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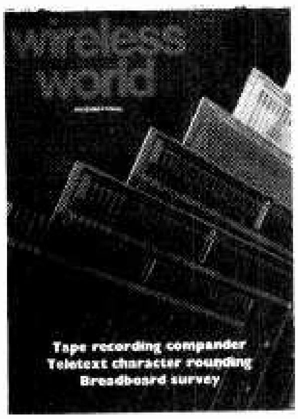
NOVEMBER 1978 40p

Tape recording compander
Teletext character rounding
Breadboard survey



Front cover shows various stages in the production of a printed circuit board at Exacta Circuits Ltd. Photographer Paul Brierley.

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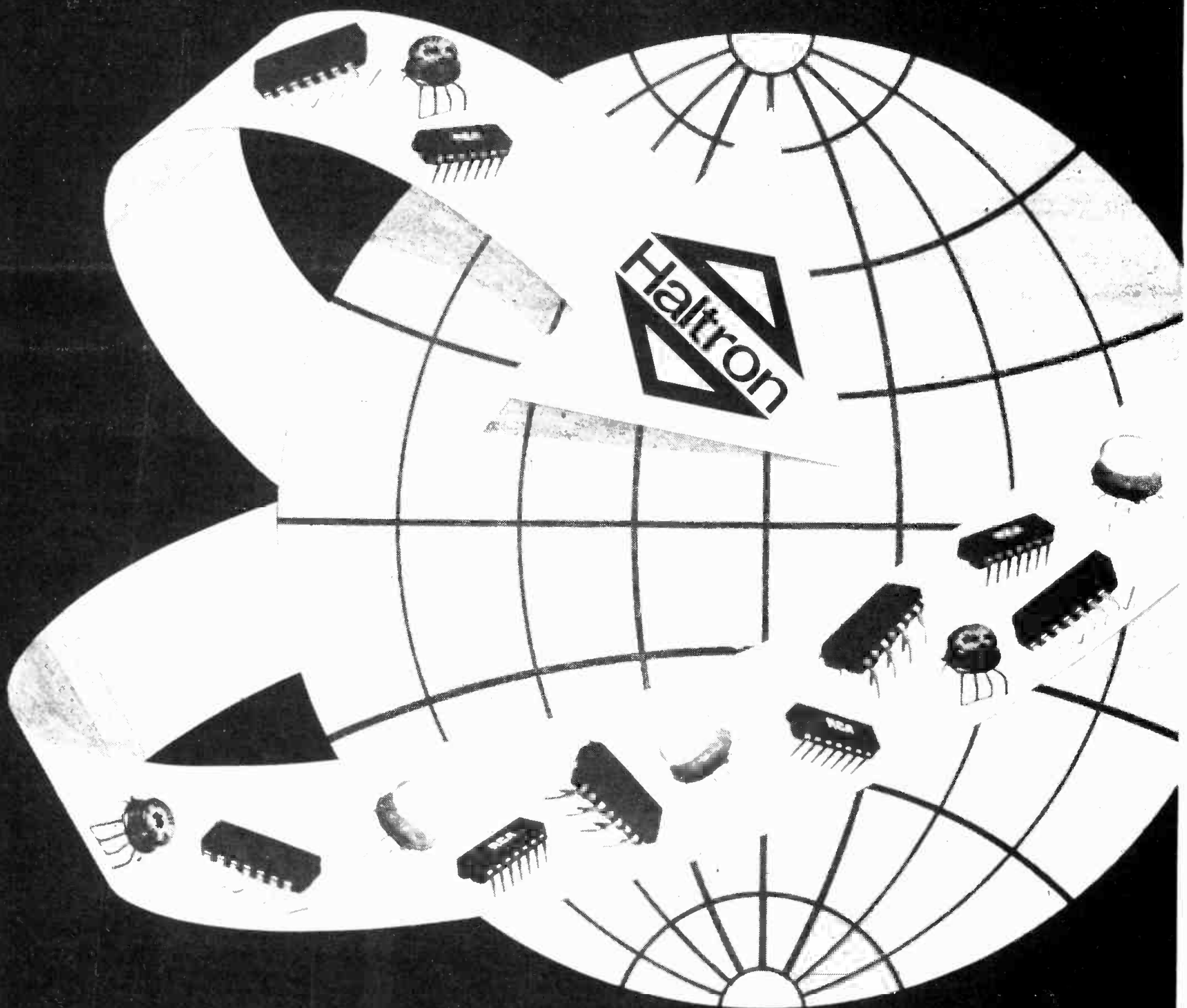
NOVEMBER 1978 vol 84 No 1515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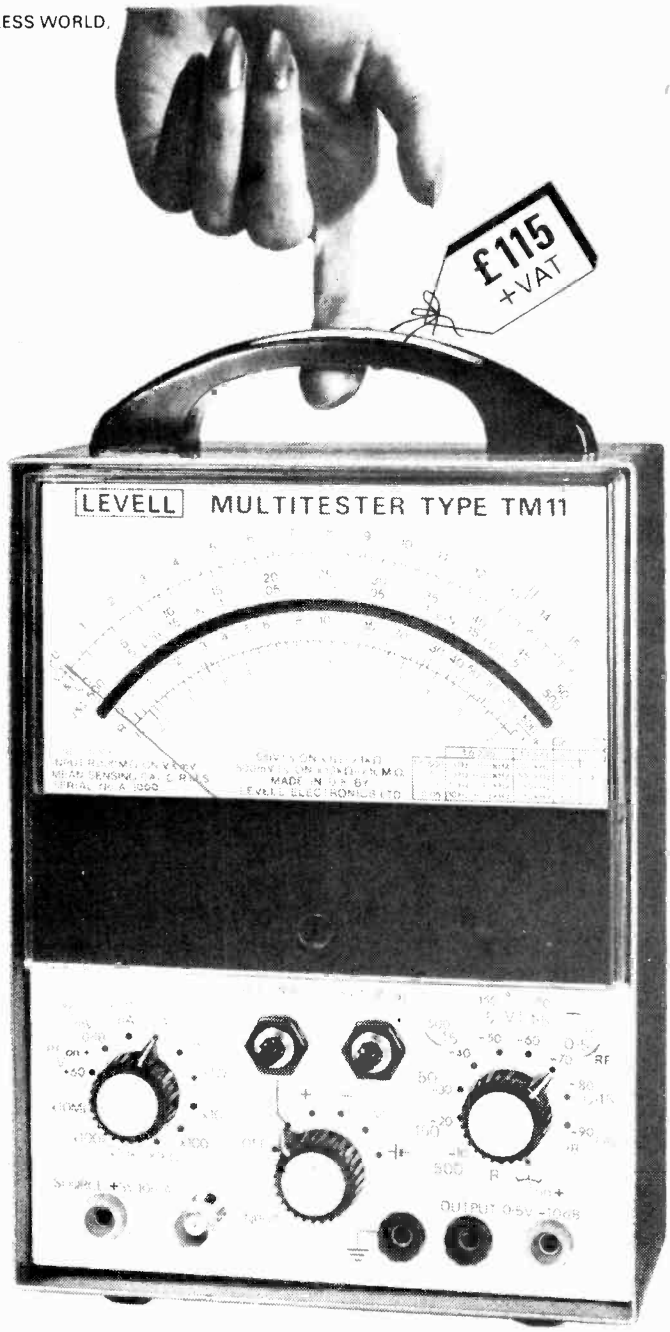

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120 BASIC RANGES

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* Selectable continuous, average or single component measurements
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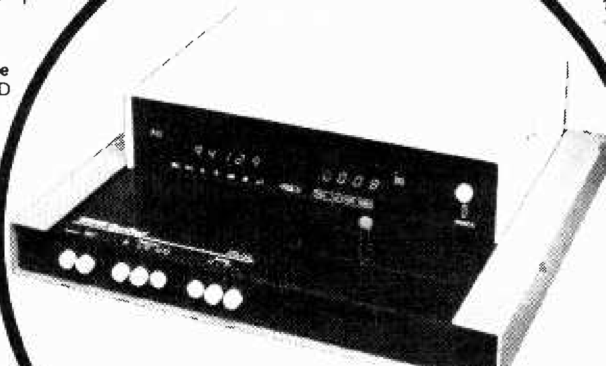
* **Five**-digit display for L and C
* **Four**-digit display for Q,D,R and G
* Optional Kelvin test fixture tests radial and axial lead components



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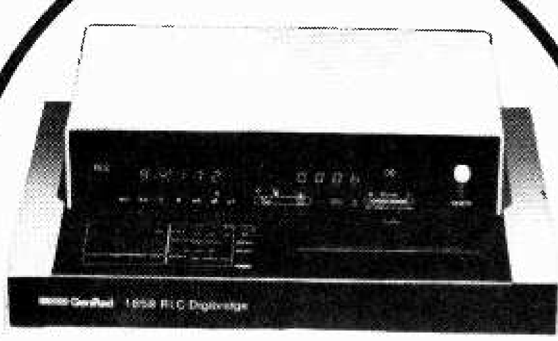

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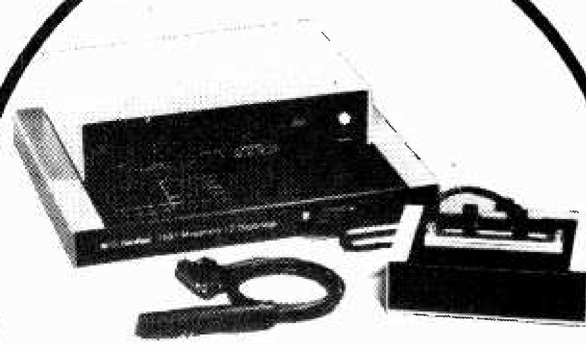

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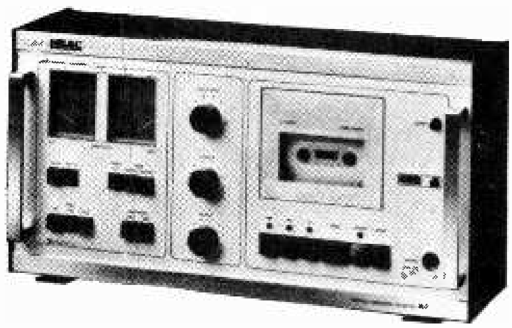

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Incorporating a 3-motor mechanism, controlled by a full solid state logic system actuated by ultra light touch buttons, this is the machine used by top recording studios and broadcasting stations, for quality cassette copies and for in - cassette duplication masters.

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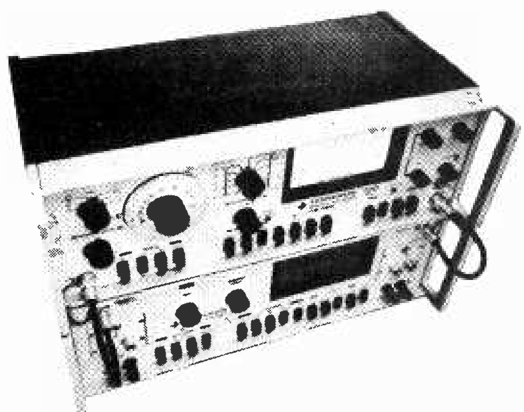
A transportable tape recorder of unrivalled facilities; taking all spool sizes up to 27 cm, and providing three speeds, plus positive action push buttons in association with logic circuits ... for fast, safe tape handling under all conditions.



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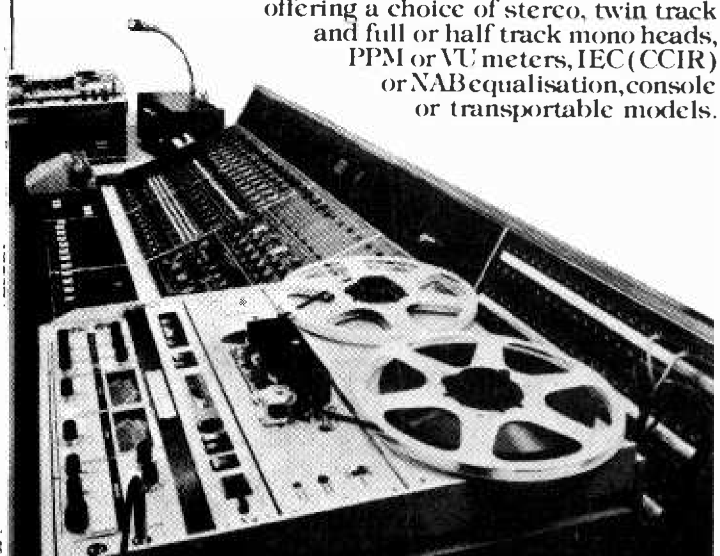
A professional studio tape recorder logic controlled for superb tape handling characteristics, offering a choice of stereo, twin track and full or half track mono heads, PPM or VU meters, IEC (CCIR) or NAB equalisation, console or transportable models.



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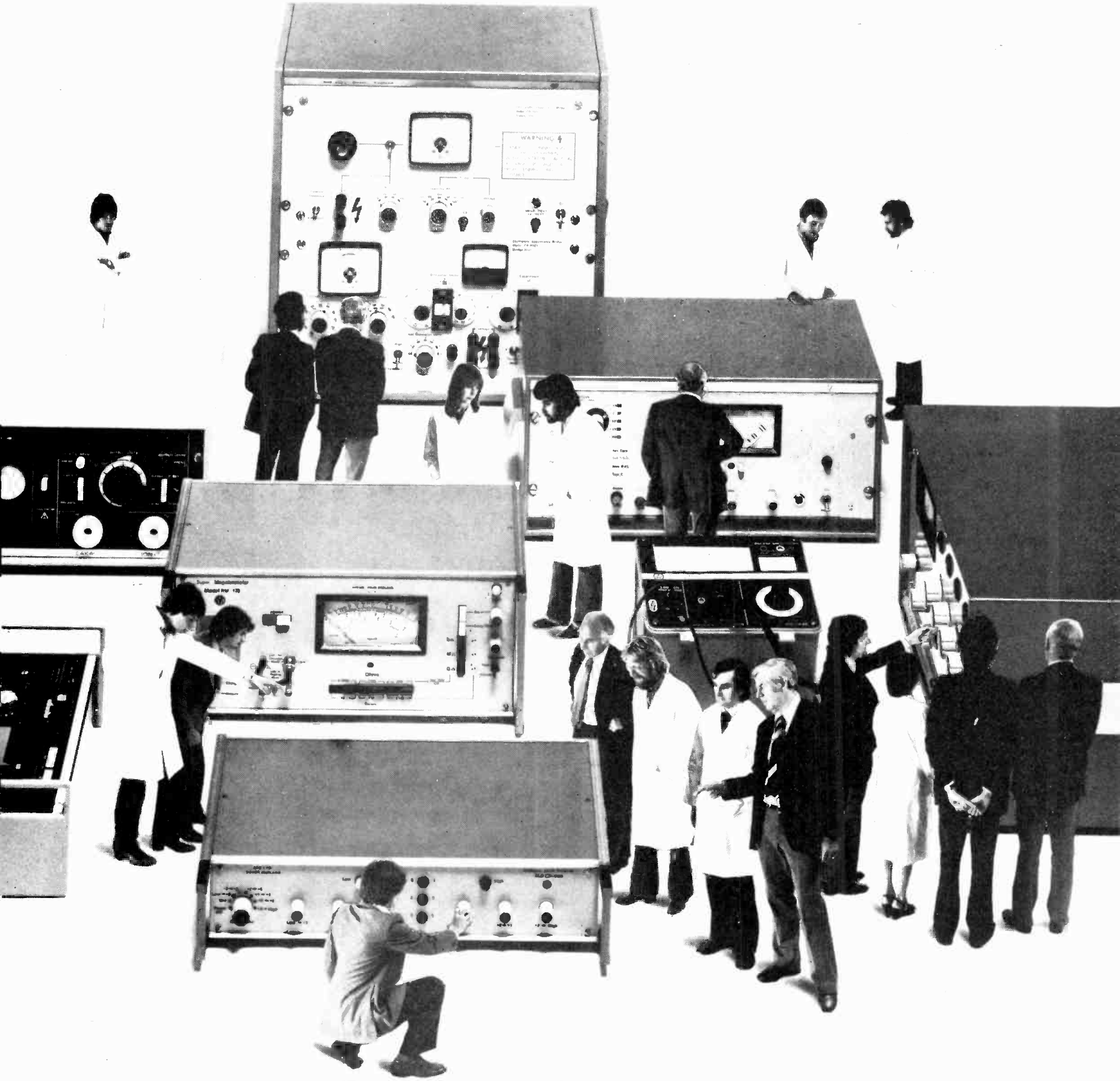

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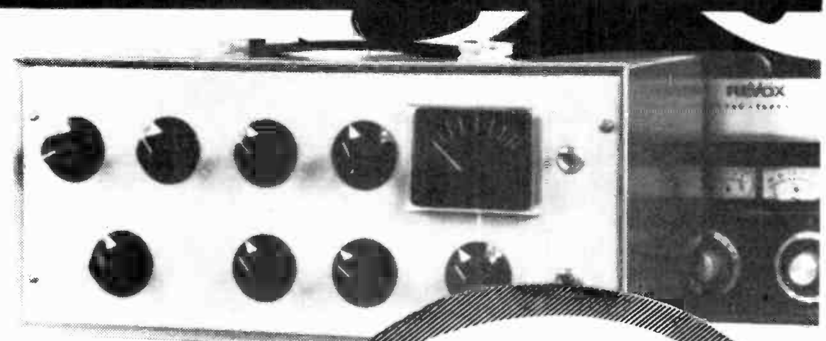

Soundex

1300 4-CHANNEL MICROPHONE LINE MIXER

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One of the Bulgin Group of Companies
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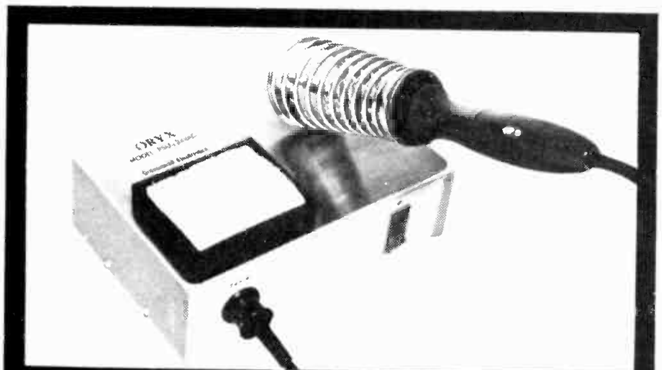

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a new compact self-contained 24 volt power supply unit for ORYX temperature controlled soldering irons.

Styled in tough plastic, the ORYX PSU 24 is a smart new supply unit that is self-contained and small enough for the smallest of benches. Designed to meet BSS 3456 the ORYX has all the features you need – and more:- ON/OFF illuminated rocker switch; 3 pin non-reversible socket supplying 24 volts; a BSS 3535 transformer; an outside primary fuse; 1.5 metre white cable to BSS 6500 and fuse protection for transformer secondary wiring.

A unique feature is the facility to modify a 3 wire power system to a 2 wire fully isolated unit and vice versa

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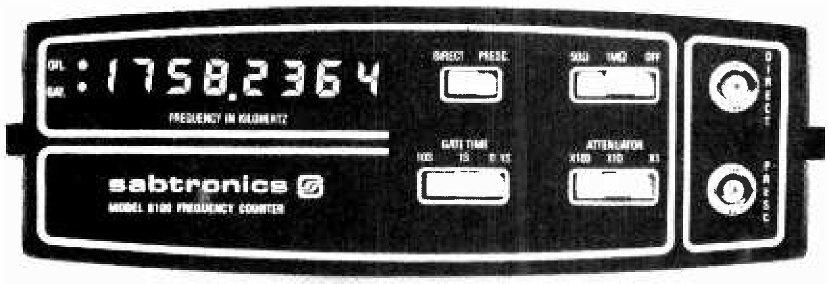
We've made the impossible AGAIN. A superior frequency counter Kit for only £69.95



Now you can forget about price/performance trade-offs when you select a frequency counter. In Sabtronics' Model 8100 kit you get all the characteristics of a much higher-priced counter for only £ 69.95.

This frequency counter, employing LSI technology, has the performance and input characteristics you demand: guaranteed frequency range of 20 Hz to 100 MHz; selectable hi/lo impedance; superior sensitivity; selectable resolution and selectable attenuation. Plus an accurate time base with excellent stability. An 8-digit LED display features floating decimal point, leading zero suppression and overflow indicator. You would expect to find all these features only on high-priced instruments – or from Sabtronics' advanced digital technology.

BRIEF SPECIFICATIONS:

Frequency Range: 20 Hz to 100 MHz guaranteed, (10Hz to 120 MHz typical) – Sensitivity: 25 mV RMS, 20 Hz to 70 MHz (20 mV typical); 45 mV RMS, 70 MHz to 120 MHz (30 mV typical) – Selectable Impedance: 1MΩ/25 pF or 50Ω – Attenuation: X1, X10 or X100 – Accuracy: ± 1 Hz plus time base accuracy – Aging Rate: ± 5 ppm/yr – Temperature Stability: ± 10 ppm, 0° to 50°C – Resolution: 0.1 Hz, 1 Hz, 10 Hz selectable – Display: 8-digit LED, floating DP, overflow indicator – Overload Protection – Power Requirement: 9-15 VDC.

Also available assembled at £ 84.95.

Optional prescaler will be available from around January 1979.

Uncompromising performance. Incredible price. A professional 3½ digit DMM Kit for less than £50.00

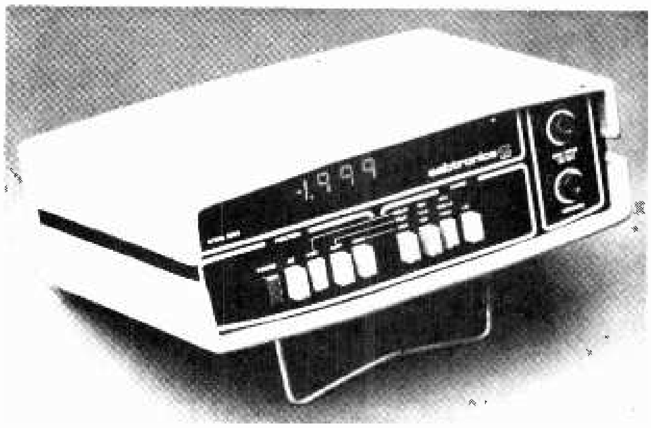
Incredible? True! Professionals and hobbyists alike are believers in this Sabtronics 2000, the only portable/bench DMM which offers such uncompromising performance at the astonishingly low price of £ 49.95.

Uncompromising performance you'd expect only from a specialist in digital technology such as Sabtronics: Basic DCV accuracy of 0.1% ± 1 digit; 5 functions giving 28 ranges; readings to ± 1999 with 100% overrange; over-range indication; input overload protection; automatic polarity.

The low price of £ 49.95? Simple: The Model 2000 is all solid-state, incorporating a single LSI circuit and high-quality components. You assemble it yourself, using our clear, easy-to-follow, step-by-step assembly manual. Kit is complete, including a high-impact case.

Now you too can have it! A professional-quality 3½ digit Sabtronics Model 2000 DMM kit for only £ 49.95. If you don't have one in your lab, use the coupon below to order NOW.

Easy to follow caliberation procedure provided in the assembly manual.



BRIEF SPECIFICATIONS:

DC volts in 5 ranges: 100 μV to 1 kV – AC volts in 5 ranges: 100 μV to 1 kV – DC current in 6 ranges: 100 nA to 2A – AC current in 6 ranges: 100 nA to 2A – Resistance: 0.1Ω to 20 MΩ in 6 ranges – AC frequency response: 40 Hz to 50 kHz – Display: 0.36" (9,1 mm) 7-segment LED – Input impedance: 10 MΩ – Size: 8" W × 6.5" D × 3" H (203 × 165 × 76 mm) – Power requirement: 4 "C" cells (not included).

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The price listed is for readers in U.K. only. Since export orders are exempt from VAT you may send your orders directly to

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Winkelriedstrasse 35
CH-6003 Luzern/Switzerland

Price:
£ 69.95 + £ 6.50 for shipping and handling for Model 8100
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address: ______

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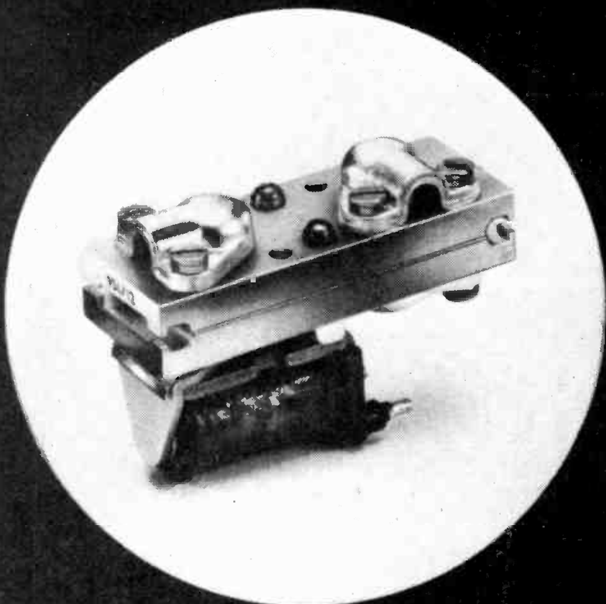
Coaxial Relay



for aerial switching

Pye Electro-Devices' Series 951 coaxial relay is designed for high speed switching of signals up to 450 MHz. It can be used to advantage in applications requiring exceptionally low inter-contact capacitance.

Multi-position clamps enable UR43 type coaxial cables to be connected directly to the relay body. Connection is simple and efficient. And there's no need for coaxial plugs and sockets. Consequently the relay is extremely compact, and weighs less than 100g.

The contacts are rated at 1A or 50W maximum, and coils are available for operation at up to 100V d.c

Contact us today for further information.

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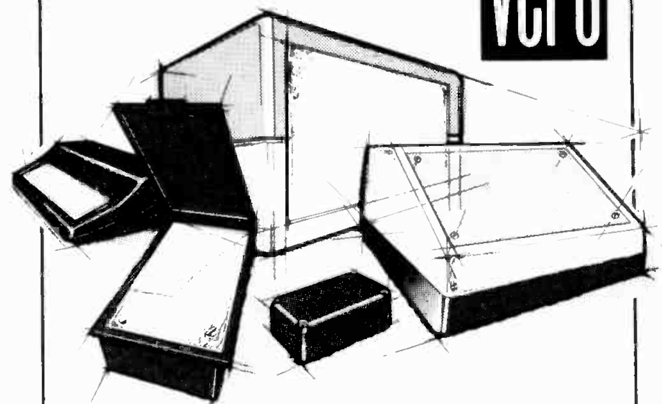

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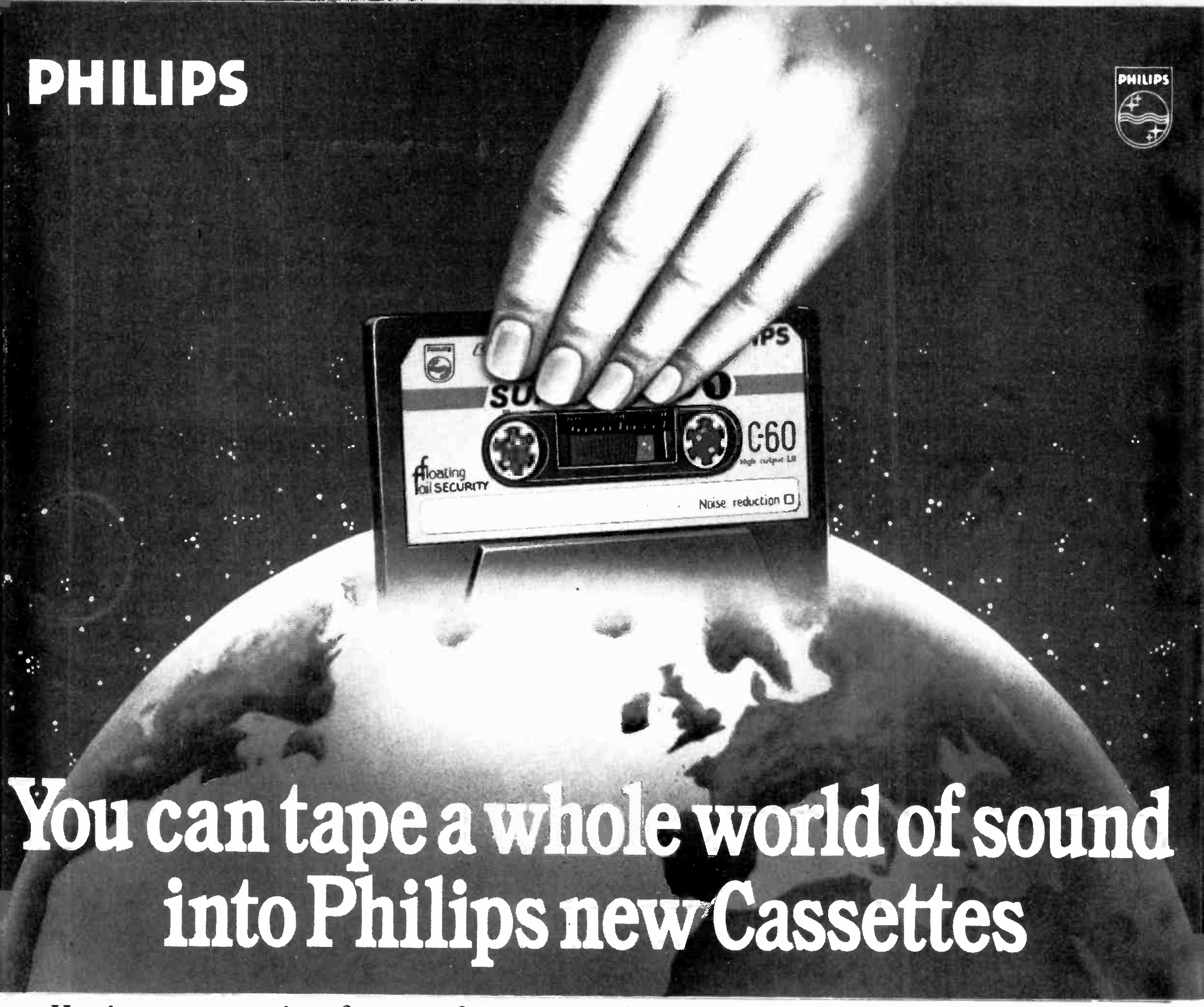

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PHILIPS

Simply years ahead

: universal Cassette for all-round . A low noise tape with balanced put and response. Suitable for use h most machines.

A Cassette specially developed for applications where high quality is required. The tape formulation guarantees high output and especially low distortion at low and middle frequencies.

For use with decks designed to give optimum performance using a higher bias tape. Super Ferro 1 works well with most modern machines, particularly those made in Japan. It gives well balanced reproduction and a higher output than normal Ferro.

Specially developed for hi-fi music, with particularly quiet background noise and brilliant high-frequency reproduction. The chromium dioxide coating gives a very smooth surface, ensuring good tape head contact.

For the most critical hi-fi fan, combining the excellent low-frequency reproduction of high density tape with the high frequency brilliance of chromium tape.

Philips new Cassettes. For the whole world of sound.

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BIMENCLOSURES

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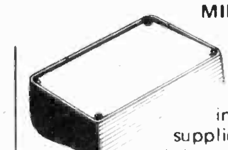
Red, Grey or Orange 14swg Aluminium removable top and bottom covers. 18 swg black mild steel chassis with fixing support brackets.

BIM 3000 (250x167.5x68.5mm) £14.58

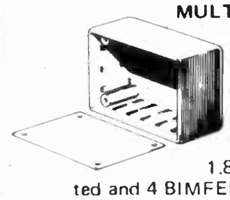
MINI DESK BIMCONSOLES



Orange, Blue, Black or Grey ABS body incorporates 1.8mm pcb guides, stand-off bosses in base with 4 BIMFEET supplied. 1mm Grey Aluminium panel sits recessed with fixing screws into integral brass bushes.

BIM 1005 (161 x 96 x 58mm) £2.18
BIM 1006 (215 x 130 x 75mm) £3.05

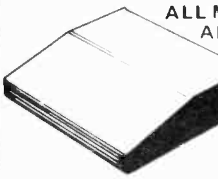
MULTI PURPOSE BIMBOXES



Orange, Blue, Black or Grey ABS with 1mm Grey Aluminium recessed front cover held by screws into integral brass bushes. 1.8mm pcb guides incorporated and 4 BIMFEET supplied.

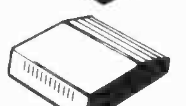
BIM 4003 (85x56x28.5mm) £1.18
BIM 4004 (111x71x41.5mm) £1.62
BIM 4005 (161x96x52.5mm) £2.19

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 panel for excellent cooling.

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



15° Sloping Panel	30° Sloping Panel	
BIM7151 (102x140x51[28] mm)	BIM7301 (102x140x76[28] mm)	£ 9.87
BIM7152 (165x140x51[28] mm)	BIM7302 (165x140x76[28] mm)	£10.86
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BIM7155 (254x211x76[33] mm)	BIM7305 (254x183x102[28] mm)	£14.47
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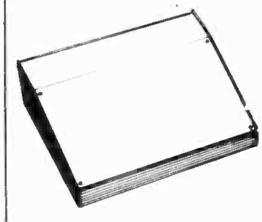
BIM7157 (356x211x76[33] mm)	BIM7307 (356x183x102[28] mm)	£16.55
BIM7158 (356x287x76[33] mm)	BIM7308 (356x259x102[28] mm)	£17.43

LOW PROFILE BIMCONSOLES



Orange, Blue, Black or Grey ABS body has ventilation slots as well as 1.8mm pcb guides and stand-off bosses in base. Double angle recessed front panel with 4 fixing screws into integral brass bushes. 4 BIMFEET supplied.

BIM 6005 (143 x 105 x 55.5 [31.5] mm) £2.37
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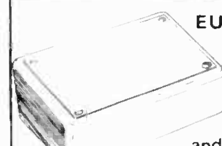
ABS & DIECAST BIMBOXES

6 sizes in ABS or Diecast Aluminium. ABS moulded in Orange, Blue, Black or Grey. Diecast Aluminium in Grey Hammertone or Natural. All boxes incorporate 1.8mm pcb guides, stand-off supports in base and have close fitting flanged lids held by screws into integral brass bushes (ABS) or tapped holes (Diecast).

	ABS		Diecast	Hammertone	Natural
(50x60x31mm)	N/A		BIM5001/11	TBA	TBA
(100x50x25mm)	BIM2002/12	£0.96	BIM5002/12	£1.46	£1.19
(112x62x31mm)	BIM2003/13	£1.13	BIM5003/13	£1.78	£1.46
(120x65x40mm)	BIM2004/14	£1.35	BIM5004/14	£2.24	£1.82
(150x80x50mm)	BIM2005/15	£1.52	BIM5005/15	£2.84	£2.28
(190x110x60mm)	BIM2006/16	£2.37	BIM5006/16	£3.94	£3.33

Also available in Grey Polystyrene with no slots and self-tapping screws
BIM 2007/17 (112x61x31mm) £1.00

EUROCARD BIMCONSOLES

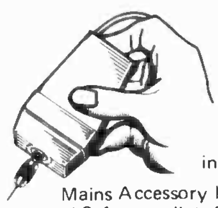


Orange, Blue, Black or Grey ABS body accepts full or ½ size Eurocards, with bosses in the base for direct fixing. 1.8mm wide pcb guides incorporated and 4 BIMFEET supplied. 1mm Grey aluminium lid sits flush with body top and held by 4 screws into integral brass bushes.

BIM 8005 (169x127x70[45] mm) £4.12
BIM 8007 (to be announced shortly)

BIMTOOLS

MAINS BIMDRILLS

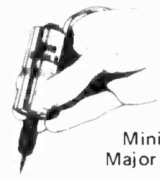


Small, powerful 240V hand drill complete with 2 metres of cable and 2 pin DIN plug. Accepts all tools with 1mm, 2mm or .125" dia. shanks. Drills brass, steel, aluminium and pcb's. Under 250g, off load speed 7500 rpm. Orange ABS, high impact, fully insulated body with spring return on/off switch £10.53

Mains Accessory Kit 1 includes 1mm, 2mm, .125" twist drills, 5 burrs and 2.4mm collet £2.48

Mains Kit 2 includes Mains BIMDRILL as above, 20 assorted drills, mops, burrs, grinding wheels and mounted points, 1mm, 2mm, 2.4mm and .125" collets. Complete in transparent case measuring 230x130x58mm £22.14

12 VOLT BIMDRILLS



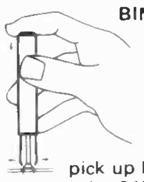
2 small, powerful drills easily hand held or used with lathe/stand adaptor. Integral on/off switch and 1 metre cable.

Mini BIMDRILL with 3 collets up to 2.4mm dia £ 8.10
Major BIMDRILL with 4 collets up to 3mm dia £13.60

Accessory Kits 1 have appropriate drills and collets as above plus 20 assorted tools. Mini Kit 1 – £15.12, Major Kit 1 – £19.44.
Accessory Kits 2 have appropriate drills, collets plus 40 tools and mains 12V dc adaptor. Mini Kit 2 – £34.02, Major Kit 2 – £39.42.

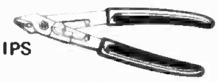
Accessory Kits 3 as appropriate Kits 2 plus stand/lathe unit. Mini Kit 3 – £45.36, Major Kit 3 – £50.76.

BIMDIPS



Rapidly inserts and withdraws any 4-18 pin, .3" pitch DIL package without beding the legs. Adjustable metal jaws for MOS type devices grip the bottom of the leg for minimum strain. Will pick up IC's from a bench, a carrier or a pcb. £13.77.

BIMSNIPS



Precision made side cutters, spring action, ground steel fine pointed blades for intricate work.

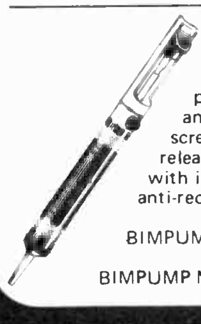
5¼" long £3.34

BIMIRONS

Type 30 General Purpose 27 watt iron with long life, rapid change element, screw on tip, stainless steel shaft and clip on hook. Styled handle with neon. £4.05

Type M3 Precision 17 watt iron, quick change tip, long life element, styled handle with clip on hook £4.43

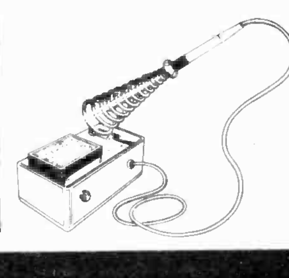
BIMPUMPS



2 all metal desoldering tools provide high suction power and have easily replaceable screw in Teflon tips. Primed and released by thumb operation with in-built safety guard and anti-recoil system.

BIMPUMP Major (180mm long) £7.99
BIMPUMP Minor (150mm long) £6.80

BIMSTATION



Type PSU6 Soldering Iron Station complete with 6V, 6 Watt miniature iron having stainless steel shaft, quick change slide on tip and long life element.

Station contains 240V/6V transformer, neon, coiled iron support and sponge iron tip cleaning pad.

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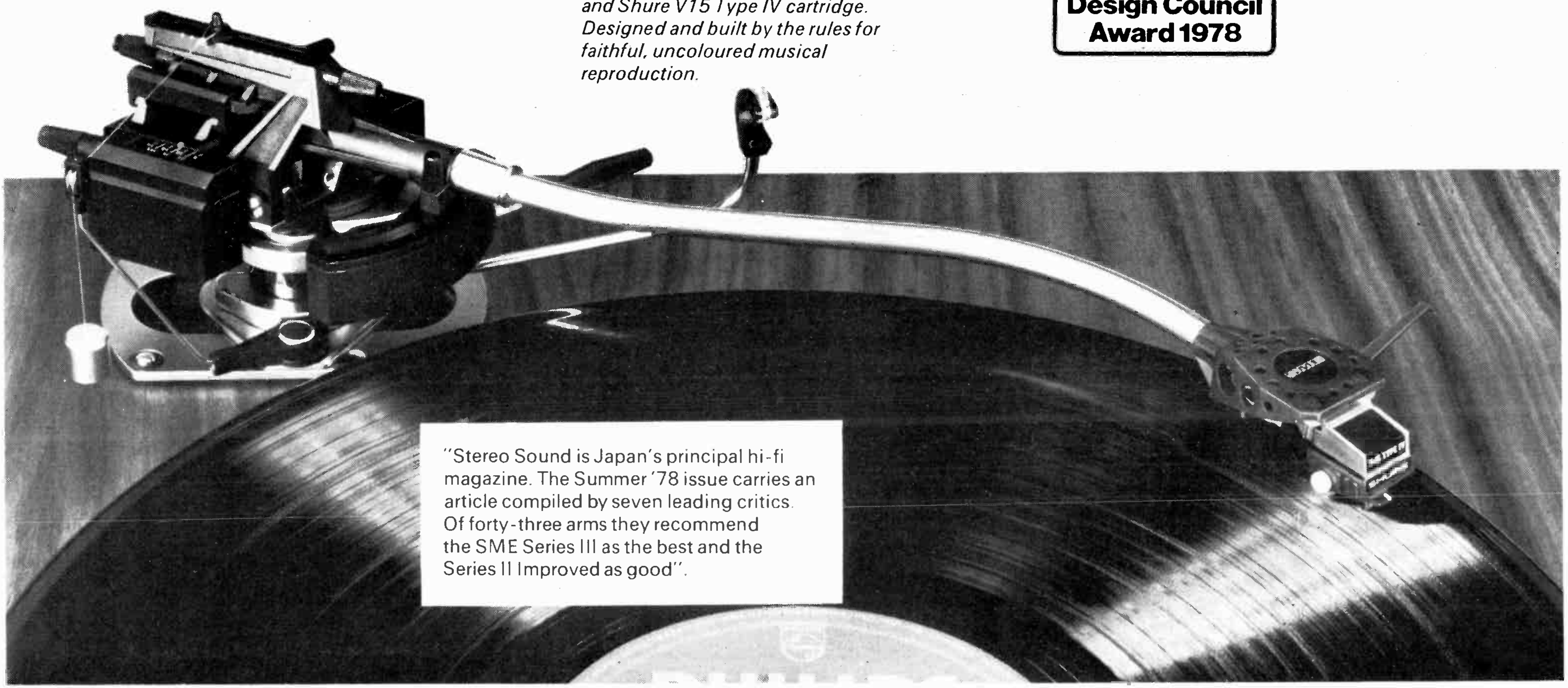

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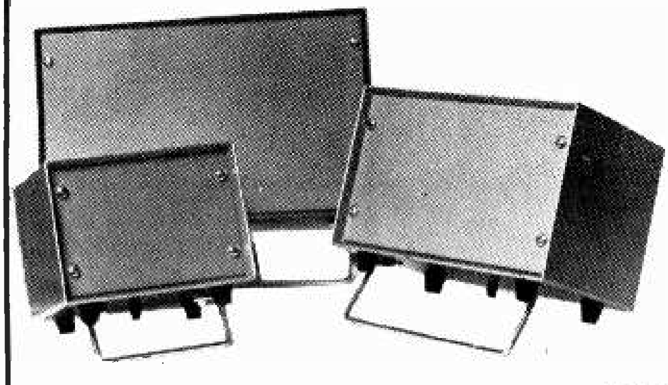
MINICASES



Type	Overall Dimension Width	Height	Depth	Case no vents	Case with vents	Chrome leg
21	6½"	4½"	4½"	—	5.35	1.10
22	8½"	5½"	5½"	—	5.90	1.10
23	10½"	6½"	6½"	—	7.00	1.20
24	12½"	7½"	7½"	—	7.65	1.20
25A	6½"	4½"	4½"	5.10	5.70	1.20
25B	6½"	4½"	6¼"	5.45	6.05	1.20
26A	8¾"	5¾"	6¼"	7.15	7.75	1.20
26B	8¾"	5¾"	8¼"	7.50	8.10	1.20
27A	12¼"	7½"	5½"	7.85	8.55	1.20
27B	12¼"	7½"	8"	8.50	9.20	1.20
28A	14"	10½"	6½"	9.25	9.95	—
28B	14"	10½"	8½"	10.10	10.80	—
29A	10"	4"	6"	6.50	7.10	1.20
29B	10"	4"	8"	6.85	7.45	1.20
30A	12"	5"	6"	7.10	7.80	1.20
30B	12"	5"	8"	7.40	8.10	1.20
31A	14"	6"	6"	7.70	8.40	1.20
31B	14"	6"	8"	8.10	8.80	1.20
61	15½"	7½"	9½"	—	11.75	—
62	17½"	8½"	9½"	—	13.60	—
63	16½"	9½"	9½"	—	13.60	—
64	15½"	7½"	12½"	—	13.60	—
65	17½"	8½"	12½"	—	15.50	—
66	16½"	9½"	12½"	—	15.50	—

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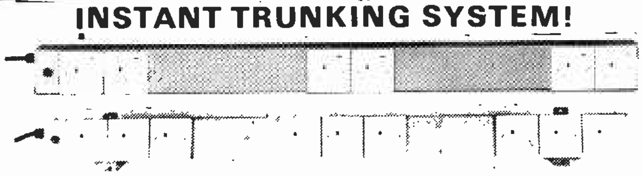

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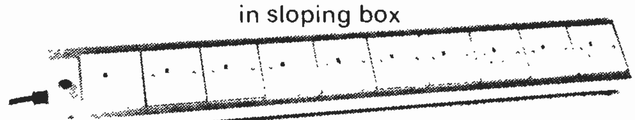

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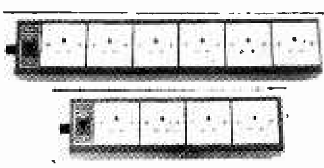

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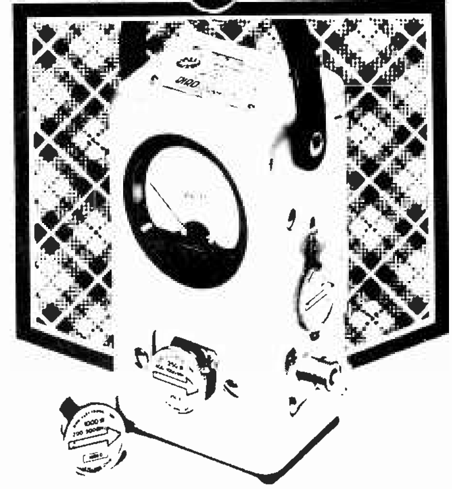

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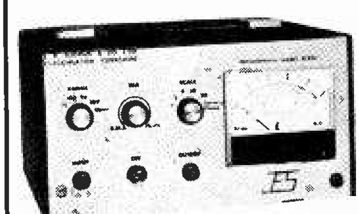

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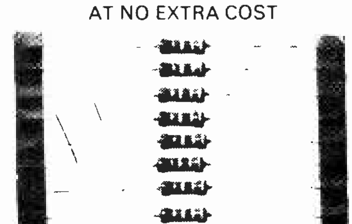

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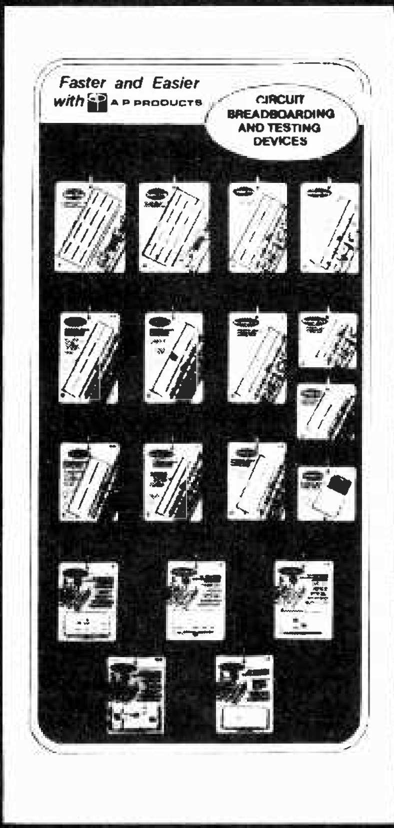

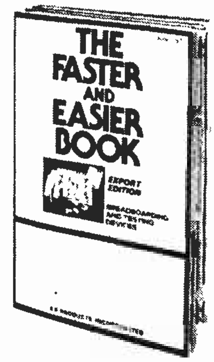

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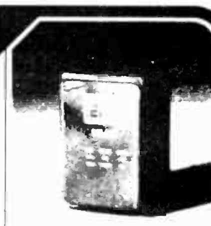
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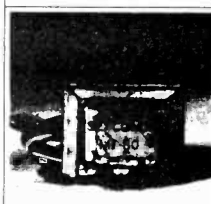
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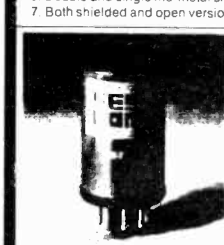
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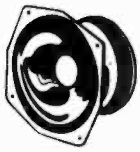

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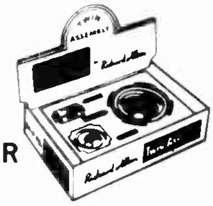
Speaker Kits	£2.50 pair
Mag. design kits	£3.50 pair

SPEAKER KITS



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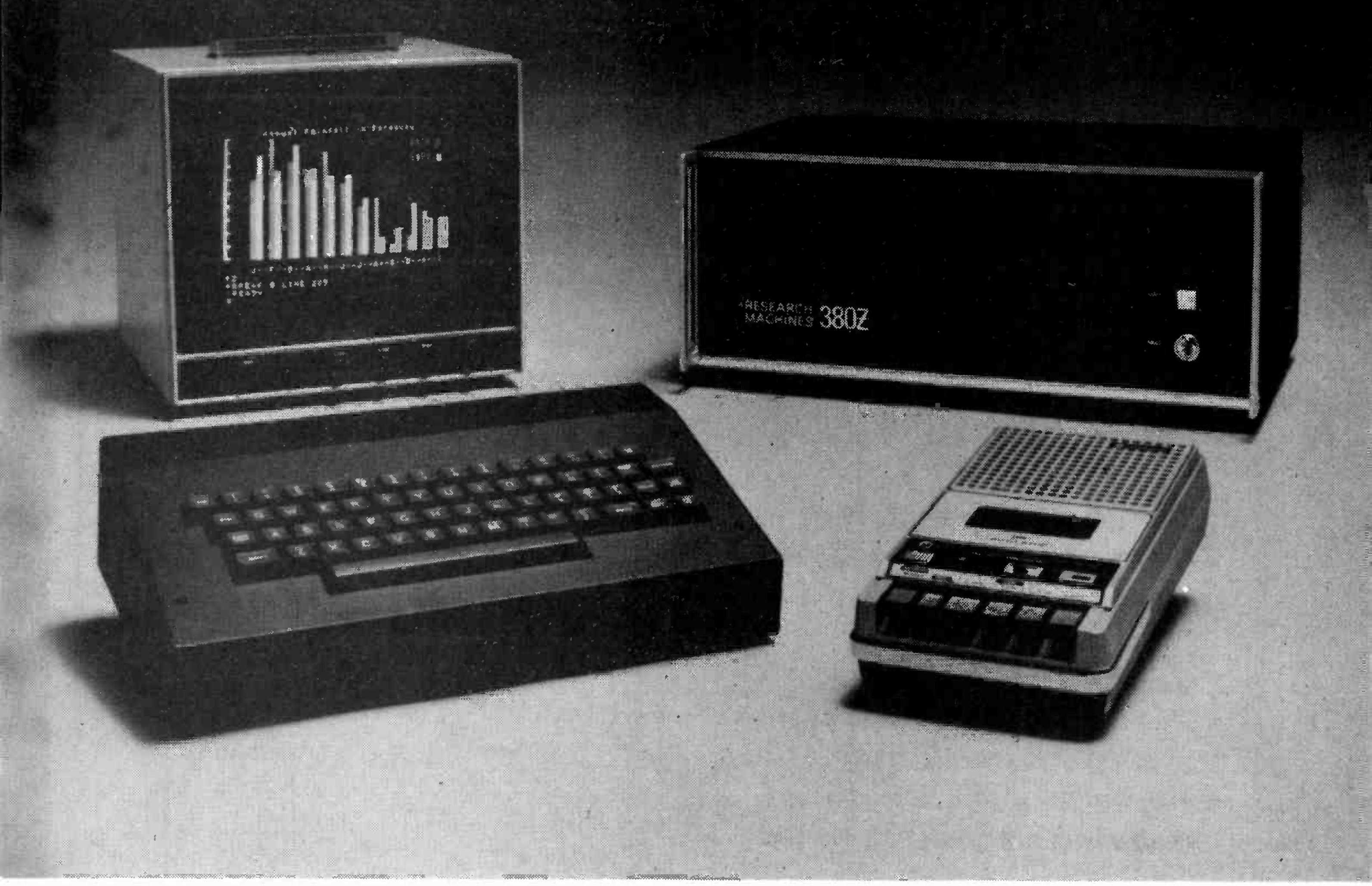

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Microcomputers are extremely good value. The outright purchase price of a 380Z installation with dual mini floppy disk drives, digital I/O and a real-time clock, is about the same as the annual maintenance cost of a typical laboratory minicomputer. It is worth thinking about!

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WHAT OTHER FEATURES SET THE 380Z APART?

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380Z/16K SYSTEM WITH KEYBOARD £965.00

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Versions of BASIC are available with the 380Z which automatically provide controlled cassette data files, allow programs to be loaded from paper tape, mark sense card readers or from a mainframe. A disk BASIC is also available with serial and random access to disk files. Most BASICs are available in erasable ROM which will allow for periodic updating.

