the highest spectral component contained in the input signal. A low-pass filter in the input path is often used to ensure this condition. The instantaneous value of the sample must be accurately stored for a length of time which enables the converter to decide which output code it should produce. Secondly, each sample amplitude is compared with a number of preset reference levels to determine the amplitude. This quantization process commonly uses linearly-related levels, although expansion or compression of the dynamic signal range by the use of non-linear quantization law has been used in the logarithmic encoding of speech signals. Finally, the digital outputs of the comparison circuitry are re-coded into a more convenient form. The resulting parallel bit streams are latched to remove time-skew between them.

Typically, a converter producing an n-bit parallel binary output for each input sample requires $2^n - 1$ accurate reference levels. The processes of sampling, quantization and coding are

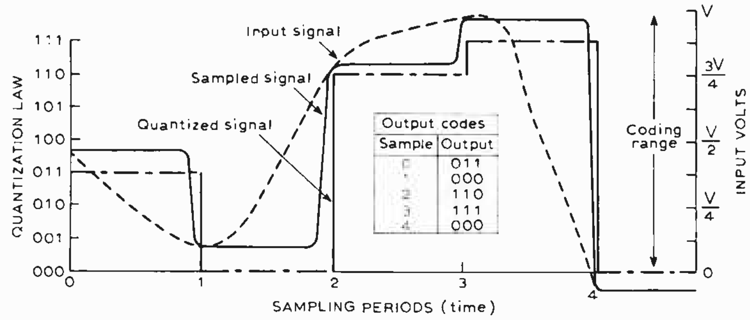


Fig. 1

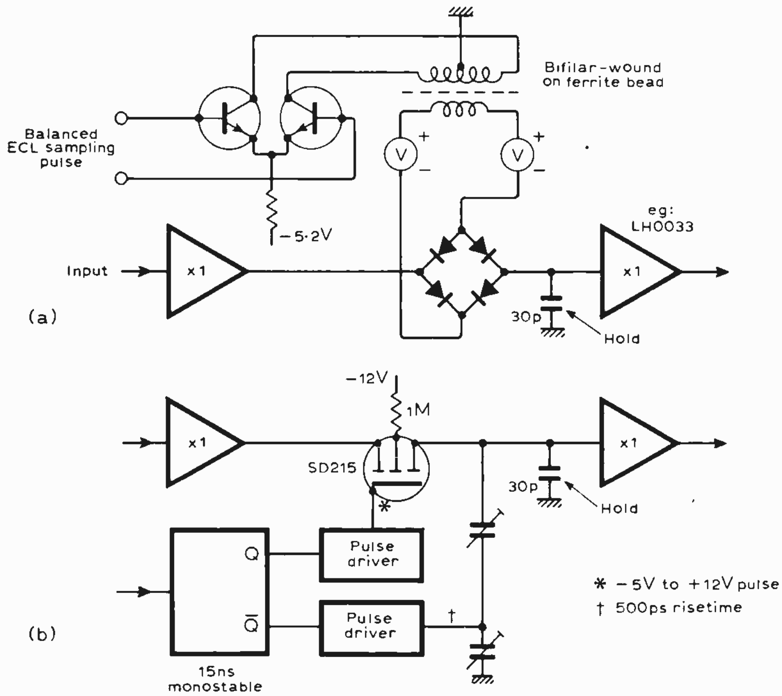


Fig. 2

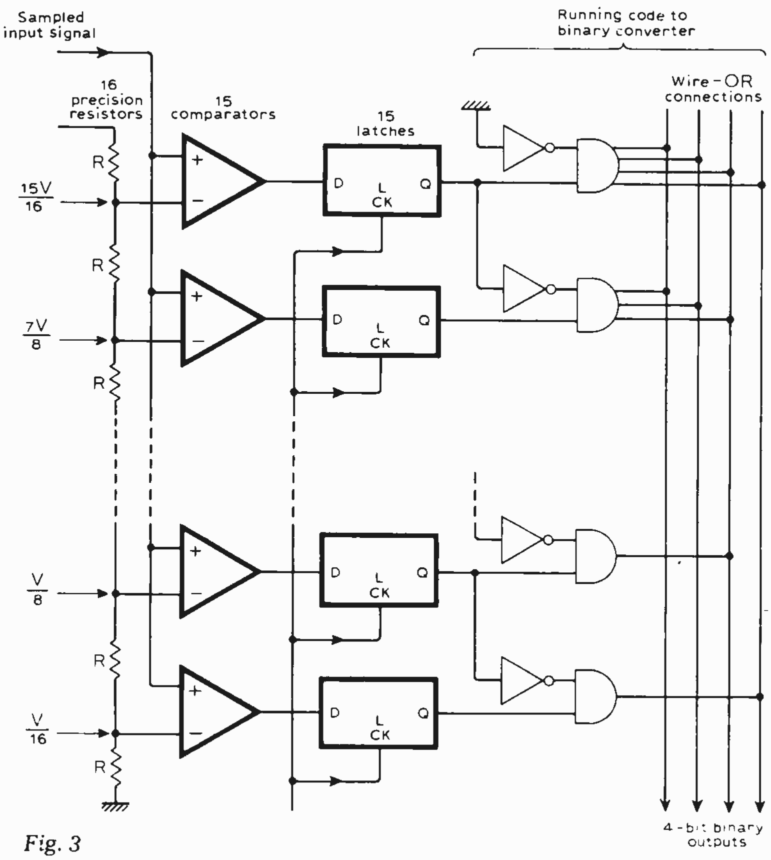


Fig. 3

Fig. 1. Sampling quantization and coding processes for pulse-code modulation of video signals.

Fig. 2. (a) Diode gate sampling switch and (b) m.o.s.f.e.t. switch with feedthrough cancellation.

Fig. 3. Parallel quantizer using comparators and a precision resistor chain for the reference levels.

shown in Fig. 1. Subjective tests with digitalized and reconstructed System I PAL tv signals suggest the need for at least eight bits per sample at sampling rates around 13MHz. For many radar applications much higher sampling rates are required, often with similar quantization accuracy.

Sample and hold techniques

In principle, the process of sampling and holding a signal is accomplished by switching the signal into a capacitor store which charges to the current signal amplitude. The switch is then opened whilst the quantizer operates on the sampled value. In practice, the time taken for electronic switches to change from low and high resistance states, the parasitic reactances associated with these devices and, in high speed samplers, slewing of the input signal all combine to limit the maximum speed and accuracy.

To reduce the decay of the stored charge during the holding interval, the capacitor is buffered by a high-impedance amplifier and its capacitance is maximised. However, to ensure that the capacitor charges to the signal amplitude during the sampling period its value must be minimized. In general, the sampling period must also be minimized because quantization cannot begin until sampling is complete. Because the input signal continues to slew during the time taken for the sampling switch to open, any shifting of this point caused by noise or sampling clock jitter will cause an error in the sample value. Furthermore, the relative magnitudes of the input and switching signals can shift the sampling period and cause a further error called "aperture uncertainty". If any coupling exists between the switch and the hold store, a proportion of the sampling pulse can be fed to the store capacitor and cause a corresponding error in the voltage.

Two types of sampling switch that have recently become popular are the diode gate and the m.o.s.f.e.t. switch, see Fig. 2. In the first-mentioned the diodes are reverse biased during the hold interval but are forward biased by a current pulse from the transmformer during the sample interval. Voltage sources are included to ensure that the diodes do not become forward biased by high signal slewing during the hold interval. The use of matched low-resistance high-speed Schottky diodes

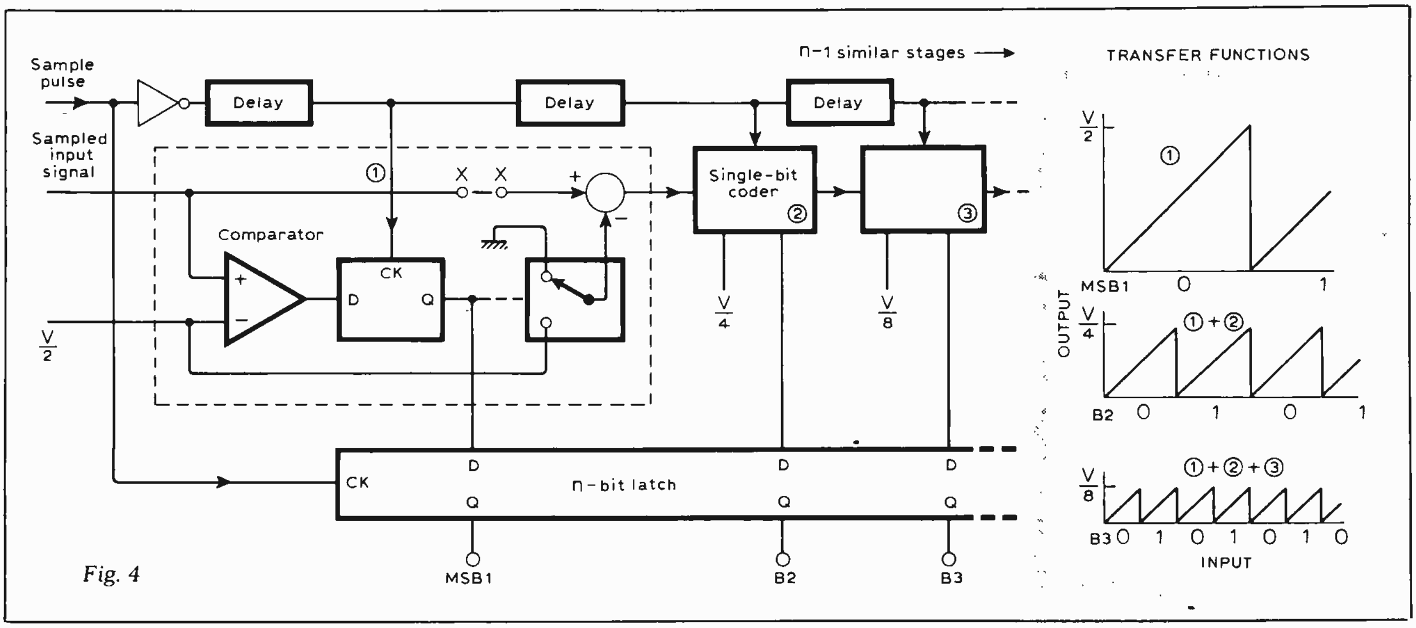


Fig. 4. Serial-successive approximation quantizer. This system only uses one comparator and precision reference level per output bit.

minimizes sample pulse feedthrough and charging time, but aperture errors are still determined by the slew drive rate of the driving pulse and drive transistors. Aperture errors of less than 100ps at sampling rates in excess of 50MHz are possible with samplers of this type. A recent development has made use of the m.o.s.f.e.t. possible in high-speed samplers[2]. In the circuit shown, sampling pulse leakage caused by gate-source capacitance is cancelled by feeding a complementary pulse directly onto the sampling capacitor. Cancellation levels up to 40dB have been achieved with an aperture error below 300ps.

Serial and parallel quantizers

An obvious technique for quantizing a signal is to apply it to the commoned inputs of several comparators, the reference levels for which are derived from a precision resistor chain as shown in Fig. 3. Because the comparators have to settle, their outputs are latched some time after the sampling period. Recoding of the output into binary can be accomplished by simple combinational logic as shown. Although this technique is accurate and using e.c.l. comparators conversion rates approaching 100MHz with four bits per sample are feasible, the component cost is high; for an n-bit binary converter, $2^n - 1$ comparators and resistors are required.

At the other end of the scale, the serial successive approximation converter shown in Fig. 4 uses only one comparator and precision reference level per output bit. The result of each comparison is used to decide whether a voltage, equal to the reference level for that comparator, should be subtracted from the stage input signal. The output from the subtractor is used as an input to the following stage. A successively more accurate representation of the input sample amplitude is built up by subtraction of binarily related reference voltages as the residue propagates along the cascade. Variations in propagation delay are removed by latching all outputs on the leading edge of the next sampling pulse. Because each stage must complete its operation before the next commences, the available time for stage operation is severely restricted. For example, a tv converter may require accurate stage operation in less than 8ns. One solution is to add a delay line into the signal path of each stage at the point marked × × on Fig 4. By correctly timing the latch pulse

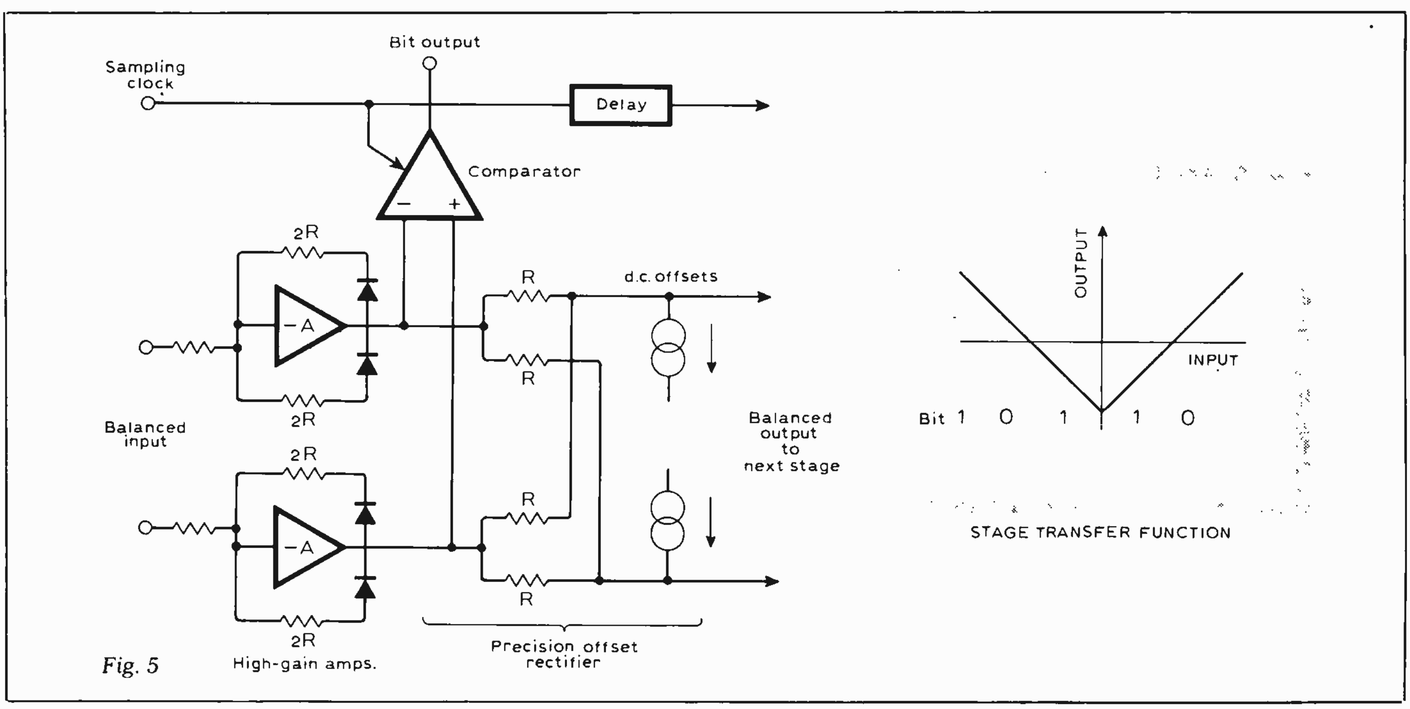


Fig. 5. Single stage of a folding encoder. This system uses a cascade of fast precision rectifiers.

to each comparator and re-designing the latch it is possible to arrange that whilst the first stage is determining the most significant bit of the present sample, the second stage is determining the second m.s.b. of the preceding sample and so on. This allows each stage to have nearly a complete sampling interval to settle. Because each stage must be accurate enough to drive the rest of the cascade, only the first stage requires maximum accuracy. Furthermore, this design has the advantage of automatically producing a binary-coded output.

A further modification, which allows the use of a common reference voltage for all stages, is to give the subtraction process a precise gain of two. Unfortunately, the precision subtractor with a stable zero-offset is a problematic part of this design.

Folding encoder

An alternative form of serial converter which has been successfully used commercially, the so-called folding encoder, uses a cascade of fast precision rectifiers. Fig. 5 shows that the transfer function of the system has a typical repetitive form, but, in this case, produces a Gray-coded output. Therefore, conversion errors occurring at major output transistions, say between binary 01111 to 10000, are less noticeable because only one bit changes per least-significant transition. The circuit is also susceptible to a high degree of integration.

Fig. 6. Eight bit series/parallel a-to-d converter with digital error correction.

Fig. 7. Recirculating parallel coder. Residue from the first four-bit quantization is fed back to the same quantizer/ coder.

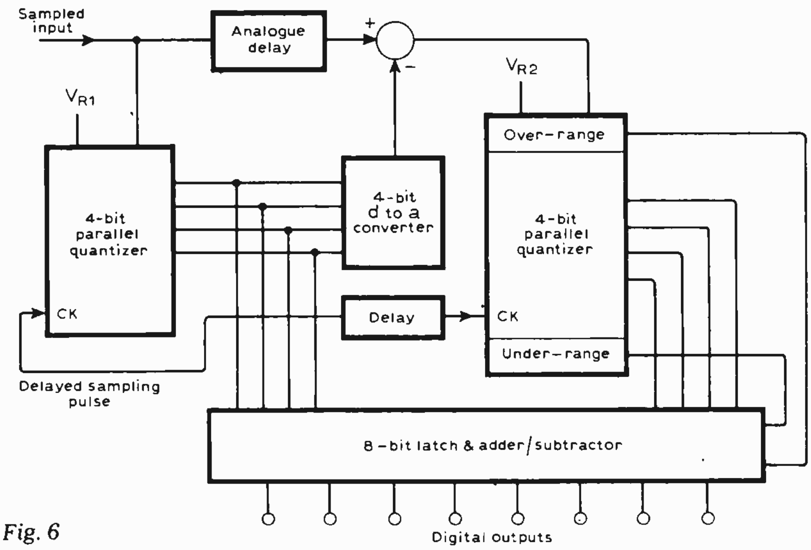


Fig. 6

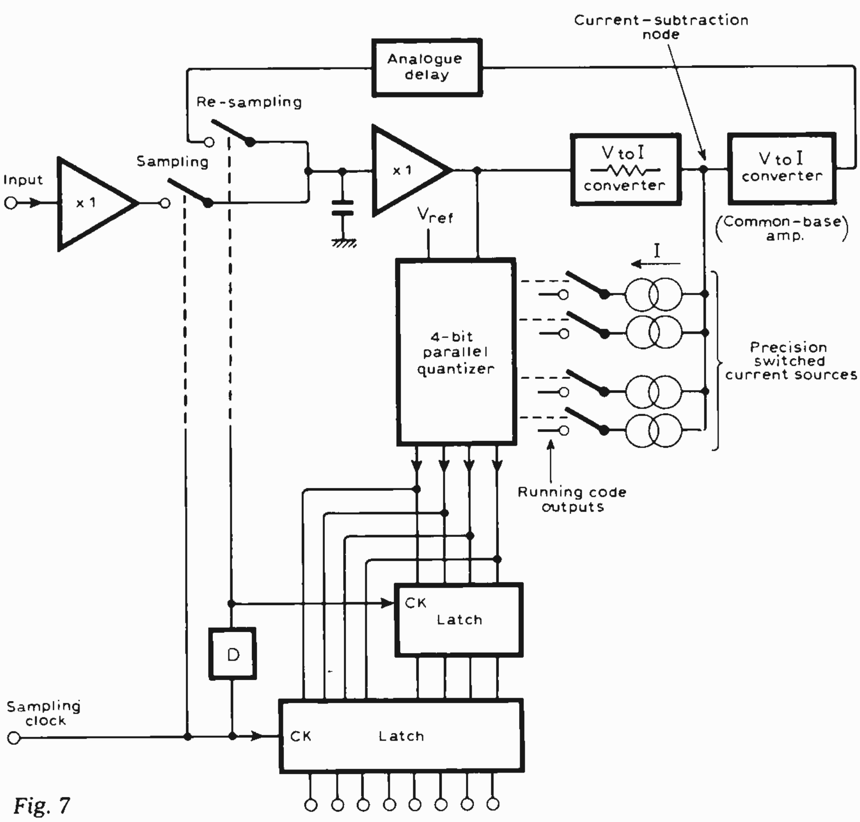


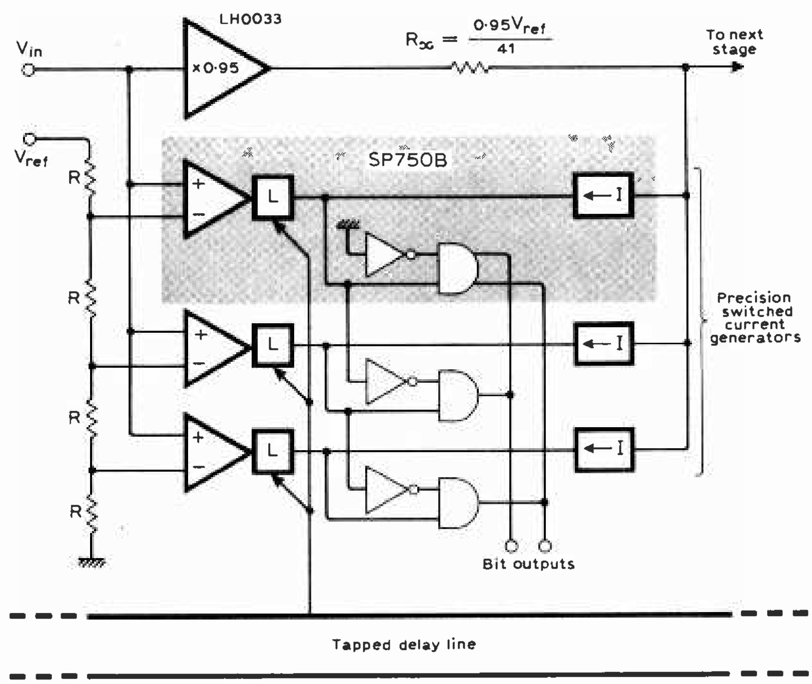
Fig. 7

Hybrid series-parallel converters

A solution to the compromise between speed, accuracy and cost is a combination of serial and parallel conversion techniques. An eight-bit 15MHz design developed by the BBC[3] uses a four-bit quantizer/coder, producing the four m.s.bs of the output, feeding a four-bit d-to-a converter, see Fig. 6. The output of the converter is subtracted from a delayed version of the input sample to produce a voltage equal to the error caused by quantization to 2^4 levels. This residue, after amplification, is coded in a second four-bit quantizer/coder to produce the least-significant four bits of the output. Errors caused by propagation delay in the two sets of four-bit outputs are removed by suitably timed latches. This design is interesting because it uses extra comparators in the second stage to detect under-range and over-range input voltage errors produced by a marginally accurate first stage. The comparators also correct the l.s.b. outputs by digital subtraction or addition.[4].

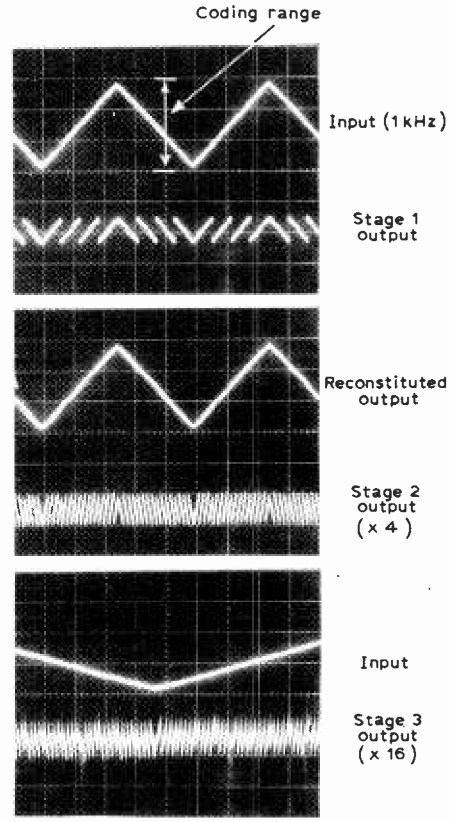
The recent development of an integrated comparator[5], latch, precision current switch and binary-coding logic has enabled the speed and accuracy of this technique to be greatly improved. Use of a current-summing d-to-a converter coupled with current subtraction allows significantly faster operation, 30MHz, than the corresponding voltage-based design. We have experimented with a modified version of this design at the University of Bradford, see Fig. 7, where the residue from the first four-bit quantization is fed back via a m.o.s.f.e.t. re-sampling switch into the same quantizer/coder. It is possible to code to eight-bit dynamic accuracy with sampling rates almost as high as the 4 + 4 converter but using only half as many comparators, and precision resistors.

Another home-produced design which is faster, more accurate and more economical, uses a cascade of four high-speed two-bit coders. Inter-stage voltage gain and I to V conversion by current summing are not required. The maximum conversion rate of this system exceeds 30MHz. Fig. 8 shows the circuit and the residues from each stage produced by the quantization of a slow ramp sampled at 20MHz. Dynamic accuracy measurement of this converter suggests that the addition of a simple error corrector to the final stage could allow a further one- or two-bit stage to be added which would reduce the



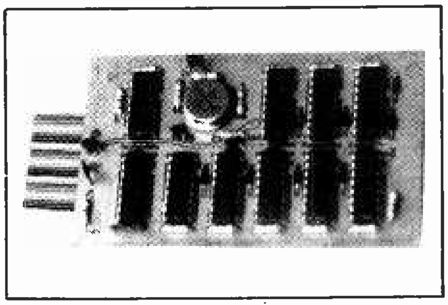
(a)

Fig. 8. (a) Single stage of a 2+2+2+2 serial coder. (b) Analogue output after coding a slow ramp.

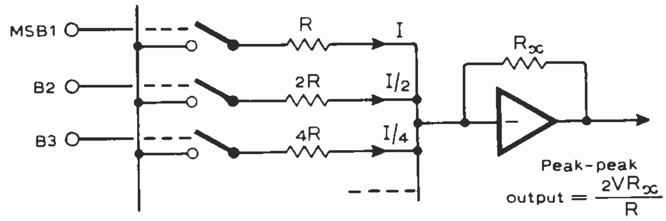


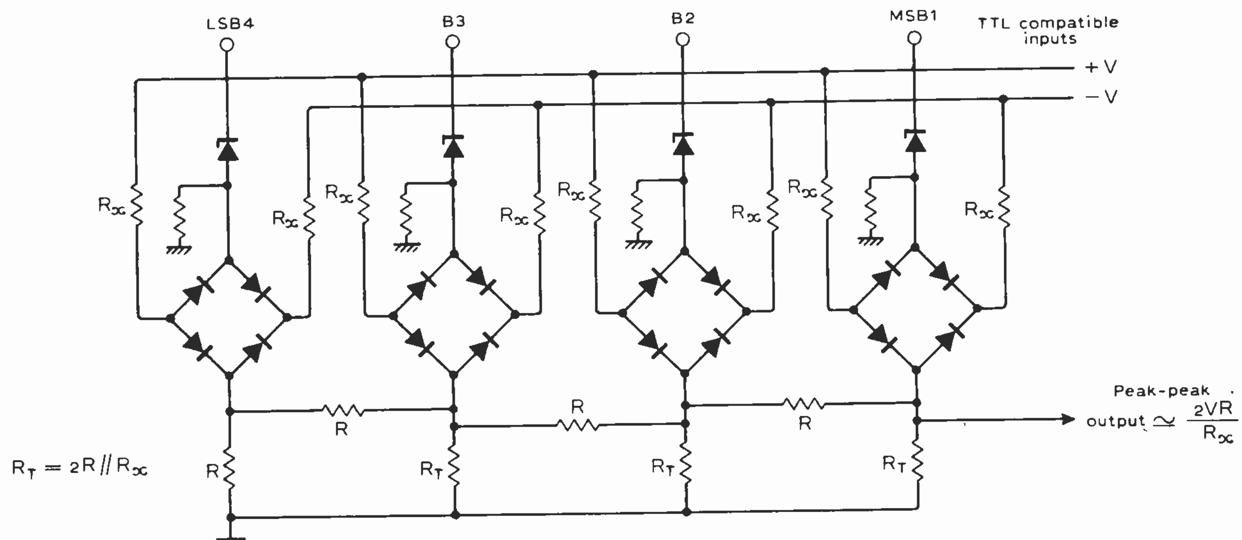
(b)

Fig. 9. Fast d-to-a conversion using binary-weighted switched currents which are summed using (a) virtual earth technique, (b) a R-2R precision resistor network. The photograph shows a practical design which combines the two techniques.



(a)





(b)

maximum conversion rate to around 25MHz and offer a, so-far rather elusive, ten-bit high-speed converter.

Digital error correction

The technique of error correction can be used in most forms of a-to-d converter although it is usually only used in high speed designs where the increased accuracy and stability justify the added complexity. The principle is to measure the conversion error in terms of either positive or negative least significant bits and to correct the coder output accordingly. Error detection is usually incorporated in the final stage of serial quantization where the converter is attempting to resolve to a least significant bit. Any errors that have been introduced earlier in the cascade will cause the signal amplitude at the final stage to lie outside its nominal range. These errors can be measured precisely by the addition of extra comparators. Digital arithmetic controlled by the outputs of these comparators is then used to subtract the error from the coder output.

Digital-to-analogue conversion

Re-conversion of digital signals into analogue form presents few problems for the levels of accuracy and word rates quoted so far. Precision high-stability resistors and thick-film networks have been available for some time although commercial integrated high-speed d-to-a converters are still thin on the ground. Two similar techniques, shown in Fig. 9, are popular for high-speed designs. In the first, precision binary-weighted switched currents are summed at a virtual-earth point. In the second, similar precision switched currents are summed binarily in a precision resistor network. The first technique has the advantage that the summing node is a virtual-earth and hence, stray capacitance associated with the current source has less effect in slowing down current transitions. Unfortunately, precision binary-weighted current generators are difficult to produce. In the second technique the advantage and disadvantages are reversed. A logical solution to the compromise is to combine the techniques and sum groups of binarily related switched currents in a reduced resistor network. A circuit which sums three groups of three precision-switched currents I, I/2 and I/4 in an R to 8 R resistor ladder can be used to decode eight-bit binary data at word rates above 50 megawords per sec. However, dynamic errors have proved to be troublesome in high-speed converters. Even if data propagation error is limited by latching the input data with a delayed sampling clock, different propagation delays in the resistor or current networks, and parasitic reactances associated with components and circuit layout produce transient spikes or "glitches" on the analogue output waveform when the input data changes. Resampling this waveform, using a second delayed clock, after the glitches have settled, reduces the problem and also simplifies the design of the subsequent low-pass reconstruction filter.

Future developments

The commercial development of any new technique depends on market conditions. At present, although a considerable range of exciting and attractive applications have been proposed for high-speed digital signal processing, particularly the prospect of digital broadcast tv systems, the cost of existing a-to-d converters is prohibiting their large-scale exploitation. Of the converter types described in this article, the serial cascade is perhaps the most attractive for future development. The idea of an integrated n-bit coder with subtractor, buffer, and latch on a single chip, which could be cascaded to any length, has obvious merits.

Techniques will shortly be capable of producing up to four-bit units with settling times of less than 8ns. On this basis, converters with gross bit-rates approaching 300Mb/s are feasible. The inclusion of an external delay line in each stage may push this limit closer to 400Mb/s.

Acknowledgement. — The authors would like to express their gratitude to Dr C. Davis of Cambridge Consultants Ltd, and Mr N. Green of Independent Television Companies Association Ltd for their encouragement during the course of over three years research.

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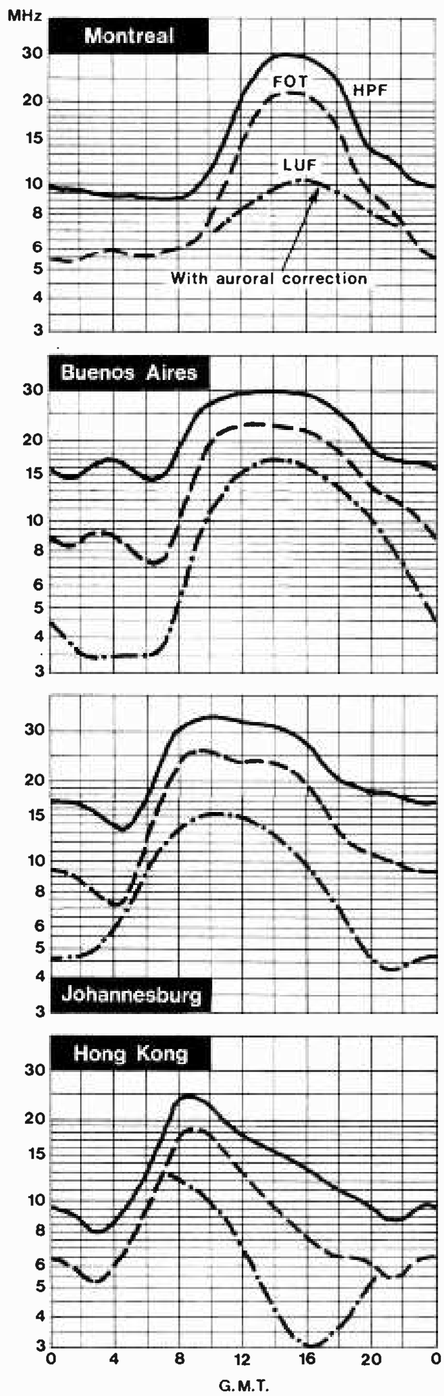
6. Henning, H. and Edsen, J. Broadband codecs for an experimental 224M bit/sec p.c.m. terminal, pp.1887 to 1940. *Bell System Tech. Review*, Vol. XLIV No. 9, 1965.
7. High speed analogue to digital conversion, IEE Seminar, Oct. 1975.

Microcomputer seminar

Readers interested in our current series on microcomputer design may like to know that a seminar is being held to introduce the Nascom I minicomputer kit (November issue, p.45) at the Wembley Conference Centre, London, on November 26, starting at 9.50 a.m. Organizers are: Lynx Electronics (London) Ltd, 92 Broad Street, Chesham, Bucks (tel: Chesham (02405) 75154).

HF predictions

Circuit reliability is the product of the probability of ionospheric reflection and the probability of achieving a desired signal to noise ratio and is thus at a maximum somewhere between FOT and LUF. The term FOT, which is the French equivalent of OWF (optimum working frequency), is thus a misnomer since it relates only to skywave probability. However since LUF is dependent on many factors which cannot be generalised it is found satisfactory in practice to take FOT as being what it says it is.



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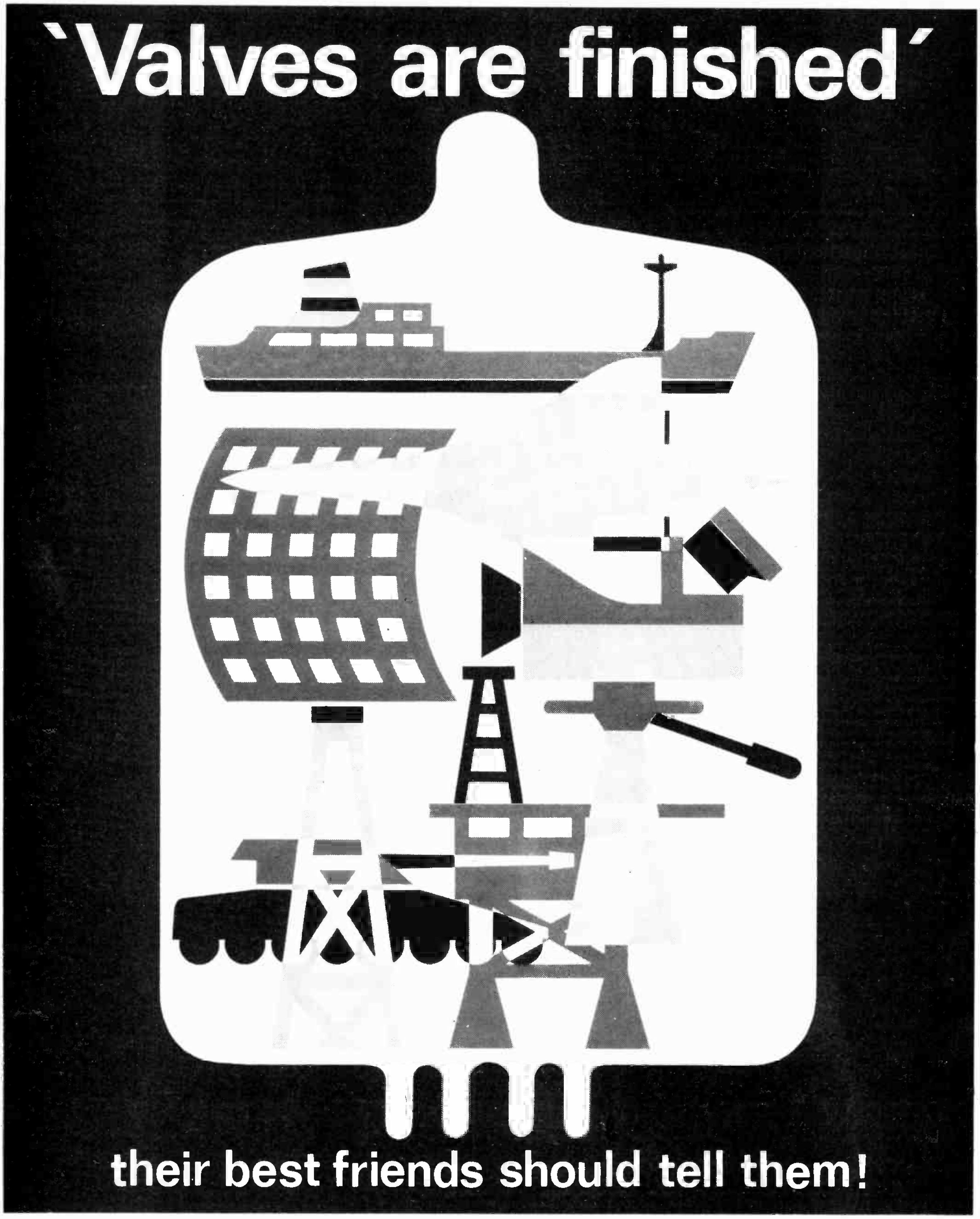

'Valves are finished'
their best friends should tell them!

