wireless world

MARCH 1980 50p

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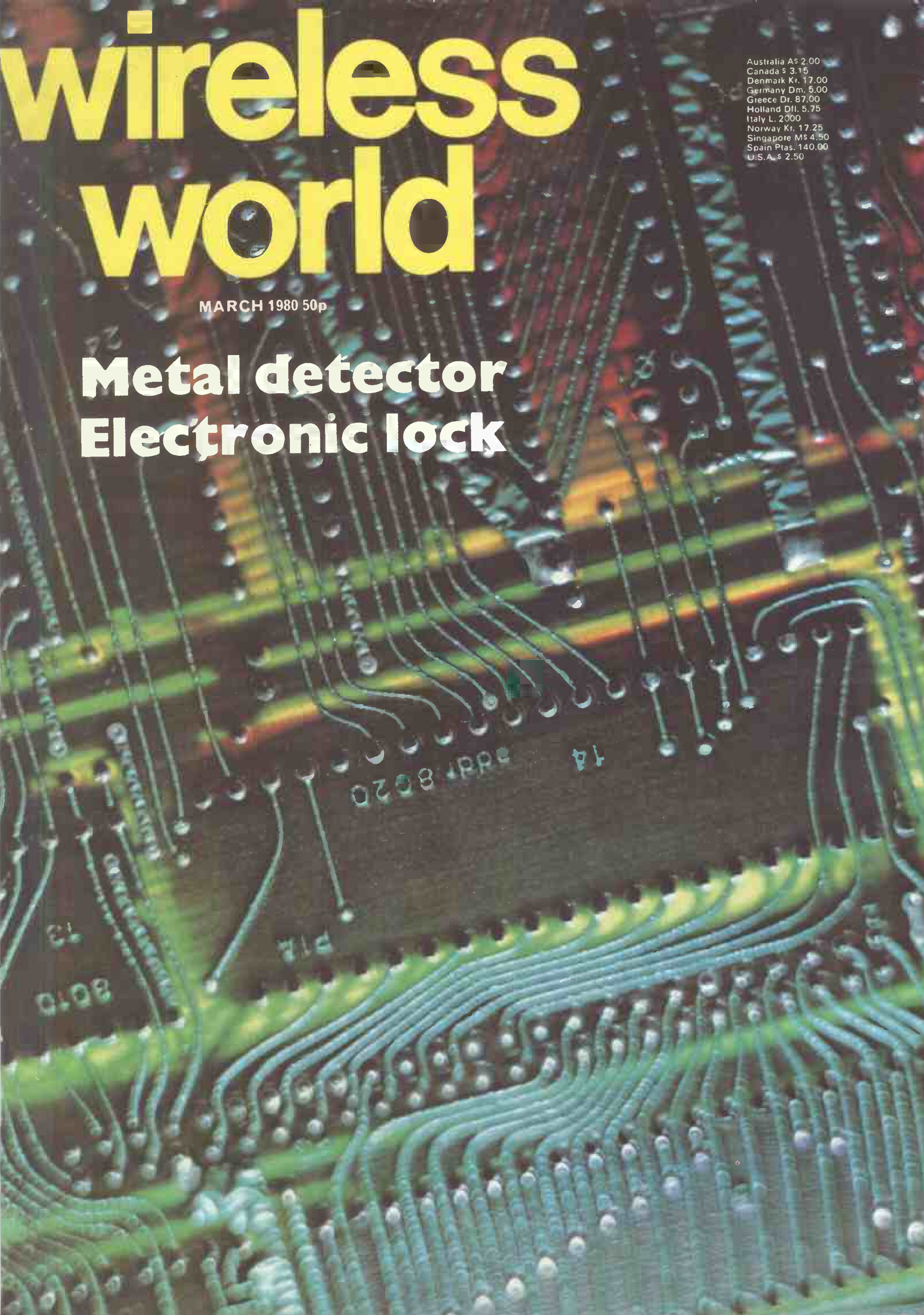
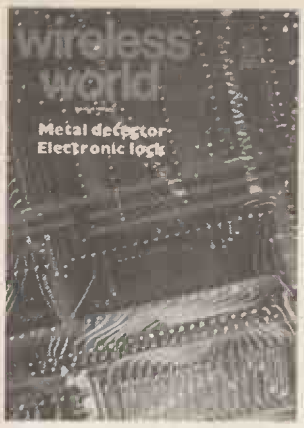
Metal detector
Electronic lock





Front cover is a photograph, by Paul Brierley, of the printed-circuit pattern on a Motorola microcomputer board.

