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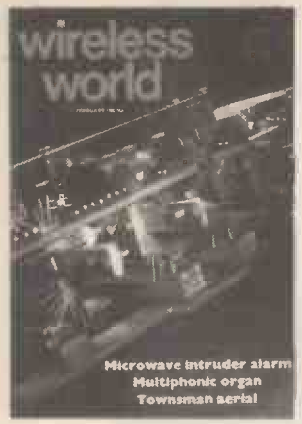

Front cover shows thyristor stack with heat sinks, made by Pinnacle Electronics Ltd. Photographer Paul Brierley.

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FEBRUARY 1980 Vol 86 No 1530

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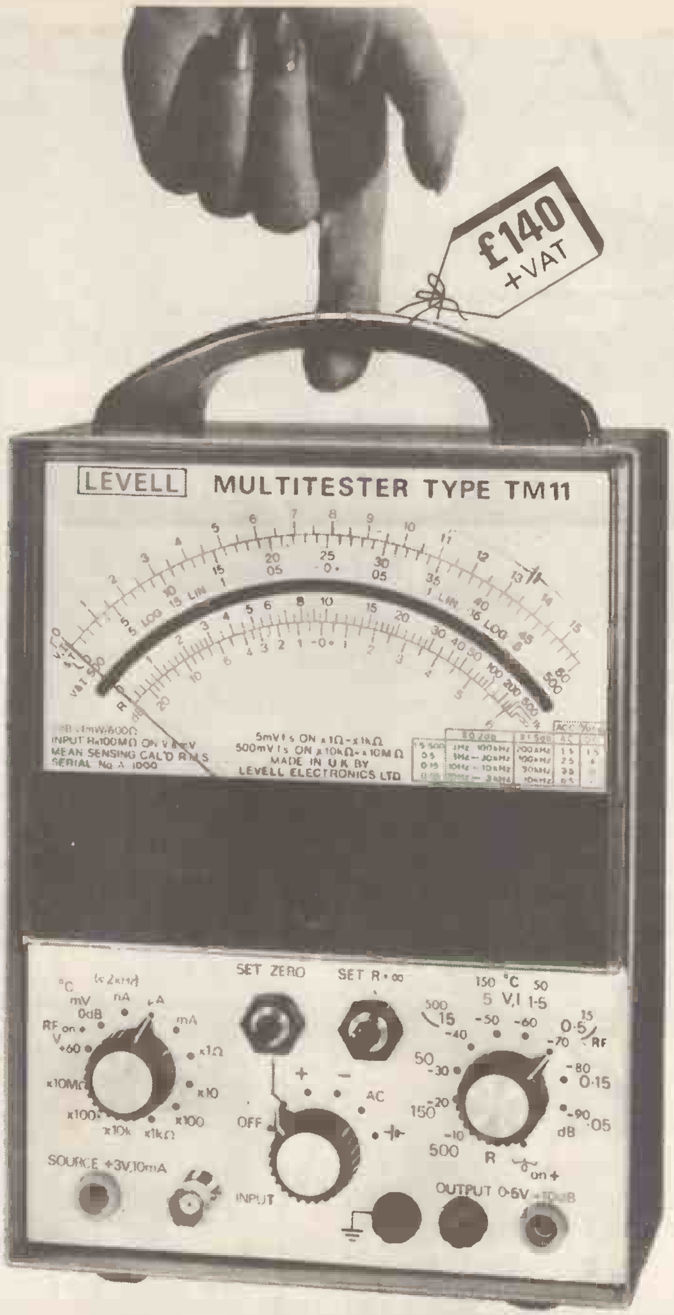

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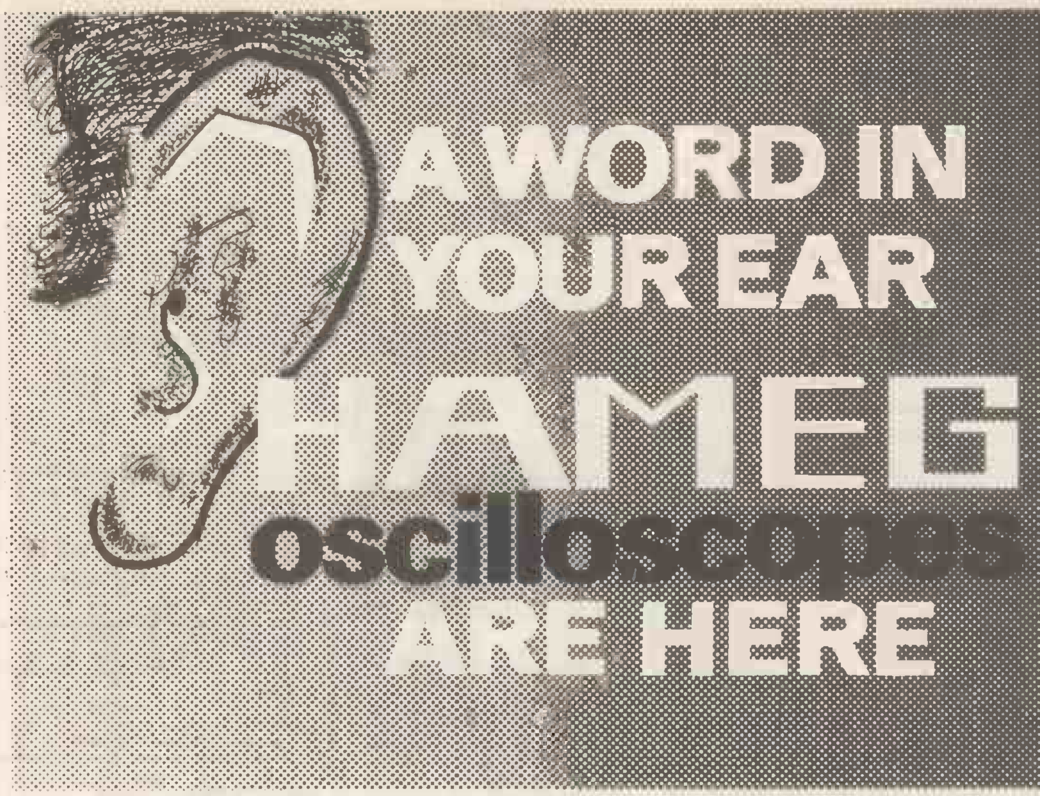

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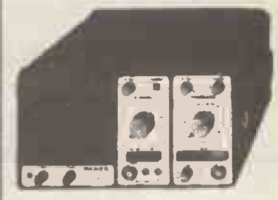

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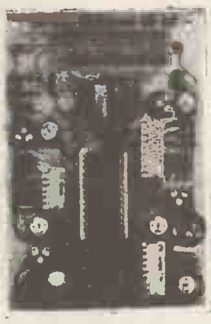
SE 01 Sound Effects Kit



The SE-01 is a complete kit that contains all the parts to build a programmable sound effects generator. Designed around the new **Texas Instruments SN76477** Sound Chip, the board provides banks of MINI DIP switches and pots to program the various combinations of the SLF Oscillator, VCO, Noise, One Shot, and Envelope Controls. A Quad Op Amp IC is used to implement an Adjustable Pulse Generator, Level Comparator and Multiplex Oscillator for even more versatility. The 3¼" x 3" PC Board features a prototype area to allow for user added circuitry. Easily programmed to duplicate **Explosion, Phaser Guns, Steam Trains,** or almost an infinite number of **other sounds**. The unit has a multiple of applications. The low price includes all parts, assembly manual, programming charts, and detailed 76477 chip specifications. It runs on a 9V battery (not included). On board 100MW amp will drive a small speaker directly, or the unit can be connected to your stereo with incredible results! (Speaker not included.)

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BRIEF SPECIFICATIONS

Model	Range 10Hz to	LED Digits	Sensitivity 50 Ohm Input 25-250 MHz	250-450 MHz	450 MHz - 1GHz	Hi-Z Input 10Hz - 60 MHz	Gate Times	Resolution 12 MHz	60 MHz	Max Freq.	TCXO Time Base 20° - 40°C	Freq.	Ext Clock Input
7010	600 MHz	9	5-20 mV	10-30 mV	20-40 mV to 600 MHz	1-10 mV	(3).1,1,10 Sec	0.1 Hz	1 Hz	10 Hz 600 MHz	1 ppm	10 MHz	Yes Option £15
8010	1 GHz	9	1-10 mV	5-20 mV	10-35 mV	1-10 mV	(8).01-20 Sec	0.1	1 Hz	10 Hz 1 GHz	1 ppm	10 MHz	Yes Std.

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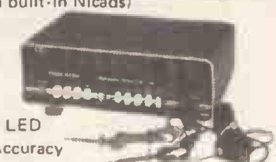

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200V	.04
1000V	.04

AC VOLTAGE: Range	Accuracy 45Hz-10 kHz	10 kHz-40 kHz	40 kHz-250 kHz
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20V	.35%	1%	3DB
200V	.35%	1%	3DB
1000V	.35%	2%	3DB

RESISTANCE Range	Accuracy High Ohms	Low Ohms
2K ohm	± .05%	± .10%
20K ohm	± .05%	± .10%
200K ohm	± .05%	± .10%
2 megohm	± .1%	± .15%
20 megohm	± .3%	± .3%

DC AND TRMS AC CURRENT Range	DC	Accuracy 45Hz-10 kHz	10 kHz-40 kHz
2 mA	.6%	1%	1.5%
20 mA	6%	1%	1.5%
200mA	6%	1%	1.5%
2000mA	6%	1%	1.5%
10 Amp	6%	1%	1.5%

TEMPERATURE	Celsius	Fahrenheit
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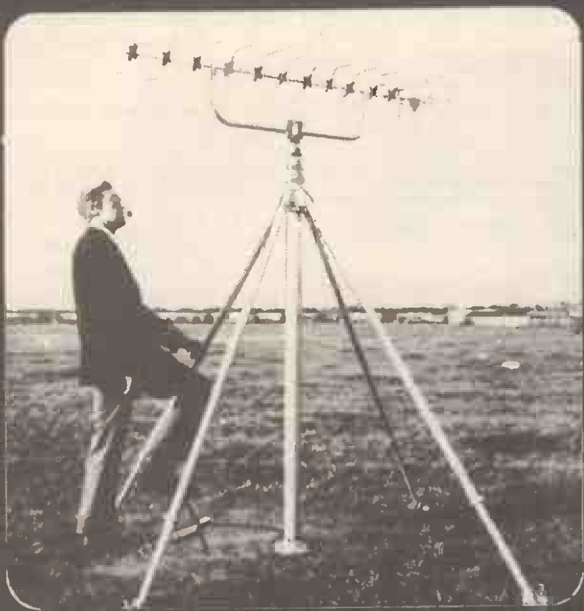

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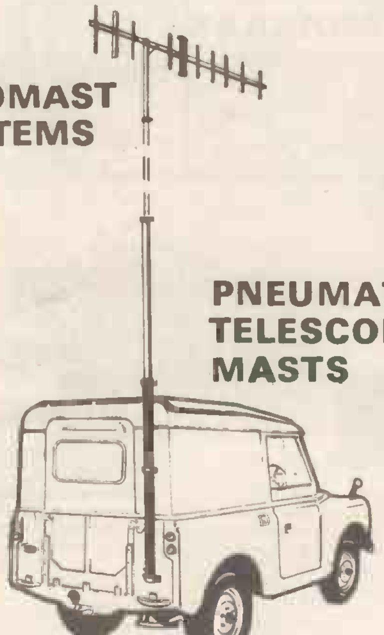

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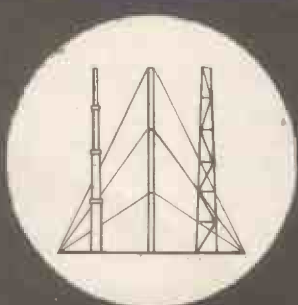

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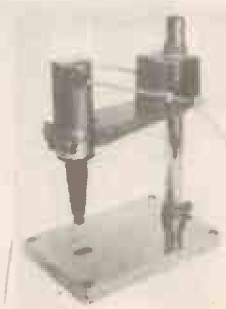

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£17.96
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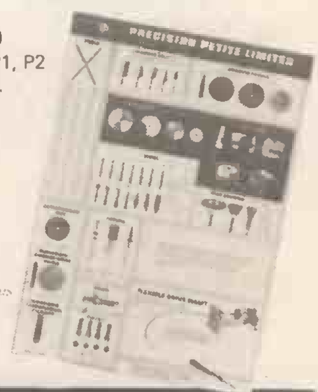

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Risetime:	11.7 nS
Overshoot:	less than 3%
Sweep time:	100 nS/cm - 0.5S/cm
Linearity:	better than 3%
Calibrator:	1 KHz 100 mV square wave
Trigger bandwidth:	DC - 40 MHz
Trace rotation:	Electrical
Phosphor:	P31
Power:	AC 100/120// 220/240V 50/60 Hz 40W
Dimensions:	260mm x 190mm x 375mm
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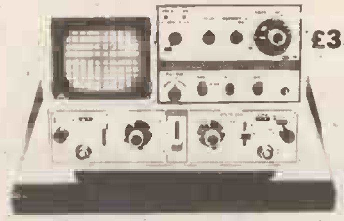
CS1352 DUAL TRACE 15 MHz/2mV PORTABLE



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The CS1352 oscilloscope offers you not only dual trace, 15MHz bandwidth operation at sensitivities down to 2mV/cm but also use from 100-240 Vac mains and portable operation using the optional rechargeable battery pack. Automatic charging is carried out when the CS1352 is plugged into a mains supply. Now you can have top performance both on the bench and out in the field — and at an affordable price.

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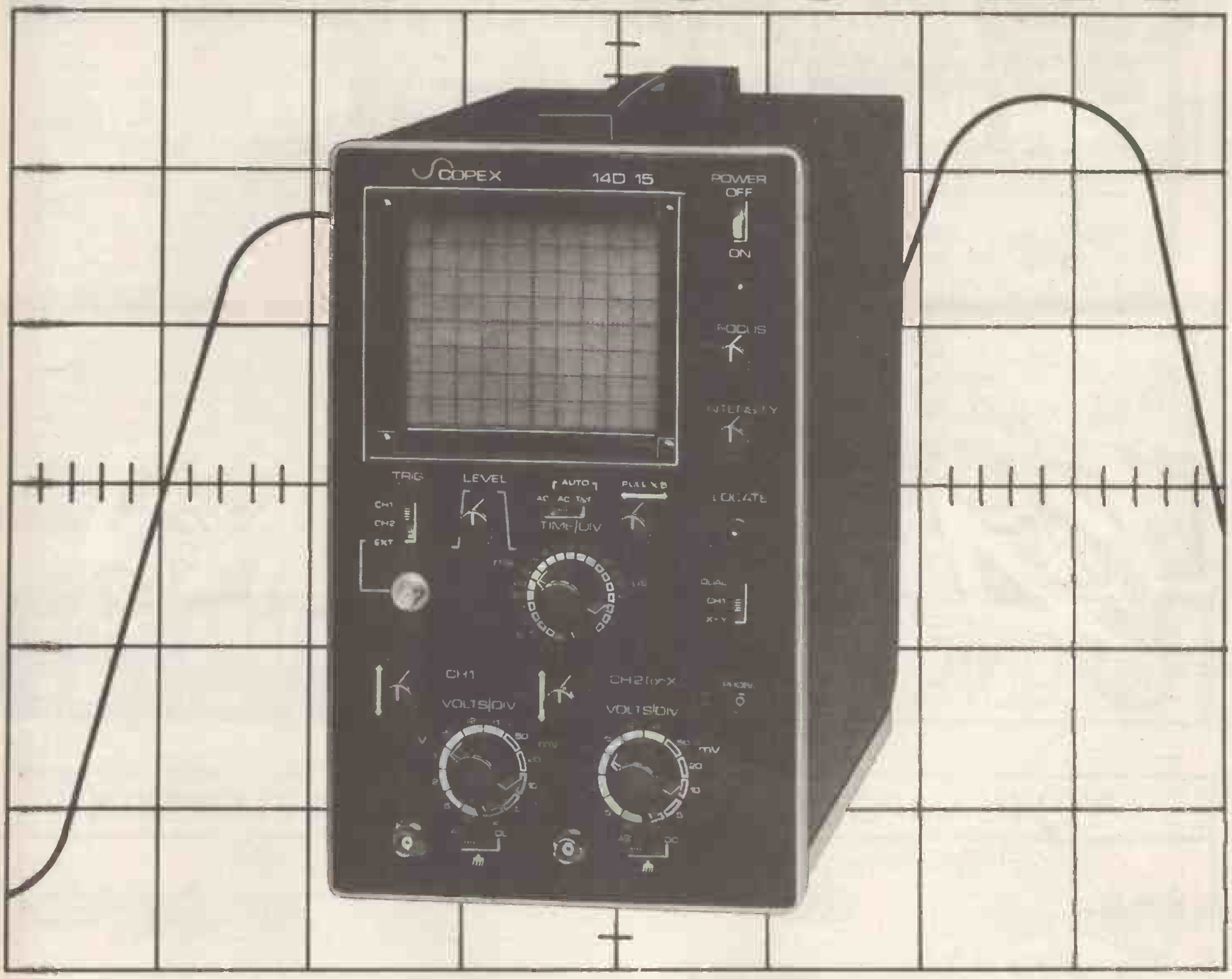

The 14D-15 is the very latest addition to the Scopex range of brilliantly engineered, easy to use oscilloscopes.

Here's what it offers:-

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V800 MOS-FET
High Performance Professional
Power Amplifier
thermal
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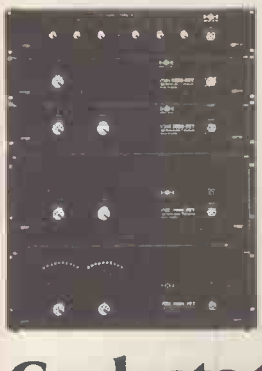
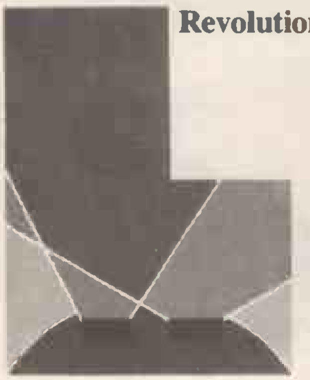


fact: the Pro Master™ sound system is not an evolution... it's a full-blown REVOLUTION!

The PRO MASTER modular sound system ushers in a new generation of sound system versatility, reliability, and quality for today's entertainers, musicians, and speakers—for use in settings as diverse as intimate clubs, lounges, large auditoriums, churches, and schools. Its multitude of performance-proven features is the result of sophisticated computer design techniques, advanced materials, and countless hours of personal consultation with performers and sound technicians.

Revolutionary New Console

Finally! The best of *both* worlds. A console so easy to use that it won't overwhelm the beginning group, yet with the advanced features and capabilities required by experienced professional performers—such as pre-fader monitor mixing, effects and/or built-in reverb, with their own tone controls, LED clipping indicators with attenuators on each input, and full patching facilities for every system component. Super power: *twin 200-watt solid-state power amplifiers!* Doubles as a stereo recording console for groups that want to "lay down a few tracks" without paying for studio time, or can be used as an ultra-sophisticated keyboard mixer with power. Unitized ARMO-DUR™ structural foam combination case and chassis makes it more durable than steel. Ultra-light: only 47 pounds.



Revolutionary: Variable Dispersion Sound System

Advanced new variable dispersion high-frequency horn system projects your sound—everywhere in the house, giving you a choice of 60° long-throw, or 120° wide-angle dispersion with the twist of a knob. Tailors the sound to the room—even L-shaped rooms.

Revolutionary New Loudspeaker

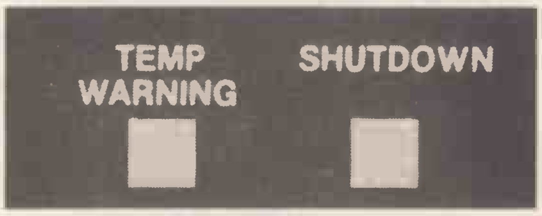
Every extra ounce—every unnecessary cubic inch—has been computer designed OUT of the PRO MASTER loudspeaker. Modern materials and moulding techniques accommodate a high-performance 15-inch woofer and a high-frequency horn and compression driver in a startlingly small, efficient enclosure. Less than 28 inches high, 23 inches wide, 16 inches deep. Weighs an easy-to-handle 58 pounds. Yet, the power handling capacity is a remarkable 150 watts, and the frequency response is 50 to 15 kHz.

Replaces All this Equipment... And Does More!

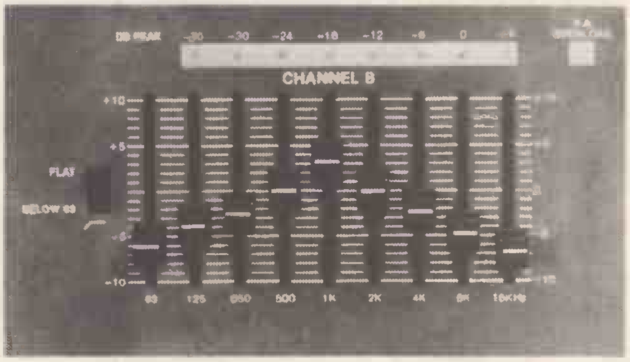
The impressive array at left includes a mixing console, two graphic equalizers, a pair of 200-watt power amps, a monitor mixer and an octave analyzer. The PRO MASTER gives you all these capabilities—plus features that you can't find in any other console, at any price: Unique FEEDBACK FINDER™ circuit, exclusive PATCH BLOCK™ patch panel, wide-range LED peak output and input clipping indicators. Plus pre-fader monitor send controls, LED power amp overload, temperature warning and shutdown indicators, 0 to 30 dB input attenuators, full stereo features, simultaneous effects and reverb on each channel. What's more, you have Hi-Z *and* Lo-Z balanced transformer-coupled mic inputs on all six mic channels, (can handle 12 mics simultaneously), plus two additional auxiliary input channels for adding synthesizers, tape players, tuners, sub mixers or any other high level output components. And each Lo-Z input features built-in simplex powering for condenser microphones.

Revolutionary: LED Status Indicators

Alerts you to developing trouble *before* it gets serious! You have time to correct the problem before it interrupts the performance. Temperature warning LED warns you if amplifier is overheating. Shutdown LED indicates power amplifier and speaker protection system activation. Only the power amplifiers are shut down until the internal cooling fan lowers the temperature.



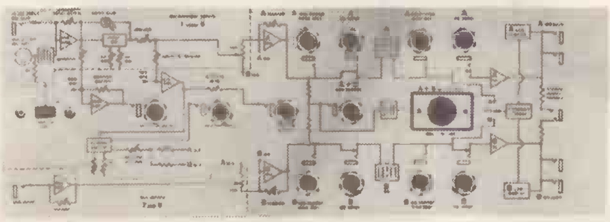
LED peak indicators virtually make VU meters obsolete. They respond to short transients that wouldn't budge a needle, and cover 42 dB without range switching. PA overload LEDs light at full power and also warn you of distortion-causing problems such as bad speaker cables or too many speakers.



Revolutionary: FEEDBACK FINDER™/ Equalizer

Controls feedback—the number one enemy of a successful performance. FEEDBACK FINDER visually indicates the troublesome frequencies for precise adjustment of the twin 10-band equalizers. Enables you to equalize for maximum gain on the house and/or monitor system. Nothing else like it!

Revolutionary: PATCH BLOCK™ Patch Panel



The back panel is a unique combination block diagram and patch panel with 12 patching jacks located at appropriate points on the block diagram. For the beginner who is taking his act on the road for the first time, the PRO MASTER works "as is," with no special connections. But with the PATCH BLOCK, the professional can create a wide variety of setups and add auxiliary equipment without makeshift connections. And you can change setups at a moment's notice without confusion. Simplicity and versatility, the PRO MASTER has them both!

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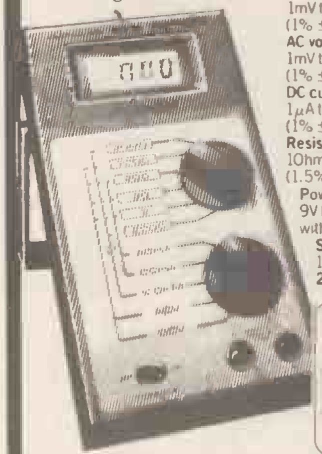
Top value test equipment from TANDY

LCD DIGITAL MULTIMETER.

Low-cost hand held digital multimeter with a full 3½ digit LCD display. 0.5% basic accuracy, auto polarity operation. 10 Mohm DC input impedance.
Reading to ± 1999.



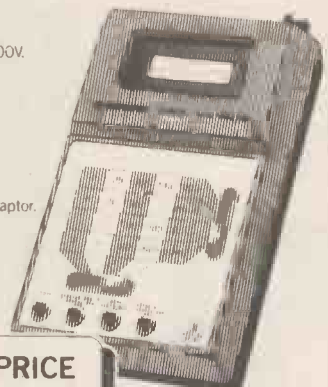
Scales:
DC volts: 1mV to 1000V (1% ± 1 digit accuracte).
AC volts: 1mV to 500V (1% ± 2 digits accurate).
DC current: 1μA to 200mA (1% ± 1 digit accurate).
Resistance: 1Ohm to 20 MOhms (1.5% ± 1 digit accurate).
Power source: 9V battery or AC with optional adaptor.
Size: 155 x 75 x 30 mm.
22–198

PRICE 53·19

LOW—COST LCD MULTIMETER

A portable, compact sized multimeter with a full 3½ digit LCD display. Auto polarity operation, low battery indicator. 10 MOhm Input impedance.

Scales:
DC volts: 2 20 200 1000V.
AC volts: 200 500V.
DC current: 2 20 200MA.
Resistance: 2 20 200 2000 KOHM.
Power source: 9V battery or AC adaptor.
Size: 37 x 85 x 130 mm.
22–197



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COMPONENTS AND PARTS

CAT No	DESCRIPTION	PRICE
276–032	LED	4 for 69p
276–033	LED	2 for 48p
276–034	LED	2 for 59p
276–142	Infra-Red Emitter Detector Pair	£1.37
277–1003	12V DC Automotive Digital Clock Module	£17.52
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276–1373	Power Transistor Mounting Hardware	50p
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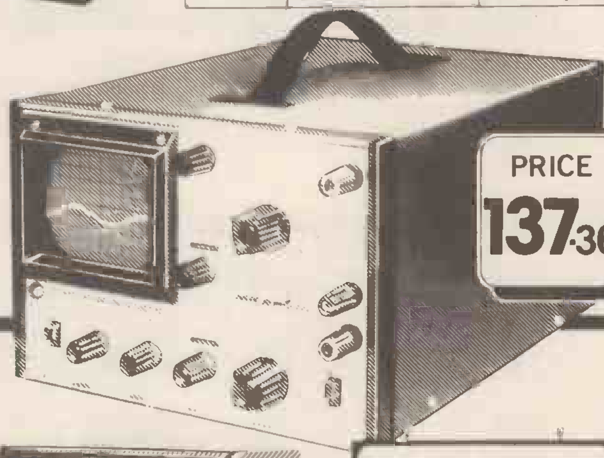
276–1364	TO 3 Heat Sink	81p

AC/DC 8 MHz OSCILLOSCOPE

A new approved 8MHz version of last years' winner! The advance design features of this oscilloscope make it an absolute essential for industrial uses on production lines, in laboratories and schools. Ideal for radio and TV servicing, audio testing, etc.

Specifications:
Horizontal axis: Deflection sensitivity better than 250mV DIV. **Vertical axis:** Deflection sensitivity better than 10mV DIV (1DIV 6mm). Bandwidth: 0.8MHz. **Input impedance:** 1MOhm parallel capacitance 35pF. **Time base: Sweep range:** 10Hz 100kHz (4 ranges). Synhronization: Internal ( ) **Size:** 200 x 155 x 300 mm. **Supply:** 220 240 50Hz. 22–9501.



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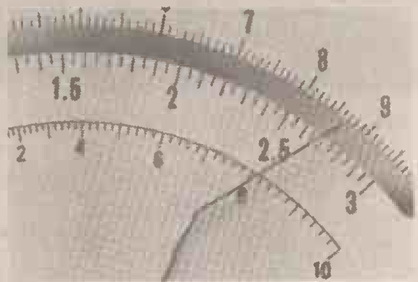

Our new 169 is a tough, lightweight, battery-powered digital multimeter for use in the field or on the bench. It is a 3½-digit, full 5-function DMM with respectable .25% DC accuracy.

Its low-parts-count, high-efficiency design keeps power consumption to a minimum for longer component life and fewer failures. MTBF is 20,000 hrs. or about 10 years.

All 5 functions are fully protected – 1400V peak on DCV and ACV, 300V on Ω, 2A (250V) on DCA and ACA. The fuse is externally accessible for quick replacement. Extensive vibration stress-testing assures the 169 will stand up to all the mechanical shock and abuse normally associated with tough applications.

Is this the end for Analogue meters?

Cost-conscious ease of maintenance is so thoroughly designed into the 169 that only one calibration adjustment a year is required. That adds up to a cost-of-ownership no other competitive DMM can touch. For example, the 169 needs only one battery change per year at a cost of about £1.50.

When you factor in features like function and range annunciation right on the display, auto-zero, auto polarity, 60% larger display than other DMMs and the easy-to-read, colour coded front panel, we think you'll get the point. No analogue meter or DMM can match the price/performance of the new 169. It costs £99 (plus VAT)

For information on the 169 or any Keithley DMM call (0734) 861287
Telex: 847047

Ex stock

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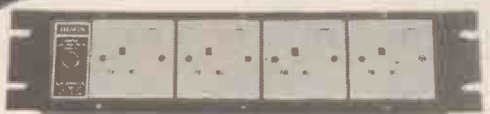

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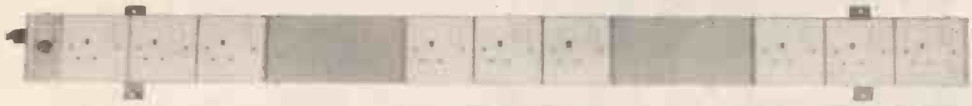

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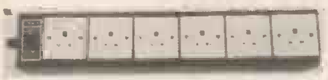

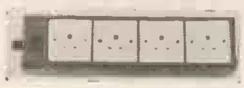

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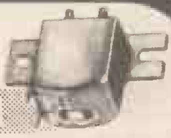

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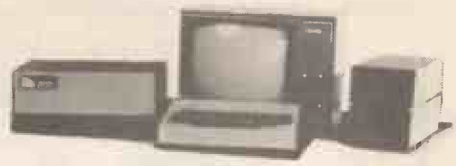

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* RCA 1802 8-bit microprocessor with 256 byte RAM expandable to 64K bytes
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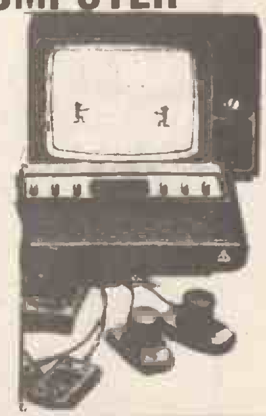

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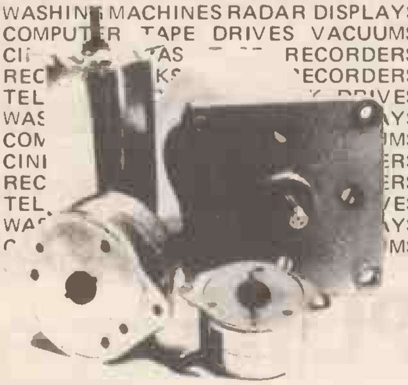

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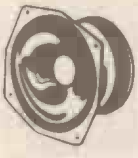

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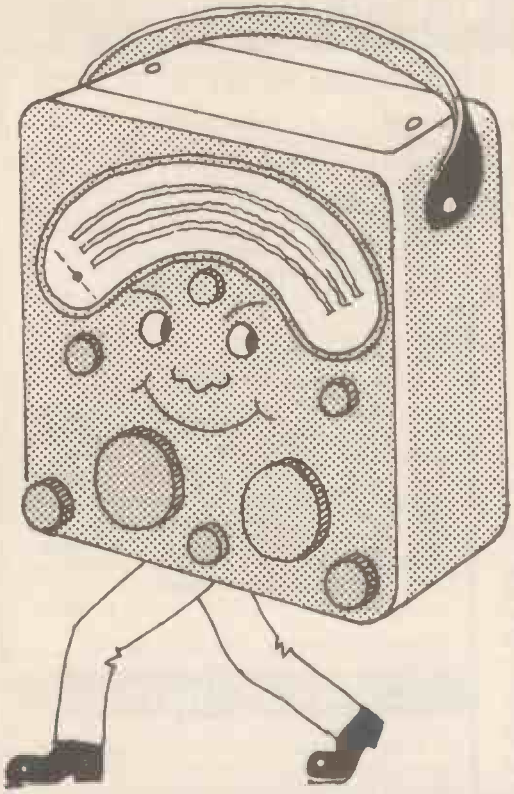

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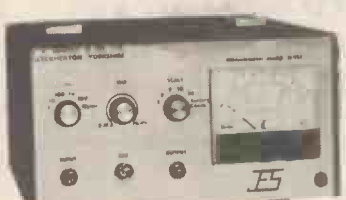

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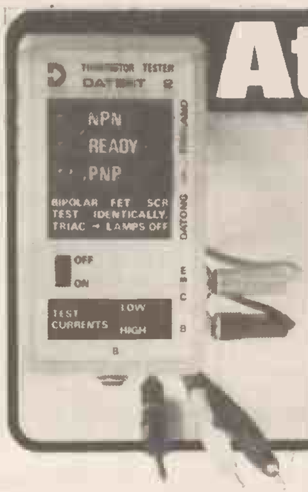

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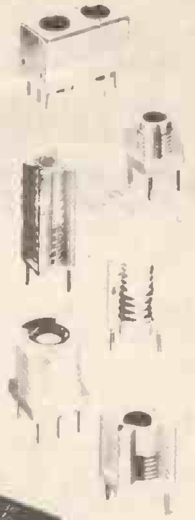

It seems a long time since TOKO first revolutionized the coil manufacturing business with their unique ranges of miniature RF and IF coils. Many imitators have come - and gone - in the meantime, but none have managed to equal TOKO's consistent quality, and skill in innovative coil design.
However, perhaps TOKO's supremacy in designing and supplying these types of wound component has tended to overshadow the other product areas of TOKO's manufacturing capability.
So the rest of this advertisement is devoted to semiconductors, ceramic and mechanical filters, and their new low cost ceramic resonator to replace the costly quartz crystal in many MPU and ultrasonic systems. And don't forget - not only do we offer you some exciting and innovative products in print - the supply is carefully maintained at all times through the only stockist/distributor of signal frequency processing coils in the UK.

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Wide capacity range tuning diodes: KV1210 and KV1220 series

A unique range of matched dual and triple diodes, possessing tuning capacity ranges in excess of 15:1 (1 - 9 v, or 1-25v series.) The diodes are supplied in either a single package, or in a snap-apart package, where each anode and cathode is separately available, and circuit layout flexibility is unrestricted.
The two basic series are for either 9v or 25v maximum bias, with a maximum matching deviation of only 2% over the entire bias range.

SIL package   Snap-apart package(s)

Electrical characteristics . Each diode - 9v series (25 volt series)

Item	Symbol	min	typ	max	units	conditions
Reverse voltage	V_{BR}	20 (30)			V dc	I_R = 10uA
Leakage	I_R			100	nA	V_R 15v (25v)
Capacitance	C_{1v}	440 (510)	500	560 (620)	pF / pF	V_R = 1v, f = 1MHz
Capacity ratio	$C_{1v\text{-}9v}$ / $C_{1v\text{-}25v}$	15 (20)	17 (22)			f= 1MHz
Q (both series)		200				V_R 1v, f= 1MHz
Temp. Coeff.	TC_Q		500 (130)		ppm/°C	V_R 5v, f= 1MHz; V_R 13v, f= 1MHz

Ordering information:

Stucture	9v	25v
3 SIL	1210	1220
2 SIL	1211	1221
3 s/a	1215	1225
2 s/a	1216	1226

SIL : Single In line
s/a : Snap apart
Prefix all types "KV"

The TOKO range of ICs is based largely on custom applications in radio/audio, calculator, printer and allied applications. Custom designs in all major technologies are available, and the standard list includes :
AM/FM complete radio and IF amplifier devices KB4402 (CA3089E), KB4420 (HA1137), KB4400 (MC1310), KB4419(AM/FM portable radio IC), KB4420 (HiFi AM tuner IC), KB4436 (FM noise blanker IC), KB4423 (Noise blanker IC), KB4437 (Pilot cancel stereo decoder IC), KB4438 (Muting HiFi audio preamp - two channel)
Clock LSI : The MK50366/50372 direct drive multifunction clock/timer ICs for LED or Fluorescent displays.
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TOKO's new CFSH series of FM IF filters have been designed for excellent thermal and long term stability in applications such as communications and car radio. Three basic bandwidths are available to suit various standards. Spurious responses in the 8-12MHz region are typically below 50dB down.
1off : 60p   100 off: 36p each

CFM2-455

TOKO's CFM2 series of AM mechanical filters are available in the range 200-600kHz. The mechanical design ensures low spurious response, and excellent stability when compared to cheap ceramic filter alternatives. With the appropriate input/output matching transformers, a shape factor of better than 3:1 is possible. Stock types are centered on 455kHz versions.
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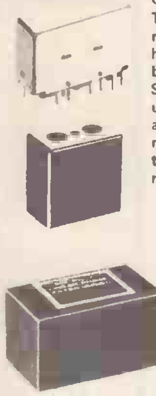

Coil block filters:
TOKO expertise in coil design is refected in the wide range of very high specification, low cost filter blocks for radio and audio.
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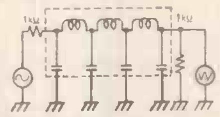

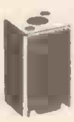

Examples from stock types:
19/38kHz mono filter 1 off £1.00
100 off £0.65
6 pole FM linear phase filter
1 off £2.45
100 off £1.36

CHOKES

TOKO's range of fixed inductors is based on three main styles (as illustrated). Between them, a range covering 1uH to 120mH in E24 series is available, with other values available to special order. (Subject to min order quantity.)
The rigid pins are suitable for all types of automatic insertion, and are spaced on 5mm centres.
Prices are unbeatable compared to other types of choke:

Type	1-49	50-99	100-499
7BA	16p	9.5p	7.2p
8RB	19p	16p	12p
10RB	33p	27p	21p

7BA covers 1uH to 1mH
8RB covers 100uH to 36mH
10RB covers 1mH to 120mH
(Tuneable signal chokes are also available in this range)

DIGITAL FREQUENCY TUNING SYSTEMS

In keeping with TOKO's policy of being prepared for all the latest advances in radio technology - Ambit have been carrying out extensive work on evaluating the new digital frequency synthesiser systems from the major manufacturers. Harware for evaluation is available now.
Mullard's uniquely versatile LN123/4 system for professional communications of all types, the low cost 'RTS' serial data controlled system for up to around 200MHz in consumer and amateur radio applications.
National Semiconductor's DS8906 AM/FM synthesiser using a single IC for prescaler/serial programmable counter/phase detector.
Hitachi's dedicated AM/FM/SW car radio MPU controlled system.
OKI electric's solution with on board RAM station recall.
Fairchild's versatile FEX2500 system for radio/TV.
Plessey's various offerings for professional, commercial and industrial applications.
Plus any others that are made available to us for general release in the meantime.

And as well as the synthesiser hardware, there are various radio systems to use as building blocks. And as you might have come to expect from Ambit, the radios are just as technology concious as the rest of the system. Not simply an afterthought in the shape of MPU specialists idea of a wireless to hang on the end of 'his baby'.
The synthesiser driven units include both bandswitched versions of fully DC operated LW/MW/FM receivers, FM only, AM only - and a new continuously tuned 5kHz to 30MHz system with switched bandwidth IFs and most of the features you would expect to find on systems costing ten or twenty times more.
Plus, of course, VHF tuners ranging from 30MHz to 220MHz in our standard PIN agc 4 and 6 circuit variants.
In other words, a total package approach to radio in the eighties - from one source.
As well as the synthesiser systems, Digital Frequency Readouts are already available with either Fluorescent, LED or LCD.
All the standard IF offsets for AM/FM, plus the new DFM4 with the addition of 10.7MHz and 2MHz offsets in the SW range. 100Hz AM resolution, 4mA consumption at 5v, 10kHz VHF resolution.
In other words, something that covers nearly all applications and requirements up to 200MHz (or 399.99MHz with the appropriate prescaler).
Next time you are thinking about any form of radio system, either consumer, communications or any associated aspect - remember that TOKO coils are available ex-stock from Ambit, or to custom specifications. A full range of chokes from one microhenry to 120 millihenries, with tuneable versions with as much as 40% tuning range.
To complement this range, Ambit also offer various crystal and ceramic filters to communications standards, a wide range of semiconductors, including JFET, MOSFET signal amplifiers. (40673/3SK51 - 100+ 33p). 100W power MOS devices, varicaps of all sorts, plus most other semiconductor requirements for your system. (Plessey 1600 series now in stock.)

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The B150 Mk. 3 – for use in production, quality control, development labs – even at goods inwards. Tough metal cabinet, and the AVO guarantee of reliability, serviceability and accuracy, all at a price that's a pleasant surprise. From good distributors everywhere.

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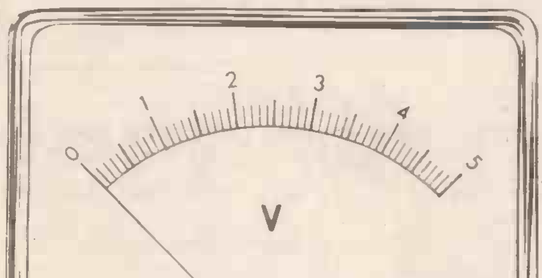

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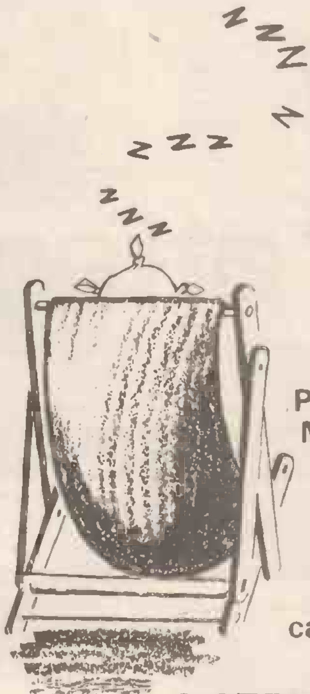

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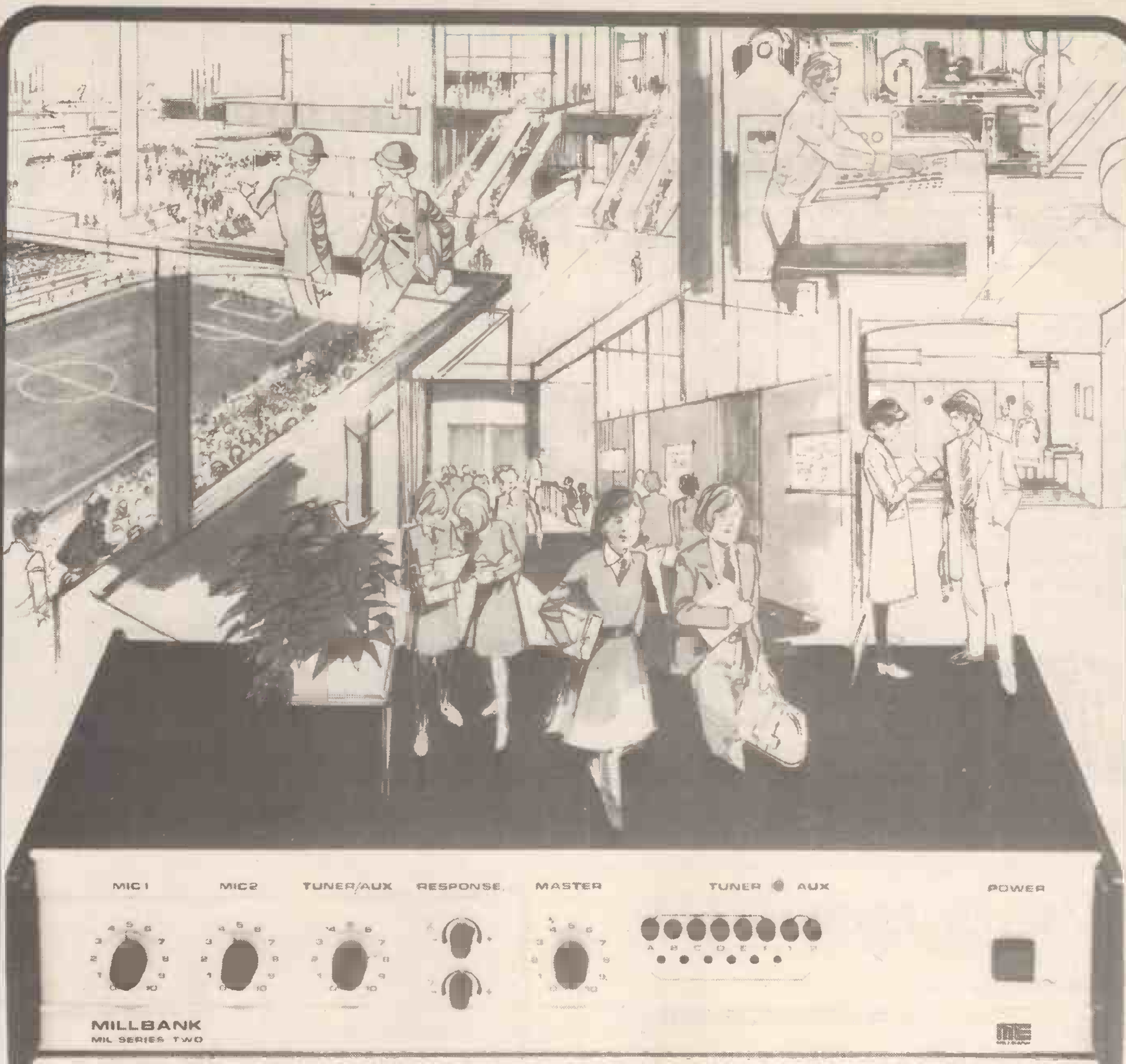
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Status symbols

There has lately been a great deal of talk, reaching a focus in *The Times* correspondence columns, on the titles that workers in our industry should grace themselves with. Considerable thought has clearly been expended on the suggestions correspondents have made; the intention is evidently to differentiate between 'engineers', who sit at desks, lost in thought, and 'craftsmen/technicians' who dwell in workshops, doing the bidding of engineers. Blame is heaped on the daily press for referring to ignoble creatures who man picket lines as engineers, as in "Engineers demand 30%", when the feeling is that they should be called 'engineering workers' or in some way dissociated from those who use their mental, instead of their manual skills. The man who repairs television sets for a living ought, it is said, to be called a technician, not an engineer.

Notions of social status, abstract except insofar as salaries are concerned, are at the root of the debate. A tenet of the status-seeker is that the more imposing his work-title, the higher the esteem in which he is held by the community: refuse-disposal operatives find it more acceptable to consult a turf accountant than to lay a bet with a bookie. The improbability of such a ploy ought, by now, to be apparent to any observer of mores.

If engineers (for lack of a better word) in electronics are not accorded by society the intangible quality of status they seek, it is more likely to be due to the value society attaches to their work than to the names they are given.

The results of the work are seen to be in entertainment, which is taken for granted, and in industrial and military systems, which are not understood: put another way, the benefits are thought to be either trivial or necessary, but remote. An engineer's store of experience and knowledge is irrelevant because, unlike a doctor or accountant, he does not, visibly at least, affect their lives in any serious way.

Distinction between technician and engineer always used to be indicated by the label 'design engineer' for the originator, and if the others wanted to call themselves engineers, no-one worried: the differential was preserved.

Low standing of engineers is not of great concern to the community. Where it is of consequence is inside a company or organization, where management is too often the preserve of accountants or sales people, or even individuals who have no training in either engineering or administration. Engineers' salaries do not compare well with those of managers who are often their educational inferiors, simply because engineers are not allowed into positions in which they can influence the direction of a company. If the control of engineers continues to be left to those who are untrained in engineering, then the dismal performance of this country in manufacturing will not improve. This is the vital reason for demanding a greater status, not a self-congratulatory assumption of grand titles.

If the recommendations contained in the Finniston Report are adopted, the engineering profession will not be short of status, and it will be hard-won. The prospect of losing one's registration through complacency should lead to a level of competence not seen in any other profession.

Microwave intruder detector — 1

Design with good interference rejection and noise monitoring

by **K. Holford,** C.Eng., Philips Research Laboratories

This design provides a simple but effective circuit which uses a cycle counting scheme to prevent the alarm being triggered by short movements or pulses. The circuit has excellent interference rejecting properties. A noise monitoring circuit is described in part 2 so that the alarm can be set up easily and reliably in terms of a low false-alarm probability.

A simple novel design of stabilizer allows the nominal 12V supply to have one volt or more of ripple before the basic noise level is disturbed.

This design is suitable for the Mullard CL8960 microwave module, a complete microwave front-end containing both the microwave generator (Gunn diode) and a mixer diode to produce the audio Doppler beat signal in response to radial movement. It requires a power supply of about 7.0 volts d.c. at about 150mA. The module has Home Office approval and has featured in a previous Wireless World design[1] in 1977. That paper and reference [2] provide useful background to movement detection by microwaves.

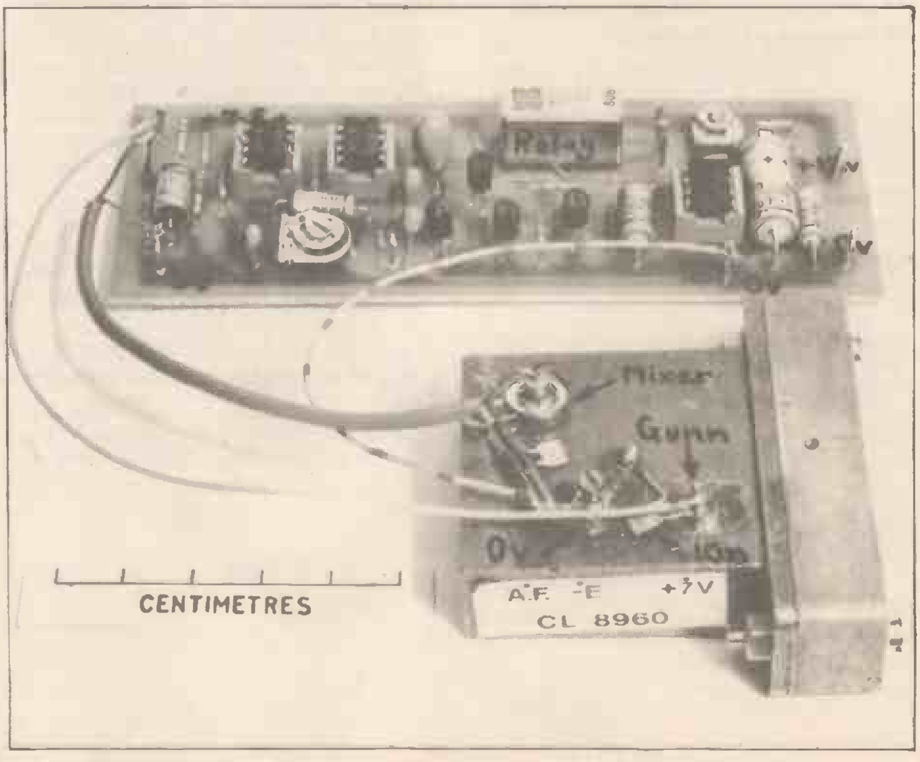
The present design is the result of considerable experience over the years in small radar design and has laid emphasis on false-alarm immunity, reliability and simplicity, and the use of a single nominal 12 volt supply for the complete microwave intruder detector (MID). The lowest usable supply voltage is important to preserve standby battery life. The circuit shows 11 volts although this can be reduced to ten by careful choice of component source and circuit settings, and to 9.5V by selection.

The great advantage of the MID, apart from its apparent ease of installation, is its constant vigilance. It can be set to sound an alarm for five minutes and then turn off if there is no further movement. This contrasts with a door-and-window switch system which, in simple installations, is likely to be out of action if disturbed. It may be silenced to await the owner's return.

However, both the design of the MID and its installation must be carried out with knowledge of the likely causes of false alarm. This can be simplified, and reliability improved to the point which makes it a very popular device, by providing an interference monitoring circuit that indicates when the alarm has an unreliable setting. Super sensitive MIDs are more likely to false alarm than less sensitive ones. Even those MIDs having good circuit design should be adjusted for a sensitivity which is no more than that necessary to ensure intruder detection. It is the setting of this sensitivity and the monitoring of the safety factor once it is set that is the key to a reliable installation. Some manufacturers "burn in" their alarms for long periods to ensure they are reliable, but this is lost if there is serious unsuspected movement in the vicinity of the MID installation. Part 2 describes a false alarm circuit for monitoring this kind of event.

False alarms attributable to the MID itself, particularly when set for a high sensitivity, can be due to amplified thermal noise, such as 1/f semiconductor noise, to vibration, or simply an interference on the power supply leads which gets into the signal circuits. The MID should contain protection against both power supply pulses and signals caused by external short transient movements.

Setting-up procedure for this intruder alarm circuit (given in part 2) can be simplified using an additional indication circuit that also monitors noise level and indicates when safety margin is reduced.



False alarm due to causes external to the MID can include those due to nearby equipment with an internal cooling fan and an aperture through which the radiation can pass and then return with a Doppler (movement) shift. In fact just an amplitude modulation of the reflection is sufficient.[2] The gas in fluorescent lamps, when switched on, ionizes to become a fluctuating reflector which can easily cause an alarm. Other causes include pedestrian movement outside windows close to the alarm. Microwave radiation can pass through glass, albeit with a considerable attenuation, as well as through dry plasterboard. Do you keep pigeons in your loft as well as a pig in the bath?

Most industrial MIDs use a light-emitting diode to show when it is detecting movement during setting up.

None, to my knowledge, provide one to show that the noise, including that due to spurious movement, is too high for reliability at the chosen sensitivity setting in the particular environment in which the MID must work. This is covered in part 2.

The starting point for an alarm design must be the power supply, its noise and outside ripple rejection properties. It helps to know that the most critical aspect of this is going to be the provision of the supply to the Gunn diode. Any ripple on this and the microwave power will be modulated and in turn will result in this ripple appearing at the mixer output. This is caused by the microwave power used for the mixing which affects the direct voltage across the mixer. If this is not satisfactory the rest of the design is suspect. The mixer output signals are in any case caused by an amplitude modulation of the mixer power when the return signal, shifted by the Doppler difference, is added to the local signal used for mixing.[2] This return signal is many orders of magnitude less than that used for mixing and hence the modulation of microwave power due to the power supply has to be extremely small. Ultimately, the radar sensitivity is limited by the mixer noise and the design should therefore aim not to artificially increase this.

In the past Gunn power supplies have not received the attention in the literature that they deserve; neither have manufacturers of microwave modules volunteered information on the sensitivity to ripple. A need exists for this to be included in the data. The ripple output from the mixer will depend first on the ripple on the Gunn supply and also on the amount of microwave power being used for mixing and the operating condition of the mixer. For instance, if a low level mixer is being used, such as in the Mullard CL8960, there will be supplementary direct current bias used to enhance sensitivity. But a mixer using about 0.5mW or more of power will often just have a 1kΩ resistor across the mixer to cause a current flow. Figure 1 shows these two types together with the resistors.

Ripple factor is defined here as the ratio of ripple voltage from the mixer to that across the Gunn diode. The microwave power used for mixing in the CL8960 is only about 0.02mW but will increase with a small reflector in front of the module so that ripple factor may be measured for other mixing powers. Such powers can occur if the module front is covered and sometimes intentionally by means of a 3mm screw or so placed in the front shroud, see Fig. 10 (part 2), and used to optimize signal-to-noise ratio with a particular amplifier or circuit design.*

The actual microwave power in use is evident by the change in direct voltage when the microwave signal is turned on. Thus setting up instructions can specify the type of bias circuit used and the direct voltage that should be expected. (Special anti-static precautions are needed during measurement to avoid mixer damage, given later.)

*The intended optimum mixer power will occur naturally if the module is bolted to a 160x430mm aperture in a 1/16in thick metal plate, such as the side of a box, and the other side of the aperture is fitted with the shroud shown in Fig. 10 which comes with it.

Table 1. Ripple transfer factor measured for microwave modules

Mixer	CL8960	CL8960	CL18960	CL8960	In-line module
Ripple factor	0	0.016	0.025	0.06	0.08
Direct voltage (V)	0.300*	0.26	0.00	−0.4	−0.2

* Zero microwave power

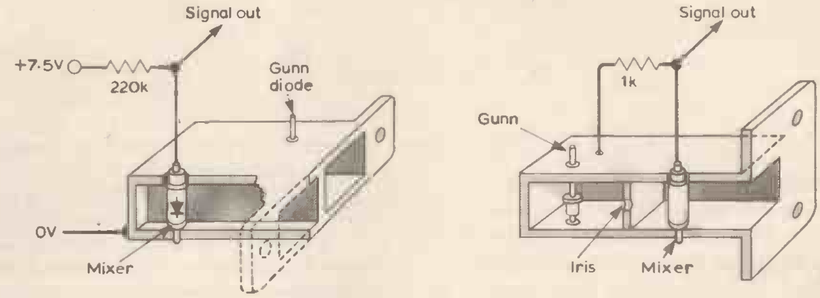


Fig. 1. Microwave part of the design is contained in Mullard CL8960 module (left). Direct current bias is not needed for in-line module, available shortly.

Gunn diode power supplies

Integrated circuit regulators in general have not reached the performance required for Gunn supplies. At least, they are not generally being released against a suitable specification. Typical is the 7808 from the 7800 series. This has an 8V output and is suitable for use with a 7.5 volt diode*. The guaranteed minimum ripple rejection is 56dB and the data shows a supply of 14 volts. This rejection is not even enough for a typical CL8960. When tested with a 150mA output a 66dB rejection at 14V became 63dB at 12 volts. Noise output of 13μV r.m.s. was acceptable but several times higher than a circuit made from discrete components.

Common practice in providing Gunn supplies is to use a zener diode to set the voltage and follow this with an emitter-follower to provide the power. In the circuit of Fig. 2 the current bias for the zener diode is derived from the supply but decoupled as much as is practical bearing in mind possible problems due to electrolytic leakage current. The 47μF capacitor across the zener diode reduces noise but only contributes to the decoupling above about 100Hz.

* This design is based on the use of 7.5 volts, as this improves low temperature reliability. Pressure for the lowest possible working voltage has caused a 7.0V release specification. Also more recent work has improved the Gunn diode. If 7.0 volt working is essential it can be used.

The 1000μF capacitor has a typical impedance at 100Hz of 2 ohms (no maximum quoted) at 0°C and the zener diode 20 ohms, so that the ripple rejection to the voltage across the zener is 2200/2 × 1000/20 × 20 = 5500 or 94dB (ignoring impedance change). Note that the splitting of the chain increased decoupling by about 30dB. This 94dB is much more than can be achieved with an output transistor when this is delivering 150mA as can be seen from Table 2.