Analogue function generator

A straight-line approximation design

by G. J. Phelps, B.Sc.

This article describes a versatile function approximator, whose analogue input and output signals are related by a segmented characteristic. The function characteristics are made up of a number of straight lines (segments), each one joining the next, at "break points," to form a continuous line. A variable characteristic is obtained by adjusting the position of intersection of any two segments.

The generation of an analogue function from an input variable has many applications, especially in the fields of measurement and process control. An example would be the linearization of a signal from a non-linear transducer in a control system.

The circuit described can be used to generate many functional relationships between its input and output signals, using a straight-line "fit" technique to produce the required characteristic.

Straight line approximators are not new. The diode function generator[1], which is a typical example of past designs, consists of the type of circuit shown in Fig. 1(a). As more of the feedback diodes are brought into conduction, so the effective amplifier gain alters. A typical characteristic for the circuit is shown in Fig. 1(b).

This scheme has two major drawbacks. Firstly, diode action affects its temperature stability, and secondly, altering one of the feedback resistors means the resetting of all of the resistors that follow it. A different approach is needed in order to obtain versatility.

Mark-to-space-ratio averaging

If we were to apply a zero-to-five-volt square wave to a simple single-time-constant CR smoothing network, any variation of the mark-to-space ratio (m.t.s.r.) would cause a change in the output of the CR smoothing network. This output change has two extreme limits, namely zero and five volts, which correspond to a total absence of a pulse (zero percent m.t.s.r.), and a pure d.c. level of five volts (100% m.t.s.r.), being applied to the input of the CR network. Indeed, the output of the network varies linearly with respect to the m.t.s.r.

Now consider three d.c. levels: zero, five, and seven volts, for example. Switching between the first two and filtering, as above, will produce a zero-to-five-volt signal depending on the m.t.s.r. However, if we now consider switching in the same way between the last two (five and seven volts), the output of the filter will be somewhere between five and seven volts, depending on the m.t.s.r. This process may be expanded still further.

The circuit described in this text has ten adjacent d.c. levels. Each level can be switched on and off, and there is a criterion that only adjacent pairs of levels can be switched, as in the simplified three-level case above. Interpolation between each level, by the m.t.s.r. process, is the basis of the function generator design.

Signal-to-time averaged b.c.d. circuit

The input to the signal-to-time averaged binary-coded-decimal (b.c.d.) circuit lies between set limits. If we choose this input to vary over zero to nine volts, relative to the circuit common, and consider the 0 to 100% variation of the input, we may divide it into nine equal intervals defined by ten input voltages (i.e. 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9V). Call these ten voltages, break voltages.

The ten break voltages correspond to the ten break points of the straight-line function generator, which composes its required function out of a nine-segment line ("fit"). As will be seen later, each break point of the function can be individually adjusted (without affecting any other), so that many different functions may be generated in a highly versatile manner.

The input to the circuit is scaled and fed into the non-inverting inputs of a string of nine comparators (see Fig. 2). Each comparator is set to "trip" (change state) at successively increased voltage levels.

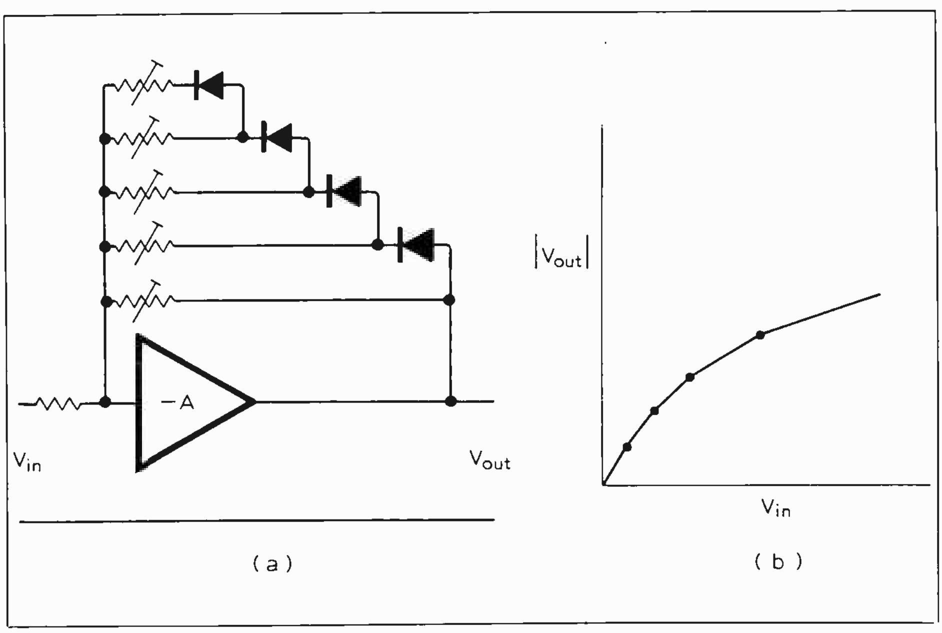


Fig. 1. (a) A typical diode function generator in which the amplifier gain alters as more of the feedback diodes are brought into conduction. (b) shows a typical characteristic for this circuit.

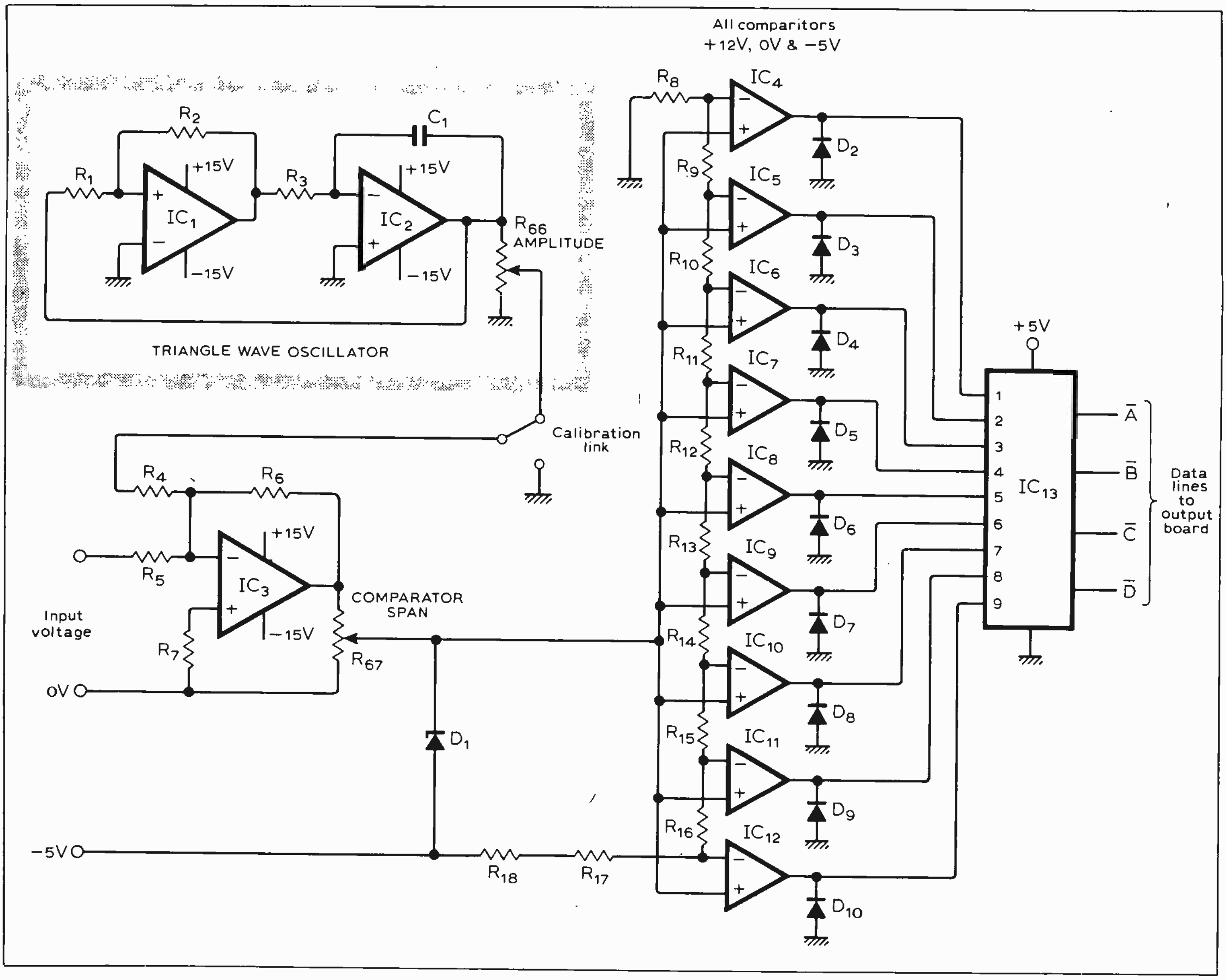


Fig. 2. Signal-to-time-averaged b.c.d. circuit consisting of nine comparators, each set to change state successively as the input voltage-level increases. The output from the encoder i.c. is in inverted-b.c.d. (see text).

The scaling is set such that, as the input voltage passes the break voltages of 1, 2, 3, 4, 5, 6, 7, 8 and 9 volts, comparators 1 to 9 trip in turn.

The output of each comparator passes into an encoder i.c. (SN74147) and the resulting inverted-b.c.d. output from this section of the circuit contains information about the input signal and the input break voltages. The exact value of the input signal relative to the ten input break-voltages is obtained by using a time averaging technique. A triangular wave, of peak-to-peak amplitude equal to the intervals (in this case 1V) between the ten break voltages, is added to the input signal. This resulting signal, which is applied to the input of the comparators, will lie between two break voltages (assuming that the input signal is not mid-way between two break voltages), see Fig. 4.

Consider now one period of the triangle waveform, and observe the time within the period that the combined signal spends between break voltages. It can be seen that this time, relative to the period of the triangular wave, is a direct function of the magnitude of the input signal. Each time the combined input voltage crosses a break voltage, the comparator for that break voltage will trip and change the b.c.d. output of this section of the circuit. It can therefore be seen that the average state of the b.c.d. output, in terms of time, will yield the exact position of the input signal relative to the ten input break voltages.

Note that for a static input signal, the typical b.c.d. output will consist of two adjacent b.c.d. states; the m.t.s.r. of each state being determined by the input magnitude relative to the ten break voltages.

Output and function generation section

The output circuit converts the time averaged b.c.d. signal of the previous state into a meaningful output. Basically, each b.c.d. state fed into the output section switches on one of ten voltage levels, all of which are pre-set by potentiometers to the functional characteristic required by the user. The voltage levels are then summed up by a summing amplifier (see Fig. 3). After passing through a second-order RC filter, the resulting signal appears at the output of a buffer amplifier (IC_{17}). Finally, the signal is scaled by the output amplifier.

The actual function generation of the circuit is achieved by mark-to-space ratio averaging, as mentioned earlier. However, here the magnitude of the input signal determines which voltages are switched on and off and what m.t.s.r. is applied to the switching voltages. The user, however, dictates the magnitude of each of the voltages switched, and therefore the way the average of the voltages changes as the m.t.s.r. of each voltage varies. Therefore, the final output of the circuit (after scaling) consists of a nine segment characteristic having ten break points, see Fig. 5. Note that each segment joins smoothly with its adjacent segments. Note also, that the break points are all independently adjustable. This means that virtually any (but not every) characteristic/function may be approximated by a nine segment fit using this circuit.

It would not be difficult to expand on

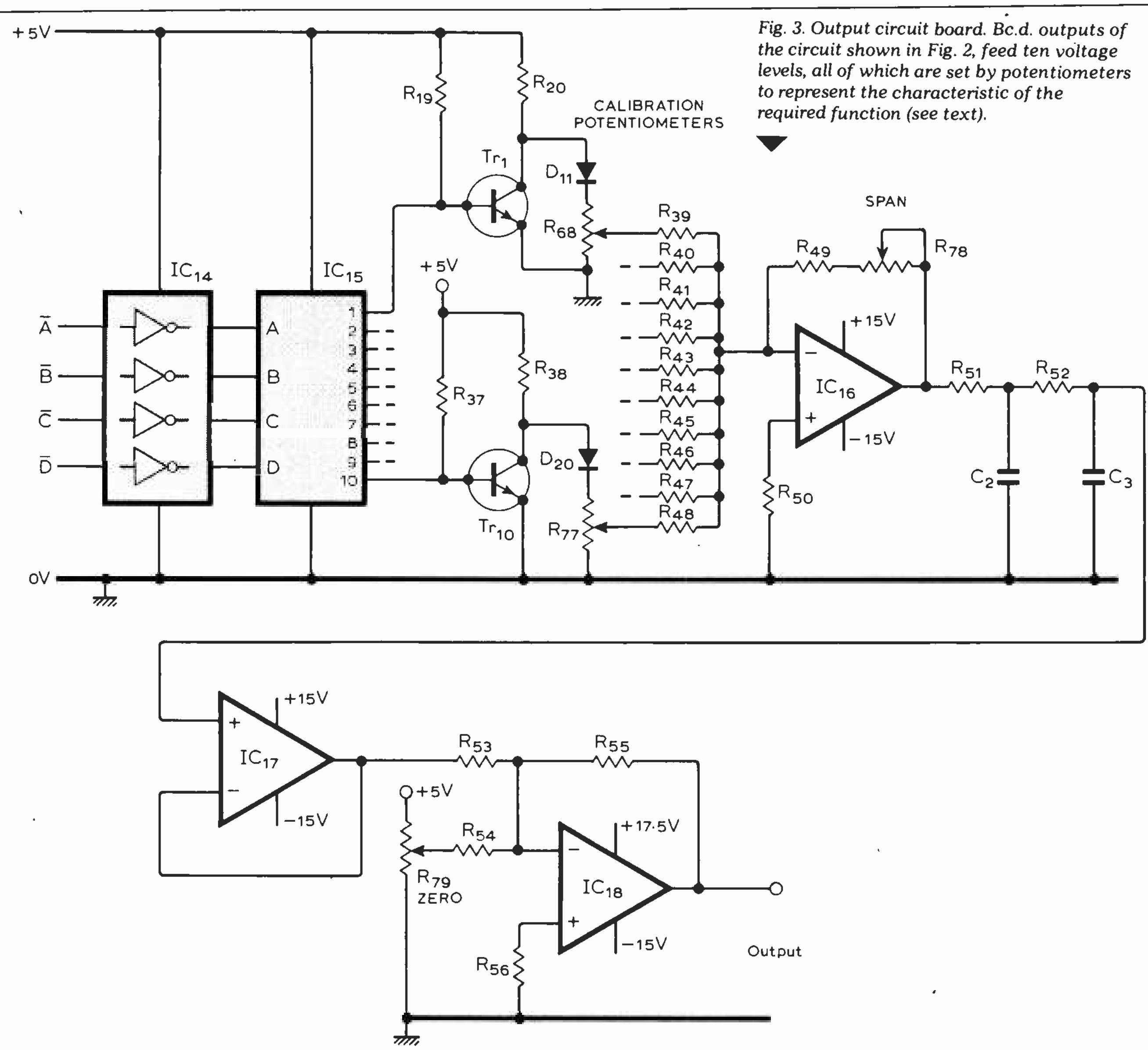


Fig. 3. Output circuit board. Bc.d. outputs of the circuit shown in Fig. 2, feed ten voltage levels, all of which are set by potentiometers to represent the characteristic of the required function (see text).

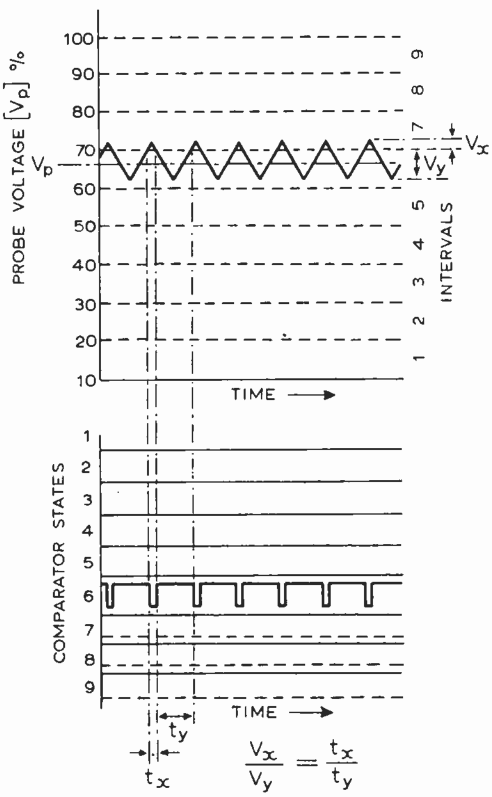
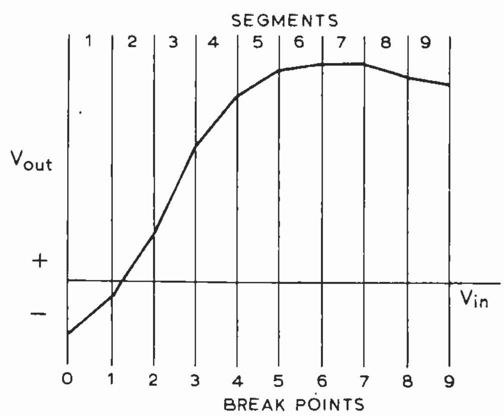


Fig. 4 shows how the time (t_x) – the time which the input signal plus the triangular wave (see text) spends between break voltages – is directly proportional to the magnitude of the input signal. That is, $V_x/V_y = t_x/t_y$.

Fig. 5. An example characteristic for the analogue function generator described in the text.



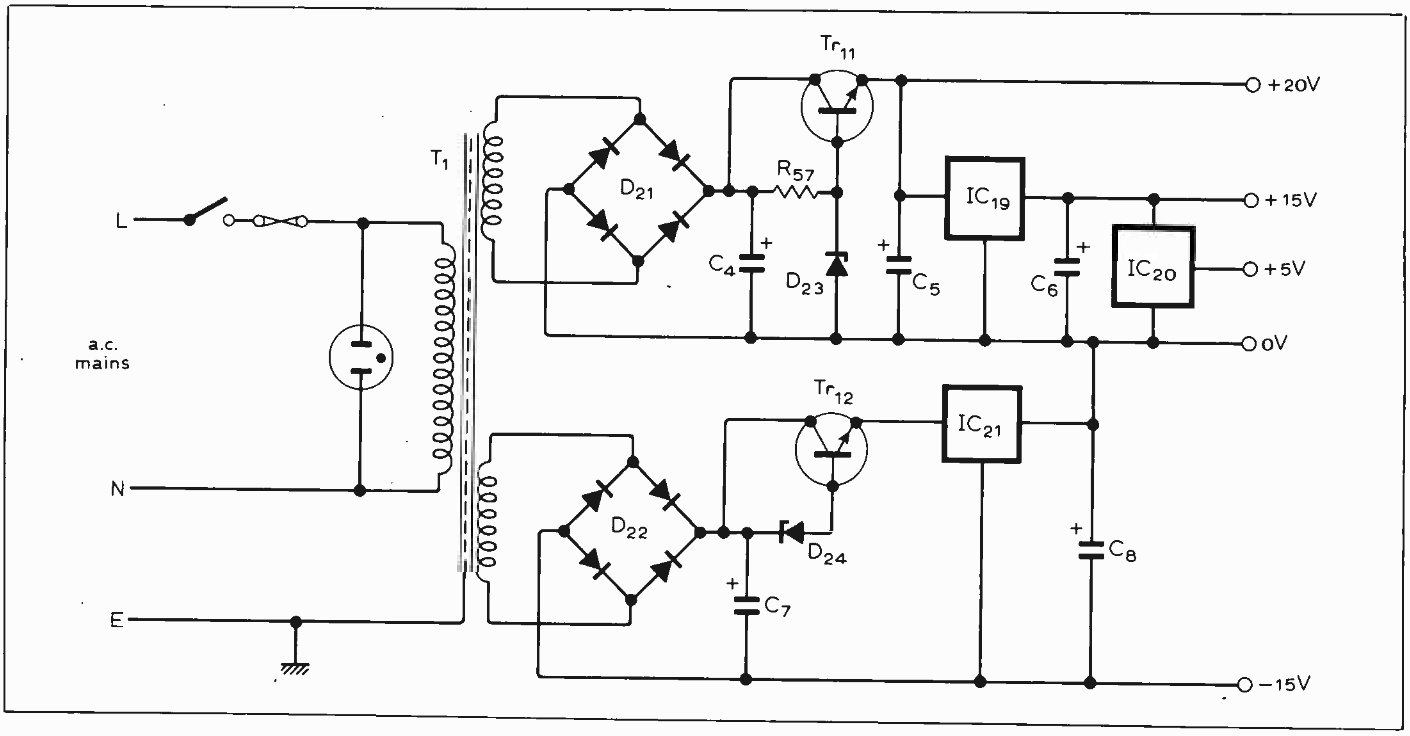


Fig. 6. Main power supply circuit.

the above idea, and produce a fit composed of more than nine segments.

Design considerations

For the circuit to be able to resolve small changes in the input, and convey the information to the b.c.d. signal, the hysteresis effect at the input (differential) of the comparators at small differential signals (specifically at the break points) must be considered. The design should also allow for the slew rate of the comparators so that the relatively fast t.t.l. can respond to the fast-changing differential input signals to the comparators.

In this case a resolution of 0.1% was desired and, with a maximum considered input hysteresis voltage of 5mV, this set the maximum signal to the comparators, for 100% input to the complete circuit, at five volts. The slew rate of the comparators was effectively speeded up by lowering the frequency of the triangular wave to about 200Hz. This gives ample time for the comparators to respond to a 5mV input differential.

The non-inverting input to the comparators is protected by using a zener diode tied to the −5V rail (see circuit). The choice of comparators and b.c.d. encoder i.c. also necessitates the incorporation of diodes D_2 to D_{10} inclusive. This arises due to the lack of input protection diodes on the l.s.i. chip, and the possible 'harmful' voltage surges at the comparator outputs. The final output of the circuit is provided with full zero and span adjustments so that the output can be calibrated.

The function generator is considerably accurate, because the conversion is largely digital. The prototype, which used metal film resistors and cermet potentiometers, showed a negligible change due to ambient temperature fluctuations.

There are many applications for this circuit. They include linearity correction of non-linear signals, generation of mathematical functions, and the generation of voltage programming functions.

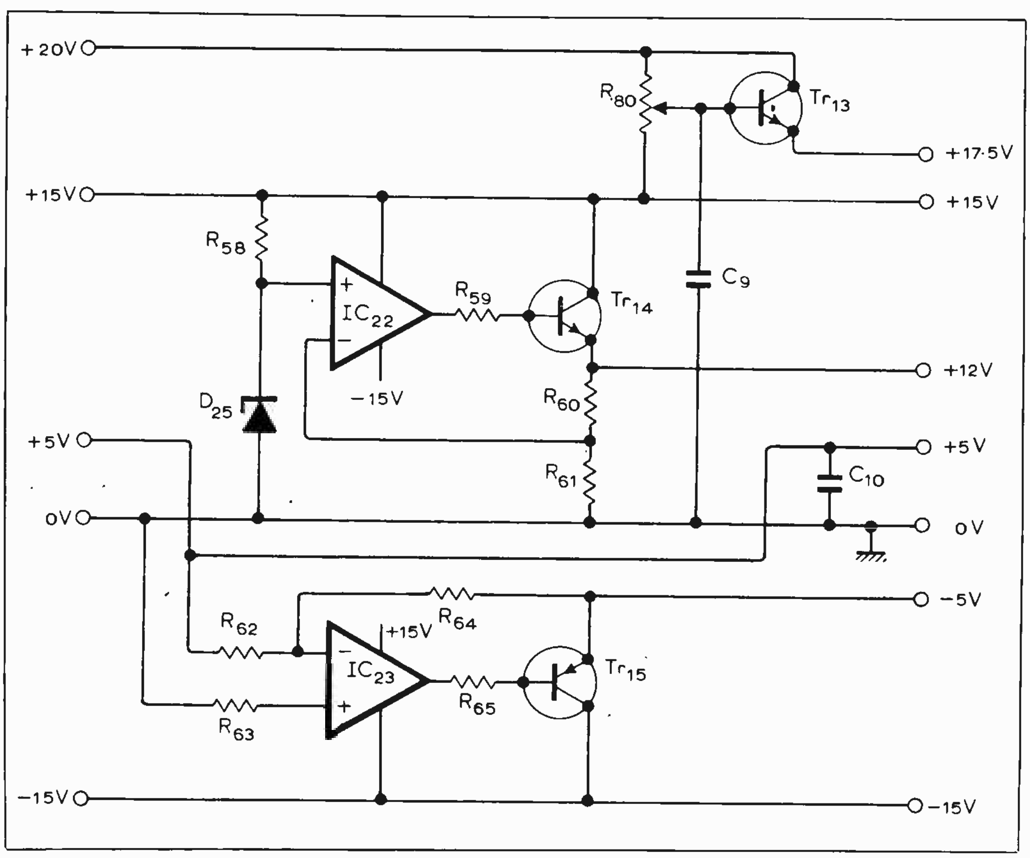
Generation of periodic waveforms

The following is as an application example of the analogue function generator being used to produce continuous functions, of variable period and complex shape. This may sound difficult, but it is really very easy.

Consider the arranged input/output characteristic (or transfer function) of the analogue function generator to be a single period of the first waveform in Fig. 8. Remember, that this complex function has been pre-programmed into the analogue function generator by use of the adjustable trimpots R_{68} to R_{77}.

Now, by using a ramp generator attached to the input of the analogue function generator, the output of the last-mentioned generator will follow

Fig. 7. Power supplies for the mother board.



the programmed characteristic as the ramp rises, returning back to the start of the characteristic as the sharp edge of the ramp falls. Therefore the output of the analogue function generator will be a continuous complex function, of programmable shape and period equal to that of the ramp input. Fig. 8 shows examples of repetitive waveforms generated in this manner.

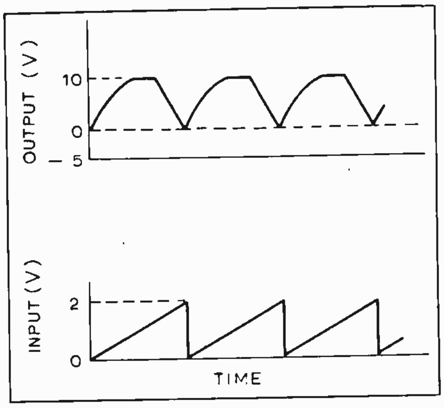


Fig. 8. Examples of periodic waveforms which can be produced by the analogue function generator

Component list

Resistors (all 2% metal oxide unless otherwise stated)

1	39k
2	100k
3	22k
4, 5	3k
6	6.8k
7	1.2k
8-17	825, 1% or better
18	1.5k
19-37 (odd)	39k, 10% carbon
20-38 (even)	4.7k
39-48	2k
49	220k
50	1.2k
51, 52	220k, 10% carbon
53, 54	1k
55	2k
56	200
57	120, 10% carbon
58	1.2k
59	130, 10% carbon
60, 61	1.2k
62	1k
63	470, 10% carbon
64	1k
65	1.5k

Variable resistors (Cermet trimmers)

66, 67	10k
68-77, 79	1k
78	50k

Diodes

1	6.8V 5% 400mW zener
2-20	1N914
21, 22	100V 2A bridge rectifier
23	20V } 5% 400mW zeners
24	5.6V } 5% 400mW zeners
25	6.2V } 5% 400mW zeners

Integrated circuits

1-3	μA741C
4-12	μA710
13	SN74147
14	SN7404
15	SN7442
16-18	μA741C
19, 21	μA7815 regulator (1A)
20	μA7805 regulator
22, 23	μA741C

All available from Bi-Pak Electronics, Ware, except IC_{13} which can be obtained from Aries Electronics, Maidenhead

Transistors

1-10	2N3709
11	2N3055
12-14	2N3053
15	2N2904

Transformer

Primary: 240V r.m.s.
Secondary: 2 × 20V r.m.s. at 300mA
Barrie Electronics, London

Capacitors (μF unless otherwise stated)

1	220n
2, 3	2.2
4, 7	680E
5	10E
6	22E
8	6.3E
9, 10	10n

Reference

1 Crump, A. E. Diode function generators, *Wireless World*, Dec. 1967, pp. 594-598.

A set of two p.c.bs for the function generator and power supply is available for £7 inclusive from M. R. Sagin at 23 Keyes Road, London NW2.

Matrix HJ: technical refinement and political jostling?

Last month the BBC strongly reacted to a recent FCC subjective evaluation of surround reproduction system by publicly criticising the FCC Laboratory "not for what they have done so much as the limitations that they pose". The report, part of an FCC Inquiry into "Quadraphonic" broadcasting, showed SQ was preferred to other two channels systems and H and QS in musical preference tests for "quad", stereo and mono.

And in what could be viewed as preparation for a united front to the FCC Inquiry, as well as a response to recent criticism of Matrix H broadcasts, the BBC Matrix H surround formula has been changed.

From about half way through the promenade concerts the centre front phase difference – until then 48° – was changed "fairly significantly", C. B. B. Wood head of engineering information told WW "and the sort of figures we are talking about are 28°, 29° and 30°".

The change from Matrix H to HJ follows criticism of the stereo compatibility of Matrix H broadcasts, particularly of the proms, now no longer described as completely "unimpaired".

The BBC had kept the change quiet to avoid prompting listeners but at an IEE lecture on the 13th October, the change was made public. They almost got through the proms without any response: the 30 letters received were largely "self cancelling" they said. At the meeting David Meares described the change to HJ as "slight" and combining "most of the worthwhile features of H and J". The tentative HJ is actually in the form of tolerance zones on the phase-amplitude or energy sphere. "Zones are really the only way" the BBC now say, because of the variety of microphone techniques. The zone broadly encompasses those points covered by phase-reduced centre-front H and J loci. Front left and right points are reduced in phase from 75° to 60° and also in amplitude. "To give credit where it is due" said the lecturer, "the format was jointly agreed with Michael Gerzon and the BBC". They hope to sort it out by the end of the year and plan further experiments within its confines. If this is "firmed up" it would then appear to provide an opportunity to argue the FCC tests to be invalid.

First discussions with the J team were kept a secret at the BBC's request, a move that could have an advantage in giving a better impression of unity than might actually be the case. There is certainly not much apparent unity between the two broadcast organizations. Whilst not disagreeing so much with Meares' analysis of the FCC report, they certainly were at odds over the feasibility of a narrow band third channel system. With the BBC refusing to take the issue any further and the IBA revving to go, given the manpower, the pointed remark by Meares, "We look forward to hearing more details of this", drew comment from the IBA engineers at the meeting.

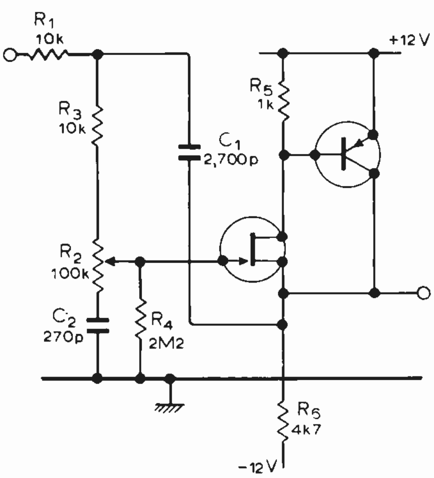
The attitudes of the two organizations are well illustrated in two recent pronouncements. "The penalty of the extra channel may be very much smaller than initially supposed" (Alan James, IBA, IEE meeting, October 13th). "We are filled with doubt as to whether a three channel system would ever get off the ground in Europe. Stranger things have happened of course. But the way to prove the pudding is well known. We would like to see someone conduct a one-year test of the three channel system and we would like to know at the end of the year how many three channel tuners and three track cassette decks the service had attracted" (C. B. B. Wood, AES Annual Dinner, 13th September, 1977).

● In answer to a query by David Read on circuit alterations to the BBC Matrix H decoder design (June issue, page 34) Meares said that although he had not put pen to paper on the effect, he couldn't tell the difference between an HJ encoding and an H encoding through an H decoder. In any case further changes may still be made. BBC Research Department tell us that due to unequal loading on the phase shift circuits in the BBC H decoder circuit, they recommend a directly-coupled emitter follower be inserted following each of the three summering circuits. Emitter load should be 10kΩ.

Circuit Ideas

Variable slope low-pass filter

An important feature of audio pre-amplifiers is a low-pass filter to limit the bandwidth at high frequencies. It is desirable to incorporate a variable slope device as this allows the amount of filtering to be selected for a particular programme source. A Sallen-Key design is suitable for second order filtering and the circuit may be realized with any suitable form of unity gain amplifier. This circuit uses an enhanced source follower which offers a high input impedance, low input bias current, and low distortion. The low bias current enables the gate of the f.e.t. to be directly coupled to the slider of the potentiometer. Resistor R_4 prevents any



noise occurring from the slifer and R_3 restricts the fractional setting of R_2 to about 0.1. This ensures that there is an ultimate roll off above audible frequencies, and also prevents any stray capacitance at the amplifier input from forming a high Q filter.

With the values shown the turnover frequency is about 6kHz and the attenuation with minimum slope is about 2dB at high frequencies. Combined with a simple CR network, the slope can be adjusted between 6 and 18dB/octave but the author's preference is to use a second switched Sallen-Key filter with fixed slope to give a total variation from 0 to 24dB/octave.

R. J. Tidey,
Oxford.

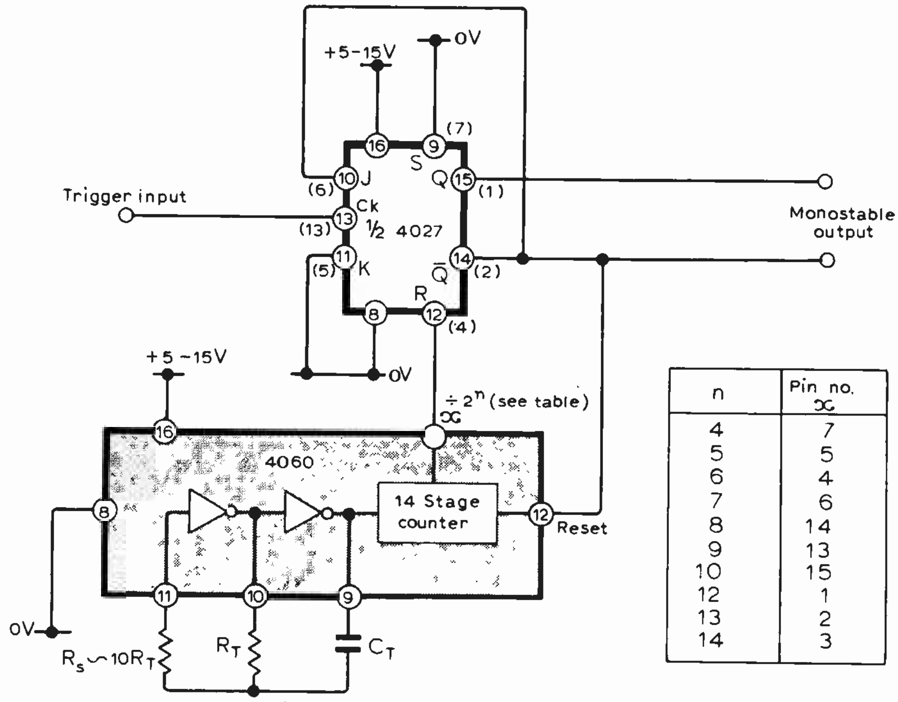
Long duration c.m.o.s. monostable

The duration of a pulse from standard c.m.o.s. monostable i.cs is affected by temperature changes and other short term variations. When accurate pulse duration is required, a more stable circuit can be made using a 4060 14-stage counter and oscillator, and half of a 4027 dual JK flip-flop.