IN OUR NEXT ISSUE

Digital capacitance meter **is a 3½-digit instrument, with full-scale readings of 200pF to 20μF.**

How serious is multipath distortion? **An investigation into this effect in v.h.f./f.m. sound broadcasting and results of recent research.**

Shared-memory v.d.u. **with opto-electronic interface is an economic and efficient peripheral for a home computer.**

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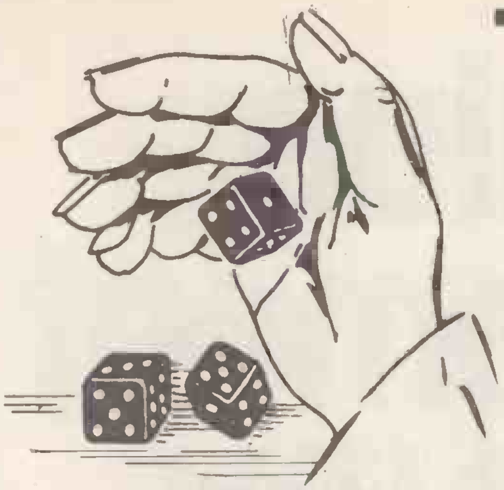
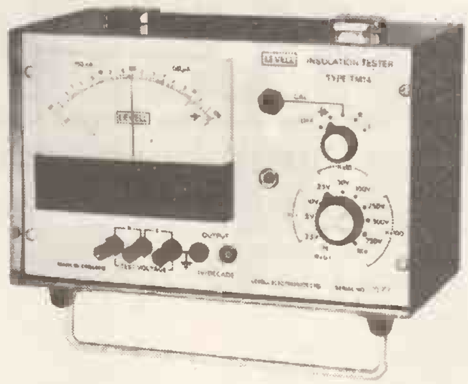
wireless world

ELECTRONICS/TELEVISION/RADIO/AUDIO

MARCH 1980 Vol 86 No 1531



DON'T GAMBLE WITH PERFORMANCE BUY LEVELL TESTERS



Tests bipolar transistors, diodes and zener diodes. Measures leakage down to 0.5 nA at 2V to 150V. Current gains are checked from 1μA to 100mA. Breakdown voltages up to 100V are measured at 10μA, 100μA and 1mA. Collector to emitter saturation voltage is measured at 1mA, 10mA, 30mA and 100mA for I_C/I_B ratios of 10, 20, 30. The instrument is powered by a 9V battery.

TRANSISTOR RANGES (PNP OR NPN)

I_{CBO} & I_{EBO}: 10nA, 100nA, 1μA, 10μA and 100μA f.s.d. acc. ±2% f.s.d. ±1% at voltages of 2V, 5V, 10V, 20V, 30V, 40V, 50V, 60V, 80V, 100V, 120V, and 150V acc. ±3% ±100mV up to 10μA with fall at 100μA <5%+250mV.

BV_{CBO}: 10V or 100V f.s.d. acc ±2% f.s.d. ±1% at currents of 10μA, 100μA and 1mA ±20%.

I_B: 10nA, 100nA, 1μA ... 10mA f.s.d. acc. ±2% f.s.d. ±1% at fixed I_E of 1μA, 10μA, 100μA, 1mA, 10mA, 30mA, and 100mA acc. ±1%.

h_{FE}: 3 inverse scales of 2000 to 100, 400 to 30 and 100 to 10 convert I_B into h_{FE} readings.

V_{BE}: 1V f.s.d. acc. ±20mV measured at conditions on h_{FE} test.

$V_{CE(sat)}$: 1V f.s.d. acc. ±20mV at collector currents of 1mA, 10mA, 30mA and 100mA with I_C/I_B selected at 10, 20 or 30 acc. ±20%.

DIODE & ZENER DIODE RANGES

I_{DR}: As I_{EBO} transistor ranges.

V_Z: Breakdown ranges as BV_{CBO} for transistors.

V_{DF}: 1V f.s.d. acc. ±20mV at I_{DF} of 1μA, 10μA, 100μA, 1mA, 10mA, 30mA and 100mA.

type TM12 **£145**

A logarithmic scale covering 6 decades is used to display either insulation resistance or leakage current at a fixed stabilised test voltage. The current available is limited to a maximum value of 3mA for safety and capacitors are automatically discharged when the instrument is switched off or to the CAL condition. The instrument operates from a 9V internal battery.

RESISTANCE RANGES

10M Ω to 10T Ω (10^{13} Ω) at 250V, 500V, 750V and 1kV.
1M Ω to 1T Ω at 25V, 50V and 100V.
100k Ω to 100G Ω at 2.5V, 5V and 10V.
10k Ω to 10G Ω at 1V.
Accuracy ±15% +800 Ω on 6 decade logarithmic scale.
Accuracy of test voltages ±3% ±50mV at scale centre.
Fall of test voltages < 2% at 10μA and < 20% at 100μA.
Short circuit current between 500μA and 3mA.

CURRENT RANGE

100pA to 100μA on 6 decade logarithmic scale.
Accuracy of current measurement ±15% of indicated value.
Input voltage drop is approximately 20mV at 100pA, 200mV at 100nA and 400mV at 100μA.
Maximum safe continuous overload is 50mA.