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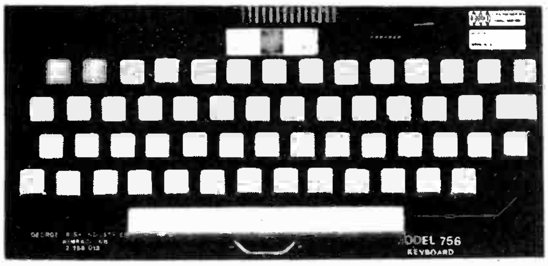

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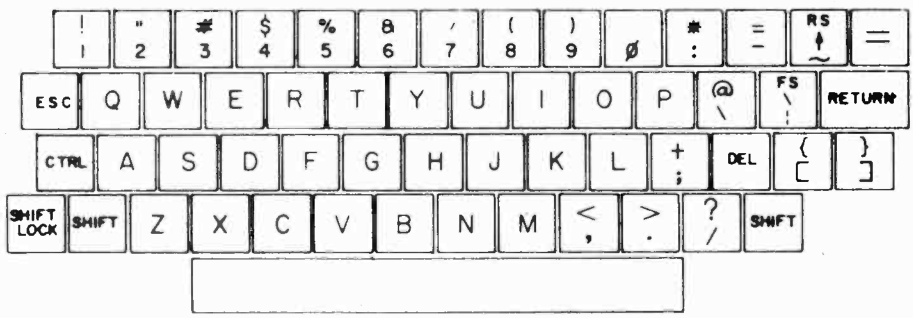

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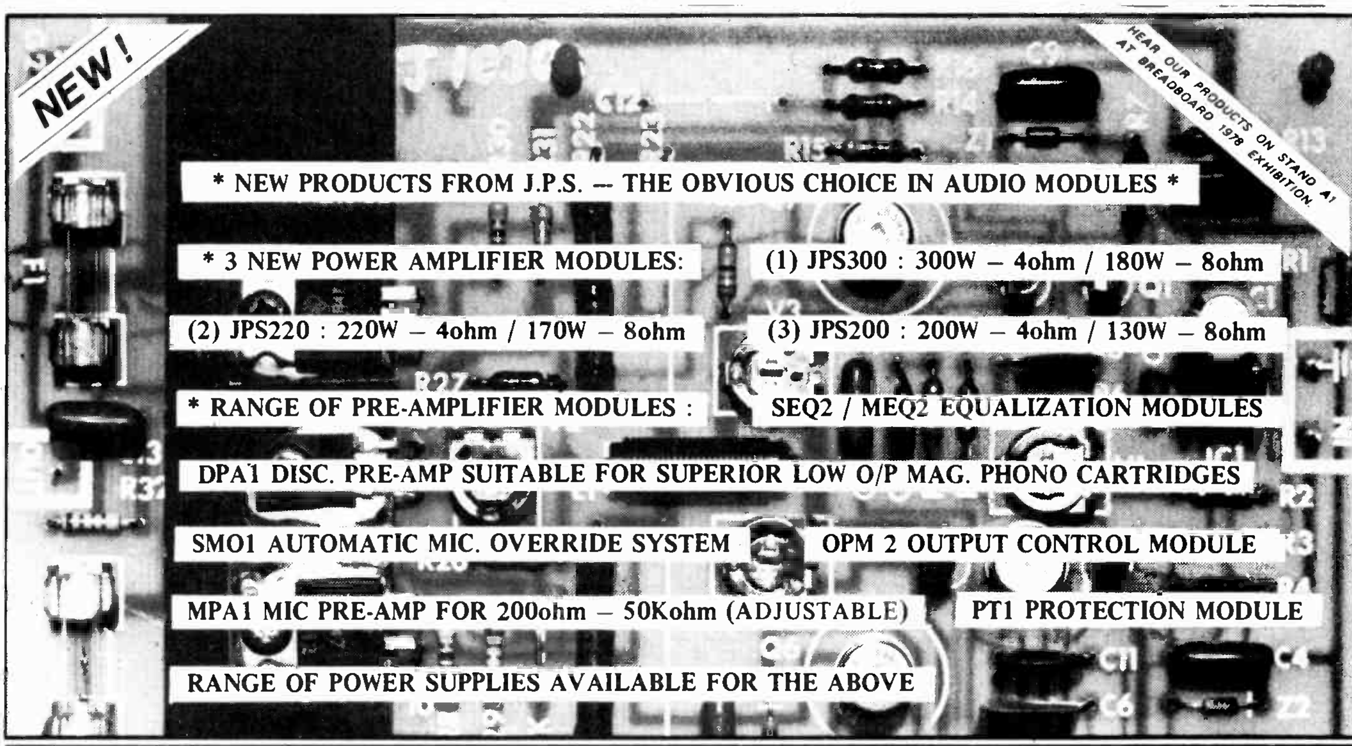

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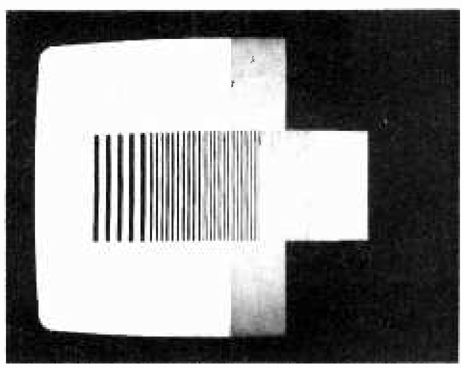

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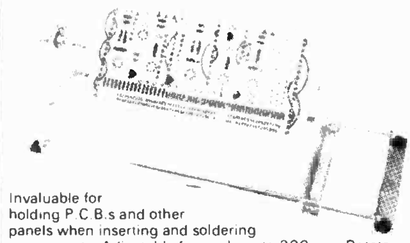

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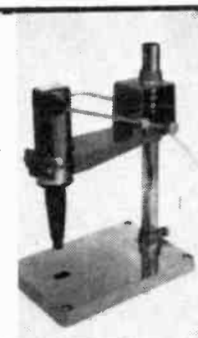

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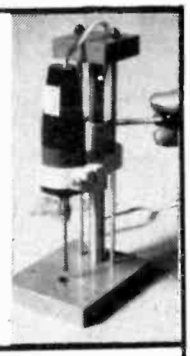

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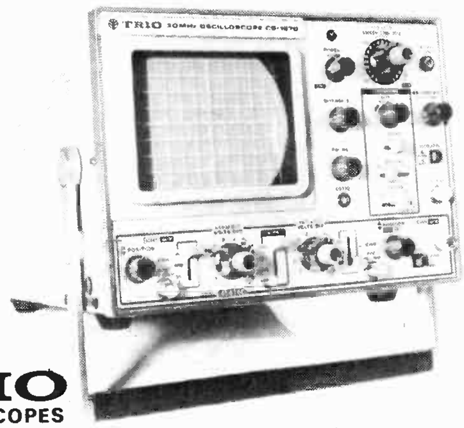

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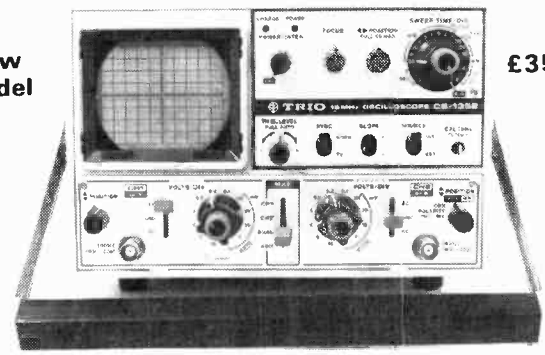

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Overshoot	Better then 3%
Signal delay	160nsec
Polarity	CH2 can be inverted
Sweep time	0.2μs/div to 0.5s/div
Magnifier	x 5
Linearity	Better than 3%
Calibrator	0.5Vpp (1kHz square wave)
Intensity modulation	More than 5Vpp
Phosphor	P31
Power	AC100/120/220/240V 50/60Hz, 25W
Dimensions	W260 x H190 x D375 (mm)
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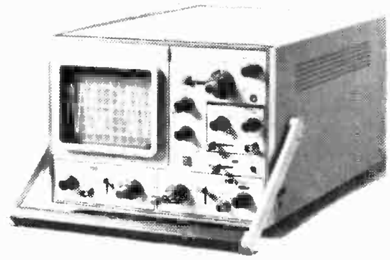

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wireless world

Intelligent machinery

THROUGHOUT 1978 electronics engineers have been looking on with mild amusement at all the excitement occasioned by the discovery of the microprocessor by the politicians, the press and the general public. It's not merely that the engineers have known all about the device and its abilities for some years anyway, but that the m.p.u. has suddenly become the symbol for a whole field of technology. Through it microelectronics has been revealed to all, and this of course just happens to be the dress in which electronic engineering appears at the moment. While the electronics man has more or less absorbed the m.p.u. as just another component to be soldered onto a p.c. board, the rest of the world is rightly concerned about the effects of the associated technical change — the widespread introduction of software — on its life an work. Committees, study groups and other organizations have been set up, and these are simultaneously encouraging the use of m.p.us in new products and manufacturing processes and examining their effects on productivity and employment. What these bodies may not be aware of, but should certainly get on to immediately, is the next stage after programmed logic, namely Artificial Intelligence.

Of course AI, as it is unfortunately abbreviated (the same initials being used for artificial insemination), has been an established field of scientific research for several decades. It could be said to have begun with the late Alan Turing's article "Intelligent machinery" which, perhaps significantly, appeared in 1947 at about the same time as the invention of the transistor. Centres for studying machine intelligence — at Edinburgh University and Stanford Research Institute to name but two — have been set up and, apart from their scientific work relating to such things as the functioning of the central nervous system, have developed robots and other systems which display some of the attributes of animal or human intelligence in the performance of tasks. As distinct from programmed or deterministic machines, they are characterized by having some degree of autonomy or self-organizing ability in the way they perform given tasks or solve problems. The field is vast and defies neat description (as does "intelligence" itself) but it could be roughly divided into the three areas of problem solving, pattern recognition and learning systems. There is a link with adaptive control systems and the dynamic programming methods used to make their searching processes amenable to digital computing.

What is now significant is that some AI self-organizing systems, complicated as they are, may soon leave the laboratory and appear in practical microelectronic form. Two semiconductor manufacturers have voiced their ideas already. In recent speeches, Robert Heikes of Motorola has referred to products "that will have a 'thinking' capability and, as such, will provide a dramatic extension to mankind's basic capabilities" while Tom Lawrence of Intel has said that microprocessors "will evolve to become units of artificial intelligence with adaptive control in the m.p.u. architecture." If, as has been predicted, the semiconductor chip of the 1980s will be capable of integrating over a million components, these pronouncements are well within the bounds of engineering possibility.

Intelligent machines, as distinct from the automatic kind that are merely deterministic, are certainly on the way. Industrial work will be de-skilled even further, and our various committees and advisory bodies such as ACARD now studying the microprocessor will have an even bigger job to do.

The UK wavelength changes

Long- and medium-wave broadcasting from November 23

by **G. H. Sturge,** M.I.E.R.E. Engineering Information Department, BBC

Many readers will have heard already of the impending changes to the frequencies used for BBC services in the l.f./m.f. sound broadcasting bands. This article gives the reasons for the changes, which stem mainly from increased demands for frequencies from other countries. A great many of these demands were written into the 1975 Geneva Plan (see January 1976 issue, p.42) which comes into effect this year on November 23rd. The author first gives the historical background and then explains in detail the BBC's reasons for its choice of the frequencies to be used for Radios 1, 2, 3 and 4 and the External Services and the effect on the transmitter network.

THE LOW FREQUENCY broadcast band extends from 155 to 285 kHz and the medium frequency band from 525 to 1605 kHz, although at present 255-285 kHz is not available for broadcasting in Western Europe. With 9kHz spacing between carriers, there is room for only 15 channels on l.f. and 120 on m.f. In the early days of radio broadcasting this would have been sufficient to assign exclusive channels to individual transmitters, but as the number of broadcasting stations in Europe increased in the 1920s an element of channel sharing became inevitable. Ever since then, periodic conferences have been necessary to regulate the use of frequencies for broadcasting by the various stations and countries. Thus we had a Geneva plan in 1926, a Prague plan in 1929, Lucerne in 1934, Copenhagen in 1948 and recently Geneva again in 1975. There was also a Montreux plan in 1939, but this was never implemented.

The latest Geneva Conference was by far the largest of its kind, because it embraced not only the European area, but the whole of Africa, Asia and Australasia as well. There are good reasons for having a single plan for the whole of this area. At present, for instance, Europe and Africa use mainly 9kHz channelling, but Asia and Australasia use 10kHz, so inevitably there are areas where heterodyne interference occurs between stations operating on the different channelling standards. This article will be concerned mainly with l.f./m.f. broadcasting in the 'European area', which in addition to Europe includes much of North Africa and the Middle East.

The recent Geneva Conference was long overdue. The Copenhagen plan made provision for 620 transmitters having a combined power of 20MW; by the end of 1976 the number of transmitters in the European area had grown to 1450 and the combined power had increased to 82MW. Mutual interference between stations has grown steadily worse and, due to the increased range of interfering signals after dark, the night-time service range obtained is in many cases only a fraction of that achieved in day-time. A crucial factor in l.f. and m.f. planning is, of course, this difference between day- and night-time propagation. Day-time reception depends almost entirely on the ground wave, which falls off in a predictable way and enables several high power stations to use the same channel without mutual interference. At night-time (and in some cases during the winter day), the signals are propagated over much greater distances by ionospheric reflection, giving rise to significant field strengths at distances up to a thousand or more miles. Although we use the terms day-time and night-time, the transition from one condition to the other is a gradual one, and in northern latitudes, night-time conditions apply during the mid-winter period to a substantial part of the working day, between about 1500 hours one day and 1000 hours the next (including the important period around breakfast time).

At earlier conferences the planners were most concerned with night-time conditions because it was during the evenings that audiences were at their largest. This situation has changed in the last 20 years, and television now claims the mass audience during the evenings, whilst radio's largest audiences normally occur in the day-time. Nevertheless, a significant number of people still listen to the radio during the evening hours, and in the United Kingdom this is typically around 1 million; there are also very large audiences during the morning and early evening periods.

November 23 — Principal new BBC frequencies

Radio 1	1053 kHz 1089 kHz	285 metres 275 metres
Radio 2	693 kHz 909 kHz	433 metres 330 metres
Radio 3	1215 kHz	247 metres
Radio 4	200 kHz	1500 metres

(With m.f. supplements in Aberdeen, Carlisle, Tyneside, Ulster and parts of South-West England).

The Geneva conference

This was held under the auspices of the International Telecommunication Union, in two sessions. The first session in 1974 was intended to settle the technical standards to be adopted; the second in 1975 prepared the frequency assignment plan. Some 100 countries were represented at the second session and the delegations were from governments, not broadcasting authorities. Thus the United Kingdom delegation was led by the Home Office, although senior engineers from both the BBC and IBA were included.

The consideration of technical standards was, of course, a long and detailed one, but the main decisions taken in the first part of the conference were these:

1. 9kHz channelling to be used throughout, with all carrier frequencies in the m.f. band to be multiples of 9. Some European countries, including the UK, and supported by the European Broadcasting Union, would have liked to change to 8kHz spacing, to provide more channels; but others, mainly in Asia, would have preferred to retain 10kHz. The adoption of 9kHz was, therefore, a compromise between these views.

Figures were also established for the minimum field strengths needed to provide a satisfactory service, depending on the geographical area and the frequency used.

2. The protection ratio adopted as providing a just acceptable standard of reception was taken as 30dB. This is the ratio between the strength of the (non-fading) wanted signal and the strength of interfering signals on the same frequency. A different figure is used for adjacent channel interference, but in considering the repercussions of the

Geneva conference, this is not a major factor.

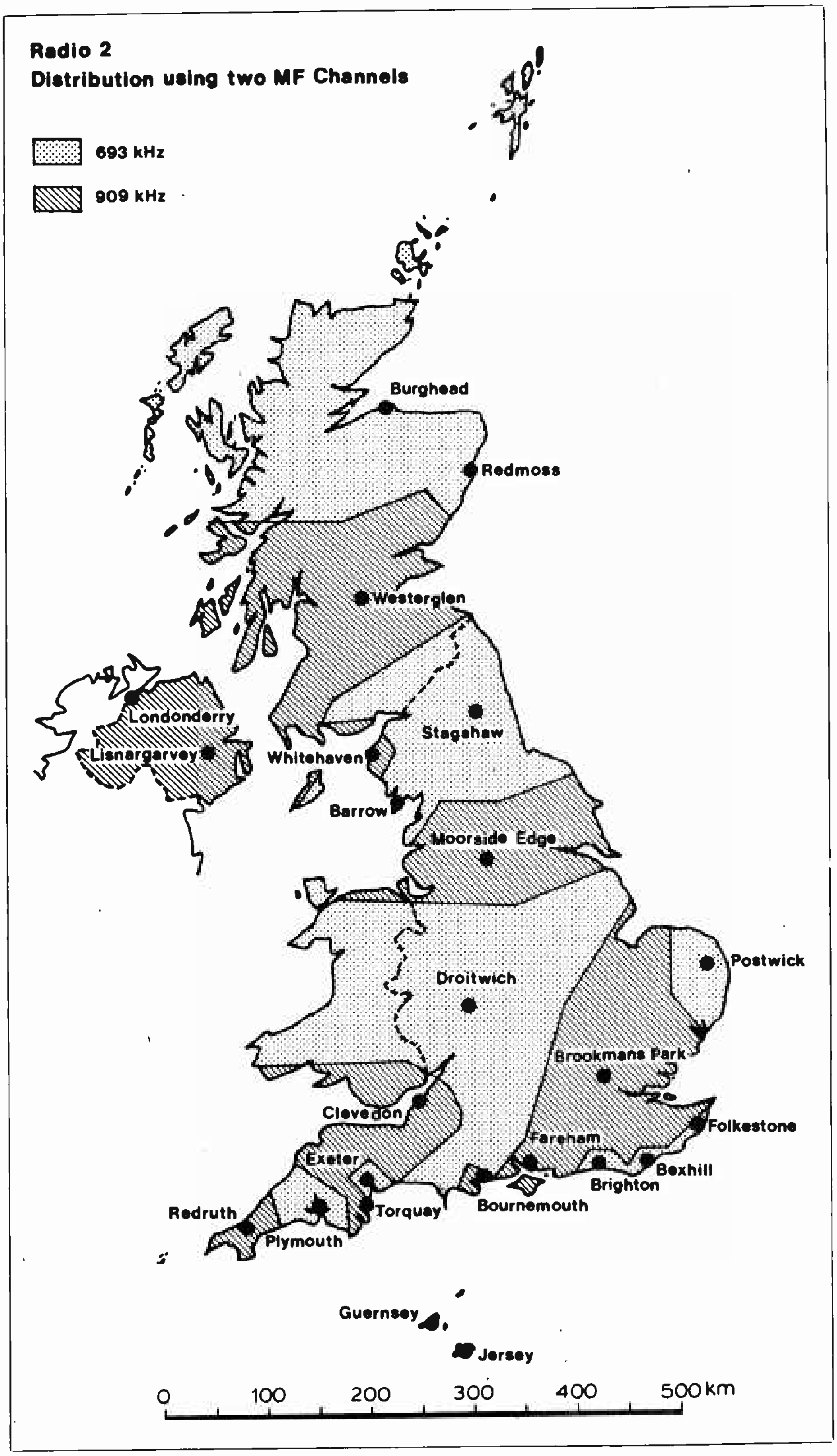
Countries were asked to submit, in advance of the 1975 session, a list of their estimated needs to cover the period from 1978 to 1989, with details of frequencies, transmitter sites and powers.

In the early post-war years the UK already had a well developed broadcasting service, and at the time of the Copenhagen conference in 1948 enjoyed a rather privileged position in European broadcasting. The situation was quite different for many of the other states represented at the Geneva conference; in 1948 they were either not in existence or else had only a rudimentary broadcasting system. It was, therefore, to be expected that these countries would submit quite legitimate claims for increased frequency assignments. For the UK, however, the Home Office decided only to submit claims for those frequencies and power levels which are already available to the UK, together with a modest claim for additional low power assignments to allow for some future development of local radio.

At the 1975 session the proposals which had been submitted by the different countries were listed so that a study could be made of all the incompatibilities, that is to say, instances where one transmitter could be expected to create an unacceptable level of interference in the service area of another. A large computer programme was used to provide an estimate of the minimum usable night-time field strength, for every transmitter, i.e., the field strength which would be needed in order to provide a 30dB margin over the sum of the interfering co-channel signals. In the absence of interfering signals, a field strength of 1 or 2 mV/m may be quite adequate for satisfactory reception. In the presence of night-time interference, a much greater field-strength — say 20 or 30 mV/m — may be needed to provide the 30dB margin. Thus the effective coverage obtained from any transmitter is usually much less at night-time than during the day. Some, but by no means all, of the most obvious incompatibilities were resolved by direct negotiation between the two countries concerned. Nevertheless, it had to be accepted that, with the considerable increase in both the number and power of transmitters, there would inevitably be an increase in the usable field strength values in many cases, leading to a reduction in night-time coverage.

In the final outcome most of the original submissions were written into the plan, and many countries were therefore able to obtain a considerably increased number of frequencies; to what extent these will actually be taken up, time alone will show. In the European area, the plan includes some 2700 transmitters, with a total power of 214MW, an increase of almost 2:1 in the number of transmitters, and almost 3:1 in total power, over the 1976 situation.

So far as the United Kingdom is concerned, all of its existing frequencies, including 13 high power m.fs and one high power l.f. were retained, most of the m.fs with a change of just 1kHz, to conform to the new channelling plan. The United Kingdom also gained the right to use an additional l.f. channel — 227kHz — at medium power, although this is shared with a 2MW transmitter at Warsaw. Some additional low power assignments were also obtained, to provide for the future development of local radio. There are of course, no exclusive frequencies in the new plan, and many of the usable field strength figures for



Radio 2 distribution. The map shows which frequency is most likely to provide satisfactory reception in any particular area. Although a signal should normally be audible in the day-time, the areas of satisfactory reception at night-time will be much more limited than those shown.

night-time are appreciably higher than at present. They range from about 8mV/m at best to over 100mV/m in the worst case, the average being around 20mV/m. The inevitable result is that when the new plan is fully implemented, most transmitter service areas will shrink quite drastically at night-time, as compared to the day-time situation, and many listeners will suffer from increased interference to their m.f. reception.

The UK channels on which high power is permitted are shown below, together with the programme services for which they have been used until November 1978:

Frequency (kHz)*	Programme service
200 (200)	Radio 2
647 (648)	Radio 3
692 (693)	Radio 4
809 (810)	Radio Scotland
881 (882)	Radio Wales
908 (909)	Radio 4
1052 (1053)	Radio 4
1088 (1089)	External Services
1151 (1152)	Independent Local Radio
1214 (1215)	Radio 1
1295 (1296)	External Services
1340 (1341)	Radio Ulster
1457 (1458)	BBC Local Radio
1546 (1548)	BBC and Independent Local Radio

*Frequencies after Nov. 23, 1978 shown in brackets

For the BBC it was necessary to consider very carefully its future plans for l.f./m.f. broadcasting. It would have been possible to leave the main networks substantially as they were; but this could have led to a reduction in coverage at night-time, affecting most services, but especially serious in the case of Radio 3. It was therefore decided to study the possibility of devising a better way of using the frequencies available, in order to overcome the increased interference so far as possible, and also to take account of certain changes which the BBC had considered desirable for some years.

Firstly, Radio 4. In the last few years we have seen the development of local radio in England, and national services in Scotland, Wales and Northern Ireland, known as Radio Scotland, Radio Wales, and Radio Ulster respectively, each including an increasing proportion of locally produced programmes. At the same time Radio 4 has developed as the BBC's main channel for news and information, leading to the concept of a Radio 4 national UK service, which could provide an alternative both to local radio in England, and to Radio Scotland, Radio Wales and Radio Ulster in those countries. The most satisfactory way of realising this concept is to transfer Radio 4 to l.f., with additional transmitters in Scotland to extend the existing coverage on long-wave.

Secondly, it is hoped to improve the coverage of Radio 1. This is one of the most popular services, yet it has had since its inception only one m.f. channel and no v.h.f. — apart from the limited use of the Radio 2 v.h.f. network. It is not, unfortunately, possible to provide complete coverage with only one medium frequency, even in the day-time. As an additional v.h.f. network is not practicable at present, two medium frequencies will be used for Radio 1, which will enable a substantial improvement to be made to both the day- and the night-time coverage.

The night-time interference level on 648kHz can be expected to increase very considerably in the new plan, and the value of this frequency for Radio 3 would, therefore, be much reduced. It is, however, a valuable frequency, which can be used more effectively by the External Services, using high power and a directional aerial system, to provide a mainly day-time service to much of northern Europe. This frequency was therefore exchanged for 1089kHz, which will be used for Radio 1.

The existing frequencies for Radio Scotland, Radio Wales and Radio Ulster will remain unchanged, although if all the Geneva plan assignments are taken up it may be necessary to increase the power of some of the transmitters concerned to maintain the night-time coverage. Similarly, the frequencies used for local radio — 1458kHz (BBC), 1152kHz (ILR) and 1548kHz — are not affected by the proposed rearrangements. This leaves five frequencies — 693, 909, 1053, 1089 and 1215 kHz — to provide the coverage required for Radios 1, 2 and 3. Two will be used for Radio 2 (693 and 909), two for Radio 1 (1053 and 1089) and one for Radio 3 (1215). The final list of BBC high power channels from Nov. 23 therefore, works out as follows:

Frequency (kHz)	Programme service
200	*Radio 4*
648	*External Services*
693	*Radio 2*
810	Radio Scotland
882	Radio Wales
909	*Radio 2*
1053	*Radio 1*
1089	*Radio 1*
1215	*Radio 3*
1341	Radio Ulster
1296	External Services
1458	Local Radio (BBC)

Programme services in italics represent a change of use.

The only major change which has been found necessary to the original plan concerns the use of 227kHz. It was intended to use this frequency for Radio 4 in Central Scotland, as well as 200kHz at Droitwich in the Midlands and Burghead in the North of Scotland. It was always recognised that interference from Warsaw, also on 227kHz, would be a problem under night-time conditions, and small m.f. transmitters were, therefore, proposed for Edinburgh, Glasgow, Dundee and Aberdeen. To check the interference situation, a series of measurements were made during 1976/77, and these showed that the CCIR propagation curves which had been used in planning the use of 227kHz were not valid for this particular path, particularly for day-time conditions in winter. It was found that the Warsaw signals were appreciably stronger than expected, and as a result the service area achieved with 227kHz would have been extremely restricted, except during the day-time in the summer. This would not be an acceptable situation and further studies showed that much better overall coverage could be achieved by synchronising all three transmitters (Droitwich, Westerglen and Burghead) on 200kHz. On this channel much lower field-strengths can be used, so a greater night-time coverage is possible; but, of course, the advantage of using two different frequencies is lost. With a single frequency, an area of unsatisfactory reception is created between adjacent transmitters in those areas where the field strengths from two transmitters are similar.

In the case of 200kHz, these areas will fall across the border country and the central Highlands of Scotland. The main population centres which could be affected are Aberdeen, Carlisle and Newcastle, and low power m.f. transmitters will be provided for those places. To reduce the effect of interaction between geographically adjacent transmissions, the 200kHz carriers will be phase locked and the timing of the audio modulation will be adjusted so that the total delay over the two paths will be as nearly equal as possible. In many places within these so called 'mush' areas, it will be possible to use the directional properties of ferrite rod aerials to favour one transmission relative to the other, and therefore improve the standard of reception. With the use of 200kHz at Westerglen, the provision of m.f. transmitters at Glasgow, Edinburgh and Dundee became unnecessary.

It should be noted that each of the networks to be used is a completley new one, except for that of 1214/1215kHz, which will be transferred almost unchanged form Radio 1 to Radio 3. The total numbers of transmitters and the total powers are as follows:

Service	No. of trans.	No. of freq.	Total output power (kW)
Radio 1	24	2	759
Radio 2	24	2	625
Radio 3	18	1*	271
Radio 4	13	1 l.f. + 8 low power m.f.	522

*Plus one or two very low-power transmitters on 1197kHz.

Local radio

Most of the m.f. channels used by the 20 BBC local radio stations will only be changed by 1 or 2kHz. In three cases, however, larger changes are involved, and these are: Radio Leicester moves from 1594 to 1584kHz. Radio Solent (Bournemouth area transmitter) changes from 1594 to 1359kHz. Radio Leeds moves from 1106 to 774kHz. This last change is necessary because the original frequency is only two channels away from 1089kHz, which is to be used for Radio 1 in the same area.

Re-engineering the network

The BBC's existing m.f./l.f. network has been built up over many years, and there are a number of old installations — dating in some cases from the 1930s — which are inefficient in terms of both power consumption and maintenance effort. A programme of modernisation was clearly overdue, but was deferred until the results of the Geneva conference were known.

The plan described above requires a complete re-organisation both of the sound distribution network and the transmitter system. To implement the changes which are needed by November 23rd, 38 new transmitters have to be installed, in addition to 24 new masts and 28 multi-frequency aerial systems; 70 more transmitters will be replaced during the next few years. It has been decided to standardise all transmitters, with output powers of 1, 10 or 50kW, and these can be used singly or in groups to provide powers of 1, 2, 10, 20, 50, 100 or 150kW. Nearly all the transmitters will be operating in synchronised groups, and the power levels and aerial directivities have been carefully planned to provide the maximum coverage.

Several stations will be carrying 3, 4 or even 5 services, and an interesting example is Burghead in the North of Scotland, which will be carrying Radio 1 on 1053kHz, Radio 2 on 693kHz, Radio 3 on 1215kHz, Radio Scotland on 810kHz and Radio 4 (UK) on 200kHz, with powers ranging from 20 to 100kW. The l.f. service will be transmitted from a T aerial suspended from two 500-ft masts, and each of these masts, in addition to supporting the T aerial, will act as a mast radiator for two of the m.f. services. For maintenance or in an emergency all four m.f. services can be combined into one mast.

Effect of the changes

The effect of the changes will, of course, vary between the four services and also from one area to another. Taken overall, however, they should provide some improvements in coverage, and a very considerable improvement over the night-time coverage which would have been achieved if the changes had been confined to those required under the Geneva plan. Taking the coverage as the percentage of the population who should be able to obtain a satisfactory standard of reception (provided that a suitable receiver is used), the situation before and after the changes is summarised in the accompanying table.

Service	Before November 23, 1978			After November 23, 1978		
	Frequencies (kHz)	Coverage % Day	Coverage % Night	Frequencies (kHz)	Coverage % Day	Coverage % Night
Radio 1	1214	87	38	1053 & 1089	96	55
Radio 2	200	98	83	693 & 909	98	65
Radio 3	647	92	71	1215	87	38
Radio 4	692, 908 & 1052	99[1]	75[1]	200*	98[2]	91[2]

*Plus 9 low-power m.f.

[1] England only
[2] United Kingdom

It will be seen that Radio 1's coverage is increased appreciably both by day and by night, as well as that of Radio 4. The day-time coverage for both Radio 2 and Radio 3 is maintained at a nearly identical level. Night-time coverage for these networks will be less than at present, but these are in the main music services, and a high proportion of listeners can be expected to use the high-quality stereo (or mono) version which is available on v.h.f.

There are, of course, considerable problems in introducing such wholesale changes, and a concerted publicity campaign is being mounted to help and guide listeners in finding the new frequencies. Problems will undoubtedly arise, not least the number of receivers without the long wave band (about 10% of the total number of sets in use) and the fact that after the changes the markings on many tuning scales will show the wrong programmes. This situation will correct itself gradually as new sets come into use; many imported receivers already have scales marked in kHz without any station names. Those who for some reason do not hear of the changes, and tune to their accustomed place on November 23rd, will in all probability still find a BBC programme, though it may not be the one they expect to hear — who knows, some new horizons may be opened.

The author would like to acknowledge the assistance and helpful comments received from many colleagues in the BBC. He also wishes to thank the Director of Engineering for permission to publish this article.

Geoffrey Sturge was educated at Gresham's School and Faraday House, from which he went into the RNVR in 1940. After three years in bomb and mine disposal, he transferred to the Fleet Air Arm, and served as Air Radio Officer in an aircraft carrier. In 1946 he joined Murphy Radio, and worked in their service, export, and distribution departments. He joined the BBC in 1962, to work in engineering recruitment, and he has been in his present post since 1970. He has been closely involved in the preparation of information on the coming frequency changes.

Transmitters to be used for Radio 1

1053kHz (285m)

Station	Power (kW)
Barnstaple	1
Barrow	1
Bexhill	2
Brighton	2
Burghead	20
Droitwich*	150*
Dundee	1
Folkestone	1
Hull	1
Londonderry	1
Postwick*	10
Stagshaw	50
Start Point	100*

1089kHz (275m)

Station	Power (kW)
Brookmans	150*
Fareham	1
Lisnagarvey	10
Moorside Edge	150*
Redmoss	2
Redruth	2
Tywyn	1
Washford	50
Westerglen	50*
Whitehaven	1

1485kHz (202m)

Bournemouth	2

*Directional aerial

Transmitters to be used for Radio 2

693kHz (433 metres)

Station	Power (kW)
Barrow	1
Bexhill	1
Brighton	1
Burghead	50
Droitwich	150
Exeter	1
Folkestone	1
Plymouth	1
†Postwick	10*
Redmoss	1
Stagshaw	50

909kHz (330 metres)

Station	Power (kW)
Bournemouth	1
Brookmans Park	140
†Clevedon	50*
Fareham	1
Guernsey	0.5
Jersey	1
Lisnagarvey	10
Londonderry	1
Moorside Edge	100
Redruth	2
Torquay	1
Westerglen	50
Whitehaven	1

†Initially Clevedon and Postwick will be restricted to 20 and 2 kW respectively.
*Directional aerial

Transmitters to be used for Radio 3

1215kHz (247m)

Station	Power (kW)
Brighton	1
Brookmans Park	50*
Burghead	20
Droitwich	30*
Fareham	1
Hull	0.15
Lisnagarvey	10
Londonderry	0.25
Moorside Edge	50*
Newcastle	2
Plymouth	1
Postwick	1
Redmoss	2
Redruth	2
Tywyn	0.5
Washford	60
Westerglen	40*

1197kHz (251m)

Station	Power (kW)
Cambridge	0.2

*Directional aerial

Transmitters to be used for Radio 4 (UK)

Station	Power (kW)
200kHz (1500m)	
Burghead	50
Droitwich	400
Westerglen	50
720kHz (417 metres)	
Lisnagarvey	10
Londonderry	0.25
603kHz (498 metres)	
Newcastle	2
1449kHz (207m)	
Redmoss	2
1485kHz (202m)	
Carlisle	1

WORLD OF AMATEUR RADIO

Radio and television interference

The latest Directorate of Radio Technology (Home Office) report on radio interference, covering 1977, again confirms that the revised method of recording the statistics, introduced in 1976, indicate the relatively small number of cases (a total of 171 complaints involving 102 sources) officially ascribed to fundamental or harmonic radiation from amateur stations. Altogether some 42,148 complaints represented all forms of interference with some 43.38% ascribed as being due to "conditions at the receiving site" (i.e. faulty receivers or inefficient aerials). While interference to television reception from all causes fell by 11.28% to 24,595, interference to radio reception rose by a hefty 22.45% to 16,313 (including 10,476 for m.f./l.f. and 5837 for v.h.f./f.m.). The rising figure for radio (in 1971 it was only 6,492 compared to 65,826 for television) indicates that pollution of the radio spectrum by electrical interference from domestic and other apparatus is no longer falling (as it did in the 1960s following legislation) but is again increasing, although the figures also suggest that there has been a marked revival of interest in sound radio in recent years. The fall in interference to television has undoubtedly been primarily the result of the change from v.h.f. to u.h.f.

Certainly amateurs in urban and suburban environments are finding the severe spectrum pollution an ever increasing problem for weak signal reception, particularly that arising from time-base and switched-mode power supplies in colour television receivers. This form of pollution is usually of an intensity where it does not interfere with tv reception and makes relatively little impact on the Home Office statistics (380 complaints). Contact devices such as faulty switches and thermostats account for 57.38% of complaints from specified sources (20.23% of all complaints). Among some of the more unusual sources of interference one finds plastic seam welders, fish thawing equipment, microwave cooking, wood glue drying, r.f.-excited arc-welders and the like — the list seems to grow longer year by year.

WARC 1979

The World Administrative Radio Conference starting at Geneva next September continues to dominate the thoughts and activities of many amateur radio organisations, although few people seem prepared to hazard any firm opinion on the likely outcome of the conference from an amateur viewpoint. IARU Region 1 Bureau points out that there are still many unknown factors, including the attitudes of many of the countries of Africa and Asia where amateur activity tends to be at a subdued level. Historically many of the most damaging attacks on the amateur service have stemmed from European telecommunications administrations and the results are evident when comparing amateur allocations in Region 1 with those of Regions 2 and 3. A recent IARU summary of the attitudes of Region 1 administrations towards amateur h.f. allocations shows a wide variation of attitudes from favourable to unfavourable towards the proposed additional allocations around 10, 18 and 24MHz although reasonable support for maintaining or improving the position in regard to existing amateur h.f. allocations.

In the air

Although sunspot activity looks set to increase to an extremely high maximum in 1979-80 there was an unusually sharp decline in activity towards the end of July, lasting through August.

Fifty years ago, on October 21, 1928, Jimmy Mathews, G6LL (still an active amateur) made the first two-way transatlantic contact on 28MHz, lasting almost two hours, with C. K. Atwater, W2JN of Upper Montclair, New Jersey. It must have been no easy matter obtaining reasonable r.f. output at 28MHz from a DET1 power valve, and like many other amateurs of the period, G6LL in North London had to obtain power from d.c. mains by means of a rotary converter. Although several other British amateurs "got across" that year, 1928 was on the declining phase of a sun-spot cycle and it was another seven years before the 28MHz band again opened for world-wide communication.

Douglas Johnson, G6DW, of Capel, near Dorking, recently held an "At Home" attended by many "old-timers" to mark the 55th anniversary of his obtaining his "experimental" call-sign in 1923.

It was, incidentally, forty years ago – October 22, 1938 – that a welcome OHMS letter came through my letter box. It contained the radiating licence G3VA (replacing an "artificial aerial" licence held since 1936). But like most newcomers of that era my initial efforts at transmission were only moderately successful. Despite many calls on 7MHz phone, my first day's efforts brought only one contact – with a friend less than a mile away! Next day, on 1.8MHz, several contacts over distances of 20-30 miles were made, and altogether in the first three months some 150 contacts with about 15 countries were achieved on 1.8, 7 and 14 MHz (the only bands then available to newcomers). Transmitter power had to be limited to about 10 watts and receivers were an 0-v-1 "straight" receiver and a domestic "all-wave" set with an external b.f.o. But it is curious how, now half-way through my 11th log book, some of those early contacts remain indelibly etched in one's memory.

A rather different contact rate has been established by Dick Spenceley, KV4AA (AJ3AA) on the U.S. Virgin Islands who can be heard most evenings contacting many European stations on 14 or 21 MHz. In two years, 1966-67, he made 67,235 contacts and looks set to achieve 100,000 in under three years – and his contacts are not just "contest-style" exchanges. He was first licensed in 1927 as K4AAN.

In brief

The RSGB is one of the sponsoring organisations for a two-day conference "Recent advances in h.f. communication systems and techniques" to he held at the IEE, Savoy Place, London next February 27-28 . . . Reciprocal licences in France now cost 117.5 francs (about £14) and cover one year . . . To operate with a reciprocal licence in the USA, it is now necessary to file FCC form 610-A at least 60 days before the proposed start of operation . . . The Radio Club of America has honoured Arthur Collins, WOCXX/WB5MAR, founder of Collins Radio, with the Armstrong Medal, while its Pioneer Award went to W. E. D. Stokes whose testimony in 1910 (when he was only about 12 years old) before a Senate hearing against the Depaw bill is generally credited with helping to preserve the existence of amateur radio in the United States when it was threatened with a complete shut-down . . . The G2NJ Trophy of the "G-QRP-Club" (devoted to low power radio communication) has been awarded to the Rev. George Dobbs, G3RJV, editor of "Sprat" and founder of the club . . . The low disposal prices of 23-channel Citizens Band equipment in the United States has encouraged many American amateurs to modify such units for low-power amateur operation on 28MHz . . . Good contacts with South American stations were achieved this summer on 1.8MHz . . . Hellschreiber equipment is being increasingly used by a group of amateurs in Western Europe on 3.5, 7 and 144MHz.

PAT HAWKER, G3VA

Character rounding for the Wireless World teletext decoder

New board offering improved display and revised timing

by J. H. Hinton, M.Sc.

When the original Wireless World teletext decoder was designed by J. F. Daniels [1,2], a deliberate choice was made by the author to omit the rounding of characters on the grounds of extra circuit complication and the increase in cost of around £20. Since 1976, the balance of argument has shifted in several ways towards the incorporation of rounding. Firstly, the improvement in appearance and legibility, though significant with double-height characters and, to a lesser extent, with ordinary capitals, is much more important with lower-case characters. Indeed, the fitting of the Texas lower-case r.o.m. to the author's decoder without rounding was a disappointment, since the lower-case characters were, by comparision, more difficult to read. Rounding means that they are now preferred to a 'capitals only' display. Secondly, the Tifax decoder, the Mullard i.c. set[3] and other commercial designs use rounding, which makes the appearance of the original *Wireless World* decoder display compare unfavourably. Lastly, the cost of the rounding facility, including extra power supplies and one or two other features, is still about £20, whereas the cost of a full decoder kit is now around £200.

The extra circuitry, shown in Fig. 1, provides the following facilities:

- character rounding on single and double-height characters, which can be disabled for comparison purposes.
- seven-clock-pulse-wide character cell, with symmetrical separated and contiguous graphics.
- optional display of characters in upper-case only.
- re-timing of Flash and Steady controls to set 'after' and 'at' correctly.

The new board uses 17 t.t.l. integrated circuits, including the Texas r.o.m. and has been designed to work with R. T. Russell's board 3[4]. A design capable of working with or without this board and for either type of character generator would have been more complicated and it was felt that people who want rounding would also want the features offered by Russell's 'new facilities' board 3. Existing Texas r.o.ms must be transferred to the new board 4.

Display cycle timing

In the original design, the display column address for the r.a.m. is changed at IC_1 dot count zero, the output data for the new character being loaded into the latches IC_{28} and (69,9)* at dot count 7. The graphics generator output responds quickly, having a propagation delay of four t.t.l. gates, but the 2513 r.o.m. requires an access time of up to 500ns; the first three dots after the data change (7, 0 and 1) are therefore used as spaces, providing a time of 375ns. The consequent absence of a gap between the last dot of an alphanumeric character and the first of a following graphic was avoided with the later use of a 75S262 r.o.m., which has an access time of 280ns maximum, by changing the strobe pulses from IC_{42} to give two spaces of 250ns before and one space after alphanumeric characters relative to graphics. Compared with the shift register technique, this method of sequentially gating the dot outputs has the advantage that when r.o.m. access time is short, only the first character column is at risk, since the others have additional time to settle.

The rounding operation involves comparison between the display row and the reference row, so the serial data for both rows must be simultaneously available to the display circuits. Three methods are possible:

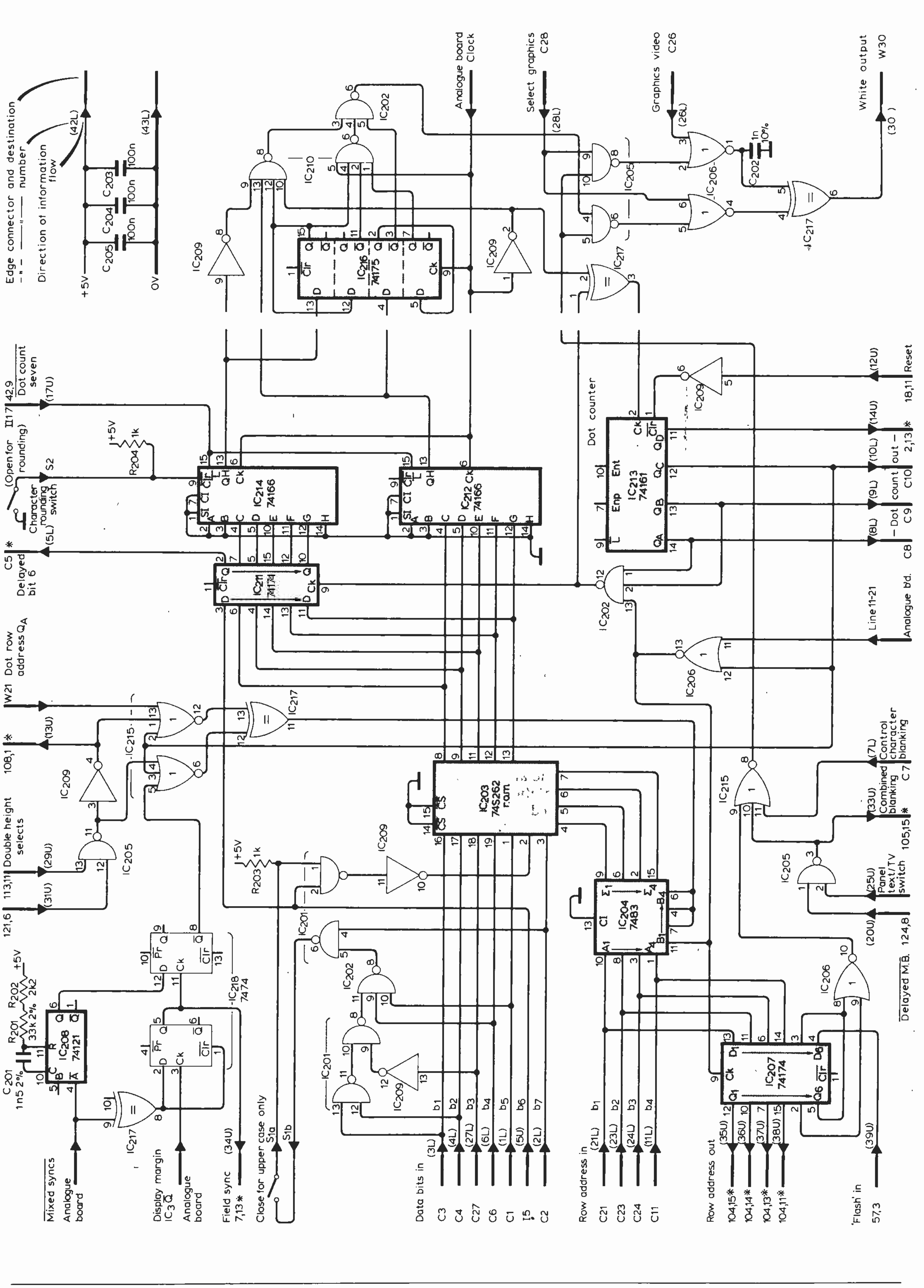
- two r.a.ms in parallel can be addressed by the two rows, as described by Mullard[5]. This is simple, but costly.
- a fast r.a.m. can be read in three cycles of a seven-clock cell, the r.o.m. addressed on the reference row during the next two cycles, its output latched and addressed on the display row during the last two cycles. This is also relatively simple, requiring no timing changes in the rest of the decoder; a new design of decoder could use this to advantage since the extra cost of a faster r.a.m. is small. The need for compatibility with existing decoders ruled this out.
- three successive character display cycles can be used to read the r.a.m., access the r.o.m. twice and display the character with rounding. This imposes an extra delay of one display cycle in the alphanumeric channel and timings must be changed to introduce a compensating delay in the graphics and control channels. This method was chosen.

In the initial teletext specification, control characters were always displayed as blank spaces, so it was immaterial when in the cycle they took effect. The original *W.W.* decoder took advantage of this by strobing the control character decoder at count 3, having allowed the new data plenty of time to propagate through the gates. Under the current specification, where control character cells may be displaying held graphics, or a 'new background' colour, they act at a cell boundary and are therefore defined either as 'set at' if they take effect immediately, or 'set after' if they do so at the transition to the next character.

Russell's board 3 deals with the propagation delay in gates 101, 106 and 116 by feeding the control character decoder and graphics generator from latches which are loaded at dot count 0, the one-clock-period interval after the r.a.m. latches are loaded (at count 7) allowing plenty of time for the gate outputs to settle. The character cell for graphics and controls is therefore one dot to the right of the alphanumeric cell, the effect being to give one space before and two after the alphanumeric symbols (with the T.I. r.o.m.), rather than two before and one after, as was originally the case. The purpose of the graphics latch IC_{102} on board 3 is to keep the most recently displayed graphics symbol available to be called up as a held graphic, its loading being controlled by AND gating of data bit 6 (high for graphics, low for alphanumerics) with dot count Q_c (1,8) so that a new graphic appearing on the data bus at count 7 is clocked into the latch at count 0.

The bit 6 signal used here is delayed in IC_{211}, which ensures that the new value appears at 116, pin 1 after Q_c has gone low, remaining static while it is high. If 116, pin 1 were fed from (117,10), the old value of bit 6, still present at the Q_c step due to delays in IC_{117} and IC_{118}, would clock IC_{102} with a spurious signal. The delay of one display cycle in the control and graphics signals needed to compensate for the extra cycle taken by the character rounder is achieved by changing the load point of the r.a.m. latches IC_{28} and (69,9) from count 7 to count 0, the same as the board 3 latches, thereby giving the one cycle delay.

*Gates and pins are identified in this way. $(\overline{69,9})$ refers to the circuit whose output is on pin 9 of IC_{69}



Edge connector and destination number
Direction of information flow
Dot counter
Analogue board Clock
Select graphics C28
Graphics video C26
White output W30
Mixed syncs Analogue board
Field sync 7,13*
Close for upper case only
Data bits in
Row address in
Row address out
'Flash' in 57,3
Delayed M.B. 124,8
Double height selects
Character rounding switch
Dot row address Q_A
Delayed bit 6

◀ **Fig. 1.** *Circuit diagram of board 4. Asterisks denote changes in connexions to board 3. Upper-case and character rounding switches are taken to body of board. All pads connected to board III are on the lower side of board IV and are denoted by suffix L. Prefixes C and W are those used on board III.*

Where two latches are used in cascade in this manner it is essential to ensure that any differences in precise loading time due to different gate paths tend to clock the second latch first. This condition is met here because the r.a.m. latches are fed from a 7442 decoder containing three stages of logic, while the control character latches IC_{112} and IC_{117} are clocked from IC_{213} Q_c, via an inverter and a gate.

With Russell's 'new facilities' modification, the controls for 'Box' and 'Unbox' are decoded on board 2 and delayed from 'set during' to the correct 'set after' by (117,5) on board 3. The additional delay of one character needed with rounding to match the other signals is provided by a 22nF capacitor on the output of IC_{41}. This method is permissible here because the signal is not used for any other purpose and because (117,5) only samples the signal at count 0, so the correct state will be loaded if the delay due to the capacitor is between 4 and 11 clock pulses. The situation with 'Flash' is more complicated, since board 3 uses the original board 2 circuitry for alphanumeric/graphic selection, blanking held over a 'Flash' or 'Steady' control character, generation and mixing of 'Flash'. The controls for Flash and Steady still set at count 3, so without the new board a graphic will start and stop flashing in the middle of the character cell. To minimise interconnexions and modifications to board 2 the select and blanking functions are performed on the new board, while the flash control gated with the oscillator signal is brought onto it. Latch (207,5) at (207,2), in conjunction with gate (206,10), delays 'Steady' to the next cell boundary, timing it into set 'at' while 'Flash' is delayed to the next boundary plus one cell to give set 'after', to achieve the specification.

Odd/even field detection

The original field sync. separator circuit gated the mixed sync. waveform with 10µs pulses from the margin generator IC_3, (a monostable flip-flop, triggered from the front edge of sync. pulses), the gate (4,13) suppressing line syncs. and equalizing pulses, while leaving field syncs. only slightly shortened. Unfortunately, the trigger delay time of the monostable (70ns max) allows a short spurious pulse through (4,13), which is removed by integrating it with C_2 (10nF) in conjunction with the 30-ohm output impedance of (4,13), a 7428 buffer gate, to prevent it being seen by IC_7 and IC_{14}. The author cured stubborn problems of vertical bounce by sampling the sync. waveform 10µs after syncs by means of a 'D' flip-flop, clocked from Q of IC_3. Clearing the flip-flop from the sync. waveform produces the same waveform as at (4,13) in the original circuit.

On the new board this function is performed by D flip-flop (218,5) which sets whenever a broad field pulse is detected (following either a line sync. or an equalizing pulse), loading into (218,8) the state of monostable 208 IC which is triggered from syncs, as seen in waveform diagram Fig. 2. Provided that its period is less than 32µs plus the duration of IC_3 pulse (10µs), field syncs occurring in the first half of a line will load (218,8) high, while those in the second half will load it low, so that it takes up a state determined by whether the final field pulse was in the first or second half of the line, thereby distinguishing between odd and even fields. The period of monostable 208 IC must be greater than 32µs; if less it will retrigger on the equalizing pulses. The timing components are therefore chosen for 37µs allowing 5µs margin each way. The resistor and capacitor must therefore be close-tolerance, high-stability components of ±2% or better.

Reference row address selection

In character rounding, the address of the reference row is alternately one more and one less than the display row. For normal-height characters this alternation occurs every field (requiring the odd/even signal), while for double height the alternation is every line, the least significant bit of the line count being used. The selection between these two signals is performed by gates (215,12) and (215,6) under the control of a normal/double height signal from board 3, the gates being enabled by a low state of the display/reference signal from IC_{213} Q_c to give a row-address alternation signal at IC_{217}, pin 11. This is fed to the 2nd, 3rd and 4th bits of the adder IC_{204} to add zero or 14 which, with the inverted display/reference signal on bit 1, gives an overall addition of one or fifteen, the latter being equivalent to a subtraction of one.

At IC_{213}, count 0, the new data is applied to the character-address of the r.o.m., together with the reference row address. At count 4, the row data is latched into IC_{211} and the address changed to that for the display row, while at count 0 the reference row data is loaded into the shift register IC_{214} and the display row data into its partner IC_{212}.

Character generation and rounding

The alphanumeric characters are built up on a dot matrix of 5 wide by 7 high, each dot having a duration of one clock cycle and a height of one line per field. The overall height is two picture lines, due to the interlacing of alternate fields. Character rounding effectively doubles both the horizontal and vertical resolution on diagonals by detecting and then smoothing them out by adding small dots, sometimes described as 'half dots', although they are really a quarter of a full dot in area, being half a clock cycle wide and one line high.

On an odd field, the upper one of the interlaced pair, the display row is compared with the reference row (the picture line immediately above) as follows. Where there is a dot in the reference row and the following point in the display row but not the following point in the reference row, these three conditions, AND gated with the second half of the clock cycle in (210,8), produce a 'pre-rounding' quarter dot, as shown in Fig. 3. The reference row is similarly gated with the previous point in the display row, the inverse of the previous point in the reference row, and the first half of the clock cycle in (210,6) to produce a 'post rounding' quarter dot. On even fields the display row is compared with the one below in the same way.

These logical operations require simultaneous availability of the preceding current and following picture

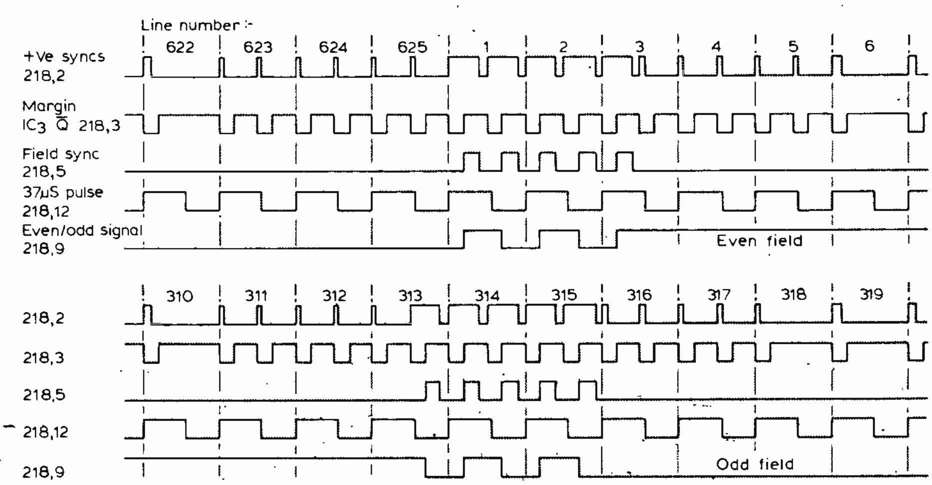


Fig. 2. *Waveforms in the odd/even field selector, IC_{218}* ▶

points on both the display and reference rows, six signals in all. The serial outputs from the shift registers IC_{212} and IC_{214} are each fed through two sections of quad D latch IC_{216} connected as a further two stages of shift register, the 'following' signals being taken direct, the 'current' ones after one stage, and the 'previous' ones after two. The complementary outputs provide the inverse signals needed, and the outputs from the pre-rounding gate (210,8) and the post-rounding gate (210,6) are combined with the 'current' display-row signal in gate (202,6).

The new facilities introduce an important difference between the actions of line/field and control-character blanking. The latter, when overridden in held graphic mode by a graphics select signal via 118, 6, disables the Y signal on board 4, leaving a space which may be displayed black or in a new background colour. The line/field blanking, applied outside the area of the display, inhibits it completely via the strobe input of R G B multiplexer IC_{105} and is also fed into board 4 to blank its white output in order to provide a proper monochrome signal there for test purposes.

Under certain circumstances, differing delays in the propagation paths of the various signals involved in the generation of the graphics Y signal give rise at character cell boundaries to glitches of incorrect data lasting a few tens of nanoseconds, which if not removed are clearly visible on the display. A t.t.l. gate in the high state acts as a source of 3.6 volts in series with about 1 90 ohms, so the exponential charging waveform across a capacitor of 1nF takes around 50ns to rise to the approximately 1.3V input threshold level of the following gate. The low-state output impedance of 10 ohms with a current limit of 50mA discharges the 1nF capacitor to the threshold level in around the same time, so positive and negative edges both undergo a delay of 50ns, while any pulses of shorter duration than this disappear altogether.

These typical figures depend on i.c. parameters, which are liable to vary between samples, and repeatability can be improved by adding resistance in series with the gate output. With 100 ohms, both transitions are expotential and the ratio of the time constants balances the effect of gate input threshold being nearer 0 than 1 level, so the edge delays are again about equal. Unfortunately, this only applies where the interval between edges is long compared with the delay time. In the case of a short pulse, where the back edge starts from a point on the exponential tail of the front edge which has not reached its full value, the back edge is delayed less than the front one, producing an overall narrowing of the pulse. Without the series resistance, negative (but not positive) going pulses can be delayed without distortion due to the almost linear capacitor waveform with very little tail, but it is not true that a pair of equal value capacitors at opposite polarity points balance out distortion – in fact they produce it on short pulses of either polarity.

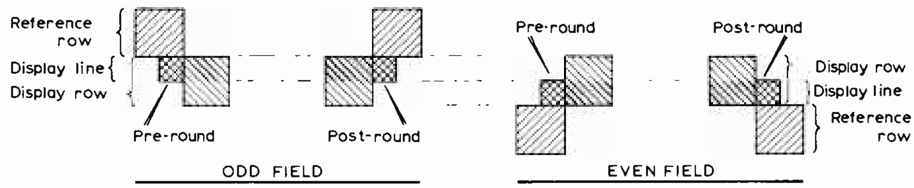


Fig. 3. *Method of rounding characters with quarter dots.*

Applying these principles to the decoder waveforms, the only area of one clock pulse width in the graphics is the central space in separated-mode characters, so a capacitor can safely be used to remove glitches, provided that is is used without gate series resistance and at a point of positive going video. A value of 1nF at (206,1) is sufficient to absorb the glitches and brings the total delay in the graphics Y channel up to around 110ns relative to the colour controls. To prevent this giving rise to wrong colours at the right hand edges of graphics held-over colour controls, a compensating delay is introduced into the latter signals. Since these contain no short pulses, 100 ohm gate series resistances can be used here in conjunction with the shunt capacitors.

Rounded alphanumerics contain bright areas of one clock pulse width, and gaps of a half, so shunt capacitors cannot be used at all on these signals. Fortunately, their phasing is less critical due to the 1 dot space either side of the character, and the arrangement of timings in the character generator to give a delay of one clock period gives acceptable relative alignment. In this circuit, a negative-going dot count 7 signal from IC_{42}, pin 9 is fed to the synchronous shift/load inputs of the 74166 shift registers IC_{214} and IC_{212}, so that the new row data from the reference latch and the r.o.m. is loaded into the two sets of parallel inputs C to G on the next positive clock edge (dot count 0). The other inputs, including H, are earthed, so that the first character dot appears on the shift register output Q_h at count 1, and the generator output (202,6) at count 2 due to the further delay in IC_{216}.