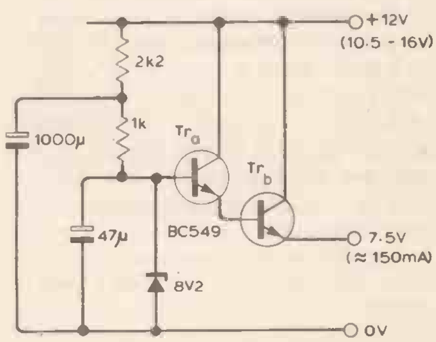


Fig. 2.

Table 2. Ripple rejection with circuit of Fig. 2.

Transistor type	BD139	BD139 BD135	BDX77	BFY52	BFX85
Rejection (dB)	97	55	61	52	52
Output noise (μV, rms)		1	2	2	2
Load current (mA)	0	150	150	150	150
No. of samples	3	3	3	3	3

The ripple rejection was found to degrade by 2dB when the supply voltage was reduced to 2.5 volts above the zener voltage.

Improved circuit

The output transistor is the limiting factor and if, as seems likely, better types will not be made available, some form of feedback must be devised using a suitable op-amp. Ideally the performance will approach that of the op-amp alone. One such attempt is shown in Fig. 3.

This circuit will achieve 100dB rejection although even 83dB is adequate. The ability of the circuit to reject ripple and tolerate a low supply voltage depends on the current output taken from the i.c. and, not least, who made it. The maximum current required for a CL8960 is 166mA and the mimimum current gain of BD135 is 40. Thus the i.c. output current can be up to 4mA. The circuit was tested with what turned out to be a high gain transistor having a base current of only 1.2mA, so an extra 3.5mA was taken to see the effect. Results are shown in Table 3.

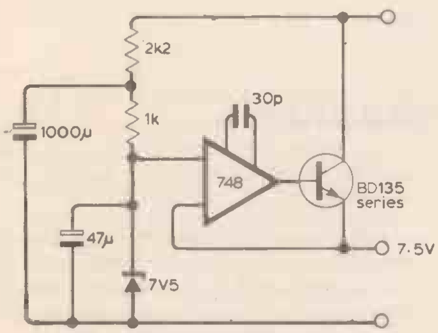


Fig. 3.

Table 3. Use of op-amp as shown in Fig. 3 improves ripple rejection.

IC type	Noise output	No. of samples	Minimum rejection	Minimum V_s for 83dB as shown	+3.5-mA
748[1]	2μ	10	101dB	9.53V	9.7V
748[2]	2μV	20	103dB	10.23V	11.0V

1 National Semiconductor, 2 other well-known make

Measurements were made at a frequency of 200Hz to avoid hum problems but at least 100dB was measured over the band 10Hz to 1kHz. The fact that this is greater than the 94dB of the bias chain is a reflection of capacitor tolerance.

The minimum voltage working was only 0.1V lower if 30dB rejection was specified and this ripple breakthrough can easily be seen on an oscilloscope. This can be used as a rough check.

From these figures you can see that a poor i.c. would show advantage in using another emitter-follower with an end-of-spread CL 8960 and BD135, due to the reduced current load which would require less voltage. With a BC547 as the second transistor the minimum voltage fell from 11.0V to 10.5V but with a good i.c. it rose from 9.7V to 10.0V, due to the higher output direct voltage required for the extra transistor over-riding the low-current improvement. These voltages and those above assume an exact 7.5V zener diode. With a 5% tolerance another 0.4V must be added.

The circuit of Fig. 3 can be simplified by noting that the i.c. output voltage is above that of the zener diode by the V_{be} of the transistor; see for instance the circuit of Fig. 4. Also by using 1kΩ plus 22kΩ preset series resistance between F and B, the voltage may be set accurately using a 6.8V zener.

The advantage of the 748 over the 741 is that the 30pF capacitor can be increased if a loop stability problem is experienced. A 741 of different manufacture did oscillate when the extra 3.5mA load was applied, although with the 748 the capacitor could be reduced to 10pF before this occurred. The manufacturer is the most important factor in choosing an i.c. In this instance a National 748 outperformed five samples of a more expensive LM308 equivalent from manufacturer (2), both in rejection and minimum working voltage.

Finally a two emitter-follower version of Fig. 4 is shown in Fig. 5 with some more measurements.

Table 4. Rejection by fig. 4 circuit with 12 volt supply was also over 100dB.

IC type	Noise output	No. of samples	Minimum rejection	Minimum V_s for 83 dB rejection as shown	+3.5mA
748[1]	2.5μV	10	>100dB	9.53V	9.76V
748[2]	2.5μV	20	>100dB	10.23V	10.83V

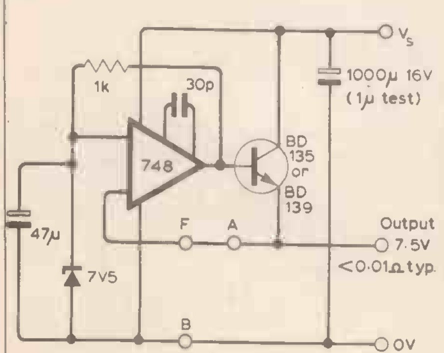
1 National Semiconductor, 2 other well-known make

Table 5. Two-transistor version for higher currents or poor i.cs

IC type	Noise output	No. of samples	Rejection ½ 12V supply	Supply min. for 83dB
748[1]	3.5μV	10	100dB	10.07V
748[2]	3.5μV	20	99dB	10.62V

1 National Semiconductor, 2 other.

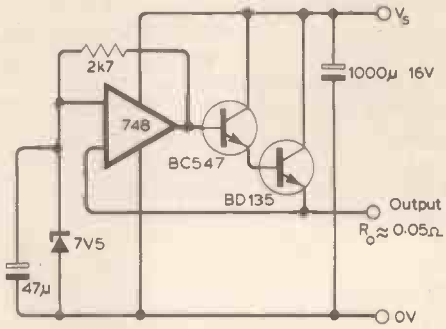
Fig. 4.



From the previous results it seems fair to expect that the circuit of Fig. 4 could be put into production with a minimum working voltage of 10.5V and a ripple rejection of 83dB, provided the i.c. manufacturer is selected with care, and even better if BD135s are available with h_{FE} minimum of 80. A considerable percentage of the products will work satisfactorily down to a supply voltage of 10V.

Measurements were made with a zener diode selected for an accurate 7.5V voltage. Any higher voltage requires the supply minimum to be raised by the difference. But also, the use of the 7.0V specified in the CL8960 data would allow a reduction of 0.5 volts. Thus a 10.5 volt minimum could be met, even with a poor i.c.

Fig. 5.



Note: 784 requires 30pF compensation capacitor.

Ripple transfer factor for the two modules is shown in Table 1. In both cases the mixer used was the Mullard BAV46 which is a typical type for this application. The CL8960 bias shown uses fewer components than in the data sheet. The direct voltage working point should be chosen for best noise figure. With a 42μA bias current and the circuit to be described this is is about half the non-microwave bias. For a 300mV diode, a variation from 90 to 270mV causes a 1.5dB worsening of noise figure and some 6dB sensitivity loss at the extremes.

Measurements show that a factor of about 0.02 should be used for design with the CL8960 and the more stringent 0.08 or more for the in-line design. The aim here will be for a 0.1 design so as to allow for future microwave module development.

If the noise from the module is naturally 5μV and the design aim is to hold the noise increase to just 1dB, the ripple contribution on its own must be not more than about 2.5μV. If it contributed 5μV the overall noise would degrade by 3dB.

The rejection required of the power supply is therefore 83dB for 2.5μV r.m.s. from 1V pk-pk with ripple factor of 0.1. Even a typical CL8960 is going to require 69dB if ripple factor is 0.02.

The 83dB minimum ripple rejection factor is achieved (see "Gunn power supplies") so as to allow 1V pk-pk on the intruder alarm supply for a module with a ripple factor of 0.1 As a typical CL 8960 has a factor of 0.02 it could tolerate 5V pk-pk ripple, although due to the voltage swing the minimum supply voltage of 10.5V would need to be increased to about 13V.

It might be thought that battery supplies would not need ripple rejection. However, this ignores practical points like switching-on and switching-off surges with long leads, possible bad connections due to corrosion and trickle charging from mains derived supplies. Thus a 1V pk-pk ripple rejection is very useful.

Doppler amplifier design had an aim of about 90dB gain and also an adequate ripple rejection. Ripple may be present due to the signals originating from outside the power supply, or caused by the power supply itself, or generated by the amplifier drawing signal current from the power supply and its associated impedance. Feeding back a voltage due to an inadequate ripple rejection can lead to an unstable amplifier. The nature of this problem is illustrated in Fig. 6. Currents I_a and I_b supply the amplifiers but contain components at the signal frequency. These in turn generate voltages via the finite output impedance of the power supply. A low impedance supply eases the problem, as do lightly loaded amplifiers which do not generate large signal currents. After this the amplifier should be designed for a good rejection factor.

A suitable amplifier circuit is shown

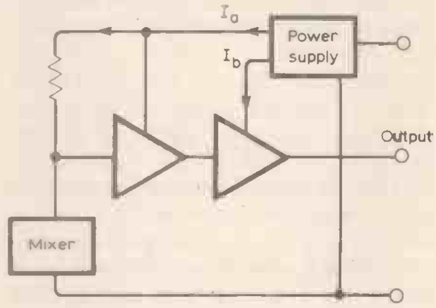


Fig. 6. Ripple may be due to signals originating from sources internal or external to the power supply. Currents shown can generate voltages through the output inpedance of power supply, hence the need for a low impedance supply and lightly-loaded amplifiers.

Fig. 7. Beat frequency amplifier with mixer bias current supply was designed to tolerate supply impedance of more than five ohms.

in Fig. 7. It was designed to tolerate a supply impedance of more than 5 ohms which is much higher than needed for a stabilized supply, but often a good design does not look very different from a poor one at first sight. The main point is not to inject signals from the supply via the networks which supply amplifier bias. The Gunn power supply can be used to power the amplifier and as this has a very low output impedance of about 0.05 ohms this will greatly help the design. For instance, some of the decoupling of the input bias chain can be omitted.

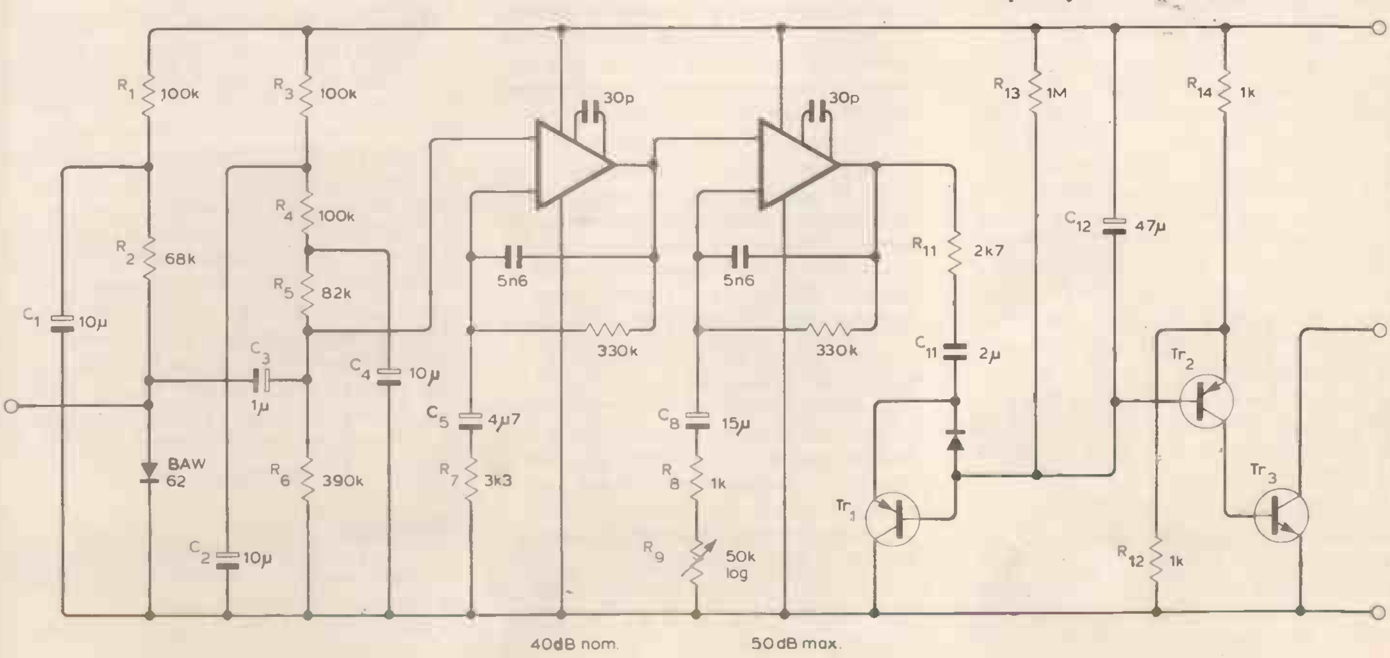
Starting at the left hand side the resistor chain R_1 and R_2 provides well-decoupled current bias for the mixer, the diode being merely for protection against the input charging up when the mixer is absent which carries the risk of mixer damage when it is re-connected. Even without microwave bias the mixer voltage is only 0.3V which is below diode conduction with the 43μA direct current bias.

The second resistor chain biases the op-amps to the best point for a symmetrically-clipped sinewave output on overdrive. With the use of the Gunn power supply capacitors C_1 and C_2 can be omitted.

The first op-amp has a voltage gain of 100 and the second 300, a total of 90dB ignoring impedance differences. Gain of the second can be reduced 50 times with R_9. Because radar range varies as the fourth power of power gain, this is equivalent to a range change of seven times. For a lower range of sensitivity the first op-amp 330kΩ resistor can be reduced.

The second op-amp is directly connected to the first and the circuit is both very economical in the use of components and has good ripple rejection properties. No economy is sacrificed in performance.

The amplitude-response of the amplifier is suitable for an MID. The low frequency cut-off is controlled by C_5



and C_8. The input capacitor plays little part as it was chosen large for low noise reasons. At maximum gain C_5 and C_8 and their associated resistors cause the response to be −3dB at 11Hz which corresponds to a radial velocity of 15.8mm/s or 0.6in/s, assuming the UK MID frequency of 10.687GHz. Range will be roughly proportional to velocity below this due to the 12dB per octave response of the two time constants. With reduced gain R_9 will reduce the fall-off of the second time constant and response will fall with speed more slowly.

The ability of the radar to reject faster-than-walking-speed targets is also controlled by two time constants, those of the capacitor across each op-amp feedback resistor. With 5.6nF capacitance across 330kohm the −3dB point per stage is at 86Hz or 1.25m/s (1.5ft/s or 2.8 mile/h). Range will be half at twice this velocity and decrease inversely proportional to velocity thereafter.

Amplifier noise was measured with both a mixer connected and a 1kohm substitute. At the time the amplifier had only one third of the size of feedback capacitors and an upper response of approximately 240Hz. Noise voltage equivalent input for the resistor varied from 0.3 to 0.6μV r.m.s. depending on which of ten i.cs was used, as measured by the usual averaging "r.m.s." meter. On an oscilloscope the larger figure corresponded to 4.4μV pk-pk equivalent. This is well below that expected from the microwave module and makes the exact value inimportant.

Amplifier gain required can be seen from the 5μV r.m.s. expected noise input and the 2V pk-pk output from the op-amps which will cause a build-up to an alarm level in the circuit which follows the op-amps. This is 103dB and so 90dB offers a reasonable safety factor. The threshold at which the circuit following the op-amps just begins to work is 1.5V pk-pk.

Fluorescent lights can interfere with the operation of an MID and the use in the presence of these must be avoided unless a circuit is fitted with rejection capabilities. The ionized gas fluctuates at 100Hz and can induce a signal in the radar. With just one lamp predominating this may be substantially at 100Hz but with several lamps a strong 200Hz component may also be present. The phase of the signal relative to the mains can also vary over the full 360° due to differences in target distance. The design of a suitable comb filter is not within the scope of this article. Low-pass filters are only marginally acceptable, even when of multipole design, because of the loss of response to all but slow movement.

In the past the MID design has paid far too little attention to protection against being set off by interference pulses, even single ones, let alone several. To some extent this is due to a lack of designers with both electronic circuit design experience and microwave engineering experience.

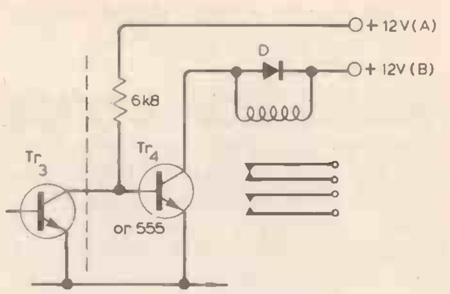


Fig. 8. Normal practice is to have a relay energized so that power failure can be indicated. For a high security area a 555 timer (fed by Tr_4 or with Tr_3 collector connected to pin 2) could be arranged to short a relay hold-off after a short interval. For use with a 555, (A) connects to 0V, the diode is omitted, Tr_4 collector becomes pin 3, and its base connects to pin 2.

Radar wavelength at 10.687GHz is 28mm and one beat frequency cycle is produced by the mixer for each 14mm of radial movement toward or away from the radar. Thus a counting or similar process is possible and hence a circuit which requires a certain distance of movement before an alarm is set off. This is not complete proof against much shorter oscillating movements which can wobble the vector[2] and produce a beat signal but it does provide valuable protection against multiple interference pulses of a few at a time and against single short infrequent movements. A memory can be provided to defeat an approach in a series of short movements and the proportioning of the memory time versus degree of protection provided is a matter for design consideration.

In the circuit shown the capacitor C_{11} is used as a bucket to charge C_{12} with one bucket of charge per cycle. Thus the radial movement distance required to charge C_{12} to about half the supply voltage and so set off the alarm by causing Tr_2 to conduct, is determined by the ratio C_{11}/C_{12}. A single movement of about 600mm or 24 inches will trip the circuit shown. Capacitor C_{11} loses some charge voltage due to the diodes.

The memory time constant is controlled by R_{13} across the capacitor and is about 47 seconds with a low leakage electrolytic – preferably tantalum for stability. Thus 37% of any previous movement is still remembered after 47 seconds. Values of C_{12} and R_{13} may be altered if required, provided electrolytic leakage-current is paid due regard. In practice any changes are unlikely to be more than three times. For instance 9 inches of movement is probably good enough for the most critical user and a 50 second memory will take some beating.

Transistor Tr_1 is a bootstrap arrangement to ensure that the charge per bucket does not fall off appreciably when C_{12} charges up. With the alarm detecting an intruder and a 7.5 volt amplifier supply the output of the op-amp will usually be at least 4V pk-pk.

In use the output transistor Tr_3 is intended to short the base-emitter junction of a relay transistor, such as in Fig. 8. It is normal with alarms to have the relay energized when the circuit is working and no alarm condition so that power failure is indicated. Transistor Tr_3 will sink several mA and is very conservatively used at 2mA. It could be ten with little risk.

Alternatively, Tr_4 could operate a 555 timer, or itself be a 555 timer in which case the base connection shown would be pin 2. The 555 appears to have a built-in diode suitable for relay driving, although this is not stated in the data. The use of a five minute alarm which expires if there is no further movement is a useful feature for avoiding a noise complaint and leaves the system ready to detect the next disturbance. For a high security area the 555 would be arranged to short a relay hold-off control as in Fig. 8. Thus an alarm is given if wires are cut.

Both the amplifier on its own and complete with the microwave module were tested for power supply ripple rejection. The amplifier at that time used smaller feedback capacitors and had an upper −3dB point per stage of 240Hz. Thus ripple rejection will be generally better above 100Hz than the figures shown.

Table 6. Typical ripple rejection for Fig. 7 and module

Ripple frequency (Hz)	10	50	100	500
Rejection with 12V supply (mV pk-pk)	55	55	70	500
Rejection with 7.4V supply (mV pk-pk)	36	36	45	500

These are typical rather than worst-case ripple figures but not too important as the use of a stabilizer with only 30dB rejection would allow a 1V pk-pk ripple on the stabilizer input. Thus, as expected, the performance is limited by the less tolerant microwave circuits. With the microwave module fitted and the stabilizer to be described a IV pk-pk ripple over the frequency range 10Hz to 1kHz had no effect with a supply voltage of 10.5V. Also with a 12V supply the ripple had to be increased above 5V pk-pk before the ripple could be seen in the noise. Removal of C_1 and C_2 from Fig. 7 when the circuit was powered from the Gunn supply did not alter this.

To be continued

References

1. M. W. Hosking, Microwave intruder alarm. *Wireless World* vol. 83 1977, July pp. and August pp.
2. Holford K. Doppler Radar With Sense, *Wireless World* vol. 78 1972, pp. 535-9.

Circuit analysis by small computer

Tedious though flexible matrix technique lends itself to computer calculation

by A. S. Beasley, B.Sc., McMichael Ltd.

As the price of desktop computers falls, they are coming to be regarded as another piece of lab equipment, along with oscilloscopes and analysers. Using such machines designs may be checked and components "tweaked" for optimum performance, without any danger of damaging expensive components.

This article shows the principles of computer circuit analysis; a second shows how a Commodore Pet can be used to "bread-board" circuits ranging from micro to audio frequencies. As desktop machines become more common this approach must look increasingly attractive to professional users in industry and education, as well as to non-professionals.

Many textbooks deal with linear two-port analysis; because of their familiarity I shall use them as an introduction to a far more powerful multiport technique.

Consider the two-port network of Fig. 1. Choose any two of V_1, V_2, I_1, I_2,

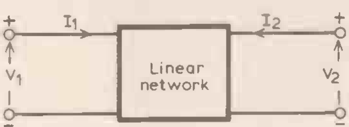


Fig. 1

as independent variables and the remaining two as the dependent variables. Choosing the voltages as the independent variables and assuming linearity, write

$$I_1 = y_{11}V_1 + y_{12}V_2$$
$$I_2 = y_{21}V_1 + y_{22}V_2$$

or in matrix form

$$\begin{pmatrix} I_1 \\ I_2 \end{pmatrix} = \begin{pmatrix} y_{11} y_{12} \\ y_{21} y_{22} \end{pmatrix} \begin{pmatrix} V_1 \\ V_2 \end{pmatrix}$$

where the y-parameters have the dimensions of admittance, the reciprocal of impedance. Figure 2 gives the y-

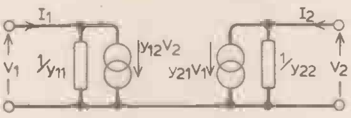


Fig. 2

parameter equivalent circuit of any linear two-port network and Table 1 gives the gain and impedance properties terminated in a load admittance Y_L and driven from a source of admittance Y_S.

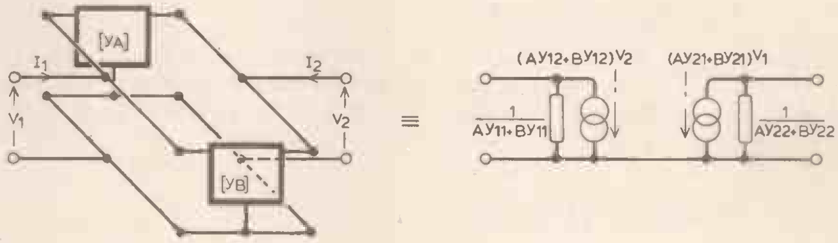


Fig. 3

Consider paralleling two different two ports, as in Fig. 3. It is immediately obvious from the equivalent circuit representation that the overall two-port network (formed by the combination of networks A and B) has the following y-parameters

$$y_{11} = {}_Ay_{11} + {}_By_{11} \qquad y_{21} = {}_Ay_{21} + {}_By_{21}$$
$$y_{12} = {}_Ay_{12} + {}_By_{12} \qquad y_{22} = {}_Ay_{22} + {}_By_{22}$$

The overall y-parameters are simply the sum of the parts. It is this property of the admittance representation that we shall now generalize: the property of adding small matrices to describe the whole circuit, i.e. $[y] = [y_A] + [y_B]$

Indefinite admittance matrix

The indefinite admittance matrix or YF matrix relates the total current at any node in the circuit to the voltages at the nodes, where voltages are referenced from some node external to the circuit. This is best illustrated by an

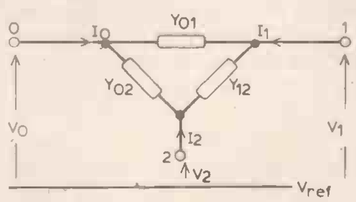


Fig. 4

where Y_{01} Y_{02} Y_{12} are admittances.

example; consider Fig. 4. You can see that

$$I_0 = (Y_{01} + Y_{02})V_0 - Y_{01}Y_1 - Y_{02}V_2$$
$$I_1 = -Y_{01}V_0 + (Y_{01} + Y_{12})V_1 - Y_{12}V_2$$
$$I_2 = -Y_{02}V_0 - Y_{12}V_1 + (Y_{02} + Y_{12})V_2$$

or in matrix form

$$\begin{pmatrix} I_0 \\ I_1 \\ I_2 \end{pmatrix} = \begin{pmatrix} Y_{01}+Y_{02} & -Y_{01} & -Y_{02} \\ -Y_{01} & Y_{01}+Y_{12} & -Y_{12} \\ Y_{02} & -Y_{12} & Y_{02}+Y_{12} \end{pmatrix} \begin{pmatrix} V_0 \\ V_1 \\ V_2 \end{pmatrix}$$

Notice that the YF matrix exhibits a great deal of symmetry. It may be shown rigorously* that for any passive circuit

- Y_{nn} is the sum of all admittances connected to node n
- Y_{nm} is minus the sum of all admittances connecting the n to the m node
- the sum of any row or column is zero (this applies to active circuits as well as it derives from conservation of charge)
- $Y_{nm} = Y_{mn}$

These four properties of the YF matrix allow any passive network to have its YF matrix written down by inspection. These same properties also allow a computer to create the YF matrix with great ease; only the nodes that components lie between and their value need be known.

Table 1

$$Z_{in} = \frac{y_{22} + Y_L}{D_y + y_{11}Y_L} \qquad A_v = \frac{V_2}{V_1} = \frac{-y_{21}}{y_{22} + Y_L}$$

$$Z_{out} = \frac{y_{11} + y_s}{D_y + y_{22}Y_s} \qquad A_i = \frac{I_2}{I_1} = \frac{-y_{21}Y_L}{D_y + y_{11}Y_L}$$

where $D_y = y_{11}y_{22} - y_{12}y_{21}$

The technique in summary

For passive networks rote application of the four rules produces the YF matrix.

For active networks use Table 2 to find the YF matrix.

For a network with active and passive components simply add the individual YF matrices obtained by considering the passive and active components on their own.

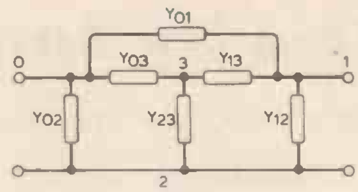
YF matrix may be reduced to a simple two-port network and then application of Table 1 gives the impedances and gains of the network.

Reduction of the YF matrix

The way to extract information from the YF matrix concerning impedances and gains (as for the two-port network) is to note that the currents in the YF representation give the total current flowing into a particular node. By Kirchhoff's Law we know that this is zero for all internal nodes, i.e. nodes not connected to the input or output of the network.

To demonstrate by means of an example, see Fig. 5. You can see that

Fig. 5



where Y_{01} etc. are admittances.

$$\begin{pmatrix} I_0 \\ I_1 \\ I_2 \\ I_3 \end{pmatrix} = \begin{pmatrix} Y_{01}+Y_{02}+Y_{03} & -Y_{01} & -Y_{02} & -Y_{03} \\ -Y_{01} & Y_{01}+Y_{12}+Y_{13} & -Y_{12} & -Y_{13} \\ -Y_{02} & -Y_{12} & Y_{02}+Y_{23}+Y_{12} & -Y_{23} \\ -Y_{03} & -Y_{13} & -Y_{23} & Y_{03}+Y_{13}+Y_{23} \end{pmatrix} \begin{pmatrix} V_0 \\ V_1 \\ V_2 \\ V_3 \end{pmatrix}$$

Because $I_3 = 0$ eliminate V_3 by putting

$$V_3 = (Y_{03}V_0 + Y_{13}V_1 + Y_{23}V_2)/\Sigma$$
$$\text{where } \Sigma = Y_{03} + Y_{13} + Y_{23}$$

For a two-port network measure voltage from node 2 (i.e. $V_2 = 0$). Substituting these relationships into the YF matrix:

$$\begin{pmatrix} I_0 \\ I_1 \end{pmatrix} = \begin{pmatrix} Y_{02} + Y_{01} + Y_{03} - Y^2_{03}/\Sigma & -(Y_{01} + Y_{03} \cdot Y_{13}/\Sigma) \\ -(Y_{01} + Y_{13} \cdot Y_{03}/\Sigma) & Y_{01} + Y_{12} + Y_{13} - Y^2_{13}/\Sigma \end{pmatrix} \begin{pmatrix} V_0 \\ V_1 \end{pmatrix}$$

So by equating all internal currents to zero we have found the two-port y-parameters, and using Table 1 we deduce the impedances and gains of the network.

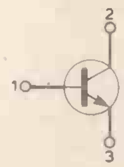
YF matrix for active components

Consider the transistor in Fig. 6. From the data sheet we can quickly discover its common-emitter y-parameters, which relate the currents into the base and collector to the voltages applied (referenced from the emitter). Now even for active components conservation of charge is obeyed so by rule three the YF matrix for the transistor is

$$\begin{pmatrix} y_{ie} & y_{re} & -(y_{ie}+y_{re}) \\ y_{fe} & y_{oe} & -(y_{fe}+y_{oe}) \\ -(y_{ie}+y_{fe}) & -(y_{re}+y_{oe}) & \Sigma \end{pmatrix}$$

where $\Sigma = y_{ie} + y_{re} + y_{fe} + y_{oe}$

Table 2 gives the YF matrices for other common two-port networks.



$$\begin{pmatrix} y_{ie} & y_{re} \\ y_{fe} & y_{oe} \end{pmatrix} \quad \begin{pmatrix} y_{11} & y_{12} \\ y_{21} & y_{22} \end{pmatrix}$$

Fig. 6

YF matrix for active and passive components

Now that YF matrices of active and passive networks can be created the "parallel networks add y-parameters" rule can be used, which carries over the more general YF matrix. The following example illustrates the techniques we can now use.

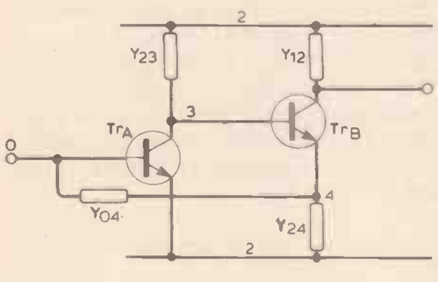
It is because this technique is so flexible, handling any configuration of components, yet is a rote procedure with straightforward though tedious calculation, that it is ideally suited to the computer.

A second article will outline a program based on the YF matrix and discuss modelling techniques.

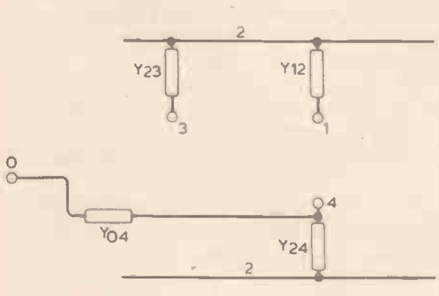
*High Frequency Amplifiers by R. S. Carson. Wiley Interscience.

Example

To analyse



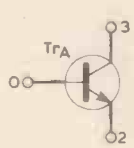
represent the circuit as a paralleling of



$$YF_1 = \begin{pmatrix} Y_{04} & 0 & 0 & 0 & -Y_{04} \\ 0 & Y_{12} & -Y_{12} & 0 & 0 \\ 0 & -Y_{12} & \Sigma_1 & -Y_{23} & -Y_{24} \\ -Y_{04} & 0 & Y_{24} & 0 & Y_{04}+Y_{24} \end{pmatrix}$$

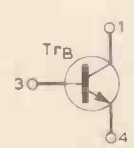
where $\Sigma = Y_{12} + Y_{23} + Y_{24}$

and



$$YF_2 = \begin{pmatrix} {}_Ay_{ie} & 0 & -({}_Ay_{ie}+{}_Ay_{re}) & {}_Ay_{re} & 0 \\ 0 & 0 & 0 & 0 & 0 \\ -({}_Ay_{ie}+{}_Ay_{re}) & 0 & \Sigma_A & -({}_Ay_{re}+{}_Ay_{fe}) & 0 \\ {}_Ay_{re} & 0 & -({}_Ay_{fe}+{}_Ay_{oe}) & {}_Ay_{oe} & 0 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

where $\Sigma_A = {}_Ay_{ie} + {}_Ay_{re} + {}_Ay_{oe} + {}_Ay_{fe}$



$$YF_3 = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & {}_By_{oe} & 0 & {}_By_{fe} & -({}_By_{oe}+{}_By_{fe}) \\ 0 & 0 & 0 & 0 & 0 \\ 0 & {}_By_{fe} & 0 & {}_By_{ie} & -({}_By_{re}+{}_By_{ie}) \\ 0 & -({}_By_{ie}+{}_By_{oe}) & 0 & -({}_By_{fe}+{}_By_{ie}) & \Sigma_B \end{pmatrix}$$

where $\Sigma_B = {}_By_{ie} + {}_By_{re} + {}_By_{oe} + {}_By_{fe}$

The overall YF matrix is then

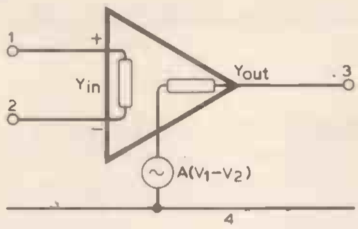
$$YF = YF_1 + YF_2 + YF_3$$

The tedious but simple calculations to reduce the YF matrix are best left to a computer; these calculations will yield the impedances and gains of the circuit.

Table 2

Op-amp

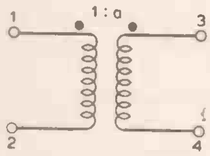
$$\begin{pmatrix} Y_{in} & -Y_{in} & 0 & 0 \\ -Y_{in} & Y_{in} & 0 & 0 \\ -A\,.\,Y_{out} & A\,.\,Y_{out} & Y_{out} & -Y_{out} \\ A\,.\,Y_{out} & -A\,.\,Y_{out} & -Y_{out} & Y_{out} \end{pmatrix}$$



Ideal transformer

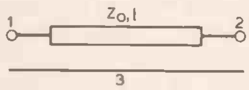
$$\begin{pmatrix} a^2Y & -a^2Y & -aY & aY \\ -a^2Y & -a^2Y & -aY & aY \\ -a^2Y & a^2Y & aY & -aY \\ -aY & aY & Y & -Y \\ aY & -aY & -Y & Y \end{pmatrix}$$

where $Y = 1.5 \times 10^4$



Transmission line

Line impedance Z_0 length l at a frequency where $h = 2\pi/\lambda$

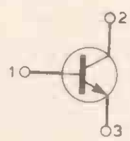


$$\begin{pmatrix} \frac{1}{jZ_0\sinh hl} + \frac{j\tan(hl/2)}{Z_0} & \frac{-1}{jZ_0\sinh hl} & \frac{-j\tan(hl/2)}{Z_0} \\ \frac{-1}{jZ_0\sinh hl} & \frac{1}{jZ_0\sinh hl} + \frac{j\tan(hl/2)}{Z_0} & \frac{-j\tan(hl/2)}{Z_0} \\ \frac{-j\tan(hl/2)}{Z_0} & \frac{-j\tan(hl/2)}{Z_0} & \frac{2j\tan(hl/2)}{Z_0} \end{pmatrix}$$

given y_e parameters

$$YF = \begin{pmatrix} y_{ie} & y_{re} & -(y_{ie}+y_{re}) \\ y_{fe} & y_{oe} & -(y_{fe}+y_{oe}) \\ -y_{ie}-y_{fe} & -y_{re}-y_{oe} & \Sigma \end{pmatrix}$$

where $\Sigma = y_{ie} + y_{re} + y_{fe} + y_{oe}$.



□

Adaptable anatomy for a.t.e.

A new form of integrated automatic test equipment, the GRADUATE, unveiled by its maker, Marconi Space and Defence Systems at the recent Brighton a.t.e. conference, offers the central advantages of "virtual instrumentation" and "reconfigurability." Although it will have to live down a laboured cap and gown presentation (it forms the "T" in the name whenever a mention occurs in the technical literature headings), the facilities lurking behind these two terms are quite real.

"Virtual instrumentation" involves dispensing with conventional test instruments, using instead software-combined modules, with the intention of simplifying measurement and readout, and adapting easily to different test requirements. Checks are made by the a.t.e. circuits and the results fed to the central v.d.u., which also displays simulated front panel controls, the instrument being simulated depending upon the way in which the a.t.e. has been "configured" by the software. A set of functional modules carries out the work and comprises three main sections, l.f., r.f., and digital. These modules are inserted into a kernel composed of four shelves, each of which has eight injection mouldings capable of holding one double or two single modules. Matching connections are provided at each module for service inputs, permitting any module to be inserted anywhere in a kernel.

The central controller is a 24-bit word processor using bit-slice technology with a fixed microcode in p.r.o.m. and an extension e.p.r.o.m. for controller firmware development. The main memory is expandable in 32K word steps up to 1M word, and standard peripherals are a v.d.u. and keyboard, dual floppy-disc drive, line printer for program development and strip printer for test results.

Part of the control process is a calibration facility, deviations of each module from its "standard" performance being stored in p.r.o.m. within the module at the time of calibration. This means that close-limit accuracy in the modules themselves is made unimportant and, assuming that the characteristics of each module are stable, their stimulus outputs and measured inputs can be automatically corrected using the stored data.

A self-test facility provides for individual modules and integral p.c.bs to be tested using resident programs, and a self-test module permits on-line validation checks to be carried out during normal testing, ensuring that any failure is not incorrectly attributed to the equipment.

Module isolation is effected using a 25kHz, three-phrase power distribution system. This is transformer-coupled and rectified on the interface power assembly board contained in each module. One ribbon cable is used to distribute the supply to each module and another carries analogue signals between them. For high frequency and fastedge signals the performance of the ribbon highway becomes inadequate and appropriate functional modules therefore have separate front panel connectors. A high-frequency, three-switch design is available, working into the microwave region.

Physically, the GRADUATE is made up by combining up to four kernels and four 19in racks, the layout being determined by the table top. In this way it can be tailored to satisfy particular constraints of space or can be laid out in a different shape to cater for expansion, relocation or change of function.

WORLD OF AMATEUR RADIO

WARC and the amateurs

The ending, early in December, of the World Administrative Radio Conference at Geneva has left both professional and amateur communications with the major problem of sorting out exactly how they will fare when the new international table of frequency allocations comes progressively into use over the years ahead. The problem, as some of us foresaw, is that a divided and highly political conference has added such a proliferation of "footnotes" to the regulations that it has almost destroyed any remaining coherence of the frequency table, and indeed some observers go so far as to suggest that it has left world spectrum management virtually in tatters. There are also now many "resolutions" not directly reflected in the frequency table.

However, at least by comparison with some other services, radio amateurs in Region 1 (and also radio astronomers) have emerged without having suffered any immediately obvious major calamities, indeed with a few useful gains, though nobody is prepared to admit being pleased with the results until the impact of various footnotes has been more fully evaluated. Certainly it is clear that all amateurs have every reason to be grateful to the International Amateur Radio Union, the R.S.G.B. and a number of the other national societies for their long-term efforts to promote better international understanding of the value of this hobby in both developed and developing countries.

The three new h.f. bands reached the international table: 10.100 to 10.150MHz (about 29.6 metres); 18.068 to 18.168MHz (16.5 metres); and 24.890 to 24.990MHz (12 metres). It will, of course, be several years before these become available to amateurs (possibly 10.1MHz will be the first to be transferred to the amateur service). The availability of amateur allocations at 7, 10, 14, 18, 21, 24 and 28MHz should prove a useful incentive for further ionospheric research as well as making long-distance operation possible at most times of the day or night, throughout most of the sunspot cycle. However the allocations are only 50 or 100kHz wide and this will call for a high degree of self-discipline to avoid the worst effects of over-crowding, particularly if the bands are open for all modes of transmission. A small "Top Band" allocation (1810 to 1850kHz) is now back in the International Table from which it vanished in 1947, with the "footnote" that permits U.K. operation between 1800 to 2000kHz remaining attached to the table. In fact U.K. amateurs do not appear to have lost any h.f. or v.h.f. frequencies, though it is too early to say whether or not operation on some bands will be adversely affected by the many new footnotes.

According to returning delegates and observers, one of the many surprises of WARC was the very disappointing attitude shown towards amateur radio by the Japanese delegation, despite that country's domination of the world market for amateur radio equipment. Amateurs are also hoping that the active role taken at Geneva by the Chinese delegation may mean less use of 7MHz amateur frequencies by broadcasting stations in that country — and possibly licensing of amateurs there. There is also a sense of relief that the new h.f. allocation for international broadcasting above 13.6MHz is unlikely to extend beyond 13.8MHz instead of the proposed 14.0MHz and this gives rise to the hope that a "cordon sanitaire" will be maintained between the megawatters and the amateur 14MHz band.

From all quarters

North American amateurs on 50MHz continued to be received in Europe daily throughout November and it seems likely that this month will prove to have been the peak period of Solar Cycle 22. Even low-power stations were received with excellent signal-to-noise ratios, usually around 1400GMT. On November 18th, Angus McKenzie, G3OSS could still copy signals from VE1ASJ near St. John, New Brunswick, Canada when that station progressively reduced power from 0.6W to about 10mW! While most of the 50MHz openings were to the East Coast of Canada and the USA, on some days excellent signals were received from stations from Texas, California and even Mexico City.

The original 144MHz London repeater GB3LO at Crystal Palace has been extensively modified and re-installed in readiness for the change to the planned new four-repeater coverage of London and for which it will become GB3SL (R2) with GB3NL at Enfield on R7; GB3WL on R1 at Hillingdon (all these three repeaters being run by the UK FM Group (London); and GB3EL on R0 at Havering. Some at least of these should be in operation by the time these notes appear. A new u.h.f. (70cm) repeater, GB3SK, has opened at Folkestone on channel RB6.

RACE (radio amateur club de l'espace), a group of French amateurs mostly working at scientific research establishments, is aiming to build equipment for a French amateur satellite.

According to observations made by Ron Ham at Storrington, Sussex, sporadic E reception of signals between 40 and 80MHz occurred on 48 days between May 19 and August 21, 1979 compared with 69 days in 1978 and 37 days in 1977, once again emphasising that there appears to be no direct connection between solar activity and the seasonal Sporadic E conditions.

There have been many different versions of how amateurs acquired their not-always-appreciated sobriquet "ham". According to a story in "Worldradio", it began in 1911, and a station operated by three young members of the Harvard Wireless Club: Albert Hyman, Bob Almy and Reggy Murray. In the period before official licences were issued in the USA, they used a self-assigned callsign formed from the initial letters of their surnames, HAM. Subsequently Albert Hyman was asked to appear before the US Congressional committee where his arguments against imposing licence fees on American amateur stations, such as HAM, attracted nationwide publicity. It is a plausible story, but there have been other accounts suggesting that like "73" (best regards) it all started much earlier, in the days of land-line telegraphists.

In brief

An American amateur, Mike Vestal, W0YZS last year became the first amateur to "Work All States" on the 430MHz (70-cm) band ... The 1980 R.S.G.B. National VHF Convention is to be held at the "Winning Post." Twickenham, Middlesex on March 8 ... Forthcoming 7MHz contests organised by the R.S.G.B. comprise a telephony contest on February 2-3 and c.w. on February 23-24 ... Decisions taken at WARC, Geneva may make it possible for Class B licensees to use the 70MHz band ... A long-range planning committee of the A.R.R.L. is attempting to identify "the opportunities and the obstacles that lie ahead and what the League should be doing to prepare for them" ... P. Balestrini, G3BPT was due to be installed as the 46th president of the R.S.G.B. in the course of an evening cruise on board the motor vessel "Mayflower Garden" on the River Thames on January 12th ... American amateurs are concerned at the very high failure rate of candidates sitting examinations for "Advanced Class" licences and have pointed out that the official FCC "study guide" often bears little relationship with the questions asked as a result of the updating of study guide and examination to different timetables.

PAT HAWKER, G3VA

More on the scientific computer — 2

An improved monitor

By J. H. Adams, M.Sc.

Since publication of the scientific computer, correspondents have suggested several features to improve the performance. This new monitor incorporates many of those features and includes a general expansion of the facilities available in BURP, including the routines for graph plotting. By restructuring the interpreter four extra functions, described in table 7, have been fitted into the three original e.p.r.o.ms. The demonstration programs have been removed, but these could be stored on tape, and the Creed 75 teleprinter interface has been replaced by a standard 110 baud ASR/KSR interface. The KSR machine is now cheaper and is fairly standard whereas the 75 may have different speeds and encoding as I suspect some readers have found to their cost.

Hardware modifications

Connections for the two extra keys are shown in Fig 3. The interface for the teleprinter is essentially a latch as in the original design, but this must be connected to D_0 instead of D_7. Most teleprinters contain an interface card for a 20mA loop or an RS-232 link. For a current loop, the second circuit drives the printer quite satisfactorily.

Firmware modifications

Changes to the firmware are detailed in tables 8 and 9. Primarily, space has been made in the first e.p.r.o.m. for three of the subroutines originally in the second which deal with instruction entry and condition testing of the MM57109. This has been achieved by using a simpler and shorter teleprinter interface, eliminating the subroutine at 034E, and trimming the low level monitor so that it ends at 024E. This has left space in the second e.p.r.o.m. for a new subroutine 051D which extends the old 04E6, now 047C, and together they can recognise and deal with the new facilities. Because these routines are quite complex, a disassembled listing of each is given in table 10.

The third r.o.m. is slightly briefer because checks for ends of lines, present in virtually all of the statement handling routines, are replaced by 051D. The command MOD (08BE) has been changed so that PRINTs buried in multi-statement lines are also changed to WRITEs. CALLs have been readdressed to suit the first two r.o.ms and CALL 042E has been replaced by the single RST byte CF (see 0008). In the original r.o.m., after going through the sequence of recognition checks for encoded commands or, later, first words of statements, the interpreter returns to the command state or ignores the rest of the line respectively, if it cannot find a match or the generated code within the firmware.

This is particularly useful for dealing with REM because, being unrecognised, such lines are ignored as explained last month. A major change in the modified r.o.m. provides jumps to 1C00 (at 0975) for commands, to 1C60 (at 0AD7) for new statements and to ID00 (at 0BDE) for new functions. As a result REM has disappeared but the apostrophe has the same effect and retains the facility for remarks.

0993 is an example of where 051D is used solely to jump spaces between the line number and the first word of the statement. Therefore, it is the point to which 051D transfers execution after coming across an ! in the text being interpreted. 097F pops off the stack, increments and pushes back the C register which is used as the line register store and then looks for and executes that new line. Thus, it is the point to which 051D transfers control after finding a ' or 8DH number in the text. Because the computer scans the text for line numbers whether they exist or not, the lines in a program should be as close together as possible (say every other line) for the fastest program execution. Using multiple statements avoids this problem to some extent and can therefore reduce the execution time of some programs, particularly simple ones, by up to 20%.

Table 7. Additional facilities for the new monitor.

INT (0B64)	Outputs the number in the 57109 to 1E00 — F and tests the exponent sign. If negative, the whole number is written to zero, if positive, the lower mantissa exponent is drawn and used to calculate (0B72-8) where blanking should start. If the exponent is not less the 09 (0B80-B), blanking is carried out. The number stack in the 57109 is then collapsed by one to remove the old value (0B97) and the new value is entered into the 57109 by a jump to 050F at 0B9A.
FRAC (0BA1)	Outputs the number and tests as in INT. If the exponent sign is negative, execution jumps to 0B96 (0BA5) and effectively does nothing. For positive exponents a similar sum involving the lower mantissa exponent digit is performed and a jump is made back to 0B79 in the INT routine (0BAE).
RND (0BB4)	029F is called which loads the refresh register into A, converts it to a three digit decimal integer and enters it into the 57109 (this subroutine runs straight into 02AD). A pseudo-random delay (0BB8-A) based on the current v.d.u. printing position is then called so that a second call of 029F will generate a second number from the Z80 refresh register which is only tenuously linked to the first. These numbers, now in the Y and X registers of the 57109, are combined through the sequence of instructions at 0BBE to give X = 128X + Y/16383, i.e. a reasonably random number between 0 and 1. Note that as this uses two of the 57109 stack registers, no more than two other variables must be present in the 57109 when RND is used.
ABS (0BD3)	This simply uses the number cruncher test instruction 12 to test for a negative number in the X register. The result of this test governs whether the instruction to change sign, 0C, is executed.

Table 8. Alterations to the first r.o.m.

024F was 03CE	0263 was 0260	0282 was 058A
02AD was 024E	02C7 was 0446	0326 was 0317
0345 was 0336	0367 was 0729	0374 was 0372
0395 was 0393	03A1 was 039F	03AB was 03A9
03C6 was 03C4	03D1 was 0260	

029F Generates a 7-bit pseudo-random number and inputs it to the 57109.
02D1 Converts the computer 6-bit ASCII to true ASCII and prints it.
02D9 Prints a space.
02DE Prints carriage return and line feed.
02E8 Prints the contents of register A.
02F0 Prints (A) as a two character hexadecimal byte.
0317 Prints CR, LF, the contents of HL in hexadecimal and a space

Using the new facilities

In low level the first feature to be noted is that READY does not disappear when a command is typed in nor does the first letter appear at the beginning of the second v.d.u. line. This is because the same algorithm is now used for both high and low level word recognition. Clashes produced in the changeover explain the changes of COR to MOD and PROM to PROG. To leave LOAD, the space key is now used instead of @. The main change which affects both levels is that the interrupt-and-reset, which occurred whenever any key was depressed, has been omitted because control can be regained by using RESET. The "arrow" keys now revert to standard keys, RESET enters the low level and Control A (depressing A and the control key simultaneously) enters the high level. The delete key to the right of] can be used to delete complete bytes by one depression per byte. Although this will cause the formatting to go out of true during the LOAD, the grouping by four is maintained and on pressing the space bar at the end of the load the format will be restored.

When loading programs in high level language, another character Control E is used to signify the end of LOADing or ADDing. This allows the colon, which was previously used for this purpose, to be included in printed messages etc. without terminating the current operation. Ensuring correct format of the input has been eased by a cursor, although with the original monitors few problems will be encountered if a space is typed when in doubt. The DEL key backsteps and clears the last v.d.u. character and also backsteps HL. Corrections are, therefore, easily typed in, but mistaken returns and line numbers cannot be corrected in this way because

Fig. 3. Modifications to the keyboard and teleprinter interface.

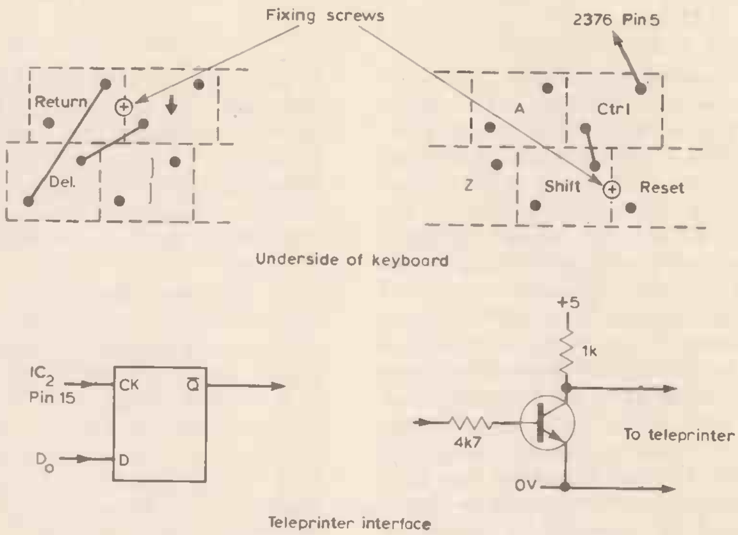


Table 9. Firmware changes.

0400	Old 04D4 running straight into 040D
040D	Old 0460
0467	Old 04BA
047C	Old 04E6, 04FA-E is added to this so that when a code of less than 0B is drawn from the look-up table at the end of the r.o.m., execution jumps to 0B60. These new codes are for ABS, FRAC, INT, RND and any others which are not simple MM57109 operations and will thus require some Z80 software.
051D	Jumps spaces and then returns on bytes less than 1B and greater or equal to 2A (except for 8D). Thus, for letters, operators and spaces, this routine will just jump spaces and return with HL pointing to the first non space, i.e. 051D is a supplement to 047C. If the byte found lies between 1A and 2A it will, after; (a) "(052D) transfer text up to the next" onto the v.d.u. and then jump back to the start of the subroutine to deal with whatever follows. (b)) (053B) collapse the stack and return. (c) ((0542) call 051D to jump spaces and then 047C to execute the text within the parentheses until the call of 051D finds a). As this) will have been found during the calling of 051D at 0546 and as) indicates that the original call of 051D is no longer required, i.e. the bracketed term has been computed, detection of) drops the stack pointer past the return address the call at 0546 so that a return is made to the original point in the interpreter from where 051D was called. After dealing with an expression in parentheses, the computed result is left in the X register of the 57109 and the SCII for), 29, is left in register A. If the interpreter has not yet recognised the byte it must now be at the end of the statement. Before looking for a ! ' or 8DH, two types of statement need special attention. 1FE1 is used in the third r.o.m. (0999) to store the code generated from the first word of the line. If it is 33 (i.e. a WRITE statement), execution shifts from 0554 to 056B. WRITE lines are similar to print types except that the material to be displayed is fed to locations from 1D80 rather than to the v.d.u. 056B sets an FF at the end of the block used and then resets DE to 1D80 and outputs the characters up to FF on the teleprinter. After restoring AF and DE it returns to 0563. If the line is a LET (code 2C) the variable to which the computed value is to be assigned is drawn from its store (1FE2) and the contents of the 57109 X register are fed to it. After dealing with these two special cases, checking of the original byte continues (0560). The remaining possibilities will transfer control rather than return from the subroutine and so the pointer is moved down the stack, losing the previously stored return address and then, after; (d) ! (0563) execution passes to 0993. (e) 8DH ' or anything else, passes execution to 097F. 8D is the code for return and indicates the end of a line. ' signifies that the rest of the line is a remark which the interpreter will also want to treat as the end of a line.
0582-4	Jumps text and then calls 051D and, when required (i.e. letters, operators or digits), 047C as well.
0589	Calls 051D as above.
0594	Old 0714.
05A9	Unchanged.
0736	Unchanged.
074A	Modified 074A.
075A	Old 076D.
0773	Used in the above two to cover common parts and thus save space.
0789	Used in INT and FRAC.
07A2	Unchanged.
07AC	Unchanged.
07B7	Unchanged.
07D6	Look-up table which now includes codes for new functions (07DA/DC/E3/E9).

they involve internal operations by the interpreter rather than the byte by byte storage which takes place during lines. The critical formatting points are LET lines where the variable following let must be followed immediately by the equal sign, and IF lines where, when a variable precedes the comparison sign, there must be a space in between.

A program in table II demonstrates the uses of the new facilities. Lines 3 and 4 show the new REM and in this case they are complete lines on their own. Remarks may be appended to any "active" line just preceded by an apostrophe. Line 5 shows printed text in an INPUT line. The input variable X is against the " to save r/w.m. space but again, spacing is not critical. In line 7, two spaces are left between step and 1 without any effect on the interpreting of the line. Note that the expression in parenthesis is spaced exactly as in a LET statement. Line 9 demonstrates the compounding of two LET type statements (with the LET omitted) by the use of an exclamation mark. The statement following ! is typed immediately after the !, again to conserve r/w.m. space. Line 11 is "If K is a whole number and if Z is also a whole number, then print half of K plus A to two decimal figures and then half of the positive difference between K and A". This line illustrates the need for a space between the variable and the greater than, equals or less than sign. A space is required because, under the original interpreter, this had to be a variable but it can now be a variable, number or function in parenthesis and therefore has to be distinguishable. A closing parenthesis has no other meaning and does not need the space, i.e. IF (X SIN I —) = Q print....

The text following an IF comparison can be any other permitted statement including another IF as shown in the example program. Therefore, the old form IF X = 0 THEN I25 will be IF X = 0 GO 125. It might seem that the freedom to place statements end to end on the same line will reduce all programs to one line in length (note that a line is not determined by the length of a v.d.u. line and may consist of any number of characters). However, this is not so because whenever a statement has to be entered as the result of a jump, or it initiates a specific jump, the statement must either start or end a program line respectively. This means that the first instruction in a FOR loop must be at the beginning of a line because further through the execution a NEXT will try to jump back to it. Similarly, the statement after the complete IF term must be on a new line because IF is basically "perform the operation specified after the conditional test if the latter is true or jump to the next line".

By similar reasoning, GOSUB and GO should be at the end of lines, as should RETURN and END. The lines to which GOSUB and GO refer should start with the statement to which the jump was directed.

While encoding the new functions by algorithm, several clashes occurred with already assigned codes and this provided an opportunity to re-encode the two log. functions into a more standard format, i.e. CLG for a common log and LOG for log. to the base e. The radian to degree conversions have also been changed by dropping the first letter, i.e. TD for a conversion to degrees and TR for one to radians.

The author is offering a set of three p.r.o.ms programmed with the new monitor firmware for £30. Alternatively, existing p.r.o.ms can be reprogrammed for £6.50 (both plus 35p post and packing). 5 The Close, Radlett, Hertfordshire.