MEASUREMENT TIME

< 3s for resistance on all ranges relative to CAL position.
< 10s for resistance of 10G Ω across 1μF on 50V to 500V.
Discharge time to 1% is 0.1s per μF on CAL position.

RECORDER OUTPUT

1V per decade ±2% with zero output at scale centre.
Maximum output ±3V. Output resistance 1k Ω.

type TM14 **£155**

Optional extras are leather cases and mains power units. Prices are ex works, V.A.T. extra in U.K.

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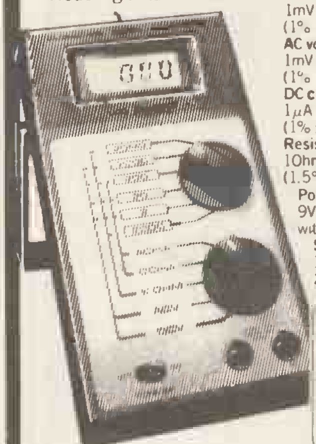
LCD DIGITAL MULTIMETER.

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.



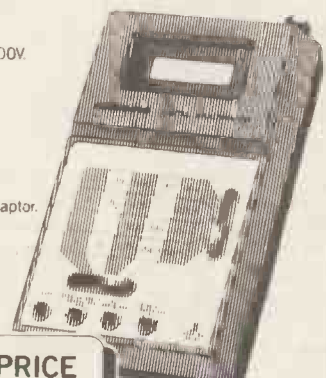
Scales:
DC volts: 1mV to 1000V (1% ± 1 digit accuracte).
AC volts: 1mV to 500V (1% ± 2 digits accurate).
DC current: 1µA to 200mA (1% ± 1 digit accurate).
Resistance: 1Ohm to 20 MOhms (1.5% ± 1 digit accurate).
Power source: 9V battery or AC with optional adaptor.
Size: 155 x 75 x 30 mm.
22–198

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



PRICE 39·93

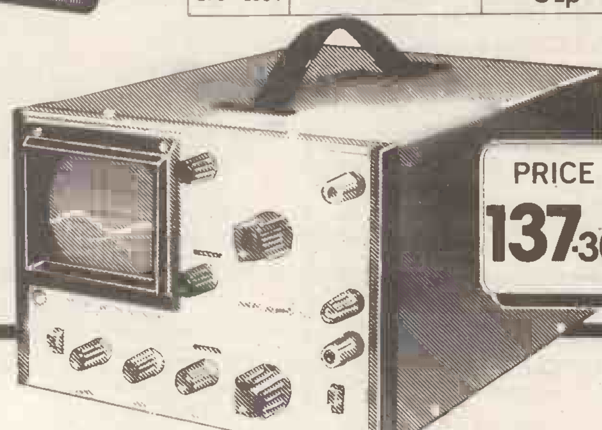
COMPONENTS AND PARTS

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
276–9110	6 pin edge connector for 277 1003	40p
276–1373	Power Transistor Mounting Hardware	50p
276–1363	TO 220 Heat Sink	60p
276–1364	TO 3 Heal 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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FD 1771 Single Density IBM Compatible	17.95
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Small. Single hybrid IC and components fit on a 2"x3" board (included). Runs on 12 VDC. Great for any project that needs an inexpensive amp. Less than 3% THD @ 5 watts. Compatible with SE-01 sound kit. £4.50 plus 50p P&P and VAT.

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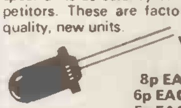
Now you can operate 115/120 Volts American equipment from 240 Volts. This converter has outlets for American type 2 or 3 pin plugs. Rated 20VA.
Only £8.95

From T.I.: **TL490 BAR/DOT DRIVER IC.** Drives 10 LEDs with adjustable analog steps. Units are cascadable up to 10 (100 steps). Drives LEDs directly. Great for **voltage, current or audio displays.** Similar in features to LM3914 with specs and circuit notes.
ONLY £1.75 NEW!

FAIRCHILD RED LED LAMPS

#FLV5057 Medium Size Clear Case RED EMITTING. These are not retested off-spec. units as sold by some of our competitors. These are factory prime, first quality, new units.