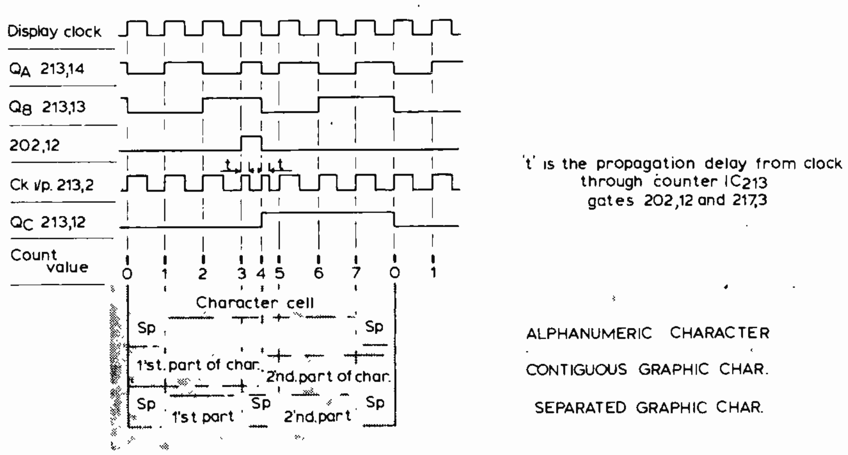


Fig. 4. *Waveforms of the dot counter IC_{213}.*

Upper-case only

Before the character rounding circuit was fitted, an experimental reversion to displaying all letters in upper case was found to imprve readability, but the crude method of switching r.o.m. bit 6 input to bit 7 renders ¼, 11, ¾, ÷, DEL, and control characters incorrect. A gating circuit to change letters a to z to upper case without affecting any other characters was therefore devised using IC_{201}, (202,8), (209,10) and (209,12). Four separate switches are provided to disable this circuitry, together with the character rounding, the control character blanking, and the new facilities provided by board 3. The feature of being able to bring these in and out of action at will is valuable for instruction and demonstration purposes, and is not provided for in l.s.i. decoders designed for consumer use.

Character-display dot counter

To help minimise the number of i.cs in the decoder, Daniels used common clock-divider circuitry for acquisition, and display modes, giving an eight-dot character cell. The alphanumeric cells have five character dots to three spaces, while graphics are split 4/4 for contiguous and 1 sp-2 char-2 sp-2 char-1 sp for separated ones. The illustrations on page 16 of the current specification[3] show a seven-dot cell, split widthwise into 3½-3½ dots for contiguous graphics and 1 sp-2 char-1 sp-2 char-1 sp for seprated ones. The new board therefore contains a new dot counter, IC_{213}, which is switched to give seven clock pulses per display character. In order to split up the graphics cells correctly it is necessary for counts 4 and 5 to occupy only half a clock pulse each, as shown in the waveform diagram of Fig. 4.

During acquisition mode (line 11-21 high), (202,12) output is high all the time, so the inverted clock waveform from (209,2) is simply inverted back again in the exclusive-OR gate (217,3). During display mode, count 3 sends (202,12) low, switching (217,3) over to non-invert and changing its output to low. A synchronous counter is needed to ensure that the propagation delay round this loop is less than half a clock cycle (72ns), so when the clock goes low (217,3) goes high, causing the counter IC_{213} to advance to 4. IC_{202}, pin 12 then reverts to high, returning (217,3) to invert, so its output goes low ready to advance the counter again when the clock goes high. The counter spends half a clock period in the '3' state and half in the '4' state due to the extra count, a scale of eight being achieved in seven clock periods. Placing the extra count in the middle preserves the symmetry of the graphics, whether separated or contiguous.

Board 3 modifications

Because alphanumerics are generated during the character cycle before that in which they are displayed, the new row address for both alphanumerics and height' has to reach the alphanumerics generator a cycle before the change is to take effect in the display. Since double height is a 'set-after' mode, the 'at' signal on IC_{113}, pin 11, whose back edge sets the double height bistable IC_{121}, can be combined with its output in gate (205,11) to change the row address at the arrival of the control character. Unfortunately, this is too early for the graphics and has to be delayed for them in 'D' latch IC_{207}, otherwise a graphic being held over a double-height control character would be incorrectly displayed as the top half of that graphic in double height.

On return to normal height, the row address for both alphanumerics and graphics now sets 'after' rather than 'at', but this of no consequence, since section 3.1.7 of the specification[4] requires that held graphics are cleared at a change between alphanumerics/graphics or between double/normal height, so a normal-height control can only be displayed as a space. The line-blanking signal is delayed one character cycle by feeding through the unused section (output pin 2) of hex. latch IC_{117}. A 1nF capacitor was found to be needed from IC_{125}, pin to to earth to prevent vertical jumping of the part of the picture below a double height row.

To enhance the action of the video switch, the mixed blanking signal is taken out ater inversion by (124,8), combined with the 'box' signal in gate (205,3) and fed back into (105,15) to disable the R G B text outputs while the tv picture is displayed. This makes the unit suitable for those sets where the preferred method of interfacing is to use the 'cut hole' signal to blank the picture in the video processor, while feeding the R G B text signals in via switching transitors wired in parallel with the set's R G B output stages.

Power supplies

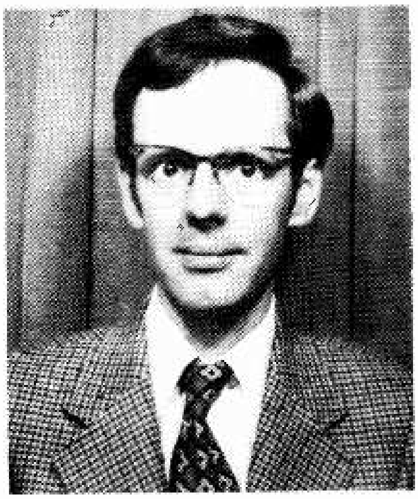
The new display board 4 together with board 3 bypasses a fair amount of board 2 circuitry, but, unfortunately, this is distributed among the i.c. packages such that only seven i.cs, numbers 52, 53, 58, 60, 61, 74 and 75 could be dispensed with completely, which reduces power consumption by only around 100mA. It is useful to retain board 2 intact for diagnostic and test purposes. There is also a risk of introducing faults by unnecessary disturbance of the board in removing i.cs.

While the original power unit may just supply board 3 if the reservoir capacitance is increased, the further current required by the new board makes an additional power supply essential, although how this is achieved depends on the individual constructor. For the prototype, a completely new power supply was built, with three 7805, three-terminal regulators feeding respectively:

–board 1 (750mA) and analogue board (100mA).
–board 2 (470mA) and board 3 (570mA).
–board 4 (530mA) and possible future additions.

The printed-circuit board is designed to mount above board 3 so that the assembly will just fit into the standard cabinet, with VR_3 removed and the existing boards mounted as close together as possible.

Construction and installation of the new board will be described in the next article.



Humphrey Hinton, aged 40, with three children, has lived most of his working life in Cambridge where his spare time is taken up with being a Church Council secretary and school manager.

After reading Electrical Sciences at Trinity College, he took an M.Sc. and then worked with tunnel diodes at Harwell before returning to Cambridge as a technical officer at the observatories. From 1968 he was engaged on acquisition and handling of test data for the Hovertrain project until its cancellation by the Government in 1973. He now works in the engineering department of Pye Business Communications Limited on special c.c.t.v. and audio systems for industry, and has recently developed a push-button, stored-number loudspeaking telephone.

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4. Russell, R.T., "Teletext Decoder Modifications", *Wireless World*, December 1977 and January 1978.
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Electrical noise measurement

Mr Richard C. Kirby, Director of the CCIR, Geneva, writes as follows about James Moir's article "Electrical noise measurement in audio engineering" in the August 1978 issue:

In this article numerous references are made to "IEC 268-3" "CCIR 468-1" and "CCIR 468-2". In fact all these references should read "CCIR Recommendation 468-2" since this is the text to which reference is made. There appears to be some confusion by the author of the two organizations ISO and CCIR.

Furthermore, since Recommendation 468-2, replaces and abrogates Recommendation 468-1, reference to this latter text should be deleted.

Finally, in the references, the insertion "CCIR Recommendation 468, Study Programme 2A-10" should read:

CCIR — Documents of the XIVth Plenary Assembly, Kyoto, 1978, Volume X, Recommendation 468-2, 1978.

Wideband noise reducer

Cost-effective i.e. design pumping effects with pre-emphasis

by **D. L. Harrison** B.Sc.(Eng)

The noise reduction system described can yield a wideband reduction of tape recorder noise of about 30dB. A compander integrated circuit forms the heart of the system and judicious use of pre-emphasis and de-emphasis reduces noise pumping effects.

ONCE OPTIMIZED for the signal levels in a particular installation the noise reduction provided by this circuit is dramatic. From a hissy, hummy tape output one can enjoy absolute silence during quiet passages without, in my opinion, noticeably degrading the music programme. The system does not use r.m.s. signal detection, as does the dbx system, but I feel that r.m.s. signal detection, whilst it does offer some advantages, is not the panacea it is often made out to be. It is less sensitive to phase errors in the channel compared with average signal detection. Admittedly the tape medium is notorious for introducing phase errors that could lead to compander mistracking if r.m.s. detection is not used. However r.m.s. detection *is* more susceptible to h.f. amplitude response errors than average signal detection* a fact rarely mentioned by the proponents of r.m.s. detection. It would seem, therefore, that r.m.s. versus average detection is something of a "swings and roundabouts" situation. Considering that the cost of the system here is about one tenth that of a dbx system and that the results are impressive. I feel a really cost-effective design has been achieved.

A problem which has plagued simple companders in the past has been that of noise pumping. When the average value of the signal is high as at A in Fig 1 the expander gain is also high and so the background noise signal is amplified. However this noise is generally not heard because of the masking effect of the signal. At B, however, the average value of the signal has dropped, i.e. a very quiet passage following a very loud passage of music. The expander is unable to change its gain instantaneously and so due to this fall back time the gain

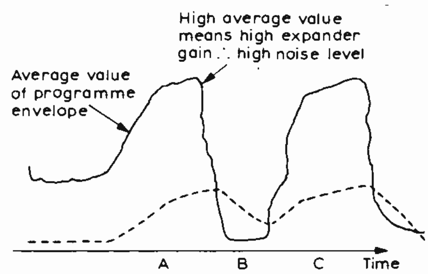


Fig. 1. *Simple companders are unable to respond instantaneously to a fall in signal level, giving rise to obtrusive changes in noise level.*

is high whilst the signal is of a low level and thus the noise can be clearly heard. This is a serious shortcoming of the simple compander because a noise level of varying amplitude which is pumped up and down by the signal level has a greater annoyance value than a steady noise level.

Fortunately the effect of this noise pumping can be subjectively reduced by including signal pre-emphasis before compression and de-emphasis after expansion. This is the method adopted by dbx Inc and by the system presented here. In this particular design a pre-emphasis of +12dB starting at about 500Hz is used. This does not eliminate noise pumping but reduces the high frequency noise by 12dB and renders it inaudible under normal listening conditions. On compression this 12dB lift becomes 6dB which is passed to the tape recorder.

Now unfortunately if one is recording at levels of about −10 to 0 VU there is very little headroom until tape saturation is reached and even less at the higher frequencies. Thus 6dB lift at frequencies above about 2kHz could very easily lead to high frequency tape saturation. This may be counteracted by including pre-emphasis in the signal detector path as shown in the system block diagram. The particular design here uses a detector pre-emphasis of +20dB starting at about 1.6kHz, in common with the dbx system. Curve (a) of Fig 2 shows the signal pre-emphasis whilst curve (b) shows the overall frequency response of a compressor combining the two amounts of pre-emphasis. At frequencies above about 2kHz the recorded signal level actually reduces.

A further problem akin to noise pum-

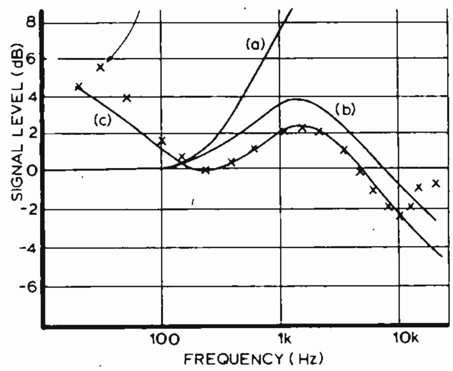


Fig. 2. *Effect of noise pumping is reduced by using pre-emphasis (curve a) prior to compression and corresponding de-emphasis on expansion to reduce h.f. noise by 12dB. Possibility of tape saturation is alleviated by adding pre-emphasis in the detector path, as in the dbx system, giving combined result of curve b. Low frequency pre-emphasis, included in curve c helps to reduce audibility of hum signals.*

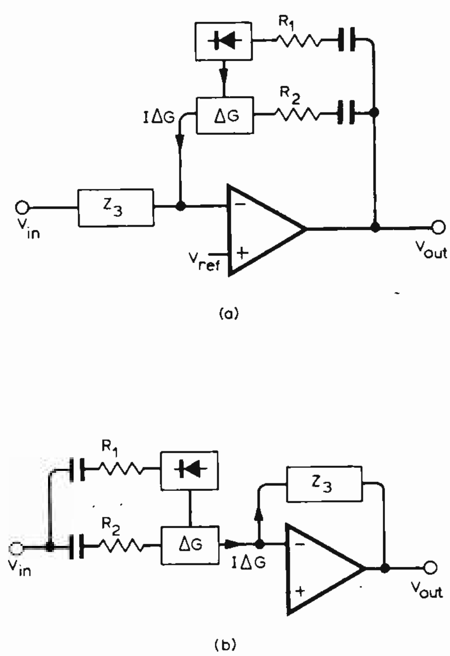
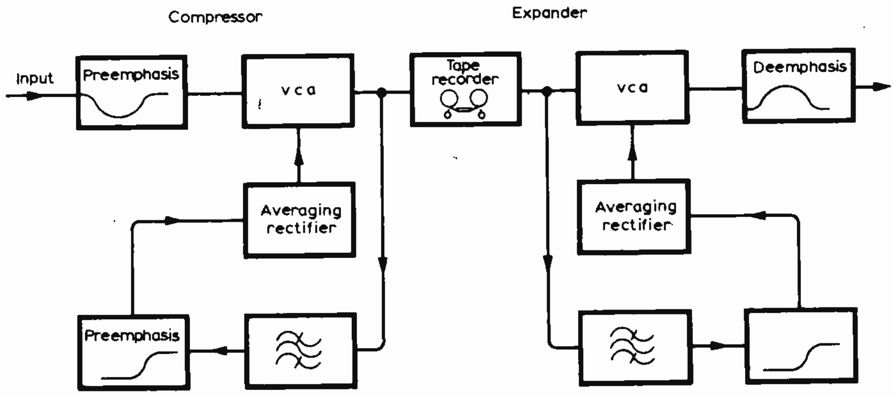


Fig. 3. *Variable-gain circuit in compressor (a) and expander (b) provides signal current into the op-amp whose amplitude is proportional to the average of the current flowing in the rectifier circuit.*

*M. G. Duncan, D. Rosenberg, & G. W. Hoffman. *Journal of the Audio Engineering Society*. Oct. 1975, vol. 23. Design criteria of a universal compander for the elimination of audible noise in tape, disc, and broadcast systems.

State of the art cassette tape decks costing say, £700, can offer a dynamic range of about 60dB, but a more realistic figure for machines which the majority of us are able to afford is about 45-50dB. As the signal-to-noise ratio of good quality discs played using high quality electronics can be about 60dB, f.m. broadcasts can be as good as 70dB, and live material can have a dynamic range exceeding 100dB, one must ensure that programme peaks do not cause tape saturation, thus losing the lower end of the dynamic range amongst the noise.

This problem has been addressed by many workers in recent years and the solution, in one form or another, is to use signal compression before recording and complementary expansion on playback. Possibly familiar is the Dolby B system for domestic use, providing up to 10dB reduction in noise frequencies above about 2kHz. Whilst a 10dB reduction is certainly worthwhile the remaining noise is still audible when listening at realistic sound levels. A more recent system, introduced by dbx Inc, yields improvements of 30dB and subjectively reduces noise to below audibility. Excellent though it may be, the system is still very expensive and so a circuit was designed with the aim of approaching the dbx performance but which was well within the scope of the amateur constructor.



The circuit achieves noise reduction by wideband compression and expansion. The compressor contains a voltage controlled amplifier (v.c.a.) whose gain is inversely proportional to the average value of its output voltage, i.e.

$$G = \frac{k_1}{V_{out(av)}} = \frac{k_1}{GV_{in(av)}}$$

$$\therefore G = \left(\frac{k_1}{V_{in(av)}}\right)^{1/2}$$

The gain of the v.c.a. is controlled by the d.c. output of an averaging rectifier stage whose output is proportional to the average value of its alternating input voltage. If input V_{in} changes by, say, +20dB then the gain will change by −10dB thus the output will increase by only +10dB. Square-law expansion is the exact complementary process. i.e. $G = k_2 \times V_{in(av)}$ thus an input change of +10dB will cause the gain to increase by +10dB and the output to increase by +20dB.

ping is that of hum pumping. This arises when the playback signal from the tape recorder contains an audible hum component. This hum signal will also be pumped up and down in level by the signal. Now whereas a high level signal will effectively mask a high frequency noise component the same is not true for a low frequency noise component (hum) hence hum pumping is subjectively even more annoying than h.f. noise pumping. This problem is eased by the use of low frequency pre-emphasis and curve (c) in Fig. 2 shows the overall compressor frequency response of the final circuit. Note that the end-to-end frequency response of the compressor and expander combination is flat since their frequency responses are complementary to each other.

In any compander system the bandwidth of signals presented to the device which measures signal level and hence controls signal gain should be the same in expand mode as in compress mode. From any high quality music source the bandwidth could be up to 20kHz whilst a low quality cassette tape recorder may have a bandwidth of only 10-12kHz. Such a mismatch means that the signals seen by the rectifier circuit are not identical on record and playback. Since most of the energy of music signals is contained in frequencies below 10kHz a 20Hz-to-10kHz bandpass filter is included in the signal feed to the rectifier to prevent this bandwidth mismatch. The lower filter frequency of 20Hz ensures that subsonic signals such as turntable rumble or acoustic pickup from passing heavy goods vehicles do not cause rectifier mistracking. The compander integrated circuit used is the Signetics NE570 which contains a stereo pair of compander circuits. Each half of this chip contains an operational amplifier, a variable gain cell and an averaging rectifier circuit. The variable gain cell can be thought of as the v.c.a. but it provides a signal current into the summing node of the op-amp whose amplitude is proportional to the average amplitude of the signal current flowing into the rectifier circuit. The relationship, with symbols as in Fig. 3(b), is

$$\frac{V_{in(av)}V_{in}}{70\mu A \times R_1R^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

The basic configuration of the NE570 in both compress and expand modes is given in Fig. 3. In compress

$V_{in} = Z_3 I_{\Delta G}$ (considering magnitudes only)

and V_{in} in equation 1 becomes V_{out}(comp)

$$\therefore V_{in} = \frac{Z_3 V_{out(av)} V_{out}}{70\mu A x R_1 R_2}$$

If we write $V_{out} = GV_{in}$

$$\text{then } \frac{V_{out}}{V_{in}} = G = \frac{70\mu A x R_1 R_2}{Z_3 G V_{in(av)}}$$

$$\therefore G = \left(\frac{70\mu A x R_1 R_2}{Z_3 V_{in(av)}}\right)^{1/2},$$

which is a square-root compression law.

$$\text{In expand, } V_{out} = Z_3 I_{\Delta G} = \frac{Z_3 V_{in(av)} V_{in}}{70\mu A x R_1 R_2}$$

$$\text{or } V_{out(av)} = \frac{Z_3 V_{in}{}^2{}_{(av)}}{70\mu A x R_1 R_2},$$

which is square-law expansion.

★ ★ ★

IN THE EXPAND MODE the output noise of the NE570 is about 20μV and the maximum signal output available is around 5V r.m.s. (2V r.m.s. in compress). Thus the available dynamic range of this chip is in excess of 105dB. To take maximum advantage of this very good figure an input amplifier stage in the form of an LM381 low-noise chip is used to drive the NE570 at fairly high levels on playback see Fig. 4. Resistors R_4 and R_3 bias the output voltage to about half supply voltage. The configuration chosen also allows the gain in playback and record modes to be changed very easily. The value of R_1 was chosen to suit my hi-fi set up and allows a maximum input signal level in compress mode at any frequency of 2.0V peak. And the value of R_2 was chosen to suit my tape recorder when playing back signals recorded at −10 to −6VU. In the expand mode the absolute maximum input signal is 300mV peak.

Referring to Fig. 3 the complex impedance Z_3 is realised in Fig. 4 by R_5, R_6 and C_7. These components provide the signal pre-emphasis as follows. At low frequencies C_7 is virtually open circuit and Z_3 is 100kΩ. As frequency increases the reactance of C_7 decreases and gradually shunts R_5 with R_6, until at high frequencies C_7 is virtually a short circuit. The h.f. impedance of Z_3 is then 33kΩ in parallel with 100kΩ (25kΩ) i.e. 12dB lower than the low frequency impedance. Hence the 12dB pre-emphasis prior to compression and 12dB de-emphasis after expansion. The value of Z_3 was chosen so that the average gain of the NE570 at the signal levels involved was approximately unity. Thus on switching the noise reduction system in and out there is little or no difference in output level.

The NE570 is d.c. biased with R_7 and R_8 with a.c. feedback being returned to ground by C_8.

Input offset currents in the variable-gain cell can cause even-harmonic distortion which can be trimmed out if desired; it is quoted as typically 0.3% if pins 8, 9 of IC_2 are left unconnected. Provision is made on the p.c.b. for R_9, R_{10} and the pre-set resistor which can be included to trim the distortion down to 0.05%, given a distortion meter to set up this adjustment.

Capacitor C_{10} is the rectifier averaging capacitor and its value determines the transient response of the compander. The value of 3.2μF was determined by experiment only and was found to suit the type of music which I most often listen to (pop with some lighter classics). You may of course, choose other values to suit your own preferences.

Resistors R_{12} and R_{13} are included to refer the a.c. signals to ground so that on switching between in and out, or between compress and expand, large d.c. changes are not passed on to the output resulting in loud "thumps".

The rectifier bandpass filter and pre-emphasis are realised by IC_3, a quad op-amp, also a fairly conventional voltage-controlled voltage source type of active filter. Resistors R_{24}, R_{25} and R_{18} bias the filter output voltage to half supply voltage.

Components R_{21}, R_{22} and C_{16} provide rectifier pre-emphasis. At low frequencies C_{16} is open-circuit and the closed-loop gain of IC3b(d) would be $R_{23}/(10+100)$kΩ. At high frequencies C_{16} is short-circuited and the gain is $R_{23}/10$kΩ, i.e. 20dB higher.

Signal pre-emphasis at low frequencies is produced by C_{11} in conjunction with R_{11} and the internal 20kΩ resistor. Resistor R_{26} limits the maximum l.f. pre-emphasis to 12dB. In compress, this network controls the feedback current via the ΔG cell and in expand the network controls the input current to the NE570 op-amp. Components R_{11}, C_{11}, R_{26} provide l.f. pre-emphasis in the compress mode and l.f. de-emphasis in the expand mode. If you find that hum pumping is still a problem experiment with different values of C_{11} and R_{26}, according to how much hum is present in the tape recorder playback output.

The lowish value of C_9, in conjunction with the low values of R_{14}, R_{15} forms a high pass filter (f_0 20Hz) to remove the change in direct voltage which occurs at the NE570 output pins when the gain changes. This does not affect the l.f. signal frequency response however, because C_9 is within the feedback loop around the NE570.

I chose to use flat p.c.-mounting NF-type relays by Thorn or National Panasonic to achieve signal switching between compress and expand mode and to switch the processor in and out of circuit. Multipole switches, other types of relay or even semiconductor switching may be used, but the p.c.b. design accepts only the NF relays, however. It is advisable to use separate power supply and earth return leads for the relays. The relay coil current is about 40mA and this will avoid small

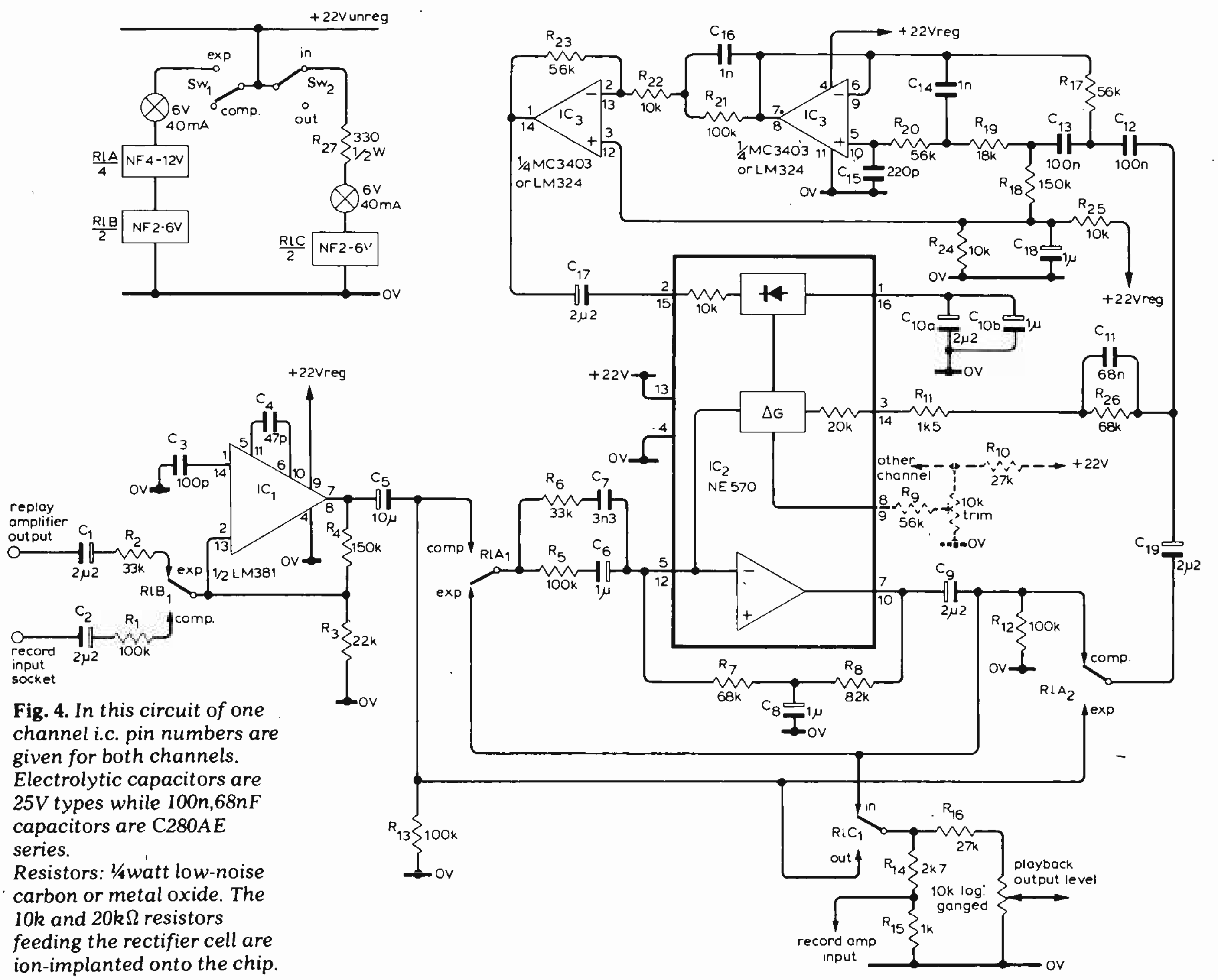
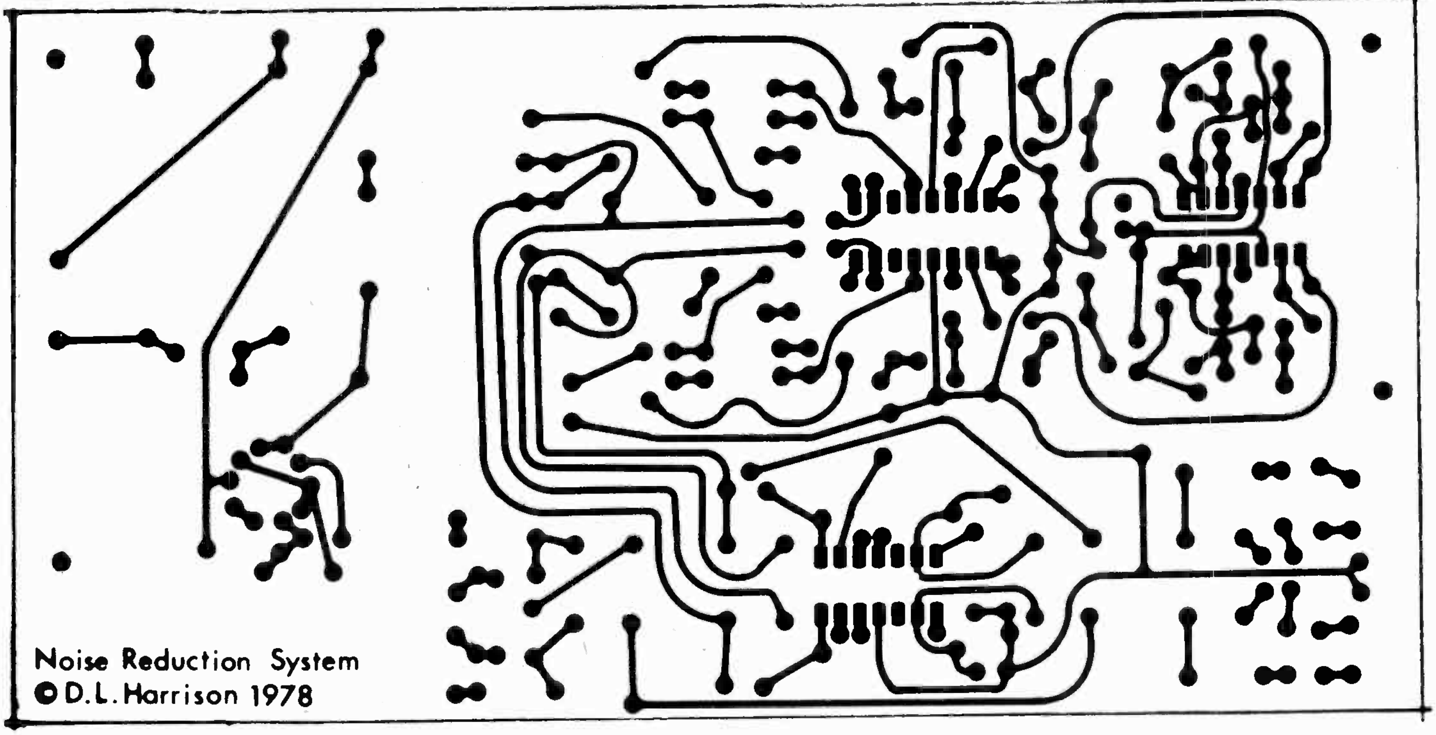
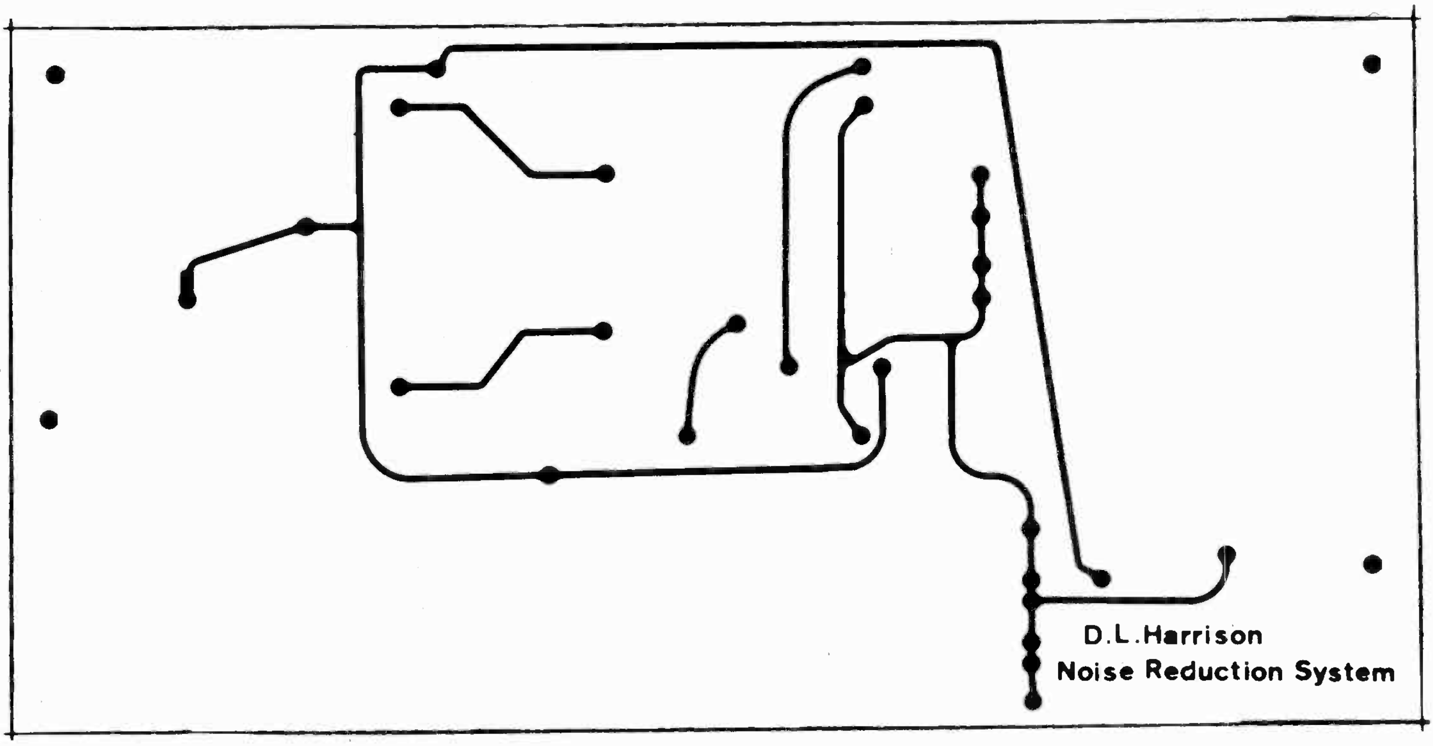


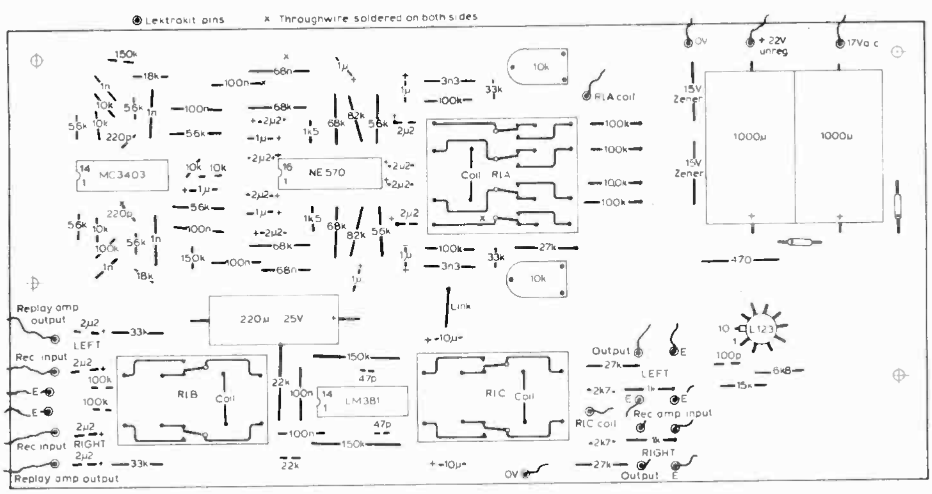
Fig. 4. *In this circuit of one channel i.c. pin numbers are given for both channels. Electrolytic capacitors are 25V types while 100n,68nF capacitors are C280AE series. Resistors: ¼watt low-noise carbon or metal oxide. The 10k and 20kΩ resistors feeding the rectifier cell are ion-implanted onto the chip.*





Double-sided glass fibre printed boards are available from the author at 22 Chandos Drive, Martlesham, Woodbridge, Suffolk IP12 4TA at £3.50 inclusive. NE570 i.c. costs £4.95 from the same source.

Board holes are 0.8mm dia. except mounting holes (3.5mm), potentiometer holes (1.3mm), and relay, terminal connections and power supply components (1mm).



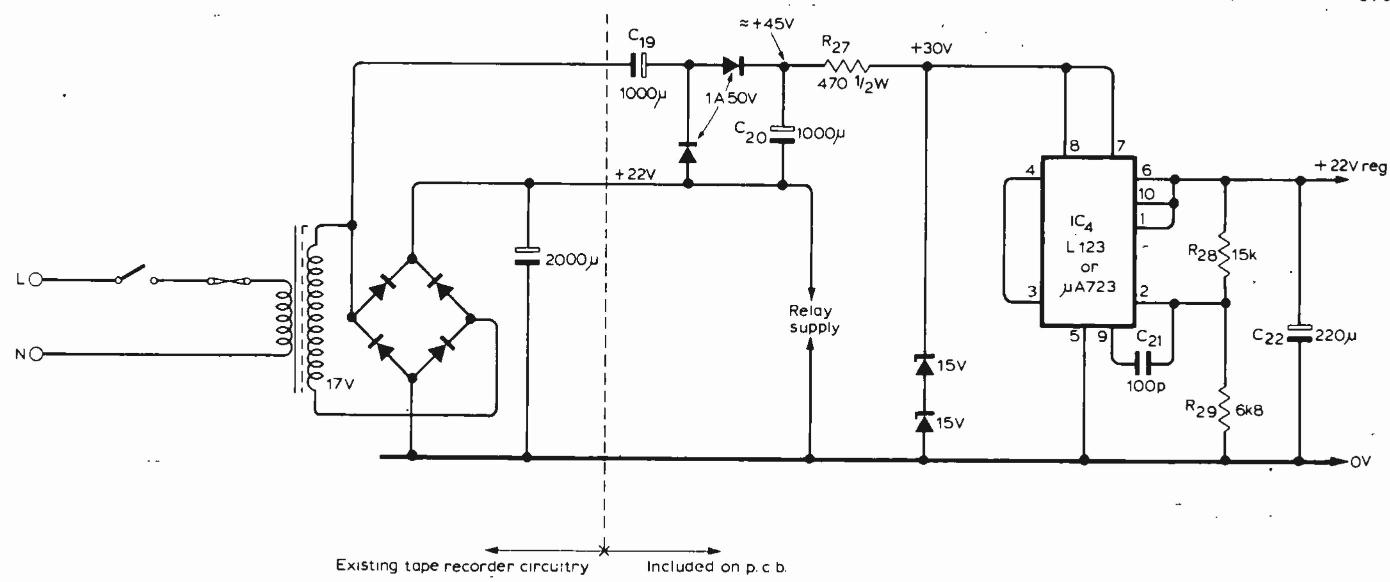


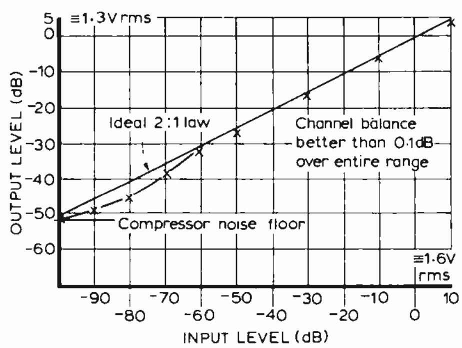
Fig. 5. *Printed board design includes the power supply components to the right of the broken line of this suggested circuit.*

clicks being heard due to transient voltage drops in the signal earth line.

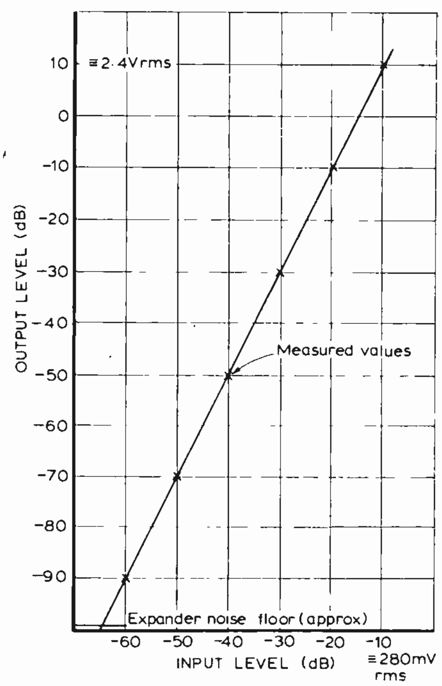
A possible power supply circuit is show in Fig. 5. As my system was to be built into an existing tape recorder I used its existing mains transformer and rectifier. The transformer secondary provided about 17V r.m.s. on load and could easily cope with the extra loading. The circuit consumes about 20mA, the relays up to 80mA and the voltage regulator another 5mA. The rectified output voltage on the reservoir capacitor of the tape recorder was about 22V d.c. on load. A voltage doubler circuit was used to obtain a voltage of about +45V. The voltage applied to the L123 voltage regulator i.c. is dropped by R_{27} and limited under no-load conditions by Z_1 and Z_2 to about 30V. The ratio $(R_{28} + R_{29})/R_{29}$ determines the output voltage. The p.c.b. design includes the power supply components to the right of the broken line in Fig. 5. The current through, and the voltage drop across, the L123 are sufficiently low for there to be no need to heatsink it.

Precautions

When a music signal is compressed, regardless of whether pre-emphasis is used or not, its tonal balance is dramatically changed. This is because higher frequency components of the signal for example cymbals, wire brush, etc., in general contain less energy than the low or mid-range frequencies. Because of their lower amplitude, when passed through a compressor they will be amplified more, relative to the lower frequency instruments, when there are no other high level signals present. This is confirmed by listening to a compressed music signal, even without pre-emphasis, when it sounds extremely bright and toppy. When recording a compressed signal, therefore, the problem of h.f. tape saturation is made even worse because there is now a greater proportion of high frequencies to deal



Compressor law with ideal curve and measured values. Measurements made at LM381 input and NE570 output at 1kHz.



Expander characteristic with ideal square law curve and 1kHz measured values (marked x).

with. This has the effect of making the waveform even more peaky in nature. If the tape recorder VU meters are of the simple averaging type instead of peak-responding then recording at levels which cause the VU meters to peak at 0VU may well cause h.f. clipping. This causes high frequency instruments to sound rather like two sheets of glasspaper being rubbed together! I found it necessary to record at levels not exceeding −6VU. This is no disadvantage because the noise reduction obtained is sufficient to ensure that tape noise is still inaudible, even when recording at these lower levels. Indeed the frequency response will almost certainly improve by recording at lower than normal levels. Determine the optimum record level and adjust R_2 to alter the gain of the LM381 stage. This compensates for lower or higher output voltages from the tape playback amplifier.□

Come and see us at "Breadboard '78"

Wireless World will be taking part in "Breadboard '78", an exhibition of electronic "kits and bits" to be held at Seymour Hall, Seymour Place, London W1, November 21-25, from 10 a.m. to 7 p.m. each day. Admission price is £1.00 (students 70p). Readers will be welcome at our stand, No. B4.

Breadboard survey – p.91

LETTERS TO THE EDITOR

INTERNATIONAL VIEWDATA/TELETEXT STANDARD

In the August issue of *Wireless World*, I read a report entitled "Systems rivalry for international viewdata and teletext." I am very interested in this report, in which I have found serious mistakes. These may lead your readers to a complete misunderstanding of what really happens and I hope you will publish some clarifications and corrections: the high quality of your public and the international reputation of your journal deserve more consideration than is shown in this anonymous report.

First, it is useful to recall that an international standard for a communication service is not issued from one national body or from one country. It comes from long discussions in international organizations such as EBU and CCIR for broadcast services and CEPT and CCITT for telecommunication services. The ISO may also be involved when data processes are concerned. Every country may take part in these discussions and propose its national solution as an example in order to reach a compromise, acceptable at the international level. There is no "systems rivalry" in this fact but international cooperation between administrations from which progress may come.

This does not preclude, unfortunately, competition between industries, and it is often a temptation for them to try advancing their own products as internationally standardized equipment. This is not the case for CCETT, which is a little study centre of French broadcasting and telecommunication administrations (and not a massive research centre as is said somewhere in your report). It is one reason why, at the Rennes meeting in late January this year, a compromise was found, compatible with present viewdata and with significant differences from the present Antiope. The fact is that French and German representatives said that they prefer to lose money now, keeping present systems for experimentation only and awaiting an international agreement to develop the definitive one. Unfortunately, the agreement obtained in Rennes between the three participants was unhappily no longer supported by the UK administration (probably due to some pressure from industry which supported the Ceefax/Oracle development) and the proposal made by the German Bundespost and the French Administration to CEPT was then modified at Darmstadt in a manner that gave better compatibility with existing standards and a lower compatibility with the viewdata system. It has been, since then, supported by six European administrations and forwarded to CCITT and ISO.

This common CEPT proposal keeps the original principles of the Antiope system presently exploited on broadcast and in interactive operations with enhancements due to contributions of other countries. It appears as an important step towards an internationally agreed standard. The Munich demonstrations for CCITT Study Groups I and VIII were of the present experimental Antiope standard and, of course, not of the proposed one. They did not suffer from a communication breakdown, as said in your report, but the demonstration given for Study Group VIII did suffer from the effects of a nice wine party kindly offered to delegates by the German Post Office! But that is another story.

Another clarification should be made. A report and contributions have been written by CCETT showing that, with the Antiope system or according to its philosophy, a twin character set is enough for all CEPT and EBU countries. A BBC report from John Chambers shows that with the teletext system it should be necessary to use seven character sets, and a GPO contribution to ISO claims the need for three character sets. But this is a minor error of your report: the box describing the Antiope system is full of such errors and confusions between the system at present used and the proposals made for international discussion. We would be very pleased to have the opportunity to describe in detail for your readers either the present Antiope broadcast or interactive system or the present state of proposals for a European standard. We consider that they deserve a complete treatment rather than such a polemic.

B. Marti
Centre Commun d'Etudes de Télévision et Télécommunications (CCETT)
Rennes
France

Editor's note: CEPT stands for Conférence Européenne des Administrations des Postes et des Télécommunications.

F.M. TRANSCEIVER SYNTHESIZER

The use of a 10.7 MHz crystal in the CA3089/HA1137 quadrature detector for n.b.f.m. most certainly does work and not as your correspondent J. D. Stumbles suggests (September Letters). In my own 2m synthesized transceiver which was built from an American ham radio article, I found that the usual LC circuit in this application was useless, being very unstable and subject to drift. This can easily be seen with the use of a centre zero meter connected between pins 7 and 10 (with the usual 4.7kΩ-5.6kΩ series resistor). Tuned to a steady signal, the pointer goes from one side to the other as the quadrature LC tuned circuit drifts. Now, the use of the crystal completely eliminates this, but the secret is to damp the crystal with about 4.7kΩ in parallel with it. It will be found that the choke shown in the original article (between pins 8 and 9) must be replaced by a very small capacitor, typically 1pF. In my case I used ½ inch of twisted wires. In fact the crystal may not act exactly on 10.700 MHz as the circuit capacitance will more than likely differ from the crystal design shunt capacitance of 25-30pF. This usually gives rise to no problems unless the use of a centre zero meter is used, and is largely academic.

Of greater concern is the well known property of this i.c. that with a high gain front end, or the use of a pre-amp, the squelch facility does not work. This can be overcome with an external squelch amplifier, and several circuits have been published lately (see recent editions of *Radio Communication*).

The CA3089/HA1137 is quite capable of giving good results with n.b.f.m., and with a narrow filter and CA3089 I have plenty of recovered audio, and a stable receiver demodulator.

Stephen J. Gilbert G30AG
Manchester 16

V.H.F. FREQUENCIES

I read with interest 'Cathode Ray's' contribution to your September issue and noted in particular his reference to the benefits for v.h.f. broadcasting if more of the 88-108 MHz band is made available for the purpose of broadcasting. While he is, of course, right in referring to this as in some sense a broadcasting band, in view of its general designation as such within the ITU I really must point out that very many very large mobile radio users in this country currently have assignments in this frequency range for p.m.r. You will, of course, appreciate that not only would we view with horror the loss of any part of our currently available spectrum, but mobile radio users generally are experiencing greater difficulty in securing what we would consider appropriate assignments from the Radio Regulatory Department of the Home Office, and we are, therefore, pressing for considerable additional spectrum to be made available to us.

I would not want to propound a dog in the manger attitude. I think we all realise that there is a legitimate claim on spectrum for many different uses and broadcasting is quite demonstrably one of them but we do have to learn to live with each other and any significant changes can only be made over quite a long term, otherwise the cost implications for many p.m.r. users are frightening.

M. S. Hicks
Greater Manchester Transport
Manchester

A.M. BROADCAST RECEPTION

While having no quarrel with the sentiments expressed by 'Cathode Ray' (September issue) on the lack of programme choice offered to v.h.f. listeners, I should like to challenge his (and, it seems, just about everyone else's) assumption that a.m. reception in the medium-frequency broadcast band need always be as poor as it usually is, and to press for a.m. quality to be taken more seriously by broadcasting authorities and receiver manufacturers alike.

This band is usually dismissed as hopeless for quality reception because it is horribly congested — which it is, but only *at night*. During the day, at all the locations in the UK and Europe that I have visited, I have never counted more than half a dozen strong local transmissions and at most twenty more distant ones, on a typical domestic receiver. Between them, there is more empty spectrum, proportionately, than in the v.h.f. broadcast band. I would therefore submit that there is a strong case for increasing the transmitted bandwidth of medium frequency transmissions to 13.5kHz during the hours of daylight, consequently radiating a very small amount of energy into the two adjacent channels on either side of the allocated frequency. Since the benefits of the widespread (but fortunately not universal) practice of eliminating audio frequencies above 5kHz are only fully conferred on those few receivers whose selectivity already introduces a comparable degreee of sideband cutting prior to the detector, adjacent channel interference is unlikely to be any worse than it is at present for the vast majority of listeners. Indeed, I should be surprised to hear of instances where listeners, tuned to their local programmes during the hours of daylight, are suffering this form of interference at all, since co-sited transmissions are invariably well spaced along the band.

This would involve, of course, acceptance by transmitting authorities and receiver manufacturers that the proper organisation of medium-frequency broadcasting consists of producing not one inevitably unsatisfactory compromise between day and night-time reception, but two distinct approaches optimised for two completely different sets of circumstances. This has never been accepted by domestic broadcasters — planning still takes place on the basis that only the ground wave is to be trusted and the sky wave is just a damned nuisance, with the absurd result that, for instance, it is easier in many parts of Scotland to receive Deutschlandfunk than it is to hear the BBC, after dark.

Given that an improvement in bandwidth is quite feasible during the daylight hours, let's also do something about the signal-to-noise ratio. First, consider spending half as much as your three-element cost on a long piece of wire and a few insulators, and admit that a ferrite rod is not the last word in aerials.) As far as dynamic range is concerned, it is generally accepted that a good deal of compression is advantageous on a.m. radio — but why not standardise the characteristic, and introduce corresponding decompression on up-market receivers? It is saddening that a.m. has been largely ignored in experiments on noise reduction when it obviously is in much greater need of it than its f.m. counterpart.

Receiver manufacturers ought to tear themselves away from the esoteric delights of designing even more spectacular f.m. receivers, the advantages of which are unlikely to be appreciated by the user, whose transmissions do not exceed broadcast standards even if his tuner does. How many hi-fi manufacturers dare publish the recovered frequency response and distortion figures for the a.m. sections of their equipment? How many reviewers comment on the a.m. performance of this equipment, except in a couple of lines vaguely indicating whether it is any better or worse than usual? How good is 'usual'? I have yet to come across a chrome-plated state of the art whose a.m. performance stands comparison with the Quad a.m. tuner, which is now a dated design, surely easy to improve on with modern devices and techniques.

It is not beyond the wit of man to design, at no great cost, an a.m. receiver with switchable bandwidth for day and night-time reception, low-distortion detection, a sensibly engineered audio response and (broadcasters willing) noise reduction, which would surely result in a.m. being weccomed as a useful additional service, instead of tagging along as such a poor relation of f.m. as to be worth little time or trouble.

Nor, I venture, is it impossible to reduce interference from television timebases, fluorescent lights, thyristor dimmers, etc. If the legislation we have is not adequate to deal with such problems it should be strengthened, and if it is adequate, it should be enforced more thoroughly. Right now, using an inexpensive but high-performance receiver[1], I can enjoy reception of certain transmissions which would astound those who cringe at the very thought of listening to an a.m. broadcast. And even if no-one will soil their hands trying to improve it, medium-frequency broadcasting will be with us still, for better or worse, in the foreseeable future.

Norman McLeod
Brighton
Sussex

Reference

1. J. W. Herbert, 'A homodyne receiver', *Wireless World*, September 1973, pp.416-419.

Editor's note: Readers may like to consider the first part of this letter in relation to the discussion in "The UK wavelength changes" by G. H. Sturge of the BBC elsewhere in this issue.

EUROVISION LINKS

In your somewhat facile dismissal of Eurovision programming (July issue, page 50) you imply that "football matches, 'It's a Knockout' and ... the Eurovision Song Contest" do not merit the retention of international television links. As is well known, these programmes are among the most popular shown on British television.

In addition, you ignore the thrice-daily Eurovision News Exchanges, from which the UK broadcasters obtain many of their news items and to which they make a valuable contribution, not to mention many other programmes that do not fall into the three categories mentioned.

I venture to suggest that you try pulling the plug on the Olympic Games in 1980 to see whether the television public share your opinions (or even your sense of humour).

R. Gressman
Technical Centre
European Broadcasting Union
Brussels

THE NAKED MICROPROCESSOR

Although I wholeheartedly agree with Mr Parr's comments about software development and maintenance (Letters, August), I feel I must challenge his view that microprocessors will remain essentially "naked."

Microprocessors were indeed developed as programmable logic, but it has become abundantly clear that the architecture of the first ones does not readily support development of large and complex programmes, particularly when written in machine code. It is interesting to note that the 16-bit microprocessors currently under development by Intel, Motorola and Zilog all have much more sophisticated architectures which are not only much closer to those found in "conventional" computers but which also make the job of high level language implementation much easier.

The rapidly decreasing cost of both hardware and software is likely to be crucial to the development of more complex systems. Hardware, particularly memory, is coming down in price constantly and there does not seem to be any likelihood that this trend will stop soon (although it might be slowed down by another "memory famine"). Software is also very cheap due to the sheer size of the market and there are signs that as this expands the prices will fall considerably lower.

There is also an increasingly large number of high level languages available: PL/1, CORAL 66, Micro COBOL, etc. This diversity means that it is easier to find software tools suited to the job in hand rather than constructing one's own or doing without.

It is to be hoped that the naked microprocessor will not be with us for very much longer; it has already donned underwear and soon it may be dressed, in stout winter clothing, to meet the storm of problems, the howls of which can already be heard!

M. R. Barrett
Hextable
Kent

ARE YOU SITTING COMFORTABLY?

"I have a dream about the future. I see the interior of a living-room. The wide windows are formed from double panes of glass, fixed and immovable. The conditioned air is fresh and warm. Old-fashioned people would feel uncomfortable without the fire and fireplace, others might miss the raucous brown box we used to call "the wireless".

But flush against the wall there is a translucent screen with numbered strips of lettering running across it. The lettering spells out titles which read like newspaper headlines. These are the titles, describing the many different "broadcasting" programmes which can be heard by just pressing the corresponding button. . . . . . Television programmes are set apart – even as I run my eye down the titles some have changed, showing that a new item has superseded the old. . . . . . I lower myself into a chair and press the proper numbered button on a remote control panel place conveniently beside me. . . . . . Tonight is the television premiere of a new English comic opera – I must get my dinner soon or I shall miss the curtain, otherwise I would stay to see the end of the tennis. But I shall get the result in my house newspaper tomorrow . . . . . Printed while I sleep, by a machine in the lobby".

In these quotations from his book *The Power Behind the Microphone* (1941) P. P. Eckersley, Chief Engineer of the BBC, 1923 to 1929, was dreaming of something which he admitted was "too expensive for practical realization".

Now that we are once again dreaming of the future ("The Paperless Revolution," *WW* July 1978, p. 38) I believe that such "dreams" should be based upon our human limitations. Eckersley remarked upon "The control panel *conveniently* beside me". This is where I must disagree with Mr Cawkell: sitting at and concentrating on his "consumersole" is not going to be a pleasure for me, much as I will delight in the multiplicity of electronic joys that it may bring. The size of the screen will surely correspond to the angle of useful vision, and the controls must be "conveniently" (ergonomically?) placed.

What will our friends the psychologists think of sitting all day or even several hours at the console?

G. Beard
London SW4

Telesoftware

Home computing via teletext

by John Hedger, Oracle service, Independent Television

Telesoftware is a name given to a scheme for broadcasting computer programmes, by means of the teletext service, directly into microcomputers built into the teletext decoders of tv receivers. The television set becomes in effect a computer which receives its programme instructions by off-air signals rather than from a local source. As well as being available to the domestic user the service could be of value in education, science and business. A study by the Independent Television Companies' Association has resulted in an experimental demonstration decoder-terminal (shown at the recent International Broadcasting Convention), which is now being tested on-air. In this article the author reviews the progress of the project, and looks at possible applications for this new broadcasting technology.

THE WORD 'Telesoftware' was coined by W. J. G. Overington, the man who proposed the idea. It literally means 'software at a distance' and refers to the transmission of programmes for a microcomputer via teletext. Software bytes are represented by pairs of standard teletext characters, thus utilising an existing and well-proved transmission technique.