Initially, the dividers are held at 0V by a high on their reset line. A monostable pulse is triggered by a positive edge which sets Q to a high, clears the reset line, and allows the counters to operate. After 2^{n-1} counts, the $\div 2^n$ output goes high to reset the bistable and zero the counters. Pulse duration is approximately $2^{n-1} \times 2.2 \times Rt \times Ct$ seconds and the variation, in normal room temperatures, is about 0.5%. Variation in supply voltage will increase this figure.

Apart from stability, this circuit has the advantage of long variable pulse times with good linearity. Application notes ICAN 6086 and 6539 from RCA give details of a crystal control which can be used to produce even more stable, fixed durations.

R. Price,
Medical Physics Department,
Leeds University.



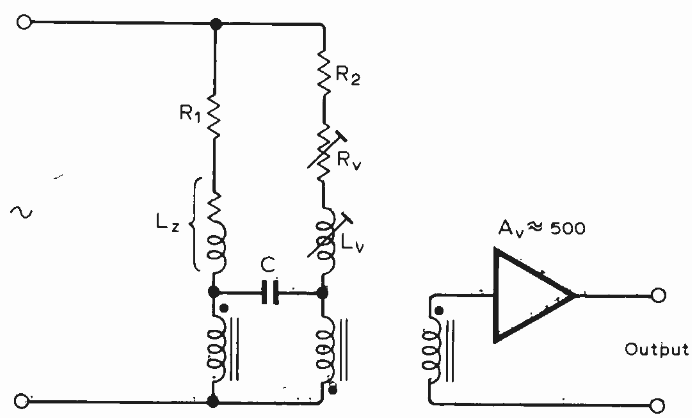
n	Pin no. x
4	7
5	5
6	4
7	6
8	14
9	13
10	15
12	1
13	2
14	3

Inductance bridge

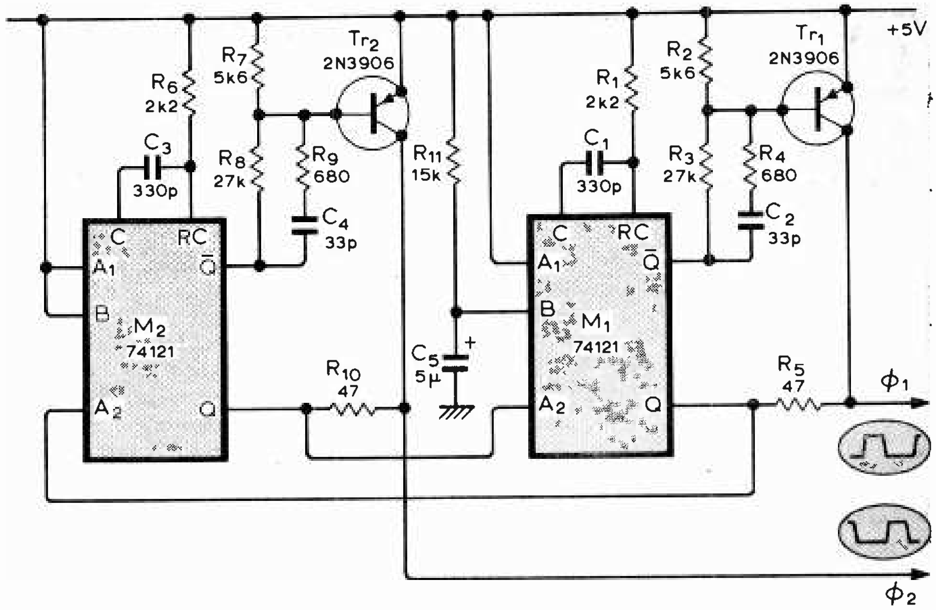
This circuit was developed to replace a high cost differential amplifier used with a.c. bridge circuits. A pulse transformer with 3 windings is connected in series with the lower limbs of the bridge. Decade resistance box Rv, and variable inductor Lv, are used for fine balancing while the ratio R_1/R_2 provides a course adjustment. As the bridge is brought towards balance, the inductance of the transformer drops rapidly to its leakage value which causes an increase in sensitivity of the system. The third winding is followed by an amplifier with a gain of about 500. If this is fed into a transistor threshold detector it is possible to detect inductance changes of less than 0.1μH in 30μH.

If the unknown limb is used in a noisy environment the interference can be filtered and fed into the known limb through capacitor C to produce a cancellation.

G. C. Kervill & T. Austin,
Sacol Controls,
Southampton.



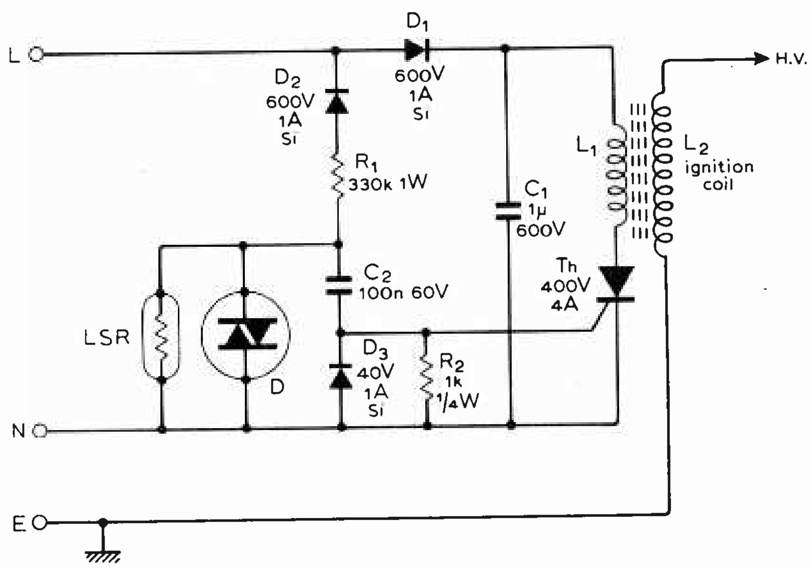
Microprocessor 5V clock generator



Many microprocessors require a clock with a full 0 to 5V swing. Standard c.m.o.s. circuits are unable to provide sufficiently fast rise and fall times and, although t.t.l. has the required speed, the high level needs forcibly pulling up to the 5V rail. The 74121 monostable has a $\overline{Q}$ output which may drive a fast switching transistor, which in turn pulls the Q output up to 5V during a logic 1 as shown. An appropriate threshold for Tr_1 is provided by the potential divider R_2, R_3. Capacitor C_2 ensures that the transitions are shorter than 50ns, and excessive overshoot or ringing is prevented by the damping resistors R_4 and R_5. For the M6800 microprocessor, two non-overlapping clock phases are required with a frequency of approximately 1MHz. These waveforms may be obtained by connecting two monostables in a ring. The values shown for the timing components give approximately 500ns pulse lengths. If a single 74123 is used for M_1 and M_2 there will be no spare A inputs to 5V, but the spare clear inputs must be tied to the supply rail. Also, R_1 and R_6 should be increased to 3k9Ω. The circuit will drive loads of 150pF and keep within Motorola's specified requirements for the M6800.

Tim Perkins,
MRC Neurological Prostheses Unit,
London S.E.5.

Line charged h.v. pulse circuit

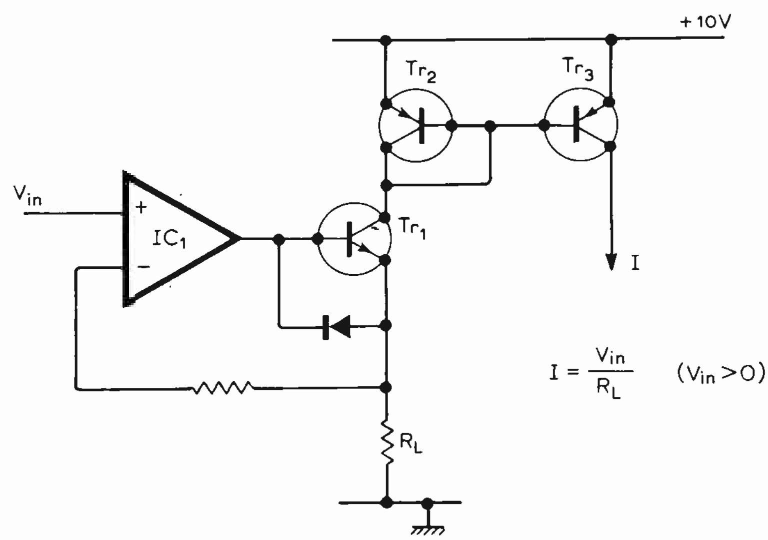


On the positive half cycle of the mains, C_1 charges to peak line voltage through D_1. On the negative half cycle, C_2 is charged through D_2, D_3 and R_1, to the peak voltage of diac D. When the diac fires at about 30V, C_2 discharges partially through the gate circuit of the thyristor. The thyristor then turns on and discharges C_1 through the primary of a car ignition coil, which generates a 20kV pulse in L_2. This sequence repeats 50 times per second.

The light sensitive resistor prevents the circuit firing if illuminated by a light source such as the flame in an oil burner which is ignited by a h.v. spark.

A. Refsum,
The Queen's University of Belfast.

Earth referenced V to I



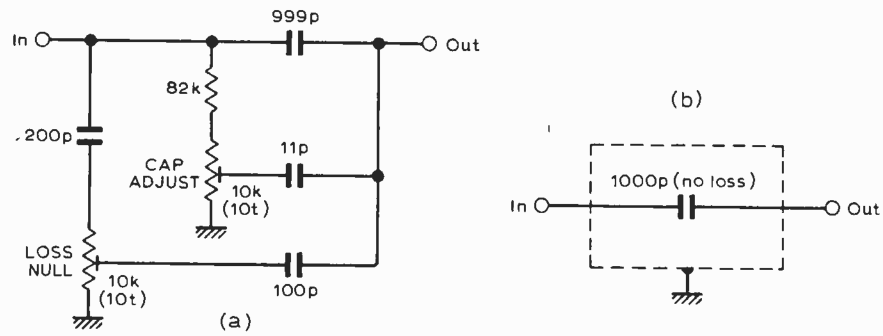
Circuits often require a voltage controlled current source in which a variable load is connected directly to earth. Most operational amplifier configurations produce either a current source or sink referenced to the supply rail. This circuit produces a voltage controlled current which may be injected to the earth rail via the load.

The operational amplifier and Tr_1 act as a voltage controlled current sink. The balanced tracking of the current mirror Tr_2 and Tr_3 is used to convert this sink current to a source current. The circuit has good thermal stability and a linearity to within 3% for output currents up to 3mA. This circuit also develops the full supply voltage across the load.

B. Wilson & K. Patel,
University of Technology, Baghdad.

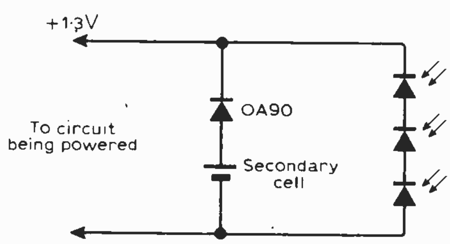
"No loss" capacitor

This simple circuit provides a "perfect" capacitor at frequencies below about 100kHz. The principle has been used to construct fixed-frequency capacitance standards for use in an accurate capacitor bridge. An oven mounted prototype provided a stability of one p.p.m. and a residual phase angle difference from pure capacitance of one micro-radian. All capacitors are silver mica types.
B. J. Frost,
Paignton,
S. Devon.



Automatic micropower battery charger

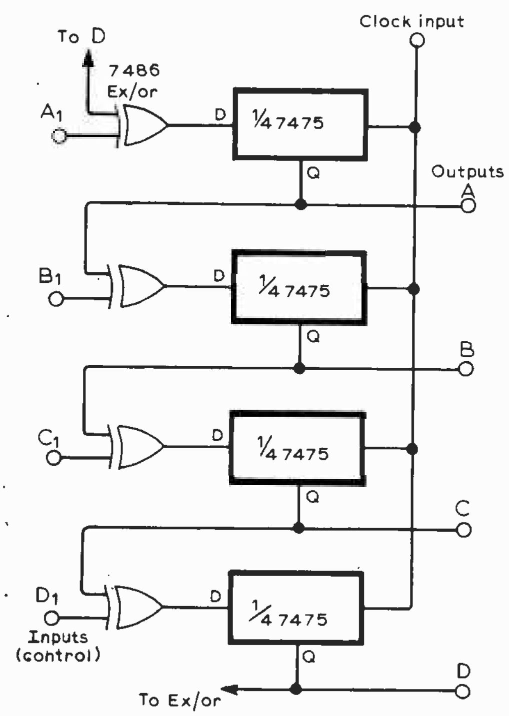
In micropower equipment it is sometimes necessary to switch between an intermittent power source, such as a solar cell, and a storage battery which must be kept charged. The circuit shown offers this facility with very few components. When the solar cell voltage is 0.2V below the battery voltage, the circuit is powered through the forward biased diode. When the cell voltage is greater than the battery voltage, the battery is charged by an approximately constant reverse leakage current from the diode. The diode, which may be a Germanium point contact or junction type such as an OA90 or OA73, should be selected for a suitable reverse leakage current. The battery can be a manganese-alkaline type or a Zn-AgO watch type cell.
M. Hadley,
University of Southampton.

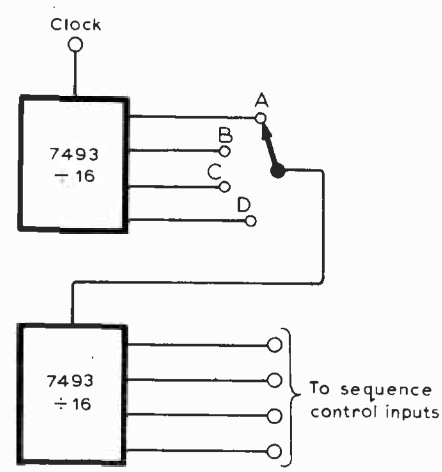


Sequence generator

This sequence generator uses a gated shift register made from a 7475 D-type latch, and four exclusive OR gates. A simple programmer can also be constructed using two 7493 binary counters. The outputs can be used as a signal source for a synthesizer, or as a sequencer for a lighting unit.

The clock pulse should be narrow to avoid race-round effects. If desired, a 74175 can replace the 7475, as this has a clear input which may be useful for resetting.
P. D. Maddison,
Portswood,
Southampton.





Books Received

Modern Electronics Made Simple by George H. Olsen is suitable for O and A level students or those teaching themselves general electronics. This book is one from a series of 67 different titles and, judging by some of the other titles such as Electronic Computers, Mathematics, and Electricity, the areas which are not covered in this book can be found in one of the others. Fifteen chapters deal with components, amplifiers, radio and television, digital electronics, power supplies, oscillators, and high-fidelity. Each chapter has a few questions at the end, and a final chapter describes ten projects. Price £2.95. Pp. 306. W. H. Allen & Co. Ltd, 44 Hill Street, London W1X 8LB.

Advanced Data-Transmission Systems by A. P. Clark is based on research, and lecture courses in digital communications at Loughborough University of Technology. The book is intended for practising or student engineers and deals with principles and techniques rather than practical considerations. Mathematical analysis is used where necessary together with worked examples. The emphasis is on future systems and, although many of the systems described have not been built, they have all been studied by computer simulation and theoretical analysis. The main purpose of these techniques is to enable the maximum transmission rate to be achieved over a linear channel, for an acceptable tolerance to noise, and an acceptable degree of equipment complexity.

After an introductory section, chapter 2 develops the theory of the discrete Fourier transform using matrix algebra and then applies it to the analysis and distortion in a sampled baseband signal. Chapter 3 develops the theory of optimum detection and estimation of a sampled baseband digital signal and applies the theory to cases where the noise is Gaussian. The final three chapters cover techniques for detecting distorted digital signals in synchronous serial data-transmission systems and parallel systems, which use code-division multiplexing. Price £12.50. Pp. 427. Pentech Press, 4 Graham Lodge, Graham Road, London NW4 3DG.

Manual of Solid State Circuit Design and Troubleshooting by Vester Robinson starts by covering the characteristics and biasing of semiconductor devices, together with design considerations. Subsequent chapters deal with audio and radio frequency circuits, signal-generating circuits, and power supplies. Design examples and graphical information are given where appropriate. The final two chapters describe bench testing procedure and troubleshooting techniques. Price £15.15. Pp. 413. Prentice/Hall International, 66 Wood Lane End, Hemel Hempstead, Herts HP2 4RG.

Synthesized f.m. transceiver — 2

The receiver and transmitter sections

by T. D. Forrester, G8GIW

Part 1 of this article described the synthesizer and oscillator sections of the transceiver and discussed the method employed for channel and mode selection. This second part describes both the transmitter and receiver sections and concludes with some tips on construction and the alignment procedure.

The receiver part of the transceiver uses standard and well-proven circuitry and should have no alignment or constructional problems. Figure 5 shows the circuit diagram for the receiver.

Tr_5 is a dual-gate m.o.s.f.e.t. which is used as a r.f. preamplifier. It has just enough gain to overcome the mixer noise and consequently it helps to ensure a good dynamic range. Tr_6 is another dual-gate m.o.s.f.e.t. This device converts the 145MHz signals to the i.f. frequency of 10.7MHz. It has a resistive drain load and feeds the 10.7MHz crystal filter, which gives the receiver all its selectivity. It must therefore be a top quality item.

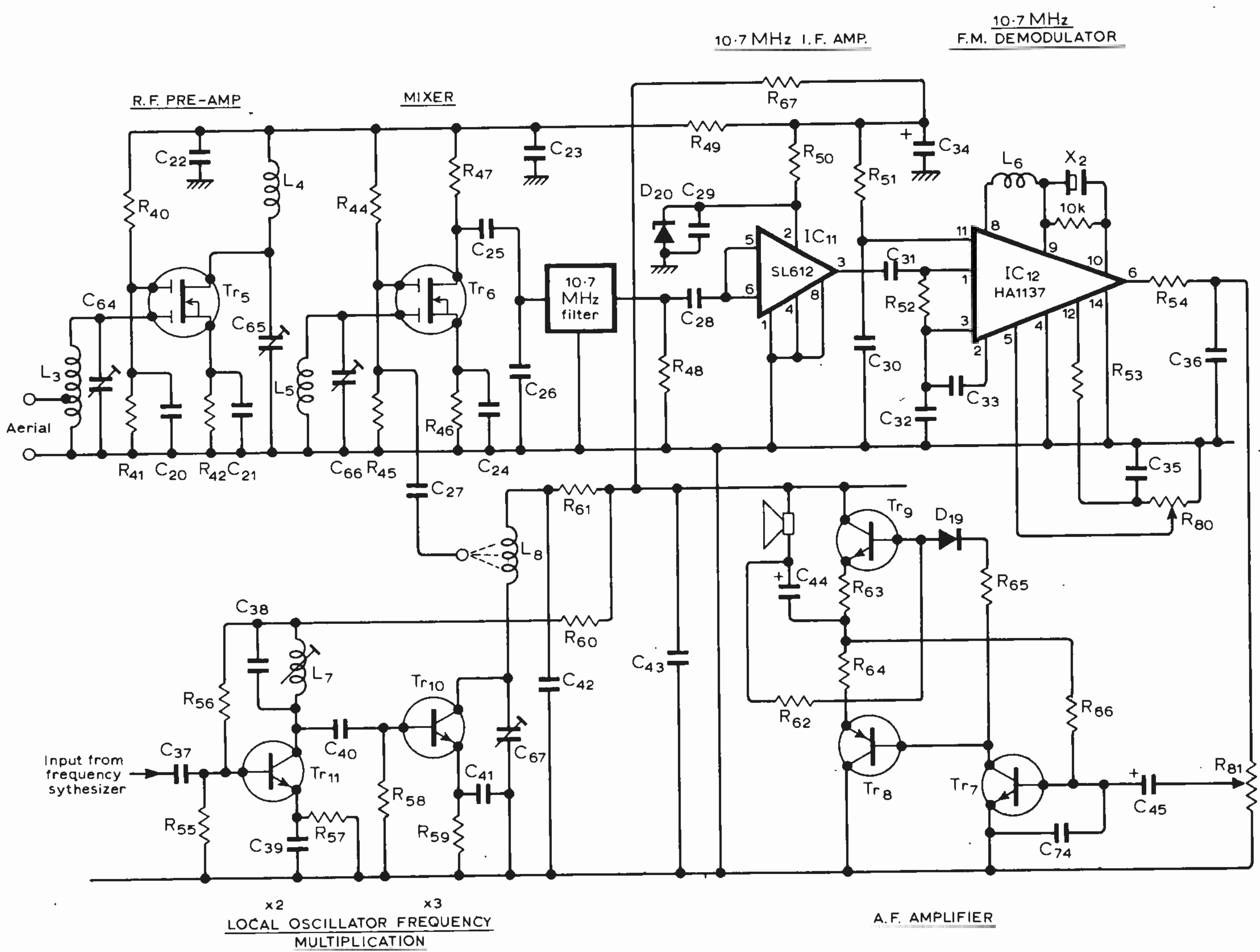
The bulk of the receiver gain is produced after the filter by the SL612 and the HA1137 f.m. discriminator. This also helps to ensure a good dynamic range combined with excellent sensitivity. The squelch control is a built-in function of the HA1137 and is sensitive enough to be lifted by a 0.2μV signal at 145MHz.

Tr_7, Tr_8 and Tr_9 act as the a.f. power amplifier, developing 200mW into an 8Ω load.

Tr_{10} and Tr_{11} form the frequency

Fig. 5. Circuit diagram of the receiver section of the transceiver. Selectivity is determined by the bandwidth of the 10.7MHz crystal filter in the i.f. circuit.

Correction: First frequency multiplier stage requires a 1000pF decoupling capacitor between top of tuned circuit and earth.



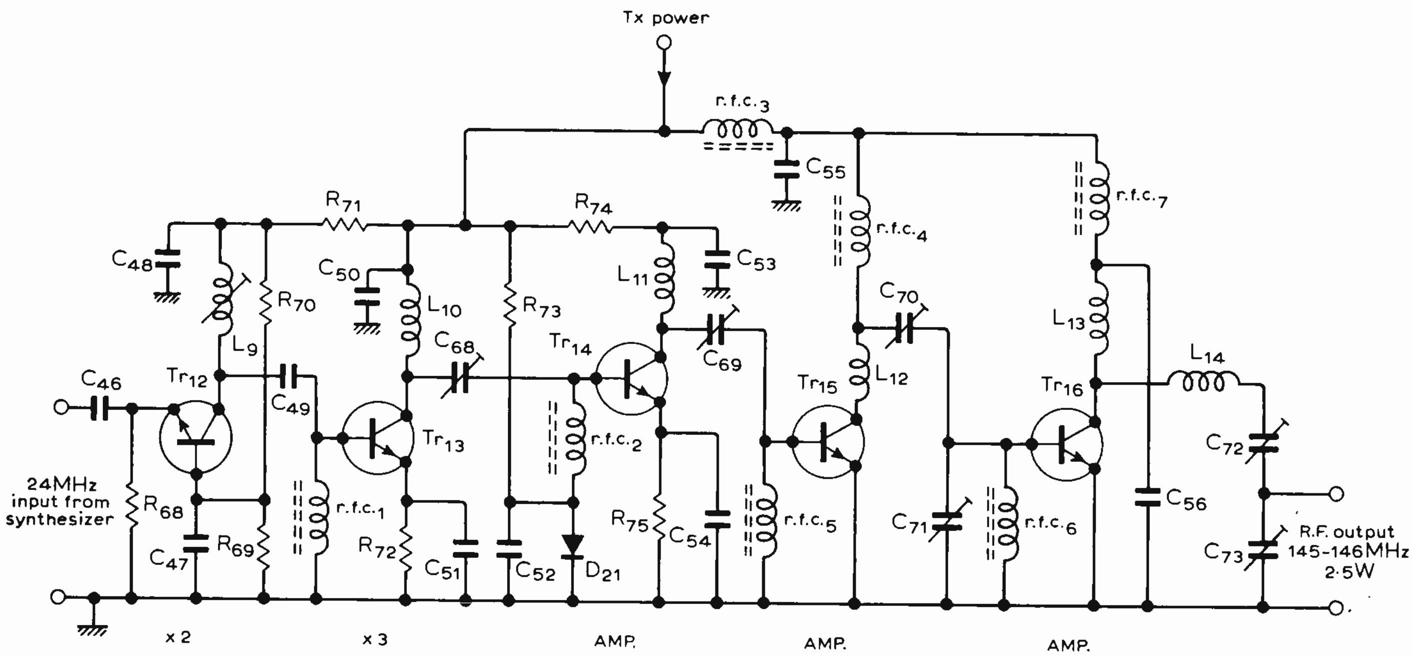


Fig. 6. Circuit diagram of the transmitter multipliers and power amplifiers.

multiplication circuit needed to convert the 22MHz signal to the required 134MHz local oscillator frequency. Tr_{11} is a Class B doubler, bringing the frequency up to 44MHz, and Tr_{10} is a Class C tripler, which converts this to approximately 134MHz.

In terms of sensitivity, noise figures, dynamic range and selectivity, the performance of the receiver is excellent; indeed it is very much better than some of the commercial transceivers available to the radio amateur.

The transmitter

As stated previously, the transmitter is based on a Mullard design, which was developed some years ago. It has been slightly modified to ease alignment problems associated with transmitter frequency multiplication. The circuit diagram for the transmitter multipliers and power amplifiers is shown in Fig. 6.

Tr_{12} acts as a Class B grounded-base frequency doubler for bringing the 24MHz synthesizer frequency to 48MHz. Tr_{13}, with its collector tuned to the 145MHz band, acts as a Class C frequency tripler.

Tr_{14} is a 145MHz amplifier which has a little forward bias applied in order to minimize the amount of r.f. drive required. Tr_{15} and Tr_{16} amplify the 145MHz signal, present at the Tr_{14} collector, to a level of 2.5W; again Class C is used in the power stages to maintain a high level of efficiency.

If the transmitter is to be used from a good portable location, it is advisable to use a band-pass filter to reduce any harmonics to an acceptable level.

Fig. 8 shows the microphone compressor and deviation control circuits of the transmitter.

Frequency modulation is applied to the varicap diode via the preset potentiometer R_{82}, which adjusts the level of deviation. The SL622, IC_{13}, is an audio compressor. This ensures that the level of deviation remains constant over the wide range of microphone inputs.

Construction

As the synthesizer is the heart of the transceiver, it was decided to build this unit first, thereby enabling it to drive the transmitter and receiver at a later date.

The synthesizer logic was built on a piece of Vero-Board measuring 3¾ × 4in, and hard wired between i.c. pins using sub-miniature wire. This method of construction was chosen as it allows easy modification and also enables the board to be made smaller than a conventional p.c.b.

The v.c.o. associated with the synthesizer was built on a separate double-sided p.c.b., one side of the board being used for a ground plane the other side being used for interconnections. Using the varicap shown, the v.c.o. operates from 18 to 36MHz for a control voltage of 0 to 12V respectively. However, other types of varicap diode may be suitable, providing the v.c.o. is capable of operating over the range of 20 to 25MHz.

The transistors used in the v.c.o. are general purpose, types 2N3707. Other types such as the BC108 and the BC109, are equally suitable.

The power supply for the synthesizer logic must provide a well-regulated and noise-free 15 volts. This is to ensure that the 4059 is sufficiently fast to cope with the 6MHz clock. A suitable power supply is shown in Fig. 7. This supply is designed to provide 15V at 100mA over a voltage input range from 9 to 18V. Note that the 74LS74 requires a 5V rail, not 15V as with the c.m.o.s. devices. To interface the 5V logic of the 74LS74, a pull up resistor, R_7, is used.

The receiver is built on a double-sided p.c.b. and contains all the circuitry shown in Fig. 5. Again, one side of the p.c.b. is used as ground plain, this is to simplify board design and minimize the possibility of instability occurring.

When building the r.f. and mixer stages it is important to keep lead lengths as short as possible in order to minimize lead inductance, which can be appreciable at v.h.f. frequencies.

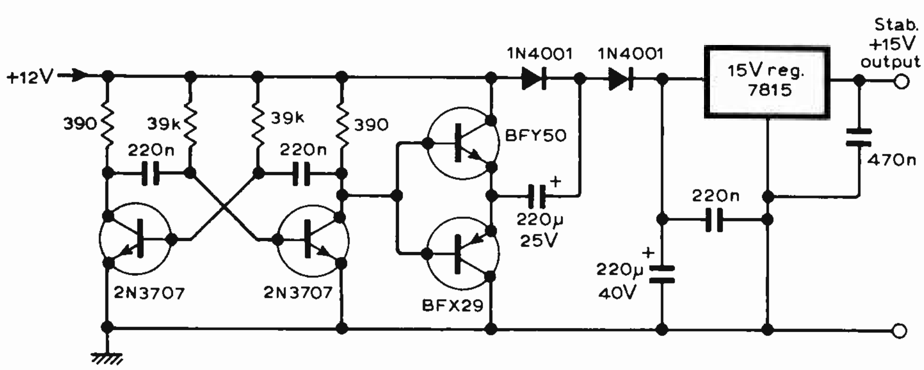


Fig. 7. A suitable regulated 15V power supply circuit for the transceiver. It requires an unregulated 12V power supply.

The 10.7MHz stages, consisting of the SL612 and HA1137, must be logically laid out. This means keeping inputs away from outputs. Also, as there is a considerable amount of gain at 10.7MHz, attention should be paid to the screening of the receiver, otherwise there might be i.f. breakthrough.

The i.f. filter probably represents the most expensive item in the receiver and could cost as much as £20. However, at the time of writing there were many ITT and STC surplus crystal filters on the market at very competitive prices. As the filter gives the receiver all its selectivity, care must be taken to ensure that the i.f. signal cannot leak around it, otherwise the receiver may be blocked off by a strong local station on another channel.

The layout of the transmitter multiplier and p.a. stages is not unduly critical, providing all leads which carry r.f. current are kept short, that is, less than ⅛in, (this includes the 1nF disc capacitors associated with the supply decoupling). Clip-on heatsinks should be fitted to the driver and p.a. stages to keep the collector temperature below 70°C.

The actual method of assembling the four boards into a complete transceiver is left to the discretion of the constructor, but it is a good idea to fit the synthesizer logic into a screened box with leads for power in, 24MHz in, control wires in, and error voltage out only. This is to reduce the possibility of any noise generated by the synthesizer logic interfering with the receiver.

The transmit/receive switching has also been left to the discretion of the constructor, although in the prototype, electronic transmit/receive switching was used, with the exception of the aerial changeover, which was a sub-miniature relay.

Alignment

The first unit to be adjusted is the v.c.o. (see Fig. 4). This is accomplished by connecting the control wire of the varicap diode to earth, then adjusting the slug in L_1 for a frequency of approximately 20MHz. After this operation, connect the control wire to V_{cc} and check that the frequency rises to above 25MHz, then tune L_2 for maximum output at 24MHz.

When the v.c.o. is aligned, connect it to the logic in the synthesizer and set the thumbwheels to channel 00 and the mode switch to normal transmit. If all is well the control voltage should settle to a value between 2 and 8V and the output frequency should be 24.16666MHz. If the frequency is slightly out, then C_2 requires adjustment to set the reference accurately at 1.0146666kHz. Switching the thumbwheels to 01 should cause the frequency to increase by 4.1666kHz at 24MHz, (25kHz at 2 metres).

To check the receiver i.f. and repeater shifts, it is only a matter of switching

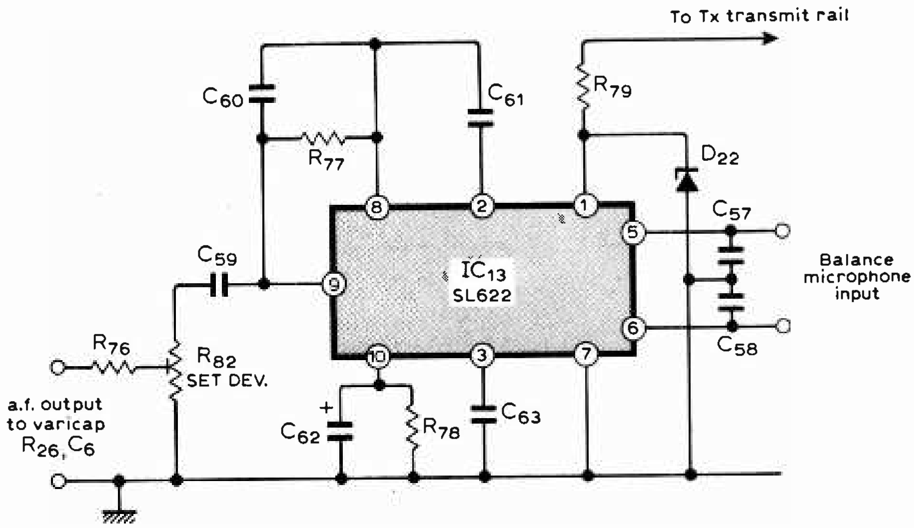


Fig 8. Microphone compressor and deviation control circuit for the transceiver.

from normal transmit on channel 00 to normal receive and checking that the output shifts from 24.1666 to 22.38333MHz, (a 10.7MHz shift down in frequency at 2 metres).

Likewise, to check the transmitter 600MHz repeater shift, switch from normal transmit to repeater transmit and check that the frequency shifts from 24.16666 to 24.06666MHz, that is, a 600kHz shift down in frequency at 2 metres. Again, when testing the inverse-repeater receive, check that the frequency shifts from 22.3833 to 22.2833MHz, that is, another 600kHz shift down in frequency at 2 metres.

If all appears well with the synthesizer, then it can be connected to the transmitter. Set the mode switch to normal transmit on channel 20 and adjust L_9 (Fig. 6) for maximum voltage across R_{72} (about 1V), ensure that the drive to Tr_{13} is on 48MHz (not 24MHz), then adjust C_{68} for maximum voltage across R_{75} (above 0.1V) and check that the collector of Tr_{13} is tuned to 145MHz (not 96MHz). It is only necessary to tune C_{69}, C_{70}, C_{71} and C_{73} in turn to produce maximum output on 2 metres.

The transmitter r.f. stages are now complete, and it only remains to apply audio to the varicap diode to produce a f.m. transmission on 2 metres. Adjusting R_{82} (Fig. 8) sets the level of deviation, and should be adjusted by monitoring the transmission on a receiver of suitable bandwidth.

To align the receiver, set the synthesizer to normal receive on channel 20, and then adjust L_7 (Fig. 5) for maximum voltage across R_{59}. Inject a signal on 145.5MHz at the aerial input and adjust C_{64}, C_{65}, and C_{67} in turn for maximum sensitivity, reducing the level of the signal as the receiver is tuned up.

Finally, to achieve the best noise figure, adjust the coupling between C_{27} and L_8 for maximum sensitivity. The receiver alignment is now complete and should require less than 1μV for full quietening, and the mute should lift on signals down to 0.5μV. After connecting an aerial to L_3 and selecting a popular channel, stations should be heard. It may be necessary to trim C_{64} slightly to match the aerial correctly. It may also be necessary to adjust the value of R_{65} slightly, to remove any crossover distortion present in the output stage.

The transceiver is now completely ready for use on the air.

Conclusion

Through the extensive use of integrated circuits in the synthesizer, and receive i.f. section, it is hoped that alignment problems associated with multichannel transceivers have been lessened considerably. That is, it is only necessary to adjust the reference crystal to 1.000MHz and the transceiver will be exactly on frequency, no matter which channel or mode is selected.

It is also possible to build the synthesizer separately and to use it to drive commercial rigs, thus avoiding many expensive crystals which could cost about £5 per channel (a 22-channel transceiver would have £110 worth of crystals inside it). By comparison, a synthesizer of the type described could be built for as little as £30 and it would also produce all 40 channels in addition to offering repeater and inverse repeater operation — obviously a great saving.

Correction notes. The 220kΩ resistors R_8 to R_{25} (see Fig. 3) on the 4560 inputs (pins 15, 1, 3, 5, 14, 2, 4 and 6) are pull-down resistors which should be between the inputs and earth, and not as shown. Connections should also be made *direct* between the inputs and the thumbwheels and mode lines; 15 to a, 1 to b, etc. The right-hand pin on IC_4 shown as pin 3, should read 'pin 8'. Further details in next issue.

Printed circuit boards

A set of p.c.bs comprising two double sided and one single sided is available for £11 inclusive from M. R. Sagin at 23 Keyes Road, London NW2. The boards accommodate components for the receiver, transmitter, synthesizer and v.c.o.