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INTERSIL UNIVERSAL TIMER/COUNTER EVALUATION KIT ICM7226A EV/KIT NEW

8 digits 5 Function 4 range to 10MHz with 0.1Hz res. time interval and period to 10 seconds with 0.1 microsecond res. units up to 10 million and ratio. A breadboarding area is provided for user to add his own input conditioning circuitry or prescalers and digital outputs are available as multiplexed as well as being displayed.
Complete kit **ONLY £39.50** + VAT

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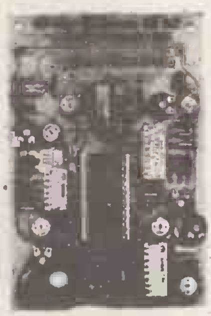
	1.24	25+	100+
LCD106	6.45	5.50	5.25

.5" Field effect LCD display featuring 3½ digits, colon, plus/minus sign, 3 decimal points and "LO BAT" indicator. Ideal for DMMs, DPMs, digital thermometers, AM/FM radio readouts. Just look at the features. Ultra low power consumption, high contrast ratio, wide viewing angle, rapid response, proven sealing techniques, superior MTBF, reflective aluminium foil. Over 300,000 already sold! Perfect interface for Intersil 7106 40 Pin DIL.

SE 01 Sound Effects Kit NEW



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 infinte 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.)

COMPLETE KIT ONLY £12.50
P&P 50p + VAT

Ordering information: For orders under £50 add 50p p.&p. Add 15% VAT to total. All items are subject to prior sale and therefore subject to availability. Prices are subject to change without notice.

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Measure Resistance to 0.01Ω ...
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New ELENCO · PRECISION USA Digital Multimeter M1200B

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*EX STOCK DELIVERY

THE ULTIMATE IN PERFORMANCE — MEASURES RESISTANCE TO 0.01 OHMS, VOLTAGE TO 100 MICROVOLTS, CURRENT TO 1 MICROAMPS AT LOWEST EVER PRICE!

FEATURES

- 3½ digits 0.56" high LED for easy reading
- 100μV, 1μA, 0.01Ω resolution
- High input impedance 10 Megohm
- High accuracy achieved with precision resistors, not unstable trimpots
- Input overload protected to 1000V (except 200mV scale to 600V)
- Auto zeroing, autopolarity
- Mains (with adaptors not supplied) or battery operation-built-in charging circuitry for NiCads
- Overrange indication
- Hi Low power ohms, Lo for resistors in circuit, Hi for diodes

SPECIFICATIONS:

DC Volts	Range 200mV, 2V, 20V, 200V, 1000V
	Accuracy 1% ± 1 digit, Resolution .1mV
	Overload protection 1,000 volts max
AC Volts	Range 200mV, 2V, 20V, 200V, 1000V
	Accuracy 1.5% ± 2 digits, Resolution .1mV
	Overload protection 1000V max, 200mV scale 600V
DC Current	Range 2mA, 20mA, 200mA, 2amp.
	Accuracy 1% ± 1 digit, Resolution 1 Microamp
	Overload protection — 2 amp fuse and diodes
AC Current	Range 2mA, 20mA, 200mA, 2 amp
	Accuracy 1.5% ± 2 digits, Resolution 1 Microamp
	Overload protection — 2 amp fuse and diodes
Resistance	Range 20, 200, 2K, 200K, 2 Meg. 20 Meg.
	Accuracy 1% ± 1 digit, Resolution .01 ohms
Environmental	Temp coefficient 0° to 30° C ± .025% °C
	Operating Temp 0° to 50° C Storage — 20° to 60° C
General	Mains adaptor: 6 - 9 Volts @ 200mA (not supplied)
	4C size batteries (not supplied)
	Size 8¼ x 5¾ x 2¼ Weight 2½ lbs.

To: Maclin-Zand Electronics Ltd
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MICRODIGITAL 1980

Apple II plus

Apple II Plus will change the way you think about computers. That's because it is specifically designed to handle the day to day activities of education, business, financial planning, scientific calculation and entertainment.

· APPLESOFT
A fast, extended 10K BASIC with 9-digit precision and graphics extensions.
· HIGH RESOLUTION GRAPHICS
On a matrix of 280 x 192 individually addressable points.
· AUTO-START ROM
With power on boot of applications programs, reset protection and improved screen editing.
· INTERNAL MEMORY EXPANSION TO 64K BYTES
For big system performance at a low cost.
· EIGHT EXPANSION SLOTS
To let the system grow with your needs

	Nett	V.A.T.	Total
Apple II Plus, 16K RAM	695.00	104.25	799.25

APPLE PASCAL
Apple Pascal is the new extension to microcomputer power

Pascal Incorporating UCSD PASCAL TM, offers extended features in a complete interactive package employing todays most sophisticated structured programming language. It provides advanced capabilities that boost performance and cut development time for large business, scientific and educational programs.

This software package provides the most powerful set of tools yet available for the microcomputer programmer.

	Nett	V.A.T.	Total
APPLE Pascal System	229.00	44.85	343.85

FLOPPY DISCS
Gives your system immediate access to large quantities of data. The subsystem consists of an intelligent interface card, a powerful Disk Operating System and one or two mini-floppy drives.