Table 10. Disassembled subroutines.

```
047C  LD A,(HL)
047D  INC HL
047E  LD C,0F
0480  CP  20
0482  JRZ  F8 047C
0484  CP  1B
0486  JRC  51 04D9
0488  CP  30
048A  JRNC 17 04A3
048C  CP  2D
048E  JRNZ 03 0493
0490  CP  (HL)
0491  JRC  0C 049F
0493  ADD 0D
0495  AND A
0496  JP PE049D
0499  OR  09
049B  AND FB
049D  RST 1
049E  RET
049F  LD C,0C
04A1  LD A,(HL)
04A2  INC HL
04A3  EX AF AF'
04A4  PUSH DE
04A5  EX DE,HL
04A6  LD HL,1E00
04A9  LD B,0F
04AB  CALL 05A0
04AE  LD L,09
04B0  LD (HL),C
04B1  LD L,00
04B3  EX AF AF'
04B4  AND 0F
04B6  CP  0E
04B8  JRNZ 02 04BC
04BA  LD A,0A
04BC  LD (HL),A
04BD  LD A,(DE)
04BE  INC HL
04BF  INC DE
04C0  CP  28
04C2  JRNC F0 04B4
04C4  CP  20
04C6  JRZ  44 050C
04C8  LD L,0A
04CA  LD (HL),0B
04CC  INC HL
04CD  LD A,(DE)
04CE  INC DE
04CF  CP  2D
04D1  JRNZ E1 04B4
04D3  LD (HL),0C
04D5  INC HL
04D6  LD A,(HL)
04D7  JR  DB 04B4
```

```
04D9  EX AF AF'
04DA  LD A,20
04DC  CP  (HL)
04DD  JRNZ 03 04E2
04DF  EX AF AF'
04E0  JR  2E 0510
04E2  DEC HL
04E3  CALL 0715
04E6  CP  20
04E8  JRNC 02 04EC
04EA  ADD 20
04EC  CP  50
04EE  JRC  02 04F2
04F0  SUB 10
04F2  ADD B4
04F4  PUSH .BC
04F5  LD C,A
04F6  LD B,07
04F8  LD A,(BC)
04F9  POP BC
04FA  CP  0B
04FC  JP C 0B60
04FF  CP  80
0501  JRC  05 0508
0503  EX AF AF'
0504  LD A,20
0506  RST 1
0507  EX AF AF'
0508  AND 3F
050A  RST 1
050B  RET
050C  DEC DE
050D  EX DE,HL
050E  POP DE
050F  XOR A
0510  PUSH HL
0511  CALL 07AC
0514  LD B,10
0516  LD A,(HL)
0517  INC HL
0518  RST 1
0519  DJNZ  FB 0516
051B  POP HL
051C  RET
```

```
051D  INC HL
051E  LD A,(HL)
051F  CP  20
0521  JRZ  FA 051D
0523  CP  1B
0525  RET C
0526  CP  8D
0528  JRZ  03 052D
052A  CP  2A
052C  RET NC
052D  CP  22
052F  JRNZ 0A 053B
0531  INC HL
0532  LD A,(HL)
0533  CP  22
0535  JRZ  E6 051D
0537  LD (DE),A
0538  INC DE
0539  JR  F6 0531
053B  CP  29
053D  JRNZ 03 0542
053F  INC SP
0540  INC SP
0541  RET
0542  CP  28
0544  JRNZ 08 054E
0546  CALL 051D
0549  CALL 047C
054C  JR  F8 0546
054E  PUSH AF
054F  LD A,(1FE1)
0552  CP  33
0554  JRZ  15 056B
0556  CP  2C
0558  JRNZ 06 0560
055A  LD A,(1FE2)
055D  CALL 040D
0560  POP AF
0561  INC SP
0562  INC SP
0563  CP  21
0565  JP Z 0993
0568  JP 097F
056B  LD A,FF
056D  LD (DE),A
056E  LD E,80
0570  LD A,(DE)
0571  CP  FF
0573  JRZ  08 057D
0575  AND 3F
0577  CALL 02D1
057A  INC DE
057B  JR  F3 0570
057D  POP AF
057E  POP DE
057F  POP DE
0580  JR  E1 0563
```

Table 11. Demonstration programs.

```
003 'THIS PROGRAM, PUBLISHED IN PART 4, TOOK 19 LINES BEFORE. NOW...
005 PRINT "THIS PROGRAM USES NEWTONS METHOD FOR SOLVING"
007 INPUT "F = F(X). ENTER AN INITIAL VALUE NOW "Q !ERASE
009 X=Q !GOSUB 25
011 G=F !X=X 1.00001 * !GOSUB 25
013 TOP !IF (G ABS )<0.000001 PRINT "SOLUTION ="G6 !END
015 Q=1 F G / 1 - REC 0.00001 * - Q * !PRINT Q8 !GO 9
025 F=X LOG X 3 * + 10.3074 -
027 RETURN

0D78

003 'THIS PROGRAM COMPUTES PAIRS OF NUMBERS WHICH, WHEN
004 'SQUARED AND SUBTRACTED, GIVE THE INPUT NUMBER
005 INPUT "INPUT NUMBER IN QUESTION "X
007 FOR A=1 STEP  1 UNTIL (X ROOT 1 + )
009 K=X A / !Z=K A - 2 / ABS
011 IF K =(K INT ) IF Z =(Z INT ) PRINT (K A + 2 / )2 (K A - 2 / ABS )
013 NEXT A !GO 5

0D26
```

New frequency allocations

WARC 79 decisions for radio services in Region 1

The list opposite gives frequency allocations to radio services decided at the World Administrative Radio Conference (WARC 79) held by the International Telecommunication Union at Geneva, 24 September to 6 December. It is taken from the revised Radio Regulations which will come into force on January 1982 and will replace the allocations made at the previous event of this kind held in Geneva in 1959 (see October 1979 issue, p.52, for background). Because of lack of space, and the interests and geographical distribution of our readers, the information presented here is no more than an extract from the international table of frequency allocations which will be part of the Regulations and in its present form runs to 174 pages and includes hundreds of footnotes, giving additions, qualifications, restrictions etc for particular countries. First, our list covers only ITU Region 1 (Europe, Africa, Middle East and Russia). Secondly, its upper limit is 10GHz whereas the WARC allocations in fact go up as far as 275GHz. Thirdly, all the footnotes have been omitted. Nevertheless, the list does give details of the main changes which are particularly important to radio services in the UK.

For example: as a result of a change in the long-wave band limits, Droitwich (Radio 4) frequency will eventually have to be moved to 198kHz; the BBC have obtained a medium-wave frequency for their Carfax traffic information service; international short-wave broadcasting has acquired overall an additional 780kHz, including an extra band; television Channel 1 (Crystal Palace and other stations) will be transferred from broadcasting to radio communication; land mobile radio may be moving into parts of television Band I and Band III by internal agreement within the UK (the 405-line television services in these bands probably will be closing down by 1985); v.h.f. radio broadcasting will eventually be extended up to 108MHz, though for a long time it will be sharing the top end of this band (104-108MHz) with communication services; at u.h.f. two 8MHz channels will eventually become available, perhaps for land mobile radio or television, between television Bands IV and V; and at the top end of the u.h.f. band there is more space for mobile services. However, it will take a good many years for all these changes to be implemented and some will not occur till near the time of the next WARC, possibly in 2000AD.

In the lists, the code letters show the radio services to which the frequencies have been allocated, and these codes are explaind in the key below. The terminology here is approximately the same as that used in the ITU frequency allocation document. In all cases the first code letter, to the immediate right of the frequency band, indicates a "primary" service (using ITU terminology) in the band, that is, a service which has equal rights with a "permitted" service but has prior choice of frequencies when frequency plans are made. The next code letter to the right could also indicate a primary service, but in some cases it could be a "permitted" service (which has rights equal to those of a primary service except that it gets the second choice in frequencies), or a "secondary" service (which must not cause interference to primary services and cannot claim protection from interference produced by them). To avoid complications in a short article, our list does not indicate the actual categories of service applying to the second and subsequent code letters, but in general a rough guide is that the order of categories when moving through the code letters from left to right is: primary, permitted, secondary.

The following notes highlight some of the changes which may be of interest to our readers.

Long waves

The limits of the l.w. broadcasting band (150-285kHz) have been moved downwards in frequency by 1.5kHz to 148.5-283.5kHz. This has been done to bring the band in line with medium waves in having its carrier frequencies at integral multiples of the 9kHz channel spacing, to avoid heterodyne interference and facilitate digital tuning of receivers using synthesizers. The 15 channels will be moved in three blocks of 5 channels, starting in 1986 with the lower limit and ending in 1990 with the upper limit. As a result the 200kHz Droitwich broadcasting frequency will be changed to 198kHz (9kHz × 22). Radio beacon frequencies for aircraft navigation within this range will be changed accordingly.

Medium waves

The band limits of the m.w. broadcasting band (525-1605kHz) have been adjusted upwards to 526.5-1606.5kHz to give the correct amounts of space for the sidebands at these limits — an adjustment that was not made at the 1974-75 regional l.f./m.f. broadcasting conference (January 1976 issue, p.42). Just below this the BBC have acquired a 7kHz band of 519.5 to 526.5kHz on a secondary basis for their experimental Carfax traffic information service.

Short waves

The short-wave broadcasters did not get the hoped-for increase of sixty per cent or more in spectrum space but did achieve an extra 780kHz overall, which amounts to 32.5% over the present allocation. They acquired a new band at 13.6-13.8MHz (21m), extended the 13m, 16m, 19m, 25m and 31m bands by amounts varying between 100kHz and

continued overleaf

Key to code letters in list

A	Amateur
AF	Aeronautical fixed
AM	Aeronautical mobile
AMS	Aeronautical mobile — satellite
AR	Aeronautical radionavigation
AS	Amateur satellite
B	Broadcasting
BS	Broadcasting — satellite
ES	Earth to space (satellite)
F	Fixed communications
HA	Hearing aids
ISM	Industrial, scientific, medical
LM	Land mobile
M	Mobile
MA	Meteorological aid
MBS	Mobile — satellite
MLS	Microwave landing system
MM	Maritime mobile
MMS	Maritime mobile — satellite
MR	Maritime radionavigation
MS	Meteorological — satellite
RA	Radio astronomy
RL	Radiolocation or radar
RN	Radionavigation
RNS	Radionavigation — satellite
S	Space research
SAT	Satellite (Earth exploration)
SE	Space to earth (satellite)
SF	Standard frequency
SFS	Standard frequency — satellite
SI	Satellite identification
TS	Time signal

Table of frequency allocations for Region 1

L.F. (kHz)	SERVICES
9-14	RN
14-19.95	F, MM
19.95-20.05	SF & TS
20.05-70	F, MM
70-72	RN
72-84	F, MM, RN
84-86	RN
86-90	F, MM, RN
90-110	RN
110-112	F, MM, RN
112-115	RN
115-117.6	RN, F, MM
117.6-126	F, MM, RN
126-129	RN
129-130	F, MM, RN
130-148.5	MM, F
148.5-255	B
255-283.5	B, AR
283.5-315	MR, AR
M.F.	
315-325	AR, MR
325-405	AR
405-415	RN
415-435	AR, MM
435-495	MM, AR
495-505	M (Distress)
505-526.5	MM, AR
519.5-526.5	BBC Carfax
526.5-1,606.5	B
1,606.5-1,625	MM, F, LM
1,625-1,635	RL
1,635-1,800	MM, F, LM
1,800-1,810	RL
1,810-1,850	A
1,850-2,025	F, M
2,025-2,045	F, M, MA
2,045-2,160	MM, F, LM
2,160-2,170	RL
2,170-2,173.5	MM
2,173.5-2,190.5	M (Distress)
2,190.5-2,194	MM
2,194-2,300	F, M
2,300-2,498	F, M, B
2,498-2,501	SF, TS
2,501-2,502	SF, TS, S
2,502-2,625	F, M
2,625-2,650	MM, MR
2,650-2,850	F, M
2,850-3,025	AM
H.F. (MHz)	
3.025-3.155	AM
3.155-3.195	HA
3.155-3.20	F, M
3.20-3.40	F, M, B
3.40-3.50	AM
3.50-3.80	A, F, M
3.80-3.90	F, AM, LM
3.90-3.950	AM
3.950-4.0	F, B
4.0-4.063	F, MM
4.063-4.438	MM
4.438-4.650	F, M
4.650-4.750	AM
4.750-4.850	F, AM, LM, B
4.850-4.995	F, LM, B
4.995-5.003	SF, TS
5.003-5.005	SF, TS, S
5.005-5.060	F, B
5.060-5.450	F, M
5.450-5.480	F, AM, LM
5.480-5.730	AM
5.730-5.950	F, LM
5.950-6.200	B
6.20-6.25	MM
6.525-6.765	AM
6.765-6.795	ISM
6.765-7.0	F, LM
7.0-7.10	A, AS
7.10-7.30	B
7.30-8.10	F, LM
8.10-8.195	F, MM
8.195-8.815	MM
8.815-9.040	AM
9.040-9.50	F
9.50-9.90	B
9.90-9.995	F
9.995-10.003	SF, TS
10.003-10.005	SF, TS, S
10.005-10.10	AM
10.10-10.150	F, A
10.150-11.175	F, M
11.175-11.400	AM
11.40-11.650	F
11.650-12.050	B
12.050-12.230	F
12.230-13.20	MM
13.20-13.360	AM
13.360-13.410	F, RA
13.410-13.60	F, M
13,553-13,567	ISM
13.60-13.80	B
13.80-14.00	F, M
14.00-14.250	A, AS
14.250-14.350	A
14.350-14.990	F, M
14.990-15.005	SF, TS
15.005-15.010	SF, TS, S
15.010-15.10	AM
15.10-15.60	B
15.60-16.360	F
16.360-17.410	MM
17.410-17.550	F
17.550-17.90	B
17.90-18.030	AM
18.030-18.052	F
18.052-18.068	F, S
18.068-18.168	A, AS
18.168-18.780	F
18.780-18.90	MM
18.90-19.680	F
19.680-19.80	MM
19.80-19.990	F
19.990-19.995	SF, TS, S
19.995-20.010	SF, TS
20.010-21.0	F, M
21.0-21.450	A, AS
21.450-21.850	B
21.850-21.870	F
21.870-21.924	AF
21.924-22.000	AM
22.0-22.855	MM
22.855-23.000	F
23.0-23.2	F, M
23.20-23.35	AF, AM
23.35-24.00	F, M
24.00-24.890	F, LM
24.890-24.990	A, AS
24.990-25.005	SF, TS
25.005-25.010	SF, TS, S
25.010-25.070	F, M
25.070-25.210	MM
25.210-25.550	F, M
25.550-25.670	RA
25.670-26.100	B
26.10-26.175	MM
26.175-27.50	F, M
26.957-27.283	ISM
27.5-28.0	MA, F, M
28.0-29.7	A, AS
29.7-30.005	F, M
V.H.F.	
30.005-30.010	SI, F, M, S
30.01-37.5	F, M
37.5-38.25	F, M, RA
38.25-39.986	F, M
39.986-40.02	F, M, S
40.02-40.98	F, M
40.66-40.70	ISM
40.98-41.015	F, M, S
41.015-47.00	F, M
47.0-68.0	B, LM
68.0-74.80	F, M
74.80-75.20	AR
75.20-87.50	F, M
87.50-100.0	B, LM
100.0-108.0	B, F, M, LM
108.00-117.975	AR
117.975-136.00	AM
136.0-137.0	AM, F, M
137.0-138.0	SE, MS, F, M
138.0-143.60	AM, LM, MM
143.60-143.65	AM, SE, LM, MM
143.65-144.00	AM, LM, MM
144.0-146.0	A, AS
146.0-149.9	F, M
149.9-150.05	RNS
150.05-153.0	F, M, RA
153.0-154.0	F, M, MA
154.0-156.7625	F, M
156.7625-156.8375	MM (Distress)
156.8375-174.00	F, M
174.0-223.0	B, LM
223.0-230.0	B, F, M, LM
230.0-267.0	F, M
267.0-272.0	F, M, SE
272.0-273.0	SE, F, M
273.0-322.0	F, M
U.H.F.	
322.0-328.6	F, M, RA
328.6-335.4	AR
335.4-399.9	F, M
399.9-400.05	RNS
400.05-400.15	SFS
400.15-401.00	MA, MS, SE
401.0-402.0	MA, SE, ES, F, MS, M
402.0-403.0	MA, ES, F, MS, M
403.0-406.0	MA, F, M
406.0-406.1	ES
406.1-410.0	F, M, RA
410.0-420.0	F, M
420.0-430.0	F, M, RL
430.0-440.0	A, RL
433.05-434.79	ISM
440.0-450.0	F, M, RL
450.0-460.0	F, M
460.0-470.0	F, M, SE
470.0-582.0	B
582.0-606.0	AR (UK only)
606.0-790.0	B, BS
790.0-862.0	F, B
862.0-890.0	F, M, B
890.0-942.0	F, M, B, RL
942.0-960.0	F, M, B
960.0-1,215	AR
(GHz)	
1.215-1.240	RL, SE
1.240-1.260	RL, SE, A
1.260-1.30	RL, A
1.30-1.35	AR, RL
1.35-1.40	F, M, RL
1.40-1.427	SAT, RA, S
1.427-1.429	ES, F, M
1.429-1.525	F, M
1.525-1.530	SE, F, SAT, M
1.530-1.535	SE, MMS, SAT, F, M
1.535-1.544	MMS
1.544-1.545	MBS
1.545-1.599	AMS
1.559-1.610	AR, RNS
1.610-1.6265	AR, RA
1.6265-1.6455	MMS
1.6455-1.6465	MBS
1.6465-1.660	AMS
1.660-1.6605	AMS, RA
1.6605-1.6684	RA, S, F, M

1.6684-1.670	MA, F, M, RA
1.670-1.690	MA, F, MS, M
1.690-1.700	MA, MS, F, M
1.700-1.710	F, MS, M
1.710-2.290	F, M
2.290-2.300	F, S, M
2.300-2.450	F, A, M, RL
2.400-2.500	ISM
2.450-2.500	F, M, RL
2.500-2.655	F, M, BS
2.655-2.690	F, M, BS, SAT, RA, S
2.690-2.70	SAT, RA, S
2.70-2.90	AR, RL
2.90-3.100	RN, RL
S.H.F.	
3.100-3.400	RL
3.40-3.60	F, SE, M, RL, A
3.60-4.20	F, SE, M
4.20-4.40	AR
4.40-4.50	F, M
4.50-4.80	F, SE, M
4.80-4,990	F, M, RA
4.990-5.000	F, M, RA, S
5.0-5.250	AR, MLS
5.250-5.255	RL, S
5.255-5.350	RL
5.350-5.460	AR
5.460-5.650	RN, RL, LM
5.650-5.725	RL, A, S
5.725-5.850	ES, RL, A
5.725-5.875	ISM
5.850-7.075	F, ES, M
7.075-7.250	F, M
7.250-7.450	F, SE, M
7.450-7.550	F, SE, MS, M
7.550-7.750	F, SE, M
7.750-7.900	F, M
7.900-8.025	F, ES, M
8.025-8.175	F, ES, M, SAT
8.175-8.215	F, ES, MS, M, SAT
8.215-8.400	F, ES, M, SAT
8.40-8.50	F, M, S
8.500-8.750	RL
8.750-8.850	RL, AR
8.850-9.000	RL, RN
9.0-9.2	AR
9.2-9.8	RL, RN
9.80-10.0	RL, F

200kHz (see list) but lost 70kHz from the lower end of the 11m band, which is now 25.67-26.1MHz. There was no change below 9MHz. These gains were obtained, initially against considerable opposition, at the expense of the fixed h.f. communication bands, which tend to alternate with the broadcasting services; but the fixed services will be offered replacement frequencies. The transfers will not start until 1984, but in any case it was decided that there will be a new conference for planning the h.f. broadcasting bands and this could take place in 1982 or 1983. The first part will establish the technical parameters, then, when everyone has digested the same basic data, the planning proper will start a year or more later. At WARC 79 nineteen delegations, including the UK's, "reserved their positions" on h.f. broadcasting, which means that, in the absence of an adequate plan, they do not intend to be bound by these decisions. They felt, for example, that not enough spectrum was allocated in the 41m and 49m broadcasting bands.

The maritime mobile service has also gained some extra space at h.f., several of the higher bands being increased by 100kHz or more.

V.h.f. bands

The radio communication services gained some extra frequencies at v.h.f. in parts of the spectrum they have not been in before. For example, 41.015-47.0MHz will be exclusively for fixed and mobile communications. Hitherto in Britain 41-47MHz has been allocated to 405-line television broadcasting (Channel 1 of Band I) and in fact the BBC will be able to keep it on a primary basis till 1987 (and the French broadcasters till 1986). Furthermore, the land mobile service of 30 countries including the UK have been allocated 47.0-68MHz (the remainder of the UK tv Band I) on a permitted basis, leaving broadcasting as the primary occupant. When, however, 405-line television broadcasting is closed down, and in the absence of alternative broadcasting requirements, land mobile radio could be allowed to take over the whole band.

The land mobile service of the UK and 15 other countries has also obtained the band 174-223MHz on a permitted basis. Hitherto 174-216MHz has been occupied exclusively by television broadcasting (Band III for 405-line transmissions in the UK) and this service will continue to use it, and the extension to 223MHz, on a primary basis until 405-line tv is closed down. And land mobile radio in 19 countries including the UK will also be moving into an adjacent band 223-230MHz on a permitted basis. The primary occupant of this band will be broadcasting, while fixed and mobile communications are to use it on a secondary basis.

The land mobile and maritime mobile services have primary allocations in 29 countries, including the UK, throughout the band 138-144MHz.

However, mobile radio will be losing some spectrum in the region of 100MHz as v.h.f./f.m. sound broadcasting is extended upwards in frequency (January issue, p. 63). Broadcasting in fact will eventually become the primary service in a band 87.5-108MHz and has a common world-wide allocation from 100 to 108MHz (a decision forced mainly by the African countries) and the UK police and fire mobile radio at present using 97.6-102.1MHz will have to move by the end of 1989. Up to then they will remain on a permitted basis and there will probably be a phased withdrawal over the next ten years. Meanwhile fixed and mobile services will continue to use 100-104MHz on a primary basis until a new plan made by a regional broadcasting conference (possibly in 1983) comes into force. And 104-108MHz is allocated to mobile radio on a permitted basis till the end of 1995 and on a secondary basis thereafter. In the UK this 104-108MHz is at present used for private mobile radio (e.g. the nationalized public services). Thus broadcasting and radio communication will be equally sharing 104-108MHz for probably the next twenty years. At the bottom end of the 87.5-108MHz band, the section 87.5-88MHz is also allocated on a permitted basis to the land mobile service in ten countries included the UK. A new conference entirely devoted to mobile radio is likely to be held in about 1982.

U.h.f. bands

Broadcasting will be the primary service in the band 470-790MHz and will share with fixed communications, also a primary service, from 790 to 862MHz. In the UK however, television Bands IV and V are at present separated by three 8MHz channels of the aeronautical navigation service, taking 582-606MHz. The channel at 582-590MHz will continue until the end of 1987 and the channel 598-606MHz until the end of 1994. Thus this aeronautical service will eventually be squeezed into one 8MHz channel at 590-598MHz and the other two could be used either for land mobile radio or television broadcasting. The top end of the u.h.f. band, 862-960MHz, has been opened up to mobile radio, which is something the UK delegation particularly wanted to achieve. In this 862-960MHz band the broadcasting service shown in the list applies only to certain countries in the African broadcasting area.

Amateur radio

The amateur radio service uses frequencies throughout the spectrum for conventional and satellite communication. For comments on the WARC 79 allocations, see World of Amateur Radio by Pat Hawker elsewhere in this issue.

We hope to deal with the allocations above 10GHz in a later issue. This is the part of the spectrum used by satellites, where some noteworthy changes have been made; for example the satellite allocation in the 10GHz region has been almost doubled and provision has been made for a mobile satellite service at 14GHz which would enable transportable earth stations to be taken to remote places for relaying television news and other events directly by satellite. Direct broadcasting from satellites to domestic rooftop aerials can now take place in the three bands: 11.7-12.5GHz (see January 1979 issue); 40-42.5GHz; and 84-86GHz. (The broadcasting satellite allocation in our list at 2.50-2.690GHz is limited to national and regional community reception systems.)

More detailed and complete information on the WARC 79 frequency allocations can be obtained from the Radio Regulatory Department, Home Office, Waterloo Bridge House, London SE1 8UA (tel: 01-275 3000). □

Multiphonic synthesizer organ

Improved circuit to eliminate 'thumps'

by J. H. Asbery, B.Sc.

The novel keyboard switching system described in an article in this journal in June, 1973, enabled six notes to be played simultaneously with the use of only six generators. One drawback to the original system was the production of 'clicks' and 'thumps' when keys were pressed and released: this new version uses the same switching arrangement, but an additional circuit to provide a smooth decay is included.

A multiphonic organ is one in which there are only as many generators as notes you wish to play at the same time, as distinct from one generator for every note on the keyboard, which is the case with a polyphonic organ. Two completely different types of multiphonic organ are in use.

The computer organ has a polyphonic generator system, producing a signal for each note of the keyboard, but only one basic waveshape. An electronic multiphonic switching system connects this signal to one of a limited number of waveshape processing units when a key is pressed. There are typically 12 of these units, so that only 12 notes may sound at the same time. A computer organ with only 6 wave shape processing units would be an attractive proposition, if a significant reduction in cost could be achieved.

The second type[1] uses a mechanical keyboard changeover switching system and generators, in which the frequency is determined by the value of the resistor connected to it by the keyboard switching system. Whilst these organs are satisfactory for home use, they are subject to a fundamental limitation: when the hand is lifted from the keyboard the connection to the resistor is broken, so that the signal ceases abruptly. At higher volume levels, such as those required for church or theatre use, this gives rise to objectional key clicks and thumps. The use of a reverberation unit mitigates this effect a little, but despite much work to find alternative means of reducing the clicks and thumps to an acceptable level, it appears that the only satisfactory and acceptable solution is to arrange for the sound to die away over a few cycles when the key is released.

Most synthesizers are monophonic, which is a severe limitation. There are a number of instruments in which a polyphonic generator system is used, the output waveform from the keyboard switching system being fed to a programmed, voltage-controlled filter, but the output from the keyboard switching system consists of a mixture of the different notes, so that it is not possible to process the signals individually by the usual synthesizer techniques.

By combining multiphonic techniques with synthesizer techniques, it is possible to overcome the limitation of the synthesizer, namely its monophonic

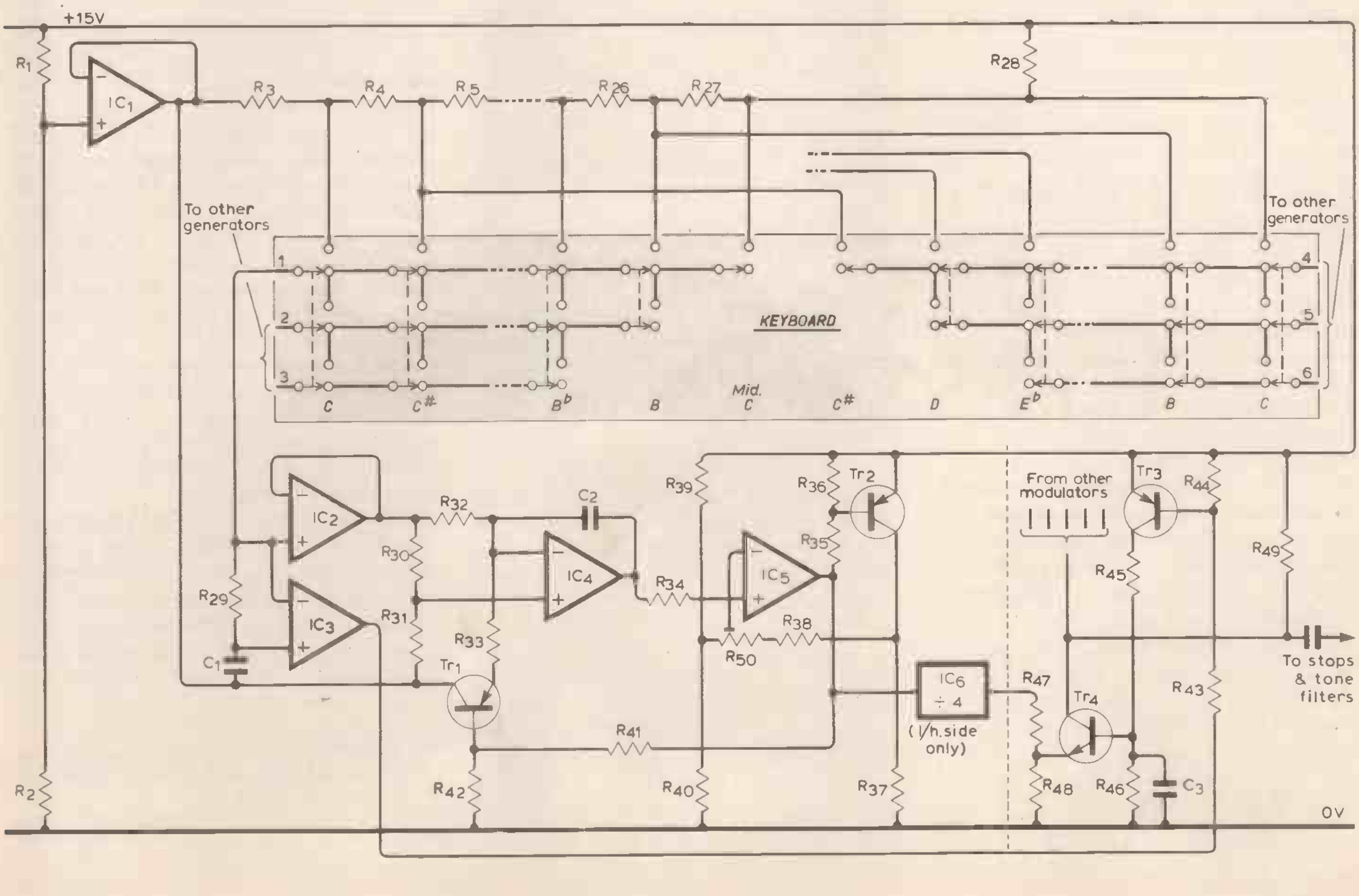


Fig. 1. Circuit of the multiphonic synthesizer organ

characteristic, by multiphonic techniques, and to overcome the limitation of inexpensive multiphonic organs by synthesizer techniques. The generators are voltage-controlled oscillators: it is therefore possible to store the switched voltage on a capacitor so that they will continue to oscillate at the correct frequency after the key has been released, and arrangements can be made to cause the sound to die away over a few cycles, completely eliminating click and thump. The waveform from each generator is available separately and unmixed for individual treatment and processing by existing synthesizer techniques.

Components list

Integrated circuits

1,2,3,4	741
5	709
6	74C93

(two 74C93s for three dividers)

Transistors

1,2,3	BC 307
4	BC.149

Capacitors

1	0.1μ, polyester 20%
2	0.025μ, polyester 5%
3,4	0.47μ, polyester 10%

Resistors

1	$2\times R_2$ 2% metal film
2	5k 20% metal film
3	162 1% metal film
4	10.0 1% metal film
5	10.5 1% metal film
6	11.3 1% metal film
7	11.8 1% metal film
8	12.8 1% metal film
9	13.3 1% metal film
10	14.0 1% metal film
11	15.0 1% metal film
12	15.8 1% metal film
13	16.9 1% metal film
14	17.8 1% metal film
15	18.7 1% metal film
16	20.0 1% metal film
17	21.0 1% metal film
18	22.6 1% metal film
19	23.7 1% metal film
20	25.5 1% metal film
21	26.7 1% metal film
22	28.0 1% metal film
23	30.1 1% metal film
24	31.6 1% metal film
25	33.2 1% metal film
26	35.3 1% metal film
27	37.4 1% metal film
28	165.0 1% metal film
29	100k carbon film
30	$=R_{31}$ 2% metal film
31	20k 20% metal film
32	$2\times R_{33}$ 2% metal film
33	7.7k 5% metal film
34	10k carbon film
35	10k carbon film
36	1k carbon film
37	1.2k 20% metal film
38	$=R_{40}$ 2% metal film
40	33k 20% metal film
41	2.2k 5% carbon film
42	4.7k 5% carbon film
43	100k 5% carbon film
44	10k 5% carbon film
45	220k 5% carbon film
46	100k 5% carbon film
47	100k 5% carbon film
48	33k 5% carbon film
49	3.3k 5% carbon film
50	1k 20% pot

The product of R_{33} and C_2 should be nominal plus or minus 1%.

We understand that Mr Asbery is prepared to supply components from 87, Oakington Manor Drive, Wembley, Middlesex.

Voltage-controlled oscillators

The requirements placed on voltage controlled oscillators for use in a multiphonic organ are more stringent than for a v.c.o. in a monophonic instrument. As there are more than one of these units, the cost and size become more significant and it is more important to minimize these. In a multiphonic instrument, the voltage for a given note is the same for all the v.c.os, so that high consistency between all the oscillators in the one instrument is essential.

The design of the ramp-type v.c.o. adopted, IC_4 and IC_5, is conventional except for the switching transistor Tr_1, which is used in a new way. When this design of v.c.o. is used with a switching transistor in conventional mode the transistor gives rise to a large variation between similar v.c.os: f.et.s. are sometimes used, but these are also subject to a wide tolerance spread. In conventional mode, the bottoming voltage of the transistor collector (transistor on) is of the order of 40 mV. Transistors are sometimes used in the reverse mode, in which the functions of collector and emitter are interchanged and the bottoming voltage is reduced to around 25mV. In the mode of operation used here, when the transistor is on, current flows from base to emitter and from base to collector in the same direction, rather like two separate diodes (except with much better characteristics). The bottoming voltage, that is the voltage between collector and emitter, is of the order of 2mV. As a result of this there is much better consistency between a number of similar v.c.o. units.

Decay switching

The second main problem of a multiphonic synthesizer is that it is not practical to provide two-pole, or two separate keyboard switching systems: the one system has therefore to perform two functions. It has to connect the v.c.o. to the voltage corresponding to the key pressed, and it provides an on/off control signal, for that generator, to control the modulation envelope sequence and any other signal processing sequence desired. The keyboard switching system connects the v.c.o. memory circuit, C_1, IC_2, to the correct voltage, enabling the oscillator to continue oscillating at the correct frequency after the note has been released. As the capacitor, C_1, holds the control voltage, there is no change of voltage and no signal available to initiate the decay sequence. If the capacitor, C_1, is omitted or much reduced, when the key is released the output voltage of IC_2 falls, providing a signal to initiate the decay sequence, but the frequency of the oscillator will be incorrect. In a monophonic synthesizer this problem is solved by a two pole switching system.

The solution adopted here is to interpose a resistor, R_{29}, between the switching system and the memory capacitor, C_1. IC_3 detects the direction of current flow through this resistor by detecting the polarity of the voltage across it. When the note is pressed the input current to the non-inverting input of IC_3 flows through R_{29}, so that the non-inverting input of IC_3 is more negative than the inverting input: the output is therefore low. When the key is released, the input current to the inverting input of IC_3 and the non-inverting input of IC_2 is derived from memory capacitor, C_1, and flows through R_{29}, and the inverting input of IC_3 becomes more negative than the non-inverting input, so that the output goes high. The output of IC_3 is the required control signal. When the key is released the output voltage of the memory, IC_2, falls by the sum of the voltages across R_{29} in the one and off states. In the organ described in this article the resulting change of frequency could not be detected by ear. However, if this slight frequency shift is not acceptable, correction can be made by mixing a small amount of the output of IC_3 with the output of IC_2.

The keyboard switching system is divided into two halves to minimize the work and cost and to reduce the range required from the v.c.os to two octaves. The left-hand oscillators are similar to the right-hand ones to ensure the required accuracy and avoid two sets of keyboard resistors. Two-stage, divide-by-2 units, to reduce the frequency by four are interposed between the output of the left-hand oscillators and the modulators or signal processing.

The keyboard resistors form a series system so that a low impedance can be provided without undue current consumption, and so that the value of each resistor only affects the frequency step from one note to the next.

The part of Fig. 1 to the left of the dotted line is the generator and on/off detector, which may be used to drive synthesizer circuits as desired. The circuit to the right of the dotted line is a simple organ envelope generator and modulator.

References

1. Multiphonic organ, J. H. Asbery. *Wireless World*, June 1973, p303.
2. 'Transistor organs for the amateur." Alan Douglas

What's so natural about *e*?

2 — The relationship of Euler's number to logarithms

by John C. Finlay

In the previous article the author presented the first part of a popular study of Euler's number, the key to universal laws of change. Here he continues with his use of graphical methods to show the relationship of *e* to natural logarithms, after discussing the invention of logarithms by John Napier.

The more inquisitive type of schoolboy, who has just managed to conquer the technique of using logarithms to the base of 10 (thanks to Henry Briggs from Yorkshire, 1561-1630), leafs through his new book of tables and comes across another table of logarithms, variously described as natural, hyperbolic or (wrongly) as Napierian. However, on seeing the odd-looking figures and the cumbersome calculations required for numbers lying outside the range of 1 to 10 he promptly shuts the book and forgets about them. That word 'natural' is pushing itself forward again and no doubt you are thinking "I won't be caught the second time. It's obviously *going* to be natural and has something to do with 'e'." And so, of course, it is. The really remarkable fact about natural logarithms is that a system very close to them was originally published by the landed Scottish aristocrat, John Napier (or Neper), 1550-1617, as the *first*-known logarithms, and long before Euler revealed any of several series for e. Now the historical approach to the study of a science is often rewarding, at the very least in clothing it with some often welcome human interest, and at best presenting a logical sequence of development of ideas and terms on a leisurely time scale, which may offer some consolation to the student of today who is expected to take it all in within five minutes! I can offer no such neat justification for looking at the history of logarithms – it is unbelievably tortuous, certainly curious, mathematically revealing and utterly fascinating. Above all, the invention of logarithms was, uniquely in mathematics, an unheralded 'bolt from the blue' (as it was described at a tercentenary celebration in 1914[10, 11]), owing nothing to any previous work.

Baron Napier, of Merchiston Castle, Edinburgh, had a major preoccupation, as a good Protestant in the dangerous times of the Spanish Armada, in lambasting Roman Catholicism and proving scientifically that the Pope was Antichrist. Fortunately, however, he took time off to try and help astronomers and navigators in their complicated calculations, a matter of growing importance in the expanding world that followed the explorations of the first Elizabethan age. In particular he wanted to reduce the labours of multiplication and division in frequently used trigonometrical formulas such as

$$\sin A \sin B = \frac{\cos(A-B)-\cos(A+B)}{2}$$

which you and I learned at school, and which was also well known in Napier's time.

Now suppose that, like Napier, you had no knowledge of the laws of indices and therefore no incentive to express numbers in that form, just what might you deduce from a comparison between these two sets of numbers:

1	2	3	4	5	6	(Arithmetic progression)
2	4	8	16	32	64	(Geometric progression)

(which we looked at earlier)? Obviously the first set is an A.P. because all the terms differ by the same value, namely unity, whereas the second is a G.P. since successive terms increase by the same multiplier, namely 2. You will then note that the G.P. is made up of multiples of 2 equal to the corresponding A.P. term, e.g. $16=2\times2\times2\times2$ (four 2s). Perhaps you have also spotted that any two terms in the G.P. multiplied together give another term somewhere in the list, e.g. $2\times4=8$ and $4\times16=64$. All this so far was well known before Napier's time. But now have another look at the A.P. terms corresponding to the last two examples:

A.P. $1+2=3$ A.P. $2+4=6$
G.P. $2\times4=8$ G.P. $4\times16=64$

Isn't it self-evident where Napier received the inspiration that was to earn him the gratitude of a myriad workers doing their calculations in science, engineering and business?

To convert the multiplication of awkward numbers into the simpler process of addition and back again clearly requires many fine steps to be practical, and they must range in geometrical progression against their 'artificial numbers' (as Napier first termed them) in arithmetic progression. Commonsense dictates that, without any precision aids to calculation, the geometric ratio should be as simple as possible, but what about the starting artificial number? Here the plot thickens, because this number was not 0, as you might expect, but 10^7.

To see where this arose, we must recall that Napier's objective was to draw up a table of artificial numbers for dealing with the multiplication of sines, and the sine in his day was not the ratio as we understand it but simply the *length* of the side opposite the relevant angle in a right-angled triangle (it must surely astonish you to realize the sex-appeal of this half-chord, due to a translation error made over 800 years ago[12]. *Sinus* in Latin means 'bosom' or 'curve', i.e. the cleavage!). Moreover the convenient idea of the decimal point for decimal fractions had not been used – it was in fact introduced by Napier when he was *preparing* his tables!

Tables of sines (as then defined) for various angles were commonly available, and to have the convenience of stating them in whole numbers a very high round number such as 10^7 was arbitrarily given to the hypotenuse of the corresponding right-angled triangle, thus allowing a 7-figure statement of the 'sine'. The *sinus totus* or 'whole sine' for 90° was than 10 000 000, for 21° was 3 583 679 (see Fig. 13) and for 0° was just 0. Napier used such figures in drawing up his tables, based upon a G.P. starting with 10 000 000 and taking off 1/10 000 000 as an easily calculated fraction from this first term and every subsequent term. He kept going until he reached the hundredth term, which worked out at about 100 less than the first term, actually 9 999 900.000 495 0 (note his use of the decimal point![10]).

He realised then that the gaps between the terms would eventually become very small, requiring millions of calculations between any two consecutive integers! Another approach was needed and Napier had a further inspiration, a geometrical model which provided not only the basis for his calculations but also a firm scale to which to peg them. Talking of pegs, let us note that by this time he had also invented the word 'logarithm' (to replace 'artificial number') from two well-known Latin words *logus*=ratio and *arithmos*=number. A logarithm was

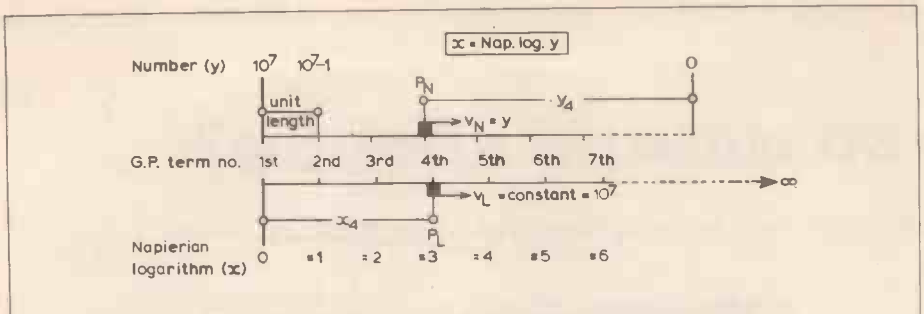


Fig. 11. *Napier's dynamic model for the definition of his logarithms.*

thus a 'ratio-number'. What a pity it was that the laws of indices were unknown to Napier! Not only would this have eased his self-imposed task, but it would have spared us yet another redundant mathematical word (logarithm = index = exponent = power![13]).

The model was a dynamic one, visualizing the comparative motion of two points along two parallel lines (Fig. 11) to the same scale of distance. One point P_L, representing the logarithm, moves at steady velocity v_L along the lower line, which is of infinite length. The other point P_N, representing the number, moves along the upper line of 10^7 units long, and at a velocity v_N equal to its distance y from the far end of the line. At the starts, for the 1st term, both P_N and P_L move away at the same velocity, equal therefore to 10^7 units, but P_N steadily slows down as y diminishes and gradually falls behind P_L. Napier defined his logarithm as

(Napierian) logarithm = x for the corresponding number y

as obtained from the model. So a zero logarithm implies a number of 10^7 and an increase in value of the logarithm corresponds to a *decrease* in the number. P_L also has to reach infinity before P_N arrives at the scale end at number zero.

Now consider the comparative positions of Napier's G.P. terms on the scales. The 2nd term, by definition, was 10^7-1, and so the distance along the number scale from 1st to 2nd terms is 1 unit (on either scale) as marked. The corresponding logarithm for the 2nd term was estimated by Napier as 1.000 000 1, which for practical purposes on the diagram can be shown as approximately 1. This establishes the linear log. scale and the term markings at approximately 2 3 4 5 6 etc. Napier was also able to fill in on the number scale (in principle, anyway) the values he had already calculated for the first 100 terms. You will see straightaway that the terms will steadily crowd up on the number scale as P_N moves to the right (the degree of compression is exaggerated for effect in Fig. 11 for the few terms shown), and that you would need an infinite number of them to reach the zero number, as suggested by the lower scale rising to infinity.

Now suppose, as I suggested before, that you, like Napier, had no knowledge of the laws of indices, nor of the calculus (the work of Newton and Leibniz was still to come). What else could you discover from his model which would help you to calculate just those logarithms that you wanted for particular numbers, instead of a thicket of largely useless G.P. terms? Well then, you might suddenly realize that by spanning equal lengths along the log. scale you could use the other favourite trick of the engineer and extrapolate your number values from those already found, skipping over a lot of unwanted ones. More generally, as Napier used[10], for 4 numbers a b c d, if $a/b = c/d$, then $\log b - \log a = \log d - \log c$. He was thus able to extrapolate from one number whose logarithm he had already calculated to another whose logarithm was to be found, at least very closely, by matching up to a ratio already calculated.

His objective, remember, was to produce a table of logarithmic sines, recorded for every minute of angle from 0° to 90° alongside the sine values already published by Vieta (1579) and others[10]. He matched the sine values as nearly as possible to the numbers appearing in his series and used ratio methods to account for the small differences in the logarithms[11]. The tables were laid out in complementary form, reading down the left-hand sides from 0° to 45° and up the right-hand sides from 45° to 90°, so that cosines and log. cosines were also obtained by reading right across the table. A central 'difference' column, recording the difference between the two adjacent columns of logarithms, also enabled log. tangents to be obtained[10].

So, after some twenty years of complex calculations, Napier eventually and valiantly accomplished his purpose in easing the multiplication of sines (and other trigonometric functions). During this work he came to realize the broader application of his logarithms to multiplication in general, although taking such logarithms from his original tables was no easy matter if they had to be interpolated between the available figures (allocated of course to particular angles)[15]. The book, published in 1614 in Latin[14], was an instant success, not only in Britain but throughout Europe as well (it included 90 pages of the tables and 57 pages of description of their uses).

Professor Henry Briggs (of London and later Oxford Universities), the leading mathematician of the day, was so impressed that in 1615 he visited Napier at Merchiston to pay his respects and to discuss the system. This was a most famous and fruitful meeting, resulting in an agreed change of 0 to be the logarithm of 1 (which Napier had already been considering) and an appropriate power of 10 to be the logarithm of 10, as being more convenient for general calculations using logarithms. This was the basis of ordinary or Briggsian logarithms. Napier died in 1617 and in the event Briggs chose the now familiar base of 10 for the new 14-place tables for numbers from 1 to 20 000 and 90 000 to 100 000 which he published in 1624[16]. Vlacq, a Dutch mathematician, filled in the gap and republished the Briggs figures in 1628[10].

Now can we leave the history of logarithms here, enthralling though it may be to some[17, 18, 19, 20, 21] and boring to others? If the latter think I seem to have been carried away by it, I have had a very definite goal – to answer the burning question of the difference between Napierian and natural logarithms, a matter fundamental to the understanding of 'e'. I am staggered to find that even many mathematicians do not recognize a difference (quotations would be invidious!), so it is no wonder that engineers are often confused. This is a classic example of the merit of going back to original sources for information. Also, above all, there is the fascinating question as to why Napier's logarithms, as the first-born, are related to e, of which he knew nothing.

Let's make a rough graph of the numbers (y) which Napier found in his series, plotted against the logarithms (x) which he allocated to them (Fig. 12).

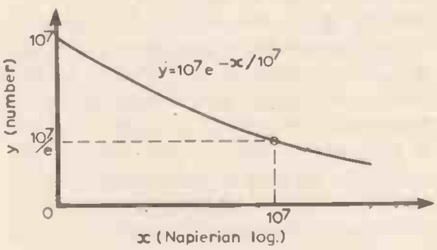


Fig. 12. *Napier's series for calculating logarithms fits this curve.*

He assigned 10^7 to a log. value of 0 and two or three points taken from his tables[14] for logs. up to around 1.5×10^7 will do. Here are some typical values:

Angle	Sine (old form)	Log . sine (Napierian)
0°	0	∞
12°53′	2 229 666	15 007 330
21°35′	3 678 541	10 000 685
37°20′	6 064 511	5 001 310
90°	10 000 000	0

The curve looks suspiciously like an exponential of a^{-x} form (Fig. 7), especially as it dies away with a feather finish to infinity on the log. scale. Perhaps it is of the e^{-x} form? To see this we can cheat a bit by looking forward to the useful curves of Fig. 17 (next part). Now examine the value of y for $x = 10^7$. Napier quotes 3 678 541 for 10 000 685 respectively (which is as near as we can get without resorting to Napier's tortuous interpolation). Divide the second figure by the first on your ever-eager electronic calculator and what do you find? Yes – e again! (1/e is of course 0.36788 to 5 figures). Fig. 12 *is* then of e^{-x} form (compare with Fig. 17) because when x, running right from zero, reaches the value of y at which the curve crossed the y axis (here 10^7), the value of y has fallen to 1/e of its crossing-over value. With a bit of careful comparison of the two figures you will see, I hope, that $y = e^{-x}$ in Fig. 17 has to become $y = 10^7 e^{-x/10^7}$ for Fig. 12

$$e^{x/10^7} = \frac{10^7}{y}$$

$$x/10^7 = \log_e 10^7/y$$

Thus Nap. log $y = x = 10^7 \log_e 10^7/y =$

$$10^7 \log_{1/e} y/10^7$$

(In case any of you with a knowledge of calculus, like our old P.M. friend, have been uneasily shuffling about during the last bit of trickery, you might like to read a very simple and elegant proof of the above results[17]. Whichever way you prove it, you can be proud of doing more than Napier could – he didn't understand negative indices!)

Now why should the numbers for Napier's logarithms have anything to do with e? Well, of course, they were formed in a geometric series of *reducing* terms, falling in proportion to their value, similar but opposite to those in the strip-by-strip build-up of $y = e^{-x}$ (Fig. 8), so that we get the mirror-image curve e^{-x} (see Figs. 7 and 17). And what about the base of Napier's logarithms? The result $10^7 \log_{1/e} y/10^7$ shows that the Napierian base is 1/e, as is also clear from the fitting of the y/x curve to e^{-x}. In contrast, for the e^x curve the logarithmic base is e. By common agreement this is termed the 'natural' logarithmic base, which it is then for the natural *growth* curve. On the other hand, Napier's base is a 'natural' (if you will forgive the confusion of meaning!) for the natural *decay* curve!

If I am allowed another brief reference to history,[21] what we now call 'natural' logarithms first appeared accidentally as interpolating numbers in Edward Wright's 1618 translation (into English) of Napier's *Descriptio*. The first deliberate tables of 'New Logarithms', as he called them, were published for numbers 1 to 1000 in 1620 by John Speidell in London, being natural logarithms without the decimal point. More than a century was to pass before the importance of natural logarithms was appreciated in analysis, including the work of Euler on negative and complex numbers (mentioned later). Johann Heinrich Lambert, an Alsatian, published the first such table in 1770.

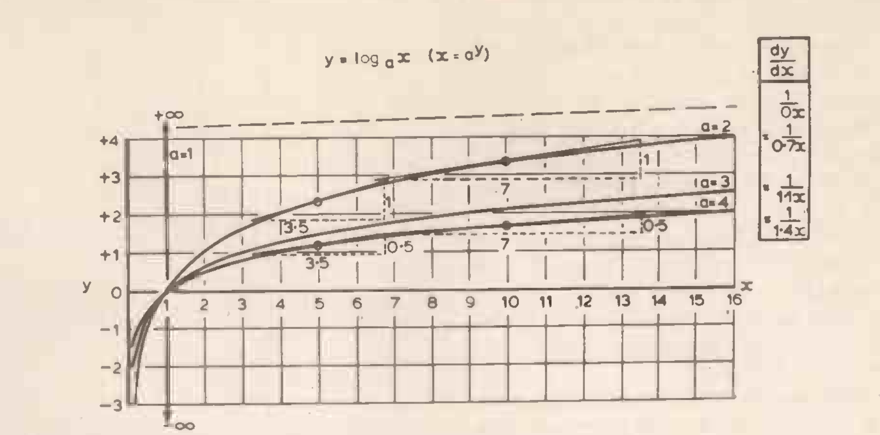


Fig. 13. *Slope relationships on various log. curves.*

To see how the value of e can be derived from natural logarithms as such, let's first consider the slopes of logarithm curves for exponential curves in general. Earlier we looked at exponential curves of the form $y = a^x$, but this time we'll interchange x and y to focus attention on the exponent as the dependent variable:

If $x = a^y$ then $y = \log_a x$ (from the definition of a logarithm).

Here are some calculated values of y for various values of x and a:

x	⅛	¼	⅓	½	1	2	3	4	8	9	16
$\log_a x$ for $a = 1$					$-\infty$ to $+\infty$						
$\log_a x$ for $a = 2$	−3	−2		−1	0	1		2	3		4
$\log_a x$ for $a = 3$			−1		0		1			2	2.52
$\log_a x$ for $a = 4$		−1			0			1			2

I have put in only the key values to keep the table uncluttered, and have plotted $y(=\log_a x)/x$ in Fig. 13. The vertical line for $a = 1$ is a special and academic case (a 'limit'), having y at all values between $-\infty$ and $+\infty$ for $x = 1$. This is the sole value of x for $a = 1$ since 1 to any power (y) is always 1. You will observe that the slopes of the curves all diminish as x gets larger. Try to find what relationship they have to x by using the tangential ruler again at a couple of points, for convenience at $x = 5$ and $x = 10$.

For $a = 2$ $x = 5$ slope $= dy/dx = 1/3.5$

whereas at $x = 10$ 1/7

This suggests that the slope is inversely proportional to x, or $dy/dx \approx 1/0.7x$, and in fact this will check out against any further measurements you may care to make.

Also for $a = 4$ $x = 5$ slope $= dy/dx = 0.5/3.5 = 1/7$

and at $x = 10$ 0.5/7

Again the slope is inversely proportional to x, and in this case $dy/dx \approx 1/1.4x$. In the same way you can find out for $a = 3$ that $dy/dx \approx 1/1.1x$.

It now strikes you that there must be a curve for some value of a between 2 and 3 for which $dy/dx = 1/x$. So let's interpolate again to find it by plotting $1/(x(dy/dx))$ against a as in Fig. 14. If you are beginning to feel that you've been here before, just look back at Fig. 6. The curve is the same, and all we've done is to exchange x and y! Those approximate coefficients 0.7, 1.1 and 1.4 ring a bell or two, and if you turn Fig. 13

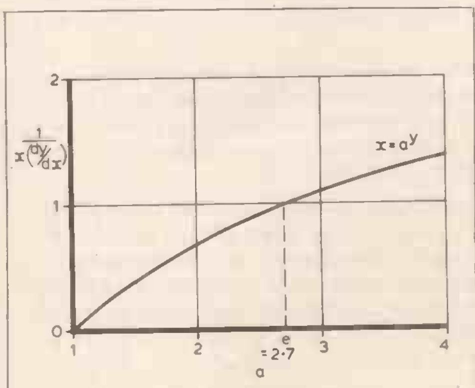


Fig. 14. *What's the value of* a *for* $dy/dx = 1/x$?

sideways and look at it in a mirror it becomes identical with Fig. 5. The point is hammered home in Fig. 15 where the curves for e^x and $\log_e x$ are shown against the same axes.

So, as well as finding another way to bring out the value of e, we have proved (no, after some ominous rumblings from the P.M. I had better substitute 'verified') that for e^x, $y = dy/dx$, and that for $\log_e x$, $1/x = dy/dx$. Those of you who aspire to the calculus will note that we have also obtained the differential coefficients with respect to x of e^x ($= e^x$) and of $\log_e x$ ($= 1/x$).

There is still one more graphical wile that we can use to find e, which you may think is even trickier than any I have so far mentioned. Consider the innocent-looking equation $y = 1/x$ and draw up a table of values for it:

x	1	1.5	2	2.5	3
$1/x$	1	0.67	0.5	0.4	0.33

Now plot these out as in Fig. 16. Construct a square as shown, spanning unity on both axes. Its area is clearly unity. Now see if you can mark off an area *under the curve* also equal to that of the square. You can do this by using another traditional engineer's dodge of counting squares, in a number of vertical strips for convenience, adding narrow strips one by one, as required, from left to right. Obviously you're going to have to move further up the baseline than 2, but how far? Yes, you've guessed that it will be to e!

Why should this be so? The curve is called a rectangular hyperbola, which suggests there might be a link here between natural and hyperbolic logarithms. We can justify the method from what we have already discovered about such logarithms. Now we have shown that the slope of the curve for $y = \log_e x$ is always $1/x$. That is differentiation in the calculus, and the reverse process is integration or summing up, meaning graphically that we must find the area under the y/x curve. If then we do this for the curve of $y = 1/x$ between two particular values of x, we are reversing the action and will finish up with the difference between the two corresponding values of $\log_e x$. The area under the curve between values $x = 1$ and $x = e$ is thus $\log_e e - \log_e 1 = 1 - 0 = 1$, as already discovered.

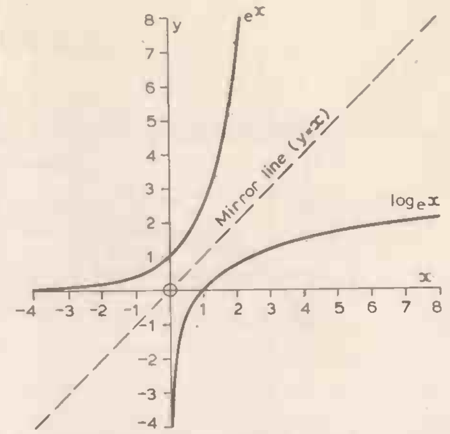


Fig. 15 *The mirror image curves e^x and $\log_e x$.*

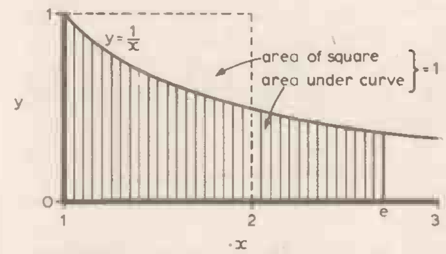


Fig. 16. *Finding e from the area beneath a rectangular hyperbola.*

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16. H. Briggs. Arithmetica Logarithmica, William Jones (London) 1624.

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21. Encyclopaedia Brittannica, Vol.14 p.304 (Origin of natural logarithms) 1959.

Literature Received

Leaflet on solid-state **transient protectors** is new from Unity Power Systems, offering complete technical information and application advice. Write to Unity Power Systems, Pembroke House, 44 Wellesley Road, Croydon, Surrey or circle WW 401

Reliability of the Intel 3636, **16k p.r.o.m.** is assessed in a report recently released by the company. Copies are obtainable from Intel Corp (UK) Ltd, Dorcan House, Eldene Drive, Swindon, Wilts SN3 3TU WW 402

Wire-strippers and **d.i.p.-socket inserters** for high-volume production are described in two brochures, available from Automation Ltd, Marbaix House, Bessemer Road, Basingstoke, Hants RG21 3NT WW 403

Semiconductor Summary for 1979/1980, from ITT is now available giving the full range of information on all **ITT devices**, infra-red remote control, i.cs for entertainment, clock, car and musical instrument applications. ITT Semiconductors Ltd, Maidstone Road, Foots Cray, Kent. WW 404

'Intelligent' **tape transport**, type 8800 from EMI, which incorporates microprocessor control and a built-in fault-diagnosis routine, is illustrated in a brochure from SE Labs (EMI) Ltd, Data Products Division, Spar Road, Feltham, Middx TW140TD. WW 405

A new type of **crystal cut**, the thermal transient compensated (t.t.c.) is described in a paper and leaflet from Cathodeon Crystals Ltd, Linton, Cambridge CB1 6JU. WW 406

Brandenburg describe their range of **static inverters**, the 060 range, in a leaflet just produced. Copies can be obtained from Brandenburg Ltd, 939 London Road, Thornton Heath, Surrey CR4 6JE. WW 407

Work in universities on vibration and noise, funded by the Science Research Council, is reviewed by the SRC in a 47 page booklet, obtaintable from SRC, PO Box 18, Swindon SN2 1ET. WW 408

Aspect is a new publication, by Vermason Ltd, on the subject of **static** — causes, problems and solutions. The two-page sheet is to be published three times a year. Hunter Bureau of Communications Ltd, Drayton House, Gordon Street, London WC1H 0AX. WW 409

A brochure on tungsten carbide drills and routers for printed-board production is available from Dymet Alloys Ltd, Frimley Road, Camberley, Surrey GU15 2QC. WW 410

The process of **mechanical plating** of small parts and its claimed advantages over electroplating are explained in a brochure, obtainable from Morlock Industries Ltd, Bridgnorth Road, Wombourne, Wolverhampton WV5 8AU. WW412

Brochure on the AXE digital **telephone switching** system is available from The Ericsson Group, Telefonaktiebolaget L.M. Ericsson, S-126 25 Stockholm, Sweden. WW413

Catalogue of small **electronic components** for the home constructor is obtainable at 30p from Ace Mailtronix Ltd, Tootal Street, Wakefield, West Yorkshire WF1 5JR.