New Products

Synthesized communications receiver

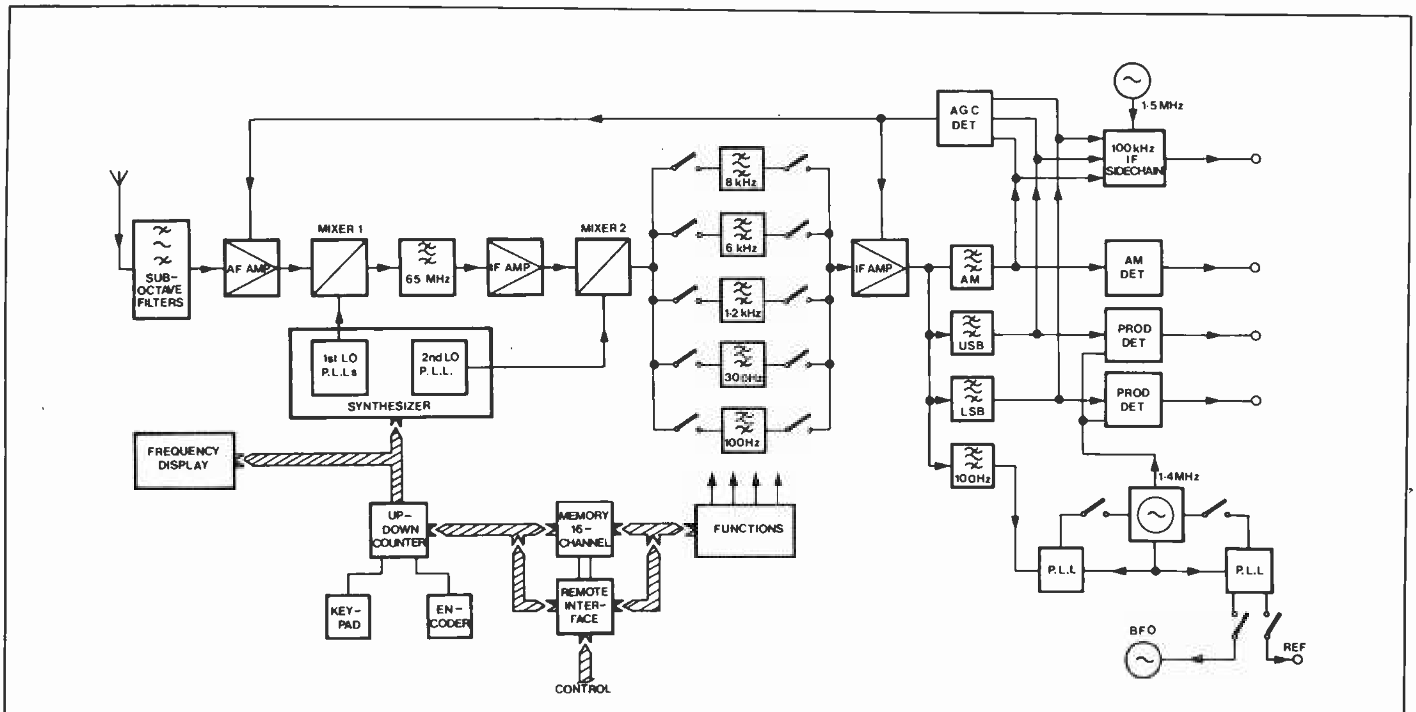
A communications receiver, designated the PR2250, is claimed by the makers, Plessey Avionics & Communications Ltd, to be the first receiver unit – as distinct from system (see p.85, Nov. 76 issue) – to take most of the tedious manual labour out of surveillance and monitoring operations. The receiver, which covers l.f., m.f. and h.f. bands from 10kHz to 30MHz, is a solid-state high-stability synthesized instrument capable of being digitally controlled from either a keypad on the front panel or from an external serial data stream. An optional microprocessor module, claimed to be unique in this type of equipment, may be programmed to allow the receiver to interface with many different control systems. Tuning is by this keypad or a photo-diode, and l.e.d. dial scanning-system (as described in pp.65-6, Sept. 77 issue), enabling fast and accurate searching to be carried out.

The tuning dial has two tuning rates, one for fine tuning and one for searching, both providing frequency steps of 10Hz. The keypad enables a new frequency to be selected quickly by simply punching in the desired frequency in kHz. A non-flicker l.e.d. display indicates the receive frequency in MHz. Push button controls also provide selection of a.m., f.m., c.w., u.s.b., l.s.b. and i.s.b. modes, bandwidth filters, a.g.c. and a.f.c. All of these selections, and the frequency, can be stored in a built-in 16-channel memory so that they can be recalled almost instantly.

The synthesizer, a patented Plessey design, allows tuning from one end of the frequency range to the other in 10ms (typical). Specifications include a sensitivity on s.s.b. of 15dB signal-to-noise-plus-noise for a 1μV (e.m.f.) input and a typical noise figure of 10dB from 100kHz to 30MHz. Intermediate frequency and spurious signal rejection is greater than 80dB down.

Although this product represents a step forward in British-made professional communications equipment, at a price of about £6,500 – which doesn't include the microprocessor – it remains to be seen whether it can survive the competition if the Japanese, who are proving to be very proficient at producing this type of equipment at low cost, succeed in entering the professional communications equipment market. Plessey Avionics & Communications Ltd, Ilford, Essex.

WW 301



Simplified block schematic diagram of the PR2250 receiver under external control.

Digital printer

A microprocessor controller is used in the SP302 five-by-seven impact dot-matrix printer to enable it to perform functions such as double-width printing and double and triple spacing, which, the makers claim, are not available on competitive units. Tab functions are fitted as standard and may be externally controlled by simple software. The standard input baud rate is 110, but other rates can be internally set. The unit prints at a rate of 50 characters per second. It will print multiple copies and is also capable of using ordinary 3⅞in adding-machine paper. The SP302 measures 244 × 127 × 305mm and has a power requirement of 25W from 115 to 230V at 50 or 60Hz. Syntest, 169 Millham Street, Marlboro, Mass. 01752, U.S.A.
WW 302

Low-cost DMM

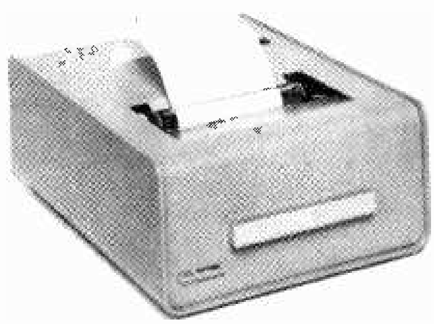
A calculator-sized 3½-digit multimeter, the PDM35 introduced by Sinclair Radionics Ltd, is available in the UK at £29.95 plus 8% v.a.t. The meter measures 155 × 75 × 30mm and weighs only 175g. Its design is claimed to be based on the results of an international survey which tried to determine the features required from a multimeter by the majority of users. As a result, the meter does not have an alternating-current range. The PDM35 has four direct-voltage ranges, from 1mV to 1kV, and six direct-current ranges, from 1nA to 200mA, with a 10mΩ input impedance on the voltage ranges, and a maximum resolution of 0.1nA on the current ranges. Accuracy in each case is 1% ± 1 digit of the reading. Its alternating-voltage range is suitable for frequencies from 40Hz to 5kHz from 1 to 500V r.m.s. with an accuracy of 1% ± 2 digits. The meter also has five resistance ranges from 1Ω to 20MΩ with an accuracy of 1.5% ±1 digit, and five junction-test ranges. Sinclair Radionics Ltd, London Road, St. Ives, Huntingdon, Cambs PE17 4HJ.
WW 303

Sound level meter

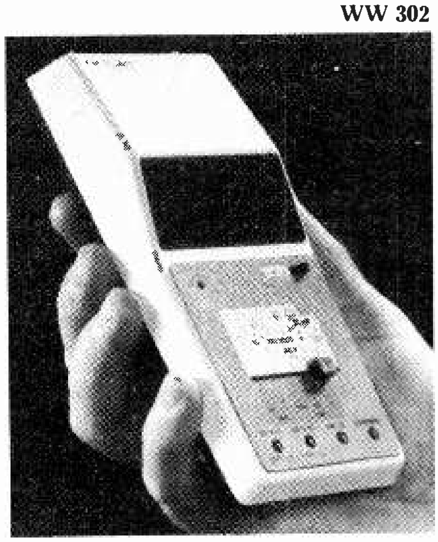
The db-306 Metrologger is a pocket-sized sound-level meter incorporating a minicomputer which measures and displays A-weighted sound levels over a selected 64dB range. It also indicates the equivalent continuous sound level, the maximum sound level sampled and the time duration of the measuring period. The instrument, which utilizes a microprocessor, is normally supplied with a ¼in ceramic microphone that can either be mounted on the Metrologger or be positioned up to 100ft away. Sound levels are displayed in 1dB increments on a digital readout which is updated four times per second. An inexpensive 9V battery having an operating life of about 72h is used to supply the device. Dawe Instruments Ltd, Concord Road, Western Avenue, London W3 0SD.
WW 304

R.f. analyser

All the elements to form a complete transmission and reflection measuring instrument are contained in the Wiltron 640 r.f. analyser. The unit comprises a swept r.f. generator covering 1 to 1500MHz, logarithmic amplifier with detectors, one of which is for reflection measurements, and a display (built by Tektronix). The display is in the mainframe of the instrument, the other elements of the system being in the form of plug-in units. System noise level is around −60dBm and the r.f. output is calibrated to +10dBm, so that a 70dB dynamic range is obtained. Several marker systems, for level and frequency, are provided; a nice refinement is the 'tilt' facility for frequency marker pips to enhance visibility on the skirts of responses. The output level is held to within 0.2dB over the 1500MHz range, and over the often-used 400-500MHz sections it is constant to within 0.1dB. Wiltron, 825E Middlefield Road, Mountain View, CA 94043, U.S.A.
WW 305



WW 302



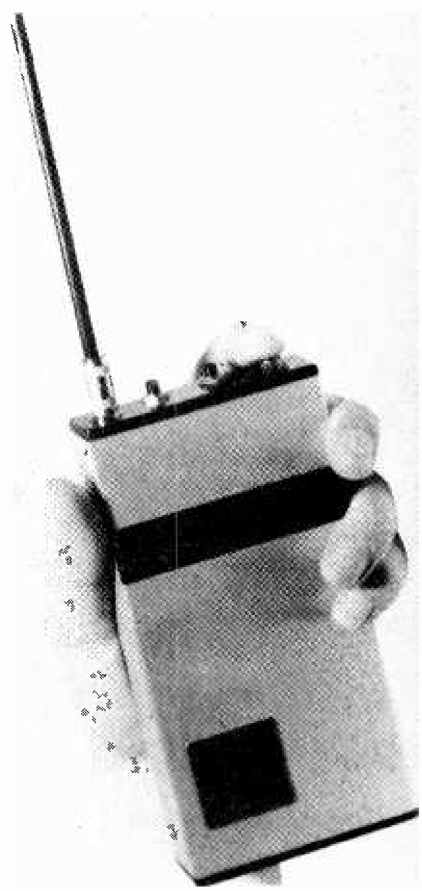
WW 303

R.f. transistor

A r.f. transistor, the BF199 manufactured by AEG-Telefunken, is suitable for video i.f. amplifier stages. It is a silicon n-p-n epitaxial planar transistor having a feedback capacitance of only 0.32pF. Absolute maximum ratings include a V_{CEO} of 25V, V_{CBO} of 40V, V_{EBO} of 4V, I_C of 25mA and I_B of 2mA. Total power dissipation is 300mW and the junction temperature is 150°C. Other characteristics include a typical gain bandwidth product of 500MHz and a typical h_{fe} of 88. The BF199 is packaged in a T092Z case. Norbain Semiconductor Division, Norbain House, Arkwright Road, Reading, Berkshire RG2 0LT.
WW 306

A-to-d converter

The LD130 three-digit analogue-to-digital converter i.c., from Siliconix, has been reduced in price by 45% from £6.36 to £3.45 (for quantities of 100 or more). This follows the company's improvements in high-volume manufacturing techniques. Sampling rates for this device vary from 1 to 60 per second and accuracy is quoted as 0.1% ±1 digit, with a 1mV resolution. Siliconix Ltd, 30A High Street, Thatcham, Newbury, Berks RG13 4JG.
WW 307



WW 304

Microcomputer development system

A microcomputer system known as the muPro-80 comprises a complete 8080A microcomputer, a control and display panel, an in-circuit emulator, a dual floppy-disc system and a software package. The software package includes a multi-purpose real-time executive and a high-level relocatable output assembler, having a number of sub-routines with Algol-type statements such as 'if', 'then begin', 'end' and 'else begin'. This package also includes a disc operating system and a text editor. User programmes can be operated in a time-share mode. The control and display panel enables memory or register contents to be examined or changed, break points to be set and the last 64 instructions to be executed and traced. All of the functions are provided for without the use of any of the system memory locations, such that all the 64K memory locations, 255 i/o ports and interrupt lines are available to the user. Microsystem Services, Duke Street, High Wycombe, Bucks.
WW 308

TV aerial isolators

Three aerial-isolation assemblies, types L1910, L1911 and L2114, have been designed for use in the 75Ω coaxial inputs of television receivers. The assemblies accept both 9.5 and 9mm diameter plugs and are suitable for v.h.f. and u.h.f. receivers. Type L1910 has a single input and single output, type L1911 has a single input into a diplexer board giving two outputs, one v.h.f. and one u.h.f., and type L2114 has a single input and output but includes a built-in high-pass filter. Radio interference immunity in the frequency band from 470 to 775MHz is greater than 25dB, and from 775 to 860MHz is greater than 20dB. Signal attenuation figures at 10MHz range from 0.5dB for the L1910 to 25dB for the L2114. The assemblies are accepted by many national safety authorities in Europe, Scandinavia and South Africa. Belling & Lee Ltd, Great Cambridge Road, Enfield Middlesex.
WW 309

D.m.o.s. f.e.ts

A range of d.m.o.s. f.e.ts, available from Mullard, is comprised of silicon-insulation gate f.e.ts of n-channel enhancement mode. The devices are manufactured by a double-diffused process which gives them frequency performances up to 2GHz. Characteristics claimed include high gains, low noise levels, good linearites, low intermodulation distortion, and low feedback capacitances. Types available include TO-72 devices for general purpose r.f. amplifiers up to u.h.f. (types SD200 to SD203), high speed f.e.ts having low 'on' resistances (SD210 to SD215), and dual-gate f.e.ts for v.h.f. and u.h.f. mixer and amplifier applications (types SD300, SD303 to SD308). Also available is the eight-pin d.i.l. type SD6000 which consists of two dual-gate devices in a single encapsulation. It is intended for use in varactor and conventional tuners for v.h.f. f.m. circuits. One device is characterised as a mixer, and the other as a r.f. amplifier. Mullard Ltd, Mullard House, Torrington Place, London WC1E 7HD.
WW 310

High-current r.f. inductors

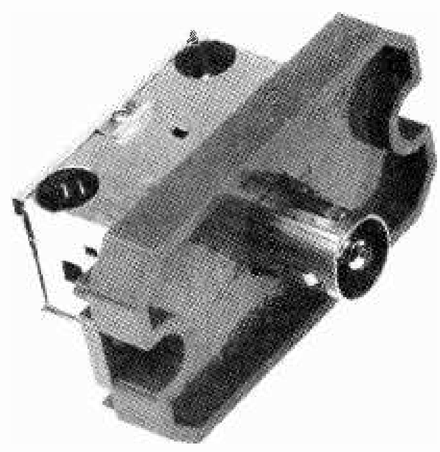
Two encapsulated r.f. inductors, introduced by Plessey Windings, are designed to carry higher-than-normal direct currents without degrading the inductance value. Type 11207, which has an inductance range from 50μH to 10mH and a typical Q-factor greater than 100, measures only 7mm in height and 19mm in diameter. Its superimposed d.c. value (the direct current which will cause the inductance to reduce to 95% of the zero d.c. value) is from 85mA to 1.2A, depending upon the inductance value. Type 11206, measuring only 6½mm in height and 14.5mm in diameter, has an inductance range from 1mH to 100mH, Q-factors from 75 to 200, and its superimposed d.c. ranges from 7 to 60mA. Plessey Windings, The Plessey Company Ltd, Ilford, Essex.
WW 311

Locking dials

Two precision locking dials, types LK25 and LK50, have been made by Argo Electronic Components Limited. The LK25 is a miniature dial (measuring 22 × 25mm) having a photoanodized face with graduations of 0-10 over an arc of 270 degrees and 0-100 over an arc of 300 degrees. The LK50, which incorporates a dial measuring approximately 2in square, has standard graduations of 0-10 over 270 degrees and 0-100 over 300 degrees. However, for both dials, graduations can be supplied to customer specification, and may be used over 360 degrees. Argo Electronic Components Limited, Stiron House, Electric Avenue, Westcliff-on-Sea, Essex, SS0.
WW 312

Crystal oscillators

A high-power v.h.f. crystal oscillator, the model CO-284W, provides a stable fixed-frequency output of 1W (+30dBm into 50Ω) at any frequency from 5 to 300MHz, and 0.5W (+27dBm into 50Ω) in the range 300 to 500MHz. The standard stability is ±0.0025% from 0 to 70°C, with optional stabilities of ±0.0003% from 0 to 50°C, or −55 to 125°C. Although the oscillator is factory set to within 10p.p.m. of the specified frequency, adjustment to within 1p.p.m. is available as an option. For phase-locking applications, electronic tuning (v.c.x.o.) is also optional. Other models in this v.h.f. family are available with lower-level sinewave (5 to 500MHz) or e.c.l.-compatible (5 to 200MHz) outputs. Lyons Instruments Limited, Hoddesdon, Herts.
WW 313



WW 309

WW 308

Push-fit terminals

Push-fit terminals in the Terminette range include both stand-off and lead-through types which are supplied in matched sets of pins and p.t.f.e. insulators. The insulators are supplied in a variety of colours and are chamfered on the lower edge to enable an easy push-fit into a prepared hole. Subsequent insertion of a pin will rigidly lock an insulator into a chassis. Terminals are available for chassis hole sizes from 0.062 to 0.156in and in metric sizes. All types meet the requirements of DEF5334B and some of these have NATO references and can be released to MOD05-29. H & T Components Limited, Crowdy's Hill Estate, Kembery Street, Swindon, Wiltshire.
WW 314

DMM kit

The Model 2000 easy-to-build kit assembles into a bench/portable 3½-digit multimeter having an accuracy, when correctly calibrated, of 0.1%±1 digit, and an input impedance of 10MΩ. It has five functions, giving 28 ranges, and is provided with 100% overrangeand overload protection. The alternating- and direct-current and resistance functions each have six ranges, enabling resistance measurements from 1Ω to 20MΩ and current measurements from 100nA to 2A to be made. The direct- and alternating-voltage functions each have 5 ranges providing voltage measurements from 100μV to 1kV. Overrange load indication, polarity and zeroing are all automatic. Price is less than £70 including tax. Sabtronics (UK) Ltd, 50 Galton Road, Westcliff-on-Sea, Essex.
WW 315

Silicon rectifiers

Silicon-controlled rectifiers in the MCR100 series, from Motorola, are sensitive to gate-trigger currents up to a maximum of 200μA. These devices, which will pass a forward r.m.s. current of up to 800mA, are supplied in peak reverse- and forward-blocking-voltage ratings from 100 to 600V in 100V steps. The reverse- and forward-blocking currents are no more than 100μA at 125°C and the maximum holding current is only 5mA. Motorola Ltd, Semiconductor Products Division, York House, Empire Way, Wembley, Middx HA9 0PR.
WW 316

Miniature trimming resistor

A high-resolution ten-turn trimming resistor, from Lemo (UK) Ltd, measures 9.7mm (max. height) by 4mm diameter. It is available in maximum values from 100μ to 100kμ, with the lowest adjustable values being about 25% of the quoted values. Power ratings are 370mW at 40°C, tolerances are ±30%, and the temperature coefficient of resistance values vary from 1×10^{-3} per degree Kelvin, for up to 1kΩ, to 2.5×10^{-3} per degree Kelvin for up to 100kΩ. Lemo (U.K.) Ltd, 6 South Street, Worthing, W. Sussex BN11 3AE.
WW 317

Temperature-operated switch

A temperature-operated switch, from Lee Green Precision Industries Ltd, operates in temperature ranges between 50 and 80°C. The Thermotrigger, as it is called, is made from vanadium pentoxide, the resistance of which changes abruptly from a high value at a low temperature to a low value at a high temperature. Temperature coefficient of resistance changes are −5% in the pre-transition region, −8% in the transition region, and −20% in the post-transition region. Lee Green Precision Industries Ltd, Grotes Place, Blackheath, London SE3 0RA.
WW 318

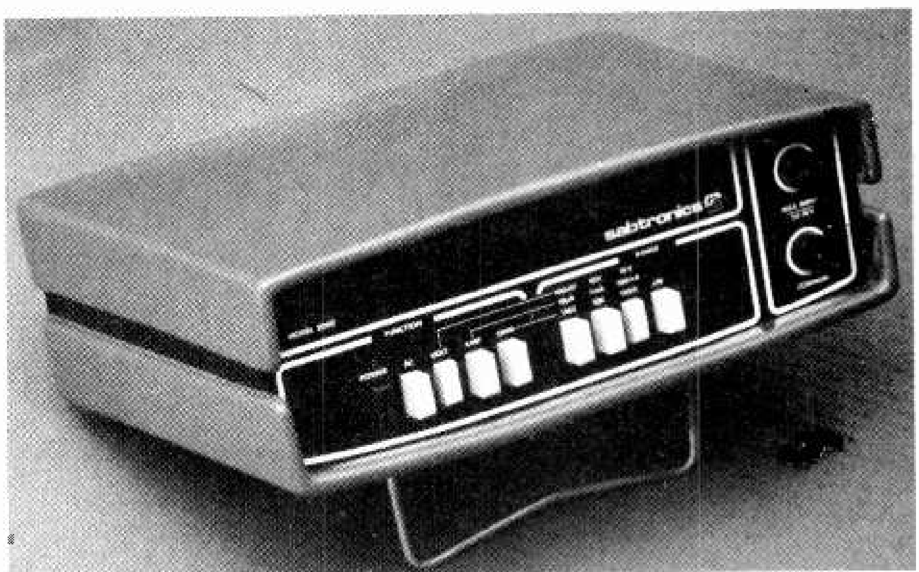
Tweezer pliers

Stirex k-40 tweezer-pliers are moulded in glass-filled propylene and have adjustable locks and self-opening handles. The locking device can be moved up or down the handles so that the jaws can grip and hold objects up to 7mm in diameter. They may also be used without the locks. The pliers, which have finely serrated jaws with tip widths of 4mm, are 165mm long overall. They are non-hygroscopic, non-magnetic, resistant to most acids, and they weigh only 14g. Tele-Production Tools Limited, Stiron House, Electric Avenue, Westcliff-on-Sea, Essex SS0 9NW.
WW 319

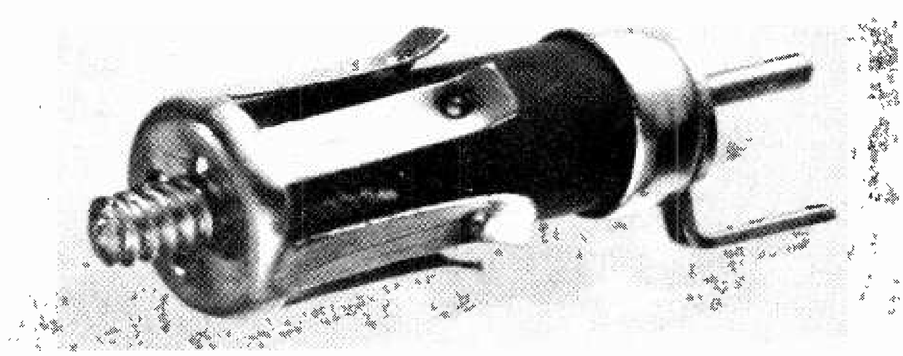
High-current relays

Relays in the Ideco range have up to four change-over contacts and are available in ratings up to 10A. Most of the relays are plug-in types having five, eight or eleven-pin bases.

Contact materials include gold-plated pure silver, silver-cadmium oxide or silver-palladium. The springs are phosphor bronze, with mechanical lives of about 50 million operations, and coil voltages range from 6 to 110V direct or 6 to 240V alternating. A. B. Relays Ltd, Orgreave Crescent, Sheffield S13 9NQ.
WW 320



WW 315



WW 317

Sidebands by mixer

M.l.s.—Mine's lots safer

As Arnold Postlethwaite once said, "It's not t'fall as 'urts thee, lad — it's t'sudden stop at t'bottom." Arnold was speaking with difficulty at the time, having just fallen downstairs, hitting every tread on the way down and was, one felt, hardly in a position to come on with the homespun philosophy.

But a little philosophy, homespun or not, would seem to be appropriate to those deliberating on the microwave landing systems of the future — electronic assistance in avoiding "t'sudden stop at t'bottom." Amid clamorous protestations of thinking only of the good of passengers, all the parties interested in the final choice of British, American or German systems are intent on making sure that they finish up on the gravy train, morally as well as financially (I use the word 'morally' in the sense of 'moral victory' and in no other manner). Whichever system is adopted by ICAO, the manufacturers who 'lose' stand to make very nearly the same profit as they would if their own system were chosen, since those who propose the Doppler method can make scanning equipment equally well, and vice versa.

So, it appears that the choice of a system is being held up for nebulous reasons of national pride, rather than for commercial and technical considerations — Doppler and scanning-beam both seem to work well in most situations. Computers don't seem to be able to come up with a clear-cut choice, particularly when told that airports have suddenly sprouted imaginary buildings, and it seems that aircraft have got to go and actually land at various 'troublesome' airports and find out the hard way. Let's hope they get on with it and reach a decision soon; one based on the facts and not political manoeuvrings, as has happened so often before. Let us also hope that, when automatic landing is eventually a common procedure, the reliability of the equipment is not open to question. The alternatives of landing on the runway or twenty feet under it must not hang on the life expectancy of a 100kΩ resistor or the cleanliness of a plug and socket.

Table talk

While desultorily casting around for something revolutionary to invent during the afternoon, my colleague froze, the peas from his knife rolling in a steady stream across the table, un-unheeded. "Why not?" he said, as our ravioli and chips grew cold, "Why not design a computer graphics thing for the telly?" We stared at him, as he caught the peas with his fork, temporarily at a loss for words, and then we all started talking at once. "But," . . . "Whatdya mean . . .?" . . . "You can't . . ." . . . and similar meaningful human communication.

As the last chip disappeared and chocolate sponge spoons were wearily taken up, we had decided that to do the job properly you would need a mainframe computer about the size of our office, and our management people are a bit funny about that sort of thing. But the idea was a good one. For example, you could rearrange all the furniture and view it from different angles, in perspective. That cabinet for all the hi-fi equipment can be seen from all viewpoints and you may then see that it would completely block Grandpa's view of the tv when the turntable lid was up. Exhibition designers would find it helpful and architects could completely remodel Bruddersfax town hall or the Humber bridge without spending a penny on concrete until it looked about right.

Not that it's a new idea, of course but, using a microcomputer and a domestic tv as display unit, it could be a lot more useful than playing ludo. Personally, I never believed all that about NAAFI tea, but I'm beginning to wonder about our canteen's ravioli.

Watt voltage?

Many years ago in the dear, dead days of my youth and long before I learned not to argue with 'experts', I had to show one of these experts who was also an M.P. one of the new signal generators made by the company for which I worked. Its attenuator was calibrated in decibels relative to 1μV across 50Ω and, because he felt that he had to say something intelligent, the chap said "Ah, but are they voltage or power decibels?" Well, that took me aback a little, but I came back, quick as a flash, and said that it didn't matter because the calibration was the same for voltage or power. The ensuing argument, which was thickly be-spattered with expressions to do with going back to school and with the possession of infinite Z between the ears did not reach an amicable conclusion, but I was saved from the Star Chamber by the fact that someone's power supply exploded and diverted his attention.

The fact is, of course, that so long as the impedances do not change, decibels can be either voltage or power. The ratio of the gain of an amplifier at 1kHz to its gain at 20kHz may be 3dB and, if you work it out, you can see that this can mean either voltage or power assuming that the output impedance is still the same. It does mean that the power output is halved and the voltage output is $1/\sqrt{2}$ that at 1kHz, but this is —3dB in each case.

Perhaps I can now stop the argument that started twenty years ago and refer people to this piece in the future.

Would you care to re-phrase that?

Far too headstrong, that's the basic problem with colonials, particularly with those in America. Give them their head and heaven only knows what they'll get up to. I dare say that, after a little time to reflect on the working of this Declaration of Independence thing, they're already beginning to regret the whole nasty business. We've been good to them — some would say we've been too generous by half. They've come over here and we've been so glad to see them back that we've let them make their motor-cars here and pretended to marvel at their talking pictures and no one's ever said an unkind word. Well, not many, anyhow.

They're good chaps, taken as a whole, although perhaps a little slow on the uptake when they're wanted, but they have had this attitude of late that has denoted a certain, well, greediness. They have turned up here and *bought* things. Things like England, for instance. And it's got to stop – they'll be wanting to take Yorkshire back to San Francisco next and reassemble it stone by stone.

As a warning not to be so selfish, then, several British companies have already decided that the best and wisest way to deal with these youthful high spirits is to do the same sort of thing back to them. Racal, for example, has taken over not only Milgo, but Dana Electronics as well. I expect they'll give them back in a little while, but it's the example that's important. EMI has had companies over there for some time now and lots of our firms have colonial outposts. Goodness knows how they manage it, what with Indians and the weather, but they all come from good, pioneering stock.

It's all very well to be independent – all young people need to break away once in a while – but freedom has to be used properly. Let us hope that they have learnt their lesson now. After all, we've done our best to keep them out of trouble. Geordie George from up in Washington all the way down to young Robert (Hope, that is) have actually *gone* there and kept an eye on them and *still* they keep saying they are independent now. They even managed to convince poor old George. Well, they can't say they weren't warned.

MAGNUM AUDIO MODULES

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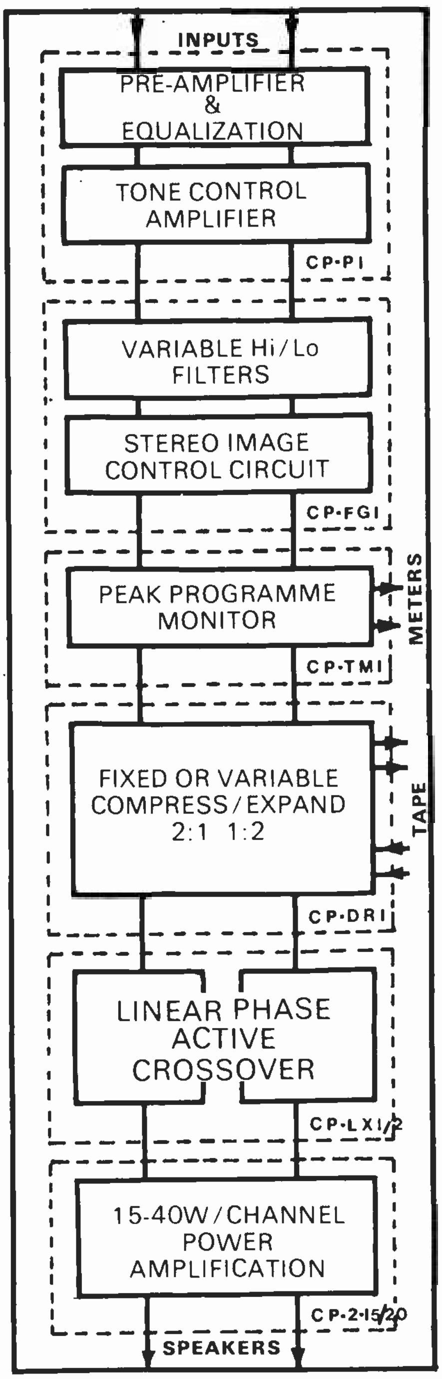

CP-P1

A fully encapsulated stereo pre-amplifier/tone control module incorporating four separate amplifiers and a stabiliser circuit which may also be used to power the **CP-FG1**. Equalisation networks associated with the low noise input stages may be switched in for disc replay and provision is made for optimum cartridge loading. The magnetic input noise level is >70db down on 3mV and distortion is <0.02%. The 33db overload margin is extended to >40db when used in conjunction with the **CP-FG1**. It only takes connection to a few pots and switches and to a ±18V supply to make a complete 'state of art' pre-amplifier.

CP-FG1

This fully encapsulated audio function module incorporates some unique features. Two stereo filters ('rumble' and 'hiss') are provided, each with its own slope control and choice of three cut-off frequencies. A stereo separation control allows variation of the apparent image width to suit listening conditions. This can provide a degree of realism not possible from conventional systems. Signal to noise and distortion performance is in line with that of the **CP-P1**.

CP-TM1

A peak programme monitor circuit which, when used with a suitable meter movement, is capable of capturing the peak-transient information in an audio signal and storing it long enough for it to be displayed by the meter movement and noted by the user. When used in any of the the **Magnum** Systems, it can ensure that the available signal to noise and distortion performance is realised

CP-DR1

This dynamic range controller has two main applications. Firstly it may be used to compensate for any compression or peak limiting which may have been applied to radio broadcasts or commercial gramophone recordings and thus restore lost realism.
Secondly, it may be used to make 'noise free' tape recordings as an additional 30-40db of dynamic range can be encoded and recorded onto most cassette recorders and then decoded and recovered on replay. The unit may also be used as a compressor for listening in high noise environments (the motor car?) or for the preparation of 'constant volume' background music.

CP-LX1 and LX2

Linear phase active crossover networks which may be used to replace any passive crossover network in an existing speaker or in your next 'creation' why not try an **LX1** in the 'High Quality Bookshelf Speaker' (WW Oct. 77 p.42)? In addition to the advantages of improved loudspeaker damping, transient response and intermodulation performance, these crossovers are easily adjusted to your chosen frequency(ies) by selecting two resistors per crossover point. Should you wish, we will preset them for you.

CP2-15/20

Encapsulated into a generous heatsink are two 15/20 Watt r.m.s. amplifiers. By virtue of their configuration, a single module can give 20 Watts per channel using 4 Ohm speakers or 15 Watts per channel with 8 Ohm speakers. Alternatively, both the amplifiers in a module may be used to drive a single speaker, effectively doubling the power to 30 Watts r.m.s. with 15 Ohm speakers or 40 Watts into 8 Ohms.
These amplifiers operate in 'Class A' up to 3-4 Watts before entering 'Class B' and hence give excellent crossover performance. Protection is provided against overload and short circuit operation and inadvertent reversed supply connection and each amplifier has its own thermal overload switch. Transient performance is virtually unaffected by loading and free from overshoot and 'T.I.M.' distortion. All this adds up to a versatile and robust unit capable of giving an extremely 'clean' and 'musical' performance.

Send SAE for details of all MAGNUM AUDIO MODULES

CP-P1. Stereo Pre-Amplifier	**£14.96**
CP-FG1. Audio Function Module	**£13.22**
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WW—058 FOR FURTHER DETAILS

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The 450 Tuner provides instant program 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, by simply changing the settings of the pre-set controls.
Used with your existing audio equipment or with the BI-KITS **STEREO 30** or the **MK60** Kit etc. Alternatively the **PS12** can be used if no suitable supply is available, together with the Transformer **T538.**
The S450 is supplied fully built, tested and aligned. The unit is easily installed using the simple instructions supplied.

★ FET Input Stage
★ VARI-CAP diode tuning
★ Switched AFC
★ Multi turn pre-sets
★ LED Stereo Indicator

Typical Specification:
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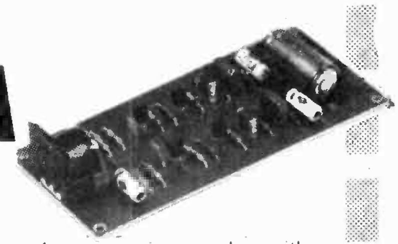
Stereo separation 30db
Supply required 20-30v at 90 Ma max.

MPA 30



Enjoy the quality of a magnetic cartridge with your existing ceramic equipment using the new M.P.A. 30, a high quality pre-amplifier enabling magnetic cartridges to be used where facilities exist for the use of ceramic cartridges only.
It is provided with a standard DIN input socket for ease of connection. Full instructions supplied.

£2.85

VAT ADD 12½%

POSTAGE & PACKING
Postage & Packing add 25p unless otherwise shown. Add extra for airmail. Min. £1.00

STEREO PRE-AMPLIFIER PA 100

OUR PRICE **£13.75**

A top quality stereo pre-amplifier and tone control unit. The six push-button selector switch provides a choice of inputs together with two really effective filters for high and low frequencies, plus tape output.

Frequency Response + 1dB 20Hz 20KHz. Sensitivity of inputs
1. Tape Input 100mV into 100K ohms
2. Radio Tuner 100mV into 100K ohms
3. Magnetic P.U. 3mV into 50K ohms

P.U. Input equalises to R1AA curve with 1dB from 20Hz to 20KHz. Supply — 20-35V at 20mA.
Dimensions — 299mm x 89mm x 35mm.