	Nett	V.A.T.	Total
Floppy disk Subsystem	349.00	52.35	401.35
Second disk drive and connecting cable	299.00	44.85	343.85

Parallel Printer Interface Card
Allows you to connect almost any popular printer to your apple. A BASIC program can produce hard-copy output as easily as it prints to the TV monitor screen. Command interpretation and printer control details are handled by the firmware built into the card, to eliminate user programming requirements.

	Nett	V.A.T.	Total
Parallel Printer Interface Card	104.00	15.60	119.60

Communications Interface Card
Allows your Apple to "talk" (through a modem) with other computers and terminals over ordinary telephone and load programs over the phone, send messages to remote terminals or access your office computer from the comfort of your home.

	Nett	V.A.T.	Total
Communications Interface Card	130.00	19.50	149.50

NEW LOW PRICES

Nascom 2

Microprocessor
Z80A 8 bit CPU. This will run at 4 MHz but is selectable between 1/2/4/ MHz.

Hardware
12" x 8" Card
All bus lines are to the Nasbus specifications
All bus lines are full buffered

Memory
On-board, addressable memory:
2K Monitor — Nas-sys 1
1K Video RAM (MK4118)
1K Work space/User RAM (MK4118)
8K Microsoft Basic (MK3600 ROM)
8K Static RAM/2708 EPROM

Keyboard
New expanded 57 Key Licon solid state keyboard especially built for Nascom. Uses standard Nascom, monitor controlled, decoding.

T.V.
The T.V. Peak to peak video signal can drive a monitor directly and is also fed to the on-board modulator to drive the domestic T.V.

I/O
On-board UART (Int. 6402) which provides serial handling for the on-board cassette interface or the RS 232/20mA teletype interface. The cassette interface is Kansas City standard at either 1200 or 300 baud. This is a link operation on the Nascom-2.

PIO
There is also a totally uncommitted PIO (MK3881) giving 16, programmable, I/O lines.

Character Generator
The 1K video RAM drives a 2K ROM character generator providing the standard ASCII Character set with some additions, 128 characters in all. There is a second 2K ROM socket for an on-board graphics package which is software selectable.

	Nett	V.A.T.	Total
Nascom-2 in kit form	295.00	44.25	339.25
Power Supply	24.50	3.68	28.18
Graphics ROM	15.00	2.25	17.25

Superboard II

The sensational single board computer from Ohio Scientific. Superboard comes fully assembled and tested. On board is a 6502 microprocessor, 4K RAM (expandable, on board to 8K), 8K Microsoft BASIC in ROM, CUTS cassette interface, full ASCII keyboard. Superboard interfaces with a video monitor or domestic television (via U H F Modulator) and provides a 24 x 24 display with Upper/Lower case and a wide range of graphics/gaming characters.

Superboard comes complete with documentation and sample software on cassette.

Ex-Stock

	Nett	V.A.T.	Total
Superboard II	188.00	28.20	216.20
U.H.F. Modulator	2.50	0.38	2.88

Video Genie

A third generation personal computer system, the video genie is a powerful microcomputer upwardly compatible with the Tandy TRS-80. TM

Central Processor
The system uses the powerful and popular Z80 processor. A system reset button is mounted at the rear of the console. Power down is NOT required should the system crash

Video Display
16 lines of 32 (2 pages) or 64 characters, switch selectable. Full software cursor control
Composite video output to a domestic television.

Memory
RAM — 1K Screen Ram
16K User RAM

ROM — 12K Extended Level II Basic interpreter, system monitor. Completely compatible with TRS-80TM Level II BASIC.

Cassette
Integral 500 b.p.s. cassette deck eliminates tape loading errors
Additional interface for second (external) cassette deck. Manual override of cassette deck and tape counter cures problems normally associated with this storage medium

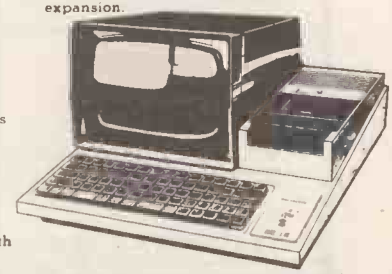
Basic
An extended Level II Basic, compatible with TRS-80 level II Basic TM
Features line editing, formatted printing, multi-dimensional arrays, AUTO Line numbering, Program tracing
A huge range of software, on cassette is already available.

Peripherals
Full ASCII keyboard with 10 key rollover eliminates keyboard bounce. Expansion connector provides a parallel I/O Port for printer

	Nett	V.A.T.	Total
Video Genie	369.57	55.43	425.00

Sharp

SHARP MZ-80K
· Z-80 based CPU.
· 4K Byte monitor in ROM.
· Internal memory capacity from 4 to 48K RAM.
· 14K Extended BASIC.
· 10 in video display, 40 chars. of 24 lines.
· 80 x 50 bit mapped graphics.
· Extensive character set with upper, lower case, graphics etc.
· Full 79 Key Keyboard.
· Built in music synthesizer with 3 octaves.
· Fast reliable cassette unit with tape counter 1200 b.p.s.
· Wide variety of system software on cassette.
· 50 pin bus connector for system expansion.