Video production switchgears, an extended effects generator and an audio mixing switching unit made by Central Dynamics of Canada and handled by Pye are briefly described in leaflets from Pye TVT Ltd, PO Box 41, Coldhams Lane, Cambridge, CB1 3JU. WW414

LETTERS TO THE EDITOR

LOOP AERIALS

A careful exploration of the medium and long wave broadcast bands leads to the conclusion that their neglect by many listeners is as much to do with poor receiver and aerial performance as with band congestion and interference. The r.f. selectivity of most portables and tuners is so poor that attaching a long wire aerial (as advised by Mr McLeod[1]) simply makes second channel interference impossibly bad. However the resonant loop or the "H-field multiplier" described by Mr Schemel[2] overcomes the twin problems of insensitivity and poor r.f. selectivity, and with large well designed loops some astonishing results can be obtained with poor receivers. The price paid is that the aerial needs to be tuned independently of the receiver, or left tuned to a preferred station. Nevertheless this is an excellent way of widening the scope of listening experience.

Following experiments with a feeder-coupled loop (described in *Wireless World* many years ago[3]) a 2m × 1m six-turn m.w. tuned loop was set up and used either as an "H-field multiplier" with portable receivers or coupled with 300-ohm cable to the ferrite rod of an f.m./a.m. tuner. Favourable results obtained during winter months suggested that with some receivers even larger loops would be useful. Mr Schemel has shown that in view of inherent noise levels $1m^2$ is the largest size necessary. However I find that the 8m × 4m single-turn outdoor loop now in use gives a better performance, probably because the very large signals help the a.g.c. of the receivers to deal better with fading. This aerial is coupled to the ferrite rod of the tuner by a few turns, 2cm in diameter, in series with the loop.

For long-wave reception a 2m × 2m 15-turn loop is used, situated in a loft and coupled by means of a single turn to 80-ohm cable. At the receiver end there is an 8cm diameter coil of about 25 turns, fixed to the side of the receiver case with tape. The receiver itself is of the Hong Kong transistor sort, which in fact cost less than the wire and cable used for the aerial.

A low-pass audio filter with a deep (−30dB) notch at 8kHz is in circuit throughout and is considered indispensable.

Finally a comment on the operation of the "H-field multiplier". I follow Mr Schemel's theory (p.51) up to the final paragraph where he mentions the conservation of energy, and says that the enhanced field, QH, is in phase quadrature with the incident field. This cannot be generally correct since the phase of the loop current passes rapidly from positive to negative (or vice versa) as the circuit is tuned through resonance. It seems better to suppose that the loop acts as a transformer, making the absorbed energy available at an impedance different from that of free space. If we regard the loop as parallel tuned, this impedance is very high, so that the ferrite rod of a receiver has only to be lightly coupled to the loop to absorb a useful proportion of the energy from it (see Mr Schemel's footnote, p.51). On the other hand a small coil in series with the loop makes the energy available at very low impedance. These are complementary points of view, the former being more appropriate when the receiver is near the middle of a large loop, the latter when it is near one of the sides.

R. A. W. Hill
Glasgow College of Technology
Glasgow G4

References

1. McLeod, N. *Wireless World*, letters, November 1978.
2. Schemel, R. E. "The Loop Aerial Revived", *Wireless World*, July 1979, p.48-52.
3. Hill, R. A. W. *Wireless World*, letters, February 1953.

The author replies:
Mr Hill, like myself, is obviously a loop proponent, and I would only like to add some observations of my own to those in his letter.

Coupling a long wire into a modern radio may be unsatisfactory, quite apart from the reasons put forward in the original article, because transistor mixers are much more liable to overload than their valve counterparts. Both overload and the decreased r.f. selectivity have the effect of producing audible beats and cross modulation.

Separate tuning of the loop increases selectivity but only improves sensitivity when coupling to the first tuned circuit is insufficient. Since this useful technique may be tried by some readers, they are cautioned to avoid overcoupling. It would appear that Mr Hill's installation is undercoupled, since he observes that quite large loop areas give a noticeable improvement in reception; it could also be that the receiver is of very poor sensitivity, and I can confirm that a large tuned loop used in this way works wonders. Notwithstanding this, my own experience with a good receiver and a closely coupled untuned loop would indicate that an area of $1 m^2$ is more than adequate.

Finally, Mr Hill observes that the phase of the loop field passes from 180° to 0° as the loop is tuned through resonance. This is indeed the case, and exactly at resonance the phase angle is 90° as stated in the article. Readers who constructed the field multiplier may have noted that the loop can almost suppress the signal rather than boost it at a critical tuning point. This occurs when the out-of-phase component of the loop field almost cancels the incident.

R. E. Schemel

THE INTELLIGENT PLUG

I was interested in the article "The intelligent plug" in the December issue. In your warning note you refer to p.m.e. and I hope you will not mind if I mention that this stands for protective multiple earthing.

Where the electricity supply authority has applied this method of earthing to its distribution system, the consumer will have been offered an earth terminal which is, in fact, a connection to the neutral of the electricity supply system. The injection of a carrier frequency between the neutral and earth on the consumer's installation will effectively be short-circuited at the incoming point of supply in that the consumer's earth conductor and neutral are both connected to the incoming supply neutral.

In an electricity distribution system where the system neutral is earthed only at the distribution sub-station, the neutral and earth connections will again be short-circuited but the impedance loop, as seen at the consumer's installation, will be sufficiently large not to significantly attenuate the injected carrier frequency.

I. E. Elliot
Eastern Electricity
Lowestoft
Suffolk

COMMITMENT IN WORK

It is heartening to find an editor who is prepared to take on the task of raising (by whatever degree) the level of awareness of his readers. Your excellent editorial in the January 1979 issue on military electronics, and more recent ones on the unpleasant social consequences of our profession, have been salutary.

What has been insufficiently stressed so far, though, is the absolutely imperative need for *individual commitment.* This applies right across the board – including involvement with "defence" projects, nuclear power ("clean, safe and cheap"), broadcasting and telecommunications (information manipulation) . . . . It is only too easy for the average engineer to look no further than the rim of his coffee cup; he has a wife and kids to support, he expects a certain standard of living and he expects society to provide it for him: the fact that his society is morally bankrupt, supported on very shaky economic foundations and in imminent danger of catastrophic collapse is something that he doesn't want to think about, let alone do anything about. Yet society is only made up of individuals; if individuals will not rouse themselves (no-one can do it for them) from their ostrich posture no improvement in society's state can come about.

Commitment on this personal level can be painful. For instance, if you do not wish to work in socially harmful areas you are restricting the variety of jobs open to you, and you may be forced to accept a lower salary, with a consequent lowering of living standard. The latter also applies if you wish to be more conservative, say, in your use of energy; electric heating is the most wasteful and inefficient misuse of energy there is (except perhaps writing letters to magazine editors), but it is also the most convenient. The commitment to a saner way of living is fundamentally the same in either case. The misuse of technology, and electronics in particular, which you have so accurately portrayed can only be finally corrected by a "grass-roots" awakening of awareness at the individual level.

There are, fortunately, signs that this is happening. For example I was recently told by an employment agency that it was by no means uncommon for candidates to specify "no military involvement" on their job application forms; perhaps the almost continuous recruitment adverts from the likes of

MSDS, Ferranti, Plessey and GCHQ are indictive of the shortage of people prepared to work on such projects. On a wider scale, the extent of interest in renewable energy sources and of opposition to the nuclear juggernaut shows a change of attitude in many people. Perhaps you could help nurse it along?

One point on your editorial "Trickle, trickle little chip" (November 1979) concerning alternative (or "appropriate") technology for the developing nations. Firstly, alternative technology is not concerned primarily with producing goods – goods are not what the Third World needs. What it needs are reliable means of feeding and sheltering itself, so that AT is generally aimed at the agricultural, building and energy supply areas. For these areas (particularly the first two) labour intensive techniques are more appropriate than capital intensive ones – though micrelectronics can still have a part to play. Alternative technology should not necessarily exclude sophistication where it is justifiable and applicable. Secondly, there is the danger that high technology produces a gap between its users and its end products, so that there is no feeling of identification between the maker and what he has made. This gap has been recognised as a major source of dissatisfaction in Western manufacturing industries; and it is one problem that the developing countries should try hard to avoid.

Tim Williams
Tunbridge Wells
Kent

SCIENTIFIC COMPUTER

I have followed with great interest the articles on the scientific computer by John Adams (April-September 1979). As an electronics engineer from a "pre-micro" era, I saw this as an ideal project to enable me to become updated. I accordingly constructed the hardware and now, with a limited amount of experience in "driving" it, I would like to offer a number of points which I feel are worthy of discussion:

(a) The "number cruncher" approach seems to me to be so very logical that it is surprising that more systems do not apply it. It must surely set the pattern for the future.

(b) I would be very interested to see detailed explanations of many more of the machine language sub routines, particularly those associated directly with the "number cruncher".

(c) The Adams computer is already excellent value for money, but could, I feel, become even better with upgraded monitor and Basic programmes. For example, there is no cursor, or backshift/delete facility (except in graphics). There is no apparent means whereby a list of results can be fed into the middle of a programme from a peripheral. Perhaps Mr Adams can be persuaded to look into this.

(d) Software programming in BURP is obviously somewhat limited at the present time. Could we have some information on how to set about writing our own, or converting those already available for the TRS80 or the Nascom, both of which employ the Z80?

If I were to ponder longer no doubt I could produce a long list of other desirable features and information requirements. I hope, however, that I have said sufficient to convince you that there are many engineers like myself who need to familiarise themselves with these latest techniques but will not have either the time or the opportunity to attend any of the many courses being offered by device manufacturers. We must, therefore, resort to the written word, and immediately are faced with a bewildering array of text books – and who can guide us in our choice? As professionally I will be designing microprocessor controlled systems, machine language is of paramount importance. Articles on the approach to and construction of typical programmes would be of considerable interest. If one turns to the magazine press the various publications with "Computers" in their title, excellent though they may be, do not approach the subject from the design engineer's standpoint. There does, therefore, seem to be a void which I hope that a periodical of the high technical standing of *Wireless World* can fill. What is really needed is a "Foundations of Microprocessor and Peripherals" series by a "Scroggie of the micros"; perhaps he already exists in John Adams. These could be supplemented by a regular flow of articles describing in detail actual applications covering all spheres, not just the computer as it is popularly understood.

I hope that I may have said sufficient to convince you that far from being minority readership, microprocessors etc. are of considerable interest to a high percentage of your readers, many of whom have no professional interest in "wireless" these days.

J. W. H. Freeman
Red Forge Ltd
Redditch

The author replies:

May I take the opportunity to thank Mr Freeman and many others for their comments on my design for a computer which was published in your April-September issues 1979. They have been of great value in drawing up the specification for the monitor described in this issue, as well as giving food for thought for further ones.

With so many users of these machines, it would now, I think, be a good time for some individual or group to set up a users' club to distribute a newsletter and, perhaps, organise meetings etc.*

Might I also reply to Dr Whittington's letter published last month. I think it a mistake to look for 'mainframe' performance from an arrangement which costs only a few per cent of the price of such equipment. Constraints on format, language (such as they are) and speed are thus inevitable. I must take issue with Dr Whittington on one point though, as, whilst it is possible (just!) to make a FOR loop take 200ms, a more typical time for a loop covering, say, 10 program lines is 60ms. To put the machine in the context of the so-called 'benchmark' tests, which have been applied to five commercially available machines, for BM5, which computes.

$$A = \frac{K}{2} \times 3 + 4 - 5$$

for K = 1 to 100, the mean execution time was 27s for the 5, as against 21s for the Scientific Computer. A monitor which is in the development stage at the moment cuts this time down to 13.8s. Should one of the semiconductor manufacturers produce a 'number cruncher' which can run at a faster clocking rate than the 800kHz which the great majority of MM57109s seem to manage, at a reasonable price, then these times, measured at that clocking frequency, should be reduced even further.

After, perhaps, more experience with the monitors Dr Whittington will find them easier to use. I must admit to a mistake in the original series in that I forgot to describe the register display facility which is present in original monitor. It is fully described in this issue. The COR command isn't quite so dangerous as is suggested as it does list back all the addresses at which it makes corrections. Experience has shown that using COR, or MOD as it now is, and then checking back for unwanted changes using this address list avoids the usual problem when, say, re-addressing a block of instructions for loading into an e.p.r.o.m., and that is missing one or two of the alterations required. MOD has a second use too, in that by changing the byte XX to YY, the computer just lists the addresses where that byte may be found.

Finally, there is a mistake on the p.c.b. supplied with the kit for the computer of which some constructors may not be aware. The 470-ohm resistor adjacent to the 'Data In' l.e.d. connector pin at the back of the board should be removed and this connector pin wired directly to pin 12 of the 4013 i.c. The l.e.d. will then perform as originally intended.

John H. Adams
Radlett
Herts

*We would be glad to hear readers' views on this suggestion. — Ed.

VHF RADIO AND ITS PROGRAMMES

May I respond to Mr MacKay and Mr Watson (October 1979 letters)* concerning the use of v.h.f. radio.

In the early days of v.h.f., the BBC certainly tried to encourage listeners to change over to these channels, for very good reasons of technical quality and freedom from interference. I cannot recall that we ever said that all broadcasting would be on v.h.f. only, with the implication that medium and long wave transmissions would be abandoned.

In the event, the public in general have been most reluctant to make the change and the v.h.f. channels are to this day (more than 20 years later) used by only a minority of listeners. Accordingly, it was a sensible choice to put Open University broadcasts on v.h.f. and to confine schools programmes to v.h.f., since this offered good coverage for the educational material while inconveniencing as few members of the general public as possible.

It is perhaps worth emphasising that the BBC is in no way on the defensive about the inclusion of educational material in our programming; together with information and entertainment, education is one of the prime requirements of our charter. Schools programmes are clearly of considerable importance in their field and the Open University is an imaginative and successful British venture which is very rightly supported by the Corporation.

The realities of the situation are therefore as follows. Educational broadcasting merits good coverage throughout the country; it is on v.h.f. for good reasons and could not be transferred to medium or long wave without inconveniencing far more listeners and nullifying the considerable investment in v.h.f. equipment by schools and others; insufficient v.h.f. channels are available to separate educational from other programming.

Turning now to more positive matters, it is clearly very much in the BBC's interests that the programmes which we make shall be received as well and as widely as possible. We are very conscious of the dissatisfaction caused by the enforced sharing of channels by educational and other programmes and we examine most carefully what can be done to relieve this. The most satisfactory long term solution is the provision of more channels by extension of the v.h.f. broadcasting band. This has been an important factor in the World Administrative Radio Conference in Geneva, although if such extension is agreed it must be some years before existing mobile users (police, fire, ambulance etc.) can be moved elsewhere and new broadcasting networks created. For short-term relief we are looking into the feasibility of transferring a proportion of schools broadcasting to the night hours, with time-switch recording in schools for replay the next day. Furthermore, we have concentrated much of the educational programming on to the Radio 4 v.h.f. channel, avoiding Radio 3 where musical items in particular benefit from high quality stereo transmission. As a result, educational material on Radio 3 v.h.f. is in general transmitted outside normal programme hours, with the exception of an hour and a half on weekdays in the early evening. The sharing of a single v.h.f. channel by Radio 1 and Radio 2 is a separate problem, to which the only solution would be an additional v.h.f. channel.

I would not presume to challenge Mr MacKay's catalogue of shortcomings and perhaps I am indeed fulsome, irrelevant, contradictory, evasive, arrogant and smooth. Although anxious to please, I have found it difficult to demonstrate all these qualities within the compass of a single letter; but I have tried as best I can to set out the facts which, unwelcome though they may be, make up a problem for which a quick and easy solution is not available.

D. P. Leggatt
Head of Engineering Information Dept
BBC, London W1

* Owing to a clerical error the publication of this letter has been delayed. Apologies to readers and the correspondents concerned. – Ed.

PERCEIVING DIRECTION IN SURROUND SOUND

The article by Ken Farrar on the Soundfield Microphone (October and November 1979) prompts some observations on the development of surround sound which I feel it timely to make. Most technical developments tend to evolve from previous practice but it is always wise as new technology becomes available to take a long hard look, unhindered by the past, at the means and at the objectives. It is therefore to be hoped that before standards are finally set the full potential of Ambisonics is properly established.

Having been intrigued by the somewhat puzzling failure of binaural reproduction to recreate concrete centre-front sound sources, the writer has carried out many experiments in the field of perception of direction by our sensors. I use the word 'sensors' rather than ears because I now have doubts as to whether our outer ears are the sole mechanism.

The following facts emerged. Firstly, using white noise as a sound source, there was no difficulty in locating the direction of its origin *with one ear effectively closed.* This appears to indicate that there are clues on which the brain can operate to determine direction other than the generally accepted ones of inter-aural intensity, phase and transient arrival-time differences. Secondly the frequency response of the ear changes quite markedly as the incident direction of the sound changes. This effect is in addition to the well known ability of the pinnae to introduce minute colorations which are direction dependent and from which we have learned to derive clues. The head appears to act as a baffle for sound coming from the side which intensifies mid-frequency components. These mid-frequency components are relatively reduced in loudness if the sound comes from the front. Thirdly there appears to be evidence that more than the outer ear may be involved in hearing. There is a passage which can convey sound between the nose and mouth and the inner ear and it was observed that the sound of white noise changed with the opening and closing of these apertures! This may have a bearing on what appears to be the ability to assess the distance of a sound source by the shape of the radiated wave-front. The more distant the sound source, the 'flatter' will be the portion of the wave-front affecting our ears. If a point source loudspeaker is replaced by one with a number of units so as to create an approximation to a plane wave, the sound in the latter case will appear to originate some distance behind the loudspeakers. Since the sound reaching the outer ears in both cases should be the same, it is impossible to explain these phenomena by conventional theory.

Returning to the failure of binaural sound to recreate concrete central front images, this can only be because some vital clue is missing. It would appear that a really concrete centre-front image can only be created by a sound coming from centre-front in actual practice. While the illusion of centre-front images created by the left-right speakers of conventional stereo are undoubtedly established by the dominance of the intensity/phase/transient time delay mechanism, the overall effect may be less than perfect. The fact that there are individuals for whom this illusion does not work confirms this. In any case this function is clearly over-sensitive to head movements.

This brings us back to the subject of four channel reproduction and I would like to suggest that before we are committed to the two front and two rear loudspeaker configuration – really an extension of stereo – experiments should be carried out with what could be a more logical system, i.e., one central front loudspeaker, one left loudspeaker, one right loudspeaker and one rear loudspeaker. For reasons too lengthy to discuss here, the writer believes that this format would have many advantages, just one of which would be that a centrally positioned soloist would tend to remain central even if one moved from the ideal 'central' seat.

James Kerr
Kerr Research
Wendover
Bucks

UHF CITIZENS'BAND IN AUSTRALIA

It is not recorded in any history book that King Canute sat on an Australian beach trying to curb the tide (your editorial, September 1979 issue). But recent Australian history has shown that our telecommunication authorities and government can do the same and succeed! Yes, c.b. is good fun, and the population has the right to expect a small part of the spectrum to be allocated for personal use. But our Canutes here were far more canny in trying to stem the tide. Instead of telling the sea to draw back, they asked — can we get the sea to recede by providing another beach? Instead of asking the sea, they asked our population and industry. They asked if there were other frequencies which could be used, if equipment could be designed and manufactured within one year at a price competitive with its 27MHz s.s.b. counterpart. They asked if the coverage on another band of frequencies would be equivalent to the local coverage of 27MHz. And, most importantly, they asked what interference problems could result from the use of other frequencies.

The result was the introduction of the world's first u.h.f. c.b. service; 1MHz of spectrum for public use, 40 channels that anyone could use anytime, anywhere. All the answers to the questions have been fully vindicated. It is better service with minimum interference, and equipment was designed and produced within the period required and at a competitive price. What is more, it has injected sanity into an area which was fast becoming imbecilic. It has provided local industry with a new market, and employment and export opportunities.

New fraternities are springing up. Long distance truck drivers are enthusiastic and enterprising roadside cafe owners advertise the fact that they are on the air on channel 'x' and will accept messages to pass on to other travellers. Sporting and particularly boating clubs are taking to the medium. The flexibility of having 40 channels from which to select at will is a real benefit.

It has also given the amateurs a 70cm unit capable of providing 40 channels each of single and two frequency simplex, a fact that has not escaped the UK amateur, as this unit is already on the UK market.

Your editorial implies by omission that there is no other choice. The antipodean experience has shown that there is. It is not too late for the UK to consider alternatives, but it will be too late if the Home Office procrastinates. As we know from the multimillion dollar disaster in the States and our own experience, if the public wants something, some enterprising entrepreneur will provide it legally or illegally. You will then be stuck with it, to the continued disadvantage of wonderwomen watchers and radiocommunication users in general.

R. B. Hooper
Philips – TMC Ltd
Clayton Victoria, Australia

LEVY ON COPYING

Your columnist Mixer's notion in the November 1979 issue that the record industry's claim for a levy on all blank tape cassettes and recorders "would be just as reasonable, and stand just as much chance of being accepted" as a similar levy charged on the use of photocopying machines is not as incredible as Mixer seems to think, at least not in Scandinavia.

Backed by existing copyright laws, very similar to those in force in Britain, the Technical and Fiction Writers Union has effectively banned duplication of printed material by photocopy-machine "until a suitable fee has been negotiated." Their present claim is 3.3 pence per copy. In Sweden, the Government is already paying writers 0.18 pence per copy, based on statistics of the copies taken in universities, school, public libraries and by local and national authorities.

Gisle Hannemyr
Porsgrunn
Norway

NEWS OF THE MONTH

Europe-wide information retrieval uses packet switching

On-line information retrieval services throughout Europe — the kind using computerised data bases — are now being linked together into a comprehensive network by a dedicated telecommunications system. Any professional worker with access to a Teletype-compatible data terminal (with printer or v.d.u.), a telephone line and a password for the system can retrieve information from general and specialised data bases in a number of European countries at a standard tariff which is independent of distance. By the end of 1980 about 140 such data bases are expected to be available. To make connection, the user has to dial on his telephone one of the computerised information services in his own country which is linked to the system. These are known as "hosts" and in the UK, for example, one of them is BLAISE, the British Library's Automated Information Service. Another UK host is Infoline, which, incidentally, will be bringing into the system the well known IEE Inspec database of physics, electronics, computing and mathematical information.

This European link-up called Euronet-DIANE, was opened in November last year. Initiated by the European Communities Commission, it is intended in the first instance for the benefit of the present nine Common Market countries but probably later will bring in Switzerland, Norway, Sweden, Spain, Austria, Yugoslavia and Greece. Euronet is the hardware part, operated by the telecommunication authorities of the EEC. Its backbone is a dedicated high-speed data transmission system operating at 48,000 bit/s on the packet switching principle (in which packets of digital data are sent by the best route at a given time to achieve the most efficient use of available lines — often interleaving packets for different addresses). The international lines carrying this data stretch across Europe from Dublin through London, Paris and Frankfurt to Rome, with branches off to Amsterdam, Copenhagen, Brussels and Luxembourg. Exchanges for packet switching are located in London (in the Post Office's Electra House, Temple Place, London WC2, which also houses the management centre controlling the day-to-day operation of Euronet) and in Paris, Frankfurt and Rome. Users' terminals are connected through the hosts to this backbone by slower speed data transmission on public or leased lines working at anything from 110 bit/s to 9,600 bit/s. A detailed description of Euronet is given by P. T. F. Kelly of the UK Post Office in *The Radio and Electronic Engineer* (IERE Journal) for November 1979. (See also "Switching into European data" by D. E. Hadley and A. C. Barnes, *Post Office Telecommunications Journal*, Autumn 1979). We understand there is some possibility that viewdata terminals (Prestel in the UK) could be made compatible with the system.

DIANE is an acronym meaning Direct Information Access Network for Europe and is the organisation of the various on-line information services themselves – the software side. At present there are 23 hosts, offering a spectrum of scientific, technical, medical, legal, social and economic knowledge. Inquiries about it can be made to:

Euronet DIANE Information, Jean Monnet Building, B4 009, ECC, Luxembourg (Grand Duchy). Local enquiries about Euronet in the UK can be made to the Post Office contact: Mr T. Lake, International Telecommunications, Landsec House, New Fetter Lane, London EC4 (tel: 01-583 4945 or 8832).

Many of the on-line information retrieval systems available through DIANE use different sets of commands. The potential user is therefore faced with the possibility of having to learn several search languages. But recently a study carried out for the ECC by Scicon in the UK has devised a common command language which allows users to search on different retrieval systems using one language. This has been accepted as a formal guideline for use by the hosts and is already being implemented by some of them. The standard command language is not meant to replace existing sophisticated search languages but as an alternative to help users who need to search on a number of different systems.

CEI honours Sam Fedida

One of the UK's foremost engineering accolades, the Macrobert Award, has been given to Sam Fedida, well known to readers of this journal as the author of a series of articles (*Wireless World*, February to May 1977 and April to June 1978) dealing with Viewdata, the information system using telephone and television in a communication/display combination he had invented while working as a Post Office research engineer.

The prize of £25,000 and the MacRobert Medal were presented to Fedida by H.R.H. the Duke of Edinburgh in his capacity as founder president of the Council of Engineering Institutions (CEI) at Buckingham Palace on 5th December 1979. The MacRobert Gold Medal was also presented on this occasion, to Post Office Telecommunications for the development of Prestel, the first public Viewdata service in the world.

Sam Fedida was born in Alexandria, Egypt, in 1918. He was educated in England and graduated with a B.Sc.(Hons) at Imperial College, London, and during the second world war served as a radar officer in the R.A.F. After the war he joined Marconi, becoming a development manager in 1960 and Assistant Director of Research in 1965. He joined the Post Office Research Department as Manager of Computer applications in 1970 and soon afterwards invented the Viewdata system, which he demonstrated publicly in 1975. He had obtained an M.Sc. in computer sciences at Birkbeck College, London in 1973.

The MacRobert Award has traditionally been awarded for the development of a novel engineering project or process and has shown a general bias towards hardware. However, the last two decades have shown that software aspects of complex electronic systems are now at least as technically challenging and this award tends to indicate the CEI's awareness of the growing significance of information retrieval systems.

PET automatically checks impedance

A combination of instruments including a Rohde and Schwarz ZPV vector analyser, a signal generator and a Commodore PET computer can, according to Aveley Electric, a British distributor for Rohde and Schwarz, be used for automatic impedance measurements. Frequency range covered is from 0.4 to 1040MHz and the test permits automatic voltage measurements of magnitude and phase, measurement of S parameters, impedances and admittances as well as group delay measurements. Measured values are displayed on the screen of the PET or are fed out via an IEC bus-compatible printer.

Post Office introduces microprocessor pay-phones

A completely new type of Post Office pay-phone, featuring microprocessor control and a numerical key-pad instead of a rotatable dial, began trials on December 10. This marks the beginning of a Post Office programme to re-equip coin-operated call boxes and an initial order of 100 of the new units has been placed with Agitelco, a member of the AGI group.

Unlike the conventional pay-phone, cash is inserted before the required number is keyed and there is no "pay tone." Coins held in store are credited to the caller and this amount is indicated on a digital display. As the call proceeds the cost is deducted from the amount in credit and 10 seconds before the credit runs out the visual display requests more money, the display being accompanied by a "bleep" on the line. The microprocessor calculates the rate from meter signals received from the local exchange in the conventional manner, disconnects the call if there is no credit left or pays out unused coins. The rate of charge is similar to that of the conventional pay-phone and depends upon distance and time of day; a "follow-on" facility is included where, upon pressing a button, further calls can be made using credit still in store.

Operator calls can still be made although these will be restricted to the UK area initially and on these calls another "bleep" signal tells the operator that the call is coming from a new "blue payphone", so called because the phones have all instructions printed in blue. Each unit is housed in a stainless steel casing and the Post Office maintains that the microprocessor approach used in this unit offers advantages including ease of installation, faster servicing resulting from the "watchdog" action of the m.p.u. in reporting faults immediately and overall cheaper running due to the elimination of the special call-charging equipment at present necessary at local exchanges.

During the trial period the Post Office will be carrying out research into customer reactions and the extent of use of the new phone compared with that of the conventional type, with the intention of a realistic assessment of the quantity needed to cover the first phase of modernisation.

Microprocessor and Electronics Centre

A showroom for electronics manufacturers, funded by private and ICFC money, was opened by Lord Trenchard in December. Jeremy Prosser, of Prosser Scientific Instruments, had the idea of a base for electronics companies to show their wares in London, to conduct interviews and to meet their potential customers. One or two economists and marketing people evidently agreed with him and combined with him to set up the venture in the World Trade Centre in East Smithfield, near the Tower of London.

A coincident exhibition helped to set the scene for the opening ceremony (it actually opened its doors in September, but the celebratory junket was delayed a few months) though many exhibits were not, one felt, of the type to inflame the imagination of the civilised world. Examples of the ways in which electronics can enrich our lives and widen our horizons included the K9 dog machine from the Dr Who television programme, a toy train controlled by a microprocessor in a manner no one present felt able to discuss, and some 'Star Trek'-inspired 'phasors', which made funny noises. Measuring instruments were in evidence, as were microcomputers in various guises.

Lord Trenchard's opening speech was a worthy example of its kind, impressing on all of us the need to use microelectronics for all we were worth and spelling out to us the disastrous consequences of failing to do so. The effect of the homily was not heightened by his aside, on leaving the still-live microphone, that he supposed he was now going to be shown the exhibits, which he couldn't, of course, be expected to understand. Lord Trenchard is a Minister of State for Industry.

The Microprocessor and Electronics Centre will be permanently open and will run a series of small exhibitions throughout the year.

Aiwa to set up "micro" hi-fi plant in Wales

Speaking in response to Aiwa's decision to set up a British subsidiary of the Japanese company, Lord Trenchard, Minister of State for Industry said, "I am delighted at Aiwa's decision to set up a plant in the UK . . . Aiwa will be the first manufacturer of miniaturised hi-fi in the UK and the first Japanese audio manufacturer to come here."

In fact, both Toshiba and Matsushita preceded Aiwa in setting up plant in the UK, although this is the largest projected undertaking in the field of "micro" hi-fi here, the estimated cost being £2 million, drawing £600,000 of British government aid. "Micro" hi-fi employs microelectronic circuits in a complete package of about 12ins by 8ins and the UK manager, Mr Stephen Chorley, expects 50% of output from the Newbridge, South Wales, plant to be exported. About half of the components used will be British and at the start of production in June 1980, between 70 and 100 new jobs will be made available to local people. The Welsh Development Agency has provided the factory on a 25-year lease to the Japanese company.

Zenith buys Heath

Zenith Radio Corporation has completed the purchase of Heath from Daystrom Inc, a wholly-owned subsidiary of Schlumberger Ltd. Heath, the Michigan-based electronic kit manufacturer, will be operated as a wholly-owned subsidiary of Zenith. New Zenith subsidiaries have been established to operate the 55 Heathkit Electronic Centres in the United States and the Heath business in Canada and Europe. Daystrom Inc, was acquired by Schlumberger in 1962.

Radio amateurs provide communications in Indian disaster

Radio amateurs provided emergency communications in disaster-struck Morvi, India, during the afternoon of August 11. Unusually heavy rains caused one of the Macchu dams to burst at both sides of the spillway, engulfing the entire city which had a population of 75,000 people. A wave seven or eight feet high devastated 80% of the buildings and left an estimated 10,000 people dead. The water continued to rise to about 15 feet and when these flood waters receded, the streets and houses were under 14 feet of mud.

Communications and power supplies were cut off almost immediately and even towns within 10 to 15km away remained unaware of the tragedy for 24 hours. When the news finally got out, India's Home Guard from the city of Rajkot, 70km away from Morvi, were the first to reach the devastated city and they set about extricating the wounded from the debris, disposing of bodies and organising relief.

The Federation of Amateur Radio Societies of India and the Radio & Electronics Society of India, realising that communications would be needed, held an emergency meeting and within three days volunteers were mobilised, equipped with transceivers, antennae and other communications equipment, borrowed from various amateurs. Flying indirectly from Bombay to Rajkot, a small team of radio amateurs joined other helpers. One of the local amateurs contacted the Home Guard and introduced the District Commandant to their facilities. The Commandant indicated that these facilities were just what they desperately needed, their own vhf equipment being totally inadequate to the problem. A main station was set up in the Commandant's office at the Home Guard's base at Rajkot, a jeep was made available and was quickly fitted out with mobile hf and two-metre equipment.

The two-metre portable equipment in particular, proved to be invaluable to the working parties who went out into the mud-filled lanes.

The amateur's facilities were used by the Red Cross and many other relief groups; they gave up 18 days of their time to provide emergency communications round-the-clock. When the telephones were reconnected between Morvi and Rajkot, the amateur's usefulness diminished and operations were wound up on September 5.

The amateurs obtained a good deal of satisfaction from the provision of emergency communications but they were also quick to point out that they had come to realise just how unprepared they were for the event and how lacking they were in suitable equipment and trained manpower. Their hope now is that, with government and other help, they can improve this situation. A story like this must encourage organisations such as RAENET (Radio Amateur Emergency Network) in the UK and other services even if they do find little opportunity to put it into practice.

Report says "Space for 12 more radio stations in London"

A study of v.h.f. spectrum availability in the London area, carried out by the former IBA engineer Fred Wise and commissioned by the Community Communications Group (COMCOM), reports that there is space for at least a dozen small radio stations in the area. The report splits possible further coverage into three categories including small stations with a coverage radii of about 1.5km, medium size stations covering a sector of the city and larger stations, aimed at specialist interests, covering the entire city.

The forthcoming extension of the v.h.f. broadcast band to, initially, 104MHz and later to 108MHz (see News columns, January 1980 *Wireless World)* as a result of allocations at WARC '79, means that a further six stations in the first category, four in the second and one in the third would be possible, but the latter would have to compete for space with both the BBC and the IBA.

Emphasis is placed in the report on the need for adequate representation of community radio interests in any plans to develop local or national services in the v.h.f. band. Commenting on the report, a spokesman for COMCOM said "We are delighted to have expert confirmation that our proposals for a "third force" of small, democratically-controlled, non-profit radio stations are technically feasible. Over the country as a whole, this finding shows there is room for many more stations than is officially admitted."

Hoff awarded microprocessor prize

The Franklin Insitute has awarded the Stuart Ballantine Medal, one of the United States' most coveted awards for scientific and technical achievements, to Dr Marcian E. Hoff, for his work in developing the microprocessor.

In addition to his work on digital microprocessors, Dr Hoff, or Ted Hoff as he prefers to be called, has contributed to the development of the first high-density memories for both mainframe computers and small computers, and more recently the development of the first analogue microprocessor. Between 1962 and 1968, he worked on computer equipment design as a research associate at Stanford. In 1968 he joined the then newly-formed Intel Corporation as applications research manager where he worked on a variety of microprocessor and memory devices. In 1969 he proposed the microprocessor architecture and his work led to the production of the first microprocessor, the 4004, in 1971.

Since 1974, Ted Hoff has specialized in Intel's telecommunications products, contributing to the development of l.s.i. circuit technologies as used in the a.-to-d. and d.-to-a. converters employed in telephone coder-decoder circuits and the 2920 analogue microprocessor.

NEWS IN BRIEF

The sixth European Conference on optical communication is to be held at the University of York from 16th to 18th September 1980. The papers presented will cover fibres and fibre cable, devices (l.e.d's, lasers and detectors) integrated optics, equipment and techniques and total systems. The deadline for abstracts is 31st March 1980 and communications regarding the conference should be addressed to Conference Dept, The Institution of Electrical Engineers, Savoy Place, London WC2R 0BL.

Six training modules, which Texas Instruments describe as a complete introduction to microprocessor technology, are being run by them as an extended range of courses at their headquarters in Bedford. Subjects covered include an introduction to microprocessing, assembly language programming, microprocessor software development using a diskette-base operating system, advanced microprocessors, Pascal language programming, Pascal executive runtime support and target system debugging. A brochure covering the range of courses is available from Mike Hughes, Microprocessor Training Centre, Texas Instruments Ltd, Manton Lane, Bedford MK41 7PA.

South London College is running a short course of nine lectures on receiver decoders (Teletext), to be held in the lecture theatre on consecutive Tuesday evenings from 6.30 to 8.30, starting on January 29th 1980. Slides and demonstrations will be features of the lectures and the course is intended for television and telecommunication technicians and engineers. Fee for the course is £7. Contact A. A. Rowlands, Course Organiser, South London College, Knights Hill, London SE27 0TX.

The 65th convention of the Audio Engineering Society is to be held at the Hilton Hotel, Park Lane and the Park Lane Hotel from Feb. 25th to 28th, 1980. Pre-registration fees are non-members £17.50, members £12.50 and student members £3.00 (student non-members £4.50). Fees at the door are non-members £20, students £6, members £15 and student members £4. Details from Laurie Fincham, K.E.F. Electronics Ltd, Tovil Maidstone, Kent ME15 6QP.

B. Sandham, electrification planning engineer, British Rail Board, will present **"Future Developments in Electrification (Railways)"** at a joint IEETE/ITEME meeting to be held at the IEE, Savoy Place, London WC2 at 5.30pm on January 30, 1980.

The IEETE have two optical fibre events planned for February 1980. D. J. Blake of the Post Office, will present **"Optical fibre communications systems"** at Swansea University at 7.30pm on February 14, and an "unconfirmed" speaker will present **"Optical fibres and cables"** at Gwent College of Higher Education, Newport, on February 19.

K. Tabor of Post Office Telecommunications will present **"Post Office System X"** at Bucks Higher Institute of Technology, High Wycombe. The IEETE meeting will be held on February 28 at 7.30pm.

Car telephone service to go automatic

A service which will permit car radiophone users in the London area to dial direct or receive calls from any of Britain's 25 million telephones or 400 million numbers available on International Direct Dialling in 90 countries, is to be introduced by the Post Office in May 1980.

The new service will operate in exactly the same way as the 'phone at home and will enable 1,500 subscribers who have been waiting for connection to take advantage of this phone-in-a-car facility. At the moment it is necessary to call the radiophone operator, ask for the number and when an unoccupied radio channel is found the number is selected and routed through to the caller. With the new service it will no longer be necessary to follow special procedures such as depressing the "press to speak" button.

"New" radio frequencies, made available by reducing the bandwidth of existing channels, have been created to accommodate the increased number of subscribers using the service. At present, the London Radiophone service, which has been in operation since 1963, is stretched to its limit at about 3,500 customers. Customers using the current manual system are being given the opportunity to switch to the automatic process, but those who choose to remain with the old service will have to have their car equipment modified to work on the reduced bandwidth channels. Conversion will be carried out free of charge by the Post Office in conjunction with Radiophone suppliers under a carefully phased programme.

Customers will rent or buy the necessary equipment from three authorised suppliers; Marconi Communication Services Ltd, Pye Telecommunications Ltd, or Storno Ltd, who will install and maintain the hardware.

Two charge rates are applicable to the automatic service; normal (working hours, 8am to 6pm) at 3½p for eight seconds and cheap (evenings and weekends) at 3½p for 15 seconds. The charge will depend on duration of call irrespective of distance and there will be no three-minute minimum. The quarterly rental will be £100, vat extra, and although the first subscribers will be dealt with in May 1980, work on the new service as a whole will begin in January 1980 and take 18 months to complete.

Additional equipment is required at the Radiophone stations and £1¾ million worth of the necessary work will be provided by Pye. These improvements will also permit users of the automatic system to make use of the facility in other Radiophone areas.

Datel 4800

A high-speed Datel service, to be known as Datel 4800, will enable users to send data at up to 4,800 bits/s over the national telephone network; the system is to be introduced by the Post Office this month and offers three types of synchronous operation; full duplex, half duplex and full duplex private circuit with half duplex public network operation as a standby facility. The system also incorporates customer test facilities enabling checks on circuits or modems before calling in PO engineers.

Is breath-testing BORIS bogus?

According to a report by Radio Australia, inventor Jim Blackwell has developed a "fool-proof" device which will keep intoxicated motorists off the road. He calls the equipment BORIS, which stands for Breath On Re-circulating Ignition System and Jim says the device is now ready for marketing after four years of development. It is fitted to the car's ignition system and the engine will not start "until the driver has blown into it. If the driver's blood alcohol level is above the legal limit, the engine does not turn over."

The inventor claims that tests at Sydney University prove that the gadget is 100% effective. The practical implications of the method, unless it is now possible to breathprint a particular driver, are that in normal use (and in the tests at Sydney University, presumably) the sober spouse and kids have to be chained up to a local lamp post or left at home; the naughty driver might otherwise be tempted to get one of them to blow into his BORIS so that he/she could roar off on a characteristic zig-zag path in a haze of alcohol and burning rubber. There's also a distinct odour of red herring in the air!

Hounsfield wins major German award

Dr Godfrey Hounsfield, who was joint winner of the 1979 Nobel Prize for Physiology and Medicine, received the 1979 Aachen and Munich Prize for Technology and Applied Natural Sciences at a ceremony in Munich recently. The prize, which is worth about £15,000, is also in recognition of Dr Hounsfield's invention and development work relating to computer tomography. The annual award was instituted in 1975 to mark the 150th anniversary of the founding of Aachen and Munich Insurance Company.

Meteosat fails

Saturday, 24 November, 1979 marked the 2nd anniversary (plus a day) of the successful operation of Meteosat 1 and at 19.30 hours on that day an apparent overload in a power supply circuit caused the spacecraft to switch itself into the stand-by mode.

A statement issue by the European Space Agency (ESA) on 6 December, 1979 points to the source of the trouble as being "a component fault in a power control unit. The fault manifests itself as a spurious signal in the circuit designed to produce protection against overload situations (such as short circuits). This prevents many of the satellite sub-systems from being switched on. This particular component is not duplicated so there is no way in which the problem can be avoided by choice of alternative circuits. However, it appears that the failure is intermittent in nature and it may well be that the satellite can restore itself to a normal mode. The investigation is continuing and ground simulations with similar circuits are being used to try to identify possible actions and to gain an understanding of the likely longer term forecast for the affected missions."

It is impossible to generate or disseminate images or to distribute information via the S band transponders, although the data collection mission continues to function normally. M. L. Christieson, author of "Meteosat earth station", *Wireless World* June 1979, says, "The failure of this satellite is a great disappointment to the many people involved with this project." Its failure may carry important implications for Meteosat 2 which is scheduled for launch in September 1980 aboard the "Ariane" launch vehicle.

Store recorders aid disease research

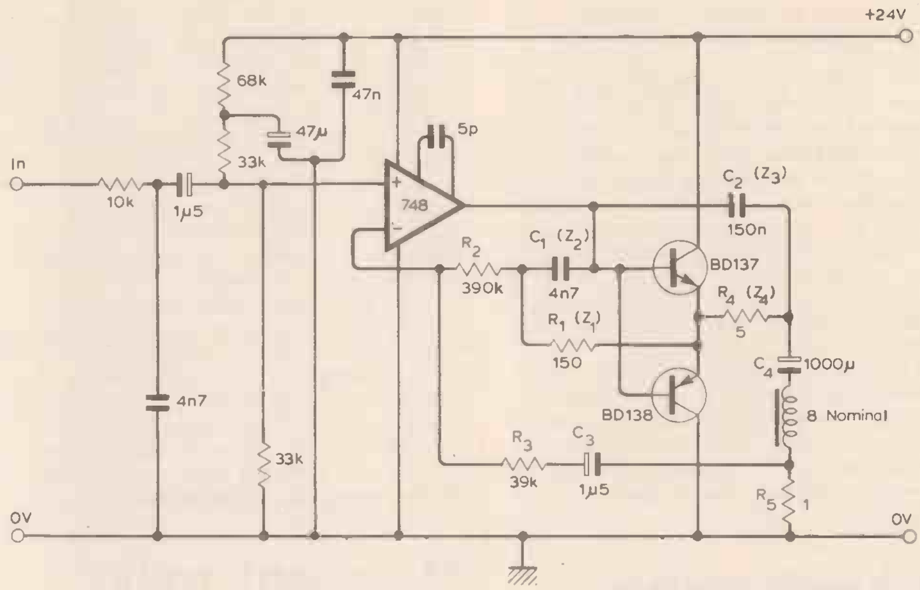
Syringo Myelia, a disease which affects the central spinal canal and which causes pain, loss of touch sensation and paralysis is being placed under renewed scrutiny at the Midland Centre for Neuro-surgery, Smethwick, using Racal's 14 channel "store" recorders. Information from transducer probes inserted into brain and spine cavities is compared with electrical signals from the heart. The seven speeds of the machine permit a "time lapse" approach which it is hoped will eventually yield a coherent picture of the disease.

CIRCUIT IDEAS

Reverberation amplifier

An effective 100mW reverberation-spring amplifier can be constructed by combining a current dumping circuit with a feedback technique described by G. Hibbert in the August 1976 issue. The feedback around R_2 R_3 R_5 and C_3 provides an approximately equal output power when the load impedance drops at resonant frequencies. Current dumping is performed by R_1 R_4 C_1 and C_2. Although the open-loop voltage gain of the op-amp is insufficient to cancel all of the cross-over distortion, with reverberation this is not audible. For other audio applications such as a headphone amplifier, the op-amp should be replaced by a high gain amplifier.

H. E. Riegstra
Amsterdam
Holland

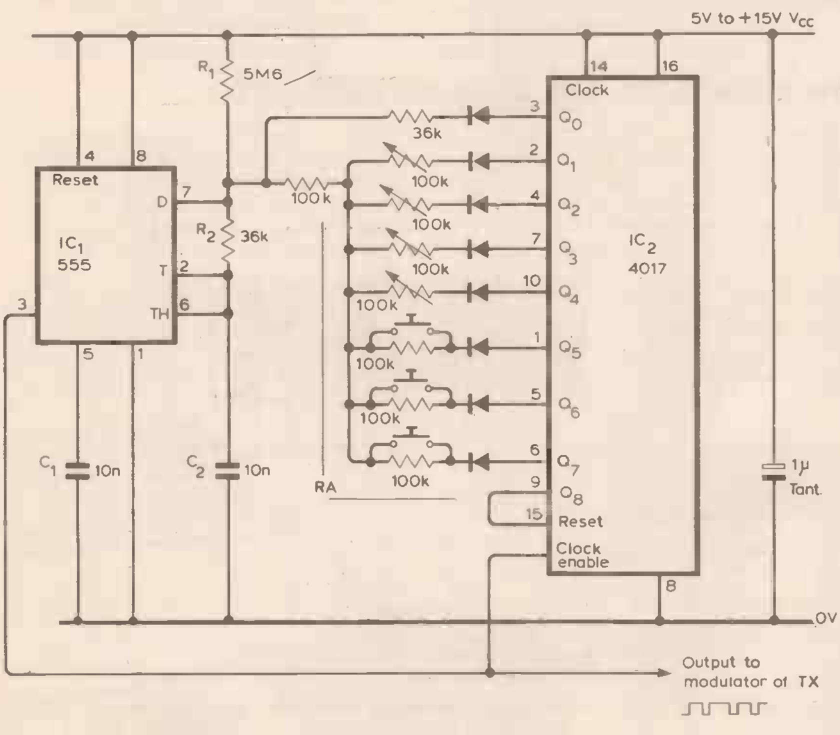


Radio control encoder

A simple seven-channel radio control encoder can be built with two i.cs as shown. The circuit operates from 5 to 15 V at 2.5 to 8mA and will provide an output current of up to 200mA. The 555 is used in the astable mode with an off time of 0.25ms and an on time between 1 and 2ms except for channel 0 which produces a 0.5ms sync. pulse.

The decade counter is clocked by the falling edge of the output and is reset when Q8 goes high. Resistor R_1 ensures that the 555 oscillates at a low frequency if no outputs are selected. If proportional control is not required, resistors R_A can be fixed values. For a supply below 8V a Zener regulator should be used to prevent variations in pulse width.

S. Ingham
Moseley
Birmingham

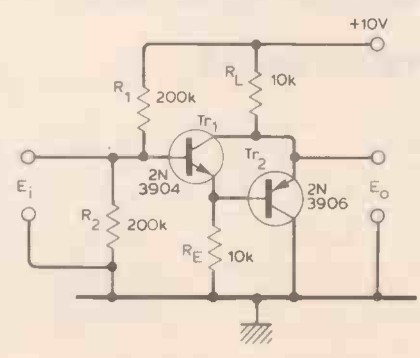


Unity gain buffer with wide frequency response

By d.c. coupling a n-p-n. common emitter stage with a p-n-p emitter follower stage sharing a common load resistor, a unity gain buffer is formed which offers a high input impedance, wide frequency response, low output impedance and low current consumption.

The 3 dB bandwidth is above 80 MHz and by selecting better transistors this can be extended. Care in minimising the lead inductance and stray capacitance will also improve this figure. Current consumption is about a mA with a 10V supply. The circuit will operate from 3 to 30V without degrading its performance. It is important to select the correct input biasing resistors because they reduce the input impedance.

A. L. Equizabal
Vancouver
Canada

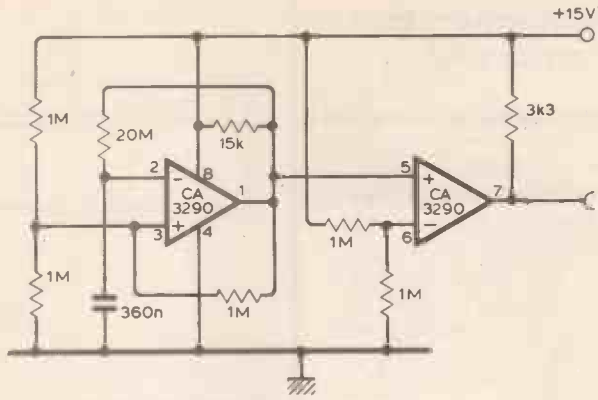


Low-frequency multivibrator

This multivibrator is based on the CA3290 dual voltage comparator which uses the bi.m.o.s. technique of combining bipolar and m.o.s. devices on a chip. The use of m.o.s. transistors in the input stage of the CA3290 provides an input impedance of around 1T7Ω and common-mode rejection for input signals below the negative supply rail.

In the circuit diagram one half of the CA3290 is used as a conventional multivibrator. Because the input impedance is very high the value of the timing resistor can be large which enables a small low leakage timing capacitor to be used for a long time delay. The second half of the CA3290 is used as an output buffer so that the multivibrator frequency is not affected by output loading.

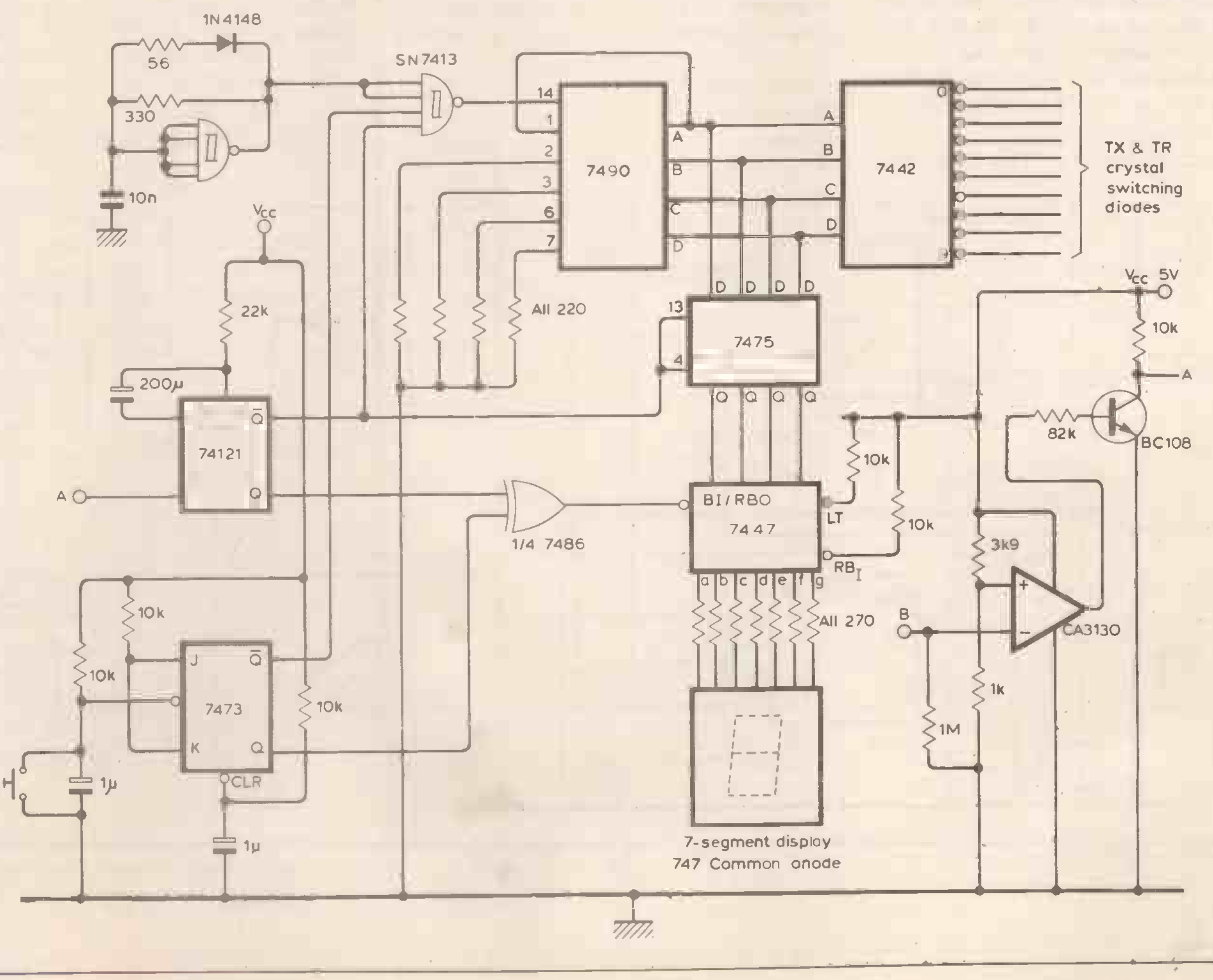
R. Buckley
RCA Solid State
Middlesex



F.m. channel scanner

This circuit scans through 10 channels of an f.m. radio or transceiver by switching crystals in the local oscillator. Point B is connected to the audio switching transistor in the receiver which is normally saturated when no signal is present. On reception of a signal, point A rises to V_{cc} and triggers the 74121 which enables the display and gates out the 7413 oscillator. The display is enabled for three seconds and if, during this time, the channel is wanted S_1 is pushed. The display disappears for the remaining period of the monostable pulse and is then enabled to confirm that the channel has been locked. If S_1 is pushed again the channel is released and the circuit continues scanning.

J. W. Jarvis
Huntingdon
Cambridgeshire

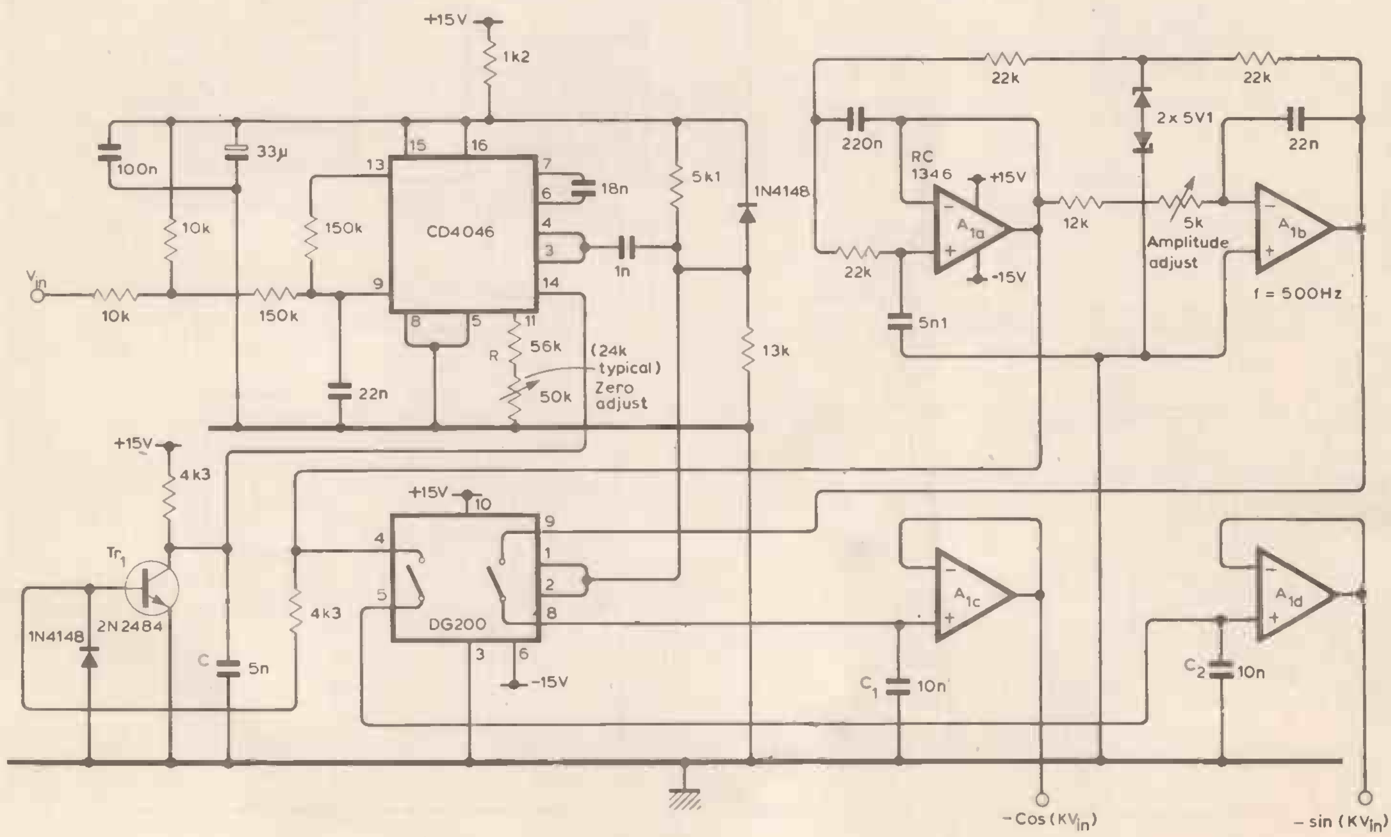


Analogue trigonometric function generator

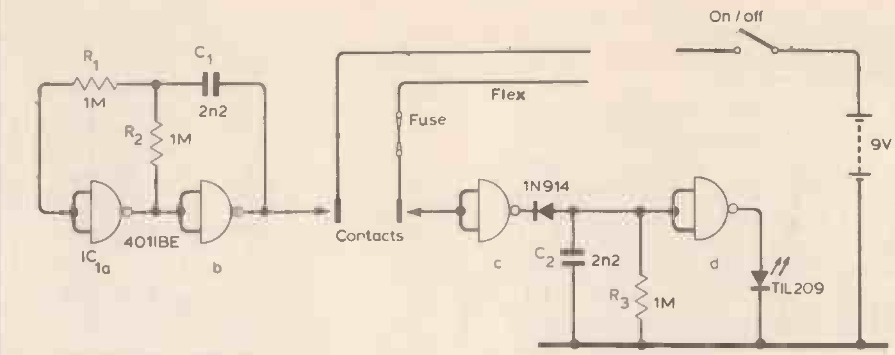
When a function generator is needed where the output is a trigonometric function of the input variable, this is usually accomplished with a digital memory or with a non-linear circuit which approximates the function over a limited range. This circuit is comparatively simple and simultaneously provides the sine and cosine functions over an angle of $\pm 2\pi$. By using analogue dividers, other trigonometric functions can also be obtained.