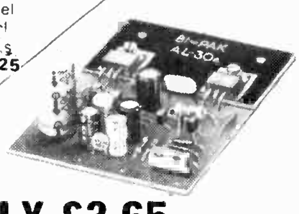
MK. 60 AUDIO KIT: Comprising 2 x AL60's. 1 x SPM80. 1 x BTM80. 1 x PA100. 1 front panel and knobs. 1 Kit of parts to include on/off switch, neon indicator, stereo headphone sockets plus instruction booklet. **COMPLETE PRICE £35.00** plus 85p postage.

TEAK 60 AUDIO KIT:
Comprising Teak veneered cabinet size 16¾"x11½"x3¾", other parts include aluminium chassis, heatsink and front panel bracket plus back panel and appropriate sockets ect. **KIT PRICE £13.25** plus 85p postage.

NEW AL30A

10w R.M.S. AUDIO AMPLIFIER MODULE

The AL30A is a high quality audio amplifier module replacing our AL20 & 30. The versatility of its design makes it ideal for record players, tape recorders, stereo amps, cassette and cartridge players. A power supply is available comprising a PS12 together with a transformer T538, also for stereo, the pre-amp PA12.



SPECIFICATION
- Output Power 10w. R.M.S.
- Supply 22 to 32 volts.
- Load Impedance 8 to 6ohms.
- Input Impedance 50K.
- Sensitivity 90mv for full output.
- Total Harmonic Distortion Less than .5% (Typically .3%).
- Frequency Response 60Hz to 25KHz ÷ 2db.
- Max. Heat Sink Temp 80 c.
- Dimensions 90 x 64 x 27mm

ONLY £3.65

STEREO 30

COMPLETE AUDIO

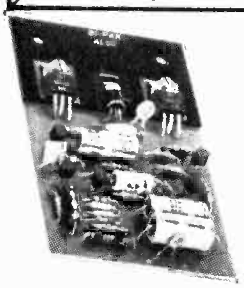
7+7 WATTS R.M.S.

P & P 45p

£16.25

The Stereo 30 comprises a complete stereo pre-amplifier, power amplifiers and power supply. This, with only the addition of a transformer or overwind will produce a high quality audio unit suitable for use with a wide range of inputs i.e. high quality ceramic pick-up, stereo tuner, stereo tape deck etc. Simple to install, capable of producing really first class results, this unit is supplied with full instructions, black front panel knobs, main switch, fuse and fuse holder and universal mounting brackets enabling it to be installed in a record plinth, cabinets of your own construction or the cabinet available. Ideal for the beginner or the advanced constructor who requires Hi-Fi performance with a minimum of installation difficulty (can be installed in 30 mins).

TRANSFORMER £3.25 plus 50p p & p
TEAK CASE £5.45 plus 70p p & p



AL 60

25 Watts (RMS)

★ Max Heat Sink temp 90C. ★ Frequency response 20Hz to 100KHz ★ Distortion better than 0.1 at 1KHz ★ Supply voltage 15-50v ★ Thermal Feedback ★ Latest Design Improvements ★ Load — 3,4,8, or 16 ohms ★ Signal to noise ratio 80db ★ Overall size 63mm. 105mm. 13mm.

Especially designed to a strict specification. Only the finest components have been used and the latest solid-state circuitry incorporated in this powerful little amplifier which should satisfy the most critical A.F. enthusiast.

£4.35

NEW PA12

NEW PA12 Stereo Pre-Amplifier completely redesigned for use with AL30A Amplifier Modules. Features include on/off volume, Balance, Bass and Treble controls. Complete with tape output.

Frequency Response 20Hz-20KHz (—3dB). Bass and Treble range 12dB. Input Impedence 1 meg ohm. Input Sensitivity 300mV. Supply requirements 24V 5mA. Size 152mm x 84mm x 33mm.

£6.70

PS12

Power supply for **AL30A, PA12, SA450,** etc.

Input voltage 15-20v A.C. Output voltage 22-30v D.C. Output current 800 mA Max. Size 60mm x 43mm x 26mm.
Transformer T538 £3.20

OUR PRICE **£1.30**

Stabilised Power Supply Type SPM80

SPM80 is especially designed to power 2 of the AL60 Amplifiers, up to 15 watts (R.M.S.) per channel simultaneously. With the addition of the Mains Transformer **BMT80,** the unit will provide outputs of up to 1.5A at 35V. Size: 63mm. 105mm. 30mm. Incorporating short circuit protection.
Transformer BMT80
£5.40 + 86p postage

£3.75

BI-PAK

P.O. BOX 6 WARE HERTS.

SHOP AT 18 BALDOCK ST., WARE, HERTS
OPEN 9 to 5.30 Mon./Sat.

NEW PRODUCTS!

NRDC-AMBISONIC 45J

SURROUND SOUND DECODER

The **first ever** kit specially produced by Integrex for this British NRDC backed surround sound system which is the result of 7 years' research by the Ambisonic team. W.W. July, Aug., '77.
The unit is designed to decode not only 45J but virtually all other 'quadrophonic' systems (Not CD4), including the new BBC Matrix H.10 input selections.
The decoder is linear throughout and does not rely on listener fatiguing logic enhancement techniques. Both 2 to 3 input signals and 4 or 6 output signals are provided in this most versatile unit. Complete with mains power supply, wooden cabinet, panel, knobs, etc.

Complete kit, including licence fee £45.00 + VAT
Or ready built and tested. £61.50 + VAT

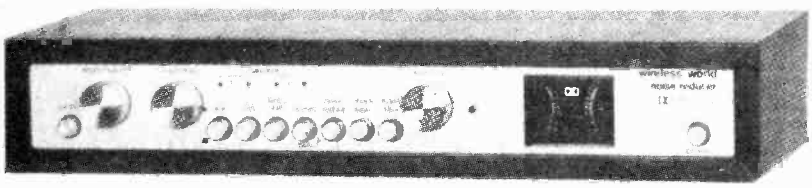
INTRUDER 1 RADAR ALARM

With Home Office Type approval

As in "Wireless World", designed by Mike Hosking, 240V ac mains operated and disguised as a hardbacked book. Detection range up to 30 feet. Complete kit. Exclusive designer approved kit £46.00 + VAT, or ready built and tested. £54.00 + VAT.

Wireless World Dolby(TM) noise reducer

Trademark of Dolby Laboratories Inc.



Featuring:
- switching for both encoding (low-level h.f. compression) and decoding
- a switchable f.m. stereo multiplex and bias filter
- provision for decoding Dolby f.m. radio transmissions (as in USA)
- no equipment needed for alignment
- suitability for both open-reel and cassette tape machines
- check tape switch for encoded monitoring in three-head machines

Typical performance

Noise reduction better than 9dB weighted.
Clipping level 16.5dB above Dolby level (measured at 1% third harmonic content)

Harmonic distortion 0.1% at Dolby level typically 0.05% over most of band, rising to a maximum of 0.12%

Signal-to-noise ratio: 75dB (20Hz to 20kHz, signal at Dolby level) at Monitor output

Dynamic Range >90db

30mV sensitivity.

Complete Kit **PRICE: £39.90** + VAT

Also available ready built and tested .... **Price £54.00** + VAT

Calibration tapes are available for open-reel use and for cassette (specify which) .... **Price £2.20** + VAT*

Single channel plug-in Dolby(TM) PROCESSOR BOARDS (92 x 87mm) with gold plated contacts are available with all components .... **Price £8.20** + VAT

Single channel board with selected fet .... **Price £2.50** + VAT

Gold Plated edge connector .... **Price £1.50** + VAT*

Selected FETs **60p** each + VAT, **100p** + VAT for two, **£1.90** + VAT for four

Please add VAT @ 12½% unless marked thus*, when 8% applies (or current rates)

Buy it with Access | EUROCARD | BARCLAYCARD | master charge

We guarantee full after-sales technical and servicing facilities on all our kits, have you checked that these services are available from other suppliers?

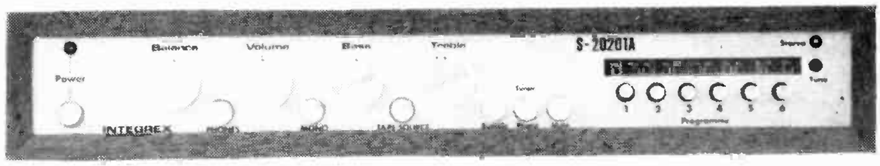
INTEGREX LTD.

Please send SAE for complete lists and specifications
Portwood Industrial Estate, Church Gresley, Burton-on-Trent, Staffs DE11 9PT
Burton-on-Trent (0283) 215432 Telex 377106

INTEGREX

S-2020TA STEREO TUNER/AMPLIFIER KIT

SOLID MAHOGANY CABINET



A high-quality push-button FM Varicap Stereo Tuner combined with a 24W r.m.s. per channel Stereo Amplifier.

Brief Spec. Amplifier Low field Toroidal transformer, Mag. input, Tape In/Out facility (for noise reduction unit, etc.), THD less than 0.1% at 20W into 8 ohms. Power on/off FET transient protection. All sockets, fuses, etc., are PC mounted for ease of assembly. Tuner section uses 3302 FET module requiring no RF alignment, ceramic IF, INTERSTATION MUTE, and phase-locked IC stereo decoder. LED tuning and stereo indicators. Tuning range 88—104MHz. 30dB mono S/N @ 1.2μV. THD 0.3%. Pre-decoder 'birdy' filter.

PRICE: £58.95 + VAT

NELSON-JONES STEREO FM TUNER KIT

A very high performance tuner with dual gate MOSFET RF and Mixer front end, triple gang varicap tuning, and dual ceramic filter/dual IC IF amp.

Brief Spec. Tuning range 88—104MHz. 20dB mono quieting @ 0.75μV. Image rejection — 70dB. IF rejection — 85dB. THD typically 0.4%.
IC stabilized PSU and LED tuning indicators. Push-button tuning and AFC unit. Choice of either mono or stereo with a choice of stereo decoders.

Compare this spec. with tuners costing twice the price.

Mono £32.40 + VAT
With ICPL Decoder £36.67 + VAT
With Portus-Haywood Decoder £39.20 + VAT

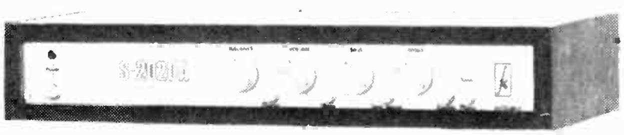
STEREO MODULE TUNER KIT

Sens. 30dB S/N mono @ 1.2μV
THD typically 0.3%
Tuning range 88—104MHz
LED sig. strength and stereo indicator

A low-cost Stereo Tuner based on the 3302 FET RF module requiring no alignment. The IF comprises a ceramic filter and high-performance IC Variable INTERSTATION MUTE. PLL stereo decoder IC. Pre-decoder 'birdy' filter Push-button tuning

PRICE: Stereo £31.95 + VAT

S-2020A AMPLIFIER KIT



Developed in our laboratories from the highly successful "TEXAN" design. PC mounting potentiometers, switches, sockets and fuses are used for ease of assembly and to minimize wiring

Power 'on/off' FET transient protection.

Typ Spec. 24+24W r.m.s. into 8-ohm load at less than 0.1% THD. Mag. PU input S/N 60dB. Radio input S/N 72dB. Headphone output. Tape In/Out facility (for noise reduction unit, etc.). Toroidal mains transformer.

PRICE: £33.95 + VAT

ALL THE ABOVE KITS ARE SUPPLIED COMPLETE WITH ALL METALWORK, SOCKETS, FUSES, NUTS AND BOLTS, KNOBS, FRONT PANELS, SOLID MAHOGANY CABINETS AND COMPREHENSIVE INSTRUCTIONS

BASIC NELSON-JONES TUNER KIT	£14.28 + VAT	**PHASE-LOCKED IC DECODER KIT**	£4.47 + VAT
BASIC MODULE TUNER KIT (stereo)	£16.75 + VAT	**PUSH-BUTTON UNIT**	£5.00 + VAT

PORTUS-HAYWOOD PHASE-LOCKED STEREO DECODER KIT .... £8.00 + VAT

LYNX Electronics (LONDON) LTD.

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NASCOM 1

MICROCOMPUTER KIT FOR ONLY £197.50 (ex. VAT)

We are proud to announce the launch of our NASCOM I Microcomputer kit at a seminar being held at the Wembley Conference Centre on November 26th.

BASIC FEATURES
—Z80 Microprocessor
—2K RAM
—1K EPROM operating system software
—Visual display through ordinary domestic TV
—Full keyboard software controlled
—Program storage through standard cassette recorder
—Teletype interface included
—Expandability to 64K bytes + high level language as future products

PHONE OR WRITE FOR YOUR TICKETS
PRICE £3.50
(Lunch extra £4.50 (optional))

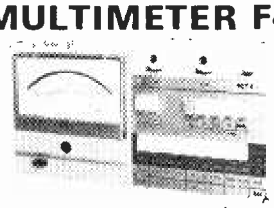
SEMINAR DETAILS
9.55 a.m.-5.00 p.m.
Highlights include:
10.00-10.20 Introduction to Home Computing
10.20-11.00 Introduction to Hardware
11.20-12.00 Introduction to Software
12.00-12.30 Introduction to NASCOM I
2.30- 3.10 Interface
3.10- 3.50 Applications
4.10- 5.00 Question Time

All ticket holders will have a chance to win a NASCOM I kit on the day. The winning number will be selected by NASCOM 1.
We have held back 50 tickets for Wireless World readers who have just learned of the project in this issue. So it is still not too late to attend the seminar.

Z & I AERO SERVICES LTD.

Head Office: 44A WESTBOURNE GROVE, LONDON W2 5SF
Tel.: 727 5641 Telex: 261306

MULTIMETER F4313 *(Made in USSR)*



SENSITIVITY.
1200V DC range. 10,000 Ω/V
Other DC ranges 20,000 Ω/V
1200 AC range. 6,000 Ω/V
600V AC range 15,000 Ω/V
300V AC range 15,000 Ω/V
Other AC ranges. 20,000 Ω/V.

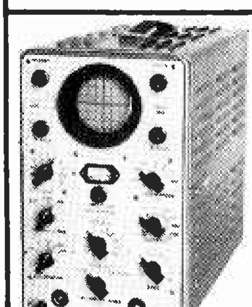
AC/DC current ranges 60-120-600uA-3-12-300mA-1.2-6A
AC/DC voltage ranges. 60-300mV-1.2-6-30-120-300-600-1200V
Resistance ranges: 300Ω-10-100-1000K
Accuracy 1 5% DC; 2.5% AC (of full scale deflection)

Mirror scale and knife edge pointer Taut suspension of movement. Transistor amplifier is used for all AC ranges thus achieving a common linear scale for both AC and DC ranges

Meter is protected by a transistorised cut-out relay circuit. Range selection is achieved by clearly marked piano keys. Power source 5 1 5V dry cells. Dimensions 95 x 225 x 120mm.

PRICE £39.50 plus VAT
Packaging and postage £1.10

OSCILLOSCOPE CI-5
Made in USSR



Extremely simple and easy to use single beam oscilloscope. Well proved design based on standard octal valves makes servicing and maintenance straightforward and inexpensive. Because of its bandwidth of 10 MHz the instrument is suitable for general electronic applications and educational purposes where a sophisticated instrument would be both too expensive and delicate 3in. tube giving a 50 x 50mm clear display. Amplitude and time base calibrations. Sensitivity 30mm/v max. Triggered and free-running time base, suitable for displaying pulses from 0 1 u sec to 3 m sec. A.C mains operation.
Price £55.00 ex. works, plus VAT
Packing and carriage (U K only) £3 00

FULLY GUARANTEED ZAERIX® VALVES

OA2	0.45	12AL5	0.65					EY87	0.50	PL504	0.90
OA3	0.55	12AQ5	0.55					EY88	0.50	PL508	0.90
OB2	0.45	12AT7	0.45					EZ40	0.50	PL509	1.30
OC3	0.45	12AU7	0.38					EZ41	0.75	PY31	0.50
OD3	0.45	12AV6	0.60					EZ80	0.30	PY33	0.63
1B3GT	0.55	12AV7	0.90					EZ81	0.35	PY81	0.45
1R5	0.55	12AX7	0.38					KT66	3.40	PY82	0.45
5R4GY	1.00	12B4A	0.80					KT88	4.80	PY83	0.50
5U4G	0.55	12BA6	0.60					PC86	0.65	PY88	0.50
5Z4G	0.55	12BE6	0.60					PC88	0.65	PY500A	1.10
5Y3GT	0.65	12BH7	0.60					PCC84	0.45	TT21	6.30
6AJ5	0.65	12X4	0.50					PCC85	0.45	TT22	6.30
6AK5	0.45	19AQ5	0.75					PCC88	0.65	UABC80	0.50
6AL5	0.30	30A5	0.70					PCC89	0.55	UAI42	0.70
6AS5	0.65	35A3	0.70	ECC84	0.35	ECL85	0.65	PCC189	0.65	UBC41	0.50
6AS6	0.80	35A5	0.80	ECC85	0.45	ECL86	0.55	PCF80	0.40	UBC81	0.50
6AT6	0.60	35B5	0.70	ECC86	1.25	EF80	0.35	PCF82	0.40	UBF80	0.50
6AV6	0.50	35C5	0.70	ECC88	0.60	EF85	0.45	PCF86	0.65	UBF89	0.50
6AW8A	0.75	35A5	0.80	ECC89	0.60	EF86	0.40	PCF200	0.80	UCC84	0.75
6AU6	0.40	35W4	0.60	ECC189	0.80	EF183	0.35	PCF201	0.85	UCC85	0.50
6BA6	0.38	50C5	0.70	ECF80	0.45	EF184	0.40	PCF802	0.55	UCF80	0.75
6BE6	0.45	EABC80	0.40	ECF82	0.45	EFL200	0.75	PCH200	0.75	UCH42	0.80
6BJ6	0.75	EAC91	0.55	ECF86	0.75	EL34	0.70	PCL81	0.55	UCH81	0.50
6BN6	0.80	EAF42	0.70	ECF801	0.75	EL36	0.60	PCL82	0.40	UCL82	0.40
6BZ6	0.55	EAF801	0.65	ECF802	0.75	EL81	0.60	PCL84	0.50	UCL83	0.70
6BZ7	0.70	EBC41	0.75	ECH42	0.85	EL82	0.60	PCL85	0.60	UF41	0.75
6C4	0.40	EBC81	0.50	ECH81	0.50	EL83	0.60	PCL86	0.80	UF42	0.75
6CB6	0.50	EBF80	0.50	ECH83	0.50	EL84	0.35	PCL200	0.75	UF80	0.40
6EA8	0.75	EBF83	0.50	ECH84	0.50	EL95	0.70	PL33	0.40	UF85	0.50
6GK5	0.70	EBF89	0.40	ECL80	0.40	EL500	0.80	PL36	0.60	UF89	0.50
6J4	0.75	EC86	0.75	ECL81	0.75	EM80	0.55	PL38	0.65	UL41	0.70
6J5GT	0.55	EC88	0.75	ECL82	0.42	EM81	0.60	PL81	0.55	UL84	0.50
GJ6	0.35	EC91	2.80	ECL83	1.15	EM84	0.40	PL82	0.50	UY41	0.55
6L6GT	0.60	ECC81	0.45	ECL84	0.60	EY81	0.45	PL83	0.50	UY42	0.55
6SL7GT	0.55	ECC82	0.38					PL84	0.50	UY82	0.60
6SM76	0.55	ECC83	0.38					PL95	0.70	UY85	0.50

All prices are exclusive of VAT

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1976/1977 CATALOGUE AVAILABLE 30p

WW—064 FOR FURTHER DETAILS

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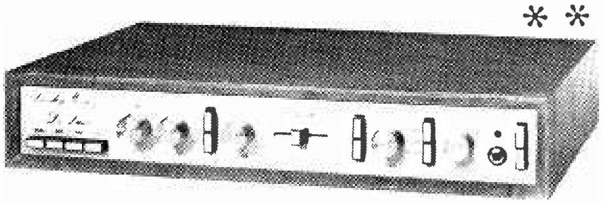
AUDIO KITS OF DISTINCTION FROM POWERTRAN

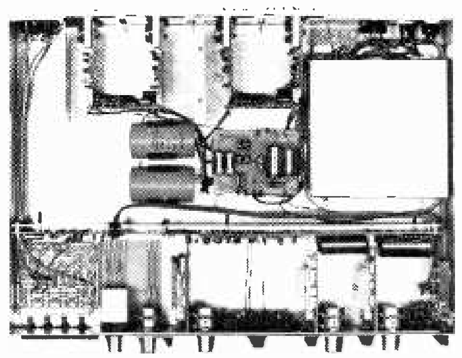
NEW! DE LUXE EASY TO BUILD LINSLEY-HOOD 75W AMPLIFIER

**



Available as Separate Packs

Details in Free Catalogue



Internal view of De Luxe Kit

SPECIAL PRICE FOR COMPLETE KIT £99.30

The standard model of our kit for Mr Linsley Hood s 75 watt design has for a long time offered exceptional performance for a very modest cost (just look at prices for comparable high quality high power ready built units!) Features of the amplifier include very low distortion (less than 0 01%) 75W rms per channel power output rumble filter variable slope scratch filter variable transition frequency tone controls tape monitoring facilities and individually adjustable inputs This model is based on 5 circuit boards which not having the controls mounted on them can if desired be effectively used separately in high performance audio systems not based on our metalwork

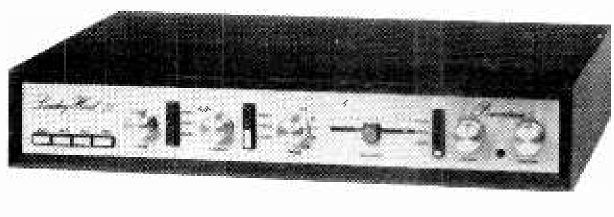
Our new De Luxe model uses 14 boards which interconnect with gold plated contacts and have the potentiometers and switches fitted to them There are 3 boards for each power amplifier 1 board for the power supply and 7 boards for the stereo pre-amplifier This system almost eliminates internal wiring making construction delightfully straightforward and as each board can be easily removed in seconds from the chassis checking and maintenance is so simple that even newcomers to electronics will be able to cope competently with the kit Additional features of our new model are inclusion of latest circuit improvements generously sized heatsinks for heavy duty use even in tropical climates and metal oxide resistors throughout for long term stability and reliability

PACK PRICES FOR STANDARD KIT

Pack	Price
1. Fibreglass printed circuit board for power amp	£1.15
2. Set of resistors, capacitors, pre-sets for power amp	£2.50
3. Set of semiconductors for power amp	£6.50
4. Pair of 2 drilled, tinned heat sinks	£1.10
5. Fibreglass printed-circuit board for pre-amp	£1.90
6. Set of low noise resistors, capacitors, pre-sets for pre-amp	£4.10
7. Set of low noise, high gain semiconductors for pre-amp	£2.40
8. Set of potentiometers (including mains switch)	£3.50
9. Set of 4 push-button switches, rotary mode switch	£5.40
10. Toroidal transformer complete with magnetic screen/ housing primary: 0 117-234 V: secondaries: 33-0-33 V. 25-0-25 V	£10.95
11. Fibreglass printed-circuit board for power supply	£0.85
12. Set of resistors, capacitors, secondary fuses, semiconductors for power supply	£5.40
13. Set of miscellaneous parts including DIN skts., mains input skt., fuse holder, interconnecting cable, control knobs	£6.20
14. Set of metalwork parts including silk screen printed fascia panel and all brackets, fixing parts, etc.	£8.20
15. Handbook	£0.30
16. Teak cabinet 18.3" x 12.7" x 3.1"	£10.70

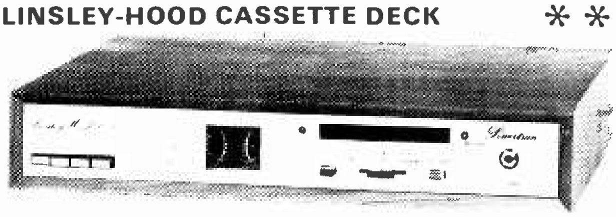
2 each of packs 1-7, 1 each of packs 8-16 inclusive are required for complete stereo amplifier. Total cost of individually purchased packs £90.80

STANDARD LINSLEY-HOOD 75W AMPLIFIER



SPECIAL PRICE FOR COMPLETE KIT £79.80

LINSLEY-HOOD CASSETTE DECK **



SPECIAL PRICE FOR COMPLETE KIT £79.60

Pack	Price
1. Stereo PCB (accommodates 2 rep. amps, 2 meter amps, bias/erase osc, relay)	£3.35
2. Stereo set of capacitors, M.O. resistors, potentiometers for above	£7.95
3. Stereo set of semiconductors for above	£8.50
4. Miniature relay with socket	£2.90
5. PCB, all components for solenoid, speed control circuits	£3.80
6. Goldring-Lenco mechanism as specified	£18.50
7. Function switch, knobs	£1.90
8. Dual VU meter with illuminating lamp	£6.95
9. Toroidal transformer with E.S. screen prim. 0-117V, 234V, Sec. 15V	£4.90
10 Set of capacitors, rectifiers, I.C. voltage regulator for power supply (Powertran design)	£2.80
11. Set of miscellaneous parts, including sockets, fuse holder, fuses, interconnecting wire, etc	£3.40
12. Set of metalwork including silk screened fascia panel, internal screen, fixing parts, etc	£7.10
13. Construction notes	£0.25
14. Teak cabinet 18.3" x 12.7" x 3.1"	£10.70

One each of packs 1-14 inclusive are required for complete stereo cassette deck. Total cost of individually purchased packs £83.00

Published in Wireless World (May, June, August 1976) by Mr Linsley-Hood, this design, although straightforward and relatively low cost nevertheless provides a very high standard of performance To permit circuit optimization separate record and replay amplifiers are used the latter using a discrete component front end designed such that the noise level is below that of the tape background Push button switches are used to provide a choice of equalization time constants, a choice of bias levels and also an option of using an additional pre-amplifier for microphone use The mechanism used is the Goldring-Lenco CRV, a unit distinguished in its robustness and ease of operation Speed control and automatic cassette ejection are both implemented by electronic circuitry This unit which is powered by a toroidal transformer and uses metal oxide resistors throughout offers an excellent match for the Wireless World Tuner and the Linsley-Hood 75 Watt Amplifier

WIRELESS WORLD FM TUNER **

SPECIAL PRICE FOR COMPLETE KIT £70.20

Pack	Price
1. Fibreglass printed board for front end IF strip, demodulator, AFC and mute circuits	£2.15
2. Set of metal oxide resistors, thermistor, capacitors, cermet preset for mounting on Pack 1	£4.80
3. Set of transistors, diodes, LED, integrated circuits for mounting on Pack 1	£5.25
4. Pre-aligned front end module, coil assembly, three section ceramic filter	£8.50
5. Fibreglass printed circuit board for stereo decoder	£1.10
6. Set of metal oxide resistors, capacitors, cermet preset for decoder	£2.60
7. Set of transistors LED, integrated circuit for decoder	£2.90
8. Set of components for channel selector switch module including fibreglass printed circuit board, push-button switches, knobs, LEDs, preset adjusters, etc.	£9.40
9. Function switch, 10 turn tuning potentiometer, knobs	£5.80
10. Frequency meter, meter drive components, fibreglass printed circuit board	£10.35
11. Toroidal transformer with electrostatic screen. Primary: 0-117V 234V, secondary: 15V	£4.90
12. Set of capacitors, rectifiers, voltage regulator for power supply	£2.10
13. Set of miscellaneous parts, including sockets, fuse holder, fuses, inter-connecting wire, etc	£2.05
14. Set of metalwork parts including silk screen printed fascia panel, acrylic silk screen printed tuning indicator panel insert, internal screen, fixing parts, etc.	£8.30
15. Construction notes	£0.25
16. Teak cabinet 18.3" x 12.7" x 3.1"	£10.70

One each of packs 1-16 inclusive are required for complete stereo FM tuner. Total cost of individually purchased packs £81.15

Designed in response to demand for a tuner to complement the world-wide acclaimed Linsley-Hood 75W Amplifier this kit provides the perfect match The Wireless World (Skingley and Thompson) published original circuit has been developed further for inclusion into this outstanding slimline unit and features a pre-aligned front end module excellent a m rejection and temperature compensated varicap tuning, which may be controlled either continuously or by push button pre-selection Frequencies are indicated by a frequency meter and sliding LED indicators attached to each channel selector pre-set The PLL stereo decoder incorporates active filters for birdy suppression and power is supplied via a toroidal transformer and integrated regulator For long term stability metal oxide resistors are used throughout

EXPORT A SPECIALITY!

Our Export Department can readily despatch orders of any size to any country in the world Some of the countries to which we sent kits last year are shown in this advertisement To assist in estimating postal costs our catalogue gives the weights of all packs and kits This will be sent free on request, by airmail together with our Export Postal Guide which gives current postage prices

EXPORT ORDERS: No minimum order charge! Prices same as for U K customers but no Value Added Tax charged Postage charged at actual cost plus 50p documentation and handling Please send payment with order by Bank Draft, Postal Order International Money Order or cheque drawn on an account in the U K Alternatively for orders over £500 we will accept Irrevocable Letter of Credit payable at sight in London

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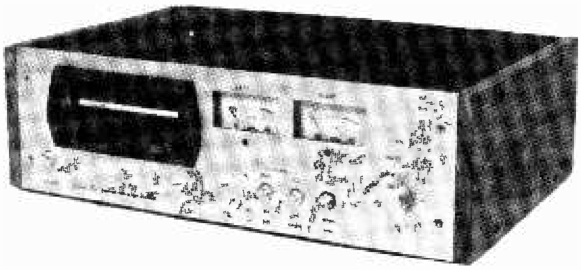
HART ELECTRONICS

The *Only* Firm for *Quality* Audio Kits

Are proud to offer the only DESIGNER APPROVED kit for the

J. L. Linsley-Hood High Quality Cassette Recorder



As these circuits are capable of such an excellent performance we feel that it is not sensible to sacrifice this potential by designing a kit down to a price. We have therefore spent a little more on professional hardware allowing us to design a very advanced modular system. This enables a more satisfactory electrical layout to be achieved, particularly around the very critical input areas of the replay preamps. These are totally stable with this layout and require no extra stabilising components. Many other advantages also come from this system which has separate record and replay amps for each channel plugging in to a master board with gold-plated sockets. The most obvious is the reduction of crosstalk and interaction which could cause trouble on a single plane board, with our modular system the layout is compact but there is no component crowding. Testing is very easy with separate identical modules and building with the aid of our component-by-component instructions is childishly simple, but the finished result is a unit designed not to normal domestic standards but tothe best professional practice.

All printed circuits are of glassfibre material, fully drilled with a tinned finish for easy and reliable soldering. Component locations are printed on the reverse side of the board and are arranged so that all identification numbers are still visible after assembly.

71x Complete set of parts for Master Board, includes bias oscillator, relay, controls, etc £9 83 + £1 23 VAT

72x Parts for Motor Speed and Solenoid Control for Lenco CRV deck. This is the proper board layout as given in the articles £3 52 + 44p VAT

73x Complete set of parts for stereo Replay Amps. and VU Meter drive £8 12 + £1 02 VAT

74x Complete set for stereo Record Amps £6 74 + 84p VAT

75x Complete set of parts for Stabilised Power Supply to circuit given in Article. This uses a special low hum field transformer with better characteristics than the commonly used toroid £8 79 + £1 10 VAT

700M2 Individual High Quality VU Meters with excellent ballistics £8 48 + £1 06 VAT Per Pair

700C/2 High Quality Custom built steel Case. Complete with Brushed aluminium front plate, mains switch, record microswitch, turned record level knob, plastic cabinet feet, all bolts, nuts and mounting hardware. All necessary holes are punched and all surfaces are electroplated. Complete step-by-step assembly instructions are included. The cover is finished in an attractive black crackle surface £16 50 + £2 06 VAT

LENCO CRV CASSETTE MECHANISM

High Quality, robust cassette transport for Linsley-Hood recorder. Features fast forward, fast rewind, record, pause and full auto stop and cassette ejection facilities. Fitted with Record / play and erase heads and supplied complete with Data and extra cassette ejection spring for above horizontal use. Price £21 60 + £2 70 VAT

Total cost of all parts £83 58

Special offer for Complete Kits £81 50 + £10 19 VAT

Optional extra solid teak end cheeks, £3 pair + 38p VAT

Reprint of 3 Linsley-Hood Cassette Recorder articles 45p post and VAT free

We also supply complete kits to make a fully integrated 30 watt stereo amplifier using the Bailey Power Amplifier circuit and the Bailey / Burrows Pre-amplifier with the Quilter Tone control modification.

Printed circuits and components are avalble for the Stuart tape circuits. These articles described a high quality tape link circuit for use with a reel-to-reel deck. Reprints of the three articles are available from us price 40p Post Free (No VAT)

ALL PARTS ARE POST FREE

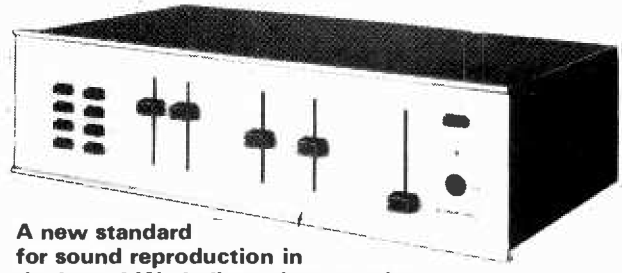
Please send 9 x 4 SAE for lists giving fuller details and Price breakdowns

Penylan Mill, Oswestry, Salop

Personal callers are always welcome
but please note we are closed all day Saturday

RADFORD HD250

High Definition Stereo Amplifier



A new standard for sound reproduction in the home! We believe that no other amplifier in the world can match the overall specification of the HD250.

Rated power output: 50 watts av. continuous per channel into any impedance from 4 to 8 ohms, both channels driven.

Maximum power output: 90 watts av. per channel into 5 ohms.

Distortion, preamplifier: Virtually zero (cannot be identified or measured as it is below inherent circuit noise.)

Distortion, power amplifier: Typically 0.006% at 25 watts, less than 0.02% at rated output (Typically 0.01% at 1 Khz)

Hum and noise: Disc.—83dBV measured flat with noise band width 23 Khz (ref 5mV); —88dBV "A" weighted (ref. 5mv)

Line —85 dBV measured flat (ref 100v)
—88d BV "A" weighted (ref 100v)

Hear the **HD250** at

SWIFT OF WILMSLOW

Dept. WW, 5 Swan Street, Wilmslow, Cheshire (Tel: 26213)

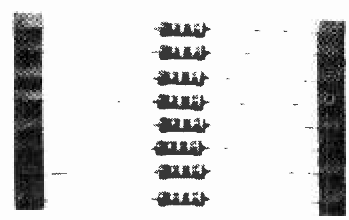
Mail Order and Personal Export enquiries: Wilmslow Audio, Swan Works, Bank Square, Wilmslow (Tel. 29599)

Now available ZD100 power amplifier and ZD22 pre-amplifier

WW—050 FOR FURTHER DETAILS

carbon film RESISTORS

ON BANDOLIERS OR PREFORMED 12.5mm
AT NO EXTRA COST



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WW—077 FOR FURTHER DETAILS

Audio Connectors

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Quick disconnect microphone connectors Amphenol (Tuchel) miniature connectors with coupling nut.

Hirschmann Banana plugs and test probes XLR compatible in-line attenuators and reversers.

Low cost slider faders by Ruf.