A complete personal computer system for the microcomputer user, at an economic price. The Sharp comes complete with all necessary peripherals, sample software and excellent documentation — giving the user a personal system of unmatched flexibility and ease of use. At the heart of the machine is the Z-80 CPU — widely accepted as the most powerful 8-bit CPU on the market. A 4K byte system monitor controls system operation. From 4 to 48K of RAM can be resident on board; enough room for the most demanding applications.

An extensive graphics character set, plus 3 octave sound generator and fast cassette unit hi-resolution video monitor complement these basic facilities. It has the ease of use and compactness of "black box" computer combined with extensive peripherals and facilities for expansion.

Sharp Basic occupies 14K of RAM: and offers extended features above those of normal microcomputer implementations;

Model	Nett	V.A.T.	Total
6K	520.00	78.00	598.00
10K	540.00	81.00	621.00
18K	620.00	93.00	713.00
22K	640.00	96.00	736.00
34K	740.00	111.00	851.00

Acorn

This compact stand-alone micro-computer is based on Eurocard modules, and employs the highly popular 6502 MPU. Take a look at the full specifications, and see how Acorn meets your requirements.

The Acorn consists of two single Eurocards:
1. MPU card; 6502 microprocessor, 512 x 8 ACORN Monitor; 1K x 8 RAM; 15-way I/O with 128 bytes of RAM; 1 MHz crystal; 5V reg; sockets for 2K EPROM and second RAM I/O chip.
2. Keyboard card; 25 click-keys (16 hex, 9 control); 8 digit, 7 segment display. CUTS standard crystal controlled tape interface circuitry.

Acorn Operating Manual
With Acorn, you'll receive an operating manual that covers computing in full, from first principles of binary arithmetic, to efficient hex programming with the 6502 Instruction set. The manual also includes a listing of the monitor programs and the instruction set, and other useful tabulations; plus sample programs.

	Nett	V.A.T.	Total
Kit	65.00	9.75	74.75
Ready Built	75.00	11.25	86.25

Acorn Memory
A high quality fibre glass, through hole plated, PCB with solder resist and component identification, this eurocard has provision for 8K of RAM (2114) and 8K of EPROM (2732).

	Nett	V.A.T.	Total
8K RAM (Kit)	95.00	14.25	109.25

ACORN V.D.U.
The Acorn V.D.U. Board connects to the Acorn Computer Bus and contains memory mapped character storage RAM which is transparently written to or read from, by the C.P.U.

An MC 6845 programmable controller I.C. Provides all the synchronisation signals to drive a 625 line 50 fields per second V.D.U. together with read addresses for the character R.A.M. Characters are then fed to an SAA 5050 character generator IC which produces the necessary dot patterns to create the characters to refresh the V.D.U.

The SAA 5050 produces Teletext standard characters and has Red, Green and Blue drive outputs giving coloured characters or graphics.

	Nett	V.A.T.	Total
V D U Card (Kit)	88.00	13.20	101.20

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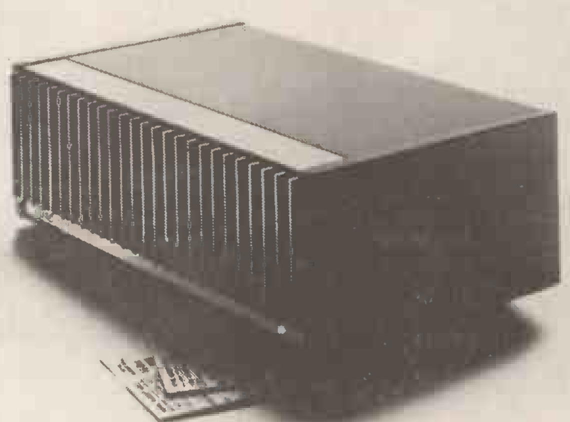

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SOLARTRON
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PHILIPS
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1461. CV(M) Portable Vibration Analyser Kit — 350

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3406A. 10 kHz-1.2 GHz — 345

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PHILIPS
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8000A 1999 FSD. AC/DC/OHMS/Current — 115