The circuit operates by continuously sampling two harmonic waveforms, the phases of which are displaced by 90°. An oscillator generates sine and cosine waveforms at frequencies much higher than V_{in}. Purity of the waveforms has a direct influence on the quality of the outputs. The two waveforms are sampled and held by a dual analogue gate, C_1, C_2, and buffered by A_{1c} and A_{1d}. Sampling is synchronized to the harmonic waveforms and time displaced proportionally to the input voltage by the p.l.l. The 4046 is locked to the sine waveform and V_{in} is resistively summed with the phase-detector output which feeds the v.c.o. input. To remain locked to the input frequency the p.l.l. cannot allow a change in the v.c.o. input and therefore generates a voltage at the phase-detector output which exactly opposes V_{in}. Due to the linear characteristic of the phase-detector, the output square wave is displaced and its leading edge used as a control for the two sample and hold circuits. To be symmetrical about $V_{in} = 0$, the p.l.l. should have zero phase shift at this point and this is achieved by adjusting the v.c.o. frequency. The input is coupled to the p.l.l. by a summing network so that V_{in} can vary symmetrically about ground by $\pm$ 4V which simulates an argument variation of $\pm 2\pi$. Transistor Tr_1 squares the sinewave at the input of the p.l.l. to provide lock. Similarly, capacitor C is needed to eliminate lock loss near $V_{in} = 0$.

Y. Netzer
Haifa
Israel



Fuse tester



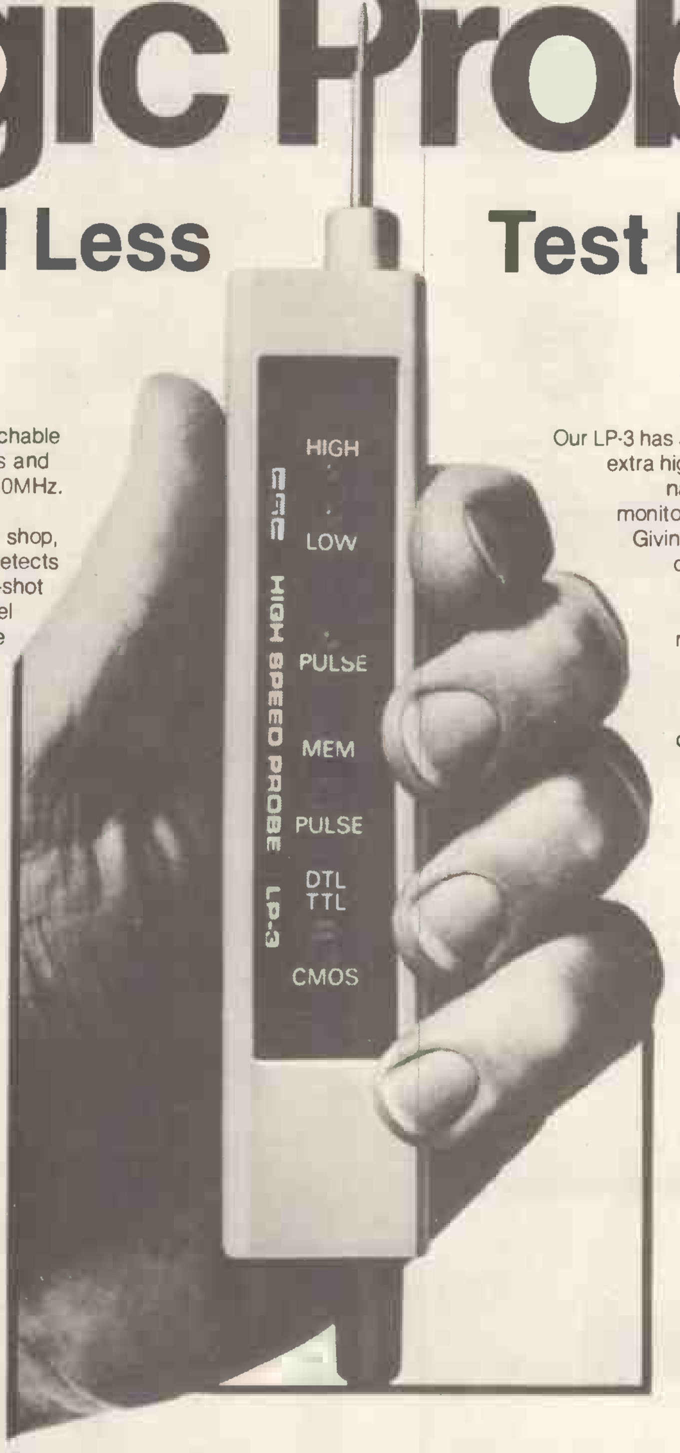
When it is necessary to test a mains fuse, unless the plug is taken apart, a conventional check relies on the resistance of the appliance. This circuit uses the capacitance between the line and neutral wires in the mains lead so a faulty connection or open circuit within the appliance cannot cause a misleading reading.

The oscillator formed by gates a and b feeds pulses into the neutral wire which induce a signal into the line. If the fuse is intact the induced signal is amplified by gate c, rectified and used to charge C_2. The voltage on C_2 is amplified and used to drive the l.e.d. The fuse tester can be checked by touching the contacts with a finger.

P. Kelly and M. Dixon
Shrewsbury

The Logic Probes

Spend Less Test More



LP-1 Logic Probe

The LP-1 has a minimum detachable pulse width of 50 nanoseconds and maximum input frequency of 10MHz. This 100 K ohm probe is an inexpensive workhorse for any shop, lab or field service tool kit. It detects high-speed pulse trains or one-shot events and stores pulse or level transistions, replacing separate level detectors, pulse detectors, pulse stretchers and pulse memory devices. All for less than the price of a DVM

£31.00*

LP-2 Logic Probe

The LP-2 performs the same basic functions as the LP-1, but, for slower-speed circuits and without pulse memory capability. Handling a minimum pulse width of 300 nanoseconds, this 300 K ohm probe is the economical way to test circuits up to 1.5 MHz. It detects pulse trains or single-shot events in TTL, DTL, HTL and CMOS circuits, replacing separate pulse detectors, pulse stretchers and mode state analysers.
(Available in kit form LPK-1 £11-92)

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The logic probes shown are all suitable for TTL, DTL, HTL and CMOS circuits.

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LP-3 Logic Probe

Our LP-3 has all the features of the LP-1 plus extra high speed. It captures pulses as narrow as 10 nanoseconds, and monitors pulse trains to over 50 MHz. Giving you the essential capabilities of a high-quality memory scope at 1/1000th the cost. LP-3 captures one shot or low-rep-events all-but-impossible to detect any other way. All without the weight, bulk, inconvenience and power consumption of conventional methods.

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The New Pulser DP-1

The Digital Pulser: another new idea from C.S.C. The DP-1 registers the polarity of any pin, pad or component and then, when you touch the 'PULSE' button, delivers a single no-bounce pulse to swing the logic state the other way. Or if you hold the button down for more than a second, the DP-1 shoots out pulse after pulse at 1000 Hz. The single LED blinks for each single pulse, or glows during a pulse train. If your circuit is a very fast one, you can open the clock line and take it through its function step by step, at single pulse rate or at 100 per second. Clever! And at a very reasonable price. **£51.00***

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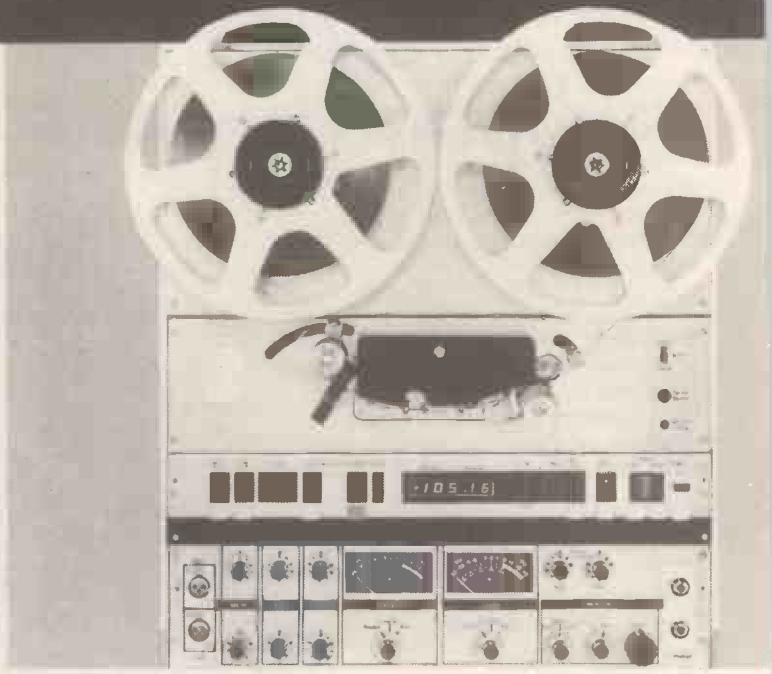
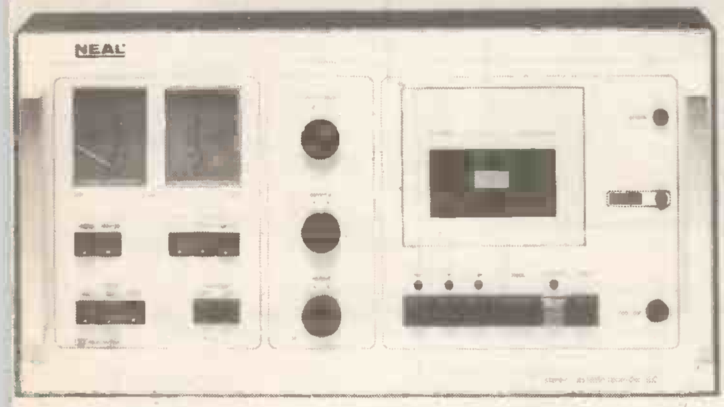
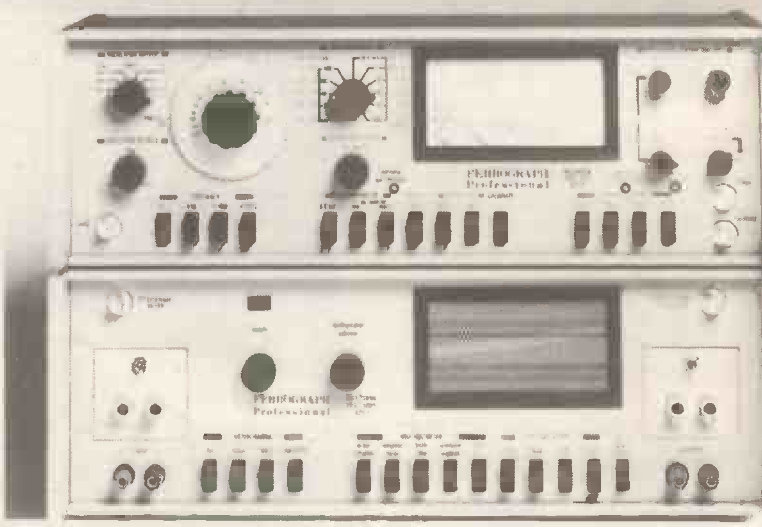


The Ferrograph SP7
A transportable recorder for fast, safe tape handling under all conditions and a new concept that brings custom-building within the price range of standard models. It takes all spool sizes up to 27cm and provides 3 speeds and positive action push buttons in association with logic circuits as well as motion sensing and command memory. Based on the Logic 7, individual specification allows choice of mono full track or half track head, stereo half track or quarter track head, line-in/line-out, microphone inputs and many other features.

The Ferrograph Studio 8
A professional studio tape recorder, logic controlled and offering a choice of stereo, twin track and full or half track mono heads, PPM or VU meters, IEC (CCIR) or NAB equalisation. It is designed to meet the needs of modern radio and television broadcasting organisations and features include servo-controlled run and spooling, tape motion sensing and three editing modes. For up to 10½" spools it accepts standard, long-play and double play ¼" tape and has total type protection by electronic interlocks.





The Neal 302
A studio cassette recorder that incorporates three a.c. motors for reliability and smooth effortless power. It is controlled by a full solid state logic system actuated by ultra light touch buttons. A massive decoupled flywheel and oversize capstan result in exceptionally low wow and flutter. Tapes are protected by constant monitoring and in the event of snag or snarl the machine returns to stop. The 302 is used by top recording studios and broadcasting stations for quality cassette copies and in-cassette duplication masters.

The Ferrograph RTS2 and ATU1
An all-in-one audio test set, the RTS2 puts an end to the use of separate instrumentation and its inherent complication of connections. The result is faster, cheaper servicing. It combines in one easy to use compact instrument the measurement of gain, noise, frequency response, input sensitivity, output power, distortion and the perameters relating to recording equipment such as wow and flutter, crosstalk, drift and erasure. Linked with a Ferrograph Auxiliary Test Unit, ATU1, its range of applications can be extended to include measurement on professional equipment.

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Neal · Ferrograph, Simonside Works, South Shields, Tyne and Wear, NE34 9NX. Telephone: 0632 566321.

Spectrum analyser adaptor

Using an r.f. instrument for audio frequency measurements

by **R. C. V. Macario,** B.Sc., Ph.D., M.I.E.E. University College of Swansea

The unit described, based on two mixer integrated circuits, enables an r.f. spectrum analyser to display a.f. system responses without loss of performance accuracy. Examples of the application of the unit presented here are measurements of the frequency responses of active audio filters and radio receivers.

Many laboratories possess versatile r.f. spectrum analysers and often associated r.f. tracking oscillators. Unfortunately the lowest frequency of operation of these instruments is often confined to a few kilohertz and this means that audio-frequency filter circuit responses usually cannot be examined directly on such instrumentation — and, indeed, if an audio frequency network analyser is not to hand the measurement of audio frequency response becomes very tedious.

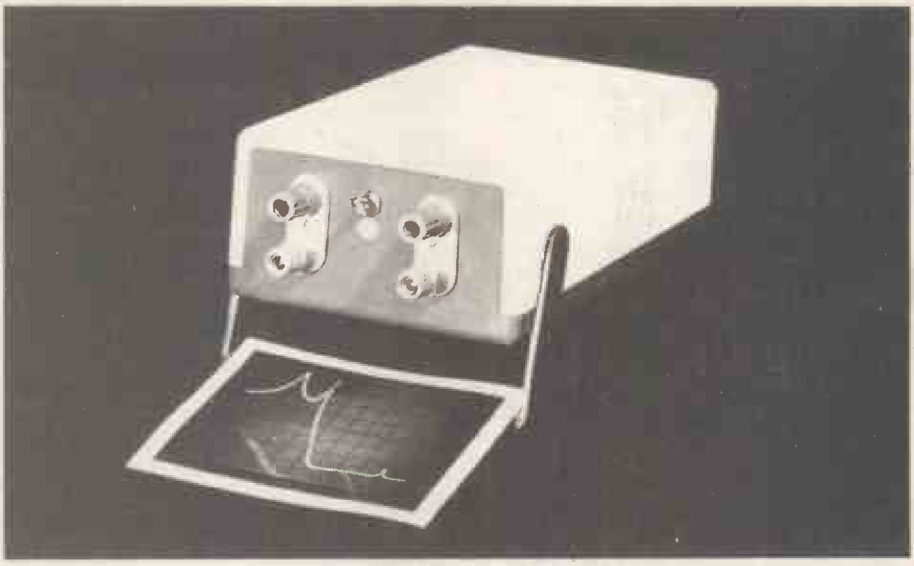
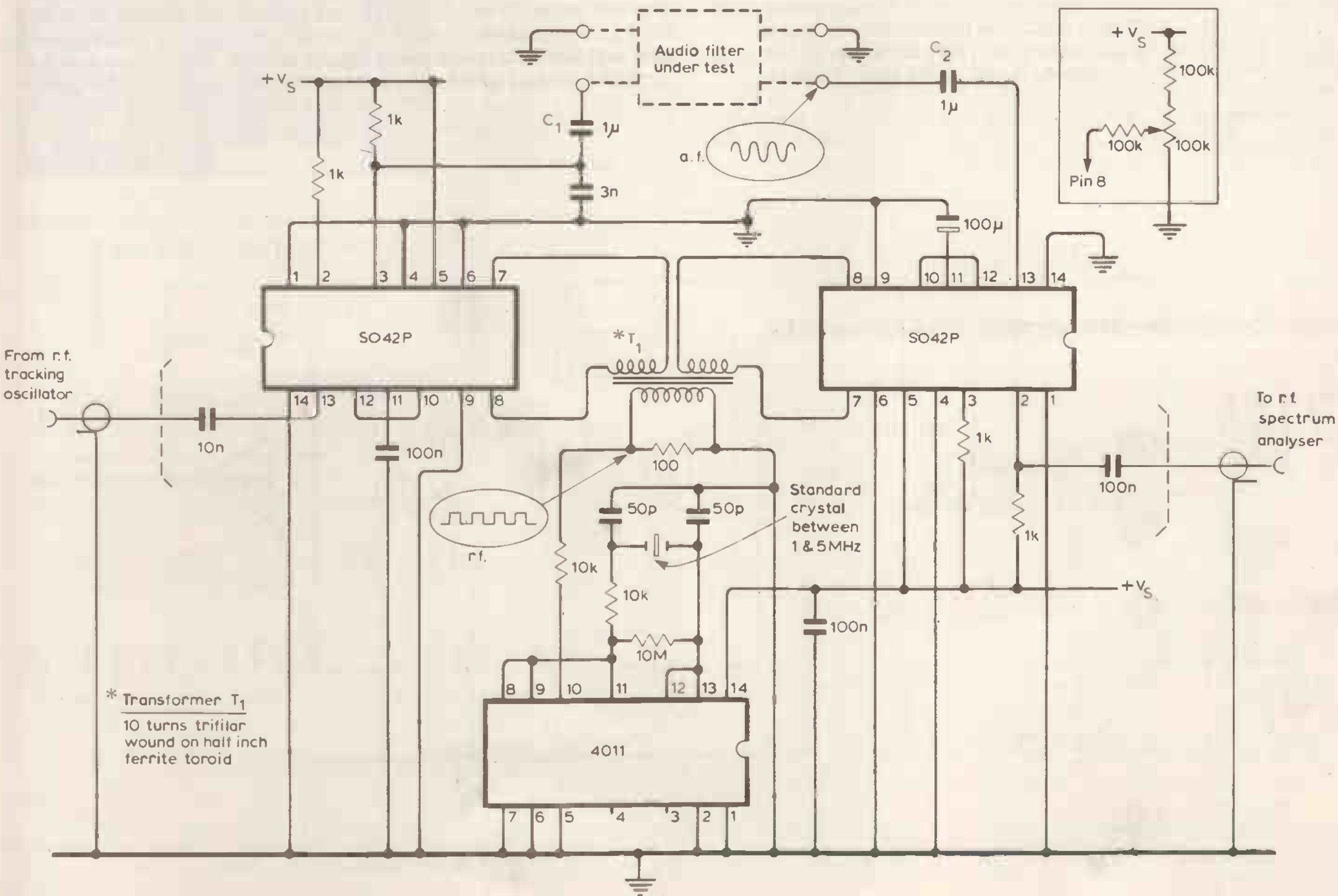


Fig. 1. The complete adaptor unit, with a photographed trace in front.

Fig. 2. Circuit diagram and waveforms of unit. To improve the carrier balance, add the circuit in the small box (top right) to pin 8 of each mixer.



The unit shown in Fig. 1 provides a simple means of shifting an r.f. signal down to audio frequencies, and then up again to the same radio frequency. Operation is centred about a frequency determined by a c.m.o.s. crystal oscillator. This has good stability and its frequency is easily changed. The centre frequency can be between 1 and 5 MHz and is determined either by a crystal one has to hand or by the frequency required to match a receiver system being measured.

The frequency shift operation is carried out using the Siemens SO42P double balanced mixer device, which needs few external components. The natural signal balance of this device is about 30dB; if better than 50dB is required the balance circuit shown in a box as an option may be added. Two of these devices are used in the unit, as shown in the circuit diagram Fig. 2. (The circuit diagram of the mixer device itself is shown in Fig. 3 for reference as it makes clear the pin connection availability. Pins 11 and 13 are used as the signal input (unbalanced arrangement in Fig. 2); Pins 7 and 8 are used as the shift carrier input (balanced); the output (unbalanced here) is taken from pin 2.)

The principle of operation is quite simple. The swept r.f. input voltage is simply shifted down to audio frequencies (and d.c.) by choosing the appropriate unit crystal frequency. These audio frequencies are then shifted up again to r.f. by an exact counterpart circuit, the second SO42P. An aspect of the circuit is the symmetry of the two operations and the equality of the shifting r.f. reference waveform.

The c.m.o.s. oscillator (4011 quad 2-input Nand gate) produces a nine volt square-wave at the crystal frequency. This is divided down to produce a 100mV signal to each mixer via the untuned wideband transformer, T_1. The maximum r.f. signal level that should be applied to the mixer inputs is 100mV peak-to-peak. This produces about 400mV peak-to-peak audio as an input to the test circuit. If the audio circuit under test produces gain then an attenuator must be inserted after the circuit under test. Responses down to 100Hz can be examined; for lower frequency responses the values of C_1 and C_2 should be increased, provided the r.f. analyser has a narrower bandwidth.

The r.f. spectrum analyser is tuned to the centre frequency of the unit, say, 2MHz. The response of the audio filter appears both sides of the centre frequency, e.g. ±10kHz. Normally one would view one side only with an r.f. sweep of, say, 1kHz per division. The dynamic range of the unit exceeds 60dB. The normal sweep rates, etc., of the spectrum analysers apply.

Construction

The circuit has been committed to a p.c. board which fits in a RS Components case type 509-383. Normal wander plug connections are assigned to the audio lines, whilst BNC sockets on the back of unit are assigned to the r.f. input and output. Because the circuit only takes 3mA it has been made battery operated using a 9V PP6 cell. A double-sided board construction is assumed.

Applications

Active filters. The unit arose because of a need to examine certain active audio filters. In particular, there is a great interest in limiting the bandwidth of a.m. medium and long wave broadcast transmissions [1, 2] and to some extent good audio filtering in a receiver can aid this desire. Also, in the construction of s.s.b./i.s.b. phase shift modulators/demodulators the design of the audio frequency low-pass filter is as important

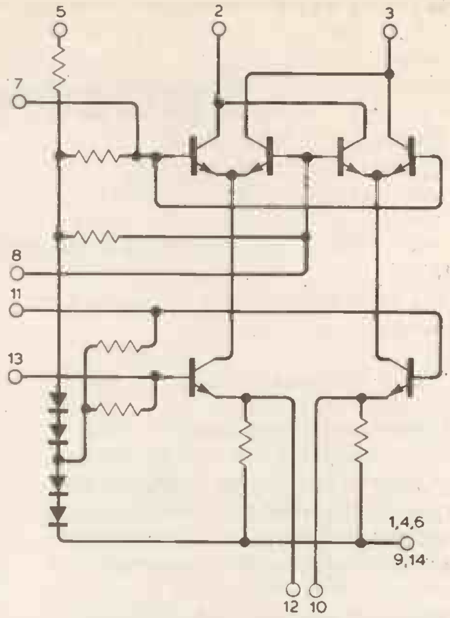
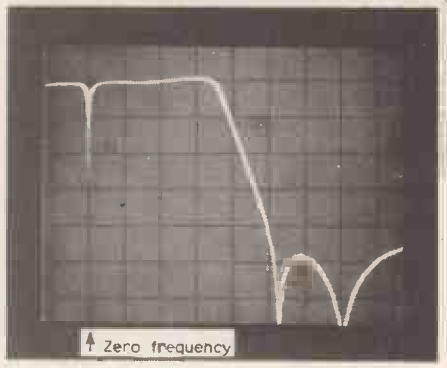
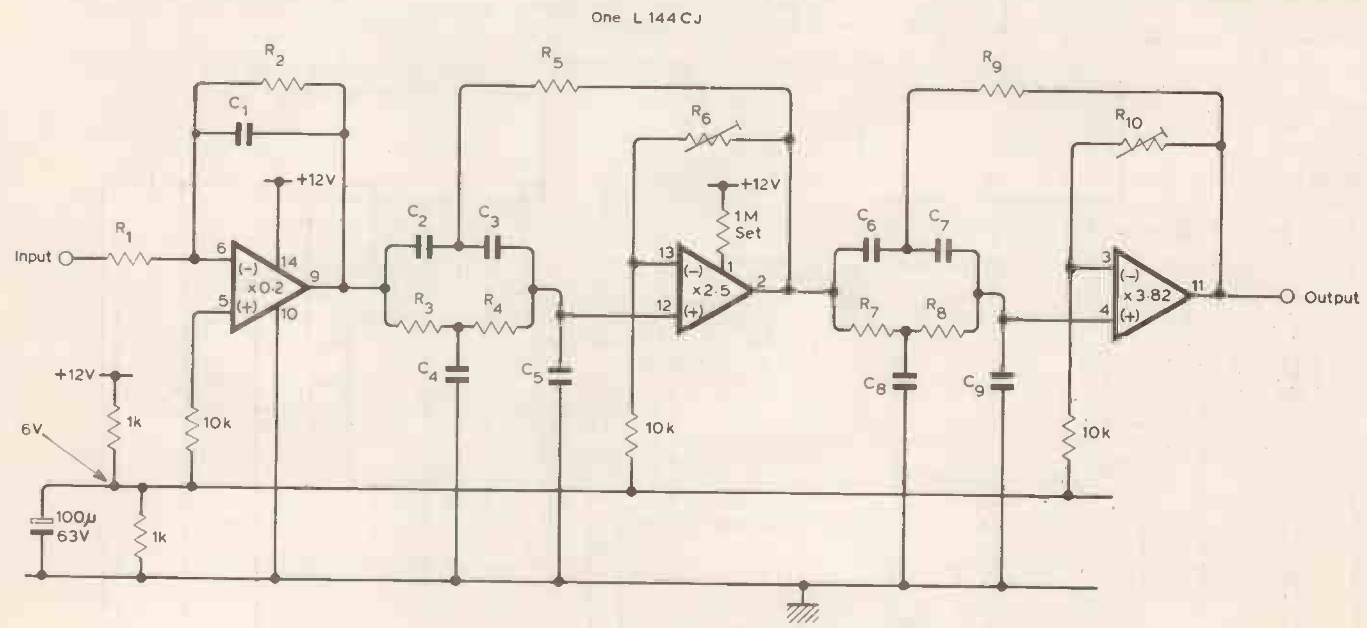


Fig. 3. Circuit diagram of the Siemens symmetrical mixer i.c. type SO42P (14 pin dual-in-line).

Fig. 4. Examples of active low-pass filters; (below) pole-zero realisation using op-amps; (opposite) conventional LC realisation using gyrators. Traces above diagrams show measured responses using the adaptor (vertical scales 10dB/div; horizontal scales 1kHz/div.).





Resistors: 1 — 56k; 2 — 12k; 3, 4 — 20k; 5 — 10k; 6 — 47k pot; 7, 8 — 16k; 9 — 8k2; 10 — 100k pot. Capacitors: 1 — 10n; 2, 3, 5, 6, 7, 9 — 1n5; 4, 8 — 3n.

as that of the phase shift networks[3].

The usual approach today in the construction of audio filters is to use RC operation amplifier networks. An alternative, however, is to use a conventional LC filter synthesized design, replace the L by a gyrator and capacitance, and have an RC gyrator design. It is of interest to examine the number of components one needs in the two cases to realise the same filter performance. The filter performance considered for comparison is as follows:

Cut-off frequency	=	4kHz
Stop band frequency	=	5kHz
Stop band attenuation	⩾	40dB

Consulting filter tables (Zverev, ref. 4) indicates a promising design is an elliptic design with:

Maximum passband attenuation ⩽ 1.25dB

Minimum stopband attenuation ⩾ 43dB

Fig. 4 summarises the two filter realizations. On the left-hand page the pole/zero realisation is accomplished by using a triple op-amp arrangement based on a synthesis technique given by Huelsman[5]. On the right-hand page an LC tabulated design[4] is realised using gyrators[6].

The feature of particular interest in Fig. 4 is the list of the number of components required. For example, in the op-amp design (one device only necessary e.g. Siliconix L144, Texas TL084), one requires 9 critical capacitors and 10 critical resistors. On the other hand, in the gyrator design one needs two devices, but only 7 critical capacitors and 5 critical resistors.

Photographs of the responses of two such filters, constructed on breadboards using 'stores' components are also shown in Fig. 4. In the gyrator version it is possible to 'tune' the response by means of R_1 and R_3 (inductances), so that it can be adjusted to be closer to the theoretical response.

Continued on page 74

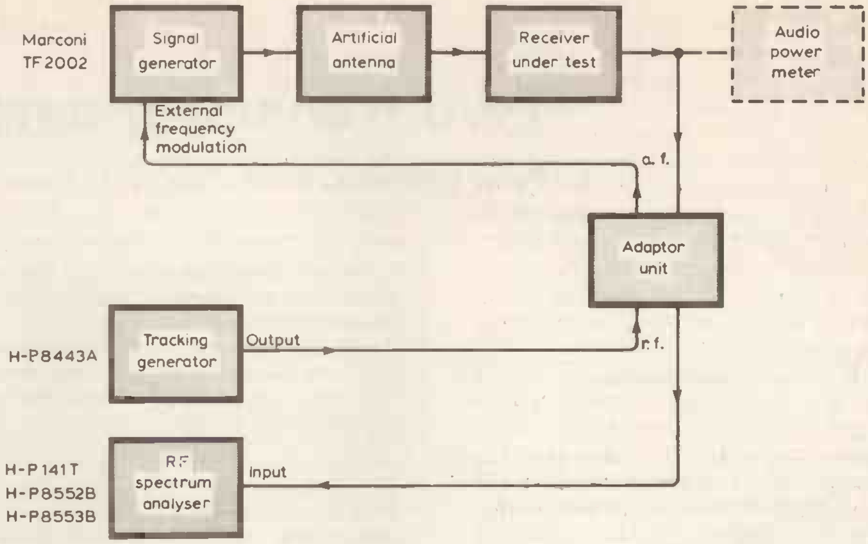
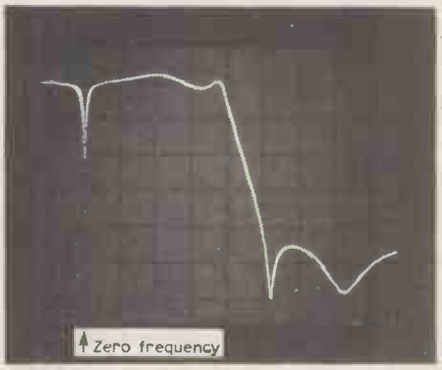


Fig. 6. Arrangement of apparatus for measuring frequency response of a radio receiver.



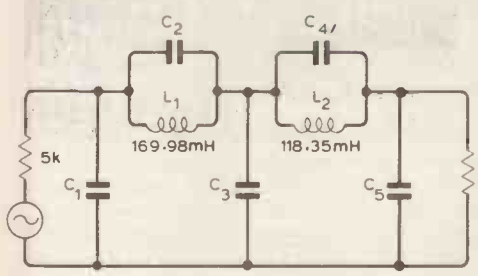
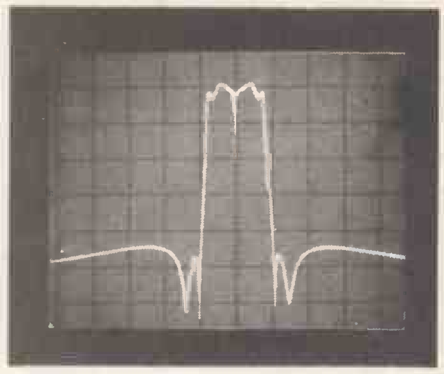
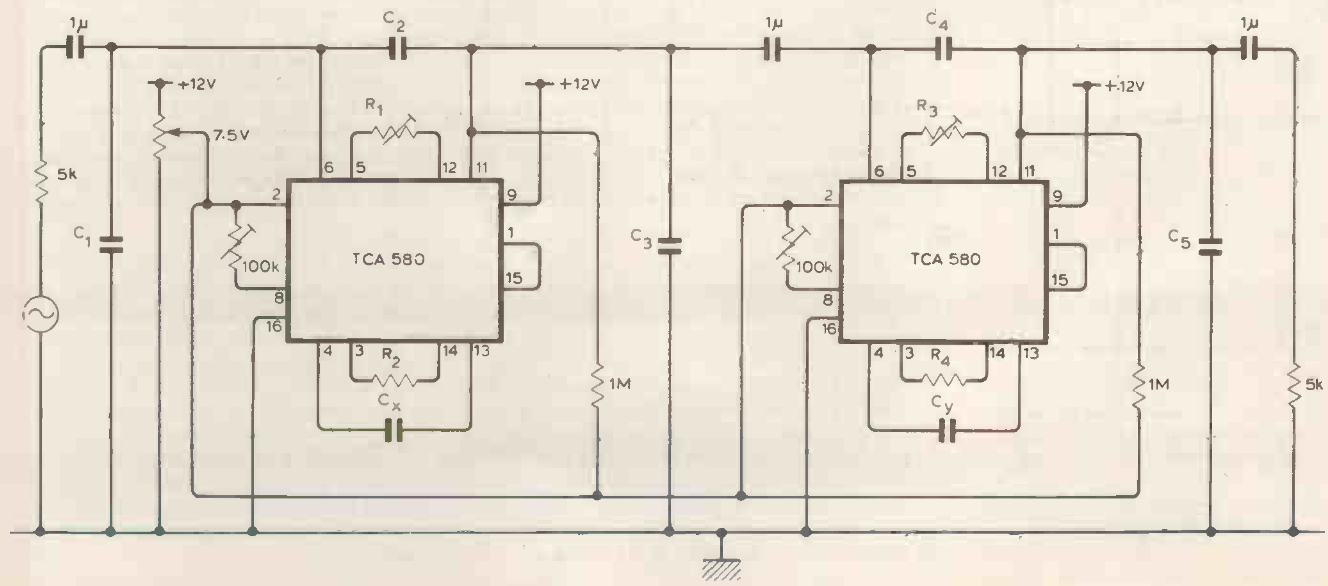


Fig. 5. Gyrator filter response as applied to a receiver response. Centre frequency is now the r.f. or i.f. frequency (vertical scale 10dB/div.; horizontal scale 5kHz/div.).



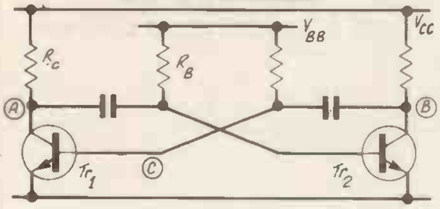
Resistors: 1, 3 — 47k pot; 2, 4 — 12k. Capacitors: 1 — 16n2; 2 — 2n7; 3 — 18n6; 4 — 8n; 5 — 12n8; x — 1n2; y — 820p.



Two transistor astables

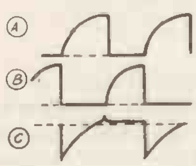
by **Peter Williams,** Ph.D. Paisley, College of Technology

TWO-TRANSISTOR ASTABLE



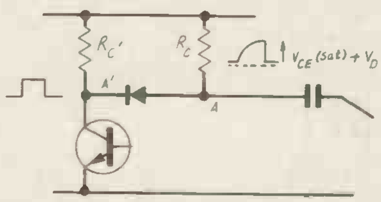
The two-transistor astable shown is the standard text-book example. It was also justifiably the standard industrial form of astable, though it needs a number of additions and modifications to improve the rise-time, remove voltage-breakdown limitations, etc. These modifications remain important as applications of principles that can be applied to other generators and pulse circuits. This form of astable also remains useful but has lost its dominance in the face of integrated-circuit alternatives. If transistor Tr_2 increases its current the fall in collector voltage is coupled through the capacitor to the other base (Tr_1) driving that transistor off. The resulting rise in the collector voltage of Tr_1 is capacitively coupled back to the Tr_2 reinforcing its original increase in current. The switching is regenerative and any such change always proceeds to the limit of one transistor on (Tr_2) and the other off (Tr_1). When the potential at B falls rapidly it drives C to a correspondingly negative value, C having started close to zero (in practice 0.7V corresponding to $V_{BE(sat)}$). Point C then charges towards V_{BB} through R_B eventually passing zero and then, at 0.5V, bringing Tr_1 into conduction. The process is then repeated with Tr_1 saturated and Tr_2 cut off. Independent control of the two parts of the cycle is inherent in the use of different CR sections for the two transistors.

ASTABLE WAVEFORMS



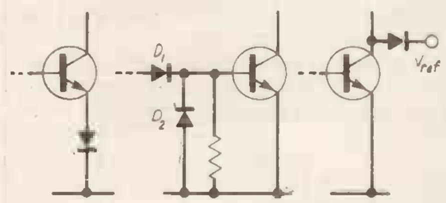
Ideally the collector waveform should be a squarewave and the base waveform a section of a perfect exponential followed by a period at zero volts. The departures from this ideal are indicated and can be explained as follows. When a transistor is driven into conduction the collector current can be very large depending on the current gain while the capacitor to which it is coupled sweeps the opposite base out of its conducting region. The transition is then slowed only by the device self-capacitances together with strays. Thus the fall-time at each collector is very short. When a transistor ceases to conduct, the capacitor has to charge through the full supply range via R_C and the opposite base-emitter diode. The rise time is thus of order $2.2R_C$ by the theory given earlier. As the timing cycle is of order $0.69CR_B$ if $V_{BB}=V_{CC}$ then the rise time clearly occupies a significant fraction of the on-duration $2.2R_C/0.69R_B$ or $3R_C/R_B$. It is not possible to reduce this greatly by manipulating the ratio R_C/R_B because that is constrained by the need to ensure saturation of the transistors when switched on. $R_B \approx 10R_C$ is a typical constraint leaving the rise time at 30% of the pulse width.

IMPROVED RISE-TIME



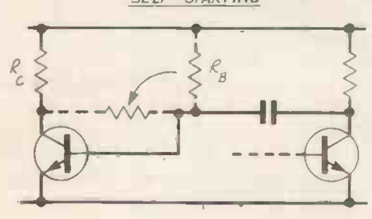
The rapid capacitor charging also shows up as a spike at the start of the base-waveform saturation region. The collector rise-time can be dramatically improved by isolating the collector from the capacitor during the recovery period. Assume the base voltage of a transistor has been swept negative so that it ceases to conduct. The capacitor begins to recharge and the potential at A rises exponentially due to the current through R_C. This rise is relatively slow and A' rises more rapidly reverse-biasing the diode. This isolates the collector from the capacitor and the rise-time is limited only by strays and self-capacitance. There is one disadvantage of the circuit and that is that R_C is involved in the recovery period while $R_C//R_C'$ has to be driven by the transistor. For a given maximum current gain this requires a reduction in R_B shortening the pulse-duration or an increase in R_C increasing the rise-time. Thus an improved waveform at A' is obtained at the expense of a worsening at A. A second snag is that A is no longer pulled down to $V_{CE(sat)}$ i.e. the step transferred to the other base is reduced by V_D, 0.6V.

VOLTAGE LIMITATIONS



At low supply voltages the fact that the base-emitter junction is subjected to a reverse voltage equal in magnitude to the supply is of no consequence. Above about 5V this reverse bias may be enough to produce breakdown in the junction. This need not be dangerous as the current is limited by the peak current available from the other transistor but it clips the base waveform. This makes the oscillation frequency more dependent on supply variations. The simple circuit is largely free of this problem as the resistor *voltage ratio* remains supply-independent as discussed earlier. As soon as one of the voltages becomes dependent on a constant breakdown voltage the ratio ceases to be constant as the supply changes. Three possible solutions are shown (i) a diode in series with each emitter absorbs the reverse voltage at the expense of raising the collector saturation voltage: this can have serious consequences if the astable is to remain compatible with, for example, logic circuits; (ii) a more complex network requires up to two diodes where D_1 will generally be slower than D_2, its stored charge helping to turn the transistor off rapidly; with D_2 omitted and D_1 of low capacitance the circuit becomes suitable for higher speeds, (iii) the collector voltage is caught by a diode at some reference level too low for breakdown to result during the following transition; the simple time-interval equation is again modified because the voltages depend partly on a constant reference and partly on a variable supply.

SELF-STARTING



This is a problem that is all too rarely discussed. At switch-on the vast majority of two transistor astables begin oscillating immediately. The start-up requires only a slight imbalance between the initial conduction build-up, which normally applies. Theoretically however the circuit could immediately go into a stable, non-oscillatory condition. If the transistors go into that saturated state simultaneously, the loop gain is less than unity and oscillation never starts. The real difficulty arises if an otherwise satisfactorily oscillating astable has its output temporarily short-circuited. Both transistors would then be driven into their saturated state and the very small rise in collector voltage from zero to $V_{CE(sat)}$ on removing the short-circuit is insufficient to propagate around the loop and raise the loop-gain to an oscillatory level. One simple way of avoiding this possibility is to ensure that the quiescent state of both devices is in the linear region i.e. that if oscillation ceases for any reason the loop gain always returns to a value sufficient to re-establish it. Each base resistor is returned to its own collector meeting this condition with only a small shift in the frequency equations.

Two transistor astables

THEORY

The voltage at B switches from V_{CC} to $V_{CE(sat)2}$. Prior to that instant C is at $V_{BE(sat)1}$, and falls by $V_{CC}-V_{CC(sat)2}$. With the resistor returned to V_{BB}

$$V_1=V_{BB}-V_{BE(sat)1}+V_{CC}-V_{CE(sat)2}$$
$$=(V_{CC}+V_{BB})-(V_{BE(sat)1}+V_{CE(sat)2})$$

This is composed of the major term $V_{CC}+V_{BB}$, obtained for ideal transistors, reduced by the finite transistor voltage drops in saturation. The corresponding value of V_2 is $V_{BB}-V_{BE(th)1}$ since the transistor enters its linear region at some voltage $V_{BE(th)1}$, where $V_{BE(sat)}>V_{BE(th)}>0$. Thus the interval between one transition and the next is

$$t_2-t_1=\tau\log_e\left[\frac{(V_{CC}+V_{BB})-(V_{BE(sat)1}+V_{CE(sat)2})}{V_{BB}-V_{BE(th)1}}\right]$$

This result is greatly simplified if

$$V_{CC}=V_{BB}\gg V_{BE(sat)1},\ V_{CE(sat)2},\ V_{BE(th)}.$$

$$\text{Then } t_2-t_1=\tau\log_e\left[\frac{2V_{CC}}{V_{CC}}\right]$$
$$=0.69\tau \text{ where } \tau=R_{BC}$$

● When Tr_1 ceases conduction potential at A has a finite rise-time due to the collector time constant. Again assuming $V_{BE}\ll V_{CC}$, and defining the rise-time as the time taken for A to rise from 10 to 90% of its final value then

$$V_1=0.9V_{CC}$$
$$V_2=0.1V_{CC}$$
$$\text{and rise time}=\tau'\log_e 9$$
$$=2.2\tau'$$
$$\therefore\ \frac{\text{rise time}}{\text{pulse width}}=\frac{2.2\tau'}{0.69\tau}$$
$$\approx\frac{3R_C}{R_B}$$

8ut $R_B\approx 10R_C$ is typical to ensure saturation of the transistor i.e.
rise time≈30% pulse width

● Voltage breakdown in the base-emitter junction modifies the waveforms and the frequency, which in the simple case is

$$f=\frac{1}{T}=\frac{1}{2\times 0.69\tau}=\frac{1}{1.38\tau}$$

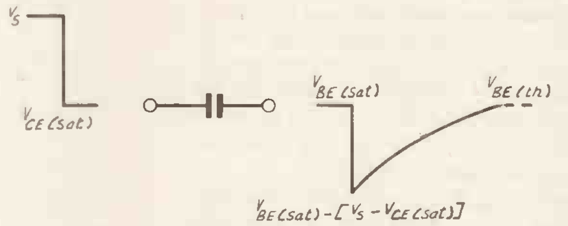
and is independent of V_{CC}.
Let V_R be the voltage on the base-emitter at which it conducts clamping the capacitor

$$V_1'=V_{CC}-V_R$$
$$V_2'=V_{CC}$$
$$t_2'-t_1'=\tau\left(1-\frac{V_R}{V_{CC}}\right)$$

$$f'=\frac{1}{2\tau\log_e\left(1-\frac{V_R}{V_{CC}}\right)}$$ and depends on V_R, V_{CC}.

EXAMPLES

1. A two-transistor astable has the following values R_C 1kΩ, R_B 15kΩ, C68nF, V_{CC}&V_{BB} 5V, $V_{CE(sat)}$ 0.15V, $V_{BE(sat)}$ 0.7V, $V_{BE(th)}$ 0.5V. Evaluate the frequency of oscillation from first principles.



The waveform sketch is of a collector waveform falling from V_s to $V_{CE(sat)}$. Just prior to that instant the other base is at $V_{BE(sat)}$ and is driven down by the same amount. When the base recovers to $V_{BE(th)}$ the other transistor takes over the second half-cycle.

$$V_1=V_s-(V_{BE(sat)}-[V_s-V_{CE(sat)}]$$
$$=2V_s-[V_{BE(sat)}+V_{CE(sat)}]$$
$$V_2=V_s-V_{BE(th)}$$
$$\therefore V_1=10-0.85=9.15\text{V}$$
$$V_2=5-0.5=4.5\text{V}$$
$$\therefore T=2\tau\log_e\left[\frac{9.15}{4.5}\right]$$
$$=1.42\tau$$
$$f=\frac{1}{1.42\times 10^4\times 68\times 10^{-9}}=1.04\text{kHz}$$

Note the likely tolerance on this figure is likely to be dominated by the τ value as the V_{BE}, V_{CE} values have mode only a marginal difference — raising T from 1.39τ to 1.42τ.

2. For the previous question, show that the rise-time of the collector waveform is about 20% of the pulse width. Can this figure be improved?

When a transistor switches off the charging time-constant is R_cC and the rise-time is taken for simplicity as the usual in level between the 10% and 90% levels. This is inaccurate as it fails to allow for the initial V_{BE} value, but it gives a useful guide.

$$\text{Thus rise-time}=CR_C\log_e\left[\frac{0.9V_s}{0.1V_s}\right]$$
$$=2.2CR_c$$
$$\text{But collector on-time is}\approx 0.71CR_B$$
$$\therefore\ \frac{\text{rise time}}{\text{pulse width}}=\frac{2.2}{0.71}\times\frac{R_C}{R_B}$$
$$=\frac{2.2}{15\times 0.71}\approx 20.6\%$$

say 20% allowing for the over-simplification.
The figure can be improved in theory by reducing R_C raising R_B or both (re-adjusting C as necessary to maintain τ). The limit is that the transistors must remain saturated i.e. $R_B/R_C<h_{FE(sat)}$
The guaranteed figure for saturated current gain is not likely to exceed say 20 making large improvements difficult. Circuit modifications are necessary for such improvements and an example is show opposite.

Townsman 2m/70cm aerial

Two-band design with no ground plane.

by B. J. P. Howlett, G3JAM

The continued witholding of the citizen's band by the Home Office has caused vastly increased occupancy of the amateur 2m and 70cm bands for everyday purposes of mutual communication between friends, and most of them use commercially-made private mobile radio equipment tailored for these frequencies, and for the 80 or so automatic/unattended repeater stations dotted about the UK.

Several years ago, the author foresaw the need for a somewhat tidier aerial for the average householder than the too-prevalent, quarter-wave, ground-plane, vertical aerial; an aerial which would be stick-like, with no ground-plane, and operating on both bands without switching. It should be weather-proof and cheap, and easily clamped to a short stub-mast with Jubilee clips from the local garage. It wasn't an easy job!

The first design, a half-wave rod driven from a quarter-wave concentric transformer, did work, but the thinness of the centre wire to match 50 ohms to 1200 ohms (the end resistance of a 12mm, half-wavelength rod at 145 MHz), relegated the design to the roof-space.

However, in the aerial shown diagrammatically in Fig. 1, the wire is 0.7mm and the inductor can be 127mm of p.v.c.-covered wire, fashioned into a hairpin shape and soldered on in parallel to the feeder cable at the point of entry. Very careful tests disclosed the interesting fact that the transformer needed to be about 0.185 wavelength long when the insulator/spacer S was 0.015 wavelength. With 12mm tubing, v.s.w.r. could easily be made 1:1, *and the feeder did not radiate.* Pro rata scaling from the 2m band to the 70cm band proved that the hairpin needed to be, not one third, but (1/3) ½ (= 0.5774) × 127 = 73mm long at three times the frequency. The *inductance* changed inversely as the frequency.

Already it was felt that enough was known about the aerial to go ahead with a full patent for the matching features, and this has now been obtained (British Patent No 1527800).

From a practical viewpoint, the aerial suffered in rain and high winds. It had to be precision-made and sealed if water was to be kept out of the two joints, either side of the precision-turned insulator/separator. The solution,

Item	2m	70cm	Red	Yel.	Brn.	Grn.
Dipole A	96.5	30	27.4	24.5	22.2	19.9
Transf. T	40.64	13	10.55	9.43	8.55	7.67
Space S	2.0	0.8	0.6	0.6	0.6	0.6
Hairpin L, total wire length	12.7	7.24	-	-	-	-
Harmonic shield	29.3					

Dimensions are given in cm for 1cm wide material, as cut. Hairpin loop made of p.v.c. insulated hook-up wire.

shown in Fig. 2, was to build the aerial flat, from off-cut strips about 1 cm wide, with a flat drilled strip insulator (of Perspex, in the author's case), the whole lot being pushed into ¾in plastic conduit and put on a high stub mast so that it would rattle, and keep the author awake at night.

Quite right! That is exactly what the kinks are for; to stop the assembly rattling in a high wind. The kinks have no electrical purpose whatsoever. The two end-plugs, one drilled for the feeder, were actually cast from body-repair (the automobile kind) resin, but could be turned from solid material, of course.

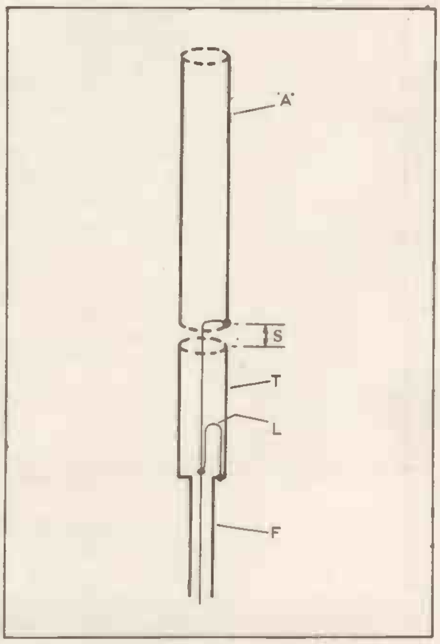


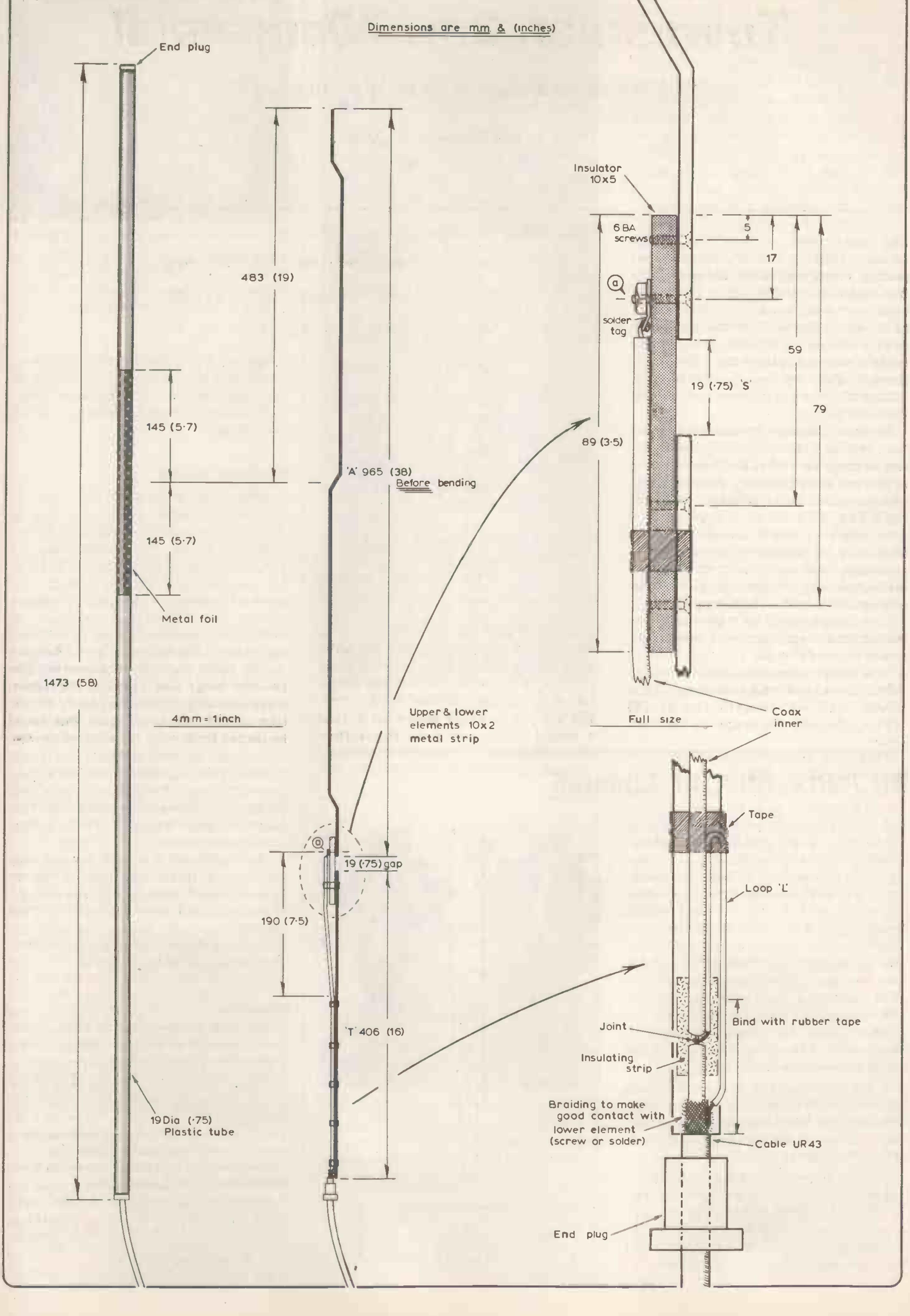
Fig. 1. Basic aerial, a half-wave element A and coaxial impedance transformer T. Loop inductor to augment impedance ratio obtainable.

Gone is the taut centre wire in the transformer, T. Instead (see construction diagram), the centre core of the feeder itself, UR43, (F) with the braiding stripped back, forms the "centre" wire. Actually, an insulated wire taped on to a wide strip is not unlike a coaxial line, except that there is the added advantage that, for fine matching adjustment, it can be flared away from the strip as shown.

So what about 70 centimetres? Well, around the outside of the plastic conduit, and directly over the middle of the 2m radiating element, a "cooking foil" (actually aluminium Silglas glazing strip), cylinder is glued, resonant at the third harmonic of 2m. This prevents radiation from the centre current maximum when the aerial is used at its third harmonic on 70cm, and leaves just the upper and lower half wavelengths (which are in phase) operating as a two-element colinear at 70cm.

The author is, perhaps, lucky to have discovered a matching and radiating system that can be adjusted to give very good matching at both frequencies at once. It did take four years, of course, and quite a bit of help along the way was given by other radio amateur

Fig. 2. Construction of 2m / 70cm aerial.



friends. None of them ever saw the final model, except from a considerable distance, but a number of the early models were made by the author and farmed out for reports. G8NCW, G3PCA, G3IMC, G8LWA, G8BAM, G3YNC (callsigns given in a random order) were early users of the aerial, and some went on to build their own. Thanks are due to all of them for the assistance they gave.

Scaling the aerial to Band V television, proved a very pleasant surprise. With short, fat dipoles, and 75 ohm feeder, the inductor L is not needed. This helped the bandwidth problem. Red zone is particularly difficult in this respect, though it must be admitted that even 1cm wide material does quite a good job, and the feeder is absolutely 'dead', allowing one to pin up the feeder after setting the aerial to the best position, without upsetting the picture again. Some users have been known to get quite light-headed about this particular feature, only rarely encountered, apparently.

No dark plans are afoot to manufacture the aerial. No doubt, however, some character will make one or other of the suggested models and sell huge quantities in a clandestine manner. Good luck.

To others, I would say, please build one with my compliments. It was a challenge to make exactly the aerial I wanted; it was a challenge, in this day and age, to invent a virtually new aerial which turned out to *be* a new aerial, at least within the definition of the patents law, whatever that is.

The table shows the dimensions of aerials for single-frequency use in other bands. □

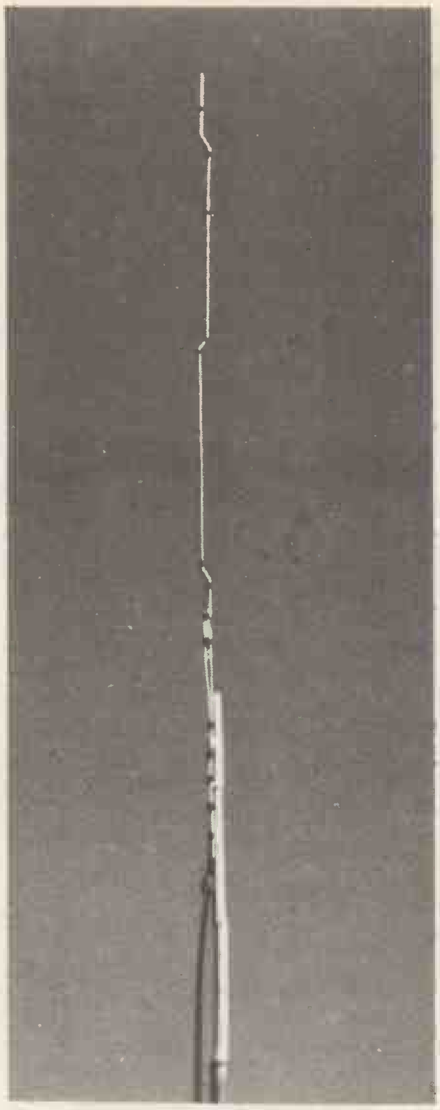


Fig. 3. Townsman without plastic tube cover.