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WW—072 FOR FURTHER DETAILS

TRANSISTORISED 3cm RADAR AMPLIFIER SWITCH: with 24v waveguide switch, .9 x .4 cm ins. with crystal CV.2355 and spark gap VX.1046. **£16.20** + £1.00 post.
TRANSISTORISED VIDEO INDICATOR (used with above amplifier): 1½" C.R.T. **£10.80** + £1.00 post.
RADAR RECEIVING ANTENNA TYPE X443 Mk. D: Suitable for detecting signals on X, K. J and Q bands. 9gHz-60gHz. Complete with waveguide horns, associated crystals. Transistorised amplifier and geared motor, etc. **£135.00,** carr. approx. £5.00.
VACUUM & PRESSURE SEAL TEST EQUIPMENT: Complete with 3 x 4" gauges indicating 0-20lbs p.s.i., 0-30lbs vacuum. With stand, hand pump, etc., **£32.40** + £3.00 carr.
INSULATION TEST SET 0 to 10 KV, negative earth, with Ionisation Amplifier, 100/230 Volts. AC **£45.90,** carr. £3.00.
UNISELECTORS: Reversible action. Twin coils 120Ω 25-way 6-bank. **£4.90** + 75p post.
FAMOUS 1154 TRANSMITTER as used in Lancasters in World War II (collector's item). **£12.50,** carr. £4.00.
RACAL RA-17 RECEIVER 500KHz—30mHz, s/hand, good condition, **£365.00** (including VAT 12½%).
EVERSHED SAFETY OHM METER: Max 10mA. Test pressure 30v. Complete in leather case. **£27.00,** post £1.00.
AVO TRANSISTOR ANALYSER CT.446: £37.80, carr. £2.20.
MARCONI FREQUENCY METER 1026/4: 2000-4000mHz 'as new' condition. **£32.40** or secondhand condition **£24.30.**
1026/2: 100-160mHz £32.40 'as new' or s/hand **£24.30.** Carriage for all type £2.00.
ANTENNA MAST 36ft: Aluminium, diameter at base 3", tapering to 2" at top, complete with red hazard lights, stays, guys, etc. Normally used with direction finding equipment. Approx. weight 3cwt. **£106.90** (including 12½% VAT), carriage rates on request. With rotating Antenna suitable for 200-400mHz **£16.90** extra (including 12½% VAT).
BURGLAR ALARM BELL: 6-8v. d.c. **£3.24** + £1.00 post.
MEGGER (Record): 500 volts **£21.60** £1.00 post.
MUIRHEAD ATTENUATORS: 75 ohms 0-8Mc/s 3V MAK 3 ranges 0-5, 0-25, 0-50dB. **£3.24** + 75p post.
REDIFON TELEPRINTER RELAY UNIT NO. 12: ZA-41196 and power supply 200-250v. a.c. Polarised relay type 3SEITR 80-0-80v. 25mA. Two stabilised valves CV-286 Centre Zero Meter 10-0-10. Size 8" x 8" x 8". New condition. **£10.80,** carr. £2.50.
SOLARTRON PULSE GENERATOR TYPE G1101-2: £81.00, carr. £2.50.
TELEPRINTER TYPE 7B: Pageprinter 24v. d.c. power supply, speed 50 bauds per min. S/hand cond. (excellent), no parts broken **£21.60,** carriage £3.50.
AUTO TRANSFORMER: 230v. 50c/s, 1000 watts. Mounted in strong steel case
CRYSTAL TEST SET TYPE 193: Used for checking crystals in freq. range 3,000-10,000kHz. Mains 230v 50hz. Measures crystal current under oscillatory conditions and the equivalent resistance. Crystal freq. can be tested in conjunction with a freq. meter. **£27.00,** carr. £2.00.
CATHODE RAY TUBES: 5" screen, tube CV-1536 **£4.32** + £1.00 post. Type 95J20 square face 5" x 3" **£8.10** + £1.00 post.
WEATHERPLOTTER RECEIVING SET AN/GMH-5: Facsimile reproducing system for weather maps. Further details on request, **£459.00** (inc. 8% VAT).
CLASS 'D' WAVEMETER NO: 1: Crystal controlled heterodyne frequency meter covering 2-8mHz. Power supply 6v. d.c. Good s/hand cond. **£9.20** + £2.00 carr.
RING TOROIDAL DUST CORES: Size 2½" outside, 1¾" inside, 5/16" thick. Box of two **£1.10** + 30p post.
ROTARY INVERTERS TYPE PE-218E: Input 24-28v. d.c. 80 amps, 4,800rpm. Output 115v. a.c. 13 amp 400 c/s. 1Ph. P.F.9 **£21.60** + £3.00 carr.
FREQUENCY METER BC-221: 125-20,000kc/s complete with original calibration charts. Checked out, working order. **£22.70** + £2.00 carr.
RECTIFIER UNIT: 200-250v. a.c. input, 24v. d.c. at 26 amps output continuous rating. **£37.80,** carr. £5.00.
PAPER TAPE: ½" roll (teleprinters, etc.) Box of ten rolls **£1.50** + £1.00 post.
CREED TELEPRINTER TABLE: £25.00 + £5 carr.

KAY MARKER SWEEP OSCILLATOR 154C: 50kHz-110mHz 50 ohms impedance. Sweep rate 0.01-1000Hz variable. Meter indicates 1v. rmf. Crystal Pulse markers 2, 5, 10, 15, 20, 40, 60 and 80mHz. **£135.00** carr. £3.50.
ATTENUATOR UNITS STC: Impedance 75 ohms. Two different types: (A) Push button 0-0.9 decibels in steps of 0.1dB and (B) Push button 0-90 decibels in steps of 10dB. Both types price **£5.40,** post 70p.
MARCONI SIGNAL GENERATOR 801/DS: 10-480mHz. **£318.60.**

BARGAIN MAPS
Large stocks of unused **U.S.A.F.** surplus maps, weather charts, etc. **including:—**
ONC-E1 — U.K. in full and part N.W. Europe. Scale 1:1,000,000.
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SIZE: 58" x 42", colour. Many others. Please send S.A.E. for list.
Price each 70p (inc. p + p)
25 x Maps (either same type OR assorted) **£10.00** + £1.00 p + p.
10 x Maps (either same type OR assorted) **£6.00** (inc. p + p)

Above prices include VAT at 8% (except where stated)
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£100 off this super Hi-Fi system the MATSI TFS60

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You can now purchase this fantastic Hi-Fi system complete for only £147.95 at what must be a fraction of it s value today.
System consists of:– the famous MATSI TFS60 Tuner/AMP; a really top quality receiver from one of Japan's leading manufacturers, 15 watts per channel FM/MW/LW, two NAD 6 speakers fitted with AR units and a Goldring belt-drive turntable with magnetic cartridge complete with an attractive plinth & cover of ultra modern design. Leads etc supplied free.
LION PRICE: Complete MATSI System £147.95
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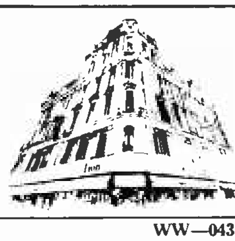

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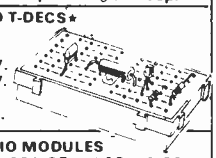
Resistors 5% carbon E12 1Ω to 10M ¼W **1½p.** 1W **3p. Preset pots** sub-miniature 0.1W E3 100Ω to 4M7 vertical **9p,** horizontal **9p. Potentiometers** 0 25W E3 4K7 to 2M2 log or lin single **30p,** dual **95p. Polystyrene capacitors** E12 63V 22 pf to 8200pf **3½p. Ceramic capacitors** vert 50V E6 22pf to 4700pf **3p.**
Polyester capacitors 250V E6 01 to 1mf **5½p,** .15, 22 **7p,** 47mf **11p. Electrolytics 50V** 47, 1, 2mf **5p, 25V** 5, 10mf **5p. 16V** 22, 47mf **6p.** 100mf **7p.** 220 mf **9p.** 470mf **11p,** 1000mf **18p. Zener diodes** 400mW E24 3V3 to 33V **8½p.**

MAINS TRANSFORMERS
6-0-6V 100mA **94p.** 9-0-9V 75mA **94p.** 12-0-12V 50mA **94p.** 0/12/15/20/24/30V 1A **£3.85.** 0/12/15/20/24/30V 2A **£5.15.** 6-0-6V 1½A **£2.75.** 9-0-9V 1A **£2.39.** 12-0-12V 1A **£2.69.** 15-0-15V 1A **£2.89.** 30-0-30V 1A **£3.59.**

PRINTED CIRCUIT MATERIALS
50 sq ins pch **40p** 1lb FeC **£1.05. Etch resist pens:** Economy type **45p.** Dalo type **83p.** Small drill bit **20p.** Laminate cutter **75p.** Etching dish **68p.**

S-DECS AND T-DECS*
S-DeC **£1.94.**
T-DeC **£3.61.**
u-DeCA **£3.97.**
u-DeCB **£6.67.**
16 dil IC carriers **£1.91.**



BI-PAK AUDIO MODULES
S450 Tuner **£21.95.** AL60 **£4.86.** PA100 **£14.95.** MK60 audio kit **£36.45.** Stereo 30 **£17.95.** SPM80 **£3.75.** BMT80 **£4.25.**

SINCLAIR CALCULATORS*
Cambridge Scientific programmable calculator **£13.95.** Prog library **£4.95.** Mains adaptor **£3.20.** Cambridge Scientific **£8.95.**

FERRANTI ZN414
IC radio chip **£1.44.** Extra parts and pcb for radio **£3.85.** Case **£1.** SAE for data

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3-WAY MODELS
Switched 6/7½/9V 300mA **£2.99.**
100MA RADIO MODELS
With press-stud connectors. 9V **£3.45.** 6V **£3.45.** 9+9V **£5.15.** 4½+4½V **£5.15.** 6+6V **£5.15.**
150MA CASSETTE MODELS
7½V with 5-pin din plug **£3.65.**

FULLY STABILIZED MODEL £6.40
Switched 3/6/7½/9V 400mA

BATTERY ELIMINATOR KITS
100mA radio types with press stud battery terminals 4½V **£2.10.** 6V **£2.10,** 9V **£2.10.** 4½V+4½V **£2.50.** 6V+6V **£2.50.** 9V+9V **£2.50.**
Stabilised 8-way types transistor stabilized to give low hum 3/4½/6/7½/9/12/15/18V 100mA model **£3.20.** 1 Amp model **£6.40.**
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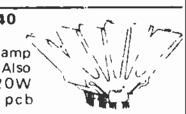
Stabilized power kits 3-18V 100mA **£3.60.** 3-30V 1A **£9.95.** 3-60V 1A **£10.95.** 3-60V 2A **£13.95.**

JC12, JC20, JC40 AMPLIFIERS



JC12 6W IC audio amp with pcb **£1.95.** Also new JC40 20W Model with pcb **£3.95.**
JC20 10W integrated circuit amp with pcb **£2.95.**
Send sae for free data on all three models, and associated power and pre-amp kits

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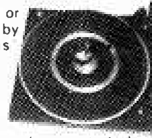
Mail order only No callers Send sae for free data on kits Post and packing 30p Prices include VAT Official orders welcome Overseas customers deduct 7% VAT on items marked* and 11% on others

U.K. RETURN OF POST MAIL ORDER SERVICE, ALSO WORLDWIDE EXPORT SERVICE

BSR HI-FI AUTOCHANGER
STEREO AND MONO £17.50 Post 75p



Plays 12", 10" or 7" records. Auto or Manual. A high quality unit backed by BSR reliability with 12 months guarantee A C 200/250V. Size 13½-11¼in. 3 speeds. Above motor board 3¼in. Below motor board 2½in. with STEREO and MONO CARTRIDGE.

B S R SINGLE PLAYER similar to above with stereo cartridge and cueing device, large turntable **£13.50**

B.S.R. P128 with magnetic cartridge. Balanced arm. Cueing device Bias Compensator **£24.50.** Post £1

PORTABLE PLAYER CABINET
Modern design. Rexine covered. Vynair front grille. Chrome fittings. Size 17 x 15 x 8in. approx **£4.50** Post 75p
Motor board cut for BSR or Garrard deck

HEAVY METAL PLINTHS
With P V C Cover. Cut out for most B S R or Garrard decks. Silver grey finish **£6.50** Post £1 50
Model "A" Size 12½ x 14¾ x 7½in
Model "B" Size 16 x 13¾ x 7in **£7.50**
Extra large plinth & cover, teak wood base Size 20" x 17½" x 9" **£19.50.** Callers only

COMPLETE STEREO SYSTEM
Two full size loudspeakers 13¾ x 10 x 3¾in. Player unit clips to loudspeakers making it extremely compact, overall size only 13¾ x 10 x 8½in., 3 watts per channel, plays all records 33 r.p.m., 45 r.p.m. Separate volume and tone controls. Attractive Teak finish. 240V a c, mains **£22.50** £1 carriage

ELAC HI-FI SPEAKER 8in. TWIN CONE

Dual cone plastic roll surround. Large ceramic magnet 50-16,000 c/s. Bass resonance 40 c/s. 8 ohm impedance 15 watts RMS **£5.95** Post 35p

SMITH'S CLOCKWORK 15 AMP TIME SWITCH
0–6 HOURS £3.30 Post 35p

Single pole two-way. Surface mounting with fixing screws. Will replace existing wall switch to give light for return home, garage, automatic anti-burglar lights, etc. Variable knob. Turn on or off at full or intermediate settings. Brand new and fully guaranteed

TEAKWOOD LOUDSPEAKER GRILLES will easily fit to baffle board Size 10½ x 7⅞in—**45p.**

R.C.S. "MINOR" 10 watt AMPLIFIER KIT
This kit is suitable for record players, guitars, tape playback, electronic instruments or small P A systems. Two versions available Mono, **£11.25;** Stereo, **£18.** Post 45p. Specification 10W per channel, input 100mV; size 9½ x 3 x 2in approx. S A E details. Full instructions supplied. AC mains powered

VOLUME CONTROLS
5kΩ to 2MΩ LOG or LIN L/S **35p.** D P **60p.** STEREO L/S **85p.** D P **£1.** Edge 5K S P Transistor **45p.**

80 Ohm Coax 8p yd.
FRINGE LOW LOSS **15p yd.**
Ideal 625 and colour
PLUGS **10p.** SOCKETS **10p.**
LINE SOCKETS **18p.**
OUTLET BOXES **50p.**

ELAC 9 x 5in HI-FI SPEAKER TYPE 59RM £3.45
Post 35p
This famous unit now available 10 watts 8 ohm

E.M.I. 13½ x 8in. SPEAKER SALE!

With tweeter and crossover 10 watt 3 ohm **£7.95** Post 45p
Ditto 15 watts 8 ohm **£10.50** Post 65p

With tweeter and crossover 20 watt. Bass res 25 c p s. Flux = 11,000 gauss. 8 or 15 ohm 20 to 20,000 c p s **£11.50** Post 75p

Bookshelf Cabinet Teak finish For EMI 13 x 8 speakers **£8.50** Post £1 00

THE "INSTANT" BULK TAPE ERASER AND HEAD DEMAGNETISER.

Suitable for cassettes, and all sizes of tape reels A C mains 200/250V. Leaflet S A E. Will also demagnetise small tools **£4.95** Post 50p

BLANK ALUMINIUM CHASSIS. 6 x 4—**70p;** 8 x 6—**90p.** 10 x 7—**£1.15;** 12 x 8—**£1.35;** 14 x 9—**£1.50;** 16 x 6 **£1.45;** 16 x 10—**£1.70. ANGLE ALI.** 6 x ¾ x ¾in.—**15p.**
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MANY ALI BOXES IN STOCK. MANY SIZES
VARICAP FM TUNER HEAD with circuit & connections **£4.95.**
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TAPE OSCILLATOR COIL. Valve type **35p.**
BRIDGE RECTIFIER 200V PIV ½ amp **50p.**
TOGGLE SWITCHES S P **30p.** D P S T **40p.** D P D T **50p.**
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PICK-UP CARTRIDGES ACOS GP91 **£1.50.** GP93 **£2.50.**
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WIRE-WOUND RESISTORS 5 watt, 10 watt, 15 watt 10 ohms to 50K **12p** each

R.C.S. SOUND TO LIGHT KIT £14
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Kit of parts to build a 3 channel sound to light unit 1,000 watts per channel.
Easy to build. Full instructions supplied. Cabinet **£3.**

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Post 45p
All parts and instructions with Zener diode, printed circuit rectifiers and double wound mains transformer. Input 200/240V a.c. Output voltages available, 6 or 7 5 or 9 or 12V d c up to 100mA or less. Size 3 x 2½ x 1½in. Please state voltage required

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Ideal for Mike, Tape, P U, Guitar, etc. Can be used with battery 9-12V or H T line 200-300V d c. operation. Size 1¾ x 1¼ x ¾in. Response 25 c/s to 25 kc/s. 26 dB gain. For use with valve or transistor equipment. Full instructions supplied. Details S.A E **£1.45** Post 30p

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6 or 12V outputs, 1½ amp **40p**
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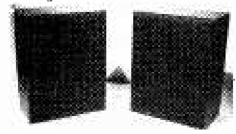
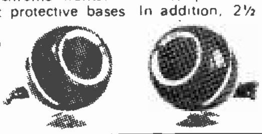
R.C.S. BOOKSHELF SPEAKERS



13 x 10 x 6in
50 to 14,000 cps
8 watts rms 4, 8 or 16 ohms
£16 pair Post £1 30

GLOBAL SPEAKERS £4.95 ea.
These little marvels of modern sound reproduction are ideally suited for today's domestic audio set-up. Two of these smart spheres, each with 5 watt deep throated ceramic magnets, will produce superb stereo reproduction.
The globe shaped cases in high gloss mouldings of red and green, are finished with chrome frontal trim and provided with screw-on rubber inset protective bases. In addition, 2½ metres of strong lead already fitted with phono plug is supplied.



Frequency Response. 100-20,000 Hz
Impedance: 8 ohms
Power Capacity: 5 watts

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120pF **TWIN GANG, 50p;** 365pF **TWIN GANG, 50p.**
NEON PANEL INDICATORS 250V. Amber or red **30p.**
RESISTORS. ¼W ½W 1W 20% **2p;** 2W, **10p;** 10Ω to 10M
HIGH STABILITY. ½W 2% 10 ohms to 6 meg **12p.**
Ditto 5% Preferred values 10 ohms to 10 meg **5p.**

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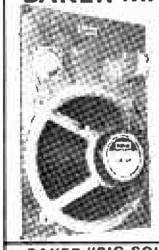
BAKER MAJOR 12" £15.00
Post £1 00



30-14 500 c/s 12in double cone woofer and tweeter cone together with a BAKER ceramic magnet assembly having a flux density of 14 000 gauss and a total flux of 145 000 Maxwells. Bass resonance 40 c/s. Rated 25W. NOTE 4 or 8 or 16 ohms must be stated

Module kit, 30-17 000 c/s with tweeter crossover baffle and instructions **£19.00** Post £1 60 each
Please state 4 or 8 or 16 ohms

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BAKER LOUDSPEAKER, 12 INCH, 60 WATT. GROUP 50/12, 4 OR 8 OR 16 OHM HIGH POWER FULL RANGE PROFESSIONAL QUALITY RESPONSE 30-16 000 CPS MASSIVE CERAMIC MAGNET WITH ALUMINIUM PRESENCE CENTRE DOME **£21.00** Post £1 60

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LOUDSPEAKER CABINET WADDING 18in wide **20p** ft

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Four inputs. Four way mixing master volume treble and bass controls. Suits all speakers. This professional quality amplifier chassis is suitable for all groups disco P A where high quality power is required 5 speaker outputs A/C mains operated. Slave output socket. Produced by demand for a quality valve amplifier. 100V line output to order. Send for leaflet. Suitable carrying cab **£16.50** Price **£94** carr £2 50

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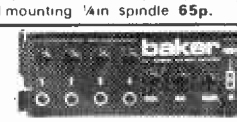
SPECIAL OFFER: 80 ohm 2¼in 2¾in 35 ohm 3in 25 ohm 2½in 3in 5x3in 7x4in, 8 ohm, 2½in 3in 3½in 5in, 15 ohm, 3½in dia, 6x4in 7x4in 5x3in 3 ohm, 2⅝in, 3½in., 5in dia **£1.50** each
PHILIPS LOUDSPEAKER, 8in 4 ohms 4 watts **£1.95**
RICHARD ALLAN TWIN CONE LOUDSPEAKERS 8in diameter 4W **£2.50.** 10in diameter 5W **£2.95;** 12in diameter 6W **£3.50.** 3/8/15 ohms please state
PIEZO ELECTRIC HORN TWEETER. Handles up to 100 watts. No crossover required **£7.95.**

Tweeter Volume Control 15 ohms 10W with one inch long threaded bush for wood panel mounting ¼in spindle **65p.**

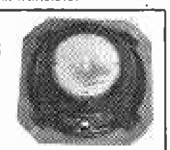
BAKER 150 WATT PROFESSIONAL MIXER AMPLIFIER



All purpose transistorised. Ideal for Groups, Disco and P A. 4 inputs speech and music. 4 way mixing. Output 4 8/16 ohms a c Mains. Separate treble and bass controls. Master volume control. Guaranteed. Details S A E **£72** £1 50 carr

100 WATT DISCO AMPLIFIER
volume treble bass controls 500 M V or 1 volt input. Four loudspeaker outputs 4 to 16 ohm. All transistor **£59**

GOODMANS COMPACT 12-INCH BASS WOOFER



Standard 12in diameter fixing with cut sides 10⅛ square 14 000 Gauss magnet 30 watts R M S 4 ohm imp. Bass resonance = 30 cps. Frequency response 30-8000 c p s **£10.95 each** Post £1

ALUMINIUM HEAT SINKS. FINNED TYPE. Sizes 6½" x 4½" x 2¼" **95p.** 6½" x 2" x 2¼" **65p.**
BALANCED TWIN RIBBON FEEDER 300 ohms. 5p yd.
JACK SOCKET Std. open-circuit 20p, closed circuit 25p; Chrome Lead-Socket 45p. Mono or Stereo.
Phono Plugs 8p. Phono Socket 8p.
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STEREO JACK PLUG 30p. SOCKET 25p.
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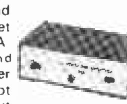
TV CONVERGENCE POTS 15p each
Values — 5, 7, 10, 20, 50, 100, 200, 250, 470, 2000 ohms

MONO PRE-AMPLIFIER. Mains operated solid state pre-amplifier unit designed to complement amplifiers without low level phono and tape input stages. This free-standing cabinet incorporates circuitry for automatic R I A A equalisation on magnetic phono input and N A B equalisation for tape heads. Power ON/OFF, PHONO/TAPE switches and pilot lamp are on the front panel, phono socket input and output are rear located



£4.50 each or £8 pair. Post 50p

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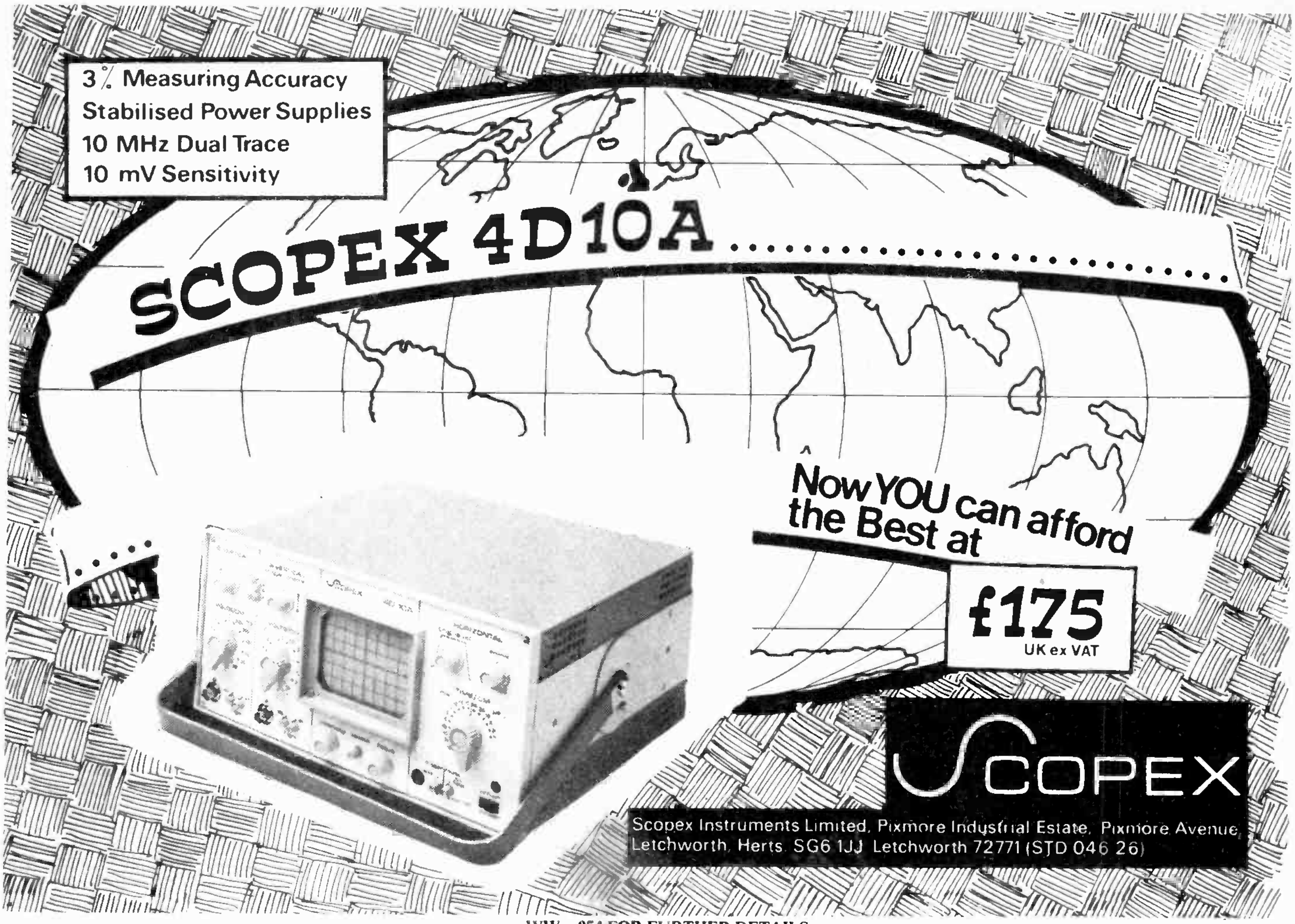

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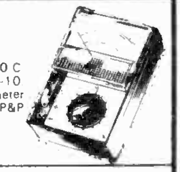

MULTI RANGE METERS Type MF15A A.C./D.C. volts 10, 50, 250, 500, 1000. Ma 0.5, 0-10, 0-100. Sensitivity 2000V. 24 range, diameter 133 × 93 × 46mm. Price **£6.50** plus 50p P&P (**£7.56** inc. VAT & P).

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Double pole 15 amp 230AC. Contacts (no dial) **£1.50.** P&P 30p (**£1.94** inc. VAT & P).

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50 micro mirror galvo. Calibrated 50-0-50 and 0-100. Mfg. by Griffin & George Ltd. Offered at fraction of maker's price, in original ministry packing **£12.00** P&P 60p (**£13.60** inc. VAT & P).

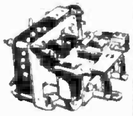
CONTACTOR

Mfg. by Hendrey Relays, type C2839 220/250 AC ops. Contact 4C/O at 20 amp at 440 volts AC price **£6.00** P&P 75p (**£7.29** inc. VAT & P).

230 VOLT AC FAN ASSEMBLY

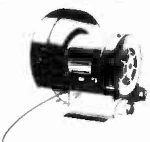
Powerful continuously rated AC motor complete with 5 blade 6½" aluminium fan. New reduced price **£3.00** P&P 65p (**£3.94** inc. VAT & P).

21-WAY SELECTOR SWITCH with reset coil



The ingenious electro mechanical device can be switched up to 21 positions and can be reset from any position by energising the reset coil 230/240v A.C. operation. Unit is mounted on strong chassis. Complete with cover. Price **£5.50** P&P 75p (**£6.75** inc. VAT & P).

VORTEX BLOWER AND VACUUM UNIT



Dynamically balanced to fully enclosed 9" rotor with max. air delivery of 1.5 cubic metres per min. Max. static pressure 600mm W.G. Suction or blow from 2 side-by-side 37mm I.D. circular apertures fitted to base of unit. Powerful continuously rated 115v a.c. motor mounted on alloy base with fixing facilities. Dimensions: Length 22cm × width 25cm × height 25cm.

These units are ex-equipment but have had minimum use. Fully tested prior to despatch. Price **£12** + £1.50 P&P (**£14.58** inc. VAT & P). Suitable transformer for 230/240v a.c. **£6** + £1 P&P (**£7.56** inc. VAT & P).

CENTRIFUGAL BLOWER

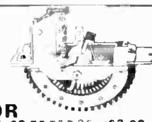
Mfg. by Smiths Industries 230/240v a.c. Miniature Model Series SE7200. Size 95mm × 82mm × 82mm. Aperture 38mm × 31mm. 12 c.f.m. **£2.75.** Post 50p (**£3.51** inc. VAT & P). 115/230v a.c. 2800/3400 r.p.m. Fan type aperture 3" × 2½" VBL4/L. Price **£12** Post £1 (**£14.58** inc. VAT & P). Also available extremely powerful blower mfg. by Fracmo.

NI-CAD BATTERIES

	Height (mm)	Width (mm)	Length (mm)
23 AH 1.2v Plastic Case £4	214	79	27
35 AH 1.2v Metal £6.50	219	75	29
40 AH 1.2v Plastic Case £8	275	80	35

Postage 30p per unit.

UNISELECTOR SWITCH



4 bank, 25 way 75 ohm coil 36-48v D.C. operation. Ex. **new** equipment. **£4.25.** P&P 75p. Total price inc. VAT **£5.40.**

MINIATURE UNISELECTOR

12v 11 way 4 bank (3 non-bridging, 1 homing) **£2.50** P&P 35p (**£3.08** inc. VAT & P).

MICRO SWITCHES

As illustrated but fitted with 1" Lever. 10 for **£2.00** P&P 30p (**£2.48** inc. VAT & P).
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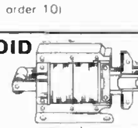
50 for **£10.00** post paid (**£10.80** inc. VAT & P).
Type 3 115M 9061 10 for **£2.50** post paid (**£2.70** inc. VAT & P).
Unimax USA. 10 for **£4.00** plus 50p P&P (min. order 10) (**£4.86** inc. VAT & P).

NEW HEAVY DUTY SOLENOID



Mfg. by Magnetic Devices 240v A.C. Operation approx. 20lb pull at 1.25". Price **£7.00** P&P 75p (**£8.37** inc. VAT & P).
Similar to above approx. 10lb pull **£3.50** P&P 60p (**£4.43** inc. VAT & P).

230-250 VOLT A.C. SOLENOID

Similar in appearance to illustration. Approximately 1½lb pull. Size of feet 1⅜" × 13/16". Price **£1.00** Post 25p (**£1.35** inc. VAT & P).

24 VOLT D.C. SOLENOIDS

UNIT containing **1 heavy duty solenoid approx. 25 lb. pull** at 1 in travel, 2 solenoids of approx. 1 lb. pull at ½ in travel, 6 solenoids of approx. 4 oz pull at ½ in travel. Plus 1 24V D.C. 1 heavy duty 1 make relay. Price **£3.00** Post £1.00 (**£4.32** inc. VAT & P). **ABSOLUTE BARGAIN**

240 A.C. SOLENOID OPERATED FLUID VALVE

Rated 1 p.s.i. will handle up to 7 p.s.i. Forged brass body, stainless steel core and spring ½ in. b.s.p. inlet outlet. Precision made. British mfg. PRICE **£2.75** Post 50p (**£3.57** inc. VAT & P).

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OUTPUT VARIABLE 0/260v. A.C.
BRAND NEW. All types.

200W (1 Amp) fitted A/C volt meter	£12.50
0.5 KVA (Max. 2½ Amp)	£15.00
1 KVA (Max. 5 Amp)	£19.50
2 KVA (Max. 10 Amp)	£32.00
3 KVA (Max. 15 Amp)	£39.50
4 KVA (Max. 20 Amp)	£60.00

Carriage extra

LT TRANSFORMERS

0-12v/24v at 1 amp **£2.50** p&p 50p (**£3.24** inc. VAT & P)
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25-0-25v at 2½ amp **£4.50** p&p 75p (**£5.67** inc. VAT & P)
0-12v/24v 10 amp **£12.35** p&p £1.50 (**£14.96** inc. VAT & P)
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0-12v at 20 amp or 0-24v at 10 amp **£12.00** p&p £1.50 (**£15.01** inc. VAT & P)
0-6v/12v/17v/18v/20v at 20 amp **£14.00** p&p £1.50 (**£16.74** inc. VAT & P)
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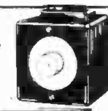
115/230 screened primary, two separate or 115v for 115 or 230v. Secondary two 115v at 150 V.A. each for 115 or 230v output. Can be used in series or parallel connections. Fully tropicalised. Length 13.5cm, width 11cm, weight 15lbs. Special price **£6.00.** carr. £1.00 (**£7.56** inc. VAT & P).

RODENE UNISET TYPE 71 TIMER



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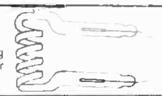
Other types available — phone for details.

FT3



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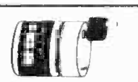
BIG INCH



Tiny precision built 3 rpm USA motor size only 1 × 1 100 volt AC op. supplied with resistor for 230 volt AC price **£2.37** p&p 20p. 4 for **£5.40** post paid.

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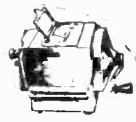

Test to I.E.E. spec. Rugged metal construction suitable for bench or field work, constant speed clutch. Size L 8 in. W 4 in. H 6 in. weight 6 lb.
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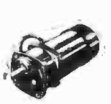
GEARED MOTORS

100 R.P.M. 115 lbs. ins.!!



115 lb. ins. 110 volt 50Hz. 2.8 amp single phase split capacitor motor. Immense power. Continuously rated. Totally enclosed. Fan cooled. In-line gearbox. Length 250mm. Dia. 135mm. Spindle Dia. 15.5mm. Length 145mm. ex-equipment tested **£12.00** Post £1.50 (**£14.58** inc. VAT & P). Suitable transformer 230/240 volt **£8.00** Post 75p (**£9.45** inc. VAT & P).

15 R.P.M.

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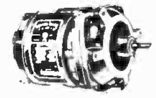
BODINE TYPE N.C.I. GEARED MOTOR



(Type 1) 71 r.p.m. torque 10 lb. in. **Reversible** 1/70th h.p. cycle 38 amp. This U.S.A. motor is offered in with transformer for 230/240v AC input. Price type **£6.25** Post 75p (**£7.56** inc. VAT & P). or less transformer **£3.75** Post 65p (**£4.75** inc. VAT & P). (Type 3) 71 r.p.m. 230 volt A.C. Continuously rated. Non reversible **£6.50** Post 75p (**£7.83** inc. VAT & P).

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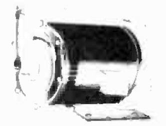
A.E.G. WATER PUMP



200/240v a.c. motor 2850 rpm 480w approx. 1/3 hp. driving a centrifugal pump with 1½" inlet and outlet delivering approx. 40 galls per min. at 10ft. head. Ideal for pumping or circulating any non corrosive light viscosity liquid. Dozens of uses in industrial labs etc. Note this pump is not self-priming. Price **£15** + 75p P&P (**£17.01** inc. VAT & P).