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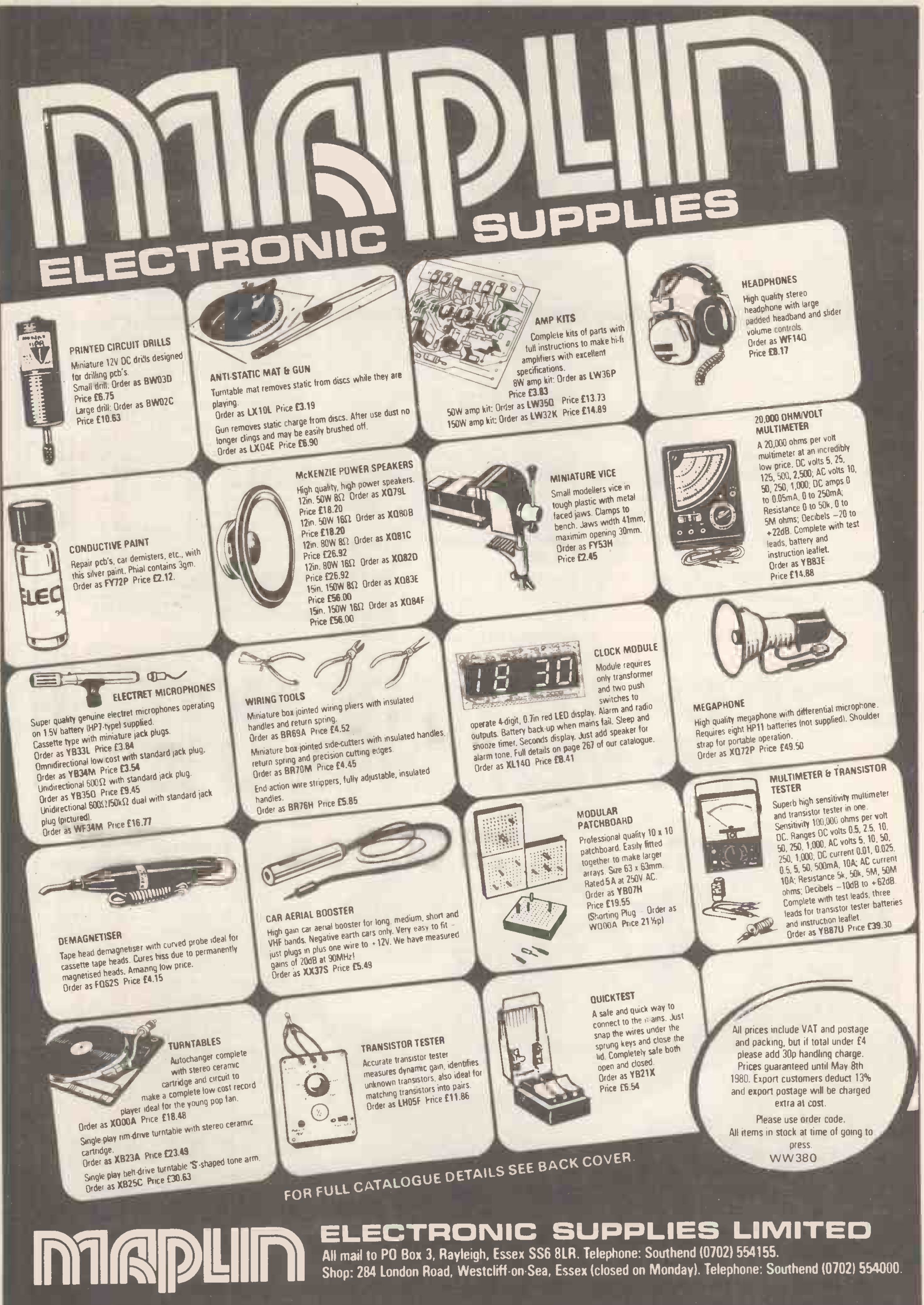
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High quality megaphone with differential microphone. Requires eight HP11 batteries (not supplied). Shoulder strap for portable operation. Order as XQ72P Price £49.50
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Accurate transistor tester measures dynamic gain, identifies unknown transistors, also ideal for matching transistors into pairs. Order as LH05F Price £11.86
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INPUT

FROM PHILIPS TEST & MEASURING INSTRUMENTS

Input advertisements are designed to meet the needs of our professional customers. They are a shop window for Philips Test and Measuring Instruments - and we will be changing the display frequently because we have a lot of products to show you.

Where you require full information about a product, tick the coupon and attach it to your name and address, or letterhead - or, of course, use the journal's reader inquiry service. You will receive in return a detailed information pack reflecting your specific requirements.

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.

Remember, its many important features include full four digits, so on mains voltage readings, for example, you might get *240.3* instead of the *240*, which a 3½ digit meter would read.

Some other **PM 2517** plus points:

- LED or LCD display
- True RMS readings of AC voltage and current
- Autoranging with manual override
- Optional accessories include temperature and data hold probes

Reader inquiry number 220

NO WAITING FOR THESE TOP PRODUCTS

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.

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- B invert facility

Reader inquiry number 221

GREAT COUNTERS MYSTERY

Philips engineers have encountered the same reaction from customers and competitors alike when showing off the new microcomputer controlled **PM 6667** (120 MHz) and **PM 6668** (1GHz) frequency counters: "How do they do it for the price?". Here's a brief summary of what the counters offer.