No more film for Channel

The smallest of the UK independent television companies, Channel Island Communications (Television) of Jersey claim to be the first European broadcaster to use electronic news-gathering equipment exclusively. All the existing film processing facilities have now been removed.

Sony Broadcast BVP300 cameras, BVU100 U-matic video recorders, editing and time-base correction equipment is used and has so far proved to be highly reliable in almost all conditions. Channel's managing director, Ken Killip, expressed his enthusiasm for the new techniques, and feels that "the electronic cameras have given a new dimension to local television broadcasting". It is no longer necessary, for example, to have people in studio to interview them; the reduction in costs and elimination of film processing time means that outside interviews are now practicable. Camera sensitivity gives freedom from the necessity to use kilowatts of lighting and the automatic colour balance in the electronic cameras obviates the use of filters for different lighting conditions. Running cost is "'negligible", since tape produced by the U-matic is dubbed onto a master for broadcast, the original being refused.

There has been no union opposition to the use of the equipment, the technicians being "most impressed", according to Brian Turner, Channel's operations manager.

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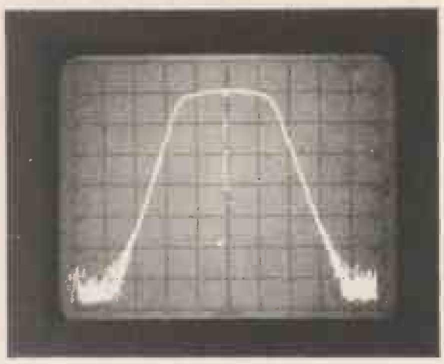

Fig. 7. Radio receiver selectivity response measurement, a car radio with 100μV input at 1MHz. (vertical scale 10dB/div. relative to 1W; horizontal scale 1kHz/div. relative to 1MHz centre frequency).

Finally, Fig. 5 shows the equivalent response of these filters when used in an a.m. radio receiver. The response bandwith is now of course twice the audio bandwidth.

Radio receivers

Another application is the examination of overall receiver responses. Fig. 6 shows an arrangement for this measurement using a standard signal generator, e.g. Marconi type TF 2002. The adaptor unit converts both the input r.f. signal to audio and the output audio to r.f. The signal generator is tuned to the receiver centre frequency, e.g. 1 MHz, and the output set to desired output level, e.g. 100μV. Some adjustment in the a.f. levels may be necessary in order to keep within the 100mV pk-pk requirement, but this is not difficult to arrange at audio. It will now be appreciated that the spectrum analyser tracking generator sweeps the r.f. signal generator input frequency across the passband of the receiver under test. The resultant audio response is then selectively monitored.

The response of a high quality car radio is shown for example in Fig. 7. This response is the aggregate of the r.f., i.f. and audio stages of the receiver. The spectrum analyser sweep rate must be sufficiently slow so as not to mislead the a.g.c. response of the receiver.

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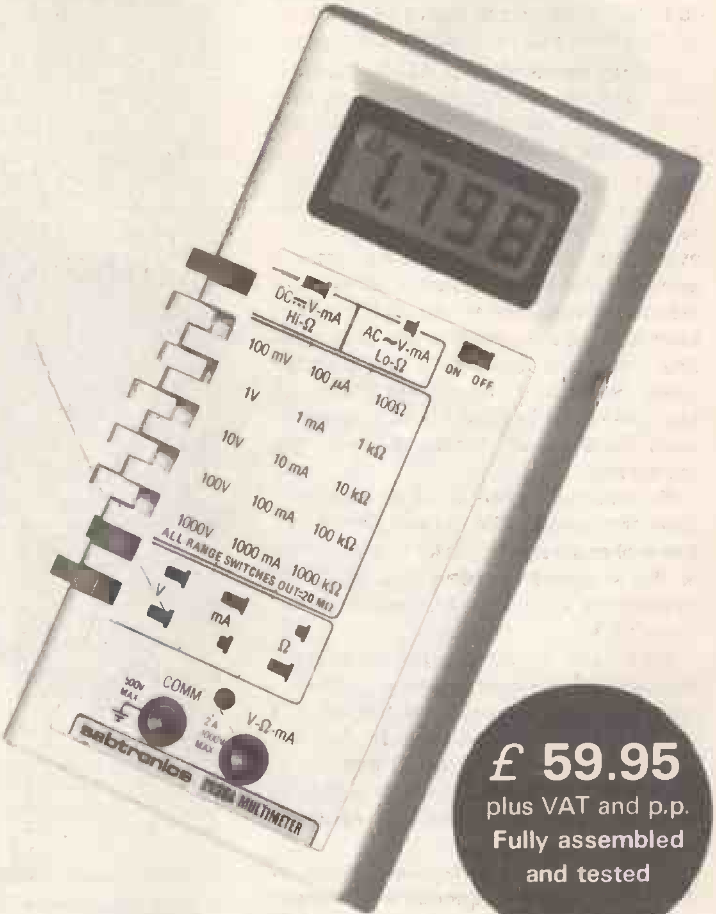

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DC Current	5 ranges	0.1 μA	to	2.000A	0.25%	± 1 digit–0.25% ± 1 digit
AC Current	5 ranges	0.1 μA	to	2.000A rms	0.5%	± 1 digit–1.0% ± 1 digit
High Ohms	6 ranges	0.1 Ω	to	20 MΩ	0.2%	± 1 digit–0.5% ± 1 digit
Low Ohms	6 ranges	0.1 Ω	to	20 MΩ	0.2%	± 1 digit–0.5% ± 1 digit
Temperature**	2 ranges	–50°C	to	+150°C	1°C	– 2.5°C.

Input impedance	10 MΩ – DCV and 10 MΩ/10pF – ACV
Burden voltage	100 mV at 1000 display
Over voltage protection	1000 (DC + AC peak)
Over current protection	2a/250 V fuse
Ohm overload protection	250V DC or AC peak
AC Frequency response	40 Hz to 5 kHz
Battery life (9V)	200 Hours typical with alkaline battery
Weight	11 Oz. (310 gms) without battery.
Accessories supplied	Test leads
Temperature Co-eff.	0.1 x /°C
Display	½" (13 mm) Character. 3½ Digit Liquid crystal display with low battery indiscator and «–» sign.
Case colour	Light grey with matching buttons.
Case Material	ABS Rugged plastic with texture.
Optional	Touch and hold probes for hard to reach measuring areas.

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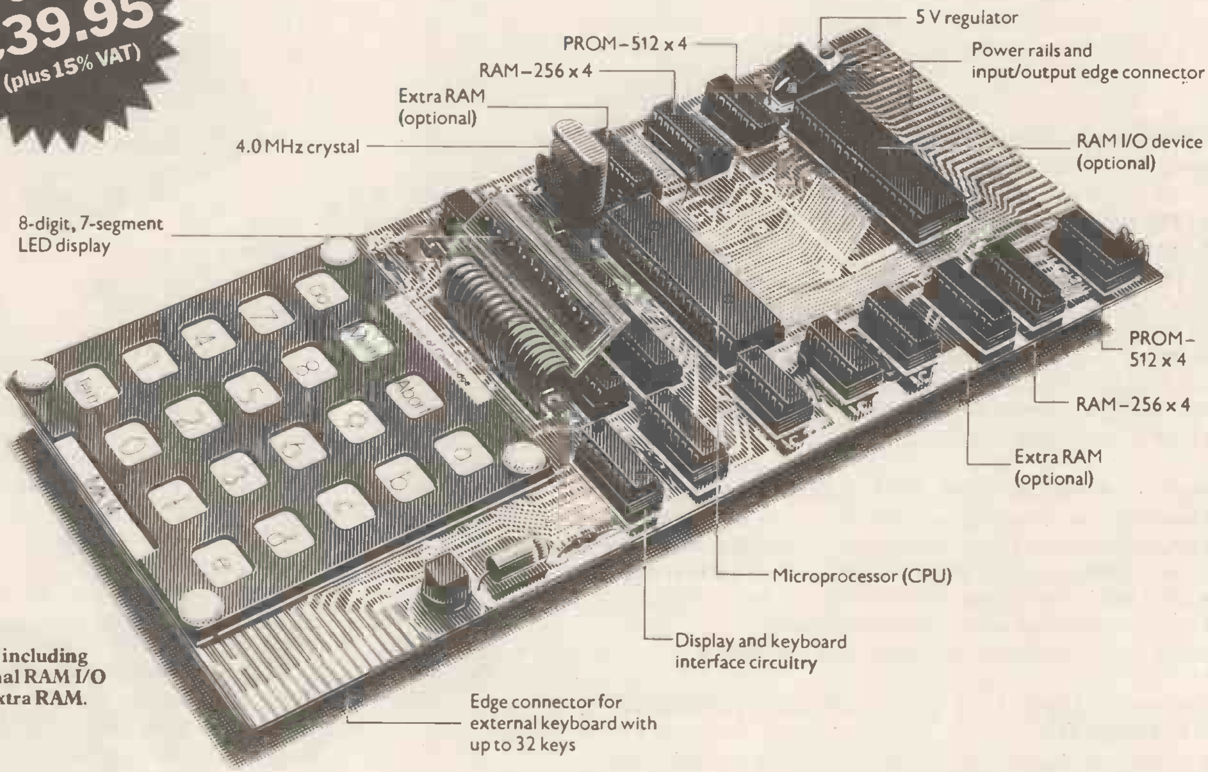

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● Hexadecimal keyboard ● 8-digit, 7-segment LED display ● 8 x 512 PROM, containing monitor program and interface instructions ● 256 bytes of RAM ● 4 MHz crystal ● 5 V regulator requires single 8 V power supply ● Space available for extra 256-byte RAM and 16 port I/O ● Edge connector access to all data lines and I/O ports.

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Clock timer — 1

Random access memory stores 16 alarm times over seven days

By R. D. Clemow and T. C. Garden

The alarm timer was originally designed to operate with a time-code clock published in the February to April 1976 issues of *Wireless World*, but it can be adapted for use with other types of digital clock. The standard circuit offers 16 alarm times during a week, although this can be expanded to 64. Alarms can be inhibited on selected days and a back-up battery powers the volatile memory during a power cut.

There are many industrial and domestic situations where it is necessary to generate a number of alarm times. This design provides up to 16 alarm times, although it is possible to increase this to 64. The timer was primarily designed for use with a time-code clock, but it can be connected to a more conventional digital clock.

The design is based on a static 1K r.a.m. which stores the alarm times. Although this form of storage is only suitable for multiplexed systems, it simplifies the circuit considerably.

The alarm times are stored as four digits of b.c.d. so that they can be easily compared with the clock time to the nearest minute.

One advantage of using a time-code clock is its automatic setting after a power cut. To make the timer compatible, a rechargeable battery is used to power the memory and a few associated i.cs during such a power cut.

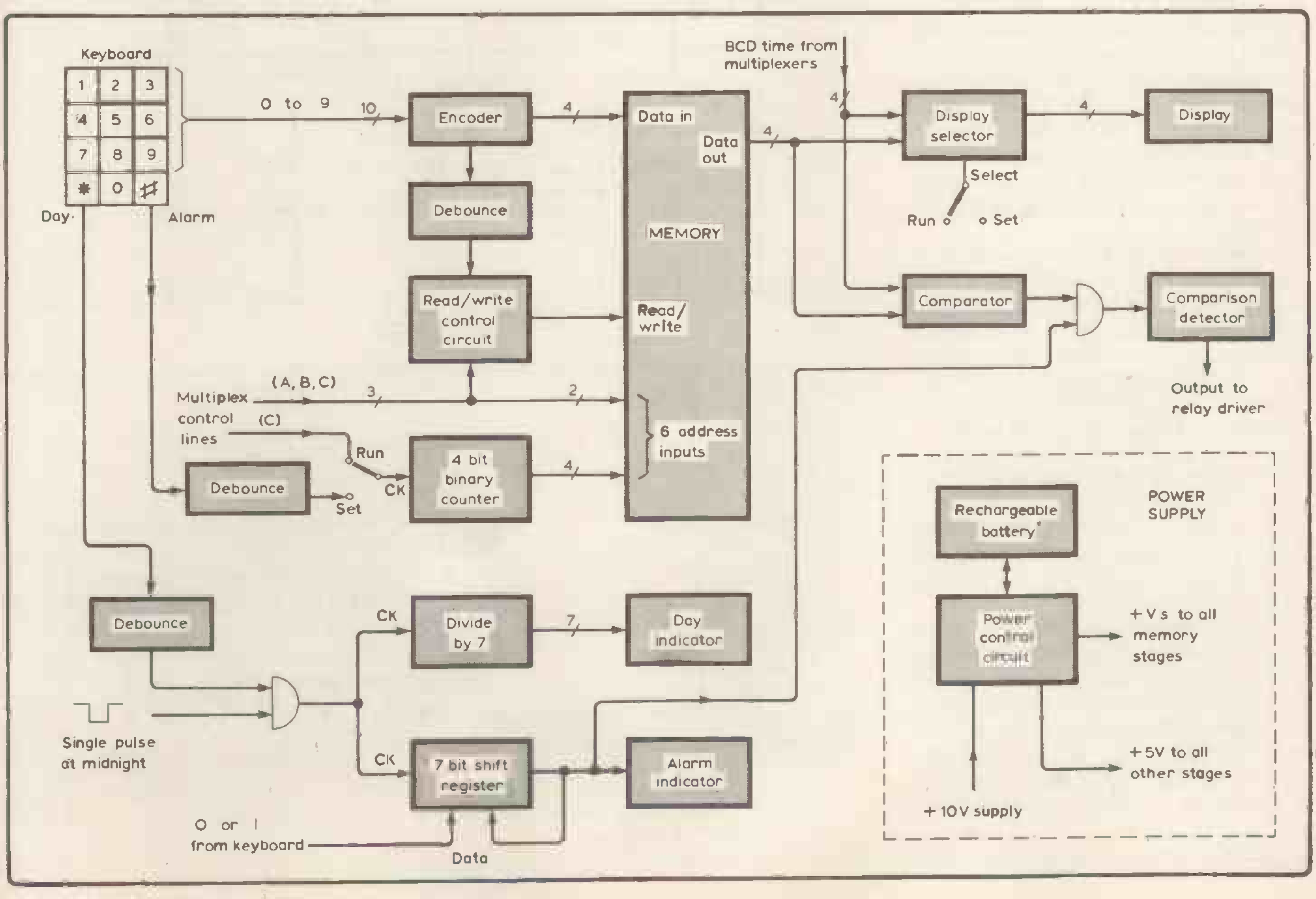
If it is necessary to inhibit alarms on certain days of the week this can be achieved by using an optional circuit. A day-of-the-week indicator comprising seven l.e.ds is also included.

Fig. 1. Block diagram of the complete timer. The circuit is designed for use with a multiplexed clock. All external connections refer to the time-code clock mentioned in the text.

The block diagram of the timer in Fig. 1. can be divided into four sections; the power supply, the day-of-the-week circuit, the memory input circuit and the memory output circuit.

Power supply

The power supply provides 5V to run both the timer and a clock. It also controls the charging/discharging of the back-up battery and provides control signals to prevent spurious clocking of the memory and shift registers when the mains supply is cut or restored. The 5V supply shown in Fig. 2. is based on a standard 3A regulator. Fig. 3. shows the battery charger and power control circuit which uses a constant current source around Tr_1 to charge the battery through D_1 R_1 with a current of about 45mA. Transistor Tr_5 regulates the 10V supply to provide 5V for the memory circuits. If the mains input fails, the 10V



supply decays rapidly and at 8V Tr_2 turns off via D_4 which enables the voltage regulator Tr_3 to supply current from the battery to the V_s line. Diodes D_1 and D_6 prevent damage to Tr_1 and Tr_5 from reverse currents. During normal operation Tr_4 is turned off and the power fail line is high. When the mains supply is removed the power fail line goes low as soon as Tr_2 has turned off and when the mains is restored, the clock display is blanked and Tr_4 is switched on via R_8. When the display blanking line goes low, Tr_4 switches off and the power fail line goes high. Capacitor C_1 prevents any switching noise reaching the power fail line which is also used to disable the memory during power cuts so that pulses on the memory read/write pin have no effect. This prevents data in the memory from being erased because if the main 5V supply fails, the memory is left in the write mode. If the timer is used with the time-code clock mentioned previously, some alterations are necessary to ensure that the display is always blanked at switch-on, see Fig. 4.

Although it is impossible to alter the data in the memory by interrupting the mains supply, the data will be lost if the battery is completely discharged after about six hours of continuous use. To indicate that a power cut has occurred, the on l.e.d. flashes until it is reset manually.

Day of the week circuit

Pressing the day key clocks a divide-by-seven counter and 7-bit shift register via a debounce circuit. The output of the counter is connected to the l.e.d. day indicator and the shift register is clocked with the counter so that they remain in step. The shift register can be set to enable or inhibit the alarm for each day of the week and the l.e.d. alarm indicator monitors the output of the shift register corresponding to the day indicated.

As shown in Figs. 5 and 6, the keyboard is inoperative with S_2 at run because the common line is left floating. With S_2 in the set position, pressing any key grounds the corresponding output pin. Therefore, pressing the day key triggers a monostable in IC_{22} which produces a 150ms low pulse at pin 12. This pulse is gated through IC_{17a}, IC_{21a} and IC_{21b} to produce a low pulse which clocks the counter IC_8 whose output is decoded by IC_9. Pressing the day key therefore advances the indicator by one. The counter is reset when pin 9 of the decoder goes low.

If the day indicator is to be automatic it must be clocked at midnight when the tens-of-hours B bit goes low. This switches Schmitt trigger Tr_7, Tr_8 whose low edge is differentiated by C_{13}, R_{38} and then fed to IC_8 via IC_{17a}. Diode D_{11} prevents a spike appearing at the input of IC_{17a} when Tr_8 is turned off at 20,00 hrs.

Any necessary correction to the time

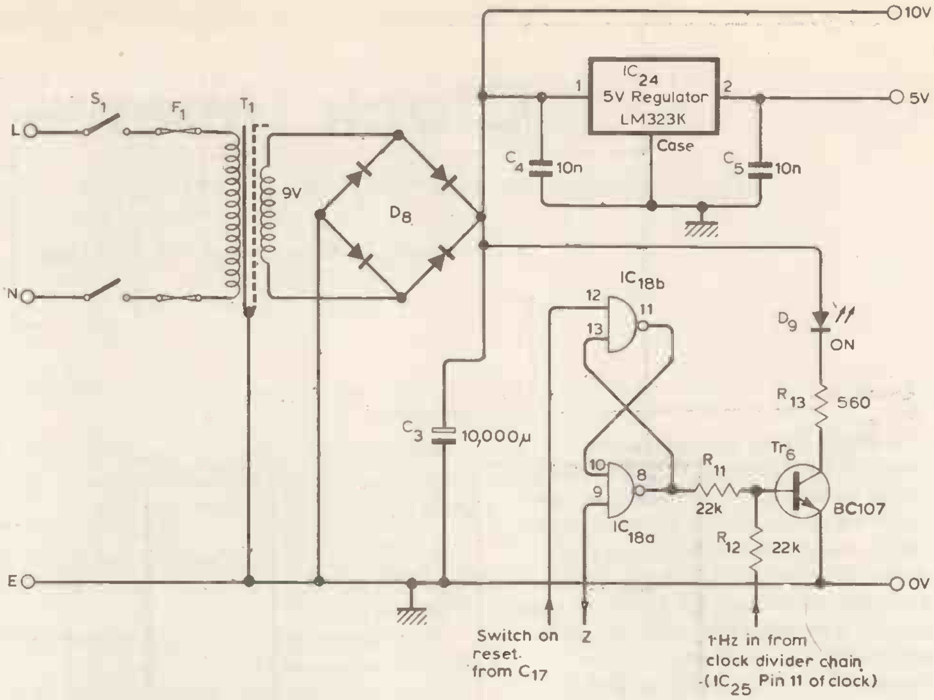


Fig. 2. Main 5V power supply.

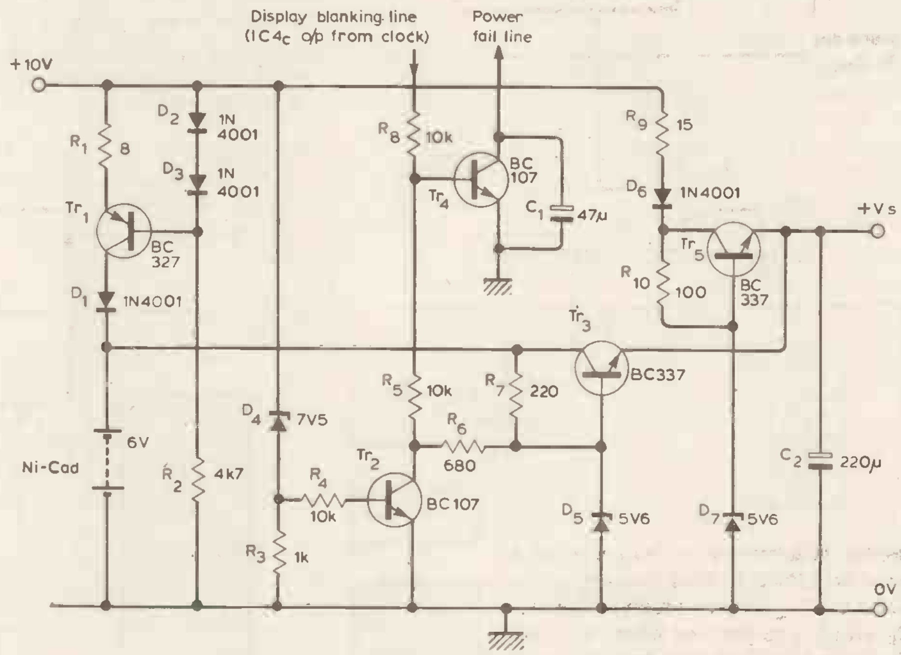


Fig. 3. Battery charger and power control circuit. Resistor R_1 is chosen for a trickle-charge current of about 45mA.

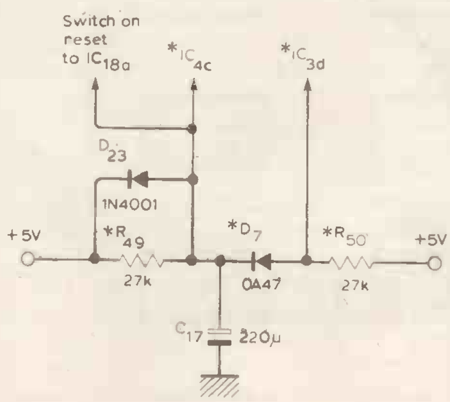


Fig. 4. Modifications to the time-code clock. The component numbers marked with an asterisk refer to the published clock circuit. C_{17} replaces a 100µF capacitor and D_{23} has been added to discharge C_{17} during short breaks in the mains supply.

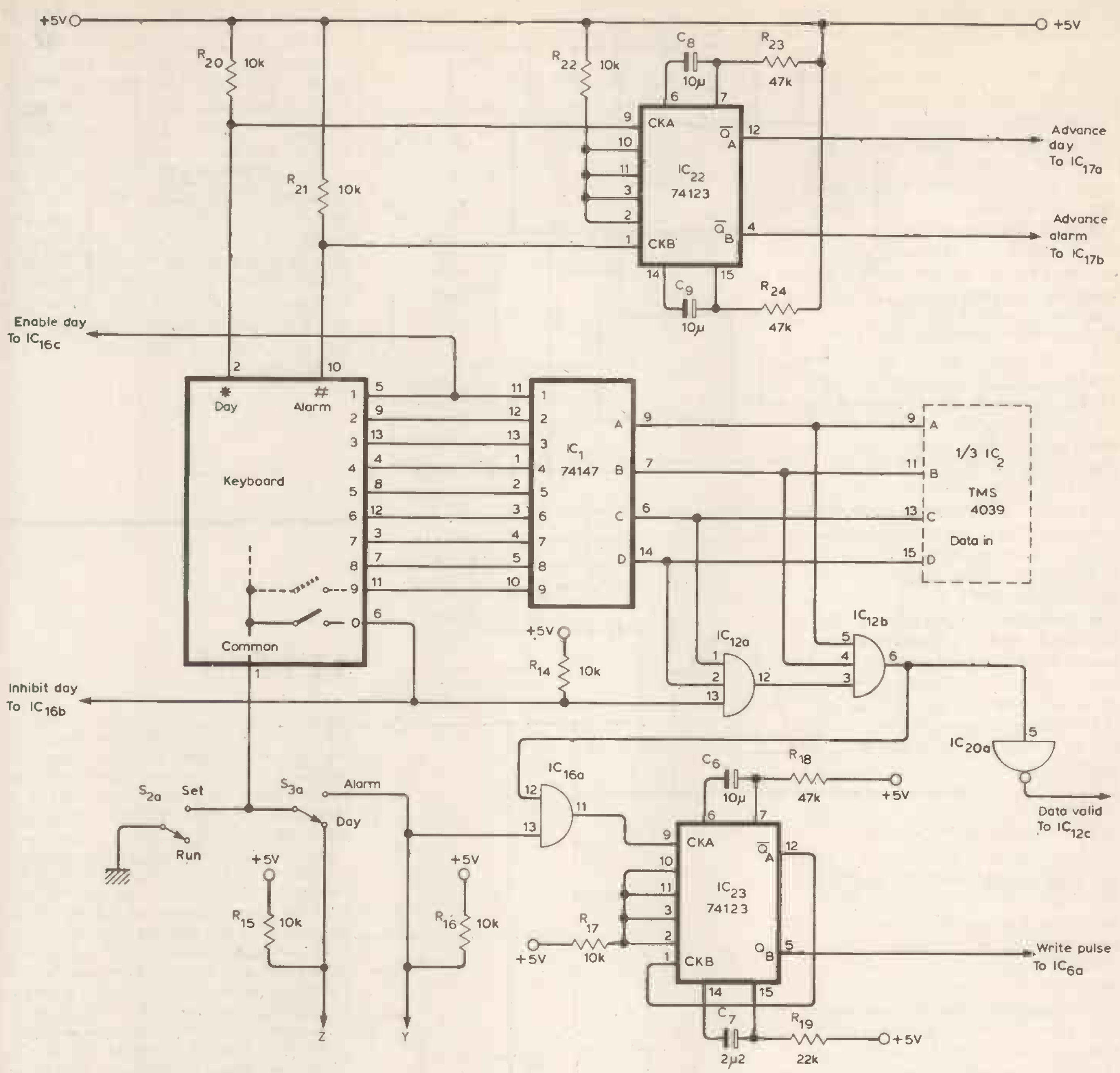


Fig. 5. Keyboard encoder and memory input circuit.

display is achieved by clocking the display at 100kHz. This causes a short pulse at IC_{17d} output which is filtered by R_{33} and C_{12} to prevent false clocking. If the power fail line goes low, IC_8 cannot be cleared and signals from IC_{17a} are blocked. When the mains is restored, the power fail line remains low while the 5V supply is recovering and only goes high when the display blanking line goes low. The day indicator is not clocked at midnight if the mains supply is interrupted when the midnight pulse is to be produced. If this occurs the day indicator will be one day behind when the supply is restored, but the flashing l.e.d. provides a warning.

The alarm enable/inhibit circuit is shown in Fig. 7. The output of IC_{21a} clocks IC_{10} so that it is always in step with IC_8. The Q outputs of IC_{11} are normally high and gates IC_{18c}, IC_{18d} recirculate data from Q7 to the data input. The alarm enable l.e.d. monitors the output of IC_{18d} and indicates whether the alarm is enabled or inhibited. With S_2 at set and S_3 at day, the Z line is grounded and the alarm is inhibited for the day indicated by pressing 0 on the keyboard. This clocks IC_{11b} via IC_{16b} so that its Q output goes low which forces the data inputs of IC_{10} high and switches the alarm enable l.e.d. off. If the day key is then pressed, the new data is clocked in and the low pulse at IC_{21b} output clears IC_{11b} after IC_{10} has been clocked.

To enable the alarm for the day indicated the 1 key is pressed which clocks IC_{11a} via IC_{16c} and clears IC_{11b} via IC_{17c}. This forces the data inputs of IC_{10} low, the alarm enable l.e.d. is switched on and, if the day key is then pressed, data is clocked into IC_{10}. This also resets IC_{11a}. When entering data, an error can

Table 1. Power supply connections for the i.cs.

4Vs	Type			
IC	OV	5V	Vs	Type
1	8	16		74147
2	8		22	TMS4039
3	7	14		74266
4	8	16		74157
5	1	8		NE555
6	7	14		7474
7	10	5		7493
8	10		5	74LS93
9	8	16		74145
10	7		14	74LS164
11	11	4		7473
12	7	14		7411
13	7	14		7427
14	7	14		7410
15	7	14		74266
16	7	14		7432
17	7	14		7408
18	7	14		7400
19	7	14		7404
20	7	14		7404
21	7		14	74LS02
22	8	16		74123
23	8	16		74123

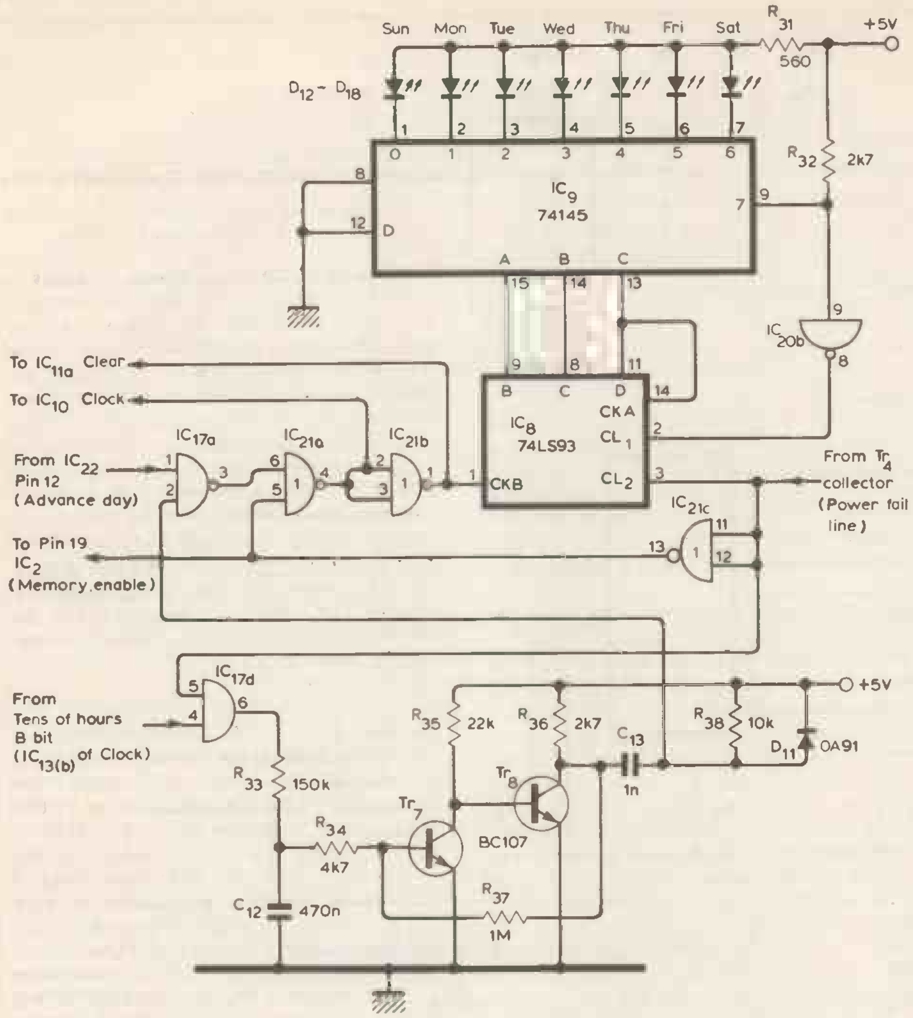
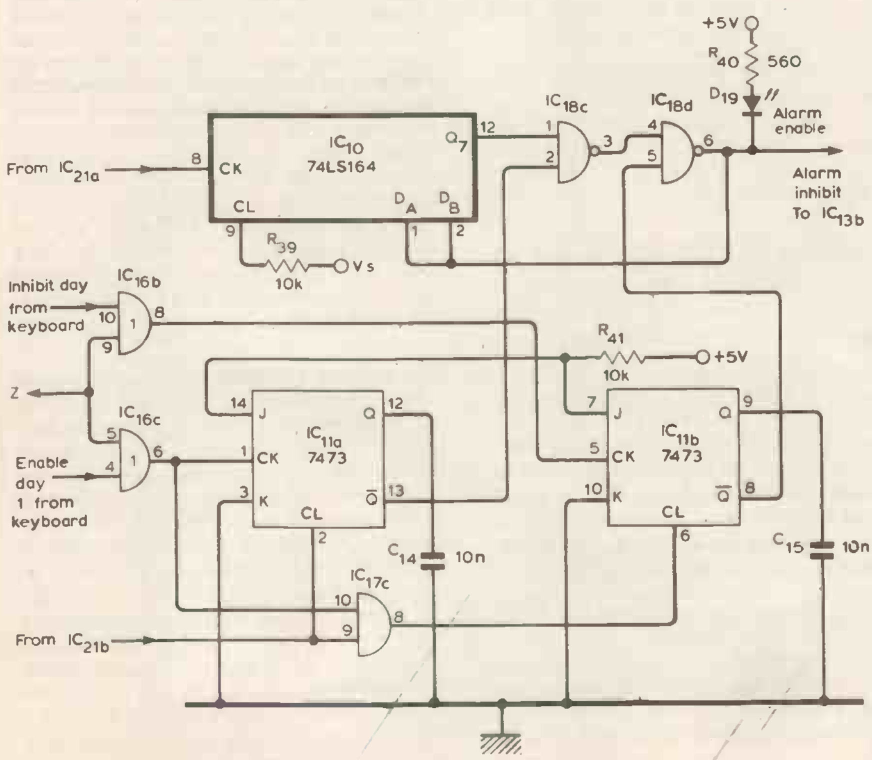


Fig. 6. Day-of-the-week indicator.

Fig. 7. Alarm enable/inhibit circuit.



be easily rectified by pressing the correct key, 0 or 1, which will override the previous data. Note that the data is not entered into IC_{10} until the day key is pressed, therefore the last action when setting the alarm enable/inhibit must be to press the day key. Capacitors C_{14} and C_{15} ensure that the Q outputs of IC_{11} go high when the mains supply is connected. When the supply is cut, the output of IC_{21a} stays low and ensures that IC_{10} cannot be clocked. Table 1 shows which i.cs are supplied by the V_s line and the main 5V line. To reduce battery drain as much as possible, low power t.t.l. i.cs are used with V_s. □

To be continued

LETTER

In recent issues of your journal I noticed a number of articles and letters concerned with the controversy surrounding the potential introduction of a citizens' band service in Great Britain. As I have many years of experience as a user of c.b. I would like to add my thoughts on this subject.

Five years ago I installed the first c.b. set in my car; recently I replaced it with a 40-channel set. The price of the first set was $150; the price of the new set only $55. Both Japanese made sets perform admirably. I use c.b. mostly while travelling. Calling or tuning in to Channel 19 (by custom this is the highway channel in most of the US) gives me instant information on road conditions many miles ahead, accidents, traffic congestions, where to find an open gasoline station etc. When travelling in an unknown area I can find out about a good restaurant, how to find a landmark and, of course, location of speed traps and other hazards of civilisation. In general I find c.b. to be an invaluable companion which keeps me alert and awake on long trips. Being able to contact in most areas a member of the REACT group or a local police department on the emergency Channel 9 gives me an additional peace of mind.

Here and in your country the major opposition to c.b. seems to originate in the ham radio community having no experience with c.b. use. I feel that this opposition comes mostly from misunderstanding of the actual and beneficial use of c.b. and from non-willingness to share the r.f. spectrum with the less disciplined brethren.

Some of the letters in your magazine also reflect a certain fear of offending authority (local constable?). I assure you that the attitude of most US police departments is quite friendly towards c.b.; in many areas Channel 9 is continuously monitored by the local police to find out about emergencies. After 10 years of motorists warning each other of speed radar they still catch enough speeders.

Cass R. Lewart
Holmdel
New Jersey, USA

BOOKS

Beneath the City Streets, by Peter Laurie, an updated version of an earlier book of the same title, contains a good deal of information about government communication systems in the UK set up to cope with "external attack, almost certainly with nuclear weapons, and internal revolution". Most of the book however, is concerned with the citadels, bunkers and other dispersed centres of government that exist in Britain to deal with such emergencies. In a chapter on civil defence there is a 9-page section on over-the-horizon radar. Will feed the prejudices of those who hate the apparatus of the state. A Panther paperback from Granada Publishing, it costs £1.95.

Teletext and Viewdata, by Steve A. Money, is an attempt to explain the still cloudy subject of television data display systems, in a simple way, to non-specialists. The book is detailed, but not specific — the author covers the whole operation of a decoder without concentrating heavily on circuit technique or confining himself to specific component types: rather, a broad understanding is offered. Several commercial decoders are described and a glossary of data display terms is included as an appendix. The book has 151 pages, is published in hard back by Butterworth and Co., 88 Kingsway, London, WC2B 6AB, and costs £5.50.

Handbook of Electronic Formulas, Symbols and Definitions, by John R. Brand, concentrates a vast amount of information into a small enough book to be conveniently to hand when it is needed. The design of the book is unusual and completely logical; the symbol being dealt with is printed at the top of the page, being followed by its definition (and it is surprising to see how many meanings some symbols possess) and formula involving it, in the convenient transposition. Formulae have been expressed in suitable form for attack by electronic calcultor. Three main sections of the 359 page book are: passive circuits, transistors and operational amplifiers; two useful appendices give a list of ratios obtainable from 5% passive component values, and a list of terms with their symbols — the reverse of the main body of the handbook. The publishers are Van Nostrand Rheinhold Company Ltd, Molly Millars Lane, Wokingham, Berkshire, although the book is American, and the price is £11.95 in hard back.

Sound Recording for Motion Pictures by Charles B. Frater, is a broad introduction to current techniques and equipment and has helpful illustrations on most of its pages. Assuming no technical knowledge, it starts with elementary chapters on the nature of sound and electricity then goes on to specific techniques such as synchronous sound recording, transfer from tape to film, editing and dubbing. Dolby noise reduction and digital sound recording are just mentioned. Too general for those already working in the field, it seems intended for beginners going into the motion picture industry. With 210 pages, in paperback, the book is published by the Tantivy Press, London, at £2.95.

Newnes Book of Audio is another compilation of articles written by the half-dozen or so people whose names seem to crop up most frequently in the audio magazines. It is intended for those who would like to buy high-quality equipment, but who are bemused by the technicalities inherent in any subect in which electronics plays a leading part, and in which advertisers tend to use pseudo-scientific expressions to give an aura of professionalism.

The first chapter is a general look at the whole field, and is followed by nine sections on individual components of an audio system, their use and testing. A very useful addition is a directory of makers and distributors. Butterworth and Co (Publishers) Ltd publish the book at £4.95 in paperback.

Microelectronics into the '80s is a view of the economic, commercial, technological and political factors which will govern the development of the industry in the next decade. It is published by Mackintosh International, a market consulting group who specialize in the electronics industry. Analyses of the semiconductor industry (its current state, government involvement, forward planning, finance) is presented for France, Italy, Japan, UK, USA and West Germany, and three articles by Mackintosh, Petritz and Barron give personal views on the future of integrated-circuit technology and application. The book contains 88 pages and costs £30. Mackintosh Publications Ltd, Mackintosh House, Napier Road, Luton.

Electronic Logic Circuits, by J. R. Gibson, is a first-level text, intended for students who have no previous knowledge. It is based on courses for first and second year students at Liverpool University.

The first two chapters are introductory, dealing with number systems, coding and components, and leading to an explanation of logic elements, Boolean algebra and circuit analysis. Chapters are then devoted to theoretical and practical logic design, both combinational and sequential, with a final section on applications.

Books on logic design tend to be very similar to one another, being of about the same length and possessing the same organization. This one is a little different, in that the author has not felt compelled to introduce logic functions via the usual Venn imagery, its explanation gaining clarity with the omission. Symbols used are those in common use in, for example, *Wireless World*. The book is published by Edward Arnold, 41 Bedford Square, London, WC1B 3DQ at £3.95 in paper back. It contains 114 pages.

Power Sources 7, edited by J. Thompson, is the latest in a series of books recording the proceedings of the International Power Sources Symposia held every two years. This one contains the 49 papers from the 11th symposium held in Brighton, 1978. Most of the contributions are accounts of advanced electrochemical research work in primary, secondary, high temperature and reserve batteries, including fuel cells, but the papers also contain reports on applications in vehicle propulsion, portable electronics, heart pacemakers, communications and other fields. Discussions on papers are included. Although its price is high at £65.00, this 774-page well-printed hardback book will be good value to specialists in the field. Publishers are Academic Press, London.

Guide to Technical Short Courses is published by the Institution of Electrical Engineers, and is abstracted from their computer database Coursefinder. Courses listed are those on electrical or electronic engineering and are of the variety lasting less than one year. Full-time or part-time studies are covered, including intensive courses of up to two weeks duration, and are listed under the college, university or company running them. Details provided include the level of study, type and duration of the course, dates, subjects covered and general remarks. There are subject and geographical indexes. The guide is published at £25 by the IEE Marketing Department, Station House, Hitchin, Herts SG5 1RJ.

Volume 12 of the IBA Technical Review is entitled **Techniques for Digital Television.** As is usual in this series, the 70 page book consists of a number of contributions by IBA engineers on a central topic — in this instance, digital video processing. The discovery some years ago of the possibility of sub-Nyquist sampling rates (less than twice the maximum analogue frequency component) led to the design of a digital television studio using the proposals, and these articles describe the components of the system. In common with the other volumes in the series, this book is extremely well presented. Libraries or engineers and students directly involved in broadcasting can obtain a free copy by writing to IBA Engineering Information Service, Crowley Court, Winchester, Hants, SO21 2QA.

Electronic Projects Index for **1978** is now available. This is the second edition, the first covering the period 1972-77, and contains entries from a further eight publications. The compiler has taken constructional articles from sixteen electronics magazines and listed them by subject, with references and a short descriptive note on each, including an estimate of the type and number of components needed for many of the projects. Classification of the articles into types of equipment described is well done, and the index is simple to use and informative. It is published at £1.30, by post, by Central Library, Northumberland Square, North Shields, Tyne and Wear NE30 1QU.

Z80 Instant Programs — machine-code routines for Nascom and other Z80 Computer systems — is by J. Hopton. The programs are listed in memory location/Op-code/ Meaning columns and are intended for a small Z80 system cabable of up to 1000 program steps. New owners of computers may find the book useful, since it begins with very simple examples, such as the production of the delays and single tones, and finishes by programming for a game. Hex notation is used throughout. The book is published in paperback by Sigma Technical Press, 23 Dippons Mill Close, Tettenhall, Wolverhampton WV6 8HH, at the very high price of £7.50. There are 190 pages.

Electronic focusing

Simulation of the human eye mechanism

by D. Di Mario

Conventional focusing systems depend on the knowledge of distance but the human eye can focus without making any distance measurements. This article outlines an electronic system which simulates the eye's ability to use colour and luminosity differentiation for focusing an image.

MOST READERS will be familiar with the manual focusing ring and distance scale on common cameras, but Konica have produced an automatic focusing camera that performs a triangulation for indirectly calculating distance. Another system developed by Polaroid uses a beam of ultrasonic waves to measure distance. However, the human eye does not use any of the above methods. The purpose of focusing is to obtain the maximum amount of information from a given image area and the knowledge of distance is only a consequence which comes from our visual experience. The photographs in Fig. 1. illustrate what is meant by maximum information. The human eye operates more like a computer than a camera and focusing seems to be achieved by scanning the area and comparing the luminosity and colour of adjacent points. When the difference reaches a maximum the image is in focus. The block diagram in Fig. 2. is an electronic version of the eye, where a phototransistor moves back and forth between two positions which are close together. A reading of the light level is taken at each position and then compared, integrated, amplified, rectified and displayed as a peak reading from an instrument. The use of two phototransistors has been excluded because high linearity is required. A logarithmic amplifier was used to accommodate the great variation in input signal due to the large range of luminosity. In the prototype the phototransistor was glued to the centre of a 1½ in speaker with most of its diaphragm removed to reduce acoustic noise. A 200Hz oscillator was used to drive a 1W amplifier for the speaker and to provide gating pulses for the analogue switches. To avoid a beat frequency caused by the 100Hz of artificial light, a sync pulse was derived from the mains. The speaker and phototransistor were housed in a sealed probe which was placed in the image area.

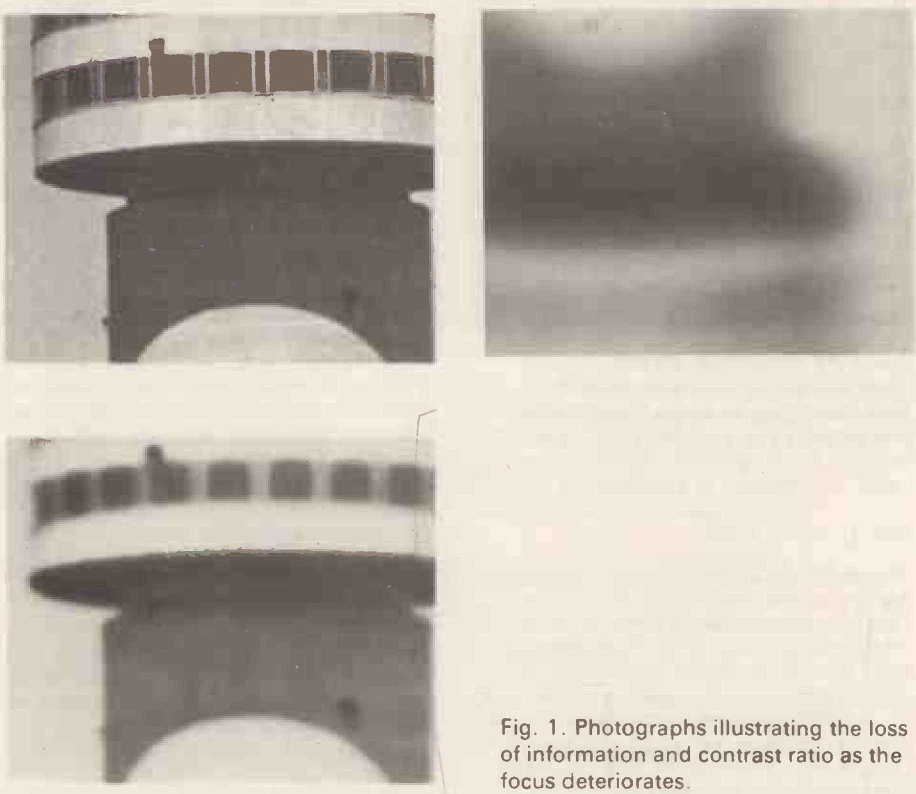
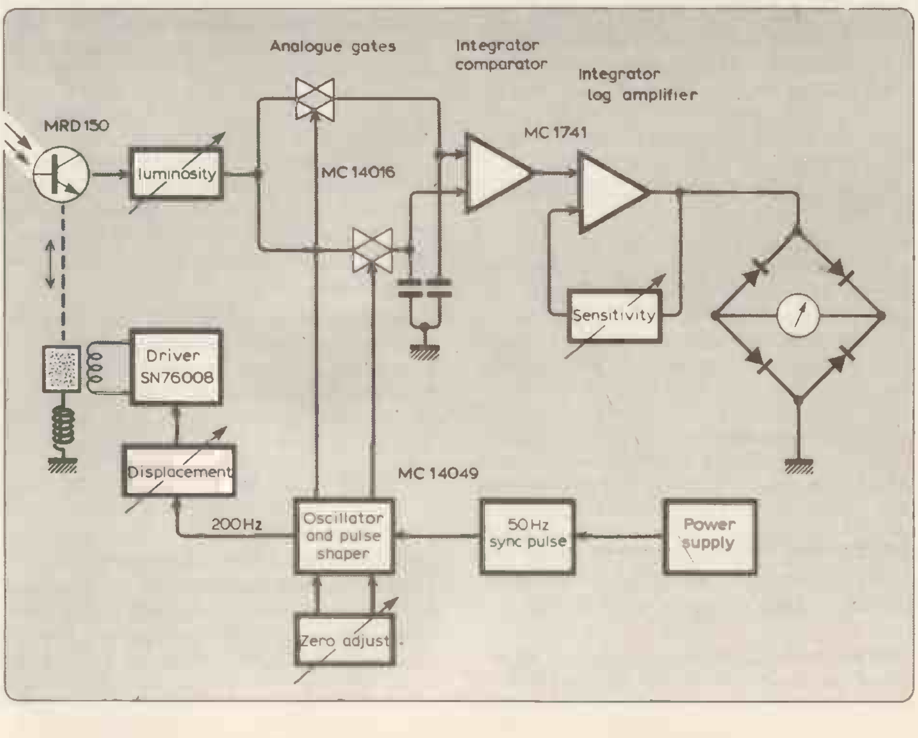


Fig. 1. Photographs illustrating the loss of information and contrast ratio as the focus deteriorates.

Fig. 2. Focusing system which measures light levels between two adjacent areas. The difference signal is amplified and displayed as a peak when the picture is in focus.



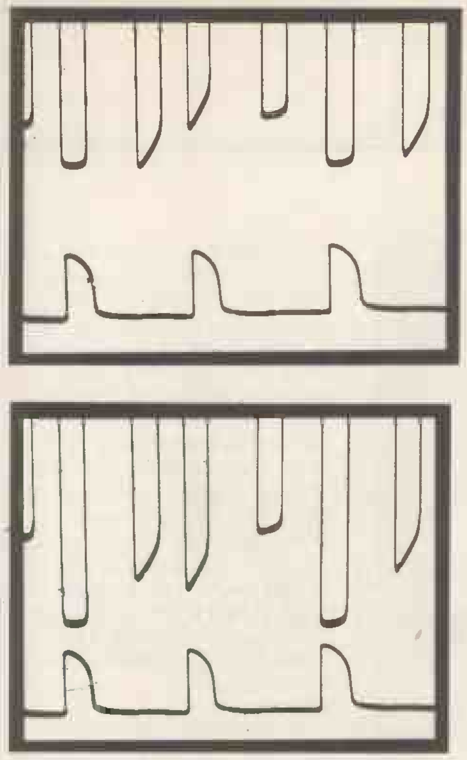


Fig. 3. Output of the phototransistor (top) and gating pulses to one of the analogue gates when the picture is (a) out of focus and (b) in focus.

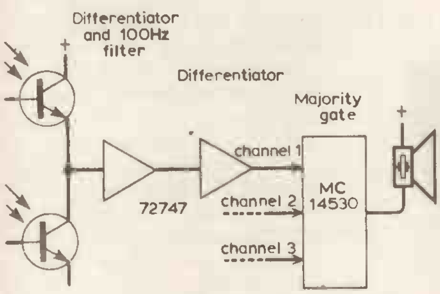


Fig. 4. Double differentiator used to detect a change in the variation of light. The majority gate ensures that a click is heard only when all of the channels produce a pulse at the same time.

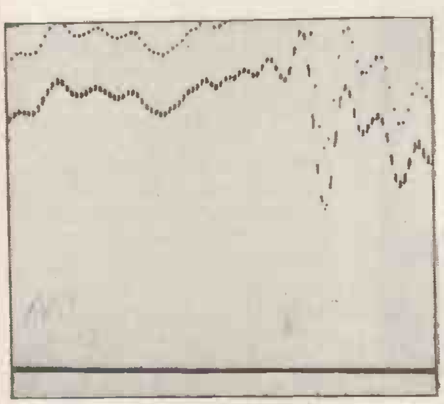


Fig. 5. Output of one channel (upper trace). The oscillation is the residual 100Hz artificial light frequency. Output from the majority gate (lower trace).

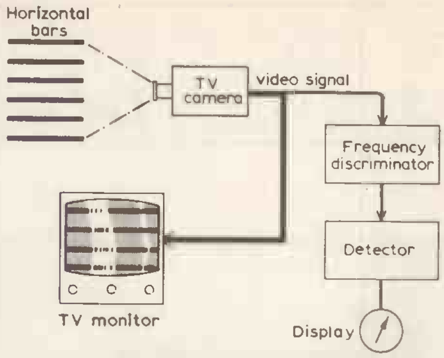


Fig. 6. Differentiation focusing system for television scanning. A focussing signal is obtained by detecting the high frequency content of a video signal.

In use the gating time is adjusted so that the instrument reads zero with the picture out of focus. The picture is then focused which should produce a peak reading. A photographic enlarger or a slide projector can be used for experimentation. To simulate the human eye accurately, several detectors should be used to cover the picture area. However, fairly accurate results can still be achieved with only one detector. Displacement of the phototransistor is dependent upon the required accuracy. A small displacement improves the point of exact focus but reduces sensitivity. In the prototype a 0.2mm displacement was used with a 300 × 300mm picture.

With very low light levels the human eye has difficulty in differentiating because the colour is absent and the depth of field is narrow. It seems that under these conditions focusing is achieved by time differentiation. The light value from a certain point is compared with the value seen a moment before until the variation of light reaches its maximum. Also, a large number of points are analyzed and when they seem to correlate we assume the picture is in focus. The diagram in Fig. 4. shows a method for constructing such a circuit. The outputs of the detectors are fed to a majority gate which gives a pulse at the output only when there are pulses simultaneously at the three inputs. Occasionally two output pulses are produced but they are always very close together and near the focusing point. During focusing a click is heard from the speaker and this corresponds to the point of best focus.

Television scanning is an ideal application for space differentiation focusing and a simplified system is shown in Fig. 6. When the picture is in focus the video signal has the highest percentage of high frequency signals. The reading on the instrument is very accurate and reaches its peak when the bars are in perfect focus.

In these examples there has been no attempt to implement a servomechanism for automatic focusing. The main purpose was to study the mechanism of focusing used by the human eye and to investigate an electronic simulation. □

The Author

Although born in England, D. Di Mario was educated in Italy and received a diploma in telecommunications. His career started in research and development at Autovox and he later worked with computers at NCR. After a period at Siemens where the author worked on electronic PABX and switching networks, he joined Italtel as a foreign contractor where he is currently involved in radio communication.