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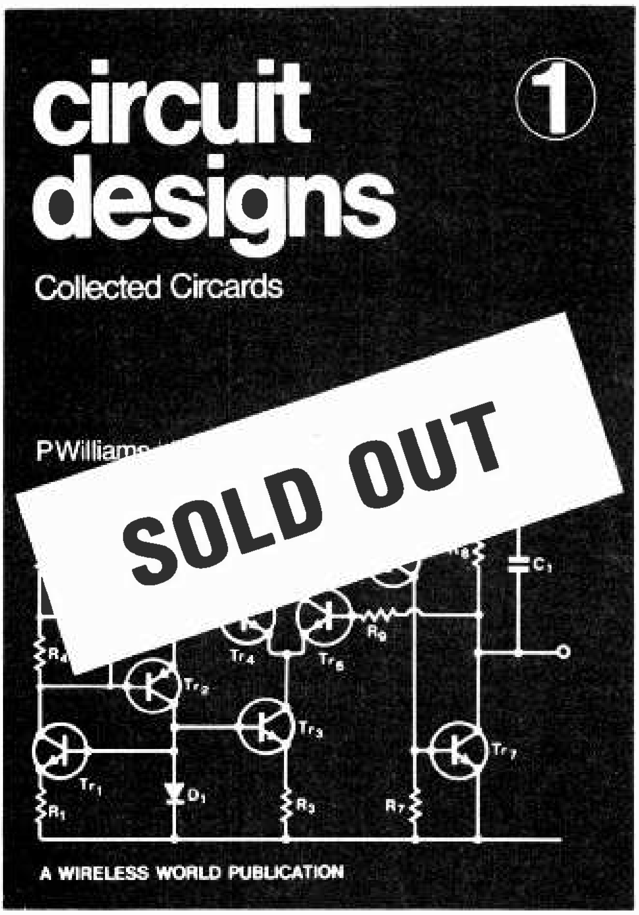

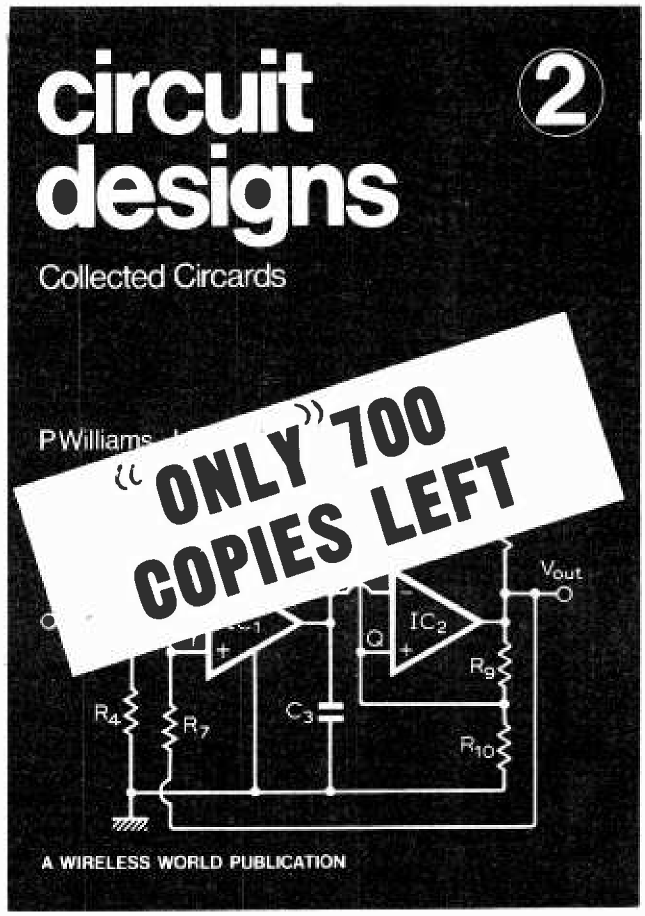

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- AC measurements
- Audio circuits
- Constant-current circuits
- Power amplifiers
- Astable circuits
- Optoelectronics
- Micropower circuits

BOOK 2

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VITRON PROCESSOR consisting of VDU: twin cassette information. **£425.** One only
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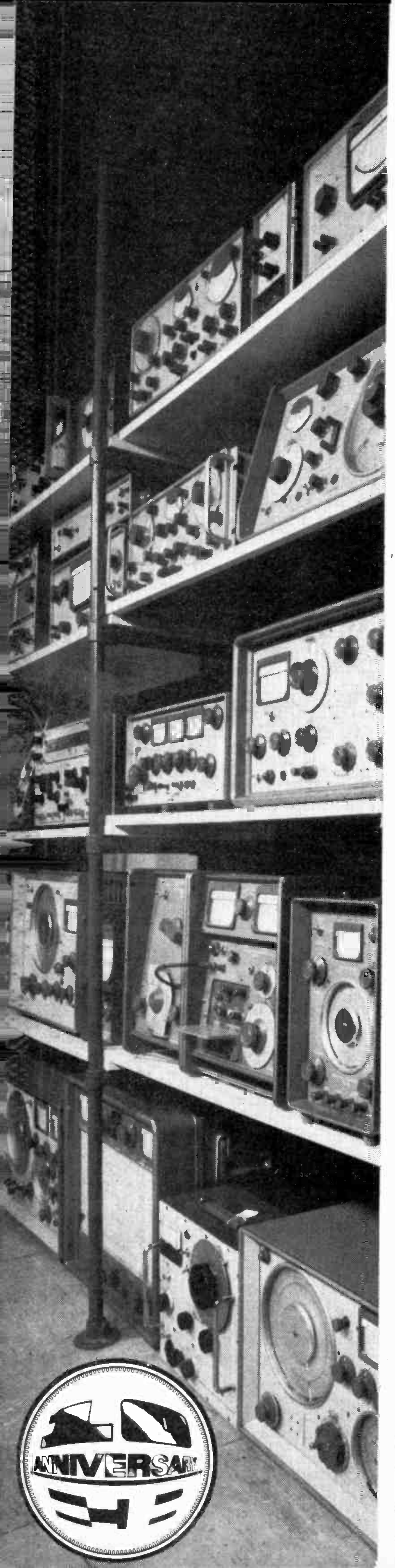
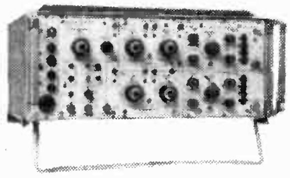


Electronic

The Test Equipment People

SIGNAL SOURCES

ADVANCE
Signal Generator J4. 10Hz-100KHz 600 ohms impedance, Sine & Square Brand new condition **£135.00**
V.H.F. Square wave Generator SG21. 10 KHz-100MHz Max. o/p 2V .. **£50.00**
H1E Audio Signal Generator. Sine & Square Wave 15Hz-50KHz. 200V to 20V (Sine). Distortion 1% 1.4mV to 140V (Square). Brand new condition **£75.00**



Type PG59 Pulse Generator 2 Channel, double pulse. Functions: Frequency, Width, Rise & Fall Time, Amplitude, Offset, Delay, Prepulse & Gate. Repetition Freq. 1Hz to 10MHz (20 MHz in double pulse mode). Delay & Width 25 nsecs/1sec. Full specification on request **£595.00**
Type SG67A Wide Range Oscillator Freq. Range 1Hz-1MHz. Sine or Square. Output Amplitude up to 2.5V. Battery operated. **£95.00**
R.F. Signal Generator 84B7 30KHz-30MHz. Output Z:— 75. Int. Mod. 400Hz. 0-80%. Provision for Ext. Mod. Audio o/p 0-10V at 400 Hz. into 600Ω **£165**
SG68A Low Distortion Oscillator, 1-5Hz-150KHz c/w BE2 battery pack. New condition **£200.00**

AVO
R.F. Signal Generator HF134. 100KHz-240MHz 75Ω. Int. mod. 1KHz @ 30%. Ext. mod. facility **£150.00**

HEWLETT PACKARD
10515A Frequency Doubler. Extends the usable frequency range of signal generators. Operating on input frequencies 0.5MHz to 500MHz it provides a doubled output in the range of 1MHz to 1GHz. The frequency response of this 50 ohm device is very flat (< ±2dB typically) over the entire frequency range and undesired harmonics are well suppressed **£75.00**
F.M./A.M. Signal Generator 202H. F.M. A.M. C.W. & pulse coverage 54 to 216 MHz R.F. o/p 0.1µV-0.2V 50ohms Impedance **£495.00**
612A-U.H.F. Signal Generator 450-1230MHz. 0.1µV-0.5V (50ohms) A.M. Internal & external. Pulse mod. facilities. SUPERB CONDITION **£1250.00**

MARCONI INSTRUMENTS
TF1060 U.H.F. Signal Generator 450-1250MHz. Sine wave and pulse a.m. **£400.00**
Signal Generator **TF867.** 15KHz-30MHz o/p 0.4µV-4V. Int. & Ext. mod. Supplied with Terminating unit **£185.00**
Solid State Generator 6058B. Freq. range 8-12.5GHz. Int. & Ext. mod. freq. Stab. 0.003%. 50Ω impedance .. **£530.00**
A.M. Signal Generator TF801D/1S Military version 10-485MHz **£450.00-£800.00**
R.C. Oscillator TF1370A 10Hz-10MHz. Square Wave up to 100KHz High Outputs up to 31.6V **£225.00**
Phase/A.M. Signal Generator TF 2003 0.4-12MHz **£150.00**
F.M./A.M. Signal Generator TF 995A/3S. Ministry type No. CT402 1.5MHz-220MHz. R.F. o/p 2µV-200mV. Internal & External Mod. Facilities V. good condition **£385.00**
A.M. Signal Generator TF801D/1. Freq. range 10-470MHz R.F. output 0-1µ-1V Piston attenuator. 50ohms Impedance.
A.M. Signal Generator TF 801B/3S 12.485MHz. 0.1µV-1V **£195.00**
Signal Generator TF144H/4. Later models in super condition **£500.00 to £650.00**
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MARCONI-SANDERS
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MUIRHEAD L.F. Decade Oscillator D880A. 2-phase 0.01Hz-11.2KHz **£225.00**
Decade Oscillator D890D. 1Hz-11.2KHz **£260.00**

PHILIPS
PM5501 Colour bar generator. Extremely light and compact instrument for mobile maintenance, 5 different test patterns for colour and black/white TV installation and service. R.F. output signal switchable. VHF, Band III and UHF Band IV. 1KHz tone for sound performance checks (sine wave) **£165.00**
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Pulse Generator PM5775 .. **£800.00**
Pulse Generator PM5776 .. **£900.00**
L.F. Generator PM5105. 10Hz-100KHz. Sine & Square Wave 2V(R.M.S.) Stabilised o/p. Low Distortion: <0.8% (10Hz-100KHz) **£156.00**

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Test leads **£4.00**
Multiminor Mk 4 c/w carrying case and leads **£14.00**
Model 7x **£40.00**
Heavy Duty Mk 5 (with case) .. **£40.00**
AVO Model 8 Mk. III and '8X' **£53.00**
AVO Model 9 or Test Set No. 1 **£55.00**

DYNAMCO
Digital Voltmeter DM 2023 c/w DC ranging unit C1. Scale 99999 0.001% F.S.D. DC Accuracy 10µV-1Kv DC **£450.00**

HEWLETT PACKARD
DVM type 3430A 3 digit 5 ranges 100mV to 100V. FS input resistances 10Mohms Overload protection **£145.00**
Digital Multimeter 34702A with Display 34740A. 4 digit display. 4 ranges both AC & DC plus 6 ranges of ohms. AC function covers 45Hz to 100KHz. Ohms ranges are 100ohms to 10Mohms FS LED display. New condition. A much sought-after device still in current production **£400.00**

PHILIPS

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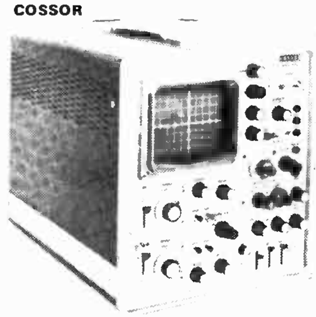
SIGN/ROGERS
A.F. Voltmeter AM324 .... **£50.00**

SOLARTRON
A.C. Converter LM1219. 30mV—300V mean reading. Freq. range 10Hz—10KH **P.O.A.**
D.C. Digital Voltmeter LM1420.2 2.5µV—1Kv in 6 ranges. ±0.05% DC accuracy **£235.00**
D.V.M. Type LM1420.2Ba. DC. true R.M.S. and mean A.C. sensing. Accurate measurement irrespective of harmonic distortion accuracy ±0.25%. Freq. 20Hz—20KHz **£350.00**
DVM Type LM 1440.2 10µV—2Kv DC 5 ranges Oven controlled zenerdiode. Accuracy ±0.033% FSD ±0.005% reading .... **P.O.A.**
D.V.M. LM1480.3 Autoranging version of LM 1440.3 Max reading 39999 5µV—2KV DC. Full spec. on request **P.O.A.**
D.V.M. LM 1604 DC only 1µV sensitivity. 0.01% accuracy. Max reading 19999 1µV—1KV. Remote and Autoranging. 110dB series mode reject on. No common Mode error .... **P.O.A.**
D.M.M. 7050 (Autoranging) **£245.00**

OSCILLOSCOPES

COSSOR



Dual Trace Scope 4000. 50MHz 7nsec Rise Time 5mV/cm sensitivity. Calibrated sweep delay. Gated trigger. X-Y display 8 × 10cm display **£495.00**
200µV/cm. Scope 130C 500KHz bandwidth. Identical X and Y amps. X2 to X50 sweep mag. **£205.00**

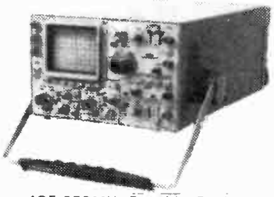
MARCONI INSTRUMENTS
40MHz TF 2200 series supplied with 3 plug ins.
V12. TM 6455 (single trace).
TM 6456 (dual trace).
TM 6457 (TV diff).
Full specs. on request. 6 MONTH WARRANTY **£250.00**

PHILIPS
PM6507 Transistor Curve Tracer. Solid State CRT — 10 × 12cm. Full spec. on request **£475.00**

PROBES
X1 Part No. 90 .... **£7.00**
X10 Part No. 91 .... **£9.00**
X1 & X10 (switchable) Part No. 95 **£11.00**

SOLARTRON
CD1740 50MHz Scope System c/w CX1741 & CX1744. Dual Trace, DC-50MHz 10 × 8cm display. Sensitivity 5mV/cm to 20V/cm. Delayed sweep, Solid State **£485.00**
Portable Scope DC-6MHz Double Beam CT436 .... **£105.00**

TEKTRONIX
DC30MHz Oscilloscope 545A c/w CA & L Plug-ins **£445.00**



Type 485 350MHz Portable. Dual Trace. 5mV/div. 1nsec/div sweep rate. Delayed sweep. Auto focus, variable trigger hold off 50 ohms internal input protection **£3,250.00**
Type 549 (Mainframe) DC-30MHz Bistable split screen storage. Automatic Erase. 5cm/µS writing speed. Calibrated sweep delay. Various plug-in units available **£750.00**
Type 551 DC-27MHz. Main frame and power supply. Various plug-in units available **£450.00**
Type 564B (Mainframe) Storage Oscilloscope. Various plug-in units available **£750.00**

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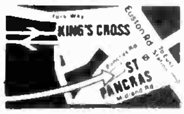

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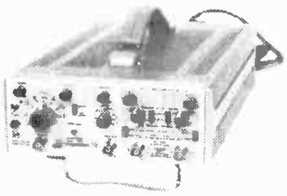
SCOPE TEST EQUIPMENT

Time Mark Generator 184 **£275.00**



5nsec Pulse Generator Model 2101 c/w loads and connectors **£575.00**
Time Mark Generator 2901 **£450.00**
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AIRMEC/RACAL
Wave Analyser 248A. 5-300MHz **£250.00-£300.00**
Wave Analyser 248 Freq. range 5MHz-300MHz **£145.00**
Modulation Meter 409 **£295.00**
Type 210A Modulation Meter. 2.5-300MHz, AM Range 0-100% FM Range 0 to ±100KHz in 4 ranges **£185.00-£245.00**

GENERAL RADIO
Type 1900A Wave Analyser c/w Graphic Level Recorder 1521B
Spec: 1900A. 20Hz-50KHz. 3 bandwidths 3, 10 and 50Hz Tracking averages 30mV-300V F.S.D. Input impedance 1M ohm 3 meter speeds
Spec: 1521B 4.5Hz-200KHz 1 mV sensitivity. Linear dB plot of r.m.s. ac-voltage level 20, 40 or 80 dB range **£2,000.00**

HEWLETT PACKARD
Sweeping Local Oscillator 3595A Plug-in for use with 3590A Wave Analyser Freq. range 20Hz to 620KHz **£650.00**

MARCONI INSTRUMENTS
Distortion Factor Meter TF142F Fundamental Freq. Range 100Hz-8KHz. Dist. measuring ranges 0-5% 0-50%. Measures all spurious components up to 30KHz **£60.00-£80.00**

RADIOMETER
Wave Analyser FRA 2 T3 Special version of FRA 2 with facilities for Intermodulation measurements and selective measurements of frequency responses. Freq. range 30Hz to 16KHz incremental freq. 0Hz to ±60Hz. Selectivity 3 curves with following 1dB points ±1.25Hz ±12.5Hz ±63Hz. Voltage range 100µV-1KV. Auxiliary Oscillator Range 0Hz to 1.6KHz and 1.5 to 1.6KHz o/p — 10V (EMF) continuously variable impedance 1 Kohms 16µF **£275.00**

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MARCONI INSTRUMENTS
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WAYNE KERR
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Plug-In Unit TC15 P1. 1MHz-500MHz. 10mV-1V. Full 500MHz display with 1Hz resolution in only 2 secs **£200.00**
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GENERAL RADIO
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HEWLETT PACKARD
R.F. Voltmeter 3406A 20µV sensitivity — average response 1 mV sensitivity. 1 mV — 3V F.S. 8 ranges. 10KHz — 1.2 GHz **£485**

RHODE & SCHWARZ
Selective Microvoltmeter. USVH BN 1521. 10 KHz — 30 MHz. 0.2 V — IV. F.s.d. of lowest range 1 V **£675**

MISCELLANEOUS

ADVANCE
Digital Panel Meters. DPM. 102, 103, 112P, 201, 204, 301, 302, 303, 306, 343 **Price and specs. on application**

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Unit Amplifier Type UA 301. Frequency 1 to 400MHz Nominal gain 7dB **£75**
Unit Amplifier UA 305. 2-400MHz Response. Nominal gain 13 dB **£100**
Full specs. on the above devices available on request.

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Coaxial Resistor 8053 10W RF coaxial load resistor **£20.00**
Wattmeter Termaline 6835 3 ranges 0-120 / 0-600 / 0-1200W 30-500MHz **£425.00**
Wattmeter Termaline 67 3 ranges 0-25 / 0-100 / 0-500W / 30-500MHz **£265**

BRUEL & KJAER
Random Noise Generator 1402 **£250.00**
Automatic Vibration Exciter 1018 **£495**

CAMBRIDGE
AC/DC Resistance Box. 5 decade **£70.00**

GENERAL RADIO
Standard Frequency Multiplier 1112A. **Price & specs. on application**
Standard Frequency Multiplier 1112B **Price & specs. on application**

HEATHKIT
Distortion Meter 1M-12U **£40.00**

MARCONI INSTRUMENTS
R.F. Power Meter TF1152/1 **£75.00**
R.F. Power Meter TF1152A/1 **£80.00**
Coqr Gain and Delay Test Set TF2904 625 line **£505.00**
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RHODE & SCHWARZ

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Programmable Phase Meter 775 **£795**

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Quantities of these equipments at bargain prices available on short delivery until 31st December, 1977.

OSCILLOSCOPES

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533A c/w CA Plug-In DC-13MHz. Dual Trace **£185.00**
535A c/w CA Plug-In DC-13MHz. Dual Trace **£200.00**
545 c/w CA Plug-In. DC-24MHz **£225**

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ADVANCE
J1A 15Hz-50KHz **£40.00**

MARCONI
TF1101 20Hz-200KHz **£85.00**

AF POWER METER

MARCONI
TF893A **£150.00**

AF ATTENUATOR

MARCONI
TF338C **£60.00**

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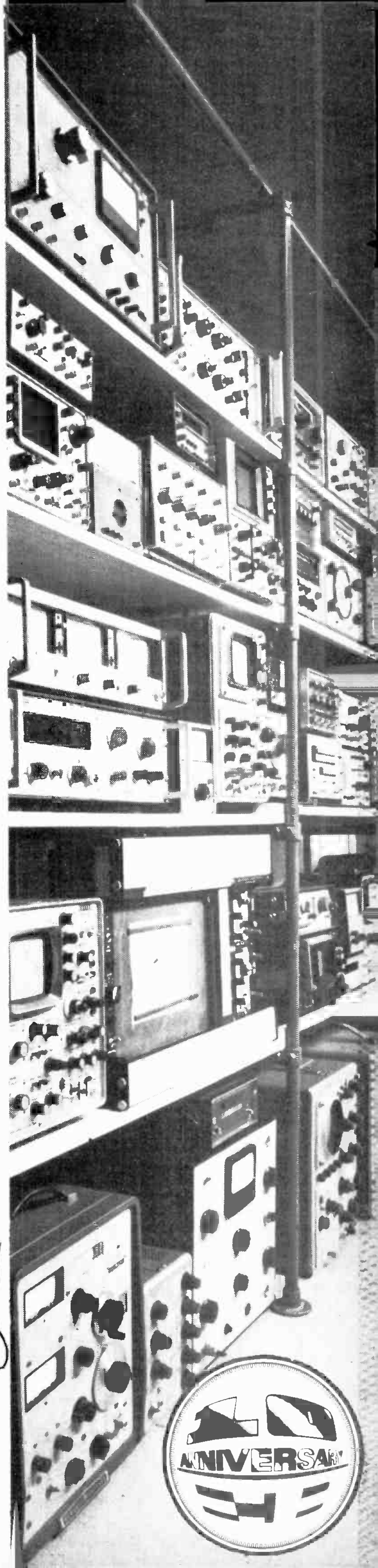

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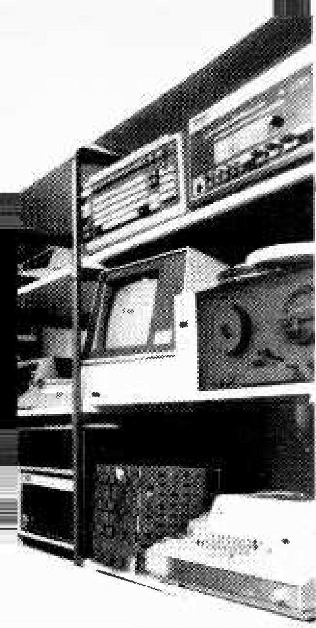
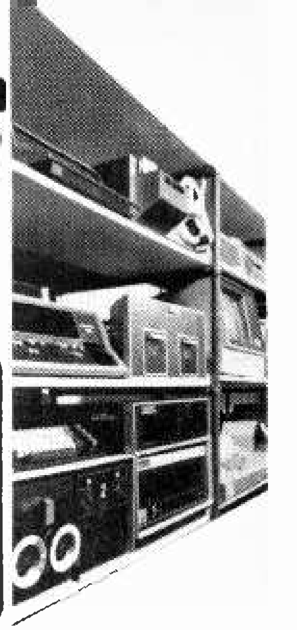


Electronic Brokers

The Computer People



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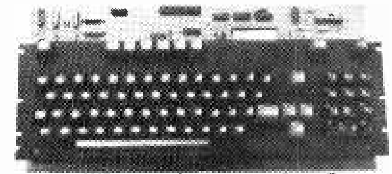

Mini-Computer Exchange

DEC PDP8E SYSTEM
● 8K Processor ● KC8EA Programmer's Panel ● KL8M and KL8JA Serial Interfaces ● RK8E Oisk Control ● 2 x RK05-BB Oisk Drives ● Mounted in 4ft. cabinet complete ● with power supply.

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DEC PR8E
High Speed Paper Tape Reader, complete with Interface

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Oisk Drive and Control. ONLY £695.00.

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DEC PDP8I, PDP8L, PDP12 Modules
Large stocks available — let us know your requirements.

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Magnetic Tape Oeck in 6ft. cabinet.

DEC PR11
High-speed Paper Tape Reader complete with POP11 interface.

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Large stocks available.

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Disk drive and control.

KB8 REED-SWITCH KEYBOARD
* 78 Station ASC11 Keyboard including separate numeric cluster, cursor control keys, and 6 special function keys
* Standard TTL logic
* Power requirements +5V @ 100mA and −12V @ 4mA
* 8-bit ASC11 code (including parity) providing full 96-character set with upper and lower case outputs
* negative strobe with 4 0 ms delay

Overall dimensions 16½ × 7¾ × 2", supplied complete with full technical data and circuit diagrams.
PRICE: £55.00 + £1.25 p&p + 8% VAT (Send £60 75)

DXS-CRT 96 station ASC11B-coded TTL-compatible 4 bank alphanumeric keyboard, 8-bit code upper and lower case alpha output plus separate numeric pad. Delayed strobe and 2-key rollover. Mounted in attractive box overall dimensions 20½ × 7¼ × 3½".
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Numerals 0-9 decimal point C K + − × ÷ = Mounted on PCB overall dimensions 5⅛ × 4⅝ × 1½"
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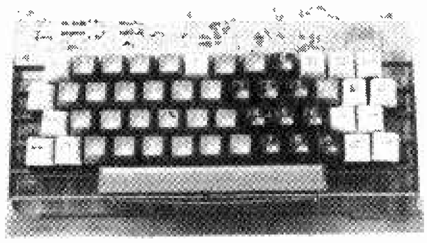

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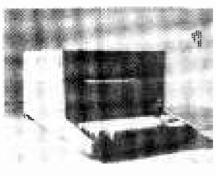

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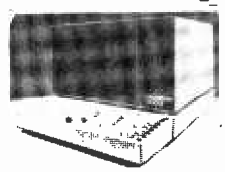

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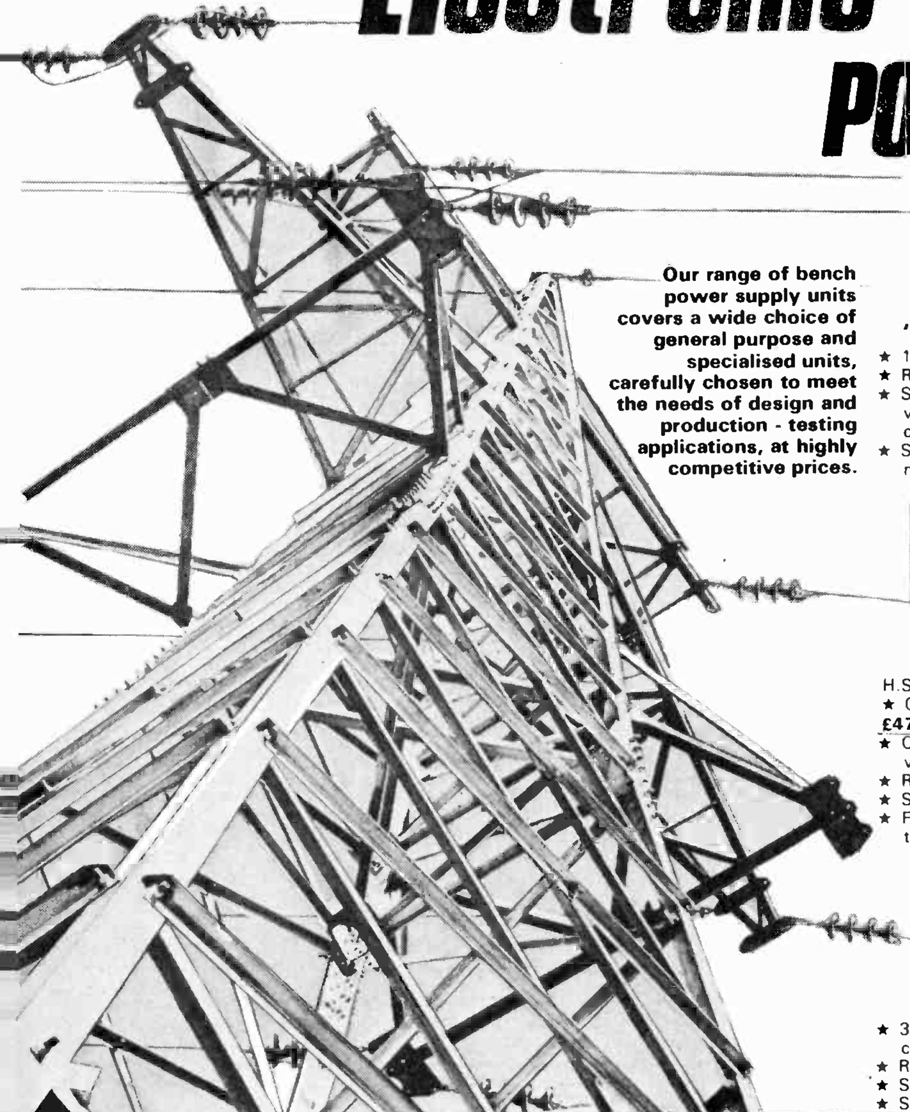

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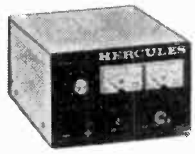

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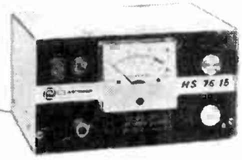

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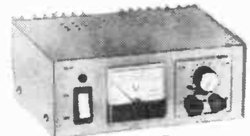

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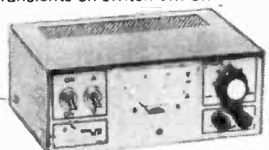

P.G. 77

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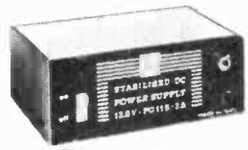

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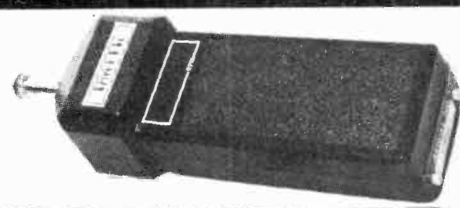

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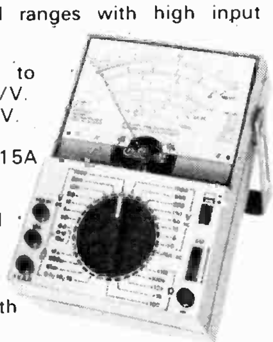

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AC142	20p	BSX19	20p	2N3442	140p
AC176	25p	BSX20	20p	★2N3565	30p
AC187	25p	★BU105	140p	★2N3643	48p
AC187K	30p	BU108	250p	★2N3644	48p
AC188	25p	★BU205	200p	★2N3702	12p
AC188K	30p	★BU208	300p	★2N3703	12p
AD149	49p	★MJE340	65p	★2N3704	12p
AD161	45p	MJ481	175p	★2N3705	12p
AD162	45p	MJ491	200p	★2N3706	12p
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AF116	30p	MJE2955	130p	★2N3709	12p
AF117	30p	MJ3001	225p	2N3773	300p
AF127	25p	MJE3055	70p	2N3866	90p
AF139	43p	★MPSA06	30p	★2N3903	18p
AF239	48p	★MPSA12	50p	★2N3904	16p
BC107/B	9p	★MPSA56	32p	★2N3905	20p
BC108/B	9p	★MPSU06	62p	★2N3906	16p
BC109/B	10p	★MPSU56	78p	★2N4058	15p
BC109C	12p	OC28	120p	★2N4059	10p
★BC117	22p	OC35	90p	★2N4060	13p
★BC147	9p	OC36	90p	★2N4123	22p
★BC148	9p	★OC71	20p	★2N4124	22p
★BC149C	10p	★R2008B	200p	★2N4125	22p
★BC157	11p	★R2010B	200p	★2N4126	22p
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★BC159	11p	★TIP29C	55p	★2N4401	27p
★BC169C	12p	★TIP30A	48p	★2N4403	27p
★BC172	11p	★TIP30C	60p	2N4427	90p
BC177	18p	TIP31A	52p	★2N5087	27p
BC178	17p	TIP31C	52p	★2N5089	27p
BC179	18p	TIP32A	58p	2N5296	55p
★BC182	12p	TIP32C	82p	★2N5401	50p
★BC183	12p	TIP33A	90p	2N6034	160p
★BC184	13p	TIP33C	115p	2N6107	55p
BC187	30p	TIP34A	115p	2N6247	190p
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★BC213	10p	TIP35A	225p	2N6254	130p
★BC214	14p	TIP35C	290p	2N6292	65p
BC461	36p	TIP36A	270p	40290	250p
BC478	30p	TIP36C	340p	40360	40p
BCY70	18p	TIP41A	65p	40361	45p
BCY71	22p	TIP41B	70p	40362	45p
BCY72	18p	TIP41C	78p	40364	120p
BD124	130p	TIP42A	70p	40409	65p
BD131	63p	TIP42B	76p	40410	65p
BD132	65p	TIP42C	82p	40411	300p
★BD135	48p	TIP2955	78p	40636	130p
★BD136	50p	★TIS93	30p	40594	88p
★BD139	52p	★ZTX108	10p	40595	97p
★BD140	58p	★ZTX300	13p	40871	80p
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BF115	22p	★ZTX502	18p		
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BF170	23p	2N697	22p	★BF244B	36p
BF173	25p	2N698	45p	★BF256B	70p
BF177	26p	2N706	20p	★MPF102	40p
BF178	28p	2N708	20p	★MPF103	40p
BF179	33p	2N918	40p	★MPF104	40p
BF180	33p	2N930	18p	★MPF105	40p
BF184	22p	2N1131	18p	★2N3819	25p
★BF194	10p	2N1132	18p	★2N3820	50p
★BF195	9p	2N1304	75p	2N3823	57p
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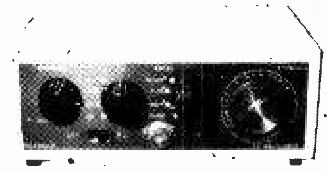

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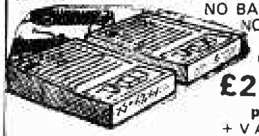

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WW—073 FOR FURTHER DETAILS

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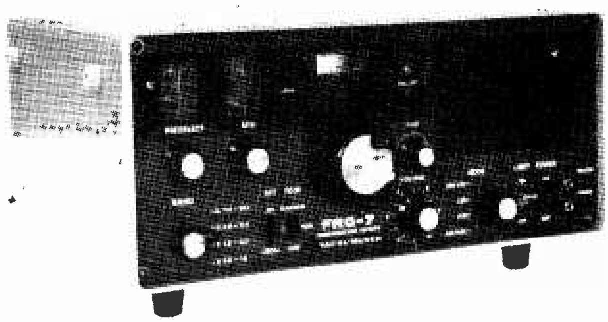

The FRG7 is a solid state mains and 12v. receiver offering continuous coverage 0.5—30 MHz with specifications unparalleled in its price range.

Its advanced circuitry provides superb performance for professional or amateur alike: search, monitor, test, amateur or broadcast band applications.

The use of a Wadley loop (using the same VHF oscillator to mix up, then after pre-mixing with a stable crystal source down again (this cancelling all drift from the variable oscillator). It provides equivalent performance to 30 crystal controlled converters feeing a low IF, but without the image problems of such an arrangement.

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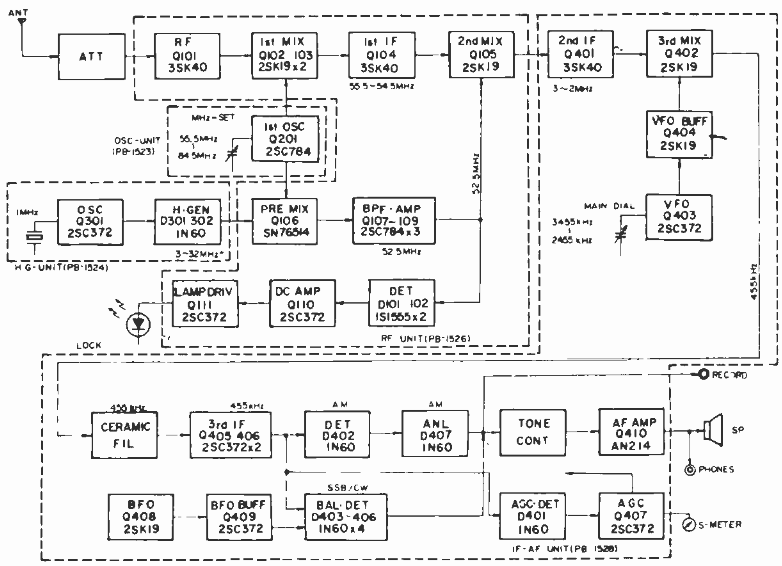

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General coverage in 4 bands
AUDIO DISTORTION less than 10% at 2W output

AUDIO OUTPUT more than 2W.
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WW—082 FOR FURTHER DETAILS

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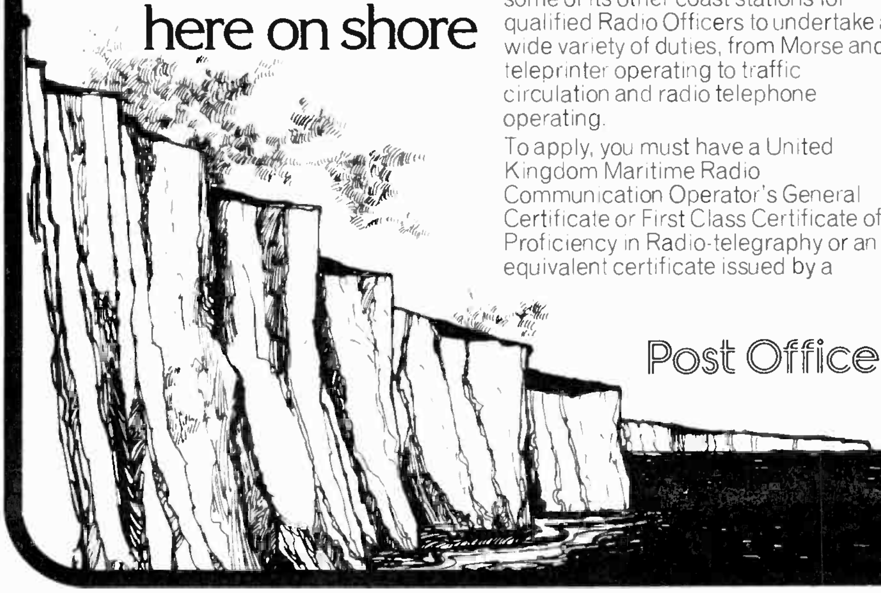

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(7721)

MARINE ELECTRONICS TECHNICAL OFFICER

An electronics Technical Officer is required to assume duty as soon as possible after 31st January, 1978, in the Marine Geoscience Group of the Department of Geology. Duties will include the maintenance and development of marine geophysical equipment, both in the laboratory and at sea. Some experience in this field would be a recommendation. The successful applicant will spend several 2-3 week cruises per year aboard the University's research vessel "Thomas B Davie."

In addition to a salary on the scale R4040 x 180 — 5100 x 240 — 5580// x 240 — 6300// x 360 — 6660 per annum plus a pensionable allowance of 10% of salary, the University offers a veriety of excellent fringe benefits.

Further details may be obtained from the Professor of Marine Geoscience, Department of Geology, University of Cape Town, Rondebosch, 7700 South Africa

Applications giving names of two referees must reach **The Registrar, University of Cape Town, Private Bag, Rondebosch 7700**, by 31st January, 1978.