The standard teletext decoder is, in fact, well suited to be adapted to work as a small computer. Its character generator and associated display circuitry can be pressed into service as a visual display. It has a page store which may be used as memory. Even its numerical keypad, normally used to select teletext pages, can be used to enter simple data. With the addition of a suitable microprocessor, extra memory and other interfacing circuitry, the result is quite a powerful stand-alone computer, right inside the television set itself.

At this stage, there is no mass-storage available, but since all the software for such a system can be stored in and transmitted from the teletext data base, the user only has to select the required page(s) containing his desired programme. Once this has been read in, it may be loaded and executed by the microprocessor, obviating the need for expensive storage peripherals or even a telephone line. Thus, once the hardware has been obtained, Telesoftware is a completely free service.

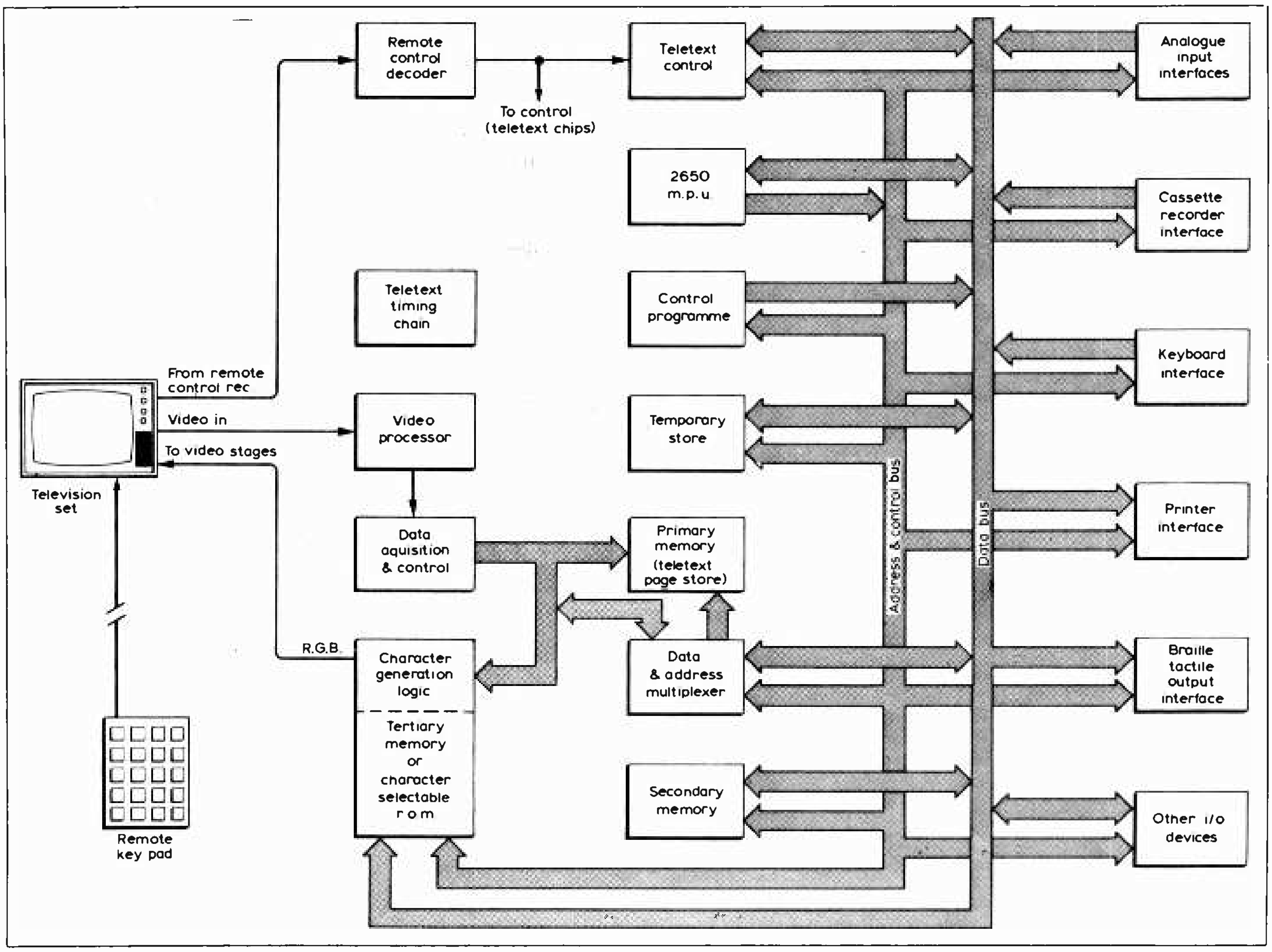


Fig. 1. *Block diagram of ideal Telesoftware concept.*

The number of separate computer programmes which may be carried by a teletext system at any one time is, of course, subject to the same limitation as the number of normal pages of text: namely, that an increase in the number of pages causes a corresponding increase in the time required to gain access to any one page. Programmes themselves, however, need not be confined to a single page, and may consist of data carried on a number of sequentially linked pages. The advantage of this is that no matter how many separate pages are employed in such a sequence, the total increase in access time on the system is limited to the time taken to transmit one page. For this reason, all Telesoftware experiments to date have been made using this method of transmission.

The original specification

The Independent Television Companies' Association has been broadcasting Oracle, a teletext news and information service, since mid 1975. After about one year of operation, ITCA were approached by W. J. G. Overington with a proposal for a Telesoftware system. At ITCA it was felt that the idea had some exciting possibilities for Oracle, and in late 1976 Overington drew up a provisional specification for Telesoftware, based upon the use of the Signetics 1650 microprocessor.

The first specification drawn up was somewhat open-ended; deliberately so, since this would allow changes to be incorporated with little difficulty. The primary aim at this stage was to interest manufacturers of decoders, broadcasters and the computer industry. The system proposed was designed around a standard teletext decoder together with a Signetics 2650 microprocessor, extra memory and interfacing logic.

The main memory used the teletext page-store r.a.m. (random access memory) already to be found in the decoder. This was arranged as two 512 × 7 bit memory blocks, and would allow programmes to be entered as 23 rows of 32 columns of teletext characters. A secondary memory was also specified; this being 8K bytes of extra r.a.m. storage. There was also a tertiary memory. This was intended to act as a partial or complete replacement for the standard teletext character r.o.m. (read-only memory), so as to allow any character set to be remotely defined to a terminal.

There was also provision for eight toggle switches to be used as an input register. An optional control programme, held on erasable p.r.o.m. (programmable read-only memory), was included, although for cheapness there was provision for a control programme to be loaded from teletext itself.

Progress of the scheme

The first broadcast of Telesoftware (a simple programme written by Overington) took place during late February, 1977. Although fairly well reported the transmission simply served to provoke interest, since the project was still embarrassed by the lack of a working terminal on which to demonstrate programmes. The situation was solved towards the end of 1977, when the ITCA initiated a study project to design and build an experimental Telesoftware terminal for demonstration purposes. It was decided to use for the experiment a simplified and somewhat modified version of Overington's original specification. Work began towards the end of that year.

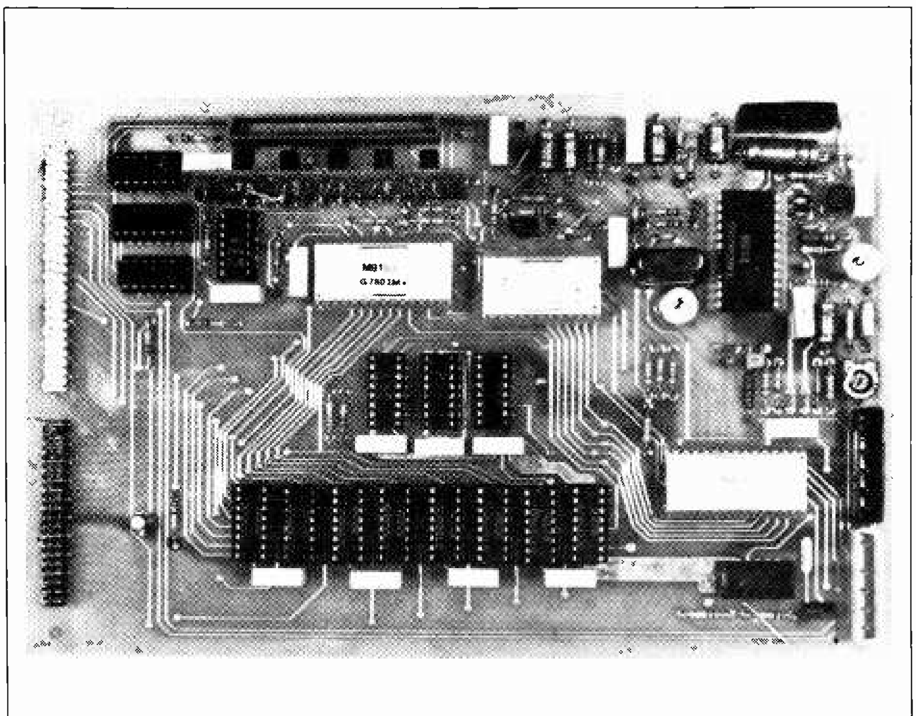


Fig. 2. *Mullard teletext decoder module.*

The aim of this project was clearly-defined; to produce a terminal capable of very quickly demonstrating the concept of Telesoftware. As a result the design was somewhat crude and far from the optimum. It was felt that by showing in a very limited way what was possible with Telesoftware this would further stimulate the interest of decoder manufacturers and broadcasters who, in the future, might continue the development to a stage where a specification for the 'ideal' software system could be incorporated as an important extension to teletext. Fig. 1 shows how such an ideal design might look.

Compatibility with teletext

It was realised at a very early stage that Telesoftware could not be allowed to interfere in any way with the present teletext specification – indeed, would have to be structured in such a way as to remain compatible with modifications which might be made in the future. For this reason, it was decided to base experimental work upon the use of entirely standard teletext transmission techniques, using normal characters in pairs to represent bytes of programme. The redundancy was used in order to preserve the integrity of the data using the Hamming error-correction techniques.

It would in the future be technically possible to use some of the extra eight rows per teletext page (25-32) which are specified as being available, although not capable of being displayed on a normal decoder, for the transmission of Telesoftware data, thus separating it from the normal editorial output. Alternatively, if normal pages were to be used it might be desirable to set a control bit in Row 00 (the header row) so as to inhibit the display of what to the viewer of a normal decoder would appear as gibberish text!

Experimental terminal

The design of the experimental terminal consisted of a single add-on board for the Mullard teletext decoder module (Fig. 2). The new board (Fig. 3) contained some 45 i.cs, these being made up of secondary memory, a temporary store, an e.p.r.o.m. to hold a special control programme (to handle data storage, to store various system subroutines etc), plus, of course, a Signetics 2650 microprocessor. The design did not incorporate a tertiary memory since by this time a foreign language character facility was already available within teletext.

With large-scale integration, of course, the final design of a terminal could be reduced to two or three i.cs, but at this early stage discrete components were employed as a matter of practicality.

The teletext keypad, which would normally be used to select pages from teletext broadcasts, was also used for system control and user data entry. It was of the ultrasonic remote control type.

The main memory was the teletext page store addressed by two bytes of indirect address, the first pointing to a row and the second to a column address. This memory occupied the addressing range hexadecimal 2000 to 3727. The temporary store, which was used as a buffer between data in main and secondary memory while it was validated, was 256 bytes of r.a.m. in the range hexadecimal 1F00 to 1FFF. The secondary memory was 2K bytes of r.a.m. in the range hexadecimal 4000 to 47FF.

The control programme was held on e.p.r.o.m. and its functions were as follows:
- To accept and interpret commands.
- To validate incoming data, using Hamming techniques.
- To transfer valid data to secondary memory.
- To re-read data incorrectly received.
- To go to the start of a programme when correctly loaded.

The whole terminal was contained in a standard colour television set.

The decision to opt for a single microprocessor and associated instruction set was basically for convenience in this particular experiment. It may be that when a final specification for Telesoftware is agreed upon it will be desirable to transmit programmes in an intermediate language rather than in a specific instruction set. This would allow different microprocessors to be used and enable the system to support a high-level language (for example, BASIC). A high-level language interpreter would be resident (on r.o.m.) within the terminal, leaving only user programmes to be transmitted via teletext.

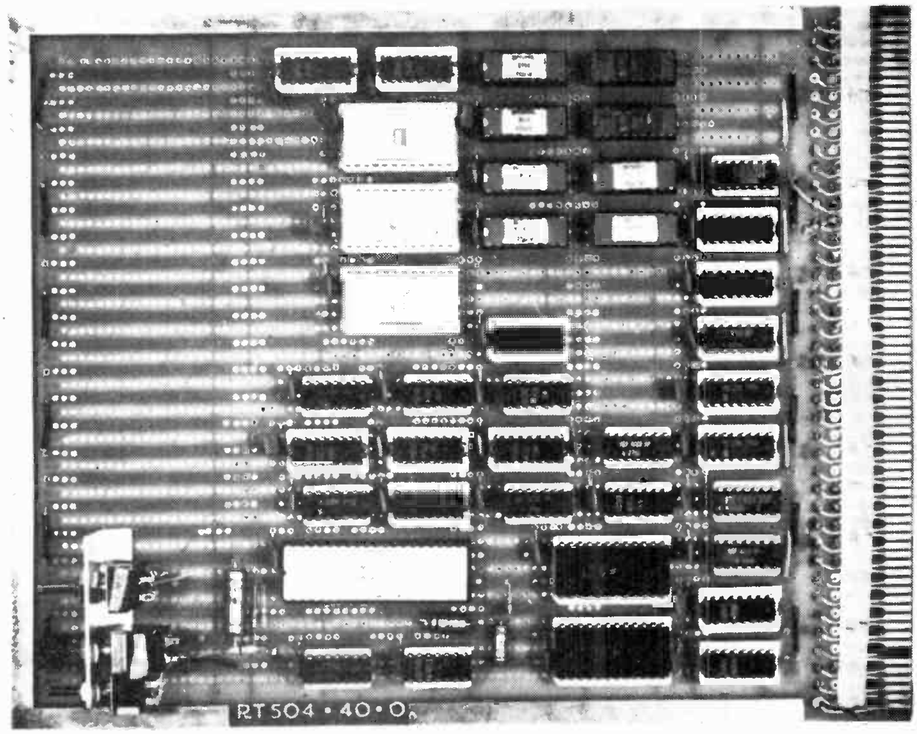


Fig. 3. *Add-on Telesoftware board to go with the teletext decoder in Fig. 2.*

It would in any case be unwise to specify a single m.p.u. device, since the system will undoubtedly have to take account of many future developments in microprocessor technology.

Experimental programmes

A number of simple test programmes were developed in order to demonstrate and test the basic workings of the system:

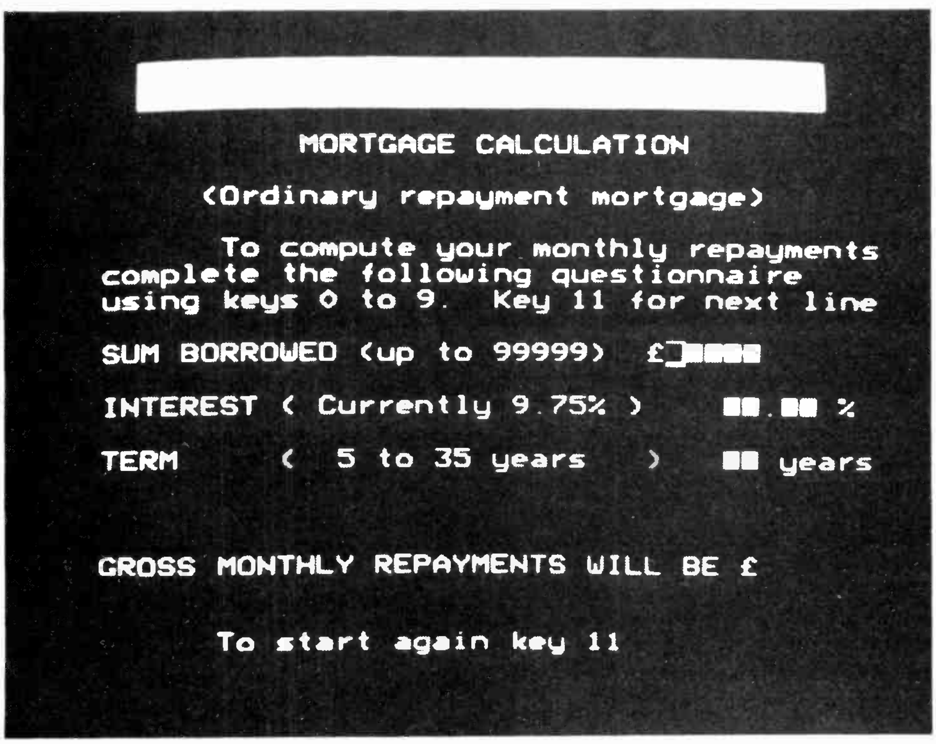


Fig. 4. *Display format used in mortgage calculation programme.*

"Test your e.s.p." was a teletext version of a well-known board-game. In this case the pattern which the player was invited to guess was generated randomly by the microprocessor and consisted of a string of 4 digits. The keypad was used to enter users' guesses. The programme was contained in about 2½ pages of teletext and intended specifically for demonstration at an exhibition.

"Mortgage calculation" allowed the user to define a number of variables in a mortgage repayment calculation, and the system would compute the repayment figure. Data for the programme was prepared by the Nationwide Building Society. (Fig. 4).

"First-aid" was designed to show the possibilities for educational uses of Telesoftware. By interacting with his terminal, the user can learn basic elements of first-aid by means of multiple-choice sequences.

"Insurance quotations service" was a programme provided by the Automobile Association for the self-assessment of insurance quotations for drivers. The programme simply asks a number of questions about the Proposer (=user!) to which he responds again by means of multiple-choice answers. The system then produces a quotation for car insurance based on his responses. This programme demonstrates the possibility of self-assessment through Telesoftware.

These programmes, and others which are being developed, are primarily intended to show the various areas of future applications for the system. Some of these are now discussed more fully.

Video games

The advantage of Telesoftware games is that the user may select from any game being broadcast, all of which can be played using the same hardware. There is no limitation such as those which are found in hard-wired games units of five or six games. Even with more sophisticated conventional games, of the cartridge type (r.o.m.-based), extra cartridges have to be purchased to vary the games repertoire. With Telesoftware every game is completely free of charge once the basic hardware has been purchased.

Depending on the complexity of the terminal, it would be technically possible to incorporate animated games, though at present games are limited to the display characteristics of the teletext format, which lends itself to games demanding verbal reasoning rather than pure hand-to-eye co-ordination. Such games also lend themselves to user input via the keypad, though it would be a simple matter to provide the terminal with one or more games 'paddles' via an analogue-to-digital converter.

Calculation and programme development

The system can be used for many different calculator type functions, e.g. tax calculations, gas and electricity consumption, metric conversion. However, for some users, a facility for developing their own programmes may be required. A high-level language such as BASIC would support such a facility though an extended ("qwerty") keyboard would be needed. It is likely that slots for extension boards (or simply sockets leading to built-in boards) would be an inherent feature of a terminal to permit the connexion of keyboard, cassette recorder, hard-copy printer, etc, in much the same way as in a conventional home computer.

However, the basic unit would be built with the more conventional user in mind who will probably be content to draw from the repertoire of programmes being broadcast on teletext. The possibility of extending the system easily to incorporate more advanced facilities could prove of great importance to educational bodies like the Open University, for whom Telesoftware could offer significant advantages with computer studies, etc.

Public information

Telesoftware may be used to provide public information of the kind often met when dealing with social security claims, health education and tax problems. All these cases often require some degree of assessment. With Telesoftware, this can be self-assessment – for example, with tax problems, a simple question-and-answer routine could probably cope with assessment of tax allowance eligibility. In this respect, Telesoftware offers a social advantage over a human adviser in many cases, since it seems that people are far more truthful and uninhibited when 'talking' to a machine instead of a human. Also, unlike a more conventional computer system, Telesoftware clearly has no means of storing the users' responses or communicating them to anyone else. This ensures security, very important when dealing, for example, with the medical field.

Education

A very large and important field of application of Telesoftware will be in education and computer aided learning. Telesoftware offers two significant advantages to the teacher: firstly, it is free, and secondly, any number of people may use it concurrently, since there is no apparent loading problem with the ether! Quite a number of proved but expensive systems already exist for computer aided learning, but all rely upon costly terminals and hardware, and are often used on a time-sharing basis, so loading probelms can occur at times of peak usage. Also, adult and further education could be assisted by Telesoftware, since it is as available in the home as it is in the classroom.

The Computing Unit at the University of Surrey is already deeply involved in the computer-aided learning field, and is now actively participating in the Telesoftware experiments.

Adult literacy and vocal output

Telesoftware could be used to provide a graded course of literacy for adults. It may be possible in the future for the terminal to have built into it a simple vocal output, using synthetic speech to back up written data, though at the time of writing the very considerable amounts of memory required to support this feature are not yet available at realistic cost.

It is also possible for a terminal to control a variety of domestic peripherals, set up telephone calls, control lights, etc. This would be of assistance to the handicapped and disabled. For the blind, teletext type data may be rendered usable by an electromechanical Braille output device of the type currently used in special computer peripherals. These use a 3 × 2 matrix of solenoids to give a tactile output along a 40-character row, though at present they are too expensive for the domestic user.

Telesoftware and the business user

Although the main use of Telesoftware will probably be in the home, there are a number of possible business applications for the system. One of these is in the detection of credit card fraud. Every terminal could be constantly supplied with the latest list of credit cards known to be lost or stolen, via teletext. The terminal store is kept constantly up-to-date, and at points-of-sale the assistant has simply to enter the number of the credit card which is presented on the numerical keypad. The terminal will scan its local store for that number and will report upon finding a match. The sales assistant can then take appropriate action. The advantage is that, unlike other similar systems, Telesoftware incurs no running charges, does not rely upon a telephone line, and is simple and cheap to install. The power to instantly update every terminal in the country with the latest stolen card numbers could be a real aid in preventing frauds involving credit cards, cheque cards, airline tickets, etc, which are constantly on the increase.

John Hedger has been involved with Independent Television's Oracle service since it started in 1975. He began his career with London Weekend Television in an administrative capacity but soon moved to programme production where he spent some time working on children's programmes. Since joining the Oracle project he has been closely concerned with both technical and editorial developments in the service and now has special responsibility for associated new technology, including Telesoftware and captioning for the deaf.

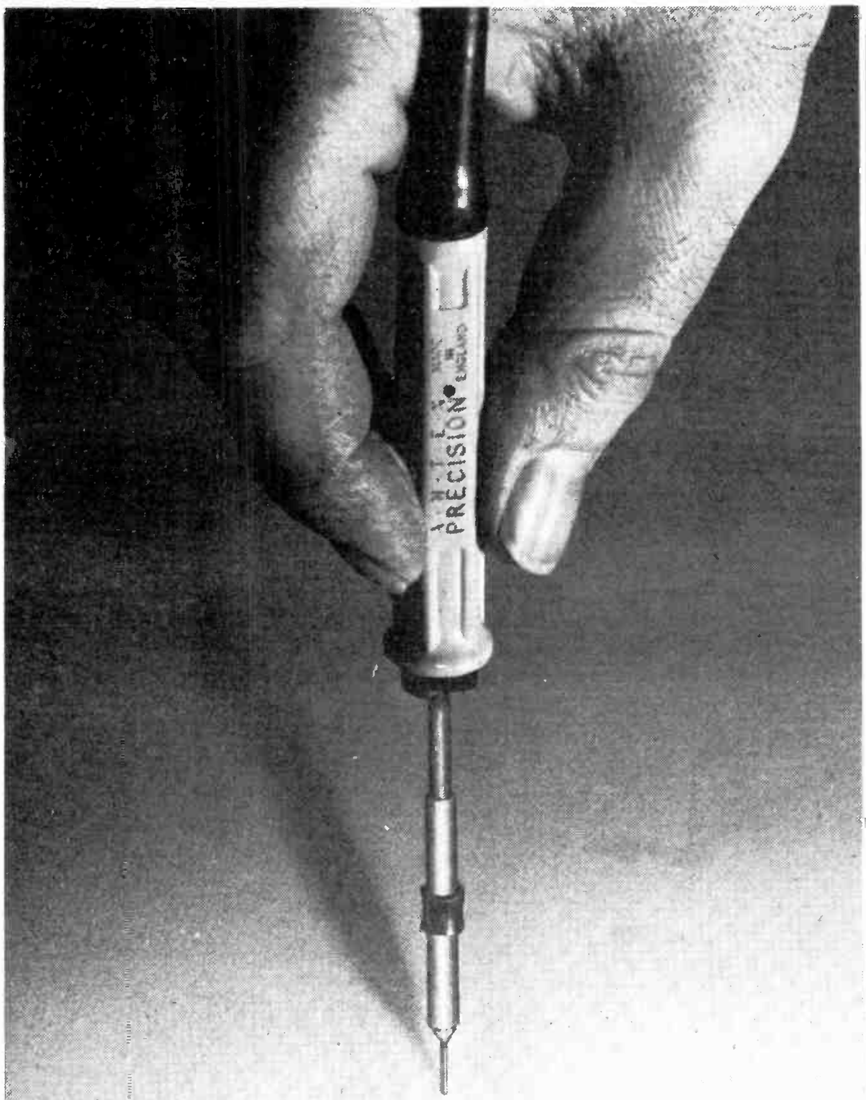
The future

It is expected that with mass-production of teletext decoders the extra cost of incorporating the basic Telesoftware facility will be in the region of £50 per unit. With this one charge the system clearly shows advantages over a wired system in a domestic market. However, the limitations of Telesoftware have also to be recognised. It can never, for example, allow the user to interrogate a large data base for a very small and obscure item; it can never order a plane ticket or make a hotel reservation. But its inherent advantages of cheapness, availability and simplicity make it very attractive to the man-in-the-street, who may not in reality be able to afford the per page running cost of systems like viewdata.

A wired system can, however, benefit from an "intelligent" terminal like that employed for Telesoftware, by making use of it as a front-end processor, maximising the use of the telephone line and thus minimising the expense.

With continuing research, the present aim is to enable the system to support a high-level language, such as 8K BASIC. Once this has been achieved, together with rationalisation in transmission techniques and data reliability, and a final specification is agreed, Telesoftware will be ready to take its place among the many other data systems which will inevitably compete for user time on the domestic television set.

Acknowledgements. The author would like to thank the following for their assistance with the preparation of this article: P. James, R. Eason and M. Figuerola of Mullard Applications Laboratory; N. W. Green of ITCA; H. Quilliam of University of Surrey.



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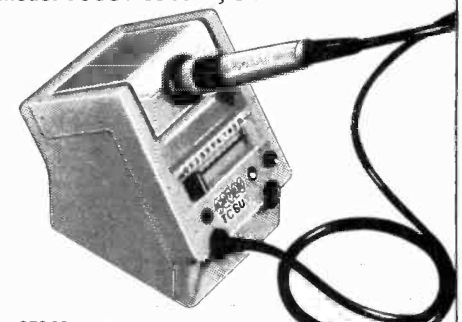

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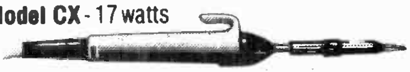

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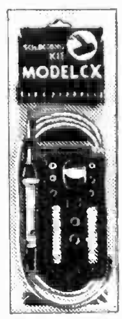

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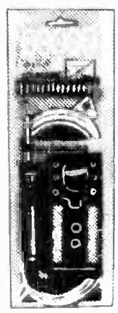

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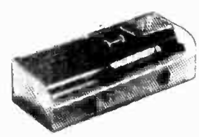

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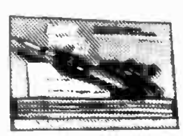

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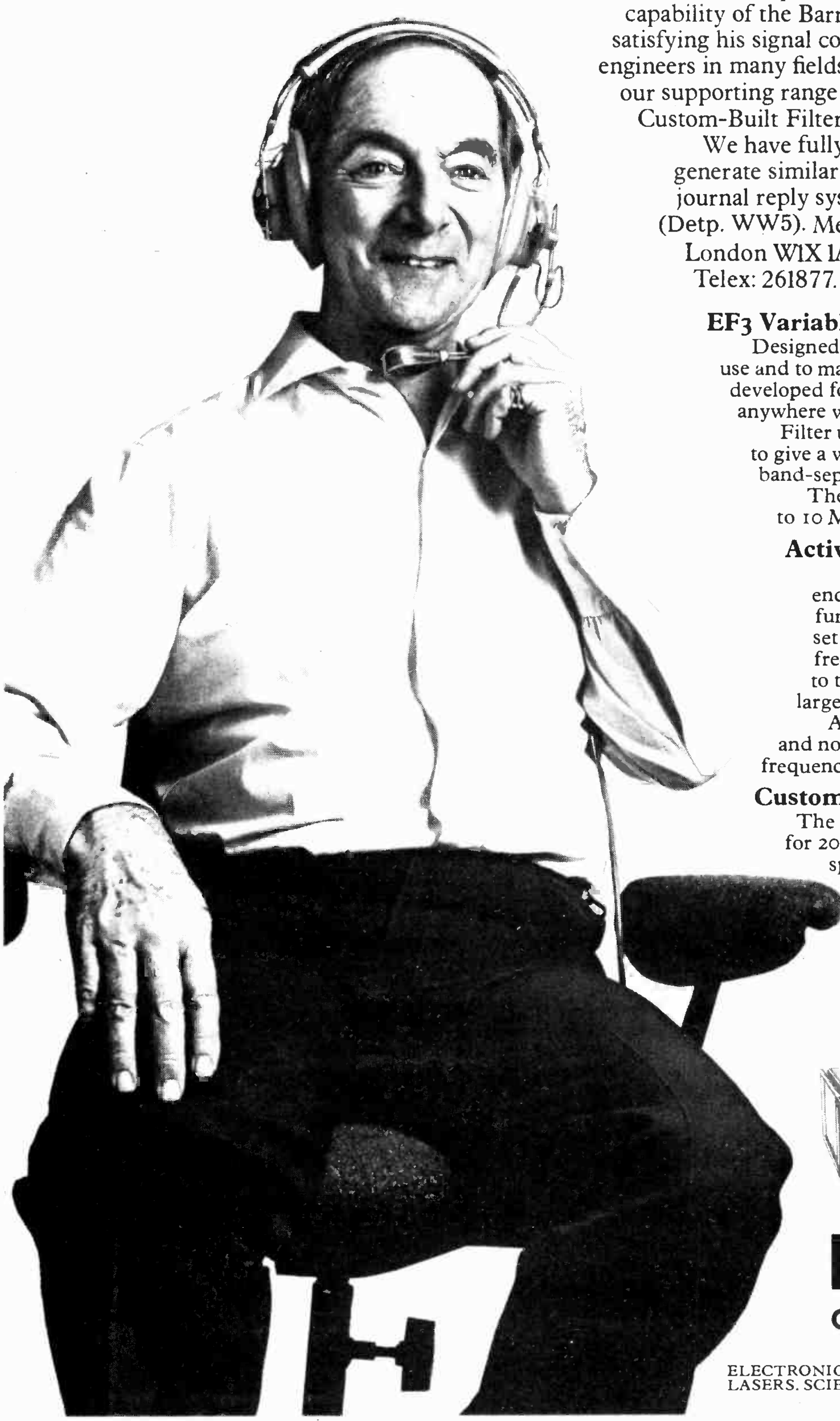

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WW—026 FOR FURTHER DETAILS

Frequency synthesizers — 3

The generation of wanted frequencies from other frequencies

by R. Thompson, M.I.E.E.

Parts 1 and 2 of this three-part series described the synthesis of frequencies by means of addition, multiplication and division. This final part covers the principles of phase-locked loops as synthesizers and presents three solutions to specific problems.

Phase-locked loops

It has already been mentioned that the major difficulty with synthesizers is not the generation of the wanted frequency so much as the rejection of unwanted products. The phase-locked loop, p.l.l., is a circuit capable of providing highly selective amplification, its unique feature being its precise and automatic tuning. It is because of this feature that the p.l.l. is used extensively in frequency synthesis.

Figure 14 shows the block diagram of a basic p.l.l. It is simply a feedback circuit which controls the phase, and hence frequency, of the output with respect to the phase of an input signal. For steady state conditions there can be no frequency error between f_{in} and f_{out}. This follows from the action of the phase detector which integrates any frequency error. There will in general be a steady state phase error, though this can be made arbitrarily small by increasing the loop gain.

The term 'type 1 loop' is sometimes applied to low gain loops and 'type 2 loop' to high gain loops. Strictly speaking type 2 loops have zero steady state phase error and employ a second integrator in the loop. However, it should be appreciated that a range of performance is available between types 1 and 2 by varying gain.

The simplest type of loop has no low pass filter. The open loop gain characteristics therefore take the forms shown in Fig. 15(a). The closed loop frequency response is also shown and the bandwidth is approximately equal to the frequency at which the open loop gains equals unity. This follows from the action of the feedback which is able to stabilise gain at all frequencies where the loop gain is greater than unity. The 6dB/octave slope is produced by the integral relationship of phase and frequency.

The loop will be able to track changes in input frequency, or compensate for voltage controlled oscillator (v.c.o.) errors, provided the frequency change does not exceed $\pi/2K_0$. This assumes that the phase detector saturates at phase errors of $\pm\pi/2$, as many detectors do. Increasing the loop gain K_o therefore increases the "hold in" range. However, this increases the bandwidth as shown in Fig. 15(a) and there is therefore a conflict between bandwidth and hold in range in the choice of K_o.

The transient response shown in Fig. 15(a) is that of a simple CR filter, as of course is the frequency response. This type of loop is in fact referred to as a first order loop since the Laplace transfer function has a first order denominator (giving a simple pole in the s plane).

If the loop low pass filter consists of a simple CR filter the transfer function becomes second order (giving two poles in the s plane). The advantage of introducing a filter can be seen from Fig. 15(b). To a first order, the closed loop bandwidth will always be equal to the open loop unity gain frequency ω_o. With the added filter therefore it is possible to increase K_o without increasing the bandwidth. The frequency responses of the loop illustrate this, although the exact shape of the response depends on the ratio ω_1/ω_o. The transient response, like the frequency response, can exhibit overshoots which are characteristic of multiple pole networks.

The time response is characterised by a 'natural' frequency, ω_n, and a damping factor ζ. In general, responses with large overshoots are highly undesirable and we may therefore still have conflicting design requirements. Loop gain (for accuracy and 'hold in'), bandwidth (for filtering) and ζ (for transient response) cannot be independently controlled by the two variables K_o and ω_1. The solution to such a design conflict is to use a modified CR filter, normally referred to as a lead/lag filter. Fig. 15(c) shows the filter. The purpose of R_2 is to take out the effect of C as the frequency increases. The filter therefore has an initial 'break' frequency ω_1 when $R_1 = X_c$ and 'breaks back' towards a simple resistive attenuator when $X_c = R_2$. A loop with such a filter is still 'second order'.

The transient response of the loop is determined primarily by the open loop phase shift around its unity gain frequency. Lowering ω_1 below ω_o increases this phase shift towards 180° from the 90° shift present with no filter.

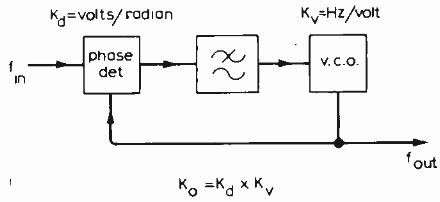


Fig. 14. *Basic phase-locked loop, in which no frequency error can exist between f_{out} and f_{in} in the steady condition.*

It has been seen that this results in decreased damping. Adding the break back at ω_2 tends to cancel the increased phase shift, its effect obviously increasing as ω_2 approaches ω_1. The effect of varying ω_2 is shown in Fig. 15(c).

The most common type of loop found in synthesizers is in fact a high gain second order loop. High gain is often not required specifically for accuracy but to reduce the level of noise generated by the phase detector. This detector is often a logic circuit producing a variable width square wave at the comparison frequency. The components of this, even after filtering in the low pass filter, will produce phase noise in the output signal. A high gain loop will have a very small steady state phase error producing very narrow low energy pulses at the detector output. Use of such high gain means that the filter must use a lead/lag network. The filter is in fact often in the form of an operational amplifier integrator which provides increased loop gain.

The loop bandwidth is controlled by a simple low pass filter and bandwidths of only a few Hertz can easily be obtained. When it is remembered that the input to the loop can be at high radio frequency the unique filtering characteristics of the p.l.l. can be appreciated. It can be used to separate wanted from unwanted signals even when the percentage frequency separation is very small.

The cut-off rate of the loop frequency response is only 6 dB/octave when a lead/lag filter is used. This can be increased at frequencies substantially greater than ω_o without altering the basic characteristics of the loop. In synthesizers this is often done to reduce comparison frequency noise generated in the phase detector which can modulate the v.c.o.

The 'hold in' range of the loop represents the range of frequency

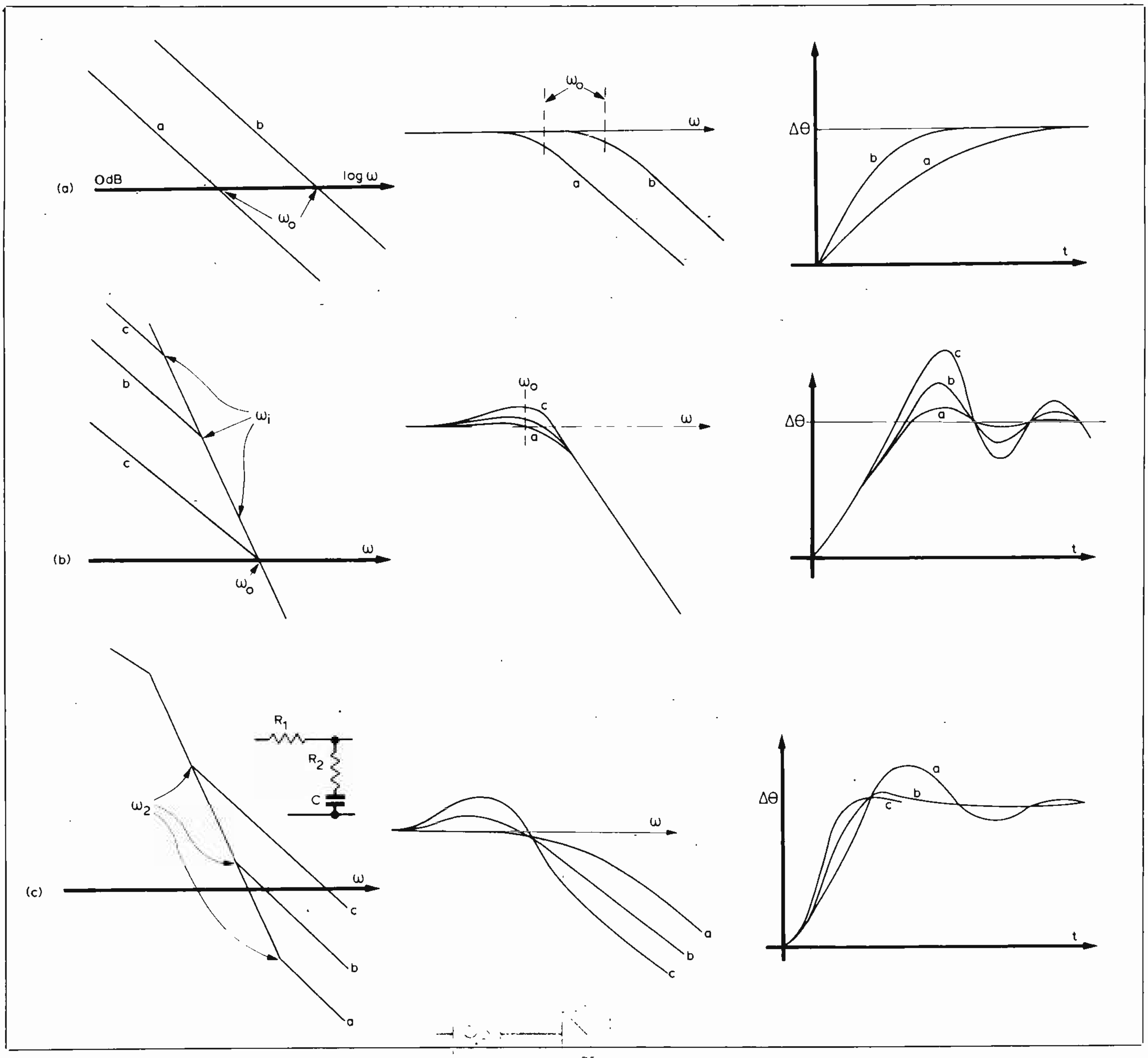


Fig. 15. *Characteristics exhibited by loops with no filter (a), simple CR filter (b) and lead/lag filter (c). Loop gains are shown in the left-hand column and the associated frequency responses in the centre. Corresponding transient respose is in the right-hand column.*

which the loop can track once phase lock has been established. The maximum frequency error for which the loop can acquire lock is called the 'pull in' range. This is never greater than the 'hold in' range and even with this range acquisition can take very long times. High gain second order loops are particularly bad in this respect. Because of this type of acquisition problem p.l.l.s sometimes use a subsidiary frequency discrimination to provide coarse tuning correction. Once phase lock is established the frequency discriminator action can be ignored.

Synthesizer circuits

Having looked at four basic types of "building block"; addition, multiplication, division and the p.l.l., we will now consider their combined application in frequency synthesizers. The basic requirement of a synthesizer is the generation of one frequency from another and this can be stated as:

$$f_2/f_1 = X/Y.$$

where X and Y are rational numbers.

Synthesis can therefore be achieved by the simple cascade of an X-times multiplier followed by a Y-times divider. Practical realisation in this form is limited by the values of X and Y.

The divider techniques described earlier allow a wide range of division ratios to be achieved with proprietory devices operationg at frequencies up to about 1 GHz. In general therefore it will be the realisation of high multiplication factors which will impose practical difficulties. Where p.l.l. techniques are not used multiplication factors of greater than 5 in one stage are difficult if reasonable spectral purity is to be maintained. The procedure adopted to avoid excessive multiplication is to split the requirement into the form:

$$X/Y = (x/y)\,(X_1 \pm X_2/Y_2)$$

For instance, if we have a specific requirement to generate 2.35 MHz from a reference to 3.52 MHz, then:

$$(f_2/f_1 = 2.35/3.52 = 235/352$$
$$= X/Y$$

this can be split into:

$$235/32 = (5/32) \times (47/11)$$
$$= (5/32)\,(4 + 3/11)$$

This synthesis involves a mixer to carry out the subsidiary addition as shown in Fig. 16. The multiplication terms, 5, 4 and 3 are all reasonable, but the addition of 4 + 3/11 represents a ratio of 44:3 in the input frequencies to the mixer. As explained earlier unwanted frequencies generated in the mixer give upper and lower bounds on the ratio for practical filtering. A better factoring is therefore:

$$(5/11)(3 + 14/11)$$

giving a mixing ratio of 33:14. The multiplication factor of 14 can be reduced by a second mixing loop as shown in Fig. 16, providing synthesis in the form:

$$(5/32)(3 + (1 + 3)/11)$$

The requirement has thus been factored into a form readily realised with practical circuit elements. It can be seen that the complexity of the synthesizer is dependent on the practical bounds set primarily by filtering problems.

Phase-locked loops are widely used in synthesizers because their excellent filtering characteristics allow very wide bounds on multiplication and mixing ratios. Before looking in more detail at the application of p.l.ls, an alternative form of selective filtering is worth mentioning. This is the "triple mixing" system shown in Fig. 17.

Highly selective fixed-tune filtering is provided and the auxiliary oscillator is used to "scan" the incoming spectrum with these filters. Filtering having been accomplished, the third mixer cancels out the auxiliary oscillator frequency together with any associated frequency drift. Mixer 2 is used to introduce an interpolation frequency, normally an incremental frequency which can be used to span the separation of the harmonics in the input signal f_1.

The p.l.l. can also be considered as a form of heterodyne/fixed filter system, the signal being converted down to zero frequency and fixed filtering provided by the low pass filter. In its basic form it can be used simply as a high grade filter in synthesizing loops, allowing constraints on multiplication and mixing ratios to be relaxed. More frequently, the p.l.l. is modified by the inclusion of a divider in the feedback loop as shown in Fig. 18(a). When modified in this way, the loop stabilises the v.c.o. frequency at n times the input frequency. The p.l.l. loop gain is reduced by a factor of n and the characteristics of the loop are modified accordingly. This arrangement operates as a multiplier, having the very important feature that its multiplying ratio is readily controllable over a wide range by proprietory divider circuits. It is also "fail safe" on its operation, simple harmonic multipliers have the problem that the wrong harmonic may be selected, particularly where high ratios are involved. In synthesisers, it is normally an advantage to have maximum bandwidth, as opposed to the p.l.l. being used as a narrow band filter of *input* signals. The wider bandwidth allows cancellation of noise generated *in* the loop, in particular v.c.o. noise. Wide bandwidth also reduces tuning time. Since the bandwidth must be subtantially less than the comparison frequency we have a design conflict between low comparison frequency for fine tuning increments and wide bandwidth for noise and tuning time performance.

The solution of the synthesizer requirement $F_1/F_1 = X/Y$ can be realised in a simple two-step operation, using a multiplying p.l.l. Figure 18(b) illustrates the solution to our previous example of 235/352.

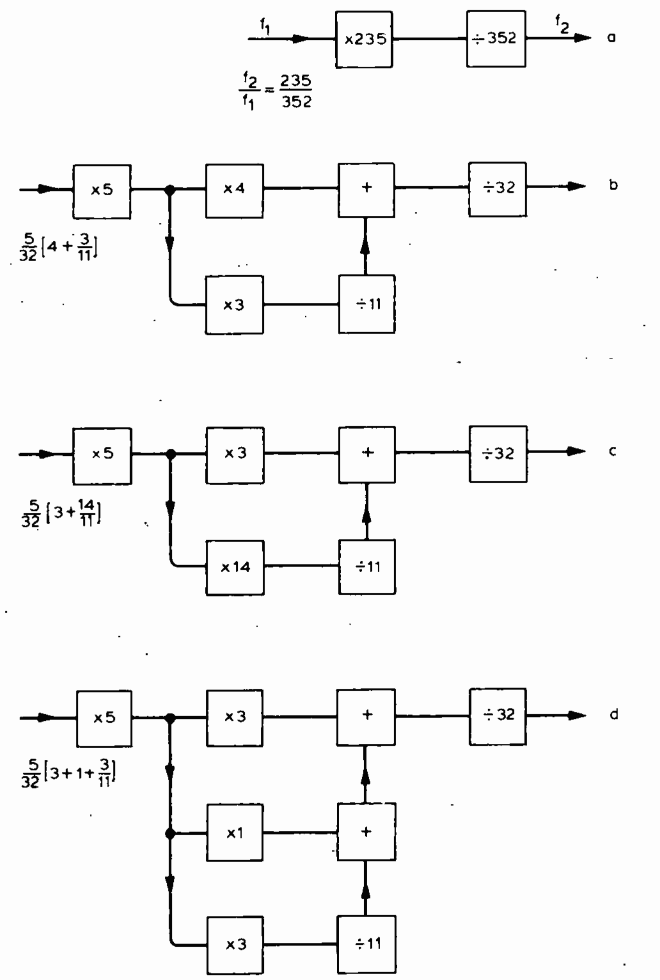


Fig. 16. *Evolution of synthesizer to perform basic functions shown at (a).*

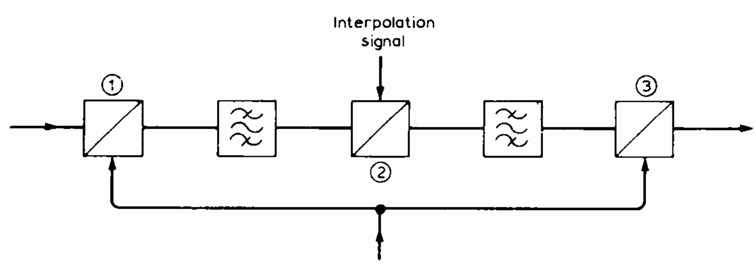


Fig. 17. *Triple mixing synthesizer.*

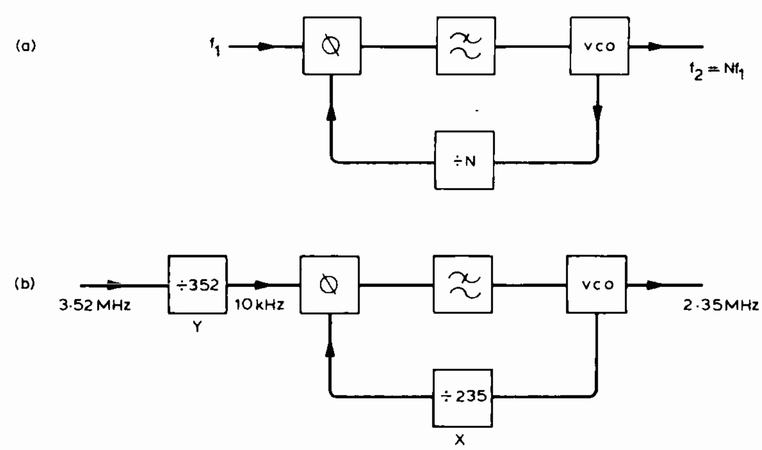


Fig. 18. *Phase-locked loop multiplier (a) and a p.l.l. multiplier solution to the 2.35/3.52 problem (b).*

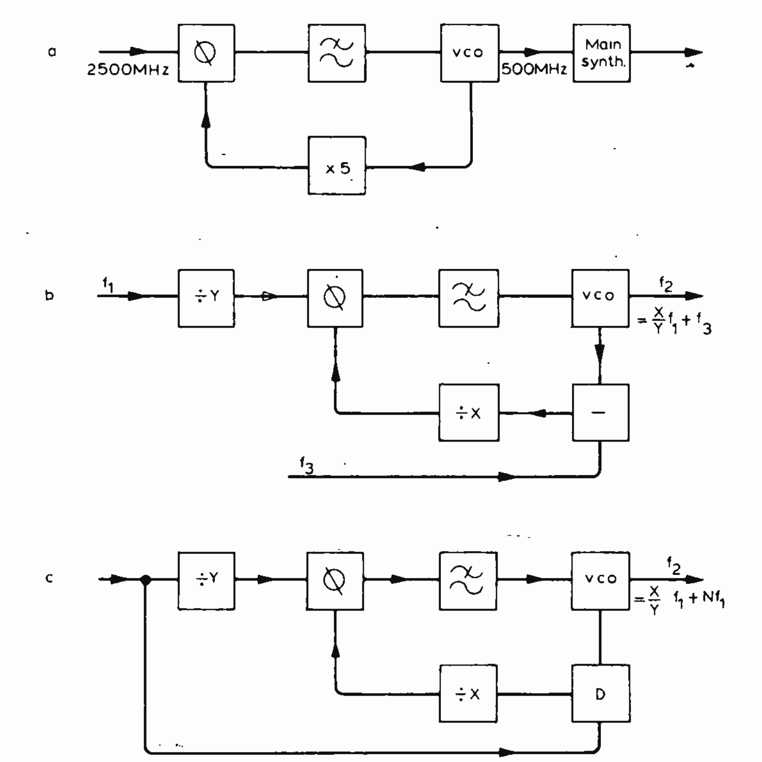


Fig. 19. *P.l.ls can be used as high-speed dividers by inclusion of a multiplier in the loop. P.l.l. at (a) divides by 5. Mixer at (b) reduces frequency requirements of divider and (c) shows alternative method.*

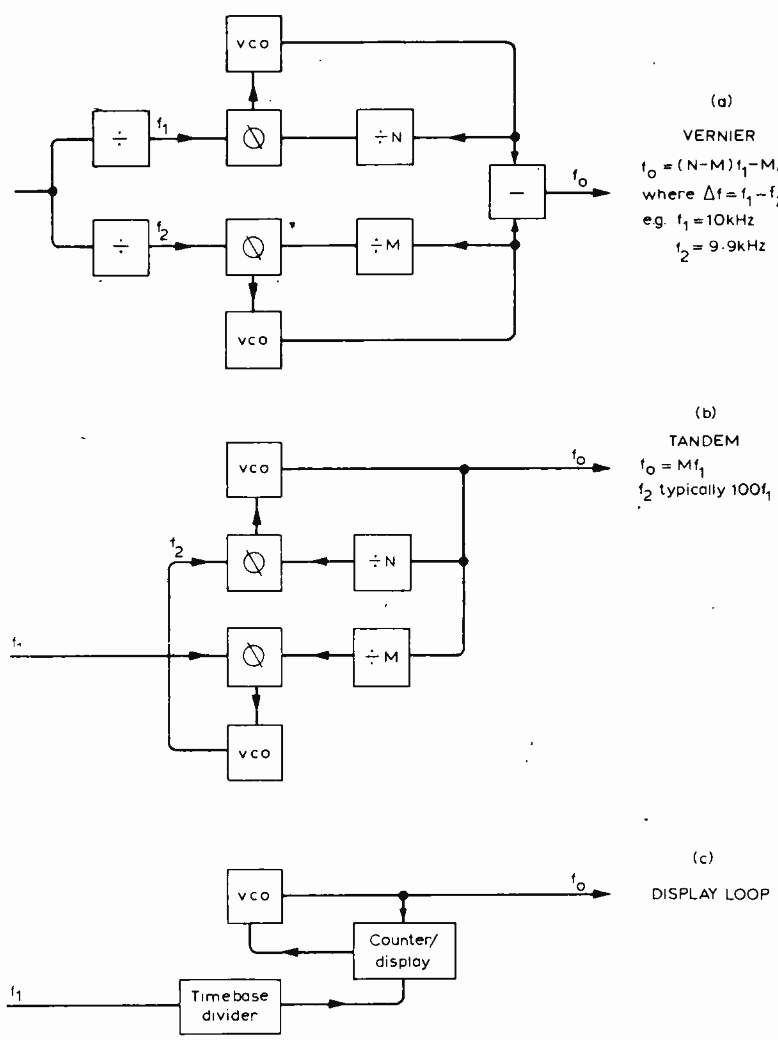


Fig. 20. *Methods of achieving wide bandwidth and small increments.*

The operating frequency of the divider circuits is often an important constraint on the synthesizer design. For this reason, Fig. 18(b) shows the division followed by multiplication; reversal of this would require the divider to operate at over 850 MHz. Currently-available dividers in integrated circuit form have the following approximate frequency limits:

direct variable dividers	– 10 MHz
variable division with "early decode"	– 25 MHz
variable modulus prescaler	– 500 MHz
fixed prescaling	–1500 MHz

At frequencies higher than this, or as an alternative to prescaling techniques, the p.l.l. can be used as a high-frequency divider by employing a multiplier in the feedback path. Figure 19(a) shows an arrangement where the reference frequency is very high.

Another alternative used to cope with high frequency requirements is to introduce a mixer into the p.l.l. This reduces the frequency handled by the divider, such an arrangement being shown in Fig. 19(b). The synthesis is $f_2 = f_1X / Y + f_3$, with a maximum frequency at the divider of $f_2 - f_3$. A harmonic of the reference frequency can be used and the digital mixer described earlier can be used as a combined mixer and harmonic multiplier. Figure 19(c) shows such an arrangement. The synthesis is $f_2 = f_1X / Y + Nf_1$ where N is the harmonic of f_1 selected by the loop. For example f_1 might be 5 MHz and f_2 required to be in the region of 56 MHz. The 11th harmonic of f_1 is subtracted from f_2 in the mixer, giving a frequency into the variable divider in the region of 1 MHz (the exact frequency depending on X and Y).

As described earlier we have problems in achieving wide bandwidth and low frequency increments. The vernier system uses two synthesizers, offset in their reference frequencies so that increments in frequency are set by the difference, as shown in Fig. 20(a).

In the Tandem system a wideband synthesizer produces a low-noise output while the fine frequency increments are achieved via a second synthesizer providing the reference frequency for the output loop. The secondary loop is slow because of the low comparison frequency, so tuning is slow when a change to that loop is involved.

The display loop system uses an accurate timebase counter to display the frequency. When the required frequency is obtained the loop is completed with correction being generated by any variation of the last digit of the counter.

The next article will conclude the series with examples of specific designs.

NEWS OF THE MONTH

64K r.a.m. unveiled by USA

The race to produce a 64k r.a.m. in volume quantities has probably been won by Texas Instruments Incorporated. Sample quantities of the 16-pin device, at $125 each (in the USA), are expected to be made available in October or November. The device has been given the designation TMS 6164.

The r.a.m., according to reported TI specifications, operates from a single 5V supply rail. This will make the device very attractive when compared with Japan's Fujitsu 64k r.a.m. which will require a dual rail for +7 and —2V supplies. A report in the American journal *Electronics* says: In achieving its single-supply operation, TI has made a significant development in m.o.s. design. All 5V m.o.s. devices now on the market require a negative supply for reverse-biasing the substrate to make inputs and outputs compatible with transistor-transistor logic — on-chip circuits called charge pumps generate the negative voltage. The new r.a.m., however, contains no on-chip substrate-biasing circuit — TI designers have altogether eliminated the need for negative voltages. "Although it is t.t.l.-compatible on the outside, the inside is geared more toward achieving an optimal speed-power product," says G. R. Mohan Rao, who headed the design team at TI. "People will be surprised when they see how we did it."