NEW PRODUCTS

Dot matrix print mechanism

A mobile head consisting of 7 vertical needles, used to build up characters on a 7 x 5-dot matrix, constitutes the heart of the DP-822 print mechanism. This is a 21 character machine with primary feed working at about 580Hz, resulting in a printing speed of 2.5 lines per second at a character height of 2.9mm. Further features are a quickly replaceable ink ribbon and the capability, according to the makers, Roxburgh Electronics, to print a good copy on 2-ply carbonless paper. For microprocessor connection a complete interface or the controller chip alone can be supplied. Dimensions are 106mm wide by 145mm long by 52.5mm high and the printer weighs 570g. The unit operates from a 12V d.c. supply and has an operating temperature range of +5 to +45°C at up to 95% relative humidity. The one-off price is £50 and £34 each in quantities of 100. Roxburgh Electronics Ltd, 22 Winchelsea Road, Rye, East Sussex TN31 7BR.
WW 301

WW 301

Digital pH / mV meter

Mains or battery operation and a 3½ digit display are the principal features of the CD330 pH and mV meter recently introduced by Walden Precision Apparatus. Functions are selected by a switch on the front panel and the instrument operates over the ranges 0 to 13.99pH units, 0 to 199.9mV (positive or negative) and 0 to 1.999V (positive or negative). The voltage ranges are provided in order to cater for redox and specific ion measurements. A digital thumbwheel switch permits selection of the exact compensation temperature required, in the range 0 to 99°C. Price is £180 + £2 p. and p., excluding v.a.t. Walden Precision Apparatus Ltd, Shire Hill Industrial Estate, Saffron Walden, Essex CB11 3BD.
WW 302

WW 302

Underwater telephones

Designed mainly for diving bell applications, the Mesotech 715B underwater telephone is completely self-contained in a rugged, pressure-proof housing. Both speaker and microphone are mounted inside the bell and the unit has been developed with high pressure helium and oxygen atmospheres in mind. The 703A telephone unit is a single side-band transmitter/receiver for voice communication. It is a dual frequency unit operating at frequencies of 8.0875kHz for long range communication and 25kHz for short range, and features phase-lock loop frequency control; a telemetry in/out facility for data transmission is also included and it can be used on other frequencies as a pinger receiver. Techmation Ltd, 58 Edgware Way, Edgware, Middlesex HA8 8JP.
WW 303

WW 303

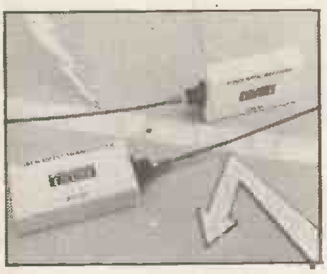
Pocket l.c.d. multimeter

The model 130 l.c.d. digital multimeter has five functions, each with five ranges, and meets many of the measurement requirements for field service use. Each function and range is selected using two rotary switches. The multimeter has direct voltage ranges from 200mV (100uV resolution) to 1000V (1V resolution) with a maximum error of ±0.5% of reading plus 1 digit, and alternating voltage ranges from 200mV, (100μV resolution) to 750V (1V resolution) within ±1% of reading plus 5 digits. Maximum allowable inputs on these ranges are 1000V d.c. or peak a.c. non-switched, 750V peak switched, continuous except on the 200mV a.c. range where inputs above 300V are limited to 15s. The input impedance on these ranges is 10MΩ, shunted by less than 100pF. The meter has direct current and alternating current ranges from 2mA, (1μA res.) to 10A (10mA res.) within error margins of ±1% rdg. + 1d. to ±2% rdg. + 1d. on the d.c. ranges and from ±2% rdg. + 5d. to ±3% rdg. + 5d. on the a.c. ranges. Overload protection on the mA inputs is by a 2A fuse (250V) and the 10A input, which is unfused, can withstand 20A for 15s maximum. Resistance ranges are from 200Ω (100MΩ res.) to 20MΩ (10kΩ res.) with accuracies from ±0.5% rdg. + 4d. to ±2% rdg. + 1d. On these ranges the maximum open circuit voltage is 1.5V and the maximum allowable input is 300V d.c. or r.m.s. The accuracy figures quoted above are guaranteed for one year and are valid for operating temperatures from 18 to 28°C. The multimeter, which measures

178×78×38mm and weighs only 400g, uses a 3½-digit, 0.6in-high l.c.d. and costs £79, excluding case and v.a.t. Keithley Instruments Ltd, 1 Boulton Road, Reading, Berks.
WW 304

Optical-fibre data link evaluation kits

Two kits intended for the evaluation of optical fibre data links are now available from the manufacturer, Burr-Brown. These are specified as the FODL-K1 and FODL-K2, the former employing the 3712T transmitter and 3712R receiver, while the later uses the 3713T transmitter and 3713R receiver. The main difference lies in respective



transmission speeds, that for the FODL-K1 being 25k baud, with a fibre optic cable 20 feet long complete with fitted connectors, compared with the FODL-K2 which is equipped with a six-foot long terminated cable but offers a transmission speed of 250k baud. Each transmitter/receiver combination is contained in a 42×77×17mm metal case. Burr-Brown International Ltd, Cassiobury House, 11-19 Station Road, Watford, Herts WD1 1EA.
WW 305

Constant voltage transformers

Recommended by the makers, Banner Electric Co, for a.c. applications where harmonics can radically affect circuit operation, the Sola CVS range of transformers contains harmonic-neutralizing circuits which obviate the need for additional LC filters. These transformers are smaller and are claimed to be more rugged than conventional transformers using filters for waveform improvement, and stabilization error is within 5% of quoted output voltage. This margin is related to an input range of 15% about the nominal input voltage. The CVS range features a harmonic content of less than 3% (r.m.s.) in the sinusoidal output waveform at full load operation. The CVN range provides the same 5% level of load stabilization but the harmonic content is 20% (r.m.s.) and these transformers are therefore more suitable for use with solenoids, filaments, etc., and applications where rectification is usually

required. All transformers can be provided for either 50 or 60Hz operation, in power ratings from 30VA up to 7kVA, and they may be operated in cascade to obtain stabilization down to 0.25% if required. Banner Electric Co, Ltd, Pindar Road, Hoddesdon, Herts EN11 0EF.
WW 306

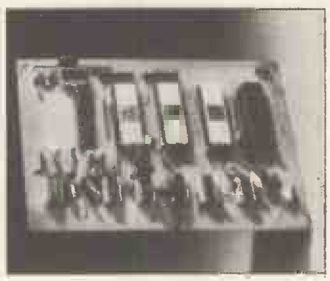
Multi-purpose mobile radio

A v.h.f./a.m. portable mobile radio, the Pocketfone P5001, can be held in the hand or worn on the body. A quick release holster is equipped for rapid, automatic switching of the send/receive facilities to or from a loudspeaker unit which may be clipped to the lapel of a coat. The portable can also be used inside vehicles. A

vehicle adaptor accepts the portable, making automatic connection to the vehicle antenna, to a rapid-charge system powered by the vehicle supply and to a high-power audio amplifier. The unit is available for bands in the frequency range 68-174MHz. Single- and up to six-channel versions are available. Transmitter output is 1W. Various plug-in options are offered and space is provided for the addition of tone signalling circuits. Among the varieties available are 5-tone encode/decode to the standard European systems, Pyecall two-tone decode, tonelock encode/decode, or a single tone encoder to provide switching of a talk-through repeater from the portable. There is a choice of interchangeable telescopic, coiled whip or pendant antennas, and also a choice of standard or heavy duty batteries. Pye Telecommunications Ltd, St Andrews Road, Cambridge CB4 1DW.
WW 307

Teletext/Prestel chips

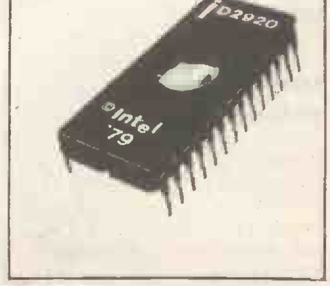
Three m.o.s./l.s.i. chips are the basis of the GIM Teleview system for teletext/viewdata television sets. This system, which can be accommodated on a single-sided



p.c. board 6 inches by 4 inches, is modular and can be extended from a basic teletext or viewdata decoder to a combined unit operating with a remote-control user's keypad. The set of chips is compatible with existing standard television circuits for digital tuning, channel indication and remote-control, as well as external accessories such as hard copy printers and keyboards, using GIM devices. The use of a standard, mask-programmed 8-bit microcomputer, i.c. PIC 1650, for control purposes means that "production costs are expected to be low enough to attract manufacturers of tv add-on equipment as well as the tv set makers, once quantity production levels have been reached." The video generator chip, although currently programmed for English language displays, has been mask programmed for other languages and character sets. The data acquisition chip takes data from either the tv receiver or telephone line via the appropriate interface, processes it according to requests and loads the data into a store. General Instrument Microelectronics Ltd, Regency House, 1-4 Warwick Street, London W1R 5WB.
WW 308

A-d-a microprocessor

Containing digital-to-analogue and analogue-to-digital converters, the Intel 2920 analogue signal processor contains a 25-bit digital processor, an e.p.r.o.m. and a small scratch pad r.a.m. The unit accepts analogue input signals between 0 and 10kHz (which limits its applications where digital filters are concerned) converts them into digital format, processes them at high speed under program control and then re-converts them into analogue form for output. The analogue section accomodates up to four inputs and eight outputs. Control of analogue and digital sections is carried out by an e.p.r.o.m. with a storage capacity of 192 24-bit words (4608 bits). The instruction format for each word is divided into five linked sectors; digital operator, source address, destination address, extent of shift and analogue operator. The r.a.m. scratch pad, which handles the arithmetic, is structured as a 40×25-bit memory. To boost processing flow, the r.a.m. has been designed with dual-port cells which can be addressed through either port. Typical applications of the 2920 might be low-pass and band-pass filters with up to 20 complex pole and/or zero pairs, threshold detectors, limiters, rectifiers, up to 25-bit multiplication and division, approximations to non-linear functions and waveform generators. Several units may be cascaded for complex processing with no loss of process rate. Intel International, Parc Seny, Rue de Moulin a Papier, 51 Boite 1, B-1160, Brussels, Belgium.
WW 309



SIDEBANDS

By Mixer

Spy fever

Some of that breakaway group over the Atlantic are obviously not especially averse to a fast buck.

In the land of the free, if we are to believe the evidence of television and film, one can no longer ring the butcher to order a couple of t-bone steaks without someone illicitly earwigging in on the conversation and recording it on tape for, presumably, nefarious purposes. Concealed radio microphones, miniature cameras and telephone taps are big business and, as a natural consequence, so are the countermeasures for these little horrors. One American company, CCS, claims a yearly turnover of 25 million dollars in this field of activity.

Assuming that attack is the best form of defence, or perhaps stretching the analogy of setting a thief to catch a thief, CCS has managed to square its conscience by providing not only the defence, but the attack as well. Dismissing any inconvenient abstract notion of ethics as "arcane moral philosophy", Gerald Freeman, a New York public relations man, implied that if you want to get on in business, your first move must be to get yourself a bit of "candid surveillance" equipment. For example, it seems that no well-equipped businessman is now roadworthy without his security system for eavesdropping, his briefcase with a secret "conversations recorder", and a covert spy – a camera that shoots round corners.

CCS will, I think, have to recognize the new opportunities presented to them on entering the UK market. Have they properly understood the real function of the standard-issue umbrella, for instance? It is nothing to do with the weather: that long stem is of exactly the right proportions to conceal a directional microphone, its amplifier being concealed in a hip-flask. All those fountain pens – they aren't just for signing for expense-account lunches – most of them contain powerful telescopes for finding out what that rotter who's pinched one's seat on the 8.45 has got for 11 across and 21 down. Mr Freeman, we're way ahead of you.

Fish and chips

I've been waiting to use that heading for a couple of years now, and I finally located the excuse in a report in a daily paper, on the subject of what the future holds in store for us. Ever since the 'microchip' became the least-understood and and most-quoted household word since Einstein published his thoughts on relativity, any poor hack who can't think of a thing to write about for his daily 500 words lies back with his feet on the desk for twenty minutes and dreams up a few uses for microprocessors. He then writes his piece entitled "Our Future With the Chip" or some such.

Since it is well known that the chip in question can do anything or that, if it can't now, it soon will, a lot of the brainstormed suggestions are feasible. I saw one last week, though, that gave every indication of having been brought forth by someone whose idea of a brisk walk is a belt down the M1 in an MGB; the end being confused with the means. The notion put forward was a fishing rod with an attached microprocessor, the idea being to set everything up automatically to catch any fish in any stretch of water at any time.

I've never been one for gratuitously attacking fish of any kind, except when they lie, surrounded by chips, in a piece of Daily Express, but I do have the distinct impression that whoever's diseased mind thought that one up had got hold of the wrong end of the stick. The whole idea, I've always thought, was to sit reflectively on the bank, pondering on the nature of the Universe: if a fish happens along and is unwise enough to investigate, then so be it, but it's the sitting that counts. If it is to be turned into a kind of production line, then the poor old fish are in for a pretty hectic time. Simply isn't cricket, at all.

Scots wha hae . . .

I have fulminated in the past over electronics being used for trivial purposes, when greater needs go unrecognized. It is gratifying, therefore, to see a genuine requirement which is capable of being fulfilled, simply and at little cost, with aim of giving a group of citizens a bit of peace and quiet.

One of my colleagues recently received a call from someone in a Scottish village, whose sleepy charm is currently being shattered fairly regularly by a Klaxon horn. It appears that the garage owner's telephone operates the horn so he can hear it over the noise of engines and British Leyland cars disintegrating. That would be all right in the normal way, but the village is a quiet one, and every time someone rings the garage to ask if their car is done yet, please, the whole village responds with a concerted leap into the air of about six inches.

One's heart goes out to these unfortunate denizens of the northern mists. There they all are, replete with haggis and fresh-caught local salmon, relaxing after a hard day tossing the caber and flogging about the grouse moor 'til fit to drop, when all Hell breaks loose at the garage and the timeless tranquillity of this little corner of Scotland is shot to pieces.

What they want, it seems, is a small transmitter, driven by the telephone, which will trigger a pocket bleeper.

They must be a more easy-going lot up there than I had previously supposed. My image of the Scotsman of yore is of a great, red-haired, red-bearded, kilt-swinging, wild-eyed giant, careering about with his claymore and doing severe damage to whoever he took exception to. It would be a foolhardy garage-owner who would upset a village full of characters like that. I can only suppose that soft living has sapped their natural boisterousness.

Ship chips

They tell me that sailing ships are coming back. It's all to do with the oil, you see — or rather the lack of it. I've seen several proposals, from sail assistance on propeller-driven ships to complete, full-blown(!) latter-day clippers, cleaving through the waves with acres of canvas billowing from the masts, miles of ropes, or sheets or whatever they call them, and all the romance of the old East India Company days. All those lovely old words will come back into everyday use — scuppers, marlinspikes, t'gallants and microprocessors. Oh, yes; it is not, it seems, the intention to use more than a modicum of musclepower to raise and lower the aforementioned canvas (nylon, more like) but to do it with motors under the control of silicone chips (they're the waterproof kind).

Well, I don't know about that. One might conceivably feel a little self-conscious bawling out "Heave-ho, my hearties" to a couple of boards full of i.cs; there is also the matter of what sanctions to impose on a mutinous dog of a u.a.r.t. that won't.

Anyone with a little imagination could work this up into the ideal transport scheme. What you need is a sailing ship, with its computer, to start with. Satellite and shore-based navaids, coupled into the computer together with heading information and met. forecasts, and maybe a maintenance man with another to stop him going potty, and you've got a virtually hands-off system. Pop all the cargo into the hold, point her in approximately the right direction, give her a shove and forget about her for a few weeks. Eventually a message will be received: "Yours of the 15th ult. turned up yesterday".

As I said, all you need is a little imagination.


Professional 3.77

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The PM 2517 has set the standard and the pace in Europe for hand-held digital multimeters and still it remains in a class of its own.

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Reader inquiry number 220

The PM 3207 - Super Scope - is a tough, general purpose oscilloscope which offers at a low price the quality and technology you expect from Philips Test and Measuring Instruments.

- 15 MHz dual trace
- Auto triggering from either channel with adjustable level between peaks and TV triggering
- 5 mV sensitivity, Y and X (via A input)
- B invert facility

Reader inquiry number 221

Both these instruments are available off the shelf from the **Philips Electronic Instruments Department** (see address below) or from the following distributors. **British Tungsram,** West Road, Tottenham, London N17 0RN. Tel: 01-808-4884. **Philips Service Centres** (25 throughout the country). Tel: 01-686-0505 for the address of your nearest branch. **Wessex Electronics Ltd,** 114-116 North Street, Downend, Bristol BS16 5SE. Tel: (0272) 571404.

PATTERN FOR THE FUTURE

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- RF signals available in bands I, III, IV and V
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- Electronically stabilised output level
- Wobbulator facility

Reader inquiry number 222

Some other Philips audio and video service instruments:

PM 5326 RF SIGNAL GENERATOR

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Reader inquiry number 223

PM 6307 WOW AND FLUTTER METER

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- Separate 'Drift' and 'Flutter' indication

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All Philips audio and video service instruments are also available from Philips Service Centres (for details see end of PM 3207 section).

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PHILIPS

WW — 082 FOR FURTHER DETAILS

Whoever sees it, you won't blush.

With JVC's help, no non-broadcast video producer need feel embarrassed when a producer from the broadcast side of the fence looks at one of his tapes. That's because JVC have developed, at an affordable cost, a portable camera which brings truly professional quality to CCTV.

It's the three-tube CY-8800E. Nothing at anywhere near the price handles colour so faithfully, with so small a registration error, with such excellent signal-to-noise ratio even in poor light.

But you don't have to believe an advertisement. Ask one of the Bell & Howell Video Centres (addresses opposite) to make an appointment to bring the camera to where you work. This will prove that among its other merits the CY-8800E travels well and is easy to carry around. Then try it on your shoulder and a tripod. This way you'll discover that it's going to serve you just as well in the studio as in the field.

Finally, when you've admired the pictures on the colour monitor, admire the features – features to optimise performance under all conditions. Fully automatic features that help make the CY-8800E so remarkably easy to use (which means you can concentrate on images, not have to apply half your mind to controls).

With the camera and monitor, the Video Centre demonstrator will be bringing (probably wearing) the JVC CR-4400LE. This is the portable, but equally professional, recorder/player for ¾" U-format cassettes. It's the perfect complement to the CY-8800E (indeed, it was designed to be just that).

The CR-4400LE will give you colour playback, direct into a monitor, on site.

It has an automatic assemble editing function and drop-out compensation. Best of all, its designers have made no concessions to quality to achieve portability. It records and plays as well as non-portable U-format equipment (with which, of course, its tapes are fully compatible).

Are all these claims valid? It will cost nothing except a phone call to a Video Centre to discover for yourself that the CY-8800E and CR-4400LE are as good as we think them to be.

If you'd prefer to read the leaflets first, use the inquiry service or send your name or headed notepaper to Dept CY/8, Bell & Howell A-V Ltd., Freepost, Wembley, HA0 1BR (no stamp needed). We're the exclusive distributor of JVC video equipment to industrial, institutional and commercial markets in the UK and Eire. And, of course, we offer the exclusive Bell & Howell Supershield warranty which guarantees free repairs and replacements (except for tapes and camera tubes) for two years from date of purchase. Plus free transportation to and from video workshop.† Plus free advice.

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WW—057 FOR FURTHER DETAILS

STAR DEVICES

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Mark III

Patents Pending

This professional quality touch sensitive keyboard has the full ASCII code set of characters available from the main keyboard, plus a separate 12 key pad to allow fast numeric entry. The MK III has a 'bleep' facility with volume control and power 'on' light plus a polyester sealed wipe clean surface making the unit particularly suitable for use in hostile environments. The MK III is supplied complete with mating gold plated edge connector in a low profile matt grey plastic case with non-slip feet.

STANDARD FEATURES

★ Operates from single +5±0.25 Volt supply
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★ Electronic hysteresis
★ 2 key rollover
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★ Positive light touch keys — two user definable.
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★ Repeat pad. Dimensions 14.4x8x1.2 inches. 365x203x31mm.

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A. Serial output compatible to RS 232/V24 .... £6.00
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A2. Internal Generation of ± 12 volts for use with option A. NOTE 2 .... £8.00
C. 20 mA Current Loop Output — Passive. Details in handbook of simple conversion to active mode. £6.00
D. On-Board +5 volt regulator. Requiring DC input of 7 to 12 volts £4.00
E. Earphone socket & plug in earphone £3.00
T. Teletypewriter (TTY) 102 character alphabetical upper-case-only link selectable by user £10.00
U. Tri-state outputs on all data bits £4.00
V. Open Collector outputs on all data bits £4.00

Various other options and modifications are possible with this keyboard. Contact STAR DEVICES for further details.

NOTE 1. With option A and/or C the Baud Rate may be externally supplied by the user.

NOTE 2: With option A the ± 12 volts @ 10mA may be externally supplied by the user.

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TYPE 980 — 16 S.P.S.T. (Form A) Switches **£7.20**
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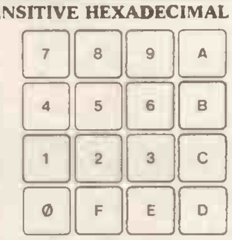

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STAR DEVICES use a proved fully sealed — high technology — flexible membrane key switch requiring a light activation pressure. All character printing is done on the back surface thereby ensuring the unit stays looking good even after many millions of operations — simply wipes clean with a damp cloth.

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Fixing centres 3.2 inches 81.3 mm

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Newbear Computing Store — Newbury 30505
Transam Components Ltd. — London NW1. 01-402 8137
Cavern Electronics — Milton Keynes 314925

U.K. & Overseas Trade enquiries welcomed

Please Supply the Following:
DESIGNED AND MANUFACTURED IN THE UNITED KINGDOM

MK III KEYBOARD............**Quantity. KEYPAD TYPE**.............**Quantity**

Please circle Options required with your keyboard.

A A1 (Specify Baud Rate)............A2 C D E T U V

CHEQUE/P.O. Enclosed for £.................... Make payable to STAR DEVICES LTD.

ACCESS — BARCLAY CARD — MASTERCHARGE — EUROCARD — TRUSTCARD — VISA

CARD NUMBER .... Expiry Date ....

NAME ....

ADDRESS .... BLOCK CAPITALS PLEASE

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.... Allow 7-10 days for delivery

Tel ....

POST & PACKING (including insurance) Keypad prices in brackets.
U.K. £1.50 (40p). EUROPE £3.00* (80p). OUTSIDE EUROPE £5.00* (£1.50). *This includes airmail delivery

★ U.K. ORDERS ADD 15% V.A.T.

PAYMENT SHOULD BE MADE IN STERLING DRAWN ON A U.K. BANK OR I.M.O.

MK III Handbook is available for £1.00 (inc. P&P). Refundable on purchase.

ELECTRO-TECH COMPONENTS LTD.

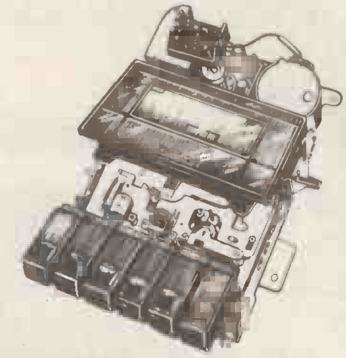
364 EDGWARE ROAD, LONDON, W.2. TEL: 01-723 5667

JVC-VICTOR HIGH FIDELITY STEREO CASSETTE TRANSPORT MECHANISM

ELECTRO-TECH COMPONENTS have secured a very large quantity of cassette transport mechanisms, equipped with all the latest improvements, as well as "SEN-ALLOY" type 1.5 micron record/replay heads, and solenoid-controlled auto-stop action. These were manufactured by JVC/VICTOR of Japan to specification of TANDBERG OF NORWAY, for inclusion in a cassette deck costing over £250. This mechanism alone would normally cost over £50.

FEATURES:

★ Close-tolerance, high-quality, top loading transport
★ "Sen-Alloy" (SA type) R/P head
★ Solenoid-driven autostop circuit
★ Automatic head cleaning device
★ Air damped "soft" cassette eject
★ Miniature microswitches for switching
★ Pre-aligned heads and calibrated motor speed regulator built in
★ Three-digit tape position counter
★ Six-function keyboard controls: "Record," "Rewind," "Forward," "Play," "Stop/Eject," "Pause."
★ PCB connectors and cables attached
★ High-mass balanced flywheel with permanent lubrication spindle
★ Full specifications for motor, heads, and switches available on request.



Price of above unit **£14.95 VAT Inc.**

Plus £1 P&P

Trade and Export Enquiries Invited

APOLOGY

WE REGRET THAT IN THE JAN. ISSUE OF W.W. DUE TO A TYPOGRAPHICAL ERROR THE CASSETTE DECK KIT (BELOW) WAS INCORRECTLY PRICED AT £15.95. THIS SHOULD HAVE BEEN £35.95. THE COMPONENT PARTS FOR THIS KIT COST OVER £40 IF BOUGHT SEPARATELY.

Regular readers of WIRELESS WORLD will know of the original LINSLEY-HOOD CASSETTE DECK design, published in May 1976. Subsequent articles by Mr. Linsley-Hood have confirmed that the design far exceeded his original expectations, so much so that he published a number of improvements, modifications, and additional features to the original design, which are now incorporated in our:

★CASSETTE DECK KIT BASED ON DESIGN OF MR. LINSLEY-HOOD ★

We have developed an outstanding stereo cassette kit with the aid of Mr. Linsley-Hood, to complement the improved specification and latest important advances in cassette electronics since the original design was published. The kit is ideal for use in conjunction with the JVC transport mechanism (above).

Included in the kit are two fibreglass PCB's, drilled and plated for immediate assembly, two VU meters, Dual LED Peak Meters, Variable Bias system, Power Supply, over 10 micro-circuit IC's for the most up-to-date performance, as well as monitoring amplifier, test and calibration cassette, etc.

Price of Kit (without transport mech.) £35.95 VAT inc. plus £1.00 P&P

Also available: A custom-designed case for the Kit, this is a fully screened enclosure, sloping panel, satin anodised, wood end panels, professional finish.

Price of Case £9.75 VAT inc. plus £1.00 P&P.

HERE IT IS! THE BRAND NEW 8022A HAND-HELD DMM

Consider the following features:
6 resistance ranges from 200 ohm-20 ohms
8 current ranges from 2mA-2A AC/DC
10 voltage ranges from 200 mv-1000v DC-200 mc-750V AC
Pocket size — weighing only 370 gms.
Full overload protection — will withstand 6kv spikes
Rugged construction — virtually indestructable
Meets tough military specs — drop proof
In line, pushbutton operation for single-handed useage
Incorporates low power cmos chip for low power consumption
All this plus a 2-year full guarantee

For only £89
Carriage and Insurance £3

SOFT CARRYING CASE £7 extra

Even more sophisticated the Fluke 8020A
Identical in most respects to the 8022A but in addition incorporates a conductance range from 2mS-200nS.

Price £112
Carriage and Insurance £3.00
A handsome soft carrying case is included (this model only)

OFF THE SHELF DELIVERY ON THESE

FLUKE

DIGITAL MULTIMETERS

BRAND NEW FROM FLUKE!!!
NOW AVAILABLE
THE 8024A HAND HELD DMM

This model incorporates all the features of the 8020A but in addition has:

A peak hold switch which can be used in AC or DC for volts and current functions.

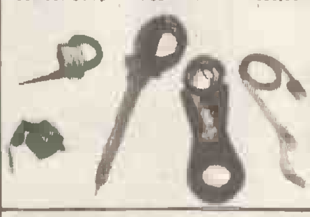
Audible continuity testing and level detection for sensing logic levels.

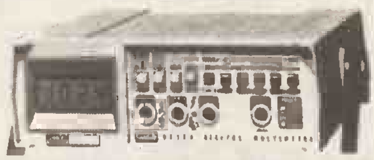
A temperature (°C) range for use with a thermocouple.

£136
Carriage and Insurance £3

The following accessories are in stock now

Y8008 Touch and Hold Probe	£18.00
80K-40 High Voltage Probe	£48.00
81RF RF Probe to 100 MHZ	£32.00
80T-150C Temperature Probe (C)	£65.00
801-600 Clamp-on AC Current Probe	£50.00





8010A AND 8012A BENCH MODEL D.M.M.s

The 8010A is a general purpose, bench/portable digital multimeter with more functions and features than ever offered for such a low price. Its companion, the 8012A, has identical characteristics except that it has two additional low resistance ranges, 2Ω and 20Ω to replace the 8010A's 10 ampere current range.
The 8010A and 8012A feature:
10 voltage ranges from 200mv - 1000v dc, 200mv - 75v ac.
3 conductance ranges from 2mS - 200 nS.
6 resistance ranges from 200Ω - 20mΩ - the 8012A has two additional resistance ranges 2Ω and 20Ω.
10 current ranges from 200µA - 2A AC/DC — the 8010A has two additional current ranges 10A AC and 10A DC.

8010A £159 8012A £179
Carriage and Insurance £3

The 8010A is also available with two rechargeable Nicad size C batteries installed in option/ —01 at £179.00.

LOW COST, AUTORANGING MULTI-FUNCTION COUNTER MODEL 1900A

- Autoranging in both frequency and period measurement modes
- Wide Frequency range —5 Hz to 80 MHz
- High sensitivity —25 mV, typically 15 mV
- Six digit LED display with leading zero suppression, automatic annunciation and overflow
- Optional internal battery pack providing 4 hours continuous operation
- Autoreset on all gate times, all function switches
- Four manually selected gate times providing resolution to 0.1 Hz
- Event counting to 10^6 events with overflow indicator
- Signal input conditioning with switchable 1 MHz low pass filter and attenuator
- Rugged moulded case with convenient tilting/carrying handle
- Optional parallel data output with decimal point and annunciation
- Traditional high Fluke quality
- Self check

£175
Carriage and Insurance £3

TE20D R.F. SIGNAL GENERATOR

Accurately covers 120 KCS. To 500 MCS in 6 bands.
Directly calibrated. Variable R.F. Attenuator 240v AC.
Dimens. 140 x 215 x 170mm.

£52.95
P.&P £1.25

TMK500 MULTITESTER 30,000 OPV
A sturdy and reliable instrument. Has internal buzzer.
AC volts: 0 to 2.5, 10, 25, 100, 250, 500, 1000.
DC volts: 0 to 0.25, 1, 2.5, 10, 25, 100, 250, 1000. DC current: 0 to 50 ua, 5 ma, 50 ma, 12 amp.
Resistance: 0 to 6K, 60K, 6 meg, 60 meg.
Decibels: —20 to +56 db.
Short test: Internal buzzer.
Size: 160 x 110 x 55 mm.

£20.50. P.&P. 75p

PLEASE ADD 15% VAT TO ALL ORDERS

EXCEPT WHERE ITEMS MARKED "VAT INCLUDED."

CALLERS WELCOME

We are open 9 a.m.-6 p.m.
Monday-Saturday
We carry a very large selection of electronic components and electro-mechanical items.
Special quotations on quantities

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AC volts: 0 to 10, 50, 100, 500, 1000.
DC volts: 0 to 5, 25, 50, 250, 500, 2500.
DC current 0 to 50 ua. 2.5 ma, 250 ma.
Resistance: 0 to 6K ohms, 6 meg ohms.
Decibels: —20 to +22 db.
Capacitance: 10 pf, 0.01 uf 0.1 uf.
Size: 4½ x 3¼ x 1 inch.

£10.95
P.&P. 75p

Y7206 SN 20,000 OPV
AC Volts: 0-10, 50, 250, 500, 1000.
DC Volts: 0-0.5, 5, 25, 125, 250, 500, 1000.
DC Current: 0-0.05, 5, 250 mA.
Resistance: 0-3k ohms, 300k ohms, 3 meg ohms.
Decibels: —20—+63 db.
Dims: 127 x 90 x 32 mm.

£10.95 P.&P. 75p

8K ON BOARD MEMORY!
5K RAM, 3K ROM or 4K RAM, 4K ROM (link selectable). Kit supplied with 3K RAM, 3K ROM. System expandable for up to 32K memory.

2 KEYBOARDS!
56 Key alphanumeric keyboard for entering high level language plus 16 key Hex pad for easy entry of machine code.

GRAPHICS!
64 character graphics option — includes transistor symbols! Only £18.20 extra!

MEMORY MAPPED
High resolution VDU circuitry using discrete TTL for extra flexibility. Has its own 2K memory to give 32 lines for 64 characters.

KANSAS CITY
low error rate tape interface.

NEW LOW PRICE!

2 MICROPROCESSORS
Z80 the powerful CPU with 158 instruction, including all 78 of the 8080, controls the MM57109 number cruncher. Functions include +, —, *, /, squares, roots, logs exponentials, trig functions, inverses, etc.
Range 10^{-99} to 9×19^{-99} to 8 figures plus 2 exponent digits.

EFFICIENT OPERATION
Why waste valuable memory on sub routines for numeric processing? The number cruncher handles everything internally!

RESIDENT BASIC
With extended mathematical capability. Only 2K memory used but more powerful than most 8K Basics!

1K MONITOR
Resident in EPROM

SINGLE BOARD DESIGN
Even keyboards and power supply circuitry on the superb quality double-sided plated through-hole PCB.

COMPLETE KIT NOW ONLY £249 + VAT

Cabinet Size 19.0" × 15.7" × 3.3" Television by courtesy of Rumbelows Ltd., price £58.62

POWERTRAN

PSI Comp 80 Z80. Based powerful scientific computer.
Design as published in Wireless World, April-September, 1979.

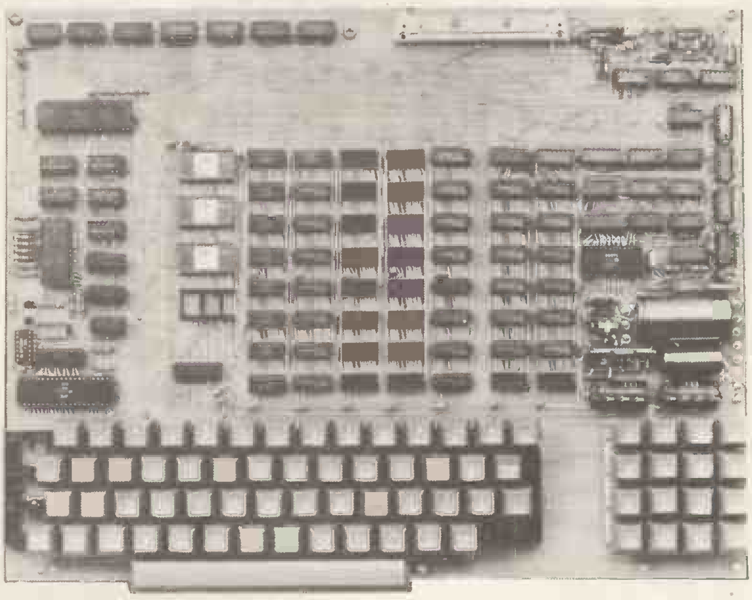
The kit for this outstandingly practical design by John Adams being published in a series of articles in Wireless World really is complete!
Included in the PSI COMP 80 scientific computer kit is a professionally finished cabinet, fibre-glass double sided, plated-through-hole printed circuit board, 2 keyboards PCB mounted for ease of construction, IC sockets, high reliability metal oxide resistors, power supply using custom designed toroidal transformer, 2K Basic and 1K monitor in EPROMS and, of course, wire, nuts, bolts, etc.

PSI COMP 80 Memory Expansion System

Expansion up to 32K all inside the computer's own cabinet!
By carefully thought-out engineering a mother board with buffers and its own power supply (powered by the computer's transformer) enables up to 3 8K RAM or 8K ROM boards to be fitted neatly inside the computer cabinet. Connections to the mother board from the main board expansion socket is made via a ribbon cable.

Mother Board:	Fibre glass double sided plated through hole P.C.B. 8.7" x 3.0" set of all components including all brackets, fixing parts and ribbon cable with socket to connect to expansion plug	£39.90
8K Static RAM board	Fibre glass double sided plated through hole P.C.B. 5.6" x 4.8"	£12.50
	Set of components including IC sockets, plug and socket but excluding RAMs	£11.20
	2114L RAM (16 required)	£5.00
	Complete set of board, components, 16 RAMS	£89.50
8K ROM board	Fibre glass double sided plated through hole P.C.B. 5.6" x 4.8"	£12.40
	Set of components including IC sockets, plug and socket but excluding ROMs	£10.70
	2708 ROM (8 required)	£8.00
	Complete set of board, components, 8 ROMs	£78.50

Floppy Disk, PROM programmer and printer interface coming shortly!



PCB size 16.0" x 12.5"

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PRICE STABILITY: Order with confidence! Irrespective of any price changes we will honour all prices in this advertisement until March 31st, 1980, if this month's advertisement is mentioned with your order. Errors and VAT rate changes excluded.

EXPORT ORDERS: No VAT. Postage charged at actual cost plus 50p handling and documentation.

U.K. ORDERS. Subject to 15% surcharge for VAT*. NO charge is made for carriage. *Or current rate if changed.

SECURICOR DELIVERY: For this optional service (U.K. mainland only) add £2.50 (VAT inclusive) per kit.

UK Carriage FREE

POWERTRAN COMPUTERS

(a division of POWERTRAN ELECTRONICS)

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BSR DE LUXE AUTOCHANGER

Plays 12", 10" or 7" records, Auto or Manual. A high quality unit backed by BSR reliability. Stereo Ceramic Cartridge. AC. 200/250V. Size 13½-11¼in. 3 speeds. Above motor board 3¾in. Below motor board 2½in. with Ceramic Stereo cartridge.

£20 Post £1.60

HEAVY METAL PLINTHS

Cut out for most BSR or Garrard decks. Post £1.60
Silver grey finish.
Model "A" Size 14½ x 12½ x 3in. **£3.50**
Model "B" Size 16 x 13¾ x 3in. **£4.50**

TINTED PLASTIC COVERS
Sizes 14½ × 12½ × 4¼in or 14½ × 12½ × 3in. £3.50 each
15¼ × 13½ × 4in. £4. 18 × 13¼ × 4in. £6.
17¼ × 9½ × 3½in. £2. 18 × 12½ × 3in. £6
14½ × 14¾ × 2½in. Rosewood sides £4. Post £1.60
Ideal for record decks, tape decks, etc.
18 × 13¾ × 3½in with standup hinges £7

BSR SINGLE PLAYER

Ideal replacement or disco deck with cueing device and stereo ceramic cartridge. 3 speeds. Large turntable, modern design **£21** Post £1.60

BSR TWO-SPEED BUDGET MODEL £15

BSR P182 3 speeds flared aluminium turntable "S" shape arm, cueing device, ceramic cartridge **£24**. Post £1.60
BSR MP60/P128 Stereo Ceramic, balanced arm, cueing device. Bias compensator **£26**. Magnetic **£5** extra.

GARRARD AUTO CHANGER CC10A

3-speed stereo cartridge
Plays all size records. 7-in. turntable **£6.95** Post £1.60

B.S.R. P163 BELT DRIVE QUALITY DECK

Manual or automatic play. Two speeds.
Precision balanced arm. Slide in head, cueing device.
Bargain price

£30 Post £1.60

Suitable magnetic cartridge **£6.50**.

ELAC HI-FI SPEAKER 8in. TWIN CONE

Large ceramic magnet. 50-16,000 c/s.
Bass resonance 40 c/s.
8 ohm impedance.
10 watts. RMS. **£5.95** Post 75p
20 watt woofer bass unit only **£7.95** Post 75p

LOW VOLTAGE POWER PACK for MODELS

Ready made. Famous make. Will supply 10 volts D.C. at 400mA. With terminals and mains lead. **£2.75** Post 50p

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With spindles
5kΩ to 2MΩ. LOG or LIN.
L/S **35p**. DP **60p**.
Stereo L/S **85p**. DP **£1.**
Edge Pot 5K. SP **45p.**
Sliders Mono **65p**. Stereo **85p.**

80 Ohm Coax

FRINGE LOW LOSS **15p** yd.
PLUGS **10p**. SOCKETS **10p**.
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OUTLET BOXES **80p**
300 ohm FEEDER **5p** yd.

EMI 13½ x 8in. LOUDSPEAKERS

With tweeter and crossover. 10 watt. 3 or 8 ohm.
£9.95 Post 75p

With tweeter and crossover. 8 ohm. 15 watts.
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Bass woofer only 15 ohm. 20 watt. **£10.95** Post 75p

Suitable Bookshelf Cabinet
Teak finish. For EMI 13 x 8 speakers.
Size 16 x 11 x 8 inches approximately. **£9.50** Post £1.60

THE "INSTANT" BULK TAPE ERASER

Suitable for cassettes, and all sizes of tape reels. A.C. mains 200/250V. Leaflet S.A.E.
Will also demagnetise small tools **£7.50** Post 50p
Head Demagnetiser only **£5.00**.

RELAYS. 12V DC **95p**. 6V DC **85p**. 240V AC **95p**.
BLANK ALUMINIUM CHASSIS. 6 x 4—**95p**; 8 x 6—**£1.40**; 10 x 7—**£1.55**; 12 x 8—**£1.70**; 14 x 9—**£1.90**; 16 x 6—**£1.85**; 16 x 10—**£2.20**. **ANGLE ALI.** 6 x ¾ x ¾in—**20p**.
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PLASTIC AND ALI BOXES IN STOCK. MANY SIZES
VARICAP FM TUNER HEAD with circuit & connections. Some technical knowledge required **£4.95**.
TAG STRIP 28-way **12p**.
TAPE OSCILLATOR COIL. Valve type, **35p**.
BRIDGE RECTIFIER 200V PIV ½ amp **50p**. 8 amp **£2.50**.
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MANY OTHER TOGGLES IN STOCK. Please enquire.
PICK-UP CARTRIDGES ACOS, GP91 **£2.00**. GP94 **£2.50**.
SONOTONE 9TAHC Diamond **£3.75**. V100 Magnetic **£6.50**.
RESISTORS. 10Ω to 10M. ¼W, ½W, 1W. 20% **1p**; 2W, **10p**.
HIGH stability. ½W 2% 10 ohms to 1 meg, **8p**.
Ditto 5%. Preferred values, 10 ohms to 10 meg, **3p**.

MATSUSHITA 18volt DC 33+45 RPM

HIGH QUALITY TURNTABLE

Our price £20 inc. VAT. Post £2

Direct drive motor/die cast 12in turntable

RCS SOUND TO LIGHT KIT Mk. 2 £18

Kit of parts to build a 3 channel sound to light unit 1,000 watts per channel. Suitable for home or disco. Post 50p
Easy to build. Full instructions supplied. Cabinet **£4.50** extra.
Will operate from 200MV to 100 watt signal.

"MINOR" 10 watt AMPLIFIER KIT £12.50

This kit is suitable for record players, guitars, tape playback, electronic instruments or small PA systems. Two versions available: Mono, **£12.50**; Stereo, **£20**. Post 45p. Specification 10W per channel; input 100mV; size 9½ x 3 x 2in. approx. SAE details. Full instructions supplied. AC mains powered.
Input can be modified to suit guitar or mike.

R.C.S. STEREO PRE-AMP KIT. All parts to build this pre-amp.
Inputs for high, medium or low imp per channel.
With volume control and P.C. Board **£2.95**
Can be ganged to make multi-way stereo mixers Post 35p.

MAINS TRANSFORMERS — ALL POST 75p.

250-0-250V 70mA, 6.5V, 2A	£3.45
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300-0-300V 120mA, 2×6.3V 2A C.T.; 5V 2A	£10.00
220V 45mA, 6.3V 2A	£2.50
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2 amp. 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 25 and 30V	£6.00
1 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£6.00
2 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£9.50
3 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£12.50
5 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£16.00

12V, 100mA	£1.30	20V, 40V, 60V, 1 amp	£4.00
12V, 750mA	£1.75	12V, 3 amp	£3.50
10-0-10V 2amp	£3.00	10V, 30V, 40V, 2 amp	£3.50
30V, 5 amp and 17V-0-17V,		40V, 2 amp	£3.50
2 amp	£4.00	20V, 1 amp	£3.00
0, 5, 8, 10, 16V, ½ amp	£2.50	20V-0-20V, 1 amp	£3.50
9V, 3 amp	£3.50	30V-0-30V, 2 amp	£8.00
25-0-25V 2 amp	£4.50	2 of 18V, 6 amp, each	£11.00
30V, 2 amp	£3.50	12-0-12V, 2 amp	£3.50
30V, 1½ amp	£3.30	9V, ¼ amp	£1.50

AUTO TRANSFORMERS 115V to 230V or 230V to 115V 150W .. £7.00
250W......£8.00. 400W......£9.00 500W......£10.00
FULL WAVE BRIDGE CHARGER RECTIFIERS.
6 or 12V outputs, 2 amp.....75p. 4 amp....£1.60
CHARGER TRANSFORMERS: 1½ amp..£1.60. 3 amp..£4.00..4 amp..£6.50
12V, 1½ amp Half Wave Selenium Rectifier 25p

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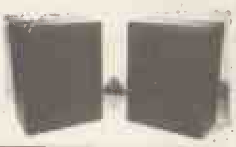

TEAK VENEERED CABINET
11 x 8½ x 7in
50 to 14,000 cps.
15 watts 3 ohm
£20 pair Post £2

LOW VOLTAGE ELECTROLYTICS
1, 2, 4, 5, 8, 16, 25, 30, 50, 100, 200mF 15V **10p**.
500mF 12V **15p**; 25V **20p**; 50V **30p**; 420mF/500V **£1.30**.
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2500mF 50V **62p**; 3000mF 25V **47p**; 50V **65p**.
4500mF 64V **£2**; 4700mF 63V **£1.20**. 2700mF/76V **£1**.
5000mF 35V **85p**. 5600mF/76V **£1.75**.

HIGH VOLTAGE ELECTROLYTICS

8/350V	22p	8+8/450V	60p	50+50/300V	50p
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32/500V	75p	16+16/450V	50p	100+100/275V	65p
50/500V	£1.20	32+32/350V	50p	150+200/275V	70p

MANY OTHER ELECTROLYTICS IN STOCK

SHORT WAVE 100pf air spaced gangable tuner, **95p**.
TRIMMERS 10pF, 30pF, 50pF, **5p**. 100pF, 150pF, **15p**.
CERAMIC, 1pF to 0.01mF, **5p**. Silver Mica 2 to 5000pF, **5p**.
PAPER 350V-0.1 **7p**; 0.5 **13p**; 1mF **150V 20p**; 2mF 150V **20p**; 500V-0.001 to 0.05 **12p**; 0.1 **15p**; 0.25 **25p**; 0.47 **35p**.
MICRO SWITCH SINGLE POLE CHANGEOVER 20p.
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TWIN GANG, 385 + 385pF **80p**; 500pF slow motion **75p**.
365 + 365 + 25 + 25pF, Slow motion drive **85p**. 120pF **50p**.
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CASSETTE MOTOR. 6 volt **£1.00**.
CASSETTE MECHANISM. Mono heads, no motor **£3.00**.

"VALVES" special offer subject to being unsold 60p. Post free

6AM6	12K7GT	PCF82	PL84	EBF80	EF80
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BAKER LOUDSPEAKERS "SPECIAL PRICES"

Post £1.50 ea.

Model	Size	Power	Type	Our price	List price
8 or 16 ohms	in	watts			
Major	12	30	Hi-Fi	£12	£17.25
Deluxe Mk II	12	15	Hi-Fi	£14	£19.75
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Group 35	12	40	PA	£12	£17.25
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Group 50	15	75	PA	£30	£40.25
Group 75	12	75	PA	£24	£27.60
Group 100	12	100	PA	£29	£33.35
Group 100	15	100	PA	£35	£40.25
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Seas	Mid-range	4in	50	8	£7.50
Seas	Mid-range	5in	80	8	£10.50
Seas	Mid-range	4½in	100	8	£12.50
Goodmans	Full-range	8in	20	8	£5.50
Seas	Woofer	8in	30	8	£14.00
Moscow	General	10in	30	8	£10.50
McKenzie	Disco-group	15in	150	8+16	£56.00
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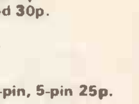

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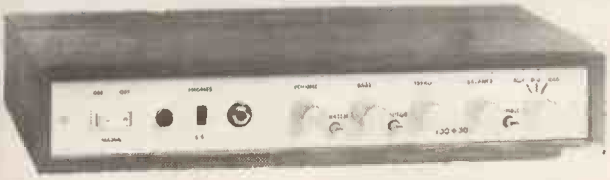
T20+20 AND T30+30 20W, 30W AMPLIFIERS



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 + VAT

T30+30 KIT PRICE £38.40 + VAT

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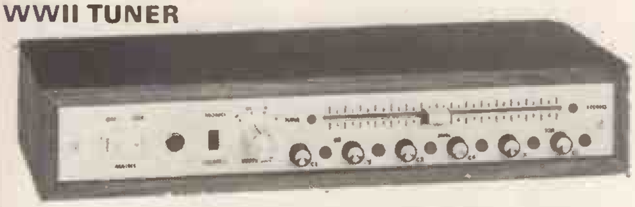
WWII TUNER



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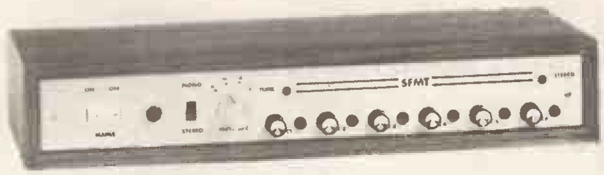
Following the success of our **Wireless World FM Tuner Kit** this cost reduced model was designed to complement the **T20+20** and **T30+30** amplifiers and the cabinet size, front panel format and electrical characteristics make this tuner compatible with either.

POWERTRAN SFMT TUNER



PRICE FOR COMPLETE KIT £35.90 + VAT

AVAILABLE AS COMPLETE KIT ONLY

This is a simple, low cost design which can be constructed easily without special alignment equipment but which still gives a first-class output suitable for feeding any of our very popular amplifiers or any other high quality audio equipment. A phase-locked-loop is used for stereo decoding and controls include switchable afc, switchable muting and push-button channel selection (adjustable by controls on the front panel). This unit matches well with the **T20+20** and **T30+30** amplifiers.

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TRANSCENDENT DPX

As featured in Electronics Today International August, September October, 1979 issues

DIGITALLY CONTROLLED, TOUCH SENSITIVE, POLYPHONIC, MULTI-VOICE SYNTHESIZER

The Transcendent PDX is a really versatile new 5 octave keyboard instrument. There are two audio outputs which can be used simultaneously. On the first there is a beautiful harpsichord or reed sound — fully polyphonic i.e. you can play chords with as many notes as you like. On the second output there is a wide range of different voices, still fully polyphonic. It can be a straightforward piano or a honky tonk piano or even a mixture of the two! Alternatively you can play strings over the whole range of the keyboard or brass over the whole range of the keyboard or should you prefer — strings on the top of the keyboard and brass at the lower end (the keyboard is electronically split after the first two octaves) or vice versa or even a combination of strings and brass sounds simultaneously. And on all voices you can switch in circuitry to make the keyboard touch sensitive? The harder you press down a key the louder it sounds — just like an acoustic piano. The digitally controlled multiplexed system makes practical sensitivity with the complex dynamics law necessary for a high degree of realism. There is a master volume and tone control, a separate control for the brass sounds and also a vibrato circuit with variable depth control together with a variable delay control so that the vibrato comes in only after waiting a short time after the note is struck for even more realistic string sounds.

Cabinet size 36.3"x15.0"x5.0" (rear) 3.3" (front)
Also available as separate packs — prices in free catalogue

COMPLETE KIT ONLY £299.00 + VAT!

To add interest to the sounds and make them more natural there is a chorus/ensemble unit which is a complex phasing system using CCD (charge coupled device) analogue delay lines. The overall effect of this is similar to that of several acoustic instruments playing the same piece of music. The ensemble circuitry can be switched in with either strong or mild effects.
As the system is based on digital circuitry data can be easily taken to and from a computer (for storing and playing back accompaniment with or without pitch or key change, computer composing etc., etc.) and an interface socket (25 way D type) is provided for this purpose.
Although the DPX is an advanced design using a very large amount of circuitry, much of it very sophisticated, the kit is mechanically extremely simple with excellent access to all the circuit boards which interconnect with multiway connectors, just four of which are removed to separate the keyboard circuitry and the panel circuitry from the main circuitry in the cabinet.
The kit includes fully finished metalwork, solid teak cabinet, professional quality components (all resistors 2% metal oxide), nuts, bolts, etc., even a 13A plug — you need buy absolutely no more parts before plugging in and making great music! When finished you will possess an instrument comparable in performance and quality with ready-built units selling for over £1200!

EXPORT A SPECIALITY!

Our Export Department can readily despatch orders of any size to any country in the world. Some of the countries to which we sent kits last year are shown in this advertisement. To assist in estimating postal costs our catalogue gives the weights of all packs and kits. This will be sent free on request, by airmail, together with our "Export Postal Guide" which gives current postage prices. There is no minimum order charge. Prices same as for U.K. customers but no Value Added Tax charged. Postage charged at actual cost plus 50p documentaton and handling. Please send payment with order by Bank Draft, Postal Order, International Money Order or cheque drawn on an account in the U.K. Alternatively for orders over £500 we will accept Irrevocable Letter of Credit payable at sight in London.

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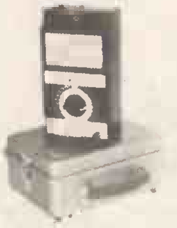
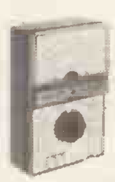
SPECIAL OFFER OF BRAND NEW USSR MADE MULTIMETERS



TYPE	U4313	U4315
Sensitivity D.C.	20,000 o.p.v.	20,000 o.p.v.
Sensitivity A.C.	2,000 o.p.v.	2,000 o.p.v.
D.C. Current	60μA-1.5A	50μA-2.5A
A.C. Current	0.6mA-1.5A	0.5mA-2.5A
D.C. Volts	75m V-600V	75mV-1000V
A.C. Volts	15V-600V	1V-1000V
Resistance	1K-1M	300Ω-500kΩ
Capacity	0.5μF	0.5μF
Accuracy	1.5% D.C. 2.5% A.C.	2.5% D.C. 4% A.C.
Price complete with pressed steel carrying case and test leads	**£10.50**	**£10.50**
Packing and postage	**£1.50**	**£1.50**

TYPE U4324



D.C. Current	0.06-0.6-60-600mA-3A
A.C. Current	0.3-3-30-300mA-3A
D.C. Voltage	0.6-1.2-3-12-30-60-120-600-1200V
A.C. Voltage	3-6-15-60-150-300-600-900V
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Accuracy	D.C. 2.5% A.C. 4% (of F.S.D.)

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Sensitivity	20,000Ω/V
Voltage ranges	2.5-1000V A.C./D.C.
Current ranges	0.05-500mA D.C. only
Resistance	5Ω-1MΩ
Accuracy	5% F.S.D.
Oscillator output	1kHz 50/50 squarewave 465KHz sinewave modulated by 1KHz squarewave

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TYPE U4341
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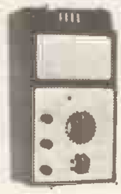

Sensitivity	16,700Ω/V D.C., 3,300Ω/V A.C.
Current	0.06-0.6-6-60-600mA D.C., 0.3-3.0-30-300mA A.C.
Voltage	0.3-1.5-6-30-60-150-300-900V D.C. 1.5-7.5-30-150-300-750V A.C.
Resistance	2-20-200kΩ-2MΩ
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4	24-30-40-48-60v	5	**£16.75**	£1.75
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6	24-30-40-48-60v	2	**£7.50**	£1.25
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13	12-15-20-25-30v	2	**£6.25**	£1.25
	3-4-5-6-8-9-10-12-15-18-20-24-30v OR 12-0-12v OR 15-0-15v CAN BE OBTAINED FROM THE ABOVE RANGE			
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4	6v twice	1¼ amps ea	**£2.95**	75p
5	6-9v twice	1 amp ea	**£2.95**	£1 00
6	10v twice	½ amp ea	**£2.50**	£1.00
7	12v twice	250m/a ea	**£2.25**	75p
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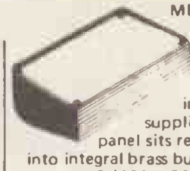
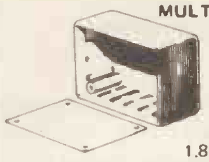


MINI DESK BIMCONSOLES
Orange, Blue, Black or Grey ABS body incorporates 1.8mm pcb guides, stand-off bosses in base with 4 BIMFEET supplied. 1mm Grey Aluminium panel sits recessed with fixing screws into integral brass bushes.
BIM 1005 (161 x 96 x 58mm) £2.48
BIM 1006 (215 x 130 x 75mm) £3.48



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) £1.34
BIM 4004 (111x71x41.5mm) £1.84
BIM 4005 (161x96x52.5mm) £2.48

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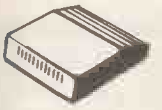
Colour Code	Top Panel	Base
A	Off White	Blue
B	Sand	Green
C	Satin Black	Gold



15° Sloping Panel	30° Sloping Panel	
BIM7151 (102x140x51[28] mm)	BIM7301 (102x140x76[28] mm)	£11.36
BIM7152 (165x140x51[28] mm)	BIM7302 (165x140x76[28] mm)	£12.28
BIM7153 (165x216x51[28] mm)	BIM7303 (165x183x102[28] mm)	£13.43
BIM7154 (165x211x76[33] mm)	BIM7304 (254x140x76[28] mm)	£14.83
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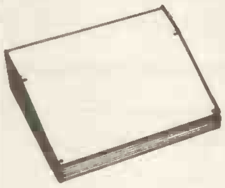
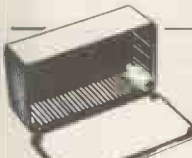
BIM7156 (254x287x76[33] mm)	BIM7306 (254x259x102[28] mm)	£17.71
BIM7157 (356x211x76[33] mm)	BIM7307 (356x183x102[28] mm)	£18.83
BIM7158 (356x287x76[33] mm)	BIM7308 (356x259x102[28] mm)	£19.92



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) £2.76
BIM 6006 (143 x 170 x 55.5 [31.5] mm) £3.58
BIM 6007 (214 x 170 x 82.0 [31.5] mm) £4.83



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
(50x50x25mm)	N/A		BIM5001/11	£1.54	£1.23
(100x50x25mm)	BIM2002/12	£1.09	BIM5002/12	£1.66	£1.32
(112x62x31mm)	BIM2003/13	£1.27	BIM5003/13	£2.24	£1.70
(120x65x40mm)	BIM2004/14	£1.51	BIM5004/14	£2.81	£2.11
(150x80x50mm)	BIM2005/15	£1.72	BIM5005/15	£3.19	£2.72
(190x110x60mm)	BIM2006/16	£2.69	BIM5006/16	£4.94	£3.96

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BIM 2007/17 (112x61x31mm) £1.06

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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.
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BIM 8007 (243x187x103[66] mm) £6.70

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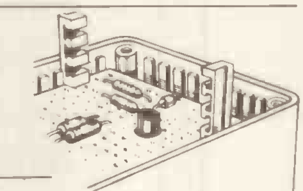
Allows pcb's to be flat mounted sandwich fashion in BIMBOXES, BIMCONSOLES, and all other enclosures having 1.5mm wide vertical guide slots. One plastic BIMDAPTOR on each corner of pcb(s) enables assembly to be simply slid into place. 54mm long, 10 slots on 5mm spacing and can be simply snipped off to length. £1.15 per pack of 25.