The University reserves the right to appoint a person other than one of the applicants or to make no appointment. 7722

DESIGN/DEVELOPMENT ENGINEERS

Ferranti wins Army contract.

Ferranti land space order.

1200 MORE JOBS FR
FERRANTI EXPANS

MoD order goes to Ferranti.

Come and make headlines with us.

Headlines like these are only possible when you're acknowledged internationally as one of the world's leaders in avionics. To keep us at the forefront we need highly motivated design/development engineers keen to make their mark. And at Ferranti there's plenty of opportunity to do just that. On projects like the Tornado, Sea Harrier, Jaguar and Lynx.

And headlines like these also mean expansion. Which explains why we're looking for more graduate mechanical and electronic engineers to join our airborne radar and inertial navigation teams. They must have the design/development experience to spearhead the progress of equipment from drawing board through to production.

We are particularly interested in talking to engineers with backgrounds in the design of:-

Digital/analogue circuitry.
Microwave and laser techniques.
Small digital computers.
Advanced instruments.
Optics.
Airborne structures and light mechanisms.

So if you're keen to make your mark on avionics, you'll find you're very much on our wavelength.

Think about it. Then ask the family how they'd like living in Edinburgh, freely acknowledged as one of Europe's finest cities.

Salaries are negotiable and, of course, we operate a contributory pension and life assurance scheme and pay realistic relocation expenses.

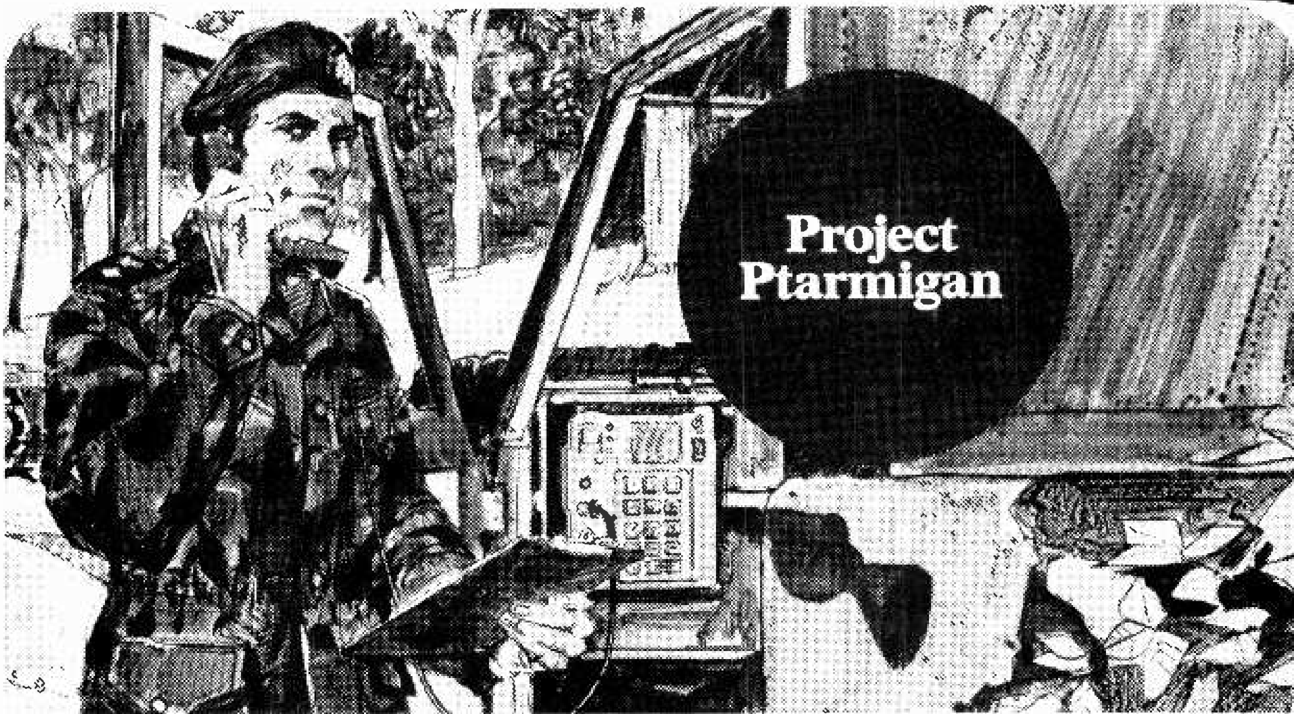
For an application form, write to John McPhee at the address below:

Ferranti Limited
Ferry Road
EDINBURGH EH5 2XS
Tel: 031-332 2411.

These posts are open to both male and female candidates.

(7000)

FERRANTI



Technician Engineers

The Plessey Development Laboratory at Havant, Hampshire, is sub-contractor for the most advanced VHF communications system ever to be developed for the British Army. This system – known as "Single Channel Radio Access" – allows mobile subscribers to use the Ptarmigan trunk telephone network for both voice and data messages.

We are now proceeding with the second phase of development, creating new career opportunities for Technician Engineers who wish to advance their knowledge.

What jobs are on offer?

We are looking for Technician Engineers with a minimum of 5 years' relevant experience in industry or H.M. Services to work in the following fields.

VHF Radio Equipment Development and Evaluation

Successful candidates will be responsible for getting development models of transmitters and receivers working and characterising their electrical and environmental performance under a wide variety of conditions.

Development of Special Purpose Test Equipment

This new development of automatic test equipment for use in the Army's Electronic Repair Vehicles will interest candidates with a knowledge of ATE and associated programming techniques.

Development and Evaluation of Digital Logic Modules

Candidates with a special interest in digital circuits and systems will find opportunities to work under the guidance of experienced senior engineers on the most up-to-date techniques, including microprocessors.

What qualifications?

The type of work we do needs people with plenty of solid practical experience of transistorised equipments, a common sense approach and a willingness to work with others towards a common goal. However, if you have the experience we are looking for, it is likely that you will also possess a City & Guilds Full Tech. Cert., ONC or HNC.

Salaries and career prospects

We operate a separate career structure for Technician Engineers which offers plenty of opportunity for promotion. You could become a Principal Technician Engineer in charge of a small section, while the exceptional younger person would be encouraged to qualify to transfer into the Professional Engineering grades. Because our plans for business expansion are soundly based on a full order book for a wide range of both government sponsored and private venture products, we can offer you both job stability and the up-to-date experience which is essential to our future growth.

Technician Engineers are recognised as important members of our teams and are rewarded accordingly. These jobs will carry salaries up to £4,000 p.a.

Situated in a semi-rural environment near Portsmouth, Chichester, the South Downs and several seaside resorts, we are well placed for housing, educational and recreational amenities. Relocation assistance will be given and there is a comprehensive range of large company benefits.

Please write with brief career details or telephone for an application form. L. Wise, Recruitment Manager, The Plessey Company Limited, Martin Road, West Leigh, Havant, Hants. Tel: (07012) 6391. Applications are invited from either sex.

PLESSEY

(7663)

Instrumentation Technologist

Salary c. £4,500

Redland Technology provide Research and Development services for manufacturing divisions of the Redland Group who manufacture materials and building components for the construction industry.

The post available is for an electronics engineer or physicist to work in the instrumentation section of the research centre, set in pleasant countryside at Graylands, Horsham, Sussex.

The successful candidate will be responsible for designing and constructing specialised instrumentation systems and for advice and consultation services on suitable techniques for process control and materials testing. He/she will be provided with technical support staff.

The work involves the measurement of a wide range of parameters, but particularly load, vibration, noise, temperature. A microcomputer is available to analyse data recorded on FM tape. Projects often result in the development of novel solutions which, where appropriate, will be patented.

Minimum qualifications are a degree or HNC in an appropriate subject plus at least two years relevant experience. Car ownership would be an advantage as some travelling will be necessary.

Please write in the first instance to:

Dr. R. A. Hazelwood, Redland Technology Limited, Technology and Product Development Centre, Graylands, Horsham, Sussex. Tel: Horsham 2351 Ext 281

Redland Technology 7712

THE UNIVERSITY OF LIVERPOOL

DEPARTMENT OF INORGANIC, PHYSICAL AND INDUSTRIAL CHEMISTRY

TECHNICIAN

The successful applicant will work on the maintenance, repair and construction of a wide range of scientific instrumentation, involving high stability power supplies, amplification of low level signals (including lock-in amplification). R.F. techniques and digital and analogue techniques. Salary in a range up to £3367 per annum (under review).

Application forms may be obtained from the Registrar, The University, P.O. Box 147, Liverpool L69 3BX. Quote ref. RV/590/WW.

(7679)

Immediate opportunity in Amman, Jordan, for

ELECTRICIAN/ ELECTRONICS TECHNICIAN

to join staff of new Army museum. Will have sole charge of sophisticated British designed electrical system including electronically controlled audio-visual installation. Appointment for approx. one year, during which time applicant will train Jordanian national. An interesting and responsible post. Salary by arrangement. All Jordanian expenses paid.

Please write in first instance Box No. WW7730.

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FREE JOBS LIST

for

FIELD SERVICE ENGINEERS, BASIC SALARIES TO £5,000 + CAR

(7707)

30 Windmill Street, London, W1 01-637 5551

SALES MANAGER

for Mainline Electronics

The Mainline division of Crellon Electronics has been formed to supply electronic components to the amateur market.

The division requires a Manager (male or female) with entrepreneurial flair and drive to take over sales and marketing.

Applicants, who must have considerable experience in this field will be fully responsible for the total promotion of the division's products – and directly concerned with its profitability.

Salary around £5,000 plus a generous profit sharing scheme Which should produce over £7,500 p.a.

Write or telephone:
Alan Thompson
Mainline Division
Crellon Electronics Ltd.
380 Bath Road, Slough, Berks.
Tel: Burnham (06286) 4434

7658

WILTSHIRE AREA HEALTH AUTHORITY
Area Physics Service

Medical Physics Technician

(GRADE IV)

Required for this new department which provides an Area physics service (centred on the City of Bath) and serving ultimately three health districts. The person appointed will be assisting with the provision of physics service chiefly to the clinical measurement activities in the Area. An interest in electronic techniques and instrumentation desirable.

Salary: £2346-£3267 per annum plus supplements.

Job description and application forms are available from the Area Personal Officer, Wiltshire Area Health Authority, Rowden Hill House, Chippenham, Wilts SN15 2AN. Tel. 0249-51251 ext. 236.

Closing date: 12th December, 1977.

(7727)

MARINE ELECTRONICS FIELD ENGINEER experienced install & service SSB VHF radar, autopilots electronics. Able to work on own initiative. Home and abroad. Must live in or near London. The right person could advance to management level. Telesconic Marine Ltd., 243 Euston Road, NW1. (7680

RADIO - TELEPHONE ENGINEERS Experienced in V.H.F. mobile equipment. Top salaries for top ability. We are a young progressive company currently the busiest and fastest expanding radio-telephone firm in London. Ring London Communications on 01-328 5344 ask for Mike Rawlings or Bill Clarke. (7356

H.M.G.C.C.

has vacancies for

ELECTRONIC ENGINEERS

to work in fields of:

a. VHF/UHF communications equipment design.
b. General circuit design analogue and digital.

Qualifications

Candidates should have one of the following academic qualifications

i. Degree in Science or Engineering
ii. Degree standard membership of a Professional Institution
iii. HNC or HND in a scientific or engineering subject

or equivalent qualifications.

Experience

For the grade of Higher Scientific Officer the following post-qualification is also required, 2 years for candidates with 1st or 2nd Class Honours degrees and 5 years for other candidates.

Salaries

Scientific Officer (under age 27)	£2462-£3840
Higher Scientific Officer	£3567-£4767

A pay supplement of £313.20 per annum is included in the above salary scales. An additional supplement of 5% of total earnings subject to a minimum of £130.50 per annum and a maximum of £208.80 per annum is also payable.

Application forms may be obtained from:

The Administrative Officer
HM Government Communications Centre
Hanslope Park
Hanslope
Milton Keynes MK19 7BH

(7682)

Metropolitan Police Office

Tape Recording Specialist

. . . to work in the Tape Laboratory, Camberwell, London, on copying and processing tapes, and preparing tapes for specialist tape recorders. Duties also include giving evidence in Court about work carried out on tapes, and occasionally analysing various phenomena of tape recordings using specialist analytical equipment and then acting as expert witness in Court. The successful candidate will be responsible for own case work (initial training given) and will work in close collaboration with Police Officers and with the various Constabularies which will necessitate travel anywhere in the country.

Candidates (aged at least 21) must have ONC in Engineering (with a pass in Electrical Engineering "A") **or** C&G Radio, TV and Electronics Technicians Cert. No. 272, **or** an equivalent or higher qualification. In addition, they should have a thorough understanding of tape recorders and recording techniques; have experience of work in professional broadcast studios on audio and video tape recorders; and be fully conversant with checking tapes for quality and defects.

Salary starting between £3490 and £4460 (according to age) and rising to £4765. Promotion prospects. Non-contributory pension scheme.

For further details and an application form (to be returned by 8th December, 1977), write to Civil Service Commission, Alencon Link, Basingstoke, Hants RG21 1JB, or telephone Basingstoke (0256) 68551 (answering service operates outside office hours). **Please quote T/9625.**

(7656)

ELECTRONICS ENGINEER

(LIGHTING CONTROL SYSTEMS)

We are a leading company in the field of thyristor controlled lighting and associated equipment, including standby power sources, power distribution and industrial control. A high percentage of our production is exported

We require an Electronics Engineer to carry out design and development on both existing and new products. The work encompasses all aspects of design from initial concept and prototypes to final production, and may include some project work.

Applicants should have a minimum qualificiation of HNC together with some industrial design experience involving analogue and digital techniques. The ability to work with minimum supervision is essential.

Contact: **P. J. Harrison, Technical Director.**

Poaron Controls Limited
60/62 Greenhill Crescent
Holywell Industrial Estate
Watford, Herts WD1 8RL
Tel. Watford (0923) 37144
Telex 922080

7726

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

TECHNICAL STAFF GRADE 5

Vacancy for electronics technician to construct and develop specialised electronic and electrical equipment, and to assist research groups with electronic instrumentation in the field of control, measurement and data-handling.

Salary range £3377-£3856 per annum inclusive of London weighting and permitted supplement. Four weeks' holiday plus additional days at Christmas and Easter. Superannuation scheme. Sports and social facilities. 37 and half hour, 5 day week.

Apply to Mr. G. J. Green, Department of Metallurgy and Materials Science, Imperial College of Science and Technology, South Kensington, London SW7 2BP.

(7694)

CATHODIC PROTECTION TECHNICIAN

Wisbech up to £3957

Applications are invited from suitably qualified persons for the above post based in Wisbech, Cambridgeshire.

The successful applicant will be required to carry out resistivity surveys, potential surveys, locations and Pearson surveys, continuity and insulating flange tests and all patterns of interference tests. Responsibilities also include negotiating with Electricity, Water, Post Office and all other Authorities concerned with Cathodic Protection.

Candidates should be experienced in all aspects of Cathodic Protection including installation and maintenance of impressed and sacrificial schemes, ground bed installations, transformer rectifiers, test posts, and all general duties associated with Cathodic Protection.

Salary within the range £2769-£3456 plus Phases I and II pay policy supplements. Excellent conditions of service including sick pay, holiday and pension schemes. The region operates a car mileage scheme.

Apply to Mr. J. G. Hagger, Area Personnel Officer, Eastern Gas, Newmarket Road, Cambridge CB5 8JE. Tel. Cambridge 65341, as soon as possible.

(7686)

EASTERN GAS

SOUTH OF SCOTLAND ELECTRICITY BOARD HUNTERSTON

'A' & 'B' NUCLEAR POWER STATIONS

require

INSTRUMENT CRAFTSMEN

AVERAGE SALARY £77 for 40 hours per week on a 3 shift 5 cycle week pattern or £69 for 40 hours per week for 1-week-end in 4 day stagger pattern.

Full details will be supplied to craftsmen writing for the standard application form and quoting reference 67/IND174/77 to the Manager, Hunterston 'A' & 'B' Nuclear Power Station, West Kilbride, Ayrshire LA23 9QJ.

The above vacancies are open to male and female applicants.

(7684)

SATELLITE COMMUNICATIONS ENGINEERING

Within the International Telecommunications Satellite Organisation (INTELSAT) two types of satellite earth station are used – Standards 'A' and 'B'. Cable and Wireless is the world's largest operator of both types of INTELSAT earth station. Our involvement encompasses ownership, operation, maintenance, consultancy and the lease of earth stations to clients. The Satellite Division plans and coordinates the procurement and commissioning of earth stations, including our own design of Standard 'B' station, and is involved in systems studies for our own network and for projected domestic satellite schemes. Rapid growth in this high-technology field means outstanding opportunities are available to men and women in the following key posts:

Standard 'B' earth station

Satellite Systems Engineers

You will be involved with the study of satellite systems, and in the preparation of specifications and procurement of earth station sub-systems. You should be numerate and hold a degree or equivalent in electrical engineering, electronics or a related discipline. Experience in microwave techniques or radio communications is essential, and experience in satellite communications systems engineering would be advantageous. Candidates with specialised experience in related fields (such as digital radio, antenna theory or microwave propagation) will also be considered.

Satellite Earth Station Planning Engineers

You will be concerned with the planning of satellite systems and the preparation of specifications, tender evaluations, procurement and installation of earth station sub-systems. You should hold an HNC or equivalent in electrical engineering, electronics or a related discipline, and membership of the Institution of Electrical Engineers or the Institution of Electronic and Radio Engineers would be an added advantage. Experience in microwave techniques or radio communications is essential, and experience in satellite communications systems engineering would be an advantage. Candidates with field operations experience but without planning experience will also be considered.

All posts are London-based, but as most of our business is overseas, you will make short trips abroad.

Starting salaries (currently under review) will be around £5,000 rising to £6,000 in annual increments. Subsequent promotion, leading to salaries of £7,600, is possible. Benefits are those to be expected of an international company, and includes relocation assistance where necessary.

Please telephone or write with full CV to:

Recruitment Manager,
Dept. A907/749,
Cable & Wireless Limited,
Mercury House, Theobalds Road,
London WC1X 8RX.
Tel: 01-242 4433 ext. 4059.

(7685)

Cable & Wireless

Leaders in International Telecommunications

Radio Frequency Spectrum Engineering

Team Leaders up to £6,915

The Directorate of Radio Technology, Central London, provides the technical expertise and engineering support for forming and implementing management policy, and is concerned with all aspects of spectrum engineering. It is also involved in the technical preparations for the 1979 World Administrative Radio Conference.

The successful candidates will each lead a section dealing with one of the following activities: the forward planning, management and regulation of civil frequency bands; radio propagation over the whole frequency spectrum; specifications and equipment type approval for fixed and mobile services, including microwave links; the application of computer techniques to frequency management problems; the nationwide radio interference service; the provision of technical advice on radio services' licensing; and the operation of an international radio monitoring service.

Candidates must have qualified for corporate membership of IEE or IERE, and in addition have several years' professional experience. They must have at least two years' experience in a relevant field, and should have a broad outlook enabling them to appreciate the general principles of frequency spectrum engineering.

Starting salary between £5705 and £6915, depending on qualifications and experience. Non-contributory pension scheme. Promotion prospects.

For further details and an application form (to be returned by 9 December 1977) write to Civil Service Commission, Alencon Link, Basingstoke, Hants, RG21 1JB, or telephone Basingstoke (0256) 68551 (answering service operates outside office hours). **Please quote T(D)85/1.**

HOME OFFICE

7681

Engineering Opportunities

Pye Business Communications Limited, a member of the Pye Group of Companies – part of the international Philips organisation – markets, installs, commissions and services a wide range of communications equipment.
The Engineers appointed to the following positions will enjoy the excellent employment conditions associated with a major company.

FIELD MAINTENANCE ENGINEERS

i) **To cover Northern England,** resident in Central Yorkshire, to work on Intercom and CCTV systems
ii) **To cover Southern Area,** preferably resident in Greater London, to work on Intercom and CCTV systems, Radio and Inductive Paging equipment.
iii) **To cover Midlands,** resident in Birmingham close to Spaghetti Junction, to work on CCTV equipment for which experience of digital techniques is essential.

INSTALLATION & COMMISSIONING ENGINEER

– **Southern Area,** resident North of the Thames, for Private Telephone systems, Intercom and Public Address systems and Paging Equipment.
A Final C. & G. Telecommunications Certificate, ONC or equivalent is essential for the above vacancies, together with a clean driving licence. Company cars will be provided.

BENCH MAINTENANCE ENGINEERS

to work at our Wembley Depot on RF and Inductive Loop Paging Receivers and/or CCTV equipment. Minimum qualification of Intermediate C. & G Telecommunications Certificate required.

Please apply to:
Mrs. Ann Macnab, Personnel Manager,
Pye Business Communications Limited,
Cromwell Road, Cambridge CB1 3HE
Telephone Cambridge 45191

Pye Business Communications Ltd
A member of the Pye of Cambridge Group

7687

CHELSEA COLLEGE
University of London

ELECTRONICS TECHNICIAN

Grade 3 required for the construction and maintenance of electronic equipment in the Electronics Undergraduate Teaching Laboratory, and also to assist with laboratory classes and Audio Visual Aids requirements.

Day release for an approved course of study could be arranged. Relevant experience and ONC or equivalent required. Salary £2930-£3276 inclusive. Further information and application forms from Mr. M. E. Cane (3ET), Department of Electronics, Chelsea College, Pulton Place, London, SW6 5PR.
7701

CHELSEA COLLEGE
University of London

ELECTRONICS TECHNICIANS GRADE 5

Vacancies exist in our Electronics Workshop and Electronics Research Laboratory. Interesting prototype design and development plus servicing or experimental work. Relevant experience essential. Salary in the range £3377-£3856 per annum (inclusive of London Allowance and Supplements). **Application forms and further details frm Mr. M. E. Cane (5E), Department of Electronics, Chelsea College, Pulton Place, London SW6 5PR.** (7710)

THE UNIVERSITY OF LEEDS. Electronics Technician (Grade 5) required, in School of Chemistry Electronics Workshop, to work on the construction and maintenance of electronic equipment. The applicant must be conversant with digital and analogue intergrated circuits, printed circuit techniques and electromechanical equipment. Preference will be given to the applicants who have substantial knowledge of, and service experience on, multichannel analysers. Qualification — HNC or equivalent and candidates must have a minimum of 7 years appropriate experience. Salary on a scale £2,889-£3,367 p.a. Applications in writing, giving details of age, experience, qualifications and state of health to Mr. G. Spink, School of Chemistry, The University, Leeds LS2 9JT. (7720

VERY EXPERIENCED Electronic Engineer for electronic, keyboard and amplification services. Salary negotiable. Phone Maurice Placyquet 01-749 3232. (7614

SENIOR ELECTRONICS ENGINEER for Department of Space Research, programme of satellite and related experiments, in particular for Spacelab II. At least 7 years experience of designing analogue and digital circuitry required, familiarity with high reliability applications, computer interfacing techniques and microprocessors an advtantage. HNC minimum qualification necessary. Salary scale £2889-£3367 p.a. (under review) apply Assistant Secretary, Personnel Office, University of Birmingham, P.O. Box 363, Birmingham B15 2TT Ref 105/C/287. (7678

ELECTRONICS TECHNICIAN (Grade 5) required in Department of Psychology, University of Reading. Final C.G. Electronic Servicing or equivalent qualification desirable. Salary in scale £2889-£3367 pa (under review). Apply with full details and names of 2 referees, quoting Ref. T.W.W. 46A. to Assistant Bursar (Personnel), University of Reading, Whiteknights, Reading, Berks, RG6 2AH. (7672

Directorate of Radio Technology

Telecommunications Officers

. . . to be responsible for the study of radio propagation matters over the whole of the radio frequency spectrum above 10k Hz and for the forward planning, management and regulation of frequency bands allocated to broadcasting, fixed, maritime and land mobile, and space services.

Duties also include: preparing specifications and type-approval of equipment for fixed and mobile services; application of computer techniques to frequency assignment problems; development of equipment for the location and suppression of radio interference; technical advice on all aspects of licensing of radio services and advice in connection with the international radio monitoring service.

The vacancies are in Central London and Stanmore, Middlesex

Candidates (aged at least 25) must have ONC in Engineering (with a pass in Electrical Engineering 'A') or in Applied Physics **or** an equivalent qualification. In addition, they must have had at least 7 years' experience of skilled work on radio, radar or other electronic work.

Salary in London starts at £4765 and rises to £5200; £190 less at Stanmore. Good promotion prospects. Non-contributory pension scheme.

For further details and an application form (to be returned by 8 December 1977) write to Civil Service Commission, Alencon Link, Basingstoke, Hants RG21 1JB, or telephone Basingstoke (0256) 68551 (answering service operates outside office hours). **Please quote T/9647.**

HOME OFFICE

Research Officer

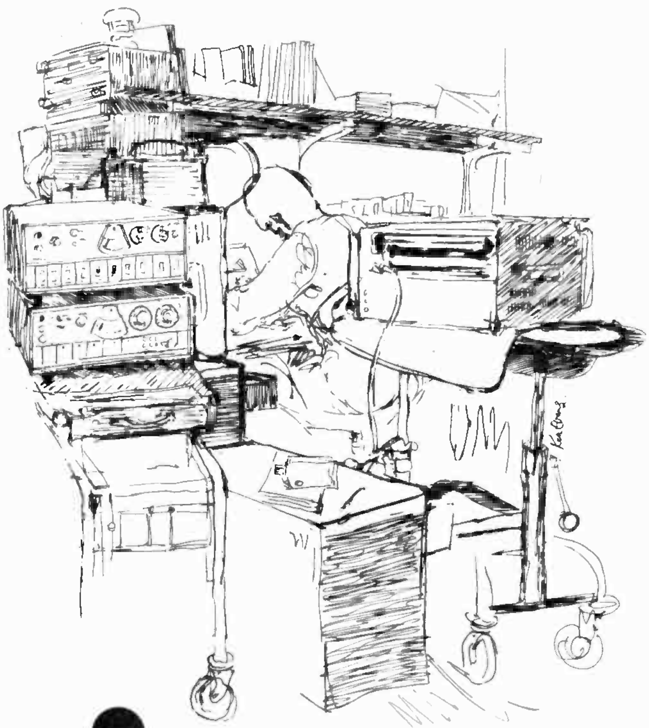
Ideal opportunity occurs for a suitably qualified person to undertake interesting and varied projects and investigatory work in the field of electromagnetic interference.
The ideal applicant, male or female, will be aged 22-40 with graduate or HNC qualification, experience of Radio frequency measuring techniques — measurement and calibration.
ERA is an independent engineering organisation specialising in the profitable application of electrotechnology within industry, commerce and the public sector.
Competitive conditions of employment amid pleasant rural surroundings offer attractive career prospects.
Contact the Personnel Manager ERA Ltd., Cleeve Road, Leatherhead Surrey. Leatherhead 74151
7662

ERA

ELECTRONICS TECHNICIAN (Grade 6) required by Physiology Dept for the design and construction of biophysical instrumentation to be used in muscle research. Experience in analog, digital and computer interfacing circuitry desirable. This is a grant supported post. Salary in range £3,802-£4,435 inc. of London Weighting. Application form from Personnel Officer (Technical Staff FF15) University College London, Gower St., London WC1E 6BT. (7692

ELECTRONIC TECHNICIAN Grade 5 required in the Chemical and Biochemical Engineering Department for the electronic workshop. Good knowledge of fault-finding and servicing standard electronic instruments required, together with the ability to work on prototype circuits. Salary in range £3,377 to £3,856 including London Weighting. Application form and further details from Personnel Officer (Technical Staff EB8), University College, London, Gower Street, WC1E 6BT. (7716

Marconi Instruments



ELECTRONIC TECHNICIANS

Opportunities for the experienced and sometimes inexperienced in St. Albans and Luton.
Work situations range from fault finding on PCB's and components, to batch product testing of equipment that utilise very advanced techniques including microprocessors and the repair/calibration of all manner and types of test instruments.
Attractive salaries and, where appropriate, relocation are offered for the right candidates.
Further information may be obtained in confidence from John Prodger
Marconi Instruments Limited,
Longacres, St. Albans, Herts. tel: St. Albans, 59292

A GEC-MARCONI ELECTRONICS COMPANY

7702

mi

DATEK SYSTEMS LTD.

A leading Company in the Phototypesetting Industry requires a:

SENIOR TEST ENGINEER

The position requires a man with several years' experience of digital systems with the ability to fault-find 74 series T.T.L. to chip level. A background in the data prep or V.D.U. market would be most appropriate and an academic level of at least H.N.C. would be expected.

The job involves some field service support in the U.K. and overseas. Salary up to £5,000 per annum.

JUNIOR TEST ENGINEER

This position requires a young engineer with a degree or Dip. Tech. in Electrical Engineering with an electronics bias.

Some experience in T.T.L. logic or microprocessors would be useful. Salary about £3,000 per annum.

The Company offers four weeks' holiday and sickness and pension scheme.

Phone or write for application form to:

Miss L. Bux
DATEK SYSTEMS LTD.
849 Harrow Road, Wembley, Middx.
Telephone: 01-904 0061

(7732)

ITN

SENIOR ENGINEERS £5712 p.a.

A senior television engineer is required to augment the existing shift maintenance team which is responsible for the day-to-day electronic maintenance of a wide range of broadcasting equipment. The duties would include the maintenance of such items as Vision Mixers and Routing Switchers, Digital Standards Converters, Oracle Computers, Character Generators and many other devices. Applicant should preferably possess an HNC or equivalent and several years of appropriate experience. Reference Number 8211.

A further vacancy exists in the electronic development section which has a five-day week work pattern. A variety of projects using latest technology, are already under way and for the right person an interesting future is assured. Applicants for the post should possess academic qualifications to HNC standard plus a minimum of four years' appropriate development experience. Reference Number 3213.

Application forms are available from Independent Television News Ltd., Personnel Office on 01-637 3144. Please quote the appropriate reference number. The closing date for these vacancies is three weeks after publication.

7704

ARTICLES FOR SALE

THE TTL DATA BOOK FOR DESIGN ENGINEERS

By Texas Instruments

PRICE: £5.50

RADIO, TV & AUDIO TECHNICAL REFERENCE BOOK by S. W. Amos. Price **£24.70.**

MICROPROCESSOR / MICROPROGRAMMING HANDBOOK by B. Ward. Price **£4.00.**

WORLD RADIO TV HANDBOOK. J. M. Frost. Price **£5.50.**

BUILD YOUR OWN WORKING ROBOT by D. L. Heiserman. Price **£3.70.**

THE RADIO AMATEUR'S HANDBOOK 1977 by A.R.R.L. Price **£6.60.**

THE MEMORY & MICROPROCESSOR DATA BOOK FOR DESIGN ENGINEERS by Texas. Price **£3.40.**

TOWERS' INTERNATIONAL TRANSISTOR SELECTOR by T. D. Towers 1977. Price **£5.00.**

SOUND RECORDING PRACTICE by Borowick, J. Price **£16.60.**

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INVERTERS

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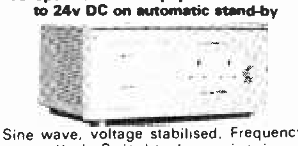

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7675

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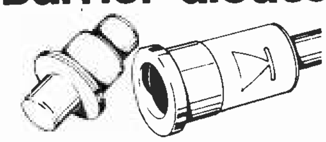

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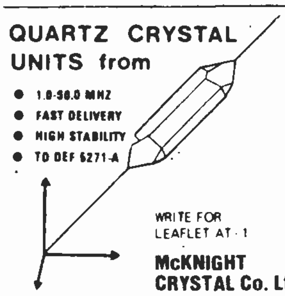

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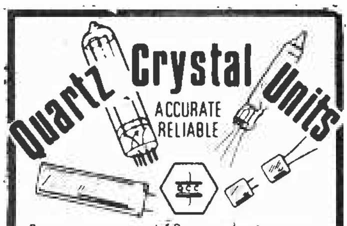

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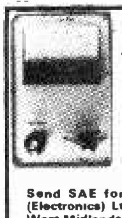

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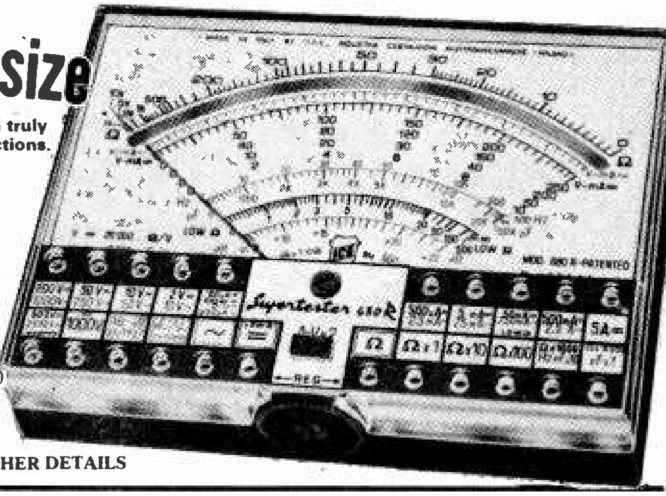

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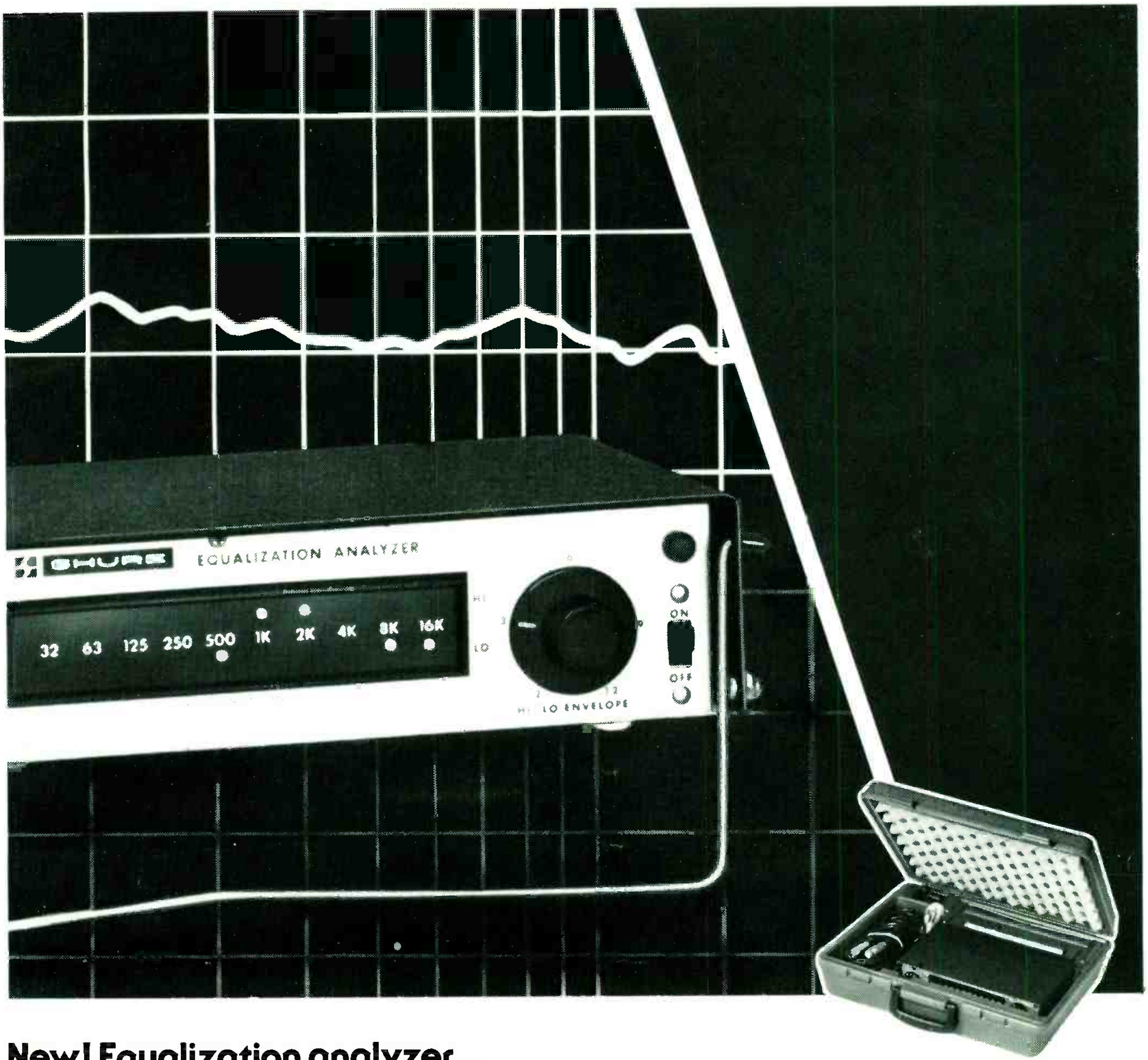

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