Not only does the new 64k device quadruple the density of current generation of 16k r.a.ms, it also outperforms them in many respects, according to the American journal. The device has a maximum power dissipation of 200mW, or 3μW/bit, compared with 462mW or 28μW/bit for TI's older 16k device, the TMS4116. Access times have also been improved. These range from 100 to 150ns and the minimum cycle times range from 200 to 250ns. Another difference is that TI's 64k r.a.m. incorporates a 256 cycle/4ms refresh period instead of the 128 cycle/2ms period used in current 4k and 16k devices.

In addition, TI has kept the bar size down to 132 by 252 thousanths-of-an-inch, and with 60% of the area taken up by the array, it is claimed by Rao to be "the first dynamic r.a.m. not dominated by the peripheral circuitry". The tricky part, according to Rao, was getting 40 internal clocks on the chip timed together. Using TI's approach the major internal clocks are guaranteed not to have a timing skew, even if the row and column strobes from the user are non-periodic.

Some analysts put the eventual 64k r.a.m. market at between $700 — 1000 million per year, which compares with an estimated current market of $200 million for the 16k r.a.m.

Though Texas Instruments are the second company to announce a 64k dynamic random access memory they claim this will become the industry Standard on account of its single 5V supply design. At a press conference for their "most significant product announcement this year" Robert Wilmot, managing director of the UK subsidiary, said they hadn't finally decided where it will be made, though initial production will be in the U.S. In any event, in terms of investment to create jobs, such a development was a "dead loss" he said. Volume production is set for the middle of 1979 but sample devices are expected late this year at £80 a piece. Mr Wilmot wouldn't discuss volume forecasts but said that by 1981 he expected price would be down to £4.

In a clear reference to the NEB's Inmos investment, Mr Wilmot said that being first is obviously a key factor. Dynamic r.a.ms were on a 68% learning curve — for every doubling in volume price fell to 68% of its prior value — and to be in business one can't afford to be late, he said. "The fate of many companies to disprove the learning curve theory in the sixties is only too well known." There had been opportunities for new companies to get into the business – Intel and Mostek were examples of companies launched on what he called a "technological discontinuity" — but he didn't see any "windows" in the foreseeable future.

Costs of active circuit elements falls in proportion to their increase in density, which appears to be at a rate of two "decades" (orders of magnitude) per decade (10 years). A density of 10,000 elements per chip will become old but as production of 64k r.a.ms and 16-bit microcomputers dominate, with 100,000 elements for chip, and which in turn will give way to 256k r.a.ms and 32-bit microcomputers as v.l.s.i. escalates to a density of a million by 1985.

Radiocommunications breakthrough by UK company

A bright idea by a design team member at Plessey Avionics and Communication's Roke Manor laboratories has resulted in the production of a v.h.f. repeater capable of receiving and transmitting radio signals on the same frequency, simultaneously. This is a major breakthrough in radio communications techniques.

Work began on the repeater, which has been given the name Groundsat, some eighteen months ago, shortly after the concept was first recognised. The discovery — Plessey claim it to be revolutionary rather than evolutionary — was made while the design team were working on the job of simplifying army communications equipment.

Because of the large market potential of this new repeater, and the communication technique, and the fact that Groundsat is primarily intended, as it stands, for use by armed forces, the technical details of the new technique cannot be made public at the present time. In the past, attempts to receive radio signals on one antenna while simultaneously retransmitting the same signal, on the same carrier frequency, on a second antenna on the same site, have failed because the first antenna, which is probably receiving only microvolts, is swamped by the second antenna, typically transmitting watts of effective radiated power. Plessey's team has found a way of overcoming this problem. While they are not the first to have followed up theories associated with this problem, they do claim to be the first to have made the theory work in practice.

Groundsat is expected to have a major impact in battlefield v.h.f. communications. Only 24 hours after their introduction to Groundsat, a spokesman for the British army made a statement to the effect that they were very impressed with the equipment and would be purchasing at least one for field trials. On the battlefield, Groundsat will enable a soldier or a patrol to remain in contact in difficult terrain where normal v.h.f. radio coverage has ceased to be effective. In order to gain a tactical advantage, a soldier in battle must use the terrain — keeping to low lying areas at the foot of a hill, for example — but this frequently causes difficulties in maintaining radio communication. The usual way of overcoming this in these situations is to employ a re-broadcast station, where the original signal is retransmitted to the soldier via an operator using a multi-set installation. The re-broadcast equipment is bulky, complex and expensive, and setting up is difficult and time consuming. In addition, several widely-spaced channels are required, with transmission and reception on separate channels, as compared with one channel for normal network operation. The repeater, which is no larger than a man-pack radio, and can be used as such, overcomes these problems and may be left unmanned in a suitable re-broadcast position. Operation is so simple that the soldier has only to press his p.t.t. switch once for normal working, and if he fails to make contact, to press again for repeater operation.

Plessey say that several armies can be expected to take advantage of their development and the prospects for exports are excellent.

Technical Specifications

Groundsat operates in the frequency range 30 to 76MHz and has 1840 or 920 channels spaced at 25 or 50kHz. Frequency modulation with a 5kHz deviation is employed and output power can be between 10mW and 1W to a 50Ω load. The unit has a re-broadcast ratio of greater than 100dB and a sensitivity of 1μV for 10dB signal-plus-noise/noise ratio. It has built-in test modes, including an overload test facility for obtaining optimum antenna separation. *(Wireless World* witnessed repeater operation using two Clansman elevated antennas with a separation of about 15m.)

Surround sound-field tests by IBA

The IBA will shortly be field testing their three-channel surround-sound broadcasting system, based on the NRDC's ambisonic technology, on independent local radio. The broadcast tests, which are in support of studies being made by the European Broadcasting Union, are expected to start in the London area on Capital Radio (93.8MHz v.h.f./f.m.) during late October or early November. Other ILR stations will also be involved — accouncements of dates and times made after consultation with the Home Office.

For the broadcasts, programme material will be specially recorded by IBA engineers using their new surround-sound mobile recording unit including, where appropriate, the new Calrec sound-field microphone (August issue, page 75). A small quantity of stereo receivers are currently being modified by the IBA for three channel reception. Listeners will be invited to participate by reporting the degree of stereo and monophonic compatibility on the receivers currently in general use. A reply-paid questionaire is to be made available from the IBA Engineering Information Service to assist the collecting of data.

The encoding scheme being used is the "2½-channel" member of the UHJ family in which a band-limited third channel is transmitted in phase quadrature to what is normally the stereo difference signal. One of the benefits of this additional information is that the 180° phase anomaly inherent in two-channel matrix systems is removed, in the psychoacoustically all-important region of the spectrum. The other important difference is the greater freedom of listener position — it was largely the constraint on position that led the major two-channel proponents — CBS, Sansui, BBC — to try and "rescue" their systems with some form of program-actuated decoding. The price to be paid, of course, is some degradation in signal-to-noise ratio but as to how much is acceptable still seems a matter for debate. The BBC have officially doggedly said in effect that no worsening is allowable (Feb. 1977 issue, page 43, Dec. 1977 issue, page 77), while the IBA clearly feel there is more to be gained than there is to be lost. Their work indicates a clear preference for 2½-channel working, compared with two-channel (with or without program-actuated decoding), and a penalty to stereo listeners of a fraction of a dB in signal to noise ratio, and a 1 to 2dB reduction for the 2½-channel mode (Sept. 1977 issue, pages 50/1).

According to the IBA, listeners who are interested in surround-sound reception, will soon be able to obtain a technical leaflet which will give full information on the kind of decoder required. *Wireless World* hope to publish this information for the benefit of readers.

Britain must take full advantage of teletext — Minister for Industry

The Minister of State for Industry, the Rt Hon. Alan Williams, MP, said at the opening of the National Teletext Week Exhibition (20/27th Sept.), that Britain had scored a very important first in the electronic field and it had done so in a remarkably short development time. "It has taken half as long, for example, to develop teletext as it took to develop v.t.r. in Japan. However, there is always the risk that we, as in the past, may fail to take full advantage of the first that we have now established, and the lead that we have established." He continued by saying that teletext was an extremely important step forward, and could eventually help to restore a balance between viewing and reading. "The Japanese have, on the v.t.r. side, been able to establish, or look as if they are going to establish, a very dominant market position because they have had and made a co-ordinated approach and attack upon the world market. Sadly, so far, we have not seen as co-ordinated an approach from British industry as far as teletext is concerned. We have the product. We are convinced there is the market. In fact we are convinced there is a market potentially for eight million sets a year, and yet, so far, we have not managed to exploit that market."

As far as the set manufacturers were concerned, Mr Williams said that it was imperative that they decide to incorporate teletext into as many of their sets as they possibly can, and as far as the component manufacturers were concerned it was imperative that they made the appropriate decisions and provided the most sophisticated and the cheapest chip components that were available. The broadcasters, retailers and rental companies had a role to play in ensuring that the opportunities, advantages and values of the new system were brought fully to the public and to the consumers.

The Government's part, according to Mr Williams, was to do anything they could to give further support to the venture. He regarded the National Teletext Week as a very important step by the industry to recognise that an opportunity was in danger of slipping by yet again and he welcomed it as an attempt to co-ordinate the activities of all sectors of the industry.

National Teletext Week, which was sponsored by the BBC, IBA, BREMA, ECIF, RETRA and the National Television Rental Association, marked the culmination of an excellent example of co-operation between the British broadcasting organisations and the manufacturers of television receivers.

Mr Donald Cullimore, a member of the Oracle board, said at the opening that the board were planning a number of new and exciting services, which they would be telling the public about in a few weeks time, and afterwards they would aim to cut down on the time it took for them to get a page on the screen and increase the number of pages and categories in the service.

The BBC's news and current affairs director Mr Richard Francis gave details of the Ceefax service. About the cost of Ceefax he said, "... from the broadcasters point of view the cost of producing the service is very cheap. Even with the new transmission equipment we are installing it probably only represents 3½p in the annual licence fee. A large expansion in what we have to offer would still only cost a few bob per person per year."

In addition to expanding the Ceefax service — including the installation of a new computer and software programme — the BBC has developed a hard-copy Ceefax print-out, which was shown publicly for the first time at the exhibition. They also have plans for developing the regional content of Ceefax and hope to start with their first sub-unit in Manchester in 1980, extending to Glasgow, Birmingham, Cardiff, Belfast and Bristol.

Telesoftware – p.61.

News in Brief

An **IERE Conference on television measurements** is to be held at the Commonwealth Institute, London, from May 21-23 1979. It will review current developments and innovations in teletext and digital systems and there will also be sessions on colorimetry, video and r.f. instrumentation and measurement techniques and distribution system performance.

At the **1978 General Assembly of EUREL** — the Convention of National Societies of Electrical Engineers of West Europe — held in Helsinki on September 7, Professor William Gosling was elected President of the Convention for 1979. Professor Gosling, who is head of the Electronics Group in the School of Engineering at the University of Bath, has been the IERE's representative to EUREL for the past four years. EUREL was founded in 1972 and now comprises 17 societies from 13 countries. Its aims are to facilitate the exchange of information and to foster multilateral collaboration between its member societies.

Seminex Ltd is calling for papers for **Seminex 79** to be held from March 26-30. In addition to microprocessor-related subjects, topics covered are to include bubble memories, opto-electronics and displays, hybrid integrated circuits, power semiconductors and microwave devices. Authors interested in preparing papers for the seminar event are asked to contact the organisers at Seminex Ltd, 79 High Street, Tunbridge Wells, Kent TN1 1XZ.

From Nov. 16-25, 47 companies will participate in the first all-British **Scientific Instruments Exhibition in Peking** organised by the British Overseas Trade Board and sponsored by the Scientific Instruments Manufacturers Association. Among the items on display will be an X-ray scanner diagnostic system, microwave instrumentation, electrophysiological measuring systems and laboratory equipment.

Multiplexed alarm

Remote sensing of up to 10 points with a two-wire system

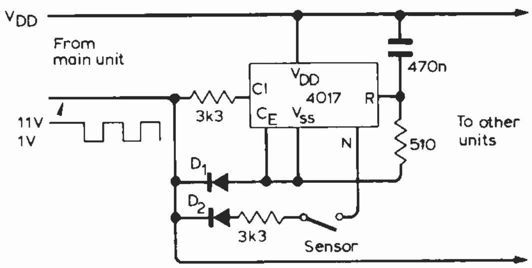
by R. J. Chance B.Sc.

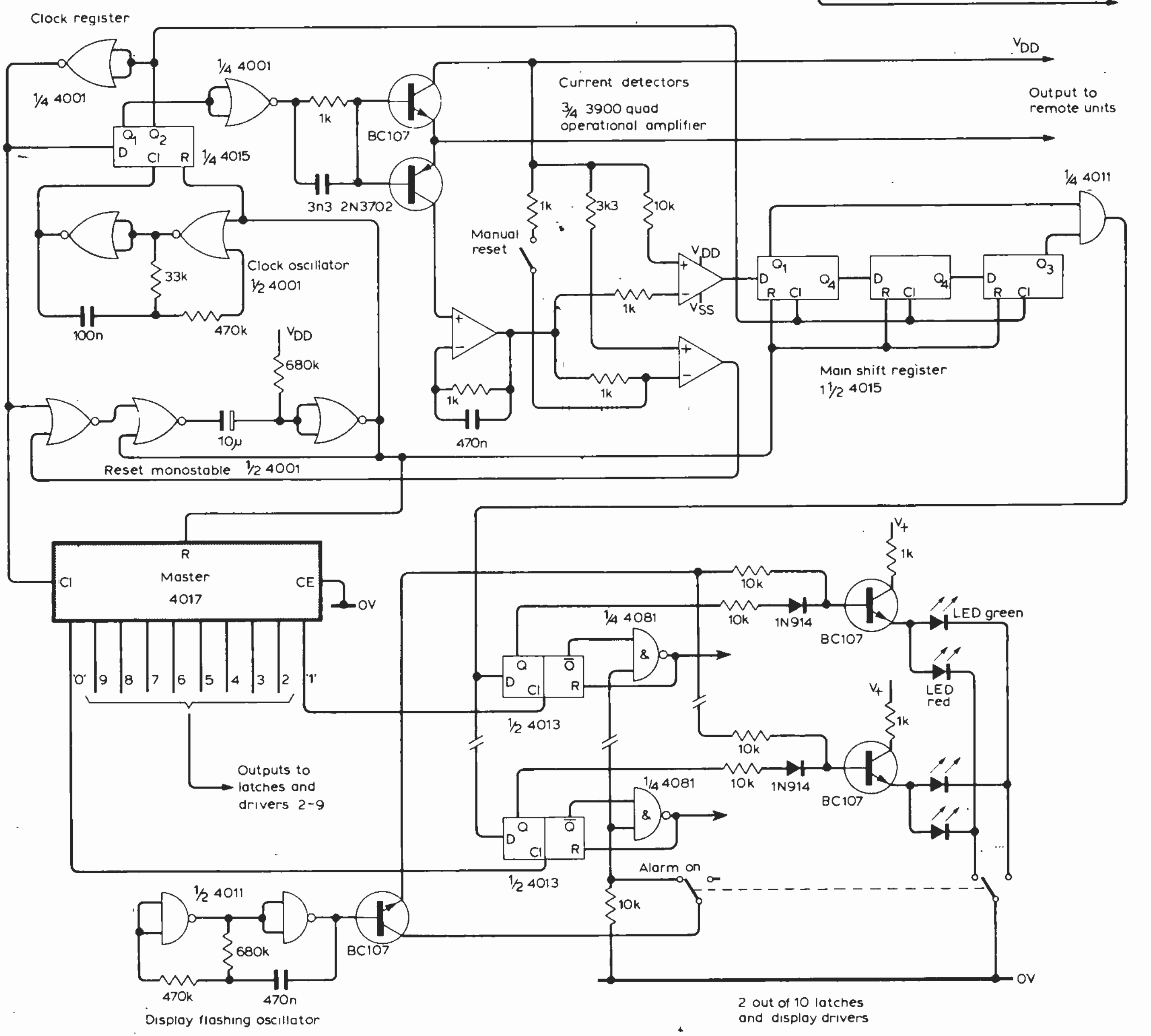
This multiplexed system is the result of improving a rather primitive burglar alarm. The redesigned circuit can detect the state of up to 10 sensors and give an immediate identification and location of an activated sensor. Because each sensor does not form part of an overall alarm loop, separate sensors or groups can activate different audible / visual signals. Installation is simplified because one pair of wires connects all of the sensors to a control unit.

BECAUSE wiring is the most inconvenient feature of an alarm system I felt that having around 10 sensors all wired separately to a central point would be unacceptable. Although time division multiplexing seemed to offer a solution where connections could be made from one site to the next, it appeared that

Fig. 1. Remote multiplexer circuit. Each unit uses a different output from one to zero.

Fig. 2. Control circuit. The 10 channels can be individually turned on and off or switched in groups.





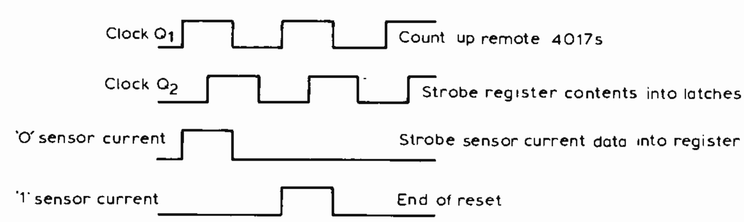


Fig. 3. *Circuit waveforms.*

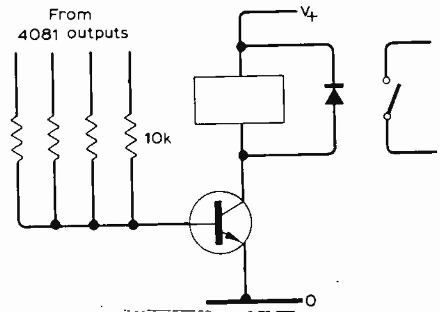


Fig. 4. *Transistor OR gate.*

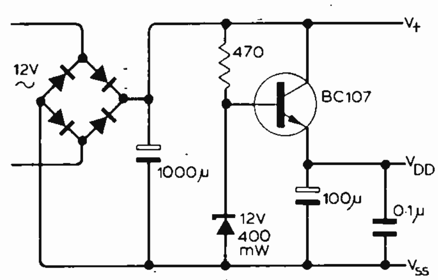


Fig. 5. *Power supply.*

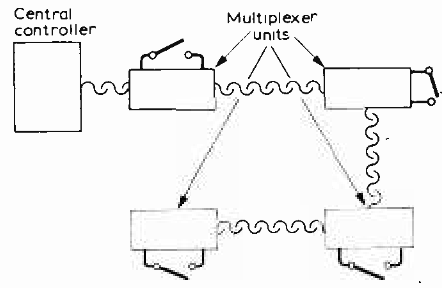


Fig. 6. *Interconnection of the remote alarm units.*

power supply lines, a reset line, clock line and a sensor state indication line would be necessary to supply the multiplexer circuit at each site. The present design has reduced this requirement to just 2 wires by making use of the low current and large power supply tolerance of c.m.o.s.

The multiplexer circuit is based on a 4017 decade counter with 10 individual outputs as shown in Fig. 1. Up to 10 of these can be used, each with a different output, to give signals in 10 time slots. A reset line has been avoided by using the power supply rail to reset the counter. When switched on, a CR time constant holds the reset line at V_{DD} to make sure that counting starts from 0. A clock line has been eliminated by switching the supply line as a square wave. When this supply waveform is applied as shown, the capacitor charges through D_1 and the resistor. Because V_{SS} is taken low before the reset pin, the 4017 is set to zero. When the square-wave input returns to V_{DD} the 4017 is powered by the charge on the capacitor, and counting proceeds from zero as long as the square wave is present.

The sensor indication line has also been eliminated by detecting the power supply current drain. If a sensor such as a reed switch is connected via a limiting resistor and D_2, between one of the 10 counter outputs and the negative supply line as shown, the current drawn through the sensor switch can be detected by the control circuit. In this way one pair of wires can be used to supply 10 remote sensors.

The main circuit is shown in Fig. 2. An oscillator and shift register generate clocking waveforms as shown in Fig. 3, and a 3900 quad op-amp converts current flowing in the line to logic levels. A master 4017 clocks these logic levels, which correspond to the 10 time slots, into 10 output latches. This data is also stored in an 11 stage shift register which holds the state of the last 11 sensor checks.

An open sensor output produces a 1, so two consecutive sensor-open signals are detected by the 2 input NAND gate connected to the 1st and 11th stages of the shift register. Because the NAND gate requires two consecutive sensor open outputs to switch, this system prevents an interference pulse from activating the alarm. If a supply current of greater than normal is detected because, for example, the remote multiplexers are not in step, the circuit is reset by a monostable.

The output of the NAND gate is fed to the data inputs of 10 D-type flip flops which are used as latches. The output from the NAND gate is sequentially clocked into these latches by the 10 outputs of the master 4017. Ten 4018 AND gates connect the Q outputs to the reset pins of the latches. When the gates are enabled by the alarm-on switch, a latch will be held in the 0 state if corresponding sensor contacts are opened for two counting cycles of the multiplexer. The latch will remain in the 0 state even if the sensor contacts are closed again. Transistors drive l.e.ds from the flip flop Q outputs, and are switched between red and green types to indicate alarm-on or alarm-off. An oscillator pulses all of the display drivers to give a flashing l.e.d. for the sensor which has been interrupted.

The 10 alarm signals are available at the 4081 outputs, and the method of using them will depend on individual requirements. Although each output can be used to drive a separate bell or siren, it is much more likely that groups of these will need to be ORed to operate one alarm. The simplest way of achieving this is to drive a transistor from the required outputs as shown in Fig. 4. A relay in the transistor collector provides a contact closure that can switch mains or low voltage alarms. Although only one switch has been shown for the alarm on/off function, it is possible to use several so that some sensor sites can be activated while others are switched off. Alternatively, 10 switches can be used to give independent control of each site. Only a simple power supply is necessary as shown in Fig. 5. The l.e.ds are powered from the unstabilised supply and a simple regulator is provided for the c.m.o.s. logic.

Installation of the alarm is obviously an individual matter, but in my installation a twisted pair of wires was used for interconnection between remote units and the control box as shown in Fig. 6. Detectors for windows were made from a loop of fine enamelled copper wire glued to the surface of the glass. This is unobtrusive and easily broken if the glass is shattered. For doors, standard reed switches were mounted vertically in a slot cut in the door jamb. A ferrite bar magnet was horizontally mounted in a slot cut in the door opposite the reed switch. This arrangement gave satisfactory operation and enough latitude to ensure that wind rattling the door did not give a false alarm.

This system has been in use for nearly three years and has proved to be far superior to the simple alarms which are available. The ability to detect which doors or windows have been left open is particularly convenient when setting the alarm, and it is felt that this facility alone is worth the extra expense. The only trouble experienced over this time has been interference caused by a particularly bad motor on the same power line. Although the correct approach would have been to suppress the motor, fitting a mains interference filter to the burglar alarm immediately cured the trouble. In this connection, it may be of interest that a 100m drum of three core mains cable appears to be more effective than a commercial LC filter. □

CIRCUIT IDEAS

Pulse generator

The number of pulses at the input of this circuit determines which output will produce one pulse. Input pulses can be applied by a push-button switch via a Schmitt trigger to remove contact bounce, or by other logic circuitry. The first positive edge triggers a monostable which disables the AND gate latches of the 7490 output. Every other positive edge retriggers the monostable and keeps the AND gates disabled until all of the negative edges have been counted by the 7490. The period of the monostable must be longer than the pulse width of the input. A b.c.d. output from the AND gates is decoded and the eight-input NAND gate resets the 7490 counter so that a single pulse is produced. The output can be applied to bistables for two-state control, or to counters for step-by-step control.

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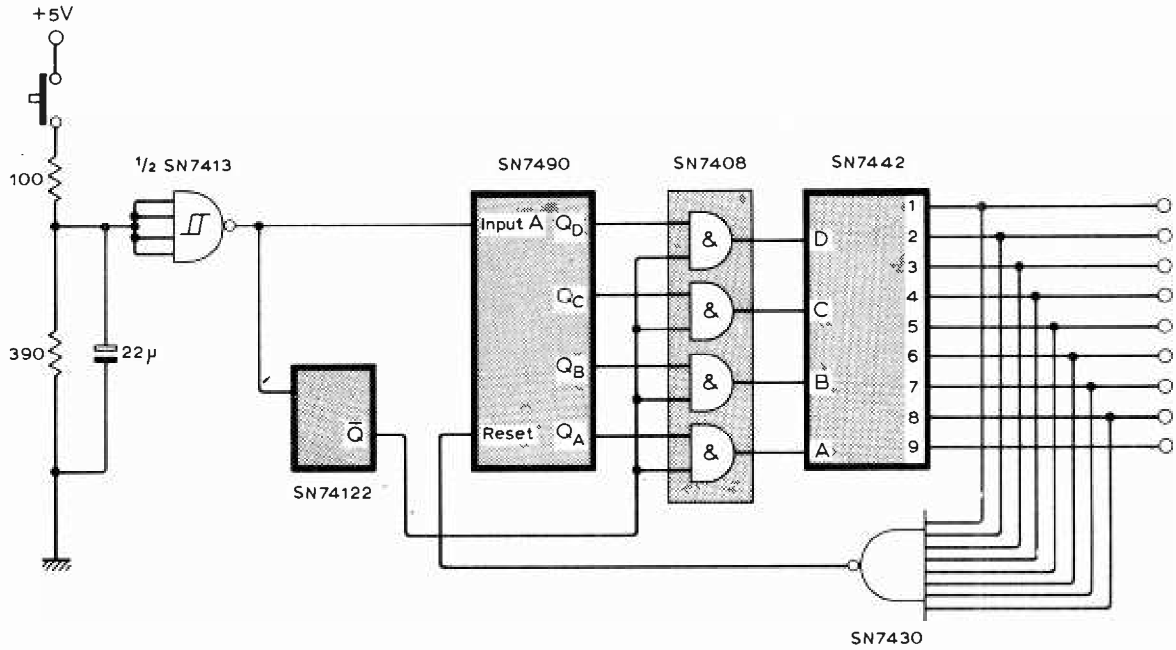

Contrast expander for weather satellite pictures

This expander performs the same function as the circuits described by Bayliss & Brush, *Wireless World* December 1973 and G. R. Kennedy, *Wireless World*, December 1976, but it operates on the detected video signal and is variable from zero to approximately 83%. Resistor R_1 is adjusted for +1V at the non-inverting input of IC_1 which then operates as an inverting amplifier with a gain of $-R_8/(R_7+R_1)$ with reference to 1V. Resistors R_2 and R_3 provide a −2V level shift to give the required but inverted transfer function. Positive video is restored by IC_2, and D_1, D_2 prevent the output from going negative.

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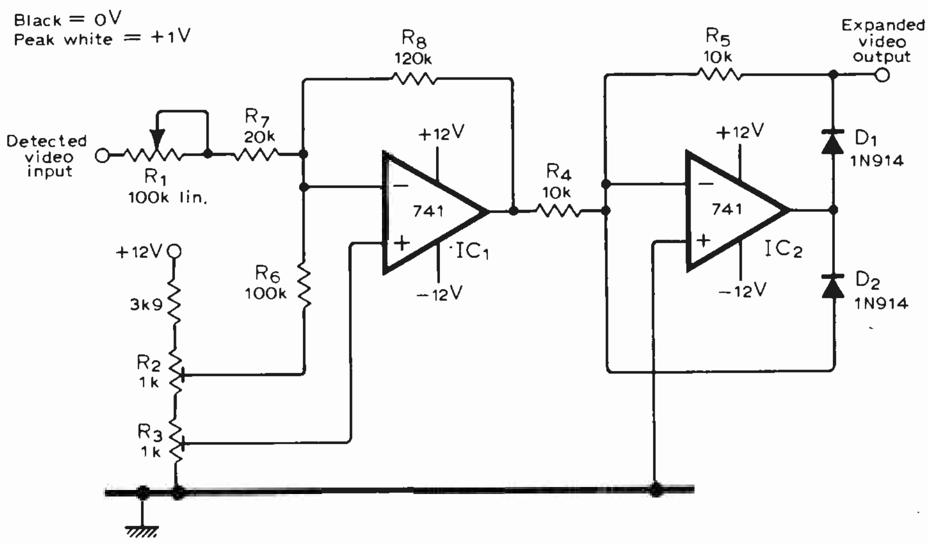

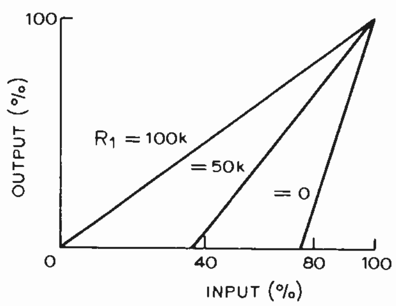

Digital extremum calculator

This circuit is useful if the extreme value of a continuously changing parallel n-bit binary signal has to be calculated. The latest and the last extremes are stored, and two comparator outputs indicate whether these are maximum or minimum values.

Data is clocked into shift-register A and then transferred into shift-register B. The comparator outputs indicate whether the input from A is greater or less than B, and change state whenever an extreme occurs. The transition triggers the corresponding monostable, and the OR gate produces a pulse which enables shift register C. The output of shift register A is then stored in C. If several shift-registers are connected in series with C, and clock by the OR gate, all of the previous extremes can be stored.

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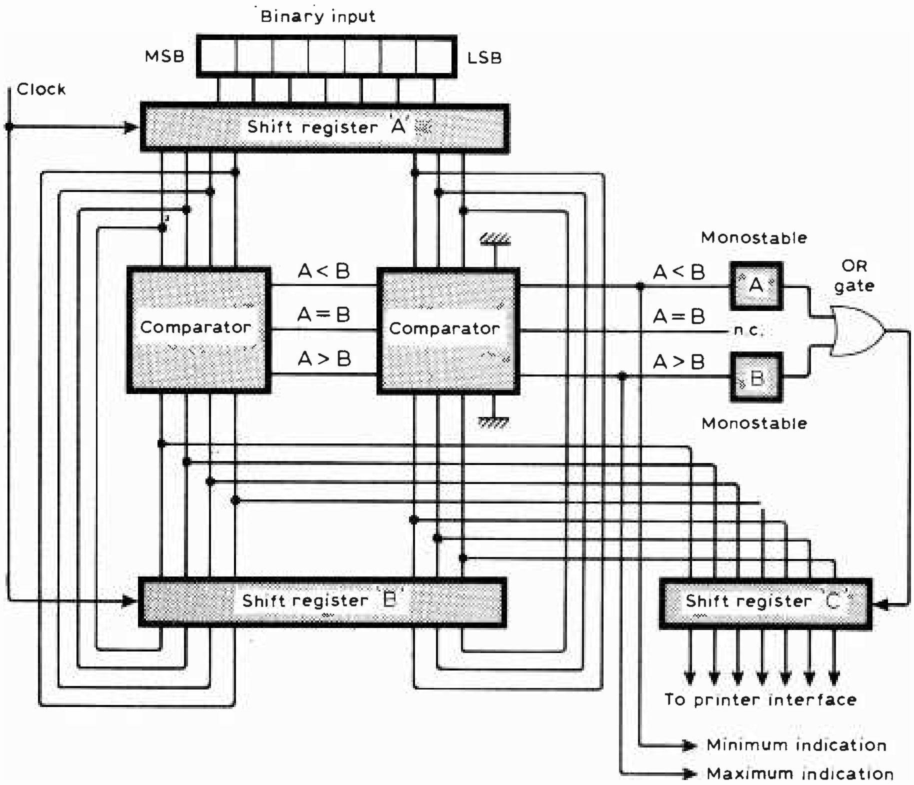

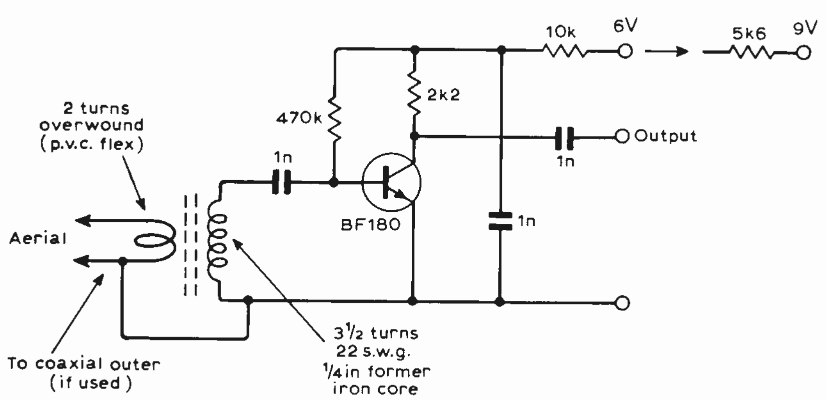

Simple v.h.f. preamplifier

This preamplifier is suitable for portable use and operates between 85 and 95MHz. The components can be mounted on a board approximately one inch square. Gain is about 15dB but this can be increased with a small sacrifice in stability by using a BF185. All resistors are ¼W metal oxide types and the capacitors are ceramic disc.

Ronald G. Young
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Sussex

Three-function RS latch

A standard RS latch as shown in (a) responds to an input at both SET and RESET by bringing both outputs low. An alternative latch, shown in (b), can be used in cases where non-complement outputs are undesirable. When RS is 00, latch 1 and hence latch 2 will not change. When RS is 01, latch 1 resets which sets latch 2. By symmetry, RS at 10 causes latch 2 to reset. With RS at 11, both outputs of latch 1 are forced low. However, two low inputs at latch 2 will not alter the output. A similar latch may be constructed using cross-coupled NAND gates.

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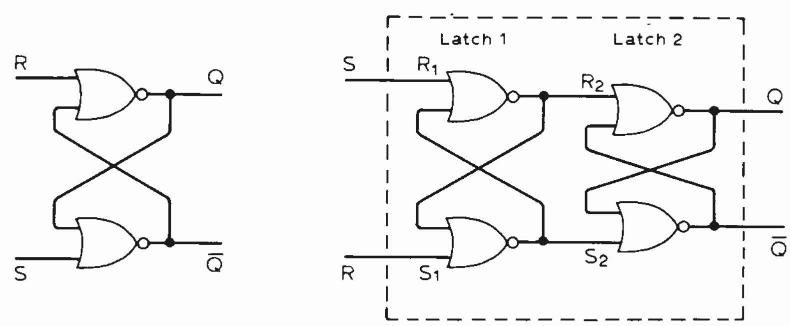

(a) (b)

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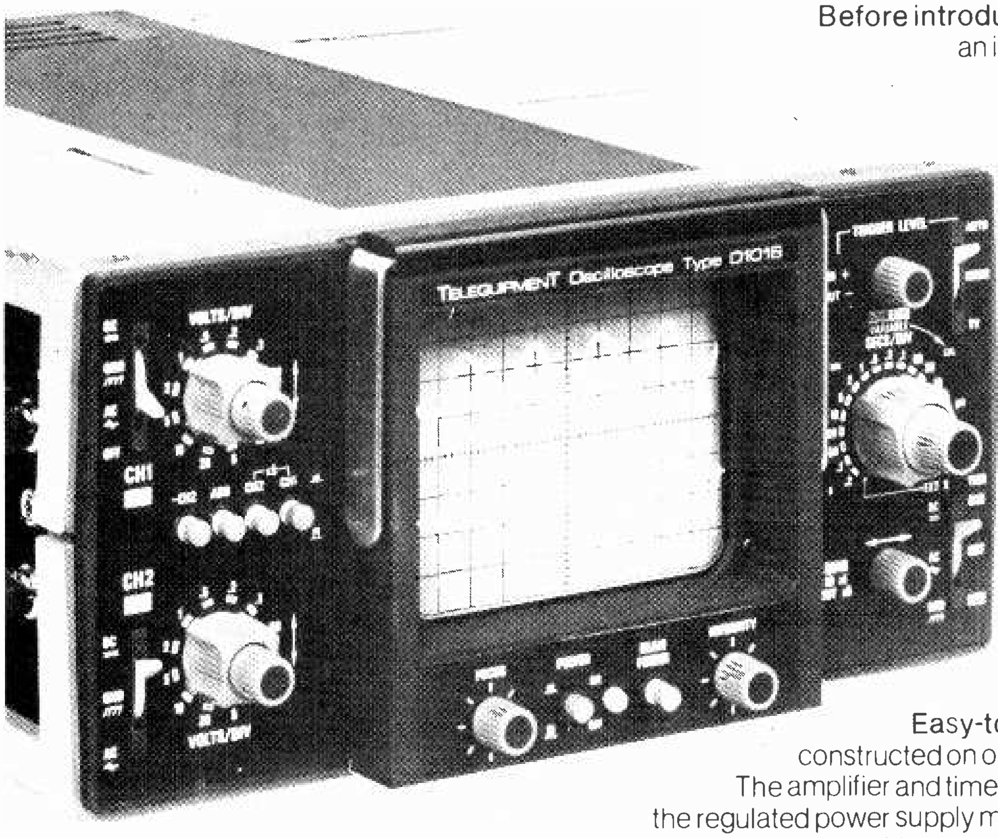

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Add-on oscilloscope waveform store

2 — Control circuitry, setting-up and operation

by R. D. Fastner (G8GRZ)

Digital storage techniques allow an ordinary dual-channel oscilloscope to function as a storage type. The input signal to the oscilloscope is extracted, converted to digital form, stored, converted back to the analogue form and displayed on the oscilloscope screen. A useful feature is that the waveform before the trigger pulse can be displayed. Circuitry is included to remove the "steps" in the waveform which would ordinarily be the result of a sampling process.

Control circuitry These circuits seen in Fig. 7 are operated from a 15V supply and consist of the sync counter, blank-length counter, store read/write bistable, roll read/write bistable and store-full bistable. "A" and "B" gate-level shifters, sync + and blank buffers are also part of these circuits but are not described in detail.

Sync. counter. This consists of three MC14510 decade counters, the input being derived from the e.o.c. pulse via IC_{31} in Fig. 5. The last stage (100's) is preset to the number of divisions required for pretriggering, i.e., 2(200) for two divisions pretrig. The terminal count from pin 7 of IC_{12} is used to flip over bistable flip-flops when the memory is "full". It is also used, after being delayed for one count, as a sync pulse.

Blank-length counter. One half of a 4013 dual "D" type flip flop, IC_{13} and a 4024 seven stage binary counter, IC_{14}, are used in this part of the circuit. Its function is to count the number of "divisions" after the tenth division displayed in order to reset the blank bistable. The count length is determined by the number of divisions the scope continues to sweep after the tenth division before flyback. The counter length is set by diodes and may range from 2% to 2.55 divisions. A length of 1.5 divisions is selected in the circuit diagram.

Store read/write bistable. When in the store mode, the outputs from this bistable, half a 4013, IC_{19}, opens or shuts the gates at the input of the memory. These outputs, when selected by IC_{15}, are labelled Read and Write for the Q and $\bar{Q}$ outputs respectively. When Read is high and Write is low, the gates, IC_{6-7} in Fig. 2, are enabled to allow the data from the memory output to flow to the memory input, hence allowing it to recirculate. Simultaneously, Write is low and this closes the gates from the a-d convertor to the memory input. When the Write button is depressed, the outputs reverse allowing the memory to be "written". This condition is once again reversed when the sync counter terminal count goes high.

Roll read/write bistable. The function of this circuit, IC_{16}, in the roll mode, is similar to that described previously, except that it is controlled by the sync counter. The effect is to change the read/write lines once per sweep for one sample, i.e., the waveform is sampled once in a thousand. This bistable is also used to delay the sync pulse by one "sample" to allow for the analogue delay in the step eliminator. When in the roll mode the Q output inhibits the counter for one count, causing it to count 1001.

Store-full bistable. This is made up from two sections of a 4011, IC_{17}, to form a bistable. When in the store mode, its function is to inhibit the sync counter between the time that the write button is depressed and the scope's sweep being detected (A or B gate going high). It is also used to preset the sync counter at the beginning of the write cycle.

Interfacing

This unit has been designed and built around the Tektronix 465 oscilloscope. For it to operate with other instruments the inputs and outputs of the unit may need to be interfaced with those of the oscilloscope.

Feeding the output waveform into the second channel of the oscilloscope should present no problems, as the output voltage has been selected so that the waveform may be expanded and compressed and at 2V/div most instruments should be able to do this. However, if desired, the gain of IC_{28}, the output buffer, may be altered as required by altering the feedback resistor.

The sync + output also should present no problems. If the 0 to + 15V edge is too high for the oscilloscope to trigger on reliably, a simple potentiometer divider may be placed across the output and the sync signal taken from the junction of the two resistors. The pull up on Tr_4 emitter should not be increased, as the increased capacitive effect between base and emitter will reflect back into the high impedance c.m.o.s. logic. This may cause trouble when in the roll mode.

The blank signal, fed into the Z mod. or axis input of the oscilloscope, has an output of 0 to + 15V, the output being at + 15V during the blank period. If inversion is required to give 0V during the

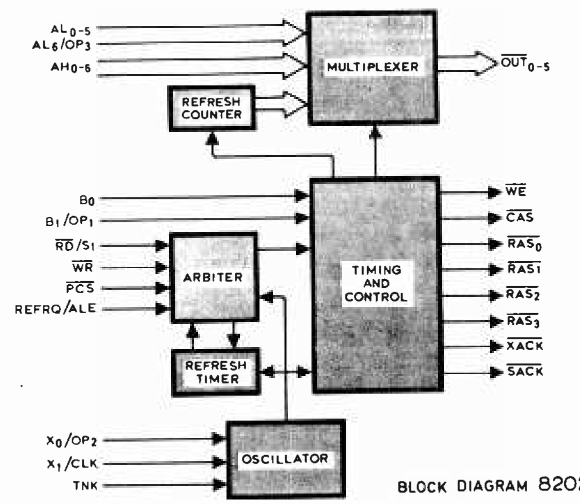


Fig. 7. Control circuit

blank period, Tr_3 base could be taken to the Q output of the blank bistable. Again, if the levels present a problem, a simple potentiometer divider could be used, as for sync +.

Due to the very large number of oscilloscope models, it is impractical to go into detail when describing the pick-off points for "A" trig, "B" trig and waveform in. All instruments of worth have trigger and blanking circuits, the former being derived from the input amplifier, via a buffer, and the latter from the sweep controlling logic.

Minimum interference is caused to the operation of the oscilloscope by taking the "waveform in" signal via an interface buffer from the "trigger buffer". This buffer can be some form of operational amplifier in the non-inverting mode (high impedance) or a simple emitter follower. The sweep waveform is usually obtained from an integrator, whose input is a step derived from the trigger circuit. Also from this circuit an unblanked signal is derived which enables the "trace" during sweep. Either of these two signals may be buffered and used for the A and B trig. Care should be taken to ensure that they are clean, and the signal does not have "chopped blanking" waveforms superimposed on it, or that the A sweep signal does not have B sweep signals (or vice versa) mixed with it. For correct blanking circuit operation within the storage unit, the "A" trig should stay high for at least 10 divisions (10 × storage unit store time/div setting) and is independent of "B" timebase which may be a positive pulse.

Some scopes have A and B gate outputs using higher output levels. In these cases R_{61}, R_{63} are changed so that $Tr_{6,7}$ base voltages are a little less than the "high" input voltage.

Practical considerations

Care should be taken when mixing analogue and digital circuits and it is recommended that the impedances around the input amplifier should be kept low to reduce adjacent track crosstalk. It was found that the wire from the position pot to the non-inverting input of the input amplifier had several microvolts of hum induced in it by the mains transformer. To stop this being superimposed on the output of this amplifier, a capacitor C, has been added from the non-inverting input to 0V. The storage capacitor, C_{28}, in the sample-and-hold section of the step eliminator is floating when the analogue switch is off, and therefore board leakage should be reduced as far as possible to prevent discharge (or charge) of this capacitor. Also the tracking to and from this capacitor should be kept as short as possible to reduce hum pick up. It has been found that slight amounts of "tilt" and hum on the integrator input have negligible effect on its output even on low displayed time/div settings.

Setting up

Only two adjustments need to be made, the first being to null the offset voltages of the d-a and output stages. This is achieved by selecting R_{14} so that with B1 only present the "waveform out" is 0V. The second adjustment is to set the gain of the input amplifier so that when a voltage proportional to ±3 divisions is fed into the unit, an output of ±6V or ±3 divisions is obtained.

To null the offset voltages first disconnect the +15V supply to the store/roll switch. This disables the read/write lines which in turn disables the read/write gates. Bits 1-8 at the memory input will now be low. Disconnect B1 to the memory input and connect it to +5V, The d-a convertor will now only see B1, and R_{14} may now be selected so that the output of the unit is as near as possible to 0V. The offset voltages of the d.a.c., step eliminator, and output buffer have now been nulled. Reconnect up the supply to the switch and B1 to the memory output.

Setting up the gain is accomplished in the following way. Connect up the inputs and outputs between the oscilloscope and unit. If a single time-base instrument is used connect the "B" trig input to 0V. Set both oscilloscope and unit to 1ms/div, the oscilloscope to "A" timebase only, and Auto trig on Ch1. Set the unit to Store mode and "B" trig, and press the Write button. The write indicator should come on and stay on. Feed into the Ch1 input of the oscilloscope a sine wave of approximately 500Hz and ±3div in amplitude (symmetrically about 0V). Ch2 should be displaying the processed waveform and the gain control RV_2, in conjunction with theposition control RV_1 may be adjusted to give a unit output of ±6V (about 0V). If the input is increased above ±3 div the output should saturate at ±6V. In the above, it is assumed that the channel whose output is used as the input to the unit is Ch1.

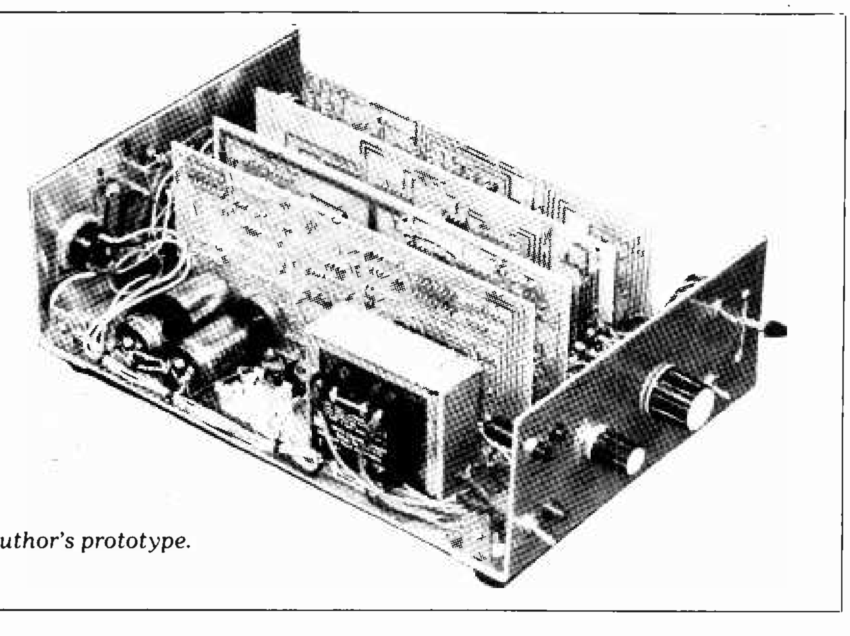
The maximum position voltage required is a little more than the maximum input voltage. If the input voltage is 50mV/div for 6 div, this gives an input voltage V_A of 300mV, and the position voltage V_B will also be around 300mV. A value for R_5 of 47kΩ satisfies this requirement.

Operation

Store mode. The oscilloscope is operated normally in either the single-sweep or normal trigger mode. So that the displayed waveform is stored as originally displayed, the time/div switches of the oscilloscope and unit should be set to the same positions. When storage is complete the oscilloscope should be triggered from the unit sync output.

The Write button is depressed before the oscilloscope triggers; this resets the store read/write bistable and causes the Write indicator to light and the data from the a-d converter to be gated into the memory. The Store Full bistable will be reset by IC_{16}, pin 12 and its $\overline{Q}$ output on pin 3 is gated with IC_{16}, pin 12 in IC_{17}, pin 4. The output of the gate is inverted by IC_{18} and the resulting high output is fed to the chip enable input of IC_{10}, inhibiting it. The circuit remains in this state, i.e. Write high, sync counter disabled and the unit waiting for the oscilloscope to be triggered.

When the oscilloscope triggers, the A gate will go high, indicating that the sweep has commenced. This high is level-shifted to +15V and IC_{17}, pin 10 goes low, setting BS_2, BS_2 Q output is fed into a pulse-forming circuit which produces a positive-going pulse of approximately 3μs duration. This pulse presets the sync counter to 200 if 2 divisions of pretrigger has been selected. The $\overline{Q}$ output of BS_2, causes IC_{17} pin 11, to go high. This, via IC_{18}, pin 3, enables the sync counter, which proceeds to count up a further 800 samples to 1000. At the count of 1000 IC_{12} terminal count goes high clocking BS_1 and setting it. "Read" will now be high and the gating is enabled to allow the data in



Author's prototype.

the memory to recirculate. Since the a-d converter was operating prior to the oscilloscope triggering, the data in the memory will consist of 200 samples, which have not been displaced by new data, and the 800 samples fed into the memory after the oscilloscope triggered. Hence, 2 divisions pretrigger and 8 posttrigger. The counter is preset in a similar manner for each of the other pretrigger positions.

Also, at the instant the terminal count goes high, BS_3, the roll read/write bistable, is reset. The $\bar{Q}$ output clocks BS_4, the blank bistable, so setting it. This has two effects: the first is to cause Blank to go high, blanking the oscilloscope's trace. The second is to inhibit Clock 1 to the memory, Clock 2 to the sync counter and Enable to the blank-length counter. These two actions result in the unit locking up, with the oscilloscope in a blanked condition, for the duration taken for the blank-length counter to time out. When the desired count (selected by diodes) is reached BS_4 is reset, re-enabling the sync counter and memory. During the blank period the memory presents the first sample to be displayed at its output. This is done so that the step eliminator can ramp the "false sample" between the end and the beginning of the stored waveform, (i.e. sample 1000 and sample 1) whilst the trace is blanked. The first clock pulse after the blank phase clocks BS_3, setting it. Sync goes high which, if the oscilloscope were set to ext. trig. would trigger the oscilloscope at the start of the stored waveform. Thus the complete store cycle is: Write button depressed-unit locks up waiting for the oscilloscope to trigger; oscilloscope triggered; counter preset; counter counts up the number of "divisions" required; terminal count reached; unit "switched" into Read; oscilloscope blanked and unit "locked up" with the first sample at the output of the memory; oscilloscope ends sweep and flyback; blank circuit times out allowing the stored waveform to be displayed. The oscilloscope trigger source is set to external so that it triggers from the unit. Triggering the unit from the "B" timebase allows delayed storage to take place.

The unit can be used to store a peak level, whilst observing the incoming waveform, by setting the oscilloscope to "A Intens by B" and setting the "B" trigger level to the peak level to be detected/stored. For example, if the normal input waveform level to the scope is ±15 divisions, the "B" timebase may be set to trigger at +1.6 div. Thus, if the input goes above +1.6 div the unit will store the waveform around this point (store peak detected).

Role mode. This extends the oscilloscope's lowest range from 0.5 s/div to 500 sec/div. The waveform appears to move from right to left, in similar manner to a paper strip recorder, with the latest level appearing on the right. When 0.5 sec/div is selected, the waveform is displayed at 0.5ms/div whilst "moving" from right to left. This provides a display that is easy to view since the whole waveform can be seen instead of a moving dot. Switching the unit to 'store' holds the waveform. The Roll mode is achieved by inhibiting the sync counter for one count, causing it to count to 1001, which means that the oscilloscope triggers on successive samples. Hence, the waveform then appears to roll round. Whilst the counter is inhibited, the read/write lines change over so that the sample before the oscilloscope triggers is "up-dated" and appears at the end of the sweep.

At the count of 999, IC_{12}, pin 7 (terminal count) is low and the unit is in the Read mode. BS_3 $\bar{Q}$ is low, the sync counter is enabled and Sync+ is high. On the next clock pulse (1000)IC_{12}, pin 7 goes high and the previous low terminal count is clocked through BS_3. This inhibits the sync counter via BS_3 $\bar{Q}$ and causes the unit to go into the Write mode. The next clock pulse (1001) again clocks the previous high terminal count state through BS_3. Sync + goes high, triggering the oscilloscope, and the sync counter is again enabled. The unit goes into Read mode for the next 999 clock pulses. In this roll mode the unit does not lock up during the blank phase, and the oscilloscope triggers on alternate sync pulses, i.e. the sync pulse follows immediately after the end of 10 divisions.

It is regretted that it is impracticable to publish the printed board design for the storage unit, but *Wireless World* can supply photocopies (made on a rather better machine than in the past) to readers who send a stamped, addressed envelope to their offices.

Acknowledgements

The author would like to acknowledge his indebtedness to Gould Advance Ltd, whose OS4 oscilloscope gave rise to the ideas of roll, pre-trigger and step-elimination, although it should perhaps be pointed out that the design of the present instrument was started three years ago – before the OS4000 was made public. Thanks are also due to Tektronix, who lent a C-5A camera for the screen photographs. □

Circuit elements

Qty	I.cs
2	CD 4010 hex. non-inverting buffer/convertor
6	CD4011 quad 2-input Nand gates
1	CD4012 dual 4-input Nand gate
2	CD 4013 dual "D" type flip-flop
1	CD 4016 quad analogue gate/switch
3	CD 4019 quad And-Or-Select gates
1	CD 4024 7-stage binary counter
1	CD 4029 presettable binary/decade up/down counter
5	MC 14510 presettable decade up/down counter
1	MC 14559 successive-approximation register
2	MC 1408-L8 8-bit digital-to-analogue convertor
1	MC 1407 a-d control circuit
4	NE 531 high-speed differential op-amp
16	NE 2528 dual 250-bit shift register
1	LM 302 voltage follower

Transistors

1	BSX19 n-p-n
3	2N2906 p-n-p
3	BC107 n-p-n

Diodes

35	1N4148 general-purpose
1	BZY 88 C4V7 Zener
1	1.8 MHz crystal (for oscilloscopes scopes with 10 horizontal divisions)

Resistors

1	470R	½w 2%
2	560R	
1	820R	
5	1k	
1	2k	
3	2k2	
1	3k	
2	5k1	
1	9k1	
10	10k	
1	11k	
8	15k	
2	18k	
1	30k	
2	33k	
3	47k	
15	100k	
1	18M	½w 5%
1	1k pot.	
1	47k trimpot	

Capacitors

1	15p tubular ceramic	
1	20p	
2	22p	
2	39p	
4	100p	
1	120p	
3	270p	
1	470p	
1	680p	
16	100n	disc ceramic
1	470p	1% mica
1	1n	
1	2n2	
1	4n	
1	10n	
1	22n	paper, polyester, etc
1	47n	
1	100n	
1	220n	
1	470n	
1	100μ	electrolytic 10V

Switches

1	3-pole	10pos. rotary
1	1-pole	2-throw toggle
2	1-pole	2-throw toggle
1	1-pole	push button
1	1-pole	4-pos. lever

Specification

The unit gives a storage area of 6 divisions vertical and 10 divisions horizontal.

Input from oscilloscope:
+300 mV for all positive storage
−300 mV for all negative storage
± 150 mV for bipolar storage
The input levels are easily adjusted to suit the oscilloscope and the 0V position is adjusted by a control on the front panel.

Time/div. ranges:
Store mode 500, 200, 100, 50, 20, 10, 5, 2, 1, 0.5 ms/div.
Roll mode: 500, 200, 100, 50, 20, 10, 5, 2, 1, 0.5 s/div.
Thus the range is from 0.5ms/div to 500 s/div in 19 ranges.

Waveform output to oscilloscope:
± 6V (2V/div)-irrespective of input polarity; i.e. 0V appears as −6V for all positive storage,
+6V for all negative storage,
and 0V for bipolar storage.
The output levels are easily adjustable.

Sync to oscilloscope
0 to +15V edge at the start of the stored waveform. This is fed into the Ext Trig input of the oscilloscope.

Blanking to oscilloscope:
+15V level after the tenth division the length of which is selected to suit the oscilloscope.

A-Gate from oscilloscope:
+5V logic level, going high at the start of "A" timebase sweep. Level must be maintained for at least 10 divisions during display stored waveform period.

B-Gate from oscilloscope:
+5V logic level or pulse going high at the start of "B" timebase (approx 10μs min).

Electronic organ tone system — 2

Frequency generation and keying matrix

by **A. D. Ryder,** M.A., Ph.D., F.I.E.E.

The previous article gave details of the reference generator and its construction on a Veroboard. This month's article describes the gate cards which are based on specially designed printed circuit boards.

One gate card is needed for each of the 12 notes in the scale. The d.c. signals from the playing keys are brought in, either directly or via the coupling circuits, through edge connections at the front. Output connections are made via the rear edge-connector which also carries supply rails, the reference signal and, if used, the vibrato signal.

Outputs of, for example, the C card are square-wave signals at multiples of 32.7Hz, the fundamental of the lowest C used. These are collected onto a set of square-wave buses (SQB) which are common to all 12 gate cards and form the inputs to the three filter cards. There are seven sinewave harmonic pitches for each department, 21 in all, which are the outputs of the filter cards. To ease filter design, the fundamental SQBs are each divided into three sections, and the rest into two, so that in all there are 45 gate card outputs. The cards also provide a spare SQB for each department so that there are a further six output lines which can be used for the various options to be described later.

The functions of each gate card are thus the local generation of the required frequencies, tied to the incoming reference, and the gating of these selectively to the square-wave buses under the control of key signals. In addition, the cards carry circuits for shaping the keying envelope, and can accept a signal for vibrato.