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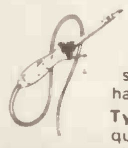
BIMIRONS



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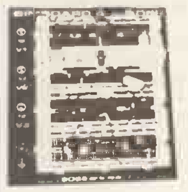
BIMBOARDS

DIL COMPATIBLE BIMBOARDS



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BIMBOARD 3 £31.83
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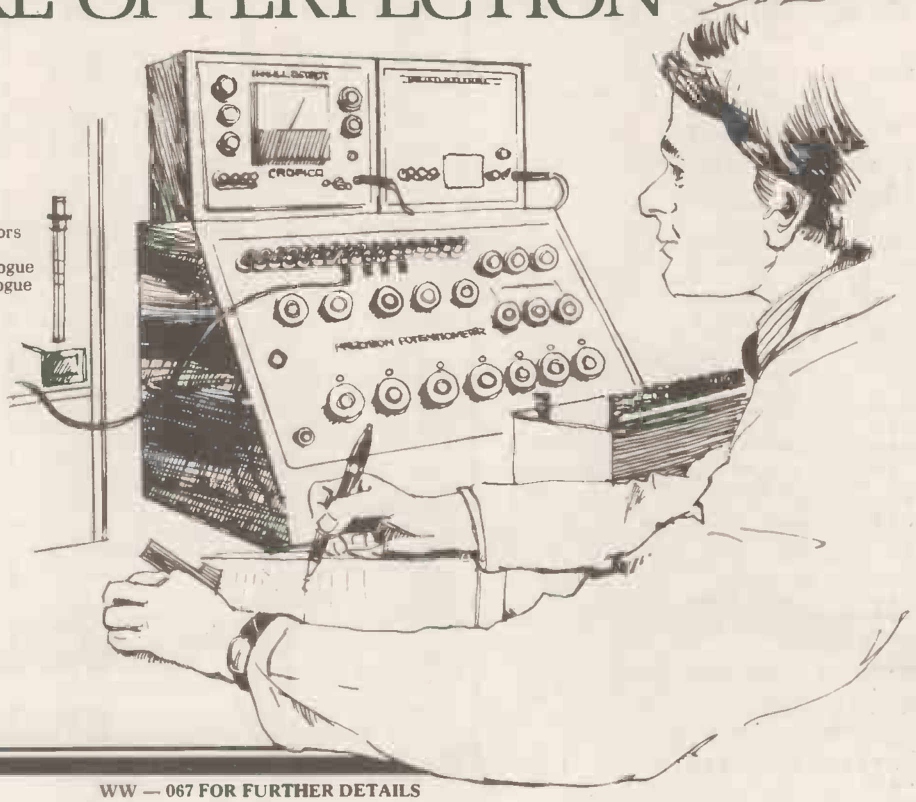

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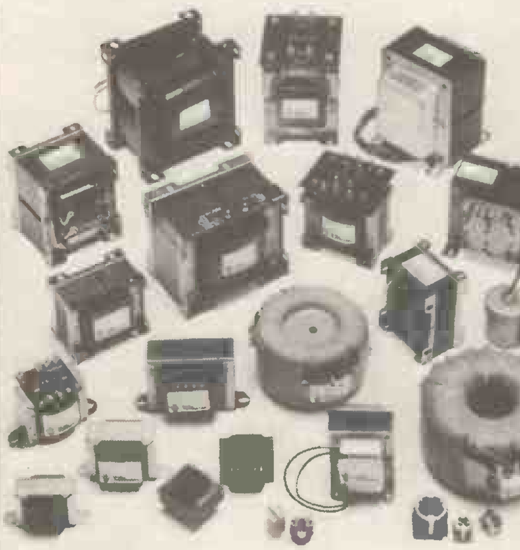

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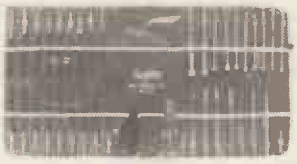

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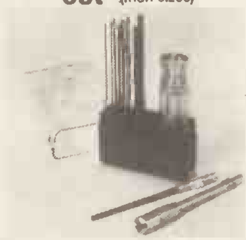

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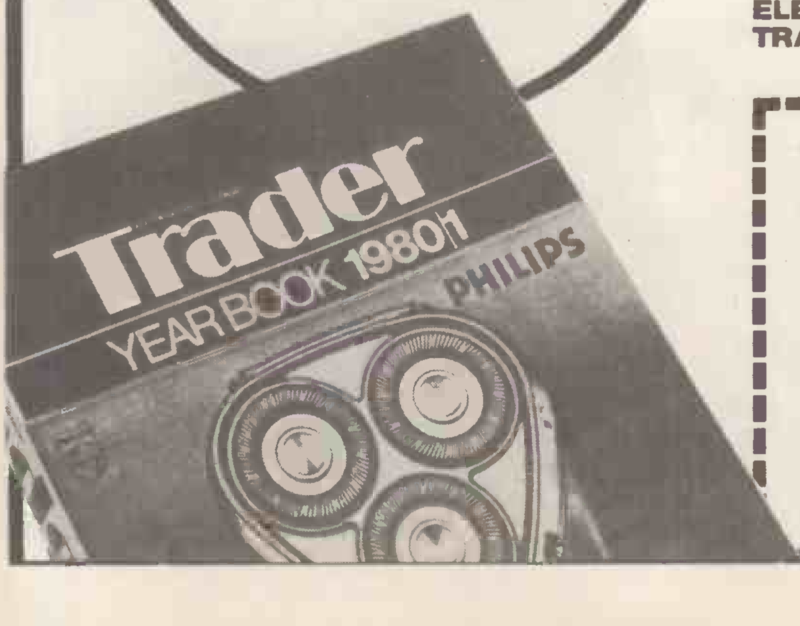

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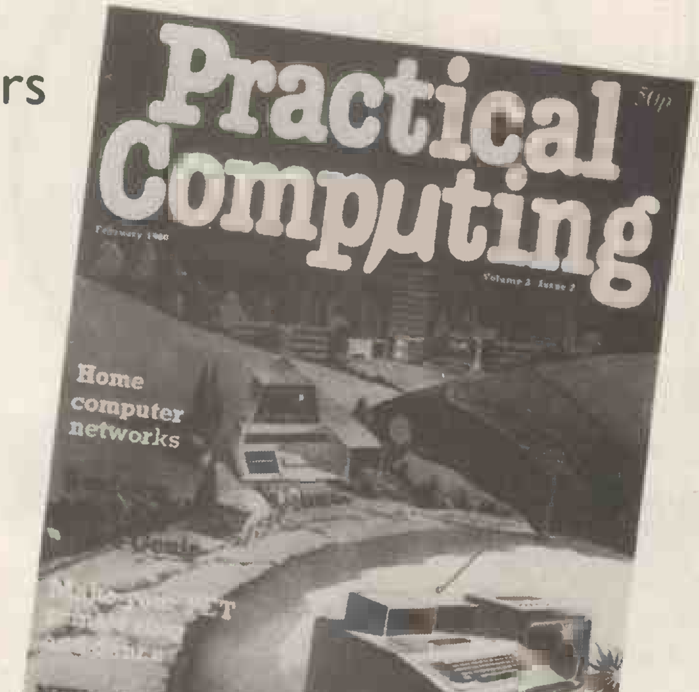

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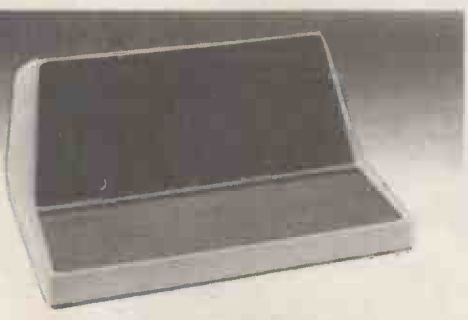

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KB771 71-station ASCII Keyboard including numeric/cursor control cluster, mounted in steel enclosure	£95.00	£115.00
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Discounts available for quantities

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Voltage Source & AC/DC Diff.
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AB AC/DC Differential Voltmeter
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digit D.M.M. 3490A ... £550
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M.M. PM2517E £120
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7065 .... £1150
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TF1370A R-C Oscillator £275
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.... £195
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FM-10 Decade Switched FM Signal Generator. Up to 500MHz . £1200
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2003 Sweeper Main Frame c/w 3302, 3331, 3341, 3351, 3360 and 3370 modules. Frequency range 0-300MHz sweep width with 0-100% of the range 0-62dB O/P attenuator in 1dB steps. O/PZ 75 Sweep time 0.01-50S. Internal 5 & 10MHz markers. Internal AM/FM modulation. Internal detector £1150
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Microcomputers are coming - ride the wave! Learn to program.

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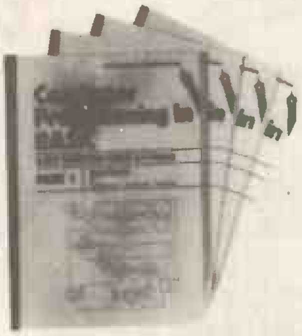

Book1 Computers and what they do well; READ, DATA, PRINT, powers, brackets, variable names; LET; errors; coding simple programs.
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Understand Digital Electronics

Written for the student or enthusiast, this course is packed with information, diagrams and questions designed to lead you step-by-step through number systems and Boolean algebra to memories, counters and simple arithmetic circuits and finally to an understanding of the design and operation of calculators and computers.

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Book 3 Half adders and full adders; subtractors; serial and parallel adders; processors and ALU's; multiplication and division systems.
Book 4 Flip flops; shift registers; asynchronous and synchronous counters; ring, Johnson and exclusive – OR feedback counters; ROMS and RAMS.
Book 5 Structure of calculators; keyboard encoding; decoding display data; register systems; control unit; program ROM; address decoding.
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Communications 80

Communications Equipment and Systems
National Exhibition Centre
Birmingham England
15 April - 18 April 1980

AN INVITATION TO

5th IN THE SERIES

Communications 80, the fifth in a series of international expositions dealing with the applications of communications equipment and systems, particularly in the major growth areas of data and business communications which are being created by the converging technologies of computing and telecommunications. The other important themes of the exposition are PTT telecommunications, civil fixed and mobile radio and emergency communications.

Communications 80 will attract visitors from all over the world (from 69 countries at the last event in 1978) who will be coming to see the latest developments in communications technology displayed by leading international manufacturers. Many of the visitors will also attend the integral conference, organised by the Institution of Electrical Engineers in association with leading international learned societies, to learn about the latest technical advances in communications equipment and systems.

Communications 80, the world's leading international exposition in the field, is actively supported by the International Telecommunication Union - the world telecommunications authority representing 153 governments; the British government, through the Home Office; the British Post Office; Cable and Wireless Ltd; and the two main UK trade associations - the Electronic Engineering Association and the Telecommunications Engineering and Manufacturing Association.

Please make a note of the dates and venue of **Communications 80** - Tuesday 15 April to Friday 18 April, 1980, at the National Exhibition Centre, Birmingham, England.

You cannot afford not to come if you make, use or specify communications equipment and systems.

I am interested in attending
Communications 80

Please send me details of exhibition ☐ conference ☐

Name ____________________

Position ____________________

Company ____________________

Address ____________________

____

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Complete, detach and mail to

Tony Davies Communications
c/o Industrial and Trade Fairs Ltd, Radcliffe House,
Blenheim Court, Solihull, West Midlands B91 2BG, England.
Telephone: 021 705 6707 Telex: 337073

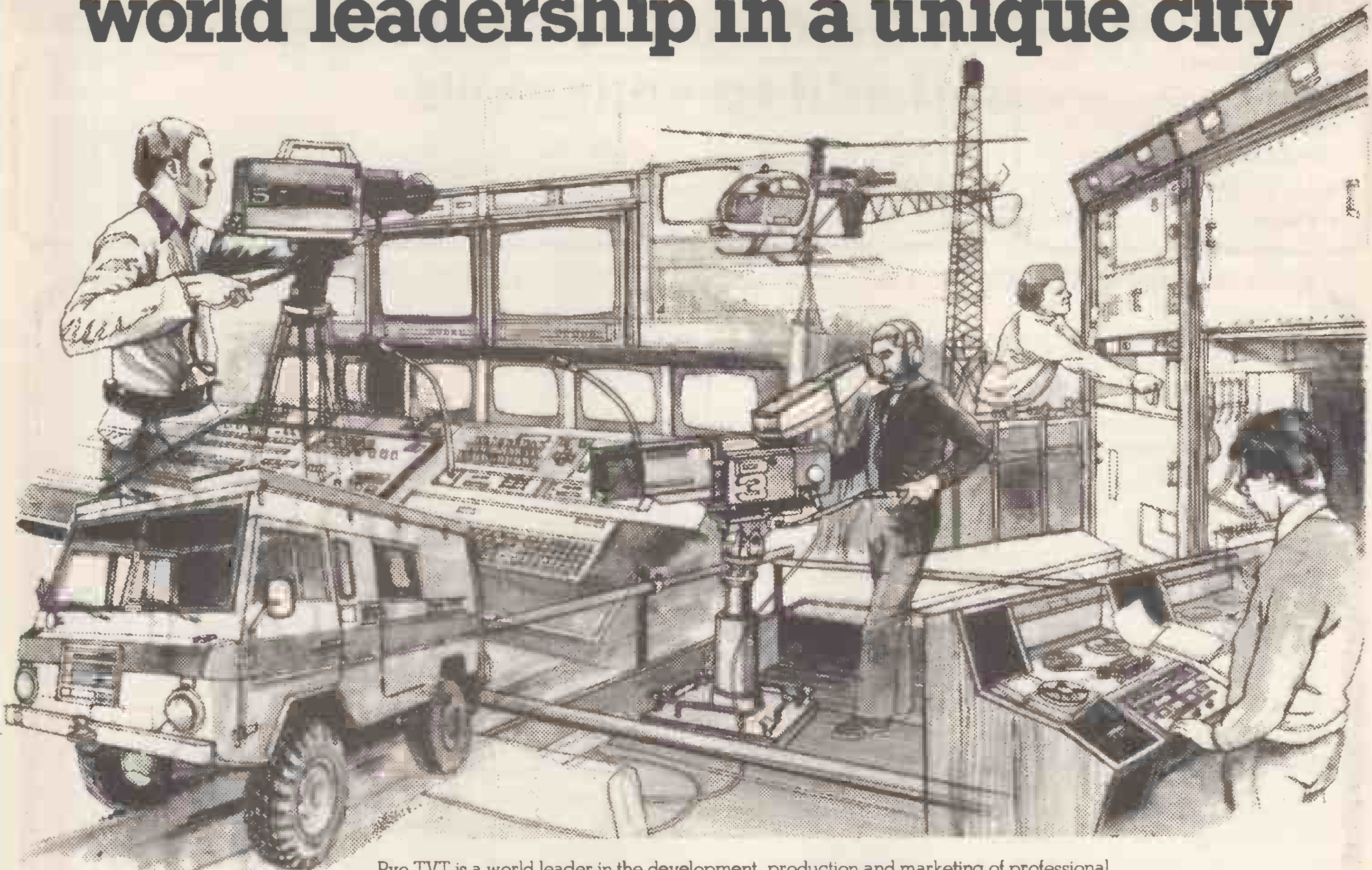
60

Appointments

Advertisements accepted up to 12 noon Friday, February 1st for March issue, subject to space being available.

DISPLAYED APPOINTMENTS VACANT: £10.00 per single col. centimetre (min. 3cm).
LINE advertisements (run on): £1.50 per line, minimum three lines.
BOX NUMBERS: 70p extra. (Replies should be addressed to the Box Number in the advertisement, c/o Wireless World, Dorset House, Stamford Street, London SE1 9LU.)
PHONE: Neil McDonnell on 01-261 8508
Classified Advertisement Rates are currently zero rated for the purpose of V.A.T.

Pye TVT~The challenge of world leadership in a unique city



Pye TVT is a world leader in the development, production and marketing of professional broadcast equipment. We export 90% of our production and our sales have grown rapidly in the last five years, with some notable recent successes. We are situated in Cambridge, and have been closely associated with its commercial and cultural activities for many years. There are good schools, historic buildings and large, green, open spaces. We are only 65 minutes away from London and an hour or so from the coast.
We need enthusiastic electronic engineers to work in the following areas:

Customer Service Engineering

We are looking for an enthusiastic and self-motivated engineer who is able to work (after equipment training) on complex broadcast equipment with the minimum of supervision. The work involves the investigation and correction of technical problems arising on equipment, including cameras, telecine and vision mixers, both in Cambridge and in the field. The job also includes customer liaison, world-wide travel and a very high level of job responsibility. It would ideally suit someone looking for variety and a strong element of problem-solving.

Studio Installation

This is another position that offers the applicant the opportunity of an independent and exciting life, coupled with the responsibility of a highly technical and important job. It involves the installation and commissioning of our studios and associated equipment worldwide. This equipment includes a variety of TV cameras, the latest video tape recorders, outside broadcast vans and sound studios. The job would probably suit a young engineer who wishes to gain a greater knowledge of TV systems.

Test Engineering

This opening is for an engineer to work with transmitter co-axial equipment. The overall purpose of the job is to test and align a broad range of co-axial combining and switching equipment. We're looking for someone who is able to operate independently and work to schedules, with a strong background of work on co-axial lines, wave guides or antennae.

Quality Assurance

Our Quality Department plays an integral part in a complex, technical, yet highly commercial environment, auditing the safety and performance of our equipment for adequate quality levels. Our reputation depends on their judgement, expertise and instincts.
We are either looking for a young graduate in electronic engineering, who has gained 2 or 3 years experience in industry, or someone with a solid background in electronic quality assurance, who qualifies for membership of I.Q.A. Our industry is being revolutionised by the advent of microprocessors, and the person we are looking for must be able to cope with these changes. He or she will be involved, from the quality point of view, in the design and development of new equipment, as well as being concerned with the production process.

Transmitter Development

Our continued success in the transmitter field world-wide, means we now have attractive openings in this department at all levels. We're looking for people with the ability to take responsibility for all aspects of design in TV, FM and AM sound broadcast transmitters. Applicants should be qualified to at least H.N.D. level with a minimum of around two years development experience — but the most important qualities are the interest and enthusiasm to become part of this highly successful team.

Studio Development

We are looking for people to join a highly-skilled development group, specialising in the design and development of studio equipment. As we are constantly initiating new developments, including a range of digital products used in signal processing and control, we would like to meet adaptable young engineers who can contribute to this fascinating and continually changing area. They would take responsibility for all aspects of digital equipment design for broadcast TV applications. Qualifications to degree standard are required for these posts.

We are offering generous relocation expenses, very good salaries and excellent working conditions for all of these positions. For further information or application forms, please contact **David Barnicoat on Cambridge (0223) 45115.**

PYE

Pye TVT Limited
PO Box 41 Coldhams Lane Cambridge England CB1 3JU
Tel: Cambridge (0223) 45115. Telex: 81103

(9964)

Radio Technicians

Work in Communications R&D and add to your skills

At the Government Communications Headquarters we carry out research and development in radio communications and their security, including related computer applications. Practically every type of system is under investigation, including long-range radio, satellite, microwave and telephony.

Your job as a Radio Technician will concern you in developing, constructing, installing, commissioning, testing, and maintaining our equipment. In performing these tasks you will become familiar with a wide range of processing equipment in the audio to microwave range, involving modern logic techniques, microprocessors, and computer systems. Such work will take you to the frontiers of technology on a broad front and widen your area of expertise — positive career assets whatever the future brings. In the rapidly expanding field of digital communications, valuable experience in modern logic and software techniques will be gained.

Training is comprehensive: special courses, both in-house and with manufacturers, will develop particular aspects of your knowledge and you will be encouraged to take advantage of appropriate day release facilities.

You could travel — we are based in Cheltenham, but we have other centres in the UK, most of which, like Cheltenham, are situated in environmentally attractive locations. All our centres require resident Radio Technicians and can call for others to make working visits. There will also be some opportunities for short trips abroad, or for longer periods of service overseas.

You should be at least 19 years of age, hold or expect to obtain shortly the City and Guilds Telecommunications Technician Certificate Part I (Intermediate), or its equivalent, and have a sound knowledge of the principles of telecommunications and radio, together with experience of maintenance and the use of test equipment. If you are, or have been in HM Forces your Service trade may allow us to dispense with the need for formal qualifications.

Registered disabled people may be considered.

Pay scales for Radio Technicians start at £3900 per annum , rising to £5530, and promotion will put you on the road to posts carrying substantially more; there are also opportunities for overtime and on-call work, paying good rates.

Get full details from our **Recruitment Officer, Robby Robinson, on Cheltenham (0242) 21491, Ext 2269,** or write to him at **GCHQ, Oakley, Priors Road, Cheltenham, Glos GL52 5AJ.** We will invite suitable applicants (expenses paid) for interview at Cheltenham.

GCHQ

Recruitment Office

Government Communications Headquarters

Oakley, Priors Road, Cheltenham GL52 5AJ

(9813)

CHELSEA COLLEGE
University of London

ELECTRONICS WORKSHOP

DEPUTY SUPERVISOR (Grade 6) and ELECTRONICS TECHNICIAN ENGINEER (Grade 5) required for interesting work for Electronics and Physics research and teaching. Includes prototype instrument design, development and construction and the servicing and repair of commercial electronic equipment.

Experience and qualifications in Electronics at an appropriate level are essential. Generous holidays. Inclusive salaries (under review):

Grade 6: £5023 to £5848 per annum
Grade 5: £4480 to £5100 per annum.

Further details and application forms from: Mr. M. E. Cane (EW), Chelsea College, Pulton Place, London SW6 5PR.

(9974)

ELECTRONIC ENGINEERS

NEEDED IMMEDIATELY

Trec Video is expanding its Broadcast facilities at its new premises close to Waterloo Station.

Applications are invited for Engineers interested in working in the following areas:

A) Outside Broadcast
B) Broadcast Video Tape Recorders
C) General Equipment Servicing

Please ring, or write to:

Mr. Derek Oliver
Chief Engineer
TREC CONSULTANTS LIMITED
1-7 Boundary Row
London, S.E.1
Tel: 01-633 9494

(9996)

ROYAL COLLEGE OF ART

An

ELECTRONICS TECHNICIAN

is required in the Department of Environmental Media to assist students in the creative use of equipment, and control all aspects of maintenance. This is a broad-based Department using Sony video facilities (½" open reel and U-Matic), sound recording equipment, film and slides, cameras and projectors.

Applicants should have at least the equivalent of a City & Guilds Certificate (Part II) and some practical experience.

Starting salary on scale £4767-£5592 (£5026-£5901) from 1.4.80).

Write, giving full details of age, qualifications and experience, to: Assistant Registrar (Staff), Royal College of Art, Kensington Gore, London, SW7 2EU.

(10011)

THE POLYTECHNIC OF CENTRAL LONDON
Division of Engineering

ELECTRONICS TECHNICIAN

Grade 5

Salary: £4479-£5100 increasing to £4707-£5364 on 1 April, 1980
These figures include **£780** London Allowance

Technician required as computer supervisor to oversee the day-to-day operation and hardware maintenance of a PDP II/40 installation with associated peripheral equipment.

Applicants should have minicomputer, hardware and/or operating systems experience.

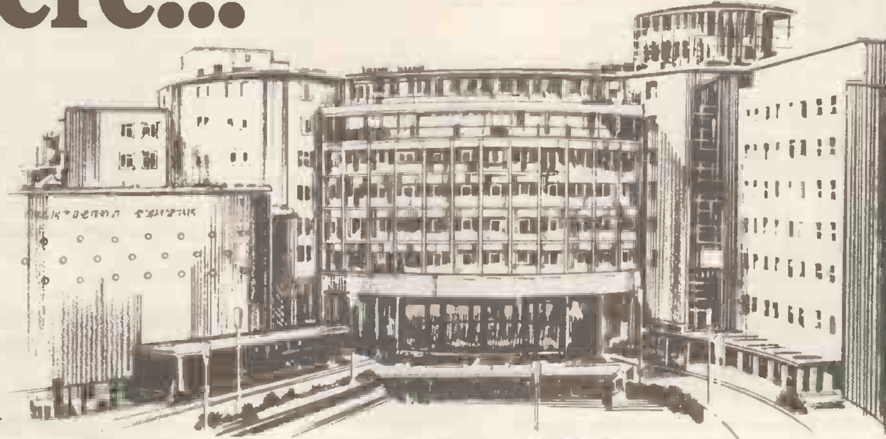
The following qualifications are required: ONC, OND with 7-9 years' experience (inclusive of training) or the equivalent and/or appropriate industrial experience.

Application form and job description from the **Establishment Officer, PCL, 309 Regent Street, London W1R 8AL (Tel: 01-580 2020 ext. 212).**

(9984)

Television Engineers

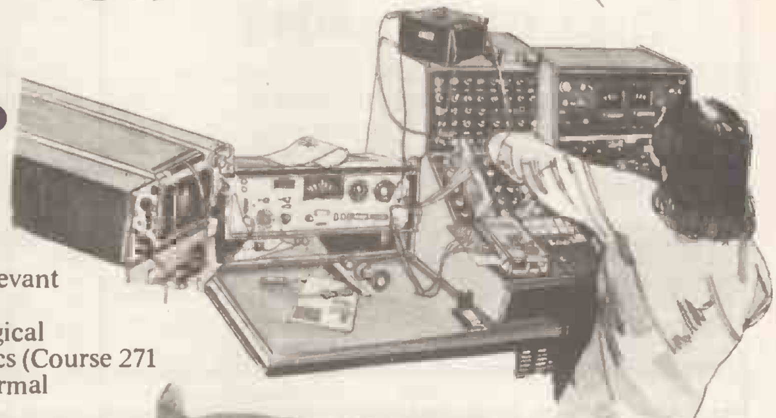
The search for excellence starts here...



Standards of BBC broadcasts are higher now than they have ever been–and the excellent quality of our transmissions is due largely to the expertise of our Engineering teams. We want to expand those teams, and for men and women who make the grade, the possibilities are endless.

Our Engineers are closely involved with production staff in the making of programmes, either by providing the facilities required or by operating equipment.

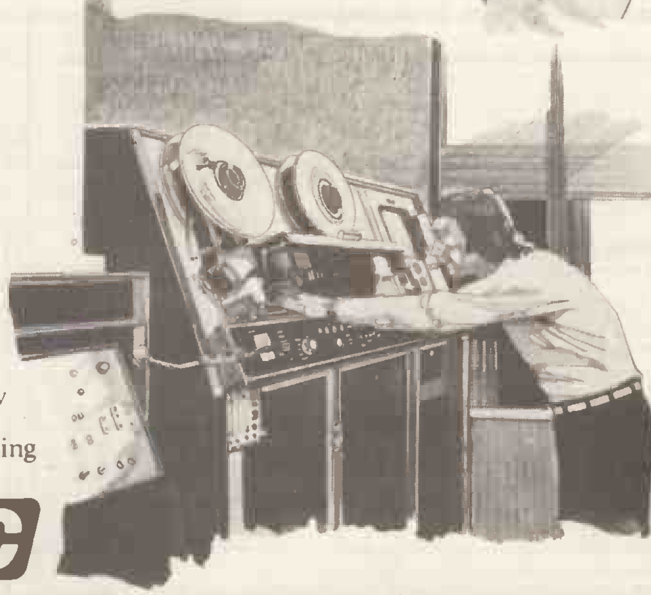
and here...



They are also responsible for the technical standards of our broadcasts and for the maintenance of our technical equipment.

You should have a degree in Electrical or Electronic Engineering, Applied Physics or a relevant science subject, an HNC/HND or higher TEC certificate or diploma, or a C&G Full Technological Certificate in Telecommunications or Electronics (Course 271 or 281); a strong interest in broadcasting, and normal colour vision and hearing.

and here...



Salaries, to be reviewed in April, range from £5760 to £6260 including shift allowances and the jobs, which are based mainly in the West London area, also carry such benefits as a pension scheme, social clubs and staff restaurants.

Opportunities for personal development through training and promotion are good.

If you are interested please complete the coupon below and then return the whole advertisement to The Engineering Recruitment Officer, BBC, Broadcasting House, London W1A 1AA, quoting reference no. 79.E.4156/WW.

BBC

Name ________ Mr/Mrs/Miss Address ________

________ Tel. No. ________

Engineering Recruitment Officer, BBC, Broadcasting House, London W1A 1AA. 79.E.4156/WW.

(9988)

Field Engineers

Oil-Well Surveys — worldwide

Selsmograph is an international leader in seismic exploration for oil and gas throughout the world.

We have openings for hardy, single people, under 28, qualified in Electronics to at least HNC level, to train as Oil-Well Field Engineers. Applicants must be prepared to work in all weathers on world-wide assignments at short notice. Please do not apply unless you meet these requirements.

The job involves responsibility for the operation and servicing of electronic instrumentation and for the production of seismic information from drilled wells. You will receive specialist training at our headquarters near Bromley, Kent, and you may be based there whilst working from the UK.

We offer competitive salaries, attractive conditions of employment and leave entitlement plus generous allowances and free messing when on operations.

Please write or telephone for an application form quoting ref. OWS. Appointments Manager, Selsmograph Service (England) Limited, Holwood, Westerham Road, Keston, Kent BR2 6HD. Tel: Farnborough Kent 53355.

(10023)

LONDON BOROUGH OF HOUNSLOW

Education Department

AUDIO VISUAL TECHNICIAN

(HOUNSLOW BOROUGH COLLEGE)

Salary £3657-£3975

To repair and maintain audio visual equipment including "U" Matic and VHS video. Some production work will also be involved and the ability to work in a small team is vital. City and Guilds qualifications are necessary.

Application forms from Mrs G. Beach, Services Officer, Hounslow Borough Colege, London Road, Isleworth, Middlesex. Tel: 01-568 0244, ext. 235.

(9983)

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SENIOR TEST AND CALIBRATION ENGINEERS

With a background in RF and microwaves, experienced in analogue, digital techniques, logic and microprocessor controlled ATE.

also vacancies exist for

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with knowledge of one or more of the above techniques.

We offer an exceptional salary ★ Performance related bonus scheme ★ Training abroad ★ Prospects of promotion ★ A wide variety of work ★ A happy atmosphere ★ Non-contributory pension scheme ★ Subsidised restaurant.

Please write or phone to.
Mr. Z. Eres (Technical Manager) extension 43.

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Surrey KT9 1LP
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(9757)

Radio Mechanic

An experienced radio mechanic, male or female, is urgently required to work on installation, maintenance and construction of a wide range of fixed, portable and vehicle radio equipment at London Fire Brigade HQ, Lambeth, S.E.1.

Rate of pay is over £85 p.w. for a 40-hour, 5-day week with excellent conditions of service.

For further details and an application form, write or phone the Brigade Personnel Officer (E3), Fire Brigade Headquarters, 8 Albert Embankment, London, S.E.1 (01-583 3811, ext. 527).

London Fire Brigade GLC

(10018)

BRUNEL UNIVERSITY
Special Engineering Programme

LABORATORY TECHNICIAN

Grade 4 required to undertake a wide range of duties relating to mechanical, electrical and electronic engineering including construction, installation, modification, maintenance and servicing of equipment for teaching and project work, which will involve a close working relationship with staff and students.

Applicants should be educated to O.N.C. or C. & G. level.

Salary (under review) in the scale £3,757-£4,275 including London Weighting.

21 days' annual leave plus Christmas and Easter weeks. Good luncheon, sports and social facilities.

Write for application form to the Establishment Secretary, Brunel University, Uxbridge, Middlesex UB8 3PH or telephone Uxbridge 37188, extension 49. Closing date: 31 January, 1980.

(9987)

Nene College Northampton

Applications are invited for the post of:

LECTURER GRADE I/II in Electrical Engineering

Candidates should be graduates or Chartered Engineers with recent industrial experience. The successful applicant will be required to teach general electrical engineering subjects including Instrumentation of the level of a TEC Higher Certificate.

Salary Scale	Lecturer Grade I	£3552-£6060
	Lecturer Grade II	£4542-£7221

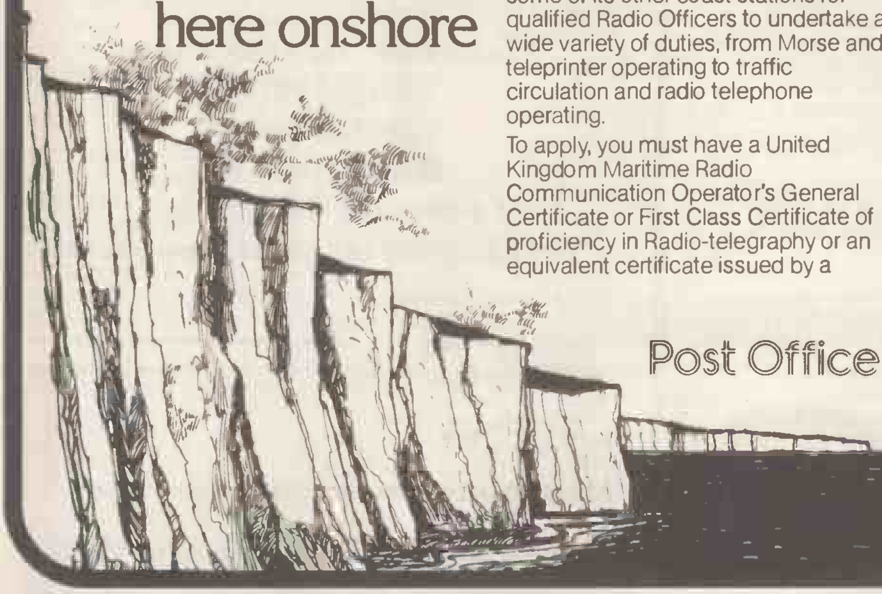
point of entry depending on previous experience.

Applications forms, which should be returned within fourteen days from the date of appearance of this Advertisement, are available, together with further particulars, from: **The Dean, School of Technology, Nene College, St. George's Avenue, Northampton.**

(10005)

Land a good job

Your Radio Officer's qualifications could mean a lot here onshore



If you're thinking of a shore-based job, here's where you'll find interesting work, job security, good money, and the opportunity to enjoy all the comforts of home where you appreciate them most – at home!

The Post Office Maritime Service has vacancies at Portishead Radio and some of its other coast stations for qualified Radio Officers to undertake a wide variety of duties, from Morse and teleprinter operating to traffic circulation and radio telephone operating.

To apply, you must have a United Kingdom Maritime Radio Communication Operator's General Certificate or First Class Certificate of proficiency in Radio-telegraphy or an equivalent certificate issued by a Commonwealth Administration or the Irish Republic. Preferably you should have some sea-going experience.

The starting pay at 25 or over will be about £5381; after 3 years' service this figure rises to around £7087. (If you are between 19 and 24 your pay on entry will vary between approximately £4229 and £4937). Overtime is additional, and there is a good pension scheme, sick-pay benefits, at least 4 weeks' holiday a year, and excellent prospects of promotion to senior management.

For further information, please telephone Kathleen Watson on 01-432 4869 or write to her at the following address: ETE Maritime Radio Services Division ( ), ET17.1.1.2, Room 643, Union House, St. Martins-le-Grand, London EC1A 1AR.

Post Office Telecommunications

(9741)

Air traffic Engineers

The Civil Aviation Authority has vacancies for men and women as Air Traffic Engineers Grade 2 in its Telecommunications Division offering a variety of work on a wide range of electronic systems and specialised equipments.

Air Traffic Engineers Grade 2 are involved in the installation and maintenance of radio, radar, air navigational and landing aids, and data processing systems. Staff are employed at Air Traffic Control Centres and some Civil Airports and other locations throughout the U.K. but at present most of the vacancies are likely to be in the South of England with some in Scotland and Shetland.

Qualifications and Experience

You should be at least 20 years of age and have obtained either the ONC (ENG) with an electronic bias or C & G Telecommunications Technician T3 Certificates or T.E.C. Telecommunications Certificate with Radio options or other similar technical qualifications.

You should also have had skilled working experience in radio, radar or data processing.

Salary

Salaries are on the incremental scale £4777–£7472. Posts in the London area attract an additional allowance (Inner London £831 — Outer London £347) Grade 1 posts (maximum salary £8980) are normally filled by promotion from Grade 2.

For full details and an application form, complete and send the coupon to : CAA Tels Staff Management (ATE2), Room K206, CAA House, 45/59 Kingsway, London WC2B 6TE.

Name______________________________

Address____________________________

(WW2/80)

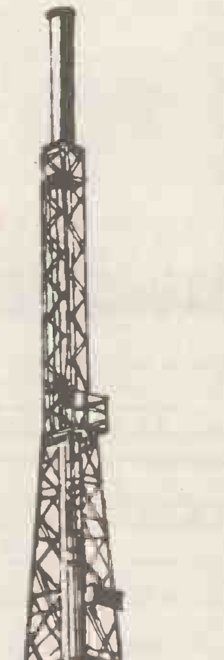
(9965)

CAA
Civil Aviation Authority

HNC Level Engineers~

(Electrical or Electronic)

Train for the future as a Broadcast Transmission Engineer



Through our network of over 500 transmission stations the IBA is responsible for the transmission of all Independent Television and Local Radio services. With a steadily increasing number of stations, the preparations for the fourth television channel and more local radio stations now underway we are taking on increased responsibilities.

We take great pride in the fact that our system is one of the best in the world and great importance is placed on maintaining the efficiency of the service. To do this we have teams of highly trained and experienced engineers all over the country.

Internal promotions and continued expansion have created a number of opportunities for H.N.C. or H.T.C. or equivalent level engineers (male or female) to train for a challenging future. Our carefully devised training programme, which will commence this summer, can lead to a recognised Diploma and combines theoretical study and practical training. This comprehensive training is a step beyond traditional learning and gives a grounding in broadcast engineering that is second to none. Naturally, course fees, accommodation and meals will be paid during the course. A full driving licence is required, but if you do not already have one, we will assist you by arranging and paying for instruction.

On the satisfactory completion of the training programme, your salary will be £5,880 per annum and then rise annually to £7,280 per annum, with further progression to £8,202 per annum. (During the training period you will receive a salary of up to £4,700 per annum, depending upon experience.)

At higher levels it will be up to you to demonstrate your ability as promotions are based on internal competition – all of our Regional engineering managers started their careers at transmitting stations.

Employment benefits include Free Life Assurance and Personal Accident Schemes, a Contributory Pension Scheme, generous relocation expenses and subsidised mortgage facilities.

Please write or telephone Mike Wright for a fully illustrated information package and application form, at IBA, Crawley Court, Winchester, Hampshire SO21 2QA. Telephone: Winchester 822574.

IBA INDEPENDENT BROADCASTING AUTHORITY

(9920)

BRIGHTON POLYTECHNIC
LEARNING RESOURCES
THREE VACANT POSTS
GOOD SALARIES OFFERED

ELECTRONIC ENGINEER

To work with a team of experienced engineers and technicians developing colour television and other audio/visual facilities throughout the Polytechnic. The systems developments range from simple sound and TV production equipment to video recording and editing to near broadcast standards.

The Electronic Engineer will apply digital and analogue techniques to develop and install new equipment, up-grade existing facilities and assist with its maintenance. Formal training to Degree or equivalent standard will be expected but proven ability and experience in electronic design and construction (preferably including television) will be rated even more highly.

VIDEO RECORDING AND STUDIO ENGINEER

To lead the work of staff in a newly equipped recording and editing area (using state of the art techniques, including Plumbicon colour technique and a wide range of VTRs — some to broadcast standard) and to contribute to the engineering development of the systems of the area. Also to supervise the two adjoining studios, containing systems with colour corrections and multi-track sound.

Operational experience of sound and colour video systems (preferably in a broadcasting or educational institution) and a degree or equivalent qualification are desirable.

VTR ENGINEER

Unique opportunity to work in the forefront of helical vtr developments; using new 1″ high band, broadcast ¾″ and all consumer formats, requiring a qualified engineer to work to broadcast standards but interested in working with all vtr formats.

Further details and application forms from the Personnel Officer, Brighton Polytechnic, Moulsecoomb, Brighton BN2 4AT. Tel. 0273 693655 Ext. 2536. Closing date 30th January, 1980.

East Sussex

(9977)

Brunei
Training Officer (Teleprinter)

Department of Telecommunications
Tax free salary up to £8,100

As part of its continuing expansion and improvement programme the Department of Telecommunications requires a Training Officer (Teleprinter).

Candidates should be over 35 years of age and have at least ten years' experience in telecommunications with a minimum of five years in a supervisory capacity. They must have a sound knowledge of teleprinter servicing and overhaul of either the CREED 444 or SIEMENS T100 machines.

The successful candidate will be responsible for the training of local staff both formally and in the field on all aspects of the discipline.

The tax free salaries include a special allowance and attracts a 25% gratuity.

Benefits include free passages, leave allowance, subsidised housing, education allowances, children's holiday visit passages, interest-free car loan and outfit allowance. Contract 3 years.

For full details and application form telephone Anne Eames 01-222 7730 ext 3231 or write quoting reference number MT/310/WD.

Crown Agents

The Crown Agents for Oversea Governments and Administrations, Recruitment Division, 4 Millbank, London SW1P 3JD.

(9982)

ELECTRONICS JOURNALISM

Electron, the weekly technical magazine for designers and managers in electronics, requires a

FEATURES EDITOR

We're looking for someone with a good all-round knowledge of electronics to commission features articles. Experience of technical writing or publishing, although preferred, is not essential, but a good command of the English language is important.

Salary: £6464 plus £210 reading allowance.

Telephone: Barrie Nicholson on 01-261 9111 extension 257
for an application form

Broadcast Engineer

TEST AND SERVICE

Seltech Equipment Limited is a leading supplier of broadcast equipment and its increasing share of the market requires a major expansion programme involving a move to larger modern premises and employment of additional engineering staff.

The position offered will involve testing and servicing a full range of broadcast products including switching, pulse generation, time code, clock and audio systems, utilising the latest technology.

The successful applicant will probably be qualified to HND level but broadcast related experience is of prime importance.

The position is based in the company's new premises at Bourne End, Bucks. Limited travel will be required.

Salary and conditions will be in keeping with the position offered.

In the first instance apply to: D. Craddock, General Manager.

SELTECH

SELTECH EQUIPMENT LIMITED
Rose Industrial Estate, Cores End Road,
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Tel: Maidenhead (0628) 36315
or Bourne End (06285) 29131

(9999)

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★ Do you want to join a fast growing international company manufacturing sophisticated computer disc and drum systems.

★ Do you want involvement, responsibility and job satisfaction.

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★ Do you want to earn **£6,000-£7,000.**

★ The above position is available to further develop our advanced disc systems incorporating high technology servo and data channel electronics.

Telephone: Mrs. Amery on Leatherhead (03723) 76221

Or apply in writing to: Vermont Research Limited
Cleeve Road, Leatherhead
Surrey KT22 7NB

(9992)

PERIPHERALS

Thames Television
We have a vacancy for a

TELECINE ENGINEER

based at our Euston Studios

The post involves the operation and maintenance of Flying Spot and Photoconductive machines.

Applicants without practical experience must have a theoretical knowledge of Telecine operations and should possess an ONC qualification or equivalent.

Salary is on a scale from £5500 per annum to £7480 per annum, dependent upon experience, for a 38-hour week.

There are 21 days holiday, Company Pension Scheme and subsidised meal facilities.

For an application form please telephone ro write to:-
Ms Pat Evans, Staff Relations Department, Thames Television Ltd. Teddington Lock, Middlesex.
Telephone: 01-977 3252, Ext. 325.

THAMES
LONDON'S WEEKDAY ITV

(10010)

IMPERIAL WAR MUSEUM LONDON

Audio Technician

The Museum illustrates and records all aspects of the two world wars and all other military operations involving Britain and the Commonwealth since 1914.

This post is in the Department of Sound Records, where the technical operations are based on a Sound Suite incorporating Leevers-Rich E200 and Revox tape machines, disc reproducers, a Neve BCM 10/2 mixing desk and ancillary facilities. It carries responsibility for regular servicing of all the audio equipment, dubbing operations and training and supervising an assistant to carry out transfer operations. Duties include some location recording, control of public listening facilities, production of programme material for the Museum's public and educational services and supervising the production of copy tapes.

Candidates should preferably have an ONC, C & G, TEC/SCOTEC or equivalent qualification in Engineering or other relevant subject, but those with special experience will be considered.

All candidates must have an aggregate of at least 8 years' recognised training (e.g. apprenticeships) and experience (which may include up to 3 years' relevant full-time study), and be experienced audio equipment technicians.

Salary (under review) starting at £5760 rises to £6330. Non-contributory pension scheme.

For further details and an application form (to be returned by February 5, 1980) write to Civil Service Commission, Alencon Link, Basingstoke, Hants, RG21 1JB, or telephone Basingstoke (0256) 68551 (answering service operates outside office hours). *Please quote ref: T/5272.*

UNIVERSITY OF ST. ANDREWS
Department of Chemistry
Applications are invited for a post of

ELECTRONICS TECHNICIAN
Grade 5

to design and maintain electronic equipment in the Department of Chemistry. Candidates should have an O.N.C., City & Guilds Ordinary Certificate or equivalent qualification.

Salary at appropriate point on scale £3700 to £4320 per annum (under review).

Applications with the names of two referees should be sent to the Establishments Officer, The University, College Gate, St. Andrews, Fife, by 31st January, 1980. (9985)

KING'S COLLEGE, LONDON

ELECTRONICS TECHNICIAN

This post in the Department of Electronic and Electrical Engineering requires experience in the construction, modification and repair of electronic equipment. Salary according to age and experience on scale £4480 p.a. to £5100 p.a. (£4706 p.a. to £5364 from 1.4.80) inclusive (under review). 5 weeks' annual holiday. Superannuation scheme. Interest-free loans for annual rail season tickets.

Apply in writing with full details to: The Head Clerk (Ref: 221751/WW), King's College, London, Strand WC2R 2LS.

(9971)

ELECTRONIC SERVICE ENGINEER

We are looking for an engineer to take charge of the maintenance of our U.K. computer centre. This position will require good digital electronics background with particular experience in computer peripherals. It will be necessary to travel to the U.S.A. for training courses and liaison with service engineers in our Canadian and North American centres. A company car will be supplied after full training. Our company offer a realistic bonus and free medical schemes.

Salary offered £7,500 p.a. negotiable depending upon experience in computer systems

Please apply to:

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Roy Self
SEFEL GEOPHYSICAL (UK) LTD.
Turriff Building
Great West Road
Brentford
Middlesex
Telephone: (01) 568 3273

(10014)

Electronics Design Engineers

Rank Research Laboratories are looking for young engineers who are keen to tackle analogue and digital electronic design for thermal imaging systems and the application of microprocessors. This work will attract engineers with ability in digital and analogue design and keenness to exploit the power of electronics in creating new systems in the fields mentioned.

Good salaries will be offered to suitable candidates and it is a Rank Organisation policy to assist professional career development. The company has a contributory pension fund and non-contributory life assurance scheme.

Men and women with a few years' R & D experience and a degree or equivalent in electronic engineering or physics are invited to phone or write for an application form to the

Administration Manager, Rank Research Laboratories, P.O. Box 33, Phoenix Works, Great West Road, Brentford, Middlesex TW8 9AG. Tel. 01-568 9766, extn. 26.

RANK RESEARCH LABORATORIES

(10019)

Opportunities for Test Engineers

If you've experience in thyristor control drives, digital logic techniques, computer systems, or microprocessors, then you could be the test engineer we're looking for.

We need several engineers to work on a wide range of electronic control equipment.

Ideally, you will have served an apprenticeship in the electrical industry, and be qualified to ONC or HNC standard, although experience could well take the place of formal qualifications.

If you're interested, apply to our Personnel Officer on Rugeley 5151 or write to him at:

THORN AUTOMATION

THORN AUTOMATION LIMITED
P.O. Box 4, Rugeley
Staffordshire, W15 1DR

Applications are welcome from both men and women.

(10023)

MEDICAL PHYSICS TECHNICIANS

YOUR EXPERIENCE COULD LEAD TO A HAPPY EXPERIENCE IN HAMPSTEAD . . . Working at the Royal Free Hospital, Britain's newest and largest teaching hospital.

We offer an experienced Technician (Grade IV — Electronics) the chance of working on the design and construction of specialised electronic equipment, which will be used in both research and clinical applications. This is an excellent opportunity for a man or woman who holds a City and Guilds Final Technological Certificate in appropriate subjects and ideally has experience in the use of both analogue and digital circuit techniques.

You will be working with four other Technicians and, apart from your design work, you will be expected to carry out maintenance on a wide range of commercial apparatus within our purpose-built and well-equipped workshop.

In addition to the salary of: £4,280-£5,504 (including all allowances — starting point depending on qualifications and experience), we offer a first-class working environment and a superb choice of facilities which include a good staff restaurant, a social club and a brand new recreation and leisure centre with a large sports hall, swimming pool and bar.

If you would like to find out more, write to the Personnel Department, The Royal Free Hospital, Pond Street, N.W.3, or telephone 01-794 0500, ext. 4286. Please quote reference 0761.

Camden and Islington Area Health Authority (T). (9994)

UNIVERSITY OF ST. ANDREWS
Department of Psychology

TECHNICIAN GRADE 5 (ELECTRONICS)

Applications are invited for the above post in the Electronics Workshop of the Psychology Department. Applicants should have a good electronics background together with practical experience in the development and construction of digital equipment and the design of computer interfaces.

The person appointed will work together with other members of the technical staff on the development of on-line experimental facilities using the Department's Data General computers and DEC GT40 Graphics Display Terminal. There will also be work with the Department's dedicated microcomputer systems (Cromenco, Minc-11). Experience with small digital computers and a knowledge of programming languages is desirable. The duties will also involve the use and maintenance of other electronic equipment in the Department.

Salary at appropriate point on scale £3700-£4320 (under review). Applications, with full details of career to date, and the names of two referees, should be sent to the Establishments Officer, The University, College Gate, St. Andrews, Fife by 31st January, 1980.

(9970)

THE INNER LONDON EDUCATION AUTHORITY
THE LONDON COLLEGE OF PRINTING
Elephant and Castle
London SE1 6SB

TELEVISION TECHNICIAN/ ENGINEER

Candidates should be conversant with ½", ¾" and 1" black and white colour equipment and be capable of electronic maintenance. Experience in professional broadcasting would be an advantage, as well as an interest in experimental video work. The successful applicant will be expected to assist in the running studio productions, and video tape editing.

Salary scale £4,436.64-£6,509.64 inclusive (ST1/2).

Application form, returnable within 14 days, obtainable from the College on 735-8484, Ext. 227

(9937)

THE UNIVERSITY OF LEEDS, SCHOOL OF CHEMISTRY. ELECTRONICS TECHNICIANS. Grade 5, required to work with a team on a wide variety of challenging and interesting work for research and teaching. A wide range of electronic experience (minimum 7 years) is required, preferably including analogue and digital circuitry. Minimum qualifications, O.N.C. or equivalent (H.N.C. or Full Technological certificate preferred). Grade 3, this post involves the construction, modification, maintenance and repair of electronic equipment. Applicants should have 3 years' relevant experience and have obtained O.N.C. or equivalent qualifications. Salaries in the range: Grade 5 £3700-£4320 pa rising to £3926-£4584 from 1st April 1980. Grade 3 £3122-£3553 pa rising to £3313-£3770 from 1st April 1980, salaries subject to further review from 1st October 1979. Applications to: Mr J. E. Farish, Supervisor Electronics Workshop, School of Chemistry, The University, Leeds LS2 9JT. (3890)

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

Phone or write: **BUREAUTECH AGY, 46 SELVAGE LANE, LONDON, NW7. 01-959 3517.**

(8994)

ELECTRONICS TECHNICIAN

The School of Chemical and Physical Sciences requires a technician to be responsible for an electronics teaching laboratory associated with physics area. Equipment includes oscilloscopes, signal generators, oscillators, various power supplies etc. The technician will be expected to work unassisted if necessary and make all preparatory arrangements in conjunction with course supervisors. Day release available.

T2 salary range £3975-£4383 inclusive.

Application forms from Assistant Registrar (Personnel), Kingston Polytechnic, Penrhyn Road, Kingston upon Thames. 01-549 1366.

(9982)

SITUATIONS VACANT

UNIVERSITY OF BRISTOL
DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

TECHNICIAN GRADE 5

A vacancy exists for a technician to work in the electronic research and teaching laboratories and in a small workshop attached to these laboratories. The work includes the use of general workshop skills for the design and construction of electronic and other equipment. In addition, responsibility will be taken for supporting students in the electronic teaching and research laboratories and for maintaining the electronic equipment.

In addition to applications from candidates who have experience appropriate to this post, applications will also be considered from candidates who are sufficiently versatile to benefit from training in electronic skills provided that they have suitable educational qualifications and, preferably, an engineering apprenticeship.

Commencing salary will be within the range £3700-£4320 per annum (scale under review).

Applications should be sent to Professor B. M. Bird, Department of Electrical and Electronic Engineering, University of Bristol, University Engineering Laboratories, University Walk, Bristol BS8 1TR.
(9969)

University of London Reactor Centre

ELECTRONICS TECHNICIAN GRADE 5

Required for an establishment engaged in research and teaching based on a nuclear research reactor. Must be capable of contructing and maintaining a variety of electronic equipment as found in a nuclear establishmeal but previous experience in this particular field is not essential. A knowledge of digital circuitry would be an advantage. Applicants should have several years' experience and an appropriate qualification is desirable.

Salary in the scale £3.700-£4.320. Under review 1.10.79 with a further minimum increase of £226-£264 from 1.3.80. Post is supernannuable: Generous sick pay scheme: working week 37½ hours. 5 weeks' annual holiday plus several days in addition to public holidays at Christmas and Easter.

Applications to: **Reactor Supervisor, University of London Reactor Centre, Silwood Park, Sunninghill, Ascot, Berks. SL5 7PY. Tel. Ascot 23911 (STD 0990), Ext. 272.**
(10004)

LONDON BOROUGH OF BRENT WILLESDEN COLLEGE OF TECHNOLOGY
Principal: A. K. Barnard, BSc, PhD, CChem, FRIC

Department of Electrical Engineering

Applications are invited for the post of

LECTURER I IN ELECTRONICS

to teach both theory and practice on TEC Electrical Engineering and City and Guilds Electronics Servicing courses.

Applicants should have good practical experience preferably in servicing/maintenance and possess at least an appropriate final C & G Technical/Craft qualification.

Salary Scale: £3,954 to £6,466 inclusive.

Further particulars and application forms (SAC) are available from the Chief Administrative Office, Willesden College of Technology, Denzil Road, LONDON NW10 2XD (Tel: 01-459 0147) returnable within 14 days.

Relocation assistance available in approved cases.
(10017)

KING'S COLLEGE, LONDON

TELEVISION TECHNICIAN

Applications are invited for this post which offers interesting and varied opportunities in the mobile unit and studio of the Faculty of Education. Closed circuit experience and current driving licence essential. Salary on scale £4480 p.a. to £5100 p.a. (£4706 p.a. to £5364 p.a. from 1.4.80) inclusive (subject to further review). 5 weeks' annual holiday. Superannuation scheme. Interest-free loans for annual rail season tickets.

For further details and application form write to: The Head Clerk (Ref: 221752/ww), King's College, London, Strand WC2R 2LS.
(9972)

ARTICLES FOR SALE

GWM RADIO LTD., 40/42 Portland Road, Worthing, Sussex. Tel: 0903 34897 for surplus supplies. AVO 8 £43. Model 7 MK II £32 inclusive P x P receivers. Eddystone 730's Atlanta Marine, B40 ex-Govt. 40ft. pneumatic masts by Scam Clark. Type 76 telephones. Quantity of Microwave Test Equipment. S.a.e. for details. 50 micro-amp AVO movements. All types of radio telephones, large or small quantities bought and sold, many one off items in stock. No lists, we are worth a visit, wholesale and retail.

LAB CLEARANCE: Signal Generators; Bridges; Waveform, transistor analysers; calibrators; standards; millivoltmeters; dynamometers; KW meters; oscilloscopes; recorders; Thermal, sweep, low distortion true RMS, audio FR, deviation. Tel. 040-376236. (8250

VHF MONITOR RECEIVERS, Air or Marine band from £50. FM Business bands from £90. For leaflets send 50p P.O., not stamps. Radio Communications Ltd, 13 Clos du Murier, St Sampson, Guernsey, Channel Isles. (9874

SPECTRUM ANALYSER Polarad 641-1 with digital memory 0.01 to 18 GHZ (40 GHZ with ext. mixer not supp.), full service manual, hardly used, mod. 2nd L.O. out at 5dBm. No VAT. £6,250 o.n.o. Tel. (0244) 813491 ext. 42/20199 eves. (10001)

'AA' SIZE 500MAH nicads, £1 each, inc. VAT, from: SMC Ltd., S.M. House, Osborne Road, Totton, Southampton SO4 4DN. Tel. (0703) 867333. Telex 477351 SMCOMM G. Dealer enquiries invited. (10002)

SOLATRON 436 double beam scope, good working order. First £60 secures. Telephone 021-444 1280.

TEK 575 semiconductor test set, £500. Hewlett Packard 7123 chart recorder, £500. Keithley 414 picoammeter, £150. — Tel. Rickmansworth 76382. (9995)

500 WATT Boozy & Hawkes amplifier. 16 and 30 watt paging amplifiers. Creed teletype No. 7s. Tel. (0622) 50350. MKS, Upper Stone St., Maidstone, Kent. (9442)

TELEPHONE ANSWERING machine available for outright purchase. — Telephone Burton-on-Trent (0283) 47427. (9609

EX-GOVT. TAPE RECORDERS: E.M.I., Ferrograph, Tandberg, Uher, Vortexion, etc. S.a.e. for details, A. Wright, 'Sunningdale', Broadheath, Worcester. (9831

UNUSED BARREL PRINTER MECH. Ribbons, hammer drivers included. £150 ono. — Ring Bracknell 50491 after 6 p.m. (9976)

SERVICES

ELECTRONIC DESIGN SERVICES. Wide engineering experience available for the design of basic circuits to complete systems. Analogue DC to 1GHz and Digital. Write or phone Mr Anderson, Andertronics Ltd, Ridgeway, Hog's Back, Seale (Nr. Farnham), Surrey. Runfold 2639. (9140

REPETITION SHEET METALWORK on Wiedemann turret press. Long/short runs. Highly competitive. Quick deliveries commission for introductions. — EES Ltd., Clifford Rd., Monks Rd., Exeter. 36489. (8060

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*Also subscription agents.

Printed in Great Britain by QB Ltd., Sheepen Place, Colchester, and Published by the Proprietors IPC ELECTRICAL-ELECTRONIC PRESS LTD., Dorset House, Stamford Street, London, SE1 9LU, telephone 01-261 8000. *Wireless World* can be obtained abroad from the following: AUSTRALIA and NEW ZEALAND: Gordon & Gotch Ltd. INDIA: A. H. Wheeler & Co. CANADA: The Wm. Dawson Subscription Service Ltd, Gordon & Gotch Ltd. SOUTH AFRICA: Central News Agency Ltd: William Dawson & Sons (S.A.) Ltd. UNITED STATES: Eastern News Distribution Inc., 14th floor, 111 Eighth Avenue, New York, N.Y. 10011.

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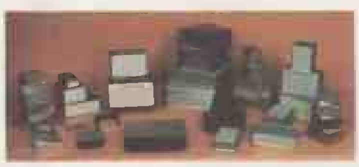

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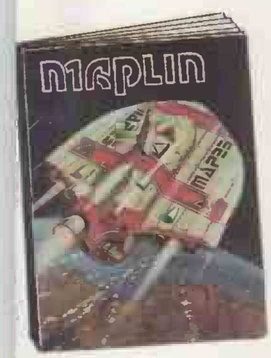

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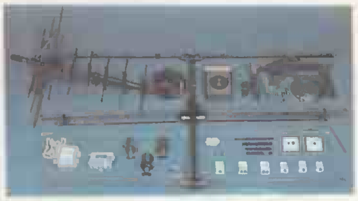

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WW—002 FOR FURTHER DETAILS

Even if tin prices stabilised, a change from 60/40 alloy to Savbit Solder could save you £100/tonne, ensure a better job...

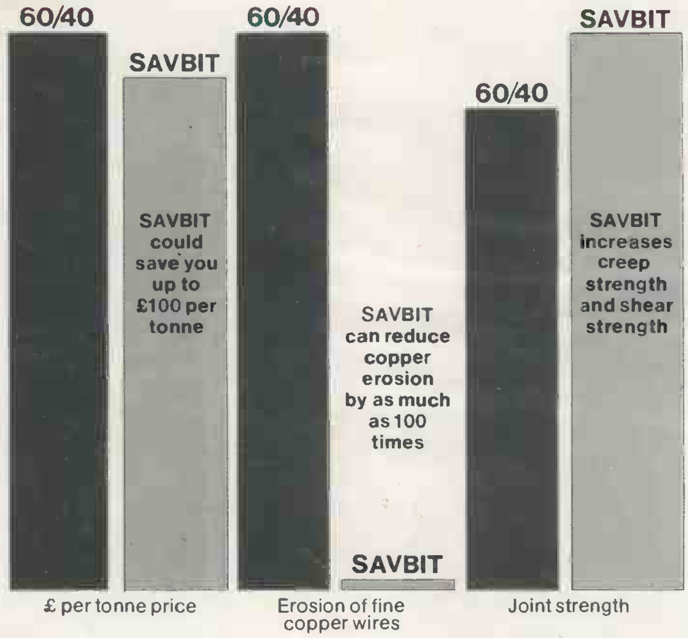
The reason is that Multicore Savbit not only solves the problem of fine copper wires and thin foils deteriorating during soldering, but also contains less tin than 60/40 alloy. **We make both so we are just offering to alleviate your rising metals costs.**

During normal soldering, a dissolving action causes the wire to weaken and embrittle – often to break during subsequent field use.

Savbit, however, is a rosin based, 5-core wire solder comparable in joint quality to standard high performance alloys, but capable of dramatically inhibiting the copper dissolving action.

As this diagram shows,* compared with a 60/40 alloy, Savbit can reduce the dissolution of copper by as much as 100 times. Yet wetting rate, flow, conductivity and capillary force are almost identical – with creep strength and shear strength actually increased.

*(Indicative of product advantages only; not to scale)

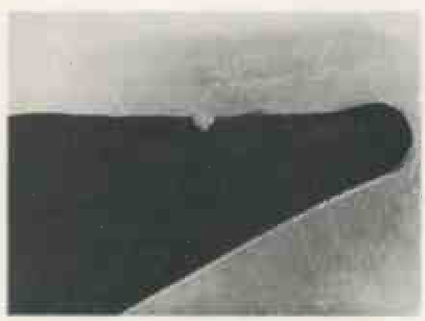


...and more

Cracked iron-plated bit, after 40,000 simulated operations using 60/40 Solder.

Some people think Savbit alloy is only usable with plain copper soldering iron bits, but this isn't true.

As these photographs illustrate dramatically, Savbit also saves significantly on the cost of iron-plated soldering iron bits, which have a copper core. This is exposed through cracks in the plating.



Cracked iron-plated bit, after 40,000 simulated operations using SAVBIT Solder.

Add this advantage to the increased reliability and joint quality Savbit offers, and you'll understand why more and more 60/40 users are making the change – and profiting. The Ministry of Defence have given a special new Approval No. DTD 900/4535A for Savbit alloy with ERSIN 362 flux to be used in lieu of Solders to B.S. 219 and B.S. 441.

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For full information on Savbit or any other Multicore products, please write on your company's letterhead direct to:

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