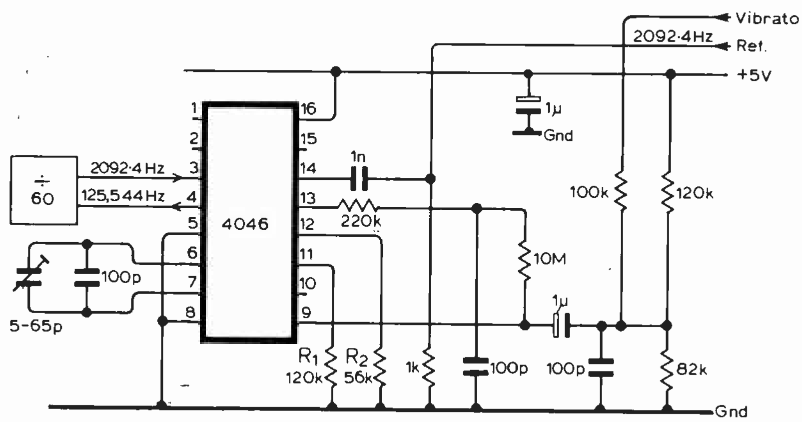


Fig. 10. *Phase lock loop for C card. This circuit multiplies the reference frequency by 60.*

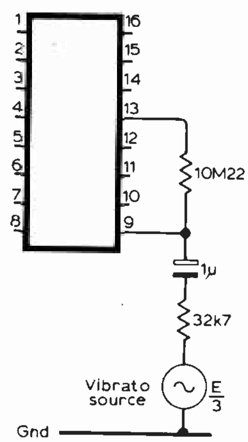


Fig. 11. *Feedback loop of p.l.l. at low frequencies.*

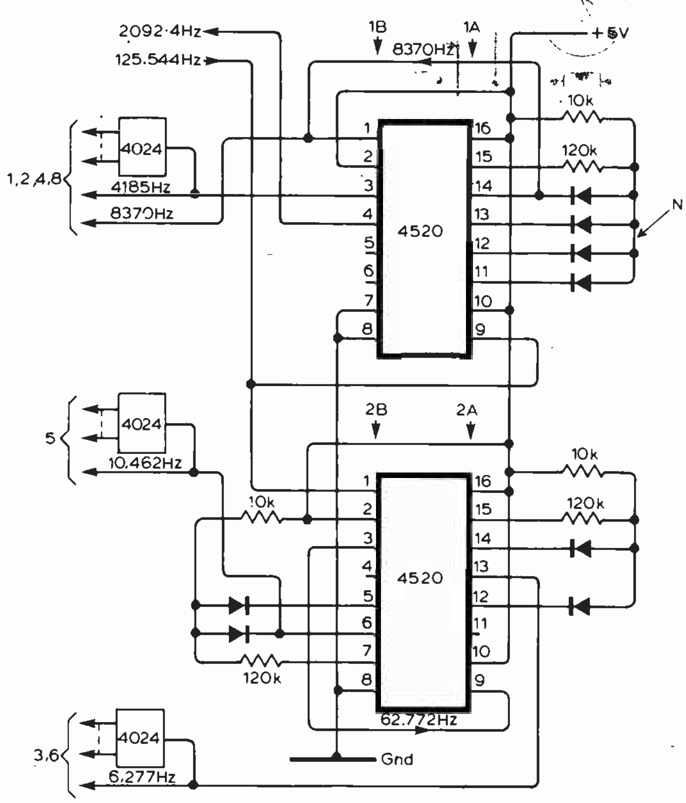


Fig. 12. *Frequency derivation on C Card. All diodes are general purpose devices such as the 1N4148.*

Frequency generation

The circuit in Fig. 10 shows how a 4046 p.l.l. is used to derive a frequency of 60 times the reference. Except for R_1 and R_2, which decrease with increasing frequency, this circuit applies to all 12 gate cards. The reference input at pin 14 is a.c. coupled, and the 1kΩ resistor,

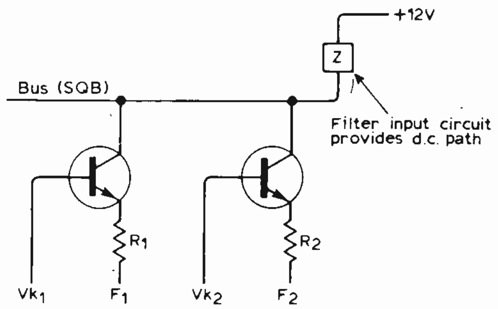


Fig. 13. *Common-base transistor gates. Input signals F_1 and F_2 are square-wave divider outputs.*

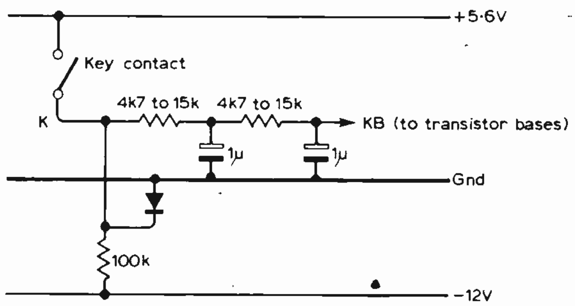


Fig. 14. *Keying circuit. The double integrating network is used to control a d.c. output component by shaping the keying envelope.*

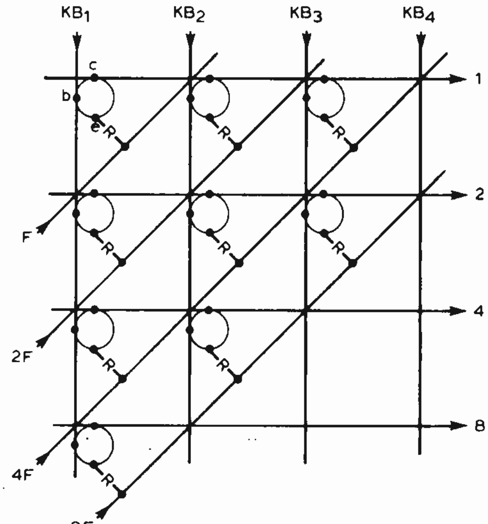
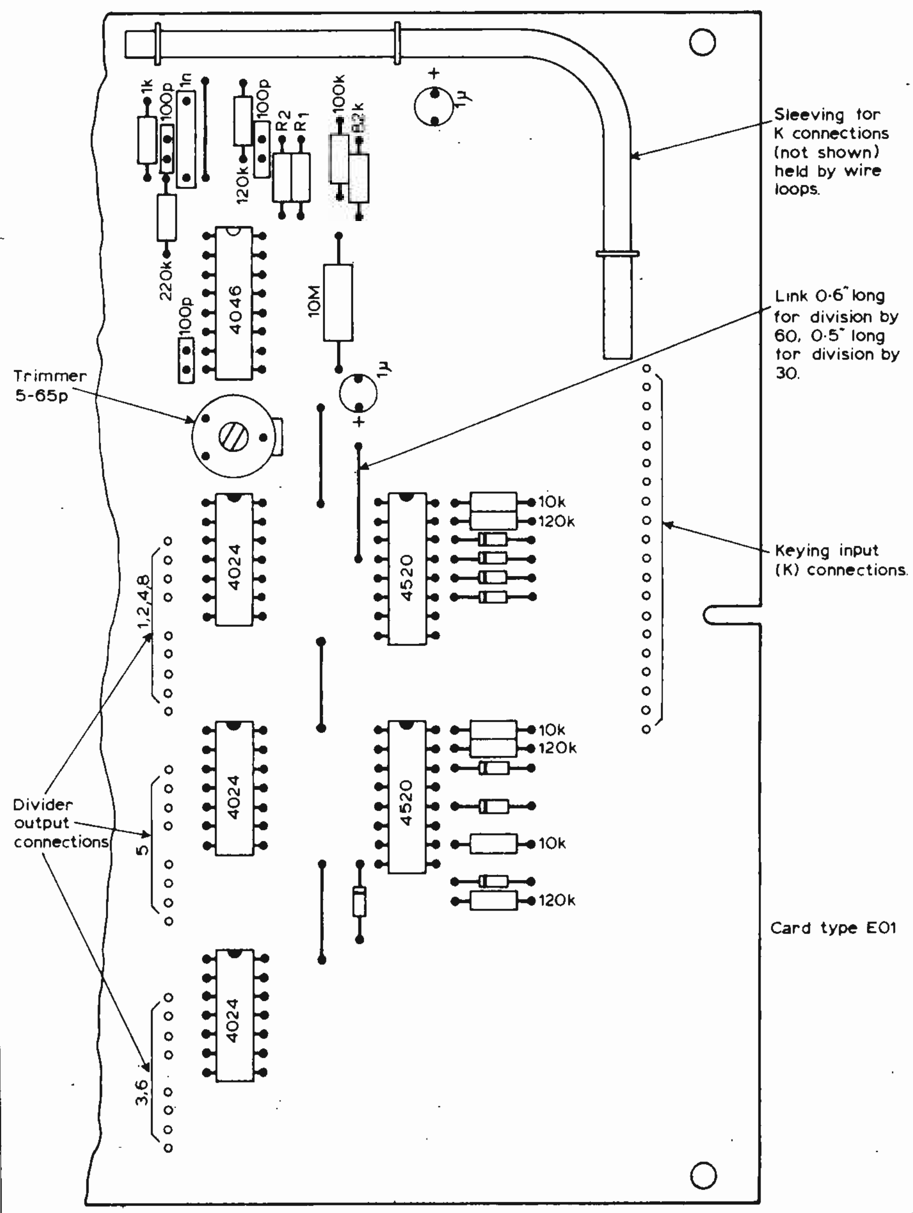


Fig. 15. *Portion of the three-way matrix. This layout is roughly the same as the p.c.b. viewed from below.*

Fig. 16. *Component layout of the frequency generating section on EO1 cards.*



together with the 22kΩ buffer in Fig. 4 control the reference level. A divider is connected between the v.c.o. output and the comparator input, and the digital phase-comparator output at pin 13 is used for control. This comparator has a switching action which reduces the settling time for a given feedback time constant. The control signal at pin 9 must have an in-phase component for stability, which in turn makes h.f. filtering desirable to minimise output jitter. Fig. 11 shows the circuit at l.f. where the lower network is the parallel combination of 82kΩ, 120kΩ and 100kΩ. Returning the capacitor to about 2V reduces the charging time at switch-on.

When a vibrato signal of 4 to 8Hz and amplitude E is applied, the amplitude at pin 9 is roughly E/3. The frequency deviations cause an antiphase square-wave signal at pin 13 which swings between about +1.25 and +3.75V. Except for very low values of E, this has negligible effect on the extent of frequency modulation. However, the mean voltage at pin 9, if not initially 2.5V, will tend to this figure, assuming symmetrical modulation, so that the mean frequency will drift slightly, though the original frequency will always lie within the modulation range. The trimmer allows initial setting-up for 2.5V. Generation of the vibrato signals is considered in a later article. Table 4 shows some frequencies used on the 12 gate cards.

Frequency dividers

In Fig. 12, each 4520 i.c., which contains two independent 4-stage dividers, has the enable inputs connected to the positive supply rail. Non-binary counts are achieved by premature reset. Counter 1A, for example, divides its input at pin 9 by 15 because the four outputs represent counts of 1, 2, 4 and 8. The diode AND connection allows line N to go high on reaching the count of 1 + 2 + 4 + 8, i.e. 15. The 120kΩ resistor in series with the reset input at pin 15, together with the input capacitance, provides a short delay to avoid switching ambiguities. The 1 output appears eight times in the cycle, the last time briefly. The 8 output has a frequency of 60ref/15 i.e. 4ref, which in this case is 8370Hz, and a mark to space ratio of approximately 7/8.

Counter 1B is used without reset, pin 7 grounded, so that the overall division to pin 4 is 60, as required for Fig. 10. The pin 3 output, at 2ref, is taken to a 4024 7-stage counter so that a total of 9 octavely-related C frequencies, the unisons, are available down to 32.7Hz.

Counter 2B is connected to divide by 12, 8 + 4, and produces an output of 5ref, again extended by a 4024 to give eight 5th harmonic pitches. As this is an even division, the 1 output at pin 3 is a square wave at 30ref, which is divided by 10 in counter 2A. Here the 4 output has the same frequency of 3ref as the 8 output, but a mark to space ratio of nearer unity. This output is used with another 4024 to provide eight 3rd and 6th harmonic pitches.

As already noted, the lowest pedal frequency is 32.7Hz, and the lowest manual is 65.4Hz. These correspond to 4ref/256 and 4ref/128 respectively. The 3rd harmonic of 32.7Hz, 5⅓ft, is 3ref/64, and the 5th, 3⅕ft is 5ref/64, so that in the basic system, neither of these buses requires the lowest output from its 4024 i.c.

The fundamental of the highest manual key, CK6, is 2093Hz, therefore the highest unison at 4ref, 8370Hz, provides only the 4th harmonic at this level. A frequency of 8370Hz is the normal limit for the fundamental of an organ pipe. With the next highest key, BK5, 4ref at 15,794Hz would provide the 8th harmonic but, as table 5 shows, the various pitches are discontinued at about 10kHz, and at CK6, the 5th is the highest provided.

Although CK6 is the highest key, the gate cards carry K6 circuits up to G, to operate with octave couplers if used. The frequency limits are noted in table 5. The highest pedal key is GK3 which has a fundamental of 196Hz and an 8th harmonic at 1568Hz. A complete K4 octave is provided for the pedal department, which extends to 3135Hz.

Alternative reference set

As noted in the previous article, the clock input to the multiple divider may be at various frequencies. For example, at 1MHz instead of 943.7kHz, the C reference is 4186Hz as shown in table 2. This is accommodated by taking the comparator signal from pin 3 of counter

Table 4. Some gate-card frequencies using the tunable reference source set to zero beat

Note	Nominal ref frequency (Hz)	Actual ref frequency (Hz)	60 ref	4 ref	5 ref	3 ref
C	2093.0	2092.4	125,544	8370	10,462	6,277
C'	2217.5	2215.2	132,912	8861	(11,076)	6,646
D	2349.3	2347.4	140,844	9390	(11,737)	7,042
D'	2489.0	2489.9	149,394	9960	(12,450)	7,460
E	2637.0	2635.9	158,154	10,544	(13,180)	7,908
F	2793.8	2791.9	167,514	(11,168)	(13,960)	8,376
F'	2960.0	2958.2	177,492	(11,833)	(14,791)	8,875
G	3136.0	3135.1	188,106	(12,540)	(15,676)	9,405
G'	3322.4	3322.8	199,368	(13,291)	(16,614)	(9,968)
A	3520.0	3521.1	211,266	(14,084)	(17,606)	(10,563)
A'	3729.3	3729.9	223,794	(14,920)	(18,650)	(11,190)
B	3951.1	3948.4	236,904	(15,794)	(19,742)	(11,845)

The brackets indicate frequencies not used directly.

Table 5. Upper frequency limits

Harmonic no.	1	2	3	4	5	6	8
Highest key	GK6	GK6	GK6	EK6	CK6	GK5	EK5
Frequency	3135	6270	9405	10,544	10,462	9,405	10,544

EK6 and GK6 do not represent actual keys, but circuits are provided up to GK6 for use with octave coupling.

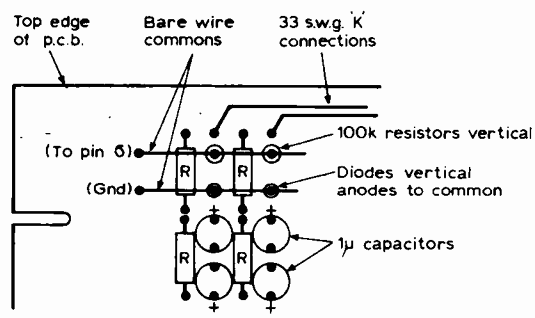
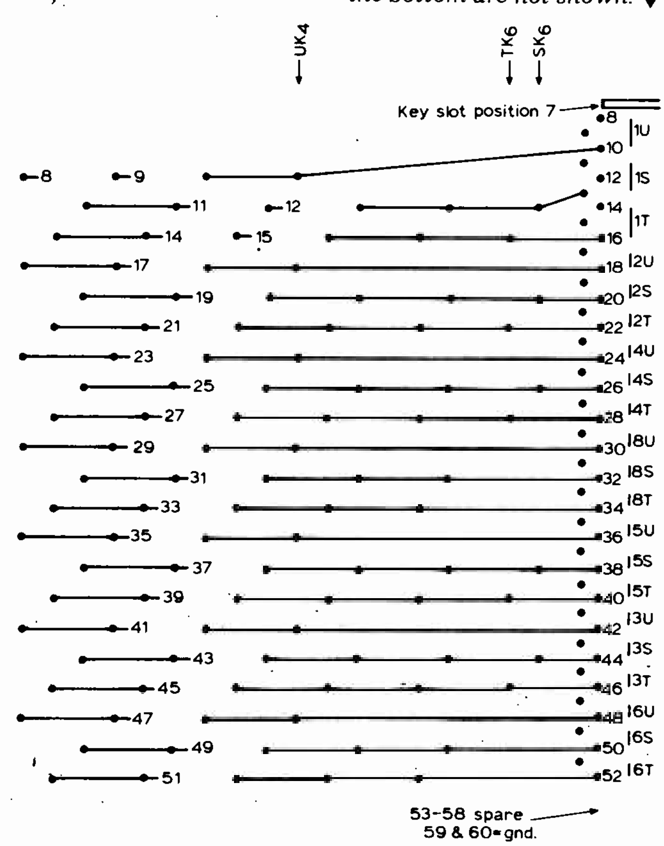


Fig. 17. *Keying circuit layout from component side, showing two circuits. Except for the value of R, all of the circuits are identical. The common wire connections bend down to enter the p.c.b. on the left.*

Fig. 18. *Card C square-wave bus output connections on copper side. This pattern also applies to cards C' to G, except for fewer gates in the TK6 and SK6 columns. Spare gate positions at the bottom are not shown.*



1B in Fig. 12, rather than pin 4, and so multiplying the reference by 30 instead of 60. This selection is by a wire link on the p.c.b. see Fig. 16.

Keying

Because a large number of gates are needed, a minimum component count per gate is desirable, and the common-base transistor configuration which was chosen is shown in Fig. 13. Input signals $F_1$and F_2 are 5V square-wave divider outputs. When the base voltage of one of the transistors, e.g. Vk_1, is zero, it is held off. As this voltage is increased, the transistor starts to conduct during the low excursions of F_1 and a current of roughly $(Vk_1-0.6)/R_1$ flows out of the emitter. When Vk_1 is about 5.6V, the transistor ceases to cut off during the F_1 cycle and the output current swing at the collector is at a maximum of $5/R_1$, with a mean level of $2.5/R_1$ for a unity mark to space ratio. A further increase of Vk_1 merely raise the mean current without increasing the a.c. component.

The high output resistance of the common-base connection means that, with practical values of filter input impedance, the contribution of each gate is more or less independent of the others, and almost entirely determined by its input resistor. The base provides a low-current input for the keying signal and, if decoupled to ground, isolates the input and output. The main cause of breakthrough with the gate off, is emitter-collector capacitance, but for the suggested BC548C transistor this is less than 0.2pF.

Although the common-base configuration has advantages over the usual diode gate, it does have a drawback in common with other unbalanced gates, of the d.c. output component. If switched directly by the key, there would be an intolerable thump at the start and finish of a note, especially as the following filters must be low-pass. This thump is controlled by shaping the keying envelope with a double-integrating circuit as shown in Fig. 14. The time constants are graded over the frequency range. A 100kΩ pull-down resistor produces a turn-off time similar to the attack time, and the voltage at K is limited by the diode.

Amplitude control

Reducing the direct keying voltage below 5.6V provides one means of reducing the volume of a complete department, without using controls in the signal path, and can be used for expression pedals and/or switchable departmental balance. A square waveform, as used here, is the only type which can be controlled in this way without affecting the harmonic spectrum.

Keying matrix

With provision for coupling, there are 68 keying circuits for each manual department, and 32 + 12 for the pedal. Thus, there are in all 180 of the circuits in Fig. 14 with 16 on each card C to G, and 13 each on G' to B.

Each KB signal controls seven gates, one for each harmonic pitch, except where the higher harmonics are discontinued at the top end. Every manual SQB set collects the outputs of up to 68 gates and similarly, each pedal SQB set collects the outputs of up to 44 gates. The generated frequencies on a gate card may feed one or more gates because, for example, the fundamental of C6 is the 2nd harmonic of C5, the 4th harmonic of C4, and the 8th of C3.

The required interconnection pattern using a three-way matrix, is shown in Fig. 15. Keying circuits, not shown, are at the top, and their KB outputs, as printed tracks, run vertically to the transistor bases. Input signals at frequencies F_1, F_2, etc., are connected by wires on the component side, and the input resistors project upwards from the board with their lower ends connected to the emitters by printed track. The collector leads pass through holes and are connected below the board by wire to form the buses 1, 2, 4, etc. This layout minimises stray capacitance across the gates. A suitable wire is 33 s.w.g. Kynar insulated, as used for wire-wrapping.

Component layout

The EO1 board carries connector pads on both of its vertical edges, 24 at the input end and 59 at the output end. The frequency-generating components shown in Fig. 16 are towards the input side, separated from the matrix area by a broad vertical ground track.

The board also carries tracks for an additional p.l.l., and for three further i.cs, associated with options to be described later. The keying components mount along the top of the matrix area and, as shown in Fig. 17, the 100kΩ resistors and diodes are mounted on end with overhead wires which terminate in the left of the board. Connections K to the input pads are made in wire starting with UK1 to position 10, TK1 to 11, and so on leaving positions 1 to 9 unused. This differs from Figs. 22 and 23, but is suggested to simplify one of the options described later. On cards with only 13 keying inputs, G' to B, positions 19, 24, 25 (UK4, TK6 and SK6) will also be unused.

Matrix area

As already mentioned, only the base and emitter leads are soldered to p.c.b. tracks, and the collector connections are made with wire as shown in Figs. 18 and 19. The output edge connections finish at oval pads indicated by the numbered dots at the right.

The labelling at the far right identifies the SQB by harmonic number and department. For example, 1U is the pedal fundamental, 2T is the great 2nd harmonic, and so on. The low, middle, where used, and high sections of each SQB are connected in sequence so that pad 8 is 1UL, pad 9 is 1UM, and pad 10 is 1UH, pad 21 is 2TL, pad 22 is 2TH, etc. Labelling is primarily for descriptive purposes and the connections are straightforward. The staggered rows of dots represent the collector leads, and the short rows are associated with the pedal buses.

Each horizontal rectangle in Fig. 20 represents a gate transistor and its vertically mounted input resistor, R_n. The upper ends of the resistors are soldered to the wire signal buses which run diagnonally. The divider output connection points of Fig. 16 are indicated at the right, and connections from these to the signal buses are made on the component side with wire.

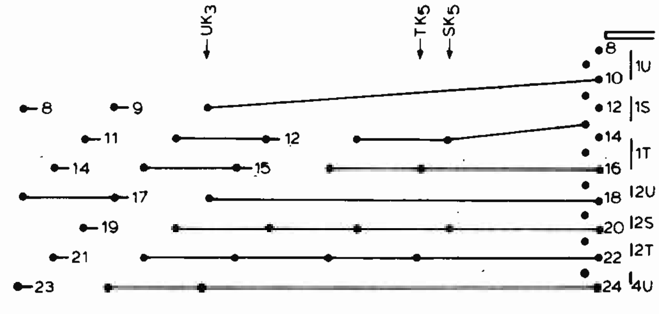
Values of R_n vary with frequency to produce, in conjunction with the filter response, a predetermined amplitude/frequency characteristic, which will be described in a later article. Choosing appropriate filter parameters minimises the variety of values on any one gate card.

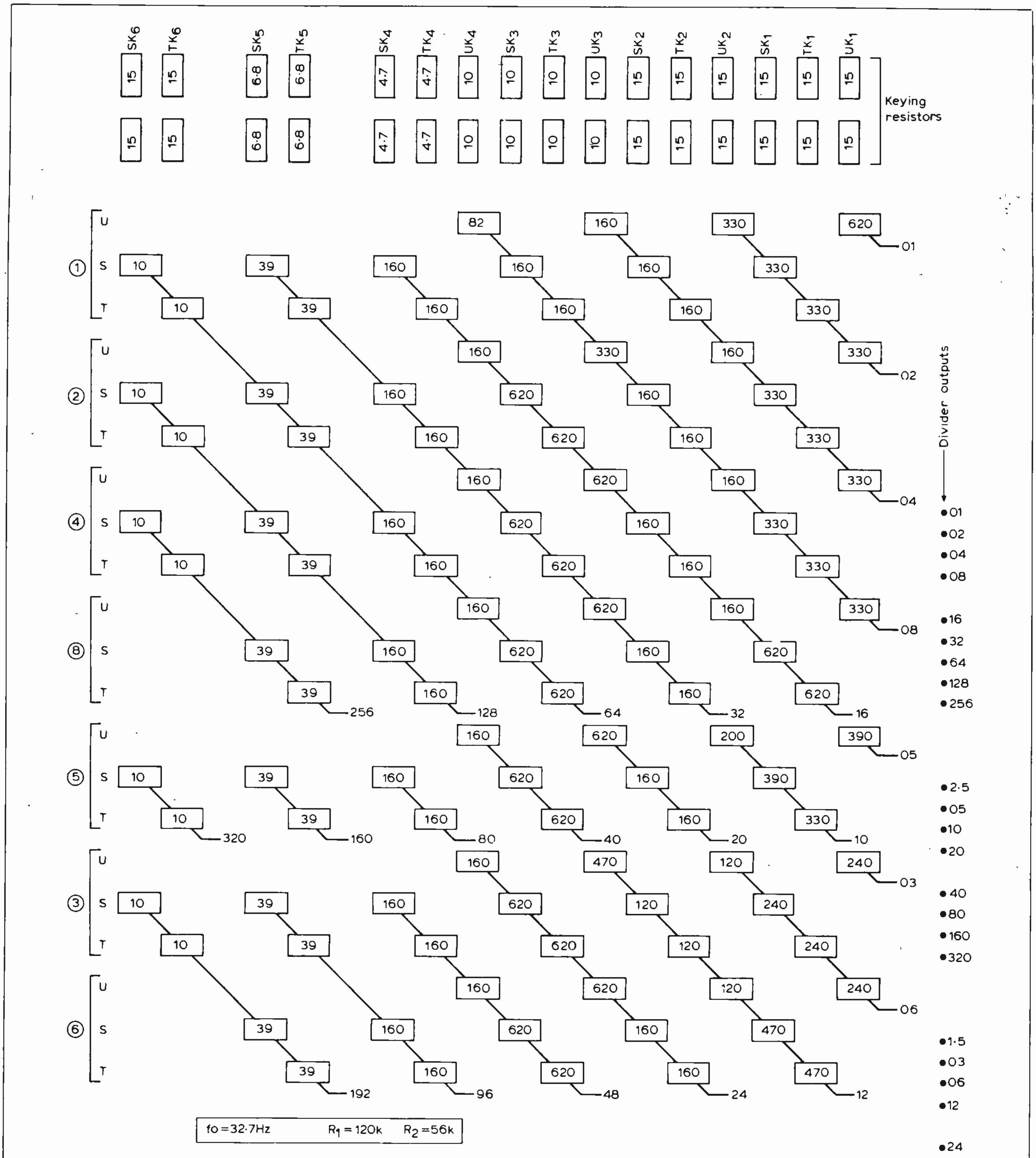
Assembly and testing

For the output connections of Figs. 17 and 18, where two or more collectors are joined, wire is stripped to length and soldered to the leftmost position. A small blob of solder is deposited on each collector lead to the right, and the wire is then held tight and soldered to each lead and finally to the output pad. To suit the suggested rack spacing, the component leads must not project more than 4½mm from the underside of the p.c.b.

It is convenient to first connect the

Fig. 19. *Card output connections for G' to B. Connection on pads 25 to 52 follow the pattern of Fig. 18, except that there are no gates in columns UK4, TK6 and SK6.*





vertically mounted resistors and diodes as sub-assemblies by using the simple jig in Fig. 21. The holes are marked out from a p.c.b., drilled to fit the components, and opened out at the top for easier soldering. Leads at the p.c.b. ends of the components are cut to a uniform short length and, after insertion in the jig, their upper leads are soldered to a straightened length of bare wire laid along the top. The jig and cutting dimensions should give a maximum projection above the board of 14mm.

It is recommended that the area in Fig. 16 is completed and tested first, which requires +5V on connector 3, ground on 59 and 60, and the appropriate reference on connector 4. The vibrato connection should be substituted by a 1μF capacitor to ground. A 1kΩ resistor temporarily in the 5V lead should not drop more than about 2V unless there is a fault, in which case it should prevent damage. Divider outputs should be checked with an oscillograph and frequency meter if possible. The trimmer should be set to give 2.5V at the lower end of the 10MΩ resistor.

Fig. 20. *Card C matrix resistors viewed from the component side. All values are in kΩ. Divider outputs are numbered as multiples of the lowest frequency on the card. Harmonic numbers are in circles. Pedal harmonics are at half the manual frequencies. The lowest three rows of the matrix, which are not shown, are spares.*

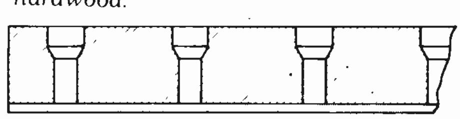


Fig. 21. *Section of assembly jig constructed from two pieces of hardwood.*

To be continued.

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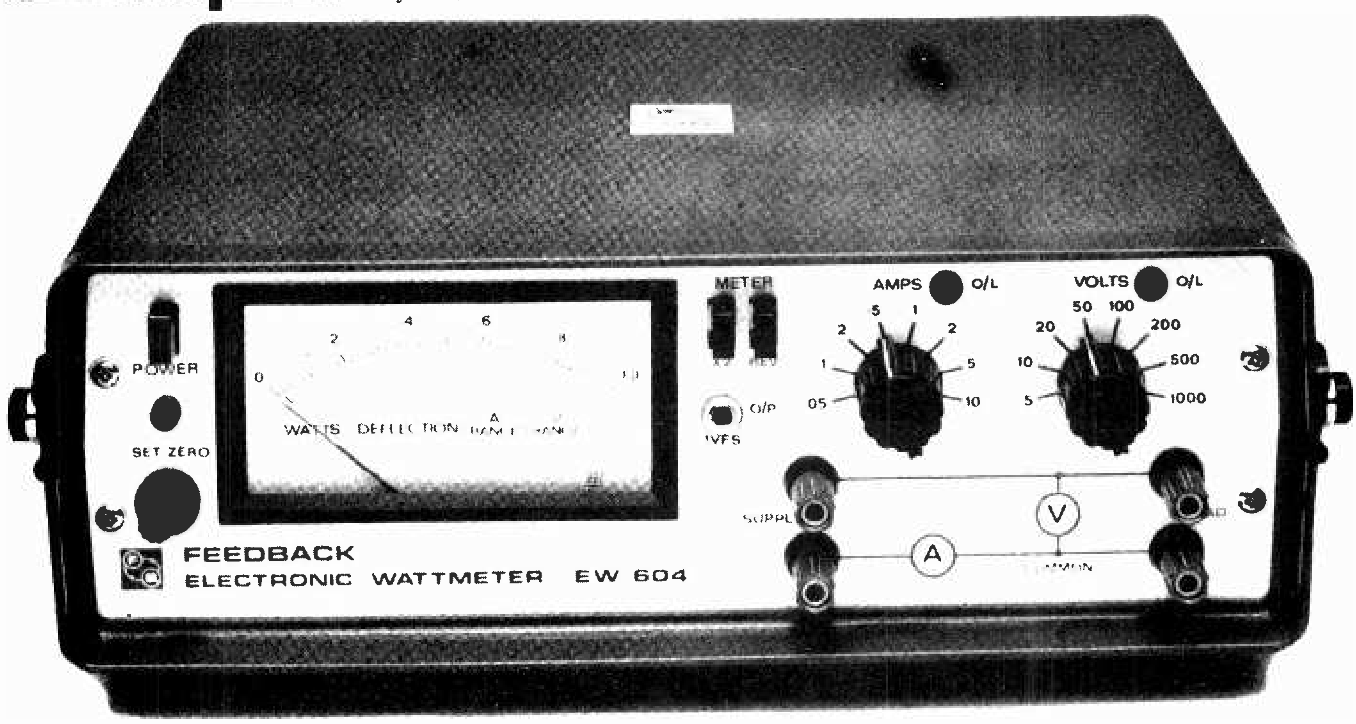

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WW—084 FOR FURTHER DETAILS

What future for television?

Possibilities for three-dimensional and other effects

by D. A. Bell, M.A., B.Sc., Ph.D., F.Inst.P., F.I.E.E., University of Hull

RECENT events have highlighted the fact that the manufacturing capacity of the television industry has always been in excess of the requirements of a steady-state market. It was at one time rescued from the doldrums by the introduction of higher definition (625 instead of 405 lines) and higher frequency radio channels. Then, after an interval, it was rescued again by the introduction of colour. Now the market is getting saturated with colour receivers – so what next? Can some other technical development be introduced which will (a) be sufficiently attractive to the public to generate a large volume of sales but (b) be compatible? There is, of course, the possibility of starting a non-compatible service service on one of the higher-frequency bands which has not yet been brought into use, but such a proposition would have to compete with the pressure for a "fourth channel" in the present service and with all the non-television services which compete for frequency allocations.

There is, of course, teletext, in the form of Ceefax and Oracle developed by the British broadcasting authorities, and the Post Office offering the view-data service called Prestel. The broadcasters have the advantage that their communication channel already exists in nearly every home, but the disadvantage that the viewer can choose only from a limited repertoire, all the items of which are actually being transmitted. In Prestel, on the other hand, the viewer can actively request items from a data bank, the size of which is in principle unlimited.

At the present time "television games" adapters are more commercially active. The presentation offered by some of these is too repetitive and pre-determined; so the next step should be to introduce more randomness, using either "noise" (e.g. from an avalanche diode) or the output of a pseudo-random binary generator. The more difficult step is to increase the degree of active participation by the player.

The third dimension

It is a simple argument that the progression from monochrome to colour should follow on from flat to three-dimensional. It has sometimes been suggested that the information in a three-dimensional picture is infinite, because there is an unlimited number of arbitrary viewing points from which the scene could be observed, each one presenting the viewer with a somewhat different picture. This high-lights the difference between 3-dimensional reconstruction of a scene and stereoscopic presentation, since the latter is limited to giving a 3-D effect *as seen from a particular view-point.* It seems clear that in any telecommunication system we must be limited to a fixed viewpoint at which the "camera" is situated, and therefore stereoscopic systems are acceptable. (This does not prevent the producer from changing view-points by switching from one camera to another or moving a camera, as at present.)

We should, however, have a brief look at two non-stereo devices before dismissing the possibilities. First, of course, is the hologram which has acquired almost an aura of magic. It is true that the appearance of the reconstructed image can be varied by changing the observer's position. But it is not true to say that this is equivalent to being able to walk round the object, because the range of view-points must be limited to the range of angles taken in by the holographic recording set-up. Then it was estimated in the comparatively early days (reference 1) that holographic television would need a bandwidth of a considerable number of gigahertz, so it has been assumed to be impracticable. Now the fact is that holography as at present known is hopelessly mismatched to the requirements of television because it is essentially precise in depth, recording to better than a wavelength of light. If we consider the presentation of a news reader, taking in an area of roughly one metre square in the studio, a 625-line system gives a surface precision of the order of one to two millimetres in that area, but a holographic system with visible light gives a perpendicular depth precision of better than a micrometre, i.e. it is over 1000 times too precise and one has to pay for this in bandwidth. At the same time the transverse precision in holography is much less, because a transverse movement produces less change in optical path length from object to recording system than does a perpendicular movement. The traditional device of using a longer wavelength, as in acoustic holography, is unacceptable both because it loses transverse resolution and still more because it loses all the optical characteristics of surfaces, such as colour. Bandwidth could be reduced by scanning only a small portion of the hologram of the scene to be transmitted, but this would lose definition in both directions. So the problem is to find a new "holographic" technique which greatly reduces the resolution in depth without unduly reducing the transverse resolution.

Another proposal for a non-stereoscopic system is the variable-focus method. This involves a projection type receiver and instead of a flat screen a cube of opalescent material is used to receive the picture. By varying the focus of the projection lens the picture appears sharply at varying depths, and if the focus is changed quickly enough and in synchronism with corresponding changes in focus in the transmitting carrier, a three-dimensional picture should be built up in the viewing cube. Both lenses, at transmitter and receiver, must operate at a large aperture in order to sharpen the focus to a particular depth. The change of focus must be rapid, and it has been suggested that moving-coil devices, similar to loudspeakers, should be used. Finally one has the dilemma of the viewing device. If the opalescent medium is too clear, most of the light will pass right through it, and not be seen by the viewer; but if it is noticeably opaque, the scene will appear to be on a stage filled with mist, so that only near objects are completely unobscured. This system represents an intriguing idea, but it does not seem to be practicable unless the opalescent box can be replaced by a variable-distance screen. This effect could be provided through an optical viewing system, but not with a large screen for family viewing.

We are then reduced to stereoscopic viewing, in which there are two problems: one is to ensure that left and right pictures are presented to the viewer's left eye and right eye respectively, and for broadcast television the problem is to devise a system which is compatible with monoptic viewing. To solve the first problem one first thinks of the cinema techniques using spectacles with pink and green lenses. With a colour tv system one need only put appropriate colour filters in front of the two cameras of a stereo pair and reproduce the two signals on a single colour tube in the receiver. Apart from any questions of eye strain resulting from using this device of splitting left and right by colour, this would not be a satisfactory advance in entertainment television because it would not allow reproduction in colour – the 3-D pictures could only be in monochrome. The obvious solution is to use polarisation instead of colour as the means of discriminating between left-eye and right-eye signals, but this would seem to need two separate transmission channels.

The problem of compatibility

The problem of compatibility can be examined at two levels. The first is to see whether the complete stereo picture can be sent over a normal transmitting channel. This has only been achieved for broadcast stereo sound by using wide band transmitters; but the number of television channels is so small, and the necessary bandwidth per channel so large, that one is reluctant to suggest the use of two channels for one stereo picture. A small group at the University of Hull has therefore been investigating the possibility of using the alternate frames of the standard interlace for left and right pictures*. One suggestion was that if the two images were presented on a common screen, the viewer's eyes and brain might recognise their nature and use them as a pair of stereo images. Although this might happen with some individuals, especially after training, it certainly did not happen with the observers who saw it for the first time, so this mode of presentation is considered to be impracticable for general viewing. One is then forced to resort to crossed polarisation and "polaroid" spectacles to separate the two images. It may eventually be possible to present the images on a single tube with a polarising screen of the liquid-crystal type which could be switched electronically; but the response time of currently known liquid crystals is too long, so at present one is obliged to use two separate picture screens (cathode-ray tubes), each having its own polarising screen. This is possible, using a half-silvered mirror to superimpose the two images and "polarised" spectacles. It came to light that such an arrangement had been tried before† and was alleged to cause some eye strain.

In any case, it has not solved the problem of compatibility at a second level, namely allowing the viewer with a non-stereo receiver to use the same programme. If he were to use one only of the images, he would be losing interlace; and although arrangements could be made to reconstruct the missing lines by correlation techniques (as proposed for bandwidth reduction in Viewphone) this would not represent true compatibility since it would require substantial alterations to receivers.

It was therefore concluded that the use of alternate frames from the interlace was not an entirely satisfactory technique. A technique which does appear to work is that of halving the transmitted field of view and transmitting over any normal channel a stereo pair of half-width pictures. These two images appear side-by-side on the viewing screen and may be combined as a stereo pair by the crossed polarisation technique; or either can be viewed separately as a normal picture. The division into two half-sized pictures may be performed either optically or electronically‡. Thus instead of using two complete communication systems for the two images, one has multiplexed a single communication system into two channels, each carrying only half as much information. Halving the width of picture may be too high a price to pay for stereo production in entertainment, though it is acceptable in some industrial applications.

Other optical effects

In entertainment television the real objective is to create an illusion rather than to allow the viewer to extract certain information analytically from the picture. If the 3-D problem is so intractable, can tv advance in any other directions and in particular can anything be learnt from developments in the cinema? The cinema tried stereoscopic presentation, e.g. by the red/green method, as a stunt but does not appear to have produced any normal film in 3-D, neither feature nor documentary. (There is an obvious argument against its uses when making news films.) The visual analogue of "surround sound" was the all-round cinema, one of the few examples of which showed a US travelogue at the Brussels International Exhibition in 1952. A small audience had to stand in a circular chamber while a number of projectors produced a 360° panoramic picture round the top of the wall. This was very impressive but clearly not practicable for commercial entertainment. The cinema adopted various versions of wide screens in order to give a picture of greater appeal without going to 3-D; and perhaps part of the psychological appeal of the cinema is its tendency to produce larger-than-life images, which is just the reverse of the small screen of television. Now if one is to maintain the standard of definition and brightness, an increase in field of view of the cinema picture requires only an increase in power of illuminant and area of film, together with an increase in size of camera lens to cover the wider film, all of which are subject to economic rather than technical constraints. But in television the transmission of more information to fill a wider picture needs more bandwidth, as well as modifications to both cameras and receiving equipment; and so long as we are concerned with broadcast tv, bandwidth is a rather scarce commodity. If the Post Office ambition of having a wide-band channel to every household is ever realised, especially if the idea moves forward from coaxial cable to glass fibre, there will be bandwidth to spare for two-channel compatible stereo and wide-screens.

In the mean time, can nothing be done? Every photographer knows that lighting is of the utmost importance in producing what he calls "plastic" effects. Do television producers make full use of this factor? An argument for using an acoustically dead studio for sound is that the listener's room will provide some reverberation; but there is no way in which this argument can be extended to vision. Mention of "plastic" effects serves as a reminder that emphasis of edges also enhances this effect. In normal television scanning, only vertical edges can be enhanced by differentiating the signal (or boosting the high frequencies) but anyone who has studied papers on the analysis of television signals in terms of picture differences must have been struck by the "bas relief" effects which can be so obtained.

A brief trial of this technique led to the conclusion that although it is of some value for "irregular" objects, such as human faces, its uses must be severely limited if the picture contains straight vertical edges of any length.

Until someone invents a workable system of compatible 3-D television, the producers of broadcast television might give more thought to the production of illusions!

*The idea arose in discussions with Mr V. A. Daniels and Mr B. Peers of the Audio-Visual Centre, University of Hull. A small feasibility-study grant was given by the Science Research Council.

† It is mentioned in a paper by J. F. Butterfield (reference 2).

‡The optical method is used by 3-D Television Systems, Inc., of 4382 Lankershim Boulevard, North Hollywood, California, who offer a 3-D conversion kit for industrial closed-circuit television. The electronic method is described by K. Sunderland of the Electronic Engineering Department, University of Hull (reference 3).

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2. Butterfield, J.F. Three Dimensional Television, *Proc. of 15th Annual Society of Photographic Instrumentation Engineers Symp.*, Annaheim, California, September 1970.
3. Sunderland, K.R. Single-Channel Stereoscopic Television – a Feasibility Study. Report to the Department of Electronic Engineering, Unversity of Hull, 1978.

Breadboard survey — 1

A look at solderless circuit construction aids

EVER SINCE electronic circuits have not behaved as designers intended, "breadboards" or patchpanels have been built to quickly assemble, modify and dismantle circuitry. Over the years various commercial types have appeared varying in style from a bare board sprouting with leads and "croc-clips," to a panel two foot long and littered with enough readouts, switches and controls to confuse even the most seasoned engineer. In the last few years several breadboard systems have been designed which are simple to use and can quickly pay their way in a workshop. Although any system which allows components to be temporarily connected together can be called a breadboard, the more popular types have a number of standard features. The most important of these is the method of interconnection. A socket based system where components are plugged in is essential for good breadboarding because the components can be quickly changed and used repeatedly. Flexibility is also important so that different component types and sizes can be used on the same board. A third facility which makes for a good breadboard is the inclusion of power supply points or rails.

Apart from these main features, there are several other points to consider before choosing a system. Size is important and this will depend on the flexibility of the breadboard, and whether it can be extended. Compatibility must also be considered together with any accessories which can or have to be purchased.

In general there are three types of breadboard currently available. The simplest types are breadboard blocks which are normally based on a matrix of sockets. These blocks will accept individual components which are then interconnected by the sockets and supplementary wiring on the block. When the circuit has been completed, the components and wires are unplugged and can be used again.

The second group of breadboards are more elaborate assemblies, often composed of several blocks mounted on a base board, with the provision of power supply terminals and several supply rails. These systems often have accessory kits such as jumper leads which can save more time. The most elaborate breadboards systems are normally housed in a purpose built case, and offer built-in power supplies, oscillators and other general purpose outputs which simplify circuit evaluation even further. Again, these complete systems are often based on individual breadboard blocks and can be used in the same way.

The main problem with all solderless breadboards is the socket connection. Unlike i.c. sockets, which are only used a few times, the conductive contacts have to be robust enough to survive many operations, and always provide a reliable low resistance contact. To overcome this potential problem, several types have strips of contacts which can be replaced if a socket is damaged. This facility is very useful because a damaged or intermittent connection can waste more time than the breadboard will save.

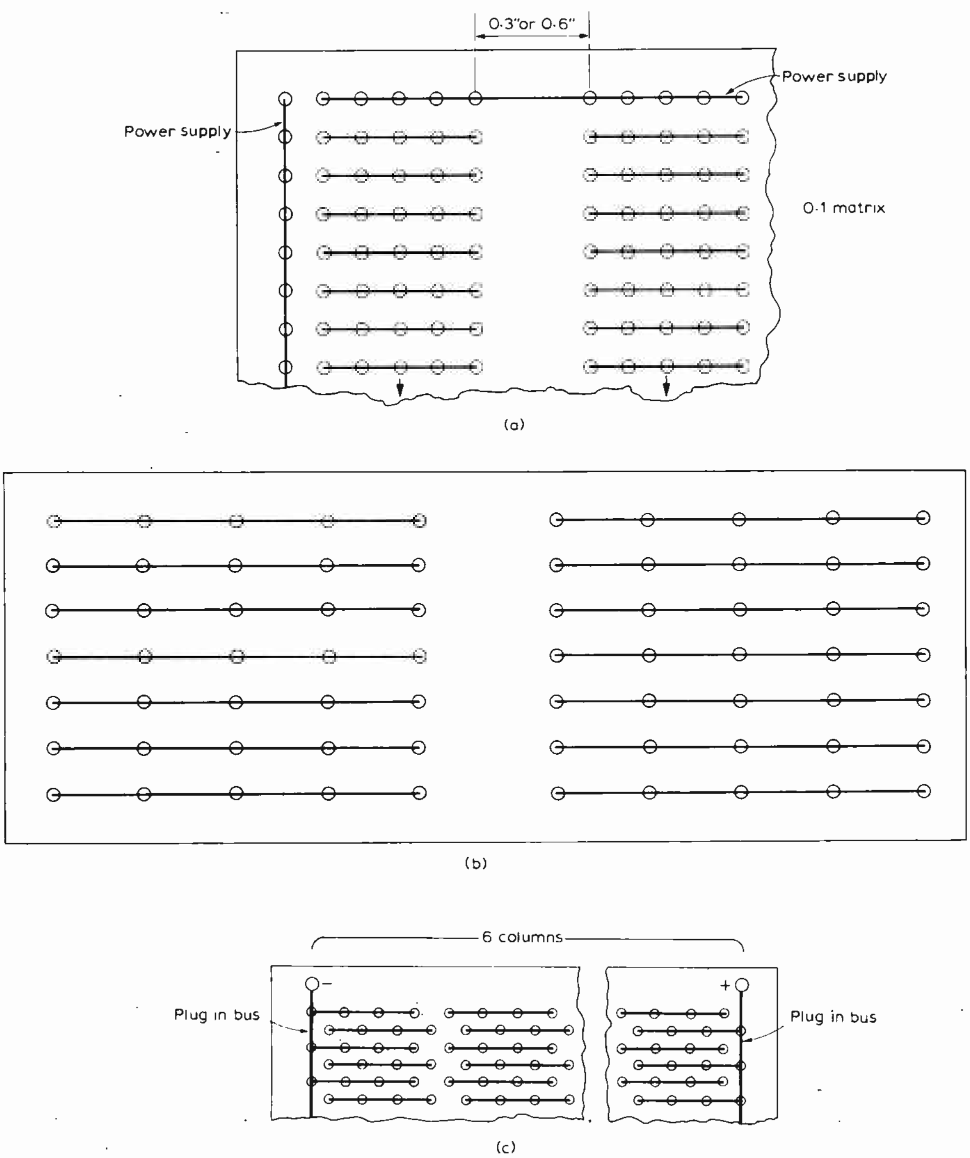


Fig. 1. Breadboard socket systems.

Breadboard blocks

Euro Bread Board, see Fig. 2, measures 92 × 82mm and follows the socket connection system of Fig 1(a). A single panel will accept 0.3 and 0.6in i.cs as well as most discrete components with leads of up to 0,85mm dia. A total of 500

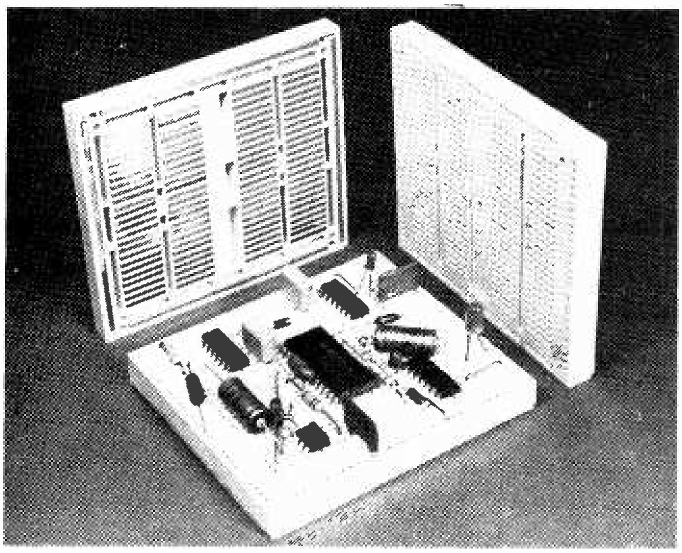


Fig. 2

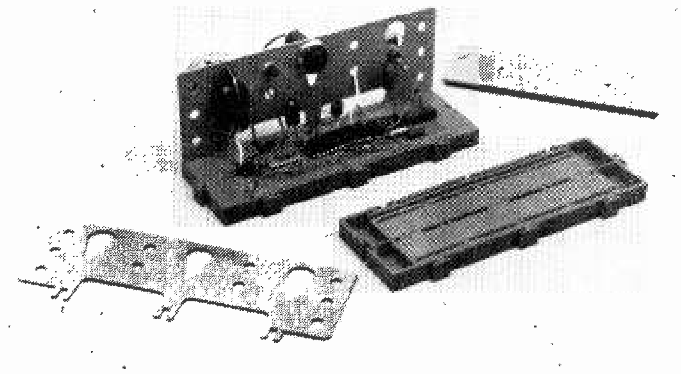


Fig. 3

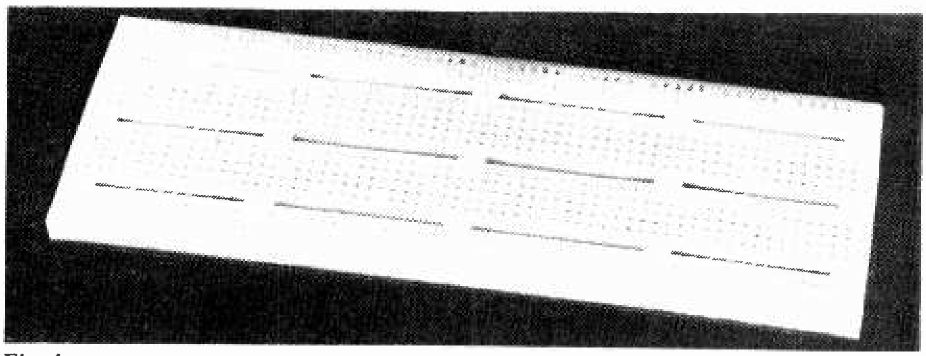


Fig. 4

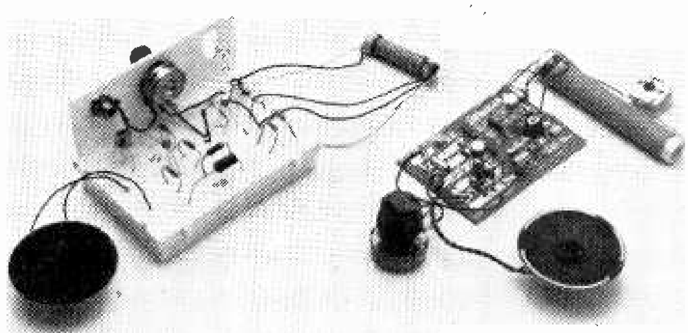


Fig. 5

sockets are provided based on a 0.1in matrix with four columns of 25 separate rows each containing five interconnected sockets. Four extra rows, each of 25 sockets, surround the matrix and are used as power supply rails. The layout is designed to accept two rows of 0.3in i.cs and one row of 0.6in i.cs. All of the socket strips, which are replaceable, are double sided types made from nickel silver alloy and rated at 1A. Contact resistance is specified as below 10mΩ and the life is quoted as above 10,000 insertions.

Bim Board 1, see Fig. 3, measures 150 × 50mm and follows the socket connection system in Fig. 1(a). The layout will accept 0.3in i.cs, or 0.6in types by sacrificing some potential connection points. Most other discrete components can be accommodated with lead diameters up to 0.85mm. The block has 470 main sockets in a 0.1in matrix organised in two columns, each of 47 rows containing five interconnected sockets. Two extra rows, each of 40 interconnected sockets, serve as power supply rails. The strips of sockets, which are replaceable, are double-sided types constructed from nickel silver with a contact resistance rating at 1A of 10mΩ. On the top of the board the matrix area has the columns and rows numbered and lettered for easier circuit construction. The plastic moulding is provided with male and female connectors so that several boards can be locked together in an expanded system. A plug-in vertical panel is also provided for mounting external components.

Super Strip, see Fig. 4, measures 165 × 57mm and follows the pin connection system in Fig. 1(a). The layout will accept 0.3in i.cs, or 0.6in types by sacrificing some potential connection points. Most other discrete components can be accommodated with lead diameters up to 0.81mm. The layout has 640 main sockets in a 0.1in matrix which is arranged as two columns, each of 64 rows containing five interconnected sockets. Four extra rows, each with two strips of 25 linked sockets, provide eight power supply rails. The double-sided strips of sockets are available in nickel silver or with a gold plated finish. The blocks are supplied with a self adhesive backing compound for instant and semi permanent mounting. This backing can be peeled off to expose the socket strips which can then be removed. However, this is a sticky procedure and normally destroys the backing. Alternatively, the block may be mounted with self-tapping screws which are supplied.

S Dec, see Fig. 5, measures 114 × 76mm and follows the socket connection system in Fig. 1(b). The board is designed to accept only discrete components with lead diameter up to 1mm. The layout has 70 sockets arranged in seven rows each with two strips of five linked sockets. The double-sided sockets are constructed from brass, and are rated at 5A. Each hole is numbered from 1 through to 70 on the top of the board.

An extension of this system, known as T-Dec, contains 208 contacts with alphanumeric labelling for the rows and columns. This board allows one i.c. to be plugged into the block via an adaptor. A further extension, known as μ-Dec has a similar layout, but allows two i.cs to be used either directly or by adaptors.

A useful feature of all three versions is the availability of complementary printed circuit boards which reflect the layout of each board. This allows a breadboard layout to be transferred permanently to a p.c.b.

Experimentor, see Fig. 6, type 300 measures 152 × 53mm, and type 600 measures 152 × 60mm. Both versions follow the connection system in Fig. 1(a), and are designed to accept 0.3in or 0.6in i.cs together with most discrete components. The layout has 470 main sockets in a 0.1in matrix organised as two columns, each of 47 rows containing five interconnected sockets.

Two extra rows, each of 40 interconnected sockets, serve as power supply rails. The strips of sockets, which can be removed by peeling off an insulated backing paper, are a double-sided type constructed from nickel silver alloy. The top of the block has the matrix area numbered and lettered, and the plastic moulding has a male and female locating groove on each side. This allows both types of block to be snapped together either side-by-side or side-to-end. For permanent mounting, the moulding is also provided with four screw holes.

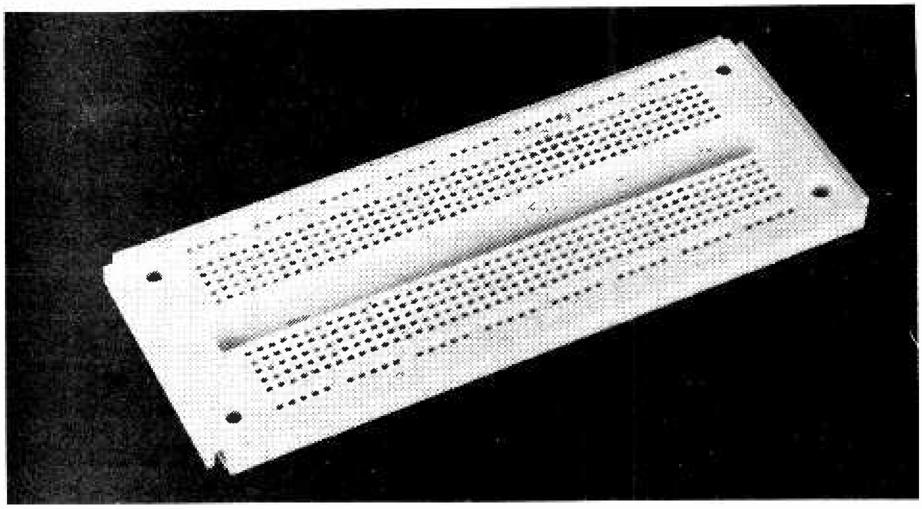


Fig. 6

I.C. breadboards from Cambion are based on i.c. sockets and 0.040in jacks. Type 702 2 105 02 has four 18-pin i.c. sockets which are connected to corresponding jack sockets. By using patch leads, connections are made between the i.c. pins. Power supply and ground terminals accept bare wires or spade connectors. Type 705 0369 01 is a similar system measuring 165 × 159mm, but with 16 0.3in i.c. sockets. Solder turrets are provided for input/output and supply connections, and supply buses travel inbetween the rows of i.cs. Two other boards in this range accommodate 32 and 64 i.c. sockets.

Alternatively, the three boards can be supplied with i.c. jacks instead of sockets.

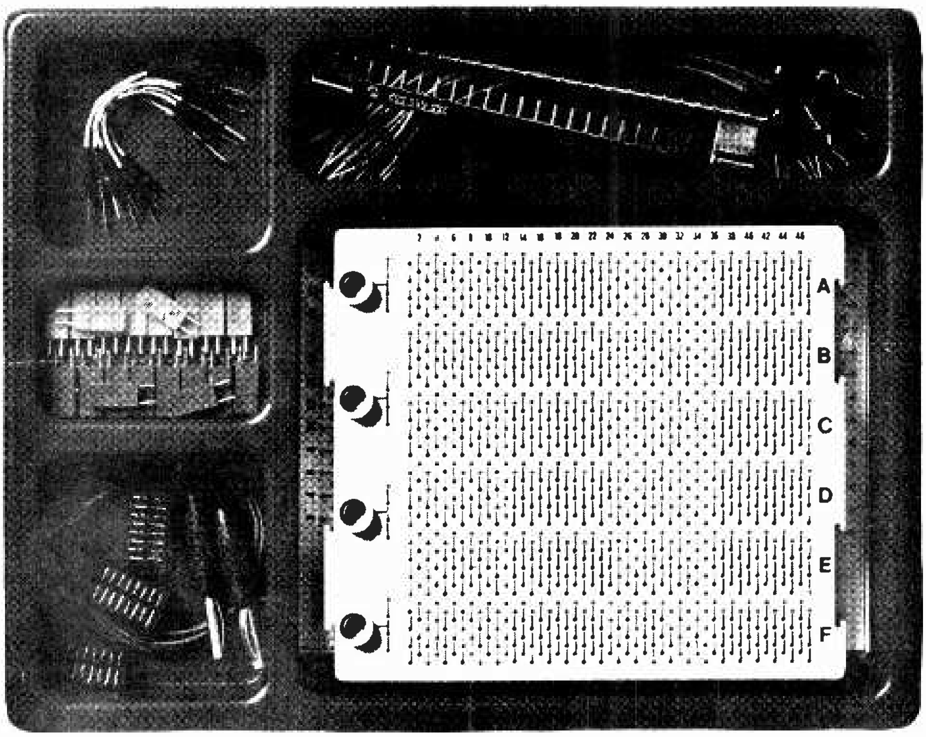


Fig. 7

The Hirschmann Experimental Plate in Fig.7 follows the layout in Fig. 1(c). The board will directly accept most discrete components with lead diameters up to 1.2mm and, via special adaptors, 0.3in i.cs. Interconnection of components is by special patch leads which are supplied in a kit. The plate has 1,128 connection points organised in six columns each with 47 rows of 4 interconnected sockets. The board is supplied with two plug strips which are used as power supply buses, and connect either 23 or 24 rows of sockets together.

The socket springs, which are constructed from beryllium copper and can be either nickel plated or gilded, have a contact resistance of around 45mΩ for 5,000 operations, and a current rating of 1A. The moulding has the columns and rows lettered and numbered, and dovetail clips are provided on two sides so that several plates may be joined together. The plate also incorporates four 4mm sockets which can be used for input and output connections.

A screw-fixed vertical panel is also available for mounting switches and potentiometers. Draft sheets are supplied which have a socket layout. This enables the constructor to draw a circuit plan on paper before assembling the breadboard.

Wonderboard is available in two sizes which measure 81 × 35mm and 81 × 140mm. The layout will accept most i.cs and discrete components as shown in Fig. 8. The basic board contains six rows of 31 holes. These rows are spaced at 0.3in and the holes are filled with a conductive elastomer.

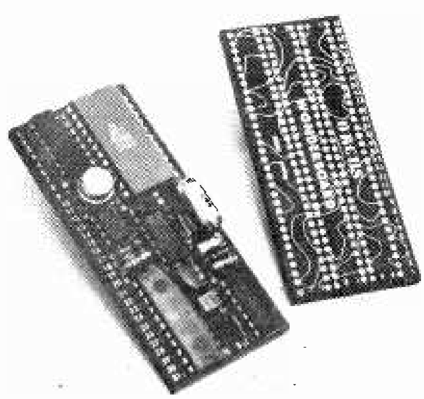


Fig. 8

Components are pushed into these contacts from the top of the board, while interconnection leads are used on the underside. Each contact can accept one component lead and up to six 26 gauge wire contacts. Contact resistance is specified as 10mΩ and the current rating is 7A, with a breakdown voltage of 9kV. Contact life is given as 150 insertions in a temperature range from −55 to +100 deg C. Both sides of the board have the co-ordinates labelled with numbers and letters for easier wiring. The larger board is laid out as four standard boards side-by-side.

The concluding article describes breadboard assemblies, and gives a list of suppliers together with prices.

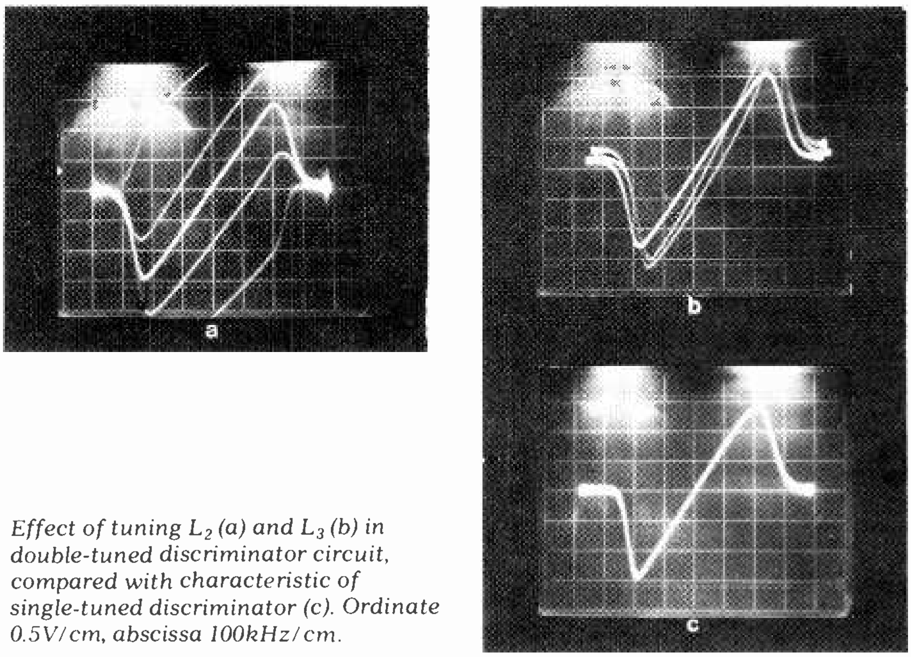
Stereo f.m. tuner — Mk II

Alignment and printed circuit board layouts

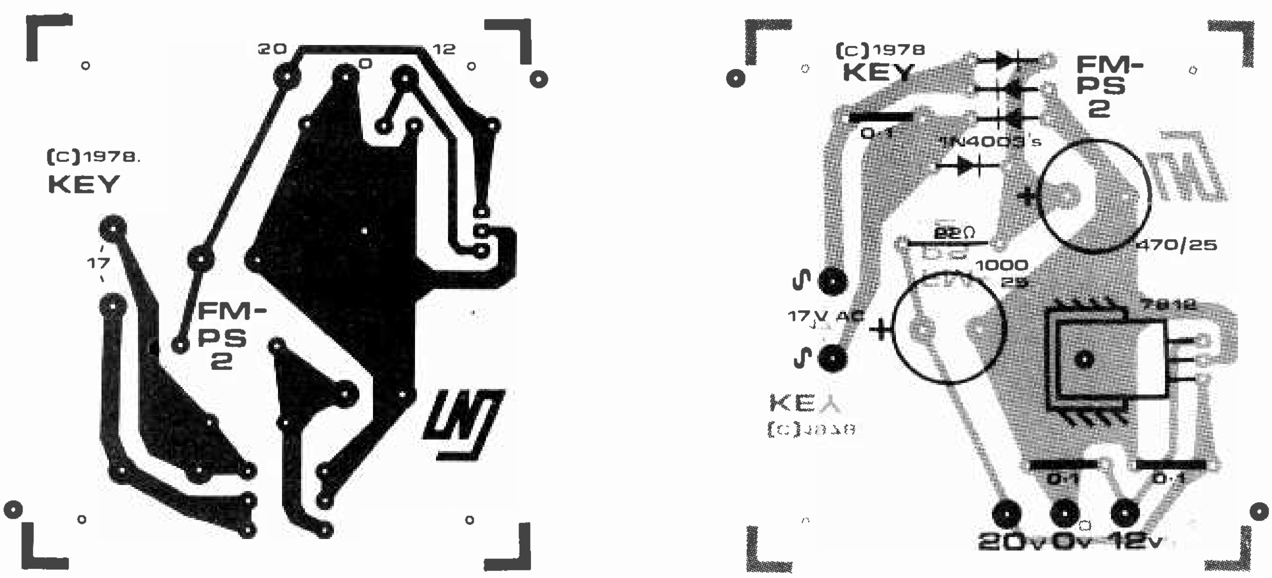
by L. Nelson-Jones, F.I.E.R.E.

The main part of the design, a development of the author's highly successful tuner of 1971, appeared in the September issue (pp. 34-39). This concluding article gives the alignment procedure and also the layouts of the printed circuit boards.

To align the circuit, disable the muting control RV_2 on the i.f. board by turning fully anti-clockwise, and then switch off the a.f.c. Set the tuner supply to +12V using RV_3, and switch the a.f.c. on again. For alignment of the quadrature coil a broadcast transmission is needed. With the receiver tuned for maximum signal level output on the "signal level" pin of the i.f. board, adjust the quadrature coil for zero difference between the a.f.c. and a.f.c.-reference voltages. With a.f.c. off, slowly tune the receiver through the station and adjust the coil, if necessary, for equal peaks on the S-shaped characteristic. This procedure is only satisfactory for the single-tuned system, and a wobbulator must



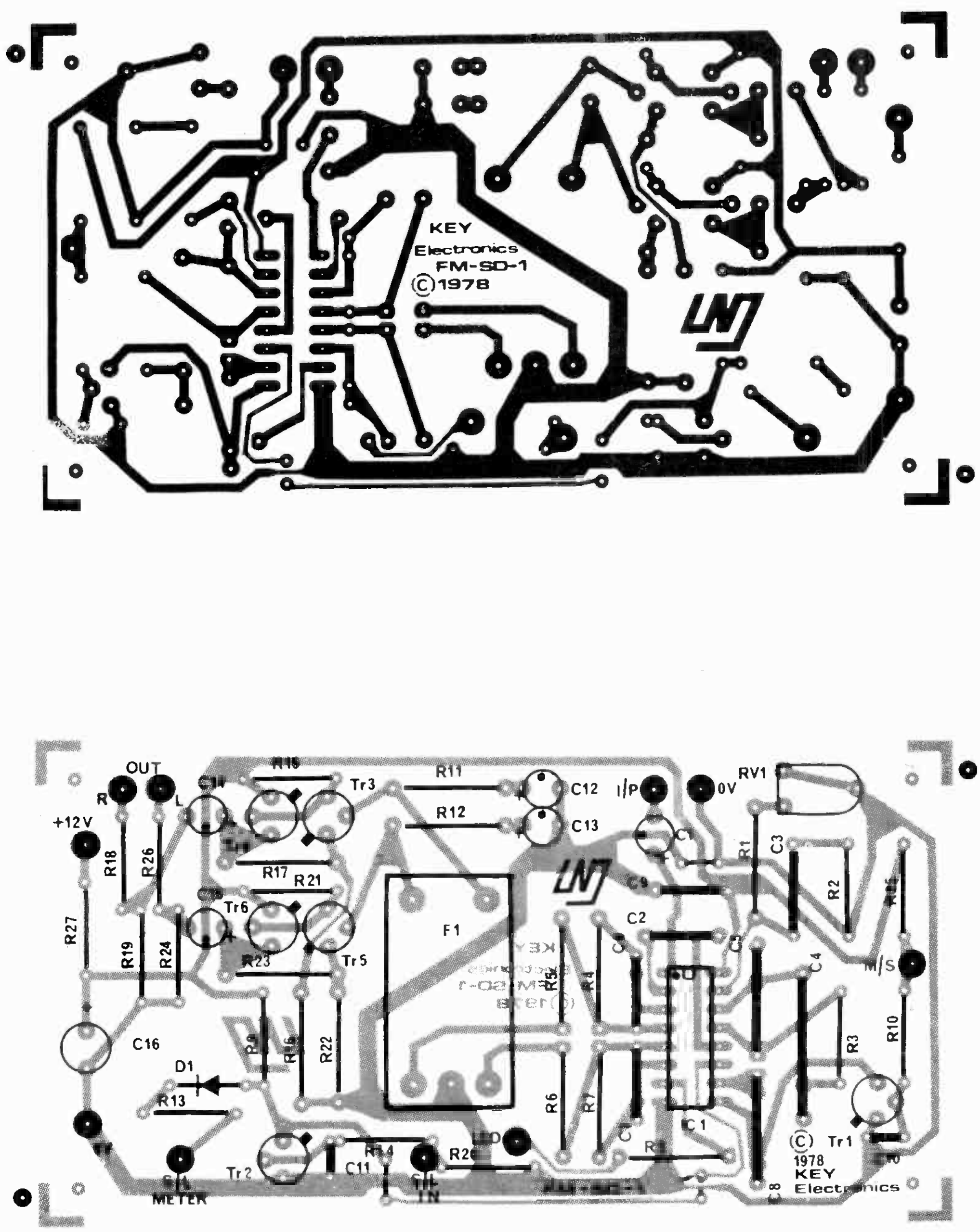
Effect of tuning L_2 (a) and L_3 (b) in double-tuned discriminator circuit, compared with characteristic of single-tuned discriminator (c). Ordinate 0.5V/cm, abscissa 100kHz/cm.



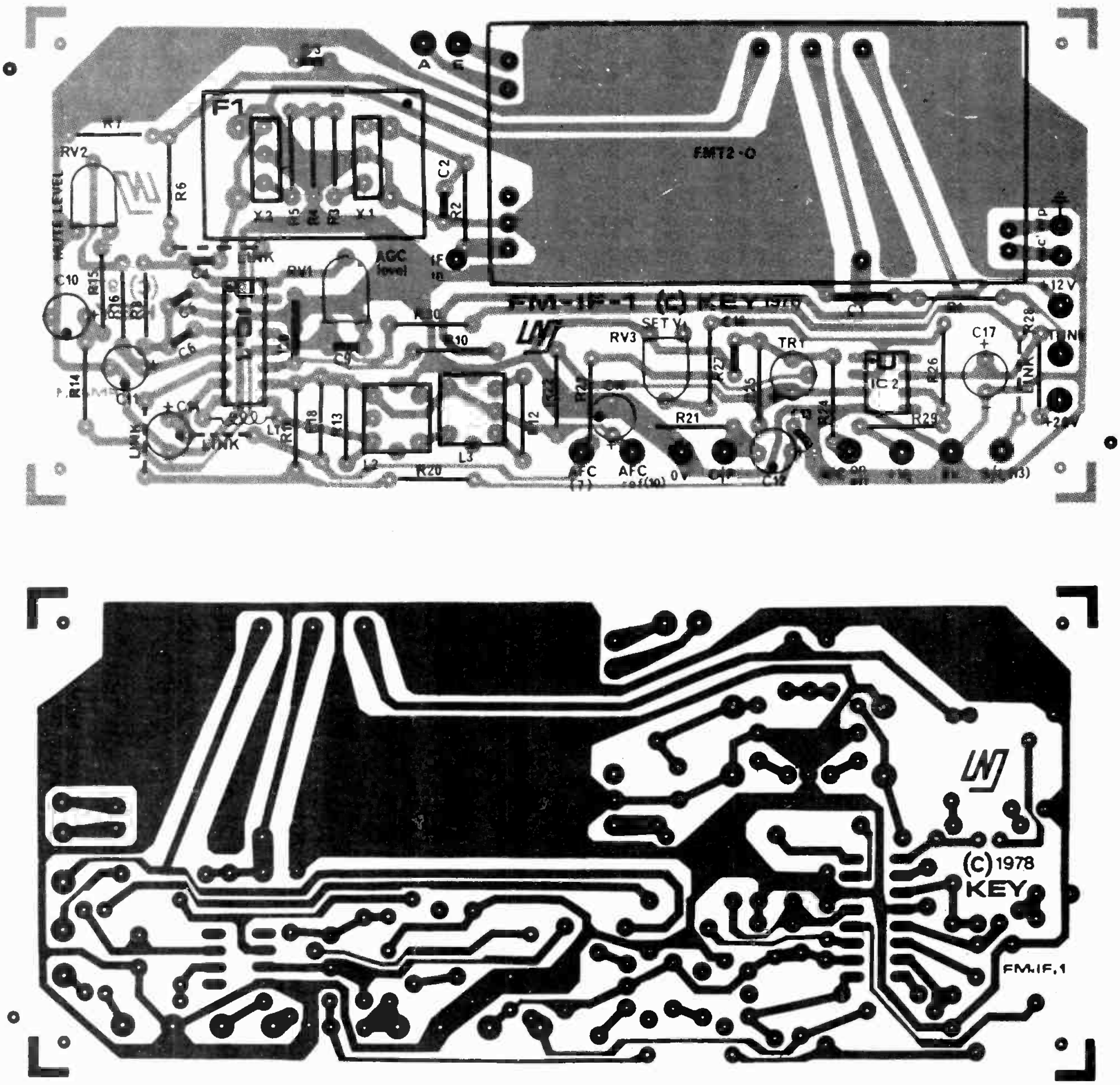
Printed circuit board layout for power supply be used for alignment of the double-tuned circuit. Next, set the a.g.c. level control RV_1, CA3189E only, to give a satisfactory law for the signal-level meter.

For the decoder the oscillator frequency is set on a stereo signal. Slowly turn the potentiometer on the decoder board until the l.e.d. lights, and continue until it goes out again. The correct setting is mid-way between these two points. If a counter-timer is available, set the frequency to 228kHz at the end of R_2 adjacent to the potentiometer.

The pre-aligned front-end needs only the i.f. coil adjusted to the frequency of the i.f. filter. Tune to a station and set for maximum signal-strength on the meter. Carefully adjust the core of the i.f. coil to peak this reading. The front-end tuning adjustments are marked, so that the complete alignment can be carried out if desired. Set the oscillator range to cover from 87.5MHz at +1.5V tuning input, to 108MHz at +11.5V tuning input. Set the tracking by adjusting the inductors at the 87.5MHz frequency, and the capacitors at the 108MHz frequency. Only the inductors and capacitors of the aerial and r.f. stages are adjusted because the oscillator is already set. For peaking the coils use the signal strength output or meter if fitted. Great care should be used when adjusting the coils because the ferrite



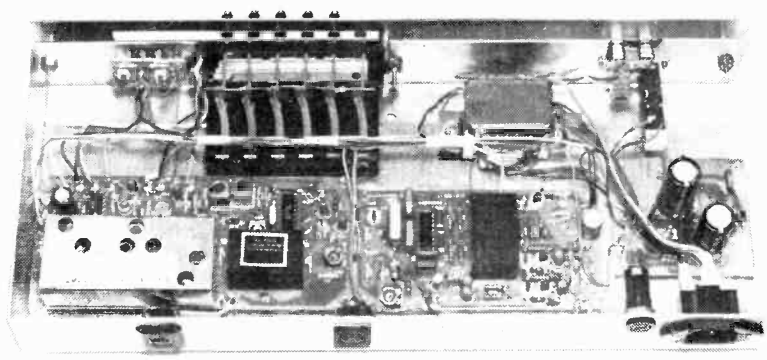
Printed circuit board layout for the decoder



Printed circuit board layout for the i.f. circuit

cores are delicate. The correct adjusting tool must be used at all times.

The Toko screened coils are slightly sensitive to the presence of metal. It is therefore necessary to check the alignment by removing the tool temporarily. This is especially important when setting the symmetry of the S-shaped discriminator characteristic. □



Overall view of the first prototype tuner

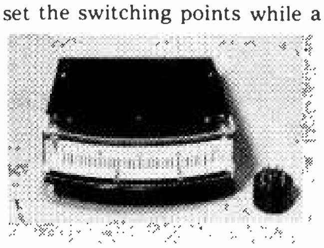
NEW PRODUCTS

Monochrome monitor

Plessey has developed a high quality monochrome monitor which they say is particularly useful for computer v.d.us where high character-density displays are required. The suggested format of 25 rows each with 80 characters can occupy up to 90% of the screen area. The monitors, which are currently available with 12 or 15in screens, use 110° c.r.ts with a 1000 line centre, and 800 line corner resolution. Linearity is 2% of raster height, and picture geometry has a distortion of less than 1.5%. Other ranges are available which operate from either a composite video signal, or from separate and sync at t.t.l. levels. Plessey Wound Products Ltd, Titchfield, Fareham, Hants.
WW 301

Meter relay

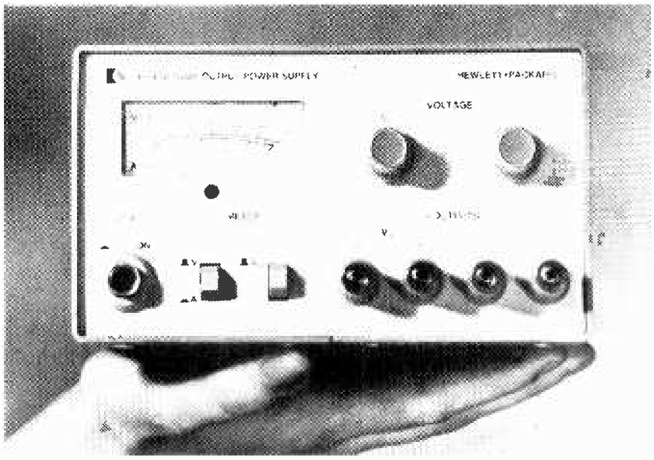
This edge type panel meter has two switchable transistor outputs which are controlled by two opto-electronic detectors that can be adjusted over the full 80mm scale. Two scale markers set the switching points while a



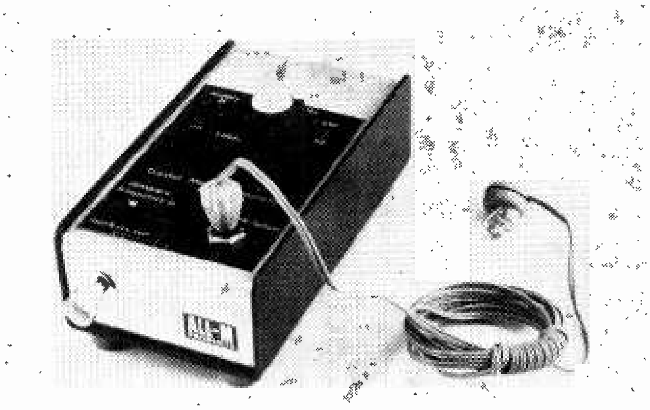
third independent pointer gives a continuous visual readout. The unit measures 100 × 30 × 139mm and can be supplied with meter movements from 100μA f.s.d. Centrelco S.A., Case Postale 241, CH-1211 Geneve 26, Switzerland.
WW 302

Dual output power supply

The model HP-6234A d.c. power supply offers two independently adjustable and isolated outputs from 0 to 25V. Both outputs, which are automatically limited at 0.2A, can be connected in series to provide up to 50V. Pushbuttons select either voltage or current for each output, and two multiple-turn controls adjust the voltage. Regulation is quoted as within 0.01%, while ripple and



WW 303



WW 304

noise are said to be less than 200μV r.m.s. The mains powered instrument measures 90 × 155 × 190mm, weights 2.3kg, and is priced at £112. Hewlett-Packard Ltd, King Street Lane, Winnersh, Wokingham, Berkshire RG11 5AR.
WW 303

Marker generator

A battery-powered, crystal-controlled marker pulse generator, the TE 5, from ALL-M Products, provides markers at 1MHz, 500kHz, 250kHz, 200kHz, 100kHz, 50kHz, 25kHz, 20kHz and 10kHz. The unit contains a mixer and amplifier to provide a beat between an unknown frequency and the selected marker, the beat being presented on an oscilloscope screen or audibly by earphones. Provision is made for an external power supply or the 9V internal battery can be used; current drain is around 7mA. All-M Products Ltd, 3 Westhill Close, Highworth, Swindon, Wiltshire SN6 7BY.
WW 304

Magnetic tape head

The C44RPS02 magnetic tape head will enable an audio cassette recorder to simultaneously record or playback up to four channels. Each channel has an impedance of 900Ω at 1kHz and a head gap of around 1.5 microns. Playback frequency response at 8kHz is 8dB ±5dB. A bias current of 300μA of 50kHz is required, while the record current is 30μA. Monolith Electronics Co Ltd, 5/7 Church Street, Crewkerne, Somerset TA18 7HR.
WW 305

Interference simulator

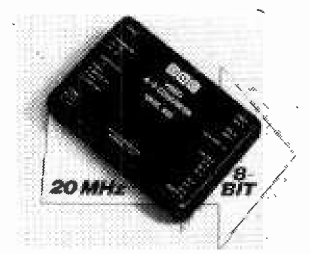
The SG41 interference simulator can be used to measure noise immunity of digital and analogue instruments, or for testing electronic components. The unit, which simulates voltage peaks, spark interference, and static discharges, can be connected between the incoming power supply or mains, and the device under test. Voltage peaks from 0.1 to 6kV can be simulated with an energy of two joules and a repetition frequency of 25Hz. Spark interference from 0.5 to 3kV may be selected with a repetition frequency of 250Hz, and static discharges with an amplitude of up to 15kV may also be repeated at 250 per sec. Seltek Instruments Limited, Hoddesdon Road, Stanstead Abbotts, Hertfordshire SG12 8EJ.
WW 306

Universal meters

The Meter Made range of movements has five basic versions with either edge or flat face displays. The blank meters are supplied in a kit of three with a sheet of rub-down scales and legends which cover most standard and a few non-standard units. As well as the normal biased left movements, centre zero and double versions are available. Kit prices start at £7.50 from Ambit International, 2 Gresham Roaa, Brentwood, Essex
WW 307

Video a.-to-d. converter

An 8-bit video a-to-d converter, type VADC820, developed by ILC Data Device Corporation, is capable of sampling at a 20MHz rate. The converter, which is compatible with NTSC and PAL standards, has been designed for digitising tv and radar signals for storage, measurement and trans-



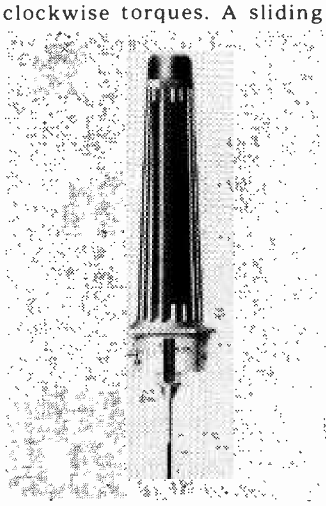
mission. The video track/hold input amplifier has a 100MHz bandwidth, and its internal f.e.t. input can be terminated for any coax impedance. Peak signal/r.m.s. noise ratio is specified as 45dB minimum, and maximum linearity error is ±1/2 l.s.b. The circuit requires ±15V, +5V and −5.2V d.c., and the logic is t.t.l. compatible. Techmation Limited, 58 Edgware Way, Edgware, Middlesex HA8 8JP.
WW 308

Crystal oscillators

The frequency range of Vectron oscillators CO-234, CO-238 and CO-239 is now extended to cover 16kHz to 100MHz (25MHz in the case of the 234). Initial frequency tolerance is ±0.005% or ±0.001% and the units work in the 0-70°C temperature range with a variation of ±0.01% maximum. Increased accuracy and stability is available, as are oscillators working in the temperature range —55 to 125°C. Power required is 5V at 15-80mA, depending on frequency. Package is either the d.i.l. type or a hermetically-sealed can. Lyons Instruments Ltd, Hoddesdon, Herts.
WW 309

Torque screwdriver

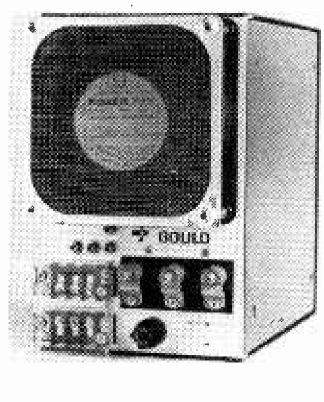
A range of precision torque screwdrivers, manufactured in Switzerland, allow bidirectional movement through 270°. Six models give ranges from 20-100gcm to 1-5kgcm with scale divisions ranging from 5gcm to 250gcm. Each model has two scales for clockwise and anti-clockwise torques. A sliding



pointer can either be positioned on the scale for a maximum torque or moved by a spring movement to indicate the greatest torque applied through the screwdriver. SS1H Equipment (UK) Ltd, Fimecor Division, 67-74 Saffron Hill, London EC1N 8RS.
WW 310

Fan cooled s.m.p.s.

A dual output switching power supply known as the MGD500, incorporates a fan cooling system which increases the power density, and allows the unit to be mounted in any plane. The supply has been designed for use with e.c.l. and offers two independently controlled outputs which track together and give a total output of 526W. Two d.c. outputs provide 5.2V, adjustable from 0 to 80A and 2.2V adjustable from 0 to 50A, with a common positive terminal. Regulation is said to be within 0.2% on both outputs and ripple is 10mV r.m.s. Dimensions for the unit are 127 × 203 × 267mm. Gould Electronic Components Division,



Raynham Road, Bishop's Stortford, Hertfordshire CM23 5PF
WW 311

Illuminated microscope

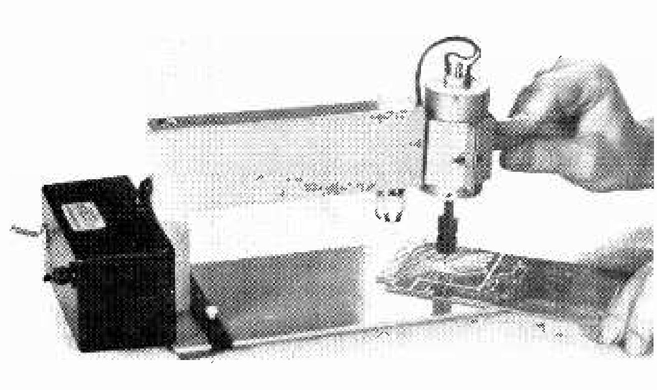
A miniature illuminated microscope from Intel Electronic Components is said to be ideal for the inspection and measurement of p.c.bs, components, and instruments. The device is 125mm long and features a graticule which is calibrated in increments of 0.1mm, and with angles from 30° to 90°. Magnification is ×20 and illumination is by a standard bulb and two 1.5V batteries. Intel Electronic Components Ltd, 30/50 Ossory Road, London SE1 5AN
WW 312

Frequency counter

The 02 series of frequency counters from R.C.S. Electronics operate from either a mains or 12V d.c. supply. Seven segment 0.6in l.e.d. displays indicate frequencies up to 520MHz as well as average period and timer functions. Sensitivity is 10mV and the stability is around 3 parts in 10^{10}. R.C.S. Electronics, 6 Wolsey Road, Ashford, Middlesex TW15 2RB.
WW 313

Drill stand

This drill stand supports the motor body on a cantilever spring system which, when depressed, switches the motor on, and off when released. The stand measures 315 × 115 × 150mm and has an integral fused and switched 12V d.c. power supply, a low voltage lamp, and a high speed motor mounted in an adjustable clamp. Throat depth is 168mm and each unit is supplied with X–Y locating jigs. Recommended retail price is £61 plus v.a.t. from Technomark, Allnut Mill, Church Road, Lower Tovil, Maidstone, Kent
WW 314



WW 314

Programmable pulse generator

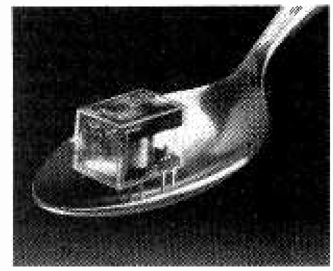
Models 1505 and 1506 are single and dual channel programmable pulse generators which have been designed for automatic test systems that require a fast rise time. The instruments feature e.c.l. drivers, and provide variable output amplitudes within ±2.5V into 50Ω. All of the pulse parameters, except for rise and fall times, are programmable by several methods including the IEEE Standard 488-1975 digital interface, a 16-bit address and data bus, a serial ASCII format, and parallel programming. Microsystem Services, Duke Street, High Wycombe, Bucks.
WW 315

Frequency doubler

A passive frequency doubler from Racal-Dana enables the output of a 240 to 570MHz signal generator to be extended to above 1GHz. The device, which is fitted with N-type connectors and measures 100 × 30 × 30mm, can be connected directly to the output socket of most signal generators in common use. When used in a 50Ω system, the insertion loss is less than 13dB and the input v.s.w.r. is less than 2:1. Racal-Dana Instruments Limited, Duke Street, Windsor, Berkshire SL4 1SB.
WW 316

Miniature p.c.b. relay

A p.c.b. mounting relay which measures 16 × 11 × 10.5mm has contacts rated at 0.5A 100V a.c.



or 1A 24V d.c. Coil ratings range from 1.5 to 24V at currents between 18.8mA and 300mA, while service life is said to be in excess of 5 × 10^6 operations. Coil resistances range from 5 to 1280Ω, and the maximum switching frequency is 1800 operations per hour. Operate and release times are both around 5ms and the insulation resistance is greater than 100MΩ. IMO Precision Controls Ltd, 349 Edgware Road, London W2 1BS
WW 317

R.a.m. controller

The 8202 i.c. from Intel is a dynamic r.a.m. controller which, say the makers, allows a designer to treat a dynamic r.a.m. in the same way as a more expensive static device. The i.c. can refresh a dynamic r.a.m. of up to 16K words without the need for external drives, and will simultaneously resolve demands for memory access and refresh. The 8202 is compatible with Intel's 8080A and 8085A microprocessors, and is capable of decoding the 8085A status lines. Intel Corporation (UK) Ltd, 4 Between Towns Road, Cowley, Oxford OX4 3NB
WW 318

Interference filters

A new range of filters for operation at voltages up to 250V a.c. offers current ratings from 1 to 30A. The JX5100 series is for general purpose applications and provides r.f.i. control of line-to-ground noise. Series JX5200 controls line-to-line interference as well as line-to-ground r.f.i., and series JX5300 offers an improved performance in low impedance applications. Sprague Electric (UK) Ltd, 159 High Street, Yiewsley, W. Drayton, Middx.
WW 319

Manual card reader

Type MCM-105-1R is a hand-operated device for reading magnetic cards. The reader, which has no moving parts, can accept cards at speeds between 75 and 1500mm/s. Power requirements are 5V at 30mA, and the operating temperature range is from —15 to +50 deg C. The reader measures 120 × 40 × 38mm, weighs 200 gm and is claimed to have a head life of at least 300,000 card operations. Roxburgh Electronics Ltd, 22 Winchelsea Road, Rye, East Sussex TN31 7BR
WW 320

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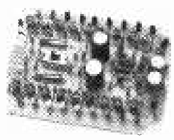
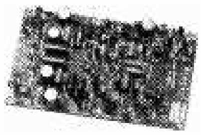
STEREO PRE-AMPLIFIERS

MC 1





CPR 1

CPR 1 — THE ADVANCED PRE-AMPLIFIER. The best pre-amplifier in the U.K The superiority of the CPR 1 is probably the disc stage The overload margin is a superb 40dB, this together with the high slewing rate ensures clean top, even with high output cartridges tracking heavily modulated records. Common-mode distortion is eliminated by an unusual design R I.A.A. is accurate to 1dB, signal to noise ratio is 70dB relative to 3.5mV; distortion <.005% at 30dB overload 20kHz

Following this stage is the flat gain/balance stage to bring tape, tuner, etc up to power amp signal levels Signal to noise ratio 86dB, slew-rate 3V/uS; T H.D 20Hz—20kHz <.008% at any level.

F.E.T. muting No controls are fitted There is no provision for tone controls. CPR 1 size is 138x80x20mm. Supply to be ± 15 volts

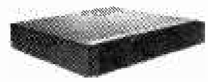
MC 1 — PRE-PRE-AMPLIFIER. Suitable for nearly all moving-coil cartridges Sensitivity 70/170uV switchable on the p.c.b. This module brings signals from the now popular low output moving-coil cartridges up to 3 5mV (typical signal required by most pre-amp disc inputs) Can be powered from a 9V battery or from our REG 1 regulator board

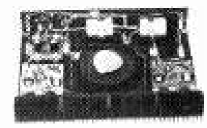
REG 1 — POWER SUPPLY. The regulator module, REG 1 provides 15-0-15v to power the CPR 1 and MC 1 It can be used with any of our power amp supplies or our small transformer TR 6 The power amp kit will accommodate it

POWER AMPLIFIERS. It would be pointless to list in so small a space the number of recording studios, educational and government establishments, etc who have been using CRIMSON amps satisfactorily for quite some time We have a reputation for the highest quality at the lowest prices The power amp is available in five types, they all have the same specification T H D typically 01% any power 1kHz 8 ohms, T.I.D insignificant, slew rate limit 25V/uS, signal to noise ratio 110dB; frequency response 10Hz-35kHz, —3dB; stability unconditional; protection drives any load safely; sensitivity 775mV (250mV or 100mV on request), size 120x80-25mm

POWER SUPPLIES. We produce suitable power supplied which use our superb TOROIDAL transformers only 50mm high with a 120-240 primary and single bolt fixing (includes capacitors/bridge rectifier).

POWER AMPLIFIER KIT. The kit includes all metalwork, heatsinks and hardware to house any two of our power amp modules plus a power supply It is contemporarily styled and its quality is consistent with that of our other products Comprehensive instructions and full back-up services enables a novice to build it with confidence in a few hours





POWER AMPLIFIER MODULES

CE 608 60W/8 ohms 35-0-35v	£16.30
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CE 1704 170W/4 ohms 45-0-45v	£29.12
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TOROIDAL POWER SUPPLIES

CPS 1 for 2xCE 608 or 1xCE 1004	£14.47
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CPS3 for 2xCE 1008 or 1xCE 1704	£17.66
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Light duty, 50mm, 2 C/W	£1.30
Medium power, 100mm, 1 4 C/W	£2.20
Disco/group, 150mm, 1-1 C/W	£2.85
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Fan mounted on two drilled 100mm heatsinks 2x 4 C/W, 65 C max with two 170W modules	£29.16

THERMAL CUT-OUT, 70 C £1.90

POWER AMP KIT £32.40

PRE-AMPS:
These are available in two versions — one uses standard components, and the other (the S) uses MO resistors where necessary and tantalum capacitors

CPR1	£29.49
MC1	£18.50
CPRIS	£39.98
MC1S	£29.49

POWER SUPPLY:
REGI **£6.75** TR6 **£1.75**

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Obtain up to 340W using 2x170W amps and this module
BD1 **£5.40**

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WW—103 FOR FURTHER DETAILS

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Colour: black case base and either a black or tan top.

PR1	£16.50	PR2	£12.90
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A very popular case of universal use

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Prices are correct at time of going to press. Prices are one off inc P&P but not VAT. Discounts for quantities
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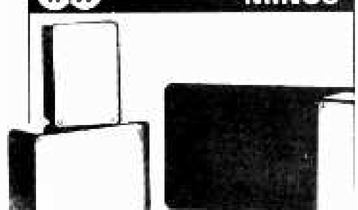
WH MINOS



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MIN 020	100	65	50	**.73**
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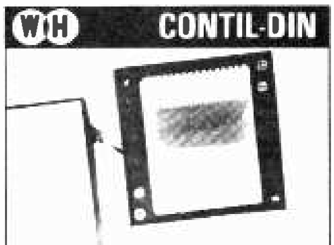
SWF 212	432	268	88.9	18.70
SWF 222	219	268	88.9	14.49
SWF 312	432	268	133.4	22.26
SWF 322	219	268	133.4	17.74

WH CONTIL-DIN



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Heavy aluminium extrusions lock rigidly together providing, heat dissipation, screening and strength, with provision for 16 P C boards and quick component mounting
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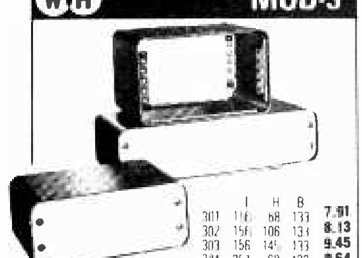
DIN 214	**6.57**	DIN 913	**9.01**		

WH MOD-3



	L	H	B	
301	[illegible]	68	133	**7.91**
302	156	106	133	**8.13**
303	156	145	133	**9.45**
304	257	68	133	**8.64**
305	257	106	133	**10.11**
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Attractive gloss blue PVC/Steel cases of wrap-round construction. Removable front and back panels give full access. Grey PVC/steel panels accept Letraset. Supplied with W.H. self adhesive feet. Black cases also available, slight extra cost

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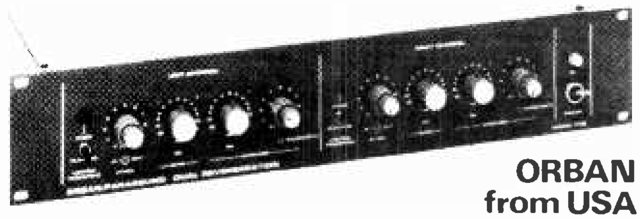
WW—074 FOR FURTHER DETAILS

NEW PRODUCT BULLETIN

ITA



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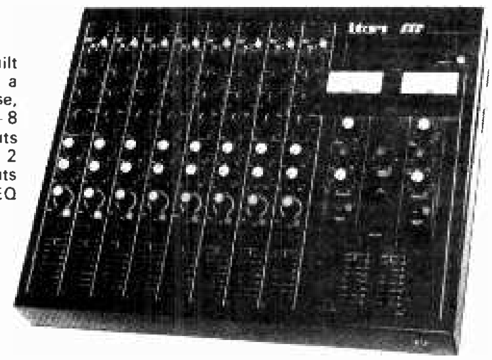

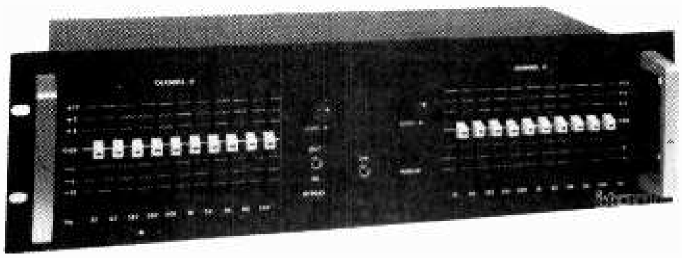

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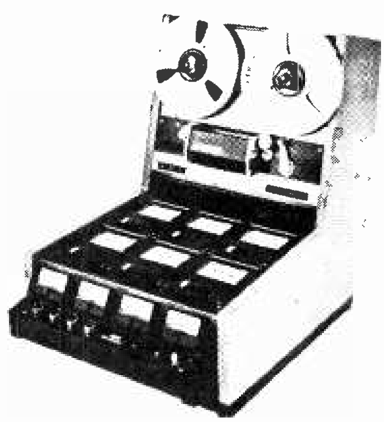

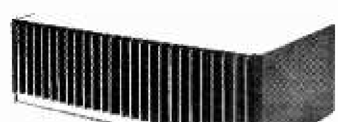

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For .025" (0,63mm) sq. post "MODIFIED" wrap, positive indexing, anti-overwrapping device.

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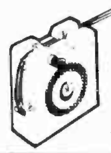
B	For AWG 26-28	BW-2628
C	Bit for AWG 30	BT-30
D	Bit for AWG 26-28	BT-2628

A £26.75 B £31.95 C £2.82 D £7.44



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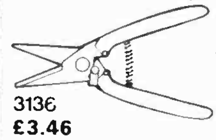
Wire Size: 30 AWG.
50 ft. Red, Blue, White
Kynar insulated.



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Extractor Tool EX-1.

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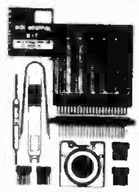
INS-1416



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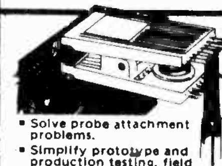
Contains: Hobby Wrap Tool WSU-30 M, Wire Dispenser WD-30-B, (2) 14 DIP's, (2) 16 DIP's, Hobby Board H-PCB-1, DIP/IC Insertion Tool INS-1416 and DIP/IC Extractor Tool EX-1.

Wire-Wrapping Kit	WK-4B (Blue)

£19.22



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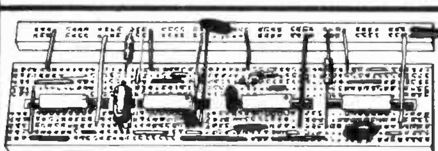

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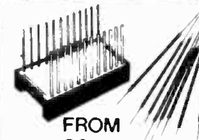
Bread boarding building blocks with universal matrices of solderless plug-in tiepoints.
- Facilitate quick, solderless circuit build-up and check-out on universal .1" x .1" matrix.
- Are offered in ten configurations.
- Accept all components with leads up to .032" diameter.
- Require no special patch cords.
- Includes integral non-shorting instant mounting backing.

HOBBY WRAP TOOL
Wire-wrapping, stripping, unwrapping tool for AWG 30 on .025 (0,63mm) Square Post.

Regular Wrap	A	WSU-30
Modified Wrap	B	WSU-30M

A £4.74 B £5.07



DIP SOCKET
Dual-in-line package, 3 level wire-wrapping, phosphor bronze contact, gold plated pins .025 (0,63mm) sq., .100 (2,54mm) centre spacing.

FROM
29p

14 Pin Dip Socket	14 Dip
16 Pin Dip Socket	16 Dip

RIBBON CABLE ASSEMBLY **£2.92**

With 14 Pin Dip Plug - 2" Long	DE 14-2
With 14 Pin Dip Plug - 4" Long	DE 14-4
With 14 Pin Dip Plug - 8" Long	DE 14-8
With 16 Pin Dip Plug - 2" Long	DE 16-2
With 16 Pin Dip Plug - 4" Long	DE 16-4
With 16 Pin Dip Plug - 8" Long	DE 16-8

See us at BREAD BOARD '78
21st-25th November
Seymour Hall
London
Stand Nos. A5-A6

OK Machine & Tool U.K. Limited
48a The Avenue · Southampton SO1 2SY
Telephone Southampton (0703) 38966/7 Telex 477222 Cablegram OKMAC

DISTRIBUTORS WANTED ***

WW—046 FOR FURTHER DETAILS

QUALITY COMPONENTS BY RETURN

Buy it with Access

Linear Circuits by RCA, National etc.

709 DIL14	25p	LM382N	105p
741 DIL8	22p	LM1303	110p
741 DIL14	35p	LM3900	50p
747C DIL14	50p	LM3909	60p
748C DIL8	30p	MC1310P	150p
CA3011	80p	MC1312P	160p
CA3014	130p	MC1314P	300p
CA3018	80p	MC1315P	520p
CA3020	160p	MC1330	100p
CA3028	125p	MC1458N	35p
CA3035	140p	MC1496N	60p
CA3036	170p	NE555	25p
CA3042	170p	NE556	60p
CA3043	180p	NE560	300p
CA3046	55p	NE561B	350p
CA3052	150p	NE562B	350p
CA3054	115p	NE565A	120p
CA3075	180p	NE566V	150p
CA3080	70p	NE567V	170p
CA3081	125p	SN76003N	200p
CA3089	180p	SN76013N	140p
CA3090	400p	SN76023N	140p
CA3123	150p	SN76033N	200p
CA3130	90p	TAA621A	215p
CA3140E	70p	TBA120S	65p
LM300H	130p	TBA540	200p
LM301AN	28p	TBA641	240p
LM304H	70p	TBA800	70p
LM308N	65p	TBA920	320p
LM318N	125p	TCA270SQ	200p
LM324N	50p	TDA1002	450p
LM339	50p	TDA1022	570p
LM380N	75p	TDA2020	320p
LM381N	105p	ZN414	75p

CMOS from RCA, National etc.

4000	15p	4040	68p
4001	15p	4042	54p
4002	15p	4043	55p
4007	15p	4046	100p
4008	65p	4049	28p
4009	35p	4050	28p
4010	35p	4051	55p
4011	15p	4052	55p
4012	15p	4066	40p
4013	35p	4068	20p
4015	60p	4069	16p
4016	35p	4070	16p
4017	55p	4071	16p
4018	65p	4072	16p
4020	60p	4073	16p
4022	55p	4075	16p
4023	15p	4078	16p
4024	45p	4081	16p
4025	15p	4510	70p
4026	95p	4511	70p
4027	35p	4516	65p
4028	52p	4518	65p
4029	60p	4520	65p
4030	35p	4585	70p

TTL from National, Texas, ITT etc.

7400	12p	7496	50p
7401	12p	7497	140p
7402	12p	74100	90p
7403	12p	74104	50p
7404	13p	74105	40p
7405	13p	74107	25p
7406	24p	74109	30p
7407	24p	74110	35p
7408	14p	74111	45p
7409	14p	74116	95p
7410	12p	74118	82p
7411	18p	74119	140p
7412	17p	74121	25p
7413	25p	74123	40p
7414	48p	74125	35p
7416	24p	74126	35p
7417	24p	74132	50p
7420	12p	74141	56p
7421	22p	74142	200p
7422	18p	74145	58p
7423	22p	74147	110p
7425	22p	74148	90p
7426	24p	74150	70p
7427	24p	74151	50p
7428	28p	74153	50p
7430	12p	74154	85p
7432	23p	74155	52p
7433	32p	74156	52p
7437	22p	74157	53p
7438	22p	74160	60p
7440	13p	74161	65p
7441	52p	74162	65p
7442	43p	74163	65p
7443	75p	74164	70p
7444	75p	74165	70p
7445	70p	74166	80p
7446	55p	74167	180p
7447	55p	74170	125p
7448	58p	74172	400p
7450	14p	74173	95p
7451	14p	74174	68p
7452	13p	74175	65p
7454	14p	74176	58p
7460	14p	74177	58p
7470	28p	74178	80p
7472	24p	74181	145p
7473	25p	74182	60p
7474	25p	74185	110p
7475	32p	74190	72p
7476	28p	74191	72p
7483	60p	74192	64p
7485	70p	74193	64p
7486	24p	74194	60p
7489	145p	74195	55p
7490	32p	74196	55p
7491	45p	74197	55p
7492	35p	74198	110p
7493	34p	74199	110p
7494	80p		
7495	52p		

Transistors

AC125	18p	BC558	12p	ZTX304	25p	2N3704	8p
AC126	18p	BC559	13p	ZTX310	13p	2N3705	9p
AC127	17p	BCY70	14p	ZTX311	14p	2N3706	9p
AC128	16p	BCY71	14p	ZTX314	22p	2N3707	9p
AC176	18p	BCY72	14p	ZTX341	21p	2N3708	8p
AC186	24p	BD115	52p	ZTX500	16p	2N3709	8p
AD161	38p	BD131	35p	ZTX501	16p	2N3710	8p
AD162	38p	BD132	35p	ZTX502	20p	2N3711	8p
AF124	27p	BD133	44p	ZTX503	20p	2N3715	10p
AF125	27p	BD135	38p	ZTX504	25p	2N3819	22p
AF126	27p	BD136	36p	ZTX530	30p	2N3823	65p
AF127	27p	BD137	38p	ZTX550	24p	2N3824	75p
AF139	36p	BD138	38p	2N696	32p	2N3866	55p
AF239	40p	BD139	35p	2N697	12p	2N3903	8p
BC107	8p	BD140	35p	2N698	28p	2N3904	8p
BC107B	10p	BF244B	36p	2N699	50p	2N3905	8p
BC108	8p	BFX29	25p	2N706	13p	2N3906	8p
BC108B	8p	BFX84	23p	2N706A	13p	2N4037	30p
BC108C	10p	BFX87	20p	2N708	20p	2N4058	12p
BC109	8p	BFX88	20p	2N914	22p	2N4059	10p
BC109C	10p	BFY50	15p	2N918	30p	2N4060	12p
BC147	7p	BFY51	15p	2N919	50p	2N4061	12p
BC148	7p	BFY52	15p	2N920	54p	2N5179	50p
BC149	8p	BU105	170p	2N929	25p	2N5457	32p
BC157	9p	BU205	140p	2N930	20p	2N5458	30p
BC158	9p	BU208	160p	2N1131	23p	2N5459	32p
BC159	9p	MJ2955	98p	2N1132	23p	2N5777	50p
BC167	8p	MPF102	36p	2N1302	38p		
BC168	8p	MPSA06	30p	2N1303	54p	**Diodes**	
BC169	8p	MPSA56	30p	2N1304	54p	0A47	10p
BC169C	9p	TIP29	40p	2N1613	22p	0A91	5p
BC170	9p	TIP29A	44p	2N1671	130p	0A200	6p
BC171	9p	TIP29B	40p	2N2160	100p	1N914	4p
BC172	7p	TIP29C	60p	2N2243	28p	1N916	5p
BC173	9p	TIP30	40p	2N2297	45p	1N4001	4p
BC177	14p	TIP30A	48p	2N2368	15p	1N4002	4p
BC178	14p	TIP30B	55p	2N2369	16p	1N4006	6p
BC179	14p	TIP30C	70p	2N2484	22p	1N4148	3p
BC182	10p	TIP31	50p	2N2846	70p		
BC182L	10p	TIP31A	50p	2N2904	22p	**Regulators**	
BC183	10p	TIP31B	60p	2N2094A	23p	7805	60p
BC183L	10p	TIP31C	65p	2N2905	22p	7812	60p
BC184	10p	TIP32	55p	2N2905A	22p	7815	60p
BC184L	10p	TIP32A	60p	2N2906	22p	7818	60p
BC207	10p	TIP32B	75p	N2906A	22p	7824	60p
BC208	8p	TIP32C	80p	2N2907	22p	78L05	30p
BC209C	10p	TIP33	75p	2N2907A	25p	78L12	30p
BC212	10p	TIP33A	80p	2N2926G	10p	78L15	30p
BC212L	10p	TIP33B	103p	2N2926R	8p	7905	80p
BC213	10p	TIP33C	116p	2N3011	22p	7912	80p
BC213L	10p	TIP34	98p	2N3053	18p	7915	80p
BC214	10p	TIP34A	95p	2N3054	50p	7918	80p
BC214L	10p	TIP34B	128p	2N3055	50p	7924	80p
BC477	19p	ZTX107	14p	2N3121	25p	79L05	70p
BC478	18p	ZTX108	14p	2N3133	25p	79L12	70p
BC479	18p	ZTX109	14p	2N3440	80p	79L15	70p
BC547	11p	ZTX300	16p	2N3441	120p	LM309K	110p
BC548	10p	ZTX301	16p	2N3442	135p	LM317K	300p
BC549	11p	ZTX302	23p	2N3702	8p	LM323K	530p
BC550	14p	ZTX303	23p	2N3703	8p	LM723	40p

Carbon Film Resistors
High stability, low noise, 0.25W 5% E12 series from 4.7 ohms to 10 Megohms. Any selection

each	100+	1000+	5000
1p	**0.9p**	**0.8p**	**0.75p**

Special development pack of 10 of each value 4.7 ohms to 1 Megohm, a total of 650 resistors **£5.70**

Potentiometers
Carbon track. Log and Linear values
5K — 2M2 single gang **26p**
5K — 2M2 single gang switched **60p**
5K — 2M2 dual gang stereo **75p**

Preset Potentiometers
Subminiature type available in horizontal or vertical mounting. 0.1W rating. 100 ohms to 2M .... **6p each**
Special development of 5 of each value from 100 ohms to 2M, a total of 70 presets (please state vertical or horizontal) **£3.95**

Ceramic Capacitors
Miniature plate type. 50V PC mounting. Available from 22pF to 1000pF in E12 series and 1500pF to 0.047uF in E6 series .... **2p each**

Polyester Capacitors
Mullard C280 series 250V PC mounting.
0.01, 0.015, 0.022, 0.033, 0.047, 0.068, 0.1, **5p;** 0.15, 0.22, **7p;** 0.33, 0.47, **10p;** 0.68, **14p;** 1.0, **17p;** 2.2μF, **28p each.**
Special development pack of 5 of each value **£6.20**

Tantalum Capacitors
0.1, 0.15, 0.22, 0.33, 0.47, 0.68, 1.0, 2.2 @ 35V **9p**
4.7 @ 25V, 6.8 and 10 @ 25V **13p**
22 @ 16V, 47 @ 6V, 68 @ 3V, 100 @ 3V **16p**
Development pack 5 of each value **£8.30**

Optoelectronics

LEDs	Red	Green	Yellow
0.125 in	**9p**	**15p**	**18p**
0.2 in	**9p**	**13p**	**18p**

Displays DL707 **90p** DL704 **90p**

DIL Sockets
8 pin **11p** 14 pin **12p** 16 pin **13p** 24 pin **30p**

Quantity discounts on any mix. TTL, CMOS and Linear Circuits 25+ 10%, 100+ 15%. All orders despatched by return. Prices VAT inclusive. Please add 30p for carriage. All components guaranteed brand new and full specification from leading manufacturers. Callers most welcome at our premises 8.30am to 6pm Monday to Saturday. All prices valid to April 30, 1979. Send 12p stamp for our new illustrated catalogue. Official orders welcome from colleges, universities etc.

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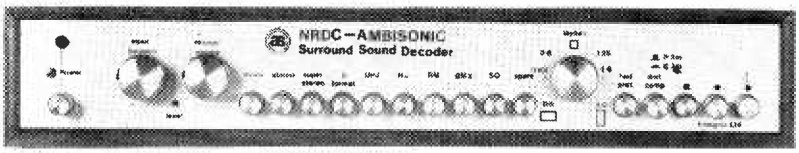
NEW STYLING

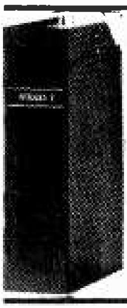
NRDC-AMBISONIC UHJ



SURROUND SOUND DECODER

The **first ever** kit specialy 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 UHJ but virtually all other 'quadrophonic' systems (Not CD4), including the new BBC HJ 10 input selections
The decoder is linear throughout and does not rely on listener fatiguing logic enhancement techniques. Both 2 or 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

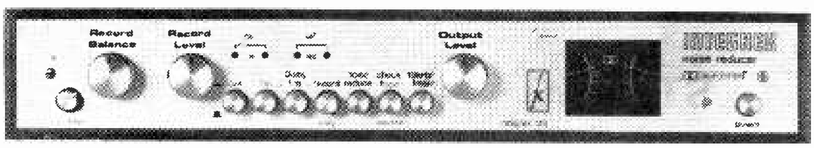
With Home Office Type approval

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 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.



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.

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.

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)

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

Buy it with Access · EUROCARD · BARCLAYCARD · master charge

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 MK. I 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.

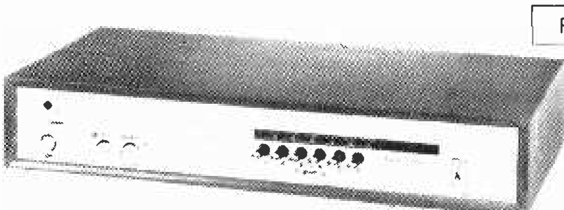
Brief Spec. Tuning range 88—104MHz. 20dB mono quieting @ 0.75µV. Image rejection — 70dB. IF rejection — 85dB. THD typically 0.4%.
IC stabilized PSU and LED tuning indicators. Push-button tuning and AFC unit. Choice of either mono or stereo with a choice of stereo decoders.

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

Please send for details of the Nelson-Jones Mk. II Kit as in this month's W.W.

STEREO MODULE TUNER KIT

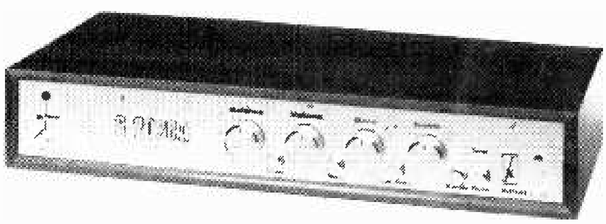


A low-cost Stereo Tuner based on the 3302 FET RF module requiring no alignment. The IF comprises a ceramic filter and high-performance IC Variable INTERSTATION MUTE. PLL stereo decoder IC. Pre-decoder 'birdy' filter Push-button tuning

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

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

SERVICE TRADING CO

WHY PAY MORE?!

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 ranges, dimensions 133 × 93 × 46mm. Price **£7.00** plus 50p P&P **(£8.10** inc. VAT & P)

TRIAC.

Raytheon tag symmetrical Triac. Type Tag 250/500v. 10 amp 500 piv. Glass passivated plastic triac. Swiss precision product for long term reliability **£1.25** P&P 10p **(£1.45** inc. VAT & P) (inclusive of date and application sheet). Suitable Diac **22p**.

0 to 60 MINUTES CLOCKWORK TIMER.

Double pole 15 amp 230AC. Contacts (no dial) **£1.50**, P&P 30p **(£1.94** inc. VAT & P). N.M.S.

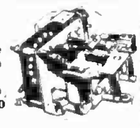
MERCURY SWITCH

Size 27m x 5mm. 10 for **£5.00**. P&P 30p, total including VAT **£5.72**. Min. quantity 10. N.M.S.

230 VOLT AC FAN ASSEMBLY

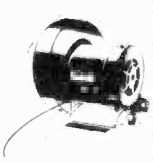
Powerful continuously rated AC motor complete with 5 blade 6½" aluminium fan. New reduced price **£3.00** P&P 65p **(£3.94** inc. VAT & P). N.M.S.

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). N.M.S.

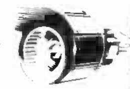
VORTEX BLOWER AND VACUUM UNIT



Dynamically balanced totally 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 x width 25cm x 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



Smith type FFB 1606 022 220/240v. A.C. Aperture 10x4½cm overall size 16x14cm. Price **£3.75 P&P 75p** (inc. VAT **£4.86**). Other types available. S.A.E. for details. N.M.S.

CROUZET 230V A.C.

2 R.P.M. synchronous, brand new **£2.90**, P&P 30p **(£3.46** inc. VAT). N.M.S.

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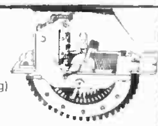

12v. 11 way 4 bank (3 non-bridging, 1 homing) **£2.50** P&P 35p **(£3.08** inc. VAT & P).

MICRO SWITCHES

Sub. min. lever m/switch type MML46. 10 for **£2.50**. Type 3 115M 906T 10 for **£2.50** post paid **(£2.70** inc. VAT & P).
BF lever operated 20a c/o. mf. Unimax USA. 10 for **£4.00** plus 50p P&P (min. order 10) **(£4.86** inc. VAT & P).
D.P. C/O lever m/switch, mfg. by Cherry Co. USA. Precious metal, low resistance contacts. 10 for **£2.50**. P&P 30p. Total inc. VAT **£3.02** (min. 10). N.M.S.

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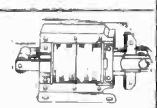

Mfg. by Magnetic Devices 240v. A.C. Operation approx. 10lb. pull at 1.25". Price **£4.00** P&P 60p **(£4.96** inc. VAT). N.M.S.

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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 **£3.50** Post 50p **(£4.32** inc. VAT & P).

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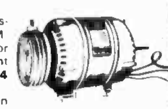

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115 lb. ins., 110 volt 50Hz 2.8 amp. single phase, split capacitor motor. Immense power. Continuously rated. Totally enclosed. Fan cooled. In-line gearbox. Length 250mm. Dia. 135mm. Spindle Dia. 15.5mm. Length 115mm, ex-equipment tested **£12.00** Post £1.50 **(£14.58** inc. VAT & P). Suitable transformer 230/240 volt **£8.00** Post 75p **(£9.45** inc. VAT & P). R&T

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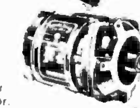

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56rpm 50lbs.inch 240vAC reversible, 0.7 amp, shaftlength 35mm, dia. 16mm, weight 6 kilos 600 grams. Price **£15.00** P&P £1.50 **(£17.82)**. N.M.S.

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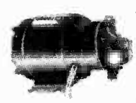

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A.C. Amp., Type 62T2, 0-1A, 0-5A, 0-20A. **A.C. Volt.** 0-15V, 0-300V. **D.C. Amp.**, Type 65C5, 0-2A, 0-10A, 0-20A, 0-100A. **D.C. Volt.** 0-15V, 0-30V. All types **£3.50 ea** + P&P 50p **(£4.32** incl. VAT), except 0-100A D.C. price **£5.00**+ 50p P&P **(£5.94** incl. VAT).

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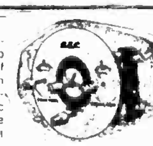

Based on an electric clock, with 25 amp. single-pole switch, which can be preset for any period up to 12 hrs. ahead to switch on for any length of time from 10 mins. to 6 hrs. then switch off. An additional 60 min. audible timer is also incorporated. Ideal for Tape Recorders, Lights, Electric Blankets etc. Attractive satin copper finish. Size 135 mm x 130 mm x 60 mm. Price **£2.25**. Post 40p (Total inc. VAT & Post **£2.87**). N.M.S.

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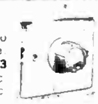
600 WATT DIMMER SWITCH



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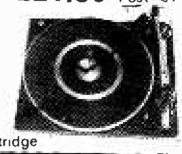

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With P V C Cover Cut out for most BSR or Garrard decks Silver grey finish
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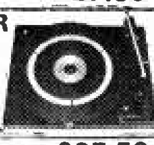

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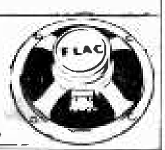

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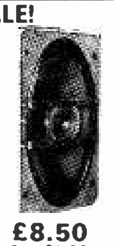

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ALI BOXES IN STOCK. MANY SIZES
VARICAP FM TUNER HEAD with circuit & connections **£4.95.** Some technical knowledge required
TAG STRIP 28-way **12p.**
TAPE OSCILLATOR COIL. Valve type, **35p.**
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SONOTONE stereo **£2.00. ADASTRA** magnetic **£5.**
WIRE-WOUND RESISTORS 5 watt, 10 watt, 15 watt **15p**
BALANCED TWIN RIBBON FEEDER 300 ohms. 5p yd.

R.C.S. SOUND TO LIGHT KIT Mk. 2
Kit of parts to build a 3 channel sound to light unit 1,000 watts per channel Suitable for home use Easy to build Full instructions supplied. Cabinet **£4** extra. Will operate from 200MV to 100 watt signal **£17** Post 35p

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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 **£2.95** Post 45p

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12 VOLT 300mA KIT. **£3.15.**

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, **£12.50;** Stereo, **£20.** Post 45p Specification 10W per channel; input 100mV; size 9½ x 3 x 2in approx S.A E details. Full instructions supplied A C mains powered.

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Will control up to 400 watts AC mains **£3.25** Post 35p

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MAINS TRANSFORMERS ALL POST 75p

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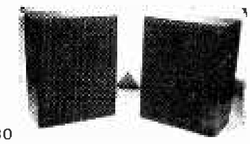

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13 × 10 × 6in approx.
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10 watts rms 4 ohms
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These little marvels of modern sound reproduction are ideally suited for today's domestic audio set-up Two of these smart spheres, each with 5 watt deep throated ceramic magnets, will produce superb stereo reproduction
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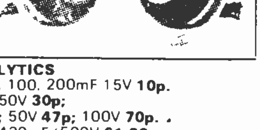

Full Range
Frequency Response
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Power Peak 5 watts

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BAKER MAJOR 12" £16.88
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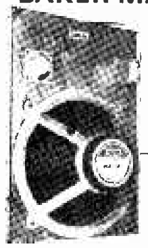

30-14,500 c/s. 12in. double cone, woofer and tweeter cone together with a BAKER ceramic magnet assembly having a flux density of 14,000 gauss and a total flux of 145,000 Maxwells. Bass resonance 40 c/s Rated 25W NOTE 4 or 8 or 16 ohms must be stated

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Please state 4 or 8 or 16 ohms

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12in 30W **£12.96**	12in 40W **£15.12**	15in 75W **£36.72**
4 or 8 or 16 ohm	4 or 8 or 16 ohm	8 or 16 ohm

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. **£22.68** Post £1.60

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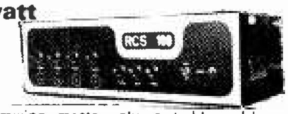
LOUDSPEAKER CABINET WADDING 18in wide **20p** ft.

R.C.S. 100 watt VALVE AMPLIFIER CHASSIS



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.
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LOUDSPEAKERS P.M. 3 OHM 7x4in **£1.50;** 6½in , **£1.80;** 8x5in , **£1.90;** 8in , **£1.95.**
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., 2½in , 2⅝in , 3½in , 5in dia. **£1.50 each.**
PHILIPS LOUDSPEAKER, 8in , 4 ohms, 4 watts. **£1.95**
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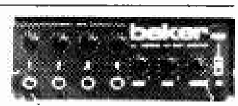
Handles up to 100 watts. No crossover required.

BLACK PLASTIC CONSTRUCTION BOX with brushed aluminium facia. Sturdy job Size 6¼ x 4¾ x 2in **£1.50**

BAKER 150 WATT PROFESSIONAL MIXER AMPLIFIER



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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
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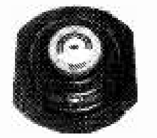
LOW VOLTAGE POWER PACK for MODELS
Ready made. Famous make. Will supply 10 volts at 400mA. With terminals and mains lead.

GOODMANS COMPACT 12-INCH BASS WOOFER



Standard 12in. diameter fixing with cut sides 12 x 10 14 000 Gauss magnet. 20 watts R M S 4 ohm imp Bass resonance = 30 c.p s Frequency response 30-8000 c p s
£9.95 each Post £1

ALUMINIUM HEAT SINKS. FINNED TYPE.
Sizes 5 × 4 × 1 **95p.** 6½ × 2 × 2¼ **65p.**
JACK PLUGS Mono Plastic 25p; Metal 30p.
JACK PLUGS Stereo Plastic 30p; Metal 35p.
JACK SOCKETS Mono Open 20p; Closed 25p.
JACK SOCKETS Stereo Open 25p; Closed 30p.
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Sockets 3-pin, 5-pin 10p.
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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

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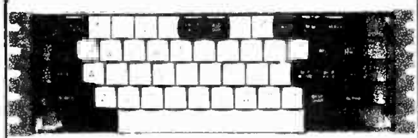
SPECIAL KEYBOARD OFFER



A special bulk purchase enables us to offer the above Keyboard at a lowest ever price. 49 coded keys encoded into a direct TTL compatible 7 bit output. Features such as delayed strobe, 5 volt D.C. single rail operation and rollover protection make this an absolute must for the MPU constructor! Supplied complete with connection diagram and edge connector, at a secondhand "no time to test" price of only **£18.50** P.P. £1·50

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Ultra low ripple 10 amp. smoothing

1500 mf 100v Screw Term	50p*
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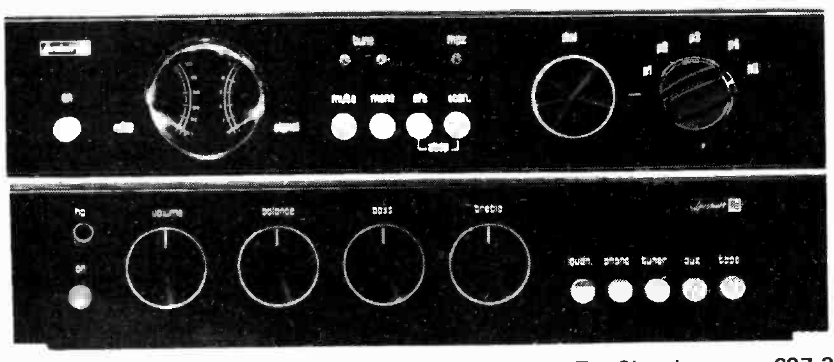
WW—127 FOR FURTHER DETAILS

Top: The Signalmaster Mk.8 Lower: The Audiomaster amplifier



Matched Pair

The *Audiomaster* 25+25W rms amplifier, and the matching *Signalmaster Mk.8* FM tuner, are fine examples of Larsholt's long experience in producing electronic kits that are neither insulting to the most experienced constructor, nor are they baffling to the beginner.
We unhesitatingly recommend them on the grounds of style *and* performance.

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Essex. telephone (0277)216029

Larsholt Electronics

Price inc VAT : Signalmaster £97.35
Audiomaster £88.80: the pair £165

WW—077 FOR FURTHER DETAILS

TEKTRONIX OSCILLOSCOPES

Main frames 545 with CA **£225**; 536, 585 with type B2 **£395**; 581A, 661 with 5T1A & 4S3 **£325**; 555, 561A with Plug-in 10 MHZ **£425**; 551, 502 High gain, Special **£160**.
The prices of main frames will vary enormously on condition and plug-ins. Hence prices are guides only.
The fact we don't advertise modern oscilloscopes, etc., doesn't mean we don't handle them, only that at our prices they are not normally around long enough to advertise. For example
H.P. OSCILLOSCOPE type 183A with 1B30A and 1B40A 3db 250MHZ **£950**.
TEKTRONIX 453 3db 50MHZ **£650**.
TEKTRONIX 454 3db 150MHZ **£1,000**.
S.E. LABS SM111 3db 20MHZ **£325**.
TEKTRONIX SPECTRUM ANALYSER 1L40 Plug-in 1.5GHZ to 40GHZ **£550**.

R&S RECEIVER 44-210MHZ HUZ BN15012 Poor **£60**.
BONTOON RX METER type 250A 0.5 to 250MHZ. Clean **£85**.
MARCONI Q METER type 1245 with 1246 **£350**.
Optional 1247 **£100**.
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R&S ENOGRAPH-G ZSG BN18531 **£120**.
R&S AM/FMGEN SMAF BN41404 4MHZ-300MHZ **£300** ea.
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R&S AM GEN 30-300MHZ SMLM BN4105 **£90** ea.
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AIRMEC AM/FM MODULATION METER type 210 **£80**.
BIRD TERMALINE WATTMETER 67C 30-1000MHZ 50 omh **£95**.
E.H. PULSE GEN model 122 **£140**.
MARCONI AM/FM MODULATION METER TF2300 with TM8045 **£450**.
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R&S POLYSCOP SWOB2. Fair condition, working **£425** ea; Very clean **£550** ea.
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MARCONI TF868 Universal Bridge **£70** ea.
AIRMEC SIG GEN type 204 1-320MHZ **£225**.
MARCONI SIG GEN TF801B **£160** ea.
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MARCONI SIGNAL GENERATOR TF1060 **£185**.
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BC147; 2N3707; BC172B; BC2518; BC34BB; BC171A/B; BC413; D10; BAX15; 1N937; BA102BE; BZX83; TIS61; 2N5040.
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1N4733A; SN7451N; BYX10-15V 0.36A; BYZ10 **15p** ea.
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EX-MINISTRY OSCILLOSCOPE CT436
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HIGH NOISE IMMUNITY LOGIC
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As ABOVE with additional 240V relay on base *and* full black plastic cover. **£2.45** ea. P&P £1.50.
SNAIL BLOWER 110V AC 500 MA Brand new by Airflow Developments. Quiet and very good looking. **£2.50** ea. P&P £1.
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LP1171 combined AM/FM IF strip. 10.7MHZ **£3.50** ea.
LP1179 FM front end with AM tuning and B7.4MHZ to 104.5MHZ tuning. 10.7MHZ IF **£3.50** ea. P&P 50p each unit. **The Pair £5.75.** P&P 75p.
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AUDIO AMPLIFIER BOARD. Size 4½ x 2½. Output pair of TIP31s. Circuit supplied. **£1.50** ea. P&P 30p.
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TELETYPE ASR35. Nice condition. **£425.**

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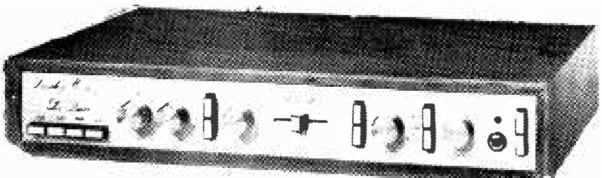
AUDIO KITS OF DISTINCTION FROM POWERTRAN

DE LUXE EASY TO BUILD LINSLEY-HOOD 75W AMPLIFIER



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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 at a very modest cost with high quality high power ready built units of comparable quality generally being over three times the price

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

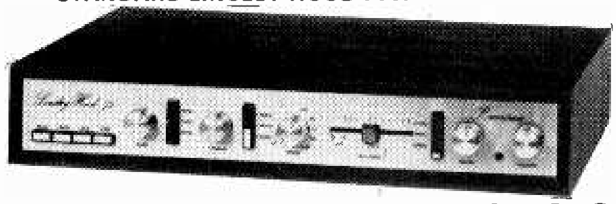
Our new De Luxe model uses 14 boards which interconnect with gold plated contacts and are designed to have the potentiometers and switches mounted upon them This system almost eliminates internal wiring making installation, after their assembly, delightfully straightforward, and as each board can be 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 the latest circuit improvements generously sized heat sinks for heavy duty use even in tropical climates and metal oxide resistors throughout for long term stability and reliability

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, finned 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	£12.95
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. High Quality Teak Veneer 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 £92.80

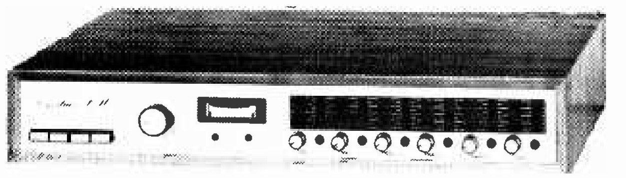
PACK PRICES FOR STANDARD KIT

STANDARD LINSLEY-HOOD 75W AMPLIFIER



SPECIAL PRICE FOR COMPLETE KIT £79.80

WIRELESS WORLD FM TUNER

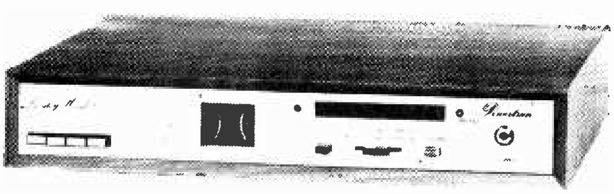


Designed in response to demand for a tuner to complement the world-wide acclaimed Linsley-Hood 75W Amplifier, this kit provides the perfect match The Wireless World (Skingley and Thompson) published original circuit has been developed further for inclusion into this outstanding slimline unit and features 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

AVAILABLE AS SEPARATE PACKS — PRICES IN OUR FREE CATALOGUE

SPECIAL PRICE FOR COMPLETE KIT £70.20

LINSLEY-HOOD CASSETTE DECK



SPECIAL PRICE FOR COMPLETE KIT £79.60

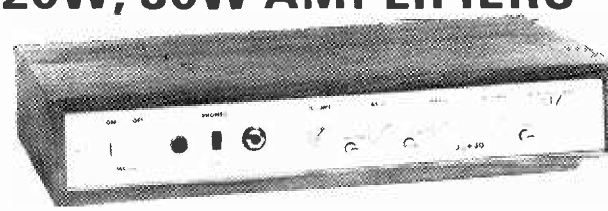
Pack	Price
1. Stereo PCB (accommodates 2 rep. amps. 2 meter, amps, bias/erase osc, relay)	£3.35
2. Stereo set of capacitors, M.O. resistors, potentiometers for above	£7.95
3. Stereo set of semiconductors for above	£8.50
4. Miniature relay with socket	£2.90
5. PCB, all components for solenoid, speed control 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 P.C.B. 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. High Quality Teak Veneer 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

Matsushita WY 436 AZ head (optional extra) . £4.50 (free with compete kit)

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 Pushbutton 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 Circuit changes as published in February, 1978, follow-up article are included in the kit AT NO EXTRA COST! A higher performance head (Matsushita WY 436 AZ head as recommended in the follow-up article) is offered as an optional extra but this will be automatically supplied FREE OF CHARGE with all orders for complete kits!

T20+20 AND T30+30 20W, 30W AMPLIFIERS



Designed by Texas engineers and described in Practical Wireless the Texan was an immediate success Now developed further in our laboratories to include a Toroidal transformer and additional improvements, the slimline T20+20 delivers 20W rms per channel of true Hi-Fi at exceptionally low cost The **easy to build** design is based on a single F/Glass PCB and features all the normal facilities found on quality amplifiers including scratch and rumble filters, adaptable input selector and headphones socket In a follow-up article in Practical Wireless further modifications were suggested and these have been incorporated into the T30+30 These include RF interference filters and a tape monitor facility Power output of this model is 30W rms per channel

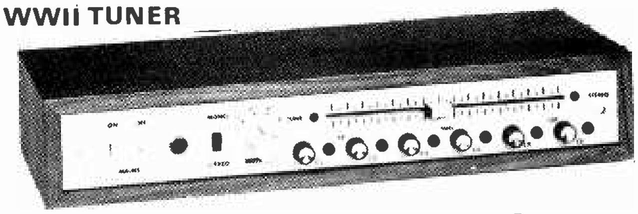
SPECIAL PRICES FOR COMPLETE KITS

T20+20 KIT PRICE £33.10

T30+30 KIT PRICE £38.40

AVAILABLE AS SEPARATE PACKS — PRICES IN OUR FREE CATALOGUE

WWII TUNER



SPECIAL PRICE FOR COMPLETE KIT £47.70

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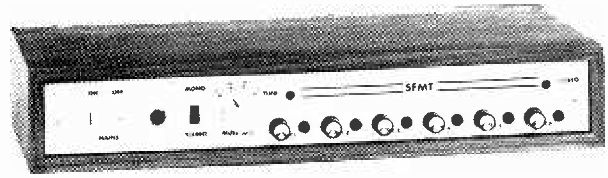
Following the success of our **Wireless World FM Tuner Kit** this cost reduced model was designed to complement the **T20+20** and **T30+30** amplifiers and the cabinet size, front panel format and electrical characteristics make this tuner compatible with either.

POWERTRAN SFMT TUNER



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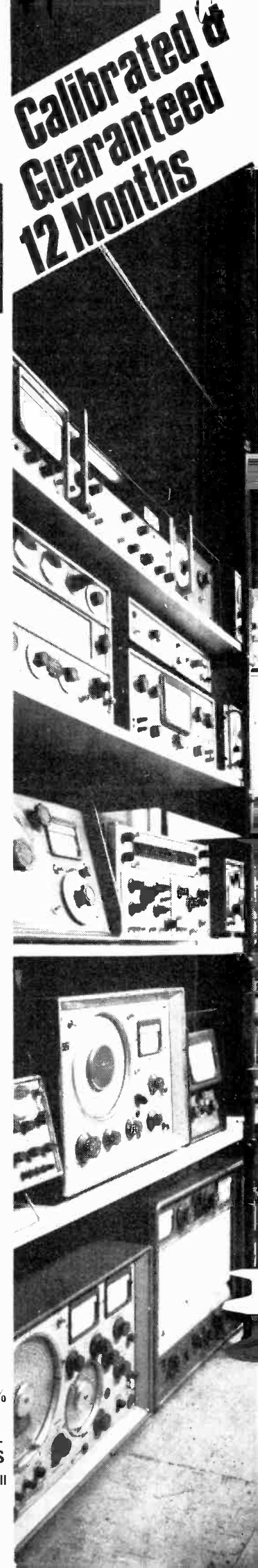

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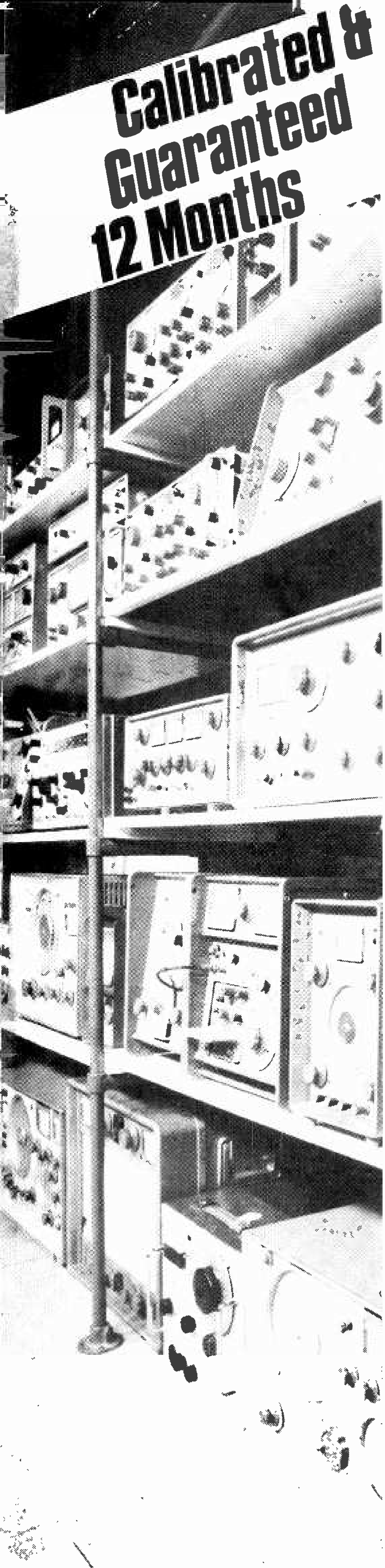

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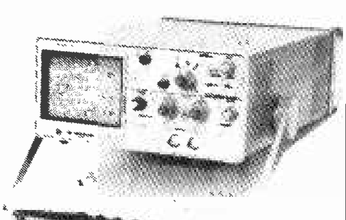

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Salary starts at 25 or over around £4093 and rises after three years to about £5093. (Starting salary for those between 19-24 varies between £3222-£3732). Overtime is additional, and there is a good pension scheme, sick-pay benefits and at least 4 weeks' holiday a year.

For further information, please telephone Andree Trionfi on Freefone 2281 or write to her at the following address:
ETE Maritime Radio Services Division (WW/B/7), ETE 17.1.1.2, Room 643, Union House, St. Martins-le-Grand, London EC1A 1AR.

Post Office Telecommunications (7141)

WESSEX EDUCATIONAL TELEVISION CONSORTIUM

CCTV ENGINEER

An engineer is required for the Consortium's mobile CCTV production unit which is based at Winchester.

Applicants should possess a graduate or full professional qualification.
Inclusive salary ranges from £4,245 to £5,073, depending on age, qualifications and experience.
Further details from The Director, Wessex Consortium, King Alfred's College, Winchester SO22 4NR. Phone 66359.
Closing date for applications is November 3rd (8606)

CHELSEA COLLEGE
University of London

ELECTRONICS TECHNICIAN

Grade 3 required for Electronics Workshop. Interesting prototype construction and servicing work mainly for Departments of Electronics and Physics. Relevant experience essential and a suitable qualification in Electronics desirable. Day release can be arranged for approved courses.

Salary £3 153-£3.525 p.a. inclusive (under review). Application forms and further information from Mr M. E. Cane (3EW), Chelsea College, Department of Electronics, Pulton Place, London SW6 5PR (8631)

AUDIO + VIDEO LTD.

SENIOR VIDEO ENGINEERS AND HIGH GRADE TELEVISION ENGINEERS

Because Audio + Video are the largest video duplicators in Europe, we naturally have a lot of high-class equipment tp produce our top quality video tapes. We have in house, the Marconi D.I.C.E., the Rank Cintel Flying Spot Telecine, the RCA TK28 Telecine, TR60, TR70c and Ampex 2000 2" Quad machines, Sony D100 duplicator, 2850, 2600, 2030, 2630, Betamax, Philips VCR 1500 and 1700, VHS, Keyline editor, etc.

We now require Senior Video Engineers with experience of maintaining and servicing any or all of the above equipment and high grade Television Engineers who can be trained to help maintain most of it. We will pay salaries in excess of £5,500 for the right people who enjoy working in television.

Please contact Cliff Carroll on 01-580 7161. (8446)

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Posts in Computers, Medical, Comms, etc. ONC to Ph.D. Free service.

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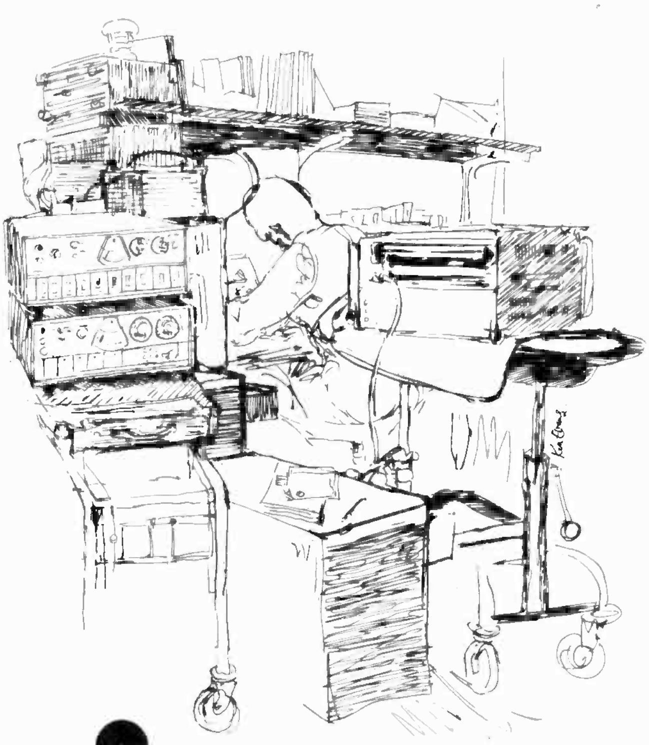
Marconi Instruments



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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

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(8638)

mi

THE MOMENT OF A COUPLE

Who but an engineer would realise this is serious technology — that we are just as interested in your cerebral prowess as your manual dexterity. Enough of the nether regions, concentrate on our vacancies.

THEY INCLUDE:

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for a new range of A.T.E. small subsidiary company of well-known manufacturer of measuring instruments. Technical ability and managerial acumen essential. To £8,000. South Coast.

YOUNG ENGINEER

for, believe it or not, the microprocessor itself. The firm will train recent graduates in relevant hardware and software. West Country, to £4,500.

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for work on Thyristor-controlled fire control systems in Aircraft. — A great challenge as equipment has to function in such different environments, Arctic to Desert regions. To £6,000, Berks.

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for some of the most advanced military work of the century involving interfacing avionic equipment to a special type computer. New factory/atmosphere for a well-known firm in Berks., to £7,500.

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Place your curriculum vitae in the experienced hands of Judy, Anne or Dawn "CHARLIES ANGELS."

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155 KNIGHTSBRIDGE, LONDON, SW1. TEL. 01-581 0286

(8644)

Electronics Engineer

Telemotive U.K. Limited is a Company in association with a major U.S.A. manufacturer with world leadership in the radio control of industrial machines, systems, and processes, in collision prevention, in remote positioning, and in other industrial electronics activities.

Our principal products are founded on the Near Field Induction Effect and on other inductive techniques in the 300 kHz band. No other U.K. Company has a comparable product line, and our business therefore offers engineering experience of unusual interest. Training in our techniques is provided.

Our current requirement is for a young engineer with versatile abilities because at different times the work will involve application engineering, testing, commissioning of systems on customers' sites, field and base service, the anglicisation of designs originating in other countries, and a measure of production control. In each of these fields there is scope for personal engineering contributions.

The position involves some travelling within the U.K. and will take the engineer into a wide variety of industries.

Telemotive is a good employer. It only employs people who are exceptional in their particular job, and it treats them accordingly. The salary will depend upon the capability of the chosen applicant.

A company car is provided.

Please forward personal details to

Telemotive U.K. Limited

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BYFLEET, WEYBRIDGE, SURREY
BYFLEET 47117

(8505)

Installation/ Service Engineers

Electronics

N.W. London based **c. £4,500+car**

Linotype-Paul is a world leader in the design and manufacture of computerised photocomposing equipment and associated peripherals. Demand for our products and the widening of our range have created further expansion requirements within our Service Engineering facility.

We are now looking for Electronics Engineers, men and women, qualified to ONC level and with experience in computers or peripherals, to install and service small phototypesetting systems. Full training is provided. In addition to the benefits you would expect from a progressive company, we offer a 1600cc estate car, generous expenses, overtime and assistance with relocation costs where appropriate.

Ring or write to David Hilton, Personnel Manager, Linotype-Paul Limited, Kingsbury Works, Kingsbury Road, London NW9 8UT Tel: 01-205 0123.

Linotype Paul 1974

THE BRITISH COUNCIL INVITES APPLICATIONS FOR THE FOLLOWING POSITION

ELECTRONICS TECHNICIAN (IRAN)

College of Nautical Studies, Chah Bahar. To stand by College training vessel during installation of radar, electronic navigation and instrumentation systems and to be responsible for all radar, electronic and radio communication equipment, carry out routine testing of all this equipment and keep service and stock records.

Candidates must have practical experience of all equipment mentioned above. Sea-going experience and City and Guilds 292 Marine Radio and Radar Technicians Certificate and Department of Trade Radar Maintenance Certificate advantageous.

Salary: in Southampton — £3,192-£5,344 pa: in Chah Bahar £4,469-£7,468 pa. Overseas benefits: Free furnished accommodation; overseas and children's allowances; return fares paid for technician and family; baggage allowance; medical scheme; annual passage paid home leave. 2-year contract from January 1979 or later.

Return fares are paid. Local contracts are guaranteed by the British Council. Please write briefly stating qualifications and length of appropriate experience, quoting reference number 78 HU 100 and title of post, for further details and application form to The British Council, 65 Davies Street, London, W1Y 2AA. (8598)

CRICKLADE COLLEGE ANDOVER

TECHNICIAN —ELECTRONICS AND ENGINEERING SCIENCE

The person appointed will be required to have a working knowledge of electronic and radio systems engineering equipment. Additional duties will be related to the operation of an engineering science laboratory. 37 hours per week, 52 weeks per year (less 18 days annual leave).

Salary within Technical Grade 1 £2,676-£2,967 plus £312 supplement.

Application forms from the Registrar, Cricklade College, Charlton Road, Andover. (Tel. 63311). (8607)

WINCHESTER AND CENTRAL HAMPSHIRE HEALTH DISTRICT ROYAL HAMPSHIRE COUNTY HOSPITAL

MEDICAL PHYSICS TECHNICIAN GRADE III

Under the control of the District Engineer in the District Electronics Department based at this Hospital. The successful applicant will be required to work on repair and maintain electro-medical and electronic equipment used by all departments within the hospitals attached to the Winchester and Central Hampshire Health District. Salary scale £3 744 p a to £4.788 p.a. Applicants not previously employed by the Health Service will start at the minimum of the scale. Minimum technical qualification O N C or equivalent

Application forms from: The District Personnel Office, Royal Hampshire County Hospital. Tel: Winchester 63535, Ext. 350/352. (8603)

ELECTRONICS ENGINEER EAST ANGLIA

Exciting possibilities exist for an electronics graduate with experience or keen active interest in consumer electronics. The right person will design and develop audio and R.F. circuits with a salary of c £4000. Relocation assistance can be made available.

Send résumé to Box 8646
c/o Wireless World
Dorset House, Stamford Street
London SE1 9LU

AN EXPERIENCED PART-TIME CAR RADIO ENGINEER

Phone for details
on **778-6369**
on **778 3391** (8627)

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We need your knowledge and experience

With sound practical experience and the necessary qualifications - degree, diploma, professional qualifications, HND, HNC, FTC, etc., depending on your specialisation - you can train as a lecturer in Further and Higher Education. A one-year grant-aided course will prepare you to teach in one of the following fields

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For further details either phone or send the coupon to any of the following colleges -

Bolton College of Education (Technical), Chadwick Street, Bolton BL2 1JW
Tel Bolton 22132

Garnet College Downshire House, Roehampton Lane, London SW15 4HR.
Tel 01-789 6533

The Polytechnic, Huddersfield, Holly Bank Road, Lindley, Huddersfield HD3 3BP
Tel Huddersfield 25611

Wolverhampton Polytechnic, Faculty of Education, Compton Road West
Wolverhampton WV3 9DX Tel: Wolverhampton 24286

Please send further details and an application form for a one-year course to train as a lecturer

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(8660) Ref WW1

While you're sitting there, looking through the limited available sources of job information, we're being asked if you're interested in better opportunities and higher earnings.

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(8636)

GUILDFORD & DISTRICT ENGINEERING TRAINING ASSOCIATION LIMITED SLYFIELD GREEN, GUILDFORD, SURREY

have a vacancy for

ELECTRONICS INSTRUCTOR

Applications are invited from people 25-50, who hold either a full Technological Certificate or have relevant practical experience for the post of Electronics Instructor.

Duties include conducting both theoretical and practical work for first year apprentices in our purpose-built training centre.

Salary (starting) £3882 p.a. with increments. Subsidised canteen, non-contributory sickness and life assurance scheme. Training in instructional techniques given if required.

Please contact: Guildford 65485.

(8596)

BBC

BBC requires an

ELECTRONIC MAINTENANCE SUPERVISOR

at its Engineering Training Department, in Evesham, Worcs.

Duties:
Directing a team of Broadcasting Engineers responsible for maintaining the full range of professional radio and television broadcasting equipment. Irregular hours of working are involved.

Requirements:
1. Ability to motivate and lead other Engineers in such a way as to provide an efficient maintenance facility.
2. Recent experience of maintaining electronic equipment.
3. A good technical knowledge of audio and/or video equipment.

One of the following qualifications is essential:
a) A degree from a British University in Electronics or Electrical Engineering
b) HNC or HND (Electrical Engineering or Applied Physics)
c) C&G Full Technological Certificate in Telecommunications
d) A pass in the Council of Engineering Institution or exemption therefrom

Reward:
A base in the Worcestershire countryside. Working in well-equipped Radio and Colour Television Studios. Excellent welfare and club facilities. Four weeks, two days leave. Pension scheme.
Salary in the range of £4160-£4570 depending upon experience and qualifications, rising to £5185 per annum plus 15% irregular hour working allowance.

Further Details:
If you would like to hear more and receive an application please send a stamped addressed envelope of at least 9" x 4" to Head of Technical Operations Training Section, Engineering Training Department, Wood Norton, Evesham WR11 4TF, quoting reference number 78.E.4073/WW.
Closing date for return of application forms fourteen days after publication.

(8590)

UNIVERSITY OF SUSSEX

SCHOOL OF MOLECULAR SCIENCES

SENIOR TECHNICIAN IN ELECTRONICS

Grade 5

The School of Molecular Sciences has an immediate vacancy for an electronics engineer. The essential requirements are a sound knowledge and practical ability to diagnose and to clear faults on the r f and electronics side of a wide range of modern analytical equipment including nuclear magnetic resonance, electron spin resonance and mass spectrometry, etc

The ability to deal with calibration and repairs to a wide range of electronic instruments is also required

Candidates should be qualified to at least full technological certificate level or equivalent and had five years' relevant experience

Salary range £3,186.00 - £3,720.00 per annum Four weeks' annual leave and excellent working conditions

Applications including the names of two technical referees, from whom further information could be obtained if necessary, to Mr P. J. Gilliver, Superintendent of the Laboratories, School of Molecular Sciences University of Sussex, Falmer, Brighton, BN1 9QJ.

(8620)

UMIST

ELECTRONICS TECHNICIAN

Applications are invited from candidates of either sex for a vacancy of Electronics Technician Grade 5 in the Department of Pure and Applied Physics. The technician is required for the development, construction and maintenance of specialised electronic equipment for research and teaching using the full range of electronics workshop procedure Applicants should be at least 24 years of age and preferably hold ONC, OND or equivalent qualifications

Salary within the scale £3,186-£3,720 per annum.

Application forms may be obtained from the Registrar, UMIST, P O. Box 88, Manchester M60 1QD, by quoting reference PH/119/AU. Closing date for applications 1 November, 1978

(8641)

RADIO COMMUNICATION ENGINEERS AND RADIO PAGING ENGINEERS NEEDED

£4,900 AND £4,400

(Remuneration inclusive of bonuses)

Applications are invited for the above positions Due to continuing expansion we need engineers at our London depot and also our new branch at Harrow Middx We are London's largest independent radio telephone company, and would be interested in hearing from you if you have knowledge of mobile V.H F equipment

Contact Mike Rawlings or Bill Clarke, on 01-328 5344

London Communications (Equipment) Ltd

30 Boundary Road London NW8 01 328 5344

(8547)

A secure and rewarding career in

Telecommunications and Instrumentation

Hertford/East Anglia based

Eastern Gas is a major Region of today's energy industry and we are currently operating and developing sophisticated Communications and Instrumentation Systems for operational and business purposes.

Continued expansion in these fields has now created a number of important vacancies for maintenance staff at our Central Workshops in Hertford and various Field Depots throughout East Anglia.

The duties, which are both varied and interesting, involve the maintenance of a wide range of Communications and Instrumentation equipment and candidates should ideally be qualified to ONC/C & G level and have some experience in one of the following:

Radio/Multiplex;
Telemetry or Digital/Logic Systems;
Electronic/Pneumatic Instrumentation.

Starting salary will be in the range £3540-£4332 plus the appropriate Weighting Allowance, and usual major benefits.

Application forms from N. H. Griffin, Personnel Officer, Eastern Gas, Star House, Mutton Lane, Potters Bar, Herts EN6 2PD. Telephone Potters Bar 51151 ext 426.

EASTERN GAS

(8584)

COMMUNICATIONS TECHNICIAN

£5,070-£5,945 p.a. 3-day week

Amongst the variety of services provided by the Port of London Authority is the maintenance of telecommunications equipment which helps to ensure the safe and efficient operation of the Port.

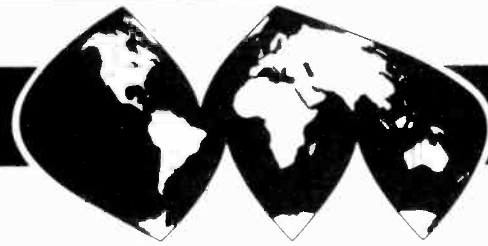
We are currently looking for a telecommunications specialist with radar and telemetry experience to become involved with the maintenance and installation of the sophisticated equipment on which this vital service depends. The equipment includes VHF and UHF, radio, radar, microwave telemetric links and UHF telemetry located between Tower Pier and the Royal Docks. Based at North Woolwich you will therefore become involved in a variety of interesting work in which you will be expected to act on your own initiative in a variety of locations. The three-day, 35 hour week is worked in 12 and 11-hour day shifts.

You should have ONC or equivalent Service qualifications but it is imperative that your background includes at least 5 years' experience of radar and radio maintenance. You must also possess a current driving licence.

The salary scale ranges from £5,070 p.a. to £5,945 p.a. and the commencing rate of pay will be the lowest point in the scale.

Please apply for an application form by ringing 01-476 7555 or by writing to the Personnel Manager, Port of London Authority, Basin South, North Woolwich, London E16 2QF.

PLA PORT OF LONDON AUTHORITY



Communicate with Racal

- Satellite Communications
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- Microprocessors

Electronic Design Engineers up to £7,000 p.a. Windsor

RACAL

With an impressive record of growth and profitability in the field of sophisticated communications systems and equipments, RACAL (SLOUGH) LIMITED now seek additional Engineering Staff at all levels.

These positions present outstanding opportunities for Engineers (male female) who, working near the state of the art, can make a real contribution to the design and development of advanced new equipment. Successful candidates will be involved from the initial feasibility study through all stages of development up to early production.

These appointments carry excellent salaries and first-class prospects. For the more senior posts a remuneration package of up to £7,000 per annum could be offered.

Please write, with details of age, experience and present salary, to:

Personnel Officer, RACAL (SLOUGH) LIMITED, Windsor, Berks. (Tel. Windsor 69811)

(8624)

ELECTRONICS ENGINEERS

Are you part of a team, or just a face in the crowd?

Eley, the country's leading sporting and target ammunition manufacturer, based in the West Midlands, need two people to fill newly-created posts.

Challenging work with a small team responsible for the smooth running of electronic systems which control our production plants.

The systems involve mainly digital/analogue electronics, some using microprocessors and mini-computers, which interface with hydraulics, electrical systems, pneumatics, optics and various transducers. You'll also assist in the commissioning of new plant and the production of maintenance manuals.

Qualifications – HNC or equivalent in electronics and control, with at least two years experience in the computer and technological field.

If a good salary, excellent chances of promotion and relocation expenses interests you then please write or telephone for an application form, to:

David Roberts, Personnel Manager, Eley, P.O. Box 216, Witton, Birmingham, B6 7BA. Tel: 021-356 4848 ext. 2277.

IMI

8625

ELEY

Chief of Test

for

DECCA COMMUNICATIONS LTD. situated in Sevenoaks, Kent

To work on their new range of High Frequency Radio Systems and to supervise a small but expanding Test Department.

Candidates should have at least 5 years' experience in the organisation, operation and supervision of a Test Department. Preference will be given to applicants with experience in H.F. Receivers and high power H.F. Transmitters.

A competitive salary will be offered along with the substantial fringe benefits associated with a major company.

Appropriate qualifications and experience should be sent, together with any service with H.M. Forces to:

Mr. C. Tyas, Personnel Assistant, Decca Limited, Decca House, 9 Albert Embankment, London SE1 7SW.

8585

DECCA *The Queen's Award for Export Achievement to Decca Ltd 1976.*

Electronics Development Engineer

How do you refine Europe's best in film processing?

You accomplish this through applying your creative engineering talents to increase our capacity for future business by improving the operation methods and equipment at our laboratories in Denham. Rank Film Laboratories is already recognised as the most advanced motion picture and television film processor in Europe with all throughput controlled by a central mini-computer but we naturally have long-term objectives for the future and will be relying on you to help meet them.

In a nutshell, your brief will be to explore the undoubted potential for further process-controlled systems, examining problems and coming up with effective solutions in terms of new equipment or systems. You will have every opportunity to conceive and implement innovative suggestions based on your knowledge of microprocessor technology and digital and analogue developments. Aged 25-45, you should also have an electronics degree and at least two years' industrial experience in the design/development of process control equipment.

For the right man or woman, it's an exciting position, which willcvenerate change within the company. Salary is around £6500 p.a. and benefits are as you would expect of a successful international company.

For further information, please telephone Colin Mossman, Technical Manager, on Denham 2323 or write for an application form to The Personnel Manager, Rank Film laboratories, North Orbital Road, Denham, Uxbridge, Middlesex.

RANK FILM LABORATORIES

(8633)

THE ROYAL FREE HOSPITAL-HAMPSTEAD

MEDICAL PHYSICS TECHNICAN II (ELECTRONICS)

An experienced engineer is required to assist with the day-to-day running of the Electronics workshop of this major teaching hospital.

Proven ability in the design of electronic circuits and systems using state-of-the-art techniques is essential. Previous experience in the medical field would be an advantage. Applicants should hold a Higher National Certificate in appropriate subjects or an equivalent, or higher, qualification.

Salary on scale: £4,824-£5,964, including all allowances.

Application form (to be returned by 3rd November, 1978) and Job Description available from the Personnel Department, Pond Street, Hampstead, London NW3 2QG. Tel. 01-794 0500. Please quote reference no. 0757.

Camden and Islington Area Health Authority (T) (8595)

SALES ENGINEER

—Knobs, Trims and Mechanical appearance items

We are looking for a specialised Sales Engineer with experience in appearance items and mechanical fittings for the Electronic and Electrical industries. A knowledge of the TV, Radio and Domestic Electrical industries is essential.

A substantial salary plus commission, vehicle, and other benefits including a non-contributory pension scheme, are offered to the successful applicant.

Please telephone: (01) 837 2701.
or write enclosing C.V. to

The Managing Director
PEDOKA LIMITED
28/29 White Lion Street
London, N1 9PD

(8613)

University of Surrey
Audio Visual Aids Unit

TELEVISION ENGINEERS

There are opportunities for two engineers to join a small but well equipped television service active in providing facilities for teaching and research throughout the University. A studio using plumbicon cameras, IVC recorders with time-code editing, and colour telecine is supplemented by a transportable two-camera unit, Sony Rovers, and VCRs for local replay. Ancillary services of graphics and film production are provided within the Unit.

The SENIOR ENGINEER (T6 £3654-£4365) will be responsible to the Chief Engineer for setting up maintaining and repairing cameras, editing VTRs, sound equipment and lighting, and operating during productions. He/she should be capable of liaising directly with academic staff and arranging facilities required for teaching and research. HNC or equivalent qualification is required.

The ENGINEER (T4 £2955-£3402) should have good experience in electronic servicing, preferably of television equipment, and be pursuing an appropriate technical qualification for which day release may be granted. The Engineer will be able to gain a wide range of experience in television operations, sound recording, and maintenance of equipment.

Applications for both posts are invited immediately on forms to be obtained from the

Assistant Secretary (Personnel)
Senate House
University of Surrey
Guildford 71281 x 452 (8601)

SENIOR SYSTEMS TEST ENGINEER

A leading company in the photo typesetting industry requires Test Engineers who feel capable of testing and installing brand new range of minicomputer based V.D.U. terminal equipment, incorporating the latest in MS1 and LS1 techniques in real-time applications.

The right candidates will be qualified to at least H.N.C. level and/or have considerable experience in digital electronics with knowledge of 74 Series T.T.L. A background of the word processing or printing industry would be advantageous. One of the positions would involve some U.K. and European travel to handle system installations and back-up service for our overseas agents.

The company provides 4 weeks' holiday and pension scheme. Salary circa £5000.

Phone for application form to

MISS BUX, DATEK SYSTEMS LTD.
849 HARROW ROAD, WEMBLEY, MIDDX.
01-904 0061

(8643)

COVENTRY AREA HEALTH AUTHORITY
Clinical Physics and Bio-Engineering Department
Walsgrave Hospital

ARE YOU INTERESTED IN A CAREER IN MEDICAL ELECTRONICS?

With the growth of technology in medicine, Electronic/Medical Physics Technicians are required by the above department to join a team involved in the maintenance and development of a wide range of physiological measurement equipment, nucleonic equipment and laboratory equipment. A knowledge of diagnostic maintenance of instrumentation and/or mini computers would be desirable.

Candidates for the post should hold an O.N.C., H.N.C., or equivalent qualification. Salary scale — Medical Physics Technician, Grade III within the range £3744 to £4788 per annum.

Further details can be obtained from Chief Physicist, Walsgrave Hospital, Telephone Coventry 613232, extension 482. Application forms (quoting ref. WW) obtained from the Sector Administrator, Walsgrave Hospital, Clifford Bridge Road, Walsgrave, Coventry CV2 2DX.

(8640)

UNIVERSITY COLLEGE OF NORTH WALES, BANGOR

ELECTRONICS TECHNICIAN

GRADE 5 £3,186-£3,720 p.a.

Applications are invited for the re-advertised post of Electronics Technician Grade 5 in the Electronics Workshop of the School of Physical and Molecular Sciences.

The successful applicant will be working with a team of technicians concerned with the maintenance and construction of electronic equipment for a wide range of research work and teaching in the School.

Applicants should have had several years' practical experience in electronics and theoretical knowledge to O.N.C. standard or equivalent.

Previous applicants need not apply again.

Applicants (two copies), giving details of age, education and experience, together with the names and addresses of two referees, should be submitted to the Assistant Registrar (Personnel), University College of North Wales, Bangor, Gwynedd, LL57 2DG, to reach him not later than 30th October, 1978. (8599)

ITN

SENIOR ENGINEER

Independent Television News Ltd. has a vacancy for a Senior Engineer to work in their Radio Links section. The work involves the installation and maintenance of temporary microwave links and R.T. systems for Outside Broadcasts.

Candidates should be qualified to H.N.C. or above and have experience of SHF, UHF and VHF radio systems. Television experience would be an added advantage.

Salary: £5,920 per annum.

Please telephone the Personnel Office on 01-637 3144 for an application form, quoting reference 3514. (8623)

SENIOR ENGINEERING POSITION

Well-established Canadian manufacturer of communications equipment requires experienced engineer to direct engineering department and carry out diversification programme.

Successful candidate will have several years' of experience in communications or instrumentation. Experience in several fields will be considered an asset as will experience in fibre optics.

Send résumé to Mr. J. E. Thomas, Lindsay Speciality Products Ltd., 50 Mary Street West, Lindsay, Ontario, Canada K9V 4S7. (8642)

Audio & Design (Recording) Ltd.
have a vacancy for a

UK SALES ENGINEER

based in Reading, Berkshire

The person we are after should preferably be single, educated to 'A' level Physics/Maths and/or OND Technology standard and possess a current driving licence.

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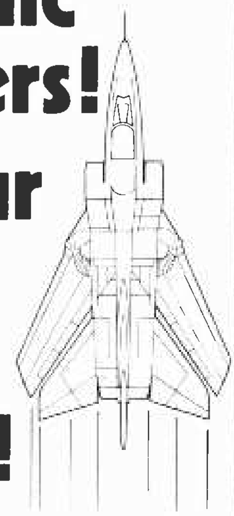

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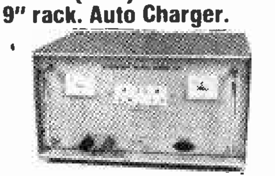

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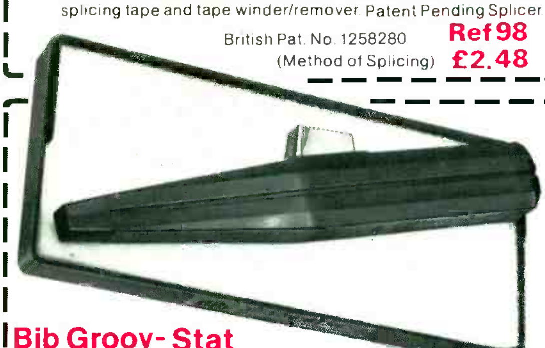

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