- Reciprocal frequency counting (for higher resolution without ± 1 cycle error)
- Auto-triggering on all waveforms
- High contrast liquid crystal display
- Self diagnostic routine
- High stability TCXD: 10^{-7}/month
- Battery option

Reader inquiry number 222

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.

	inquiry no	
PM 2517 multimeter	220	☐
PM 3207 oscilloscope	221	☐
PM 6667/8 counter	222	☐

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PHILIPS **Test & Measuring Instruments**

PHILIPS

In future, recording the present will be a thing of the past.

What's past is past. And said to be best forgotten.

But it's fundamental to the very existence of communications recording to be able to replay a selected portion of tape to find out what was said by who, to whom ... and when. And 'when' can be vital.

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TIMESEARCH can generate a coded time reference signal of crystal accuracy and index it onto the tape. It can read and display that signal. It can search a tape at high speed for a pre-selected time signal and automatically initiate replay at that time.

In communications recording, the future becomes the present; the present becomes the past. And when you need to recall the past with precision, you need TIMESEARCH.

And for providing precise time signals every 10 seconds for recording onto magnetic tape: the International Timing Unit.

Racal Recorders always on the right track

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RACAL

The New MSI SYSTEM 12

The MSI System 12 computer system combines the popular MSI 6800 processor ... complete with 56K of memory ... the MSI FD-8 QUAD floppy disk system, and the new MSI HD-8/R 10 megabyte fixed/removable hard disk system in one compact desk unit.

Ideal for business applications, the MSI System 12 gives you a large capacity hard disk for mass storage, and a floppy disk system for program loading, back-up, software updates and exchanges. System 12 will use MSIDOS, SDOS or FLEX operating systems. A variety of programs is available including Multi-User BASIC and a complete Management/Accounting package.

Complete with industry standard CRT and high speed printer, the MSI System 12 is one of the most powerful micro-computer systems available.

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STRUMECH

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Quantum Electronics

NEW PRODUCTS — NEW PRODUCTS

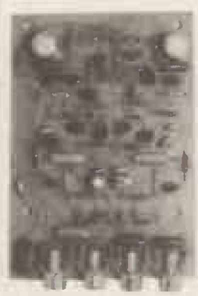
Our product range for the 80s is outlined but it is impossible to cover everything in such a small space. For detailed information and a price list send a large SAE or a dollar bill.

PRE-AMP & POWER AMP KITS

The pre-amp is now available in kit form in versions to suit any cartridge and consists of the module **C1** (below) and the hardware kit HK1. No soldering is involved and assembly takes about 20 mins. There are six power amp kits, four mono and two stereo, from 45 to 260W to satisfy virtually every requirement. They use ready-built and tested p.c. boards to achieve an ease of construction similar to module based kits at lower cost. There are also mains supply kits to enable independent use of the pre-amp, which is normally powered via our power amp. Similar equipment is also available ready-built from us or via our dealers.

C1 + HK1	**£68.70**	P2 (stereo 45W per channel) kit	**£87.28**
C1mc + HK1	**£70.95**	P4 (stereo 110W per channel) kit	**£109.42**

MOVING-COIL & PRE-AMP MODULES

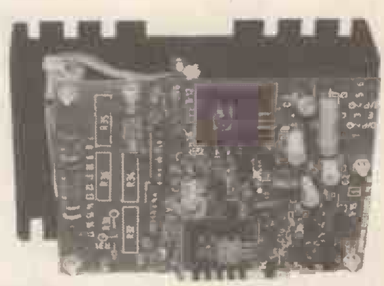


MC1

C1 (C1mc)

Previously restricted to trade and export, the C1 pre-amp module is now available separately in 3 versions to match any cartridge. It has unbeatable specifications, caters for disc, auxiliary and 2 or 3 head tape machines and requires only a rough supply of ± 18 to 35V d.c. The new moving coil pre-pre-amp achieves low thd, high overload, good r.f., rejection and good noise performance without resorting to the expensive multiple transistor design. Only tantalum capacitors and metal oxide resistors are used in the signal path and it can be powered either via the Cl or by a battery. Hardware kits are available to build both types and they are also available ready-built.

MC1 Module: **£22.25** C1 Module: **£49.50** C1mc **£51.75**



POWER AMP MODULES AND SUPPLIES

The power amp modules are now also available to retail customers in a variety of powers and formats up to 260W r.m.s. They use the same high performance circuitry as the kits above, giving t.h.d. below .01% at 1kHz, but are capable of sustained high level use with excellent reliability. There are power supplies for use with any one or two of these modules, all of which use toroidal transformers, also available separately. The module illustrated is a medium duty 150W r.m.s. type, the M1508, which requires the MS3 supply.

M1508: **£35.79** MS3: **£26.28**

Exports: We can deal efficiently with orders to any country. Please write with your specific requirements for a quote by return. All equipment can be wired for 110V mains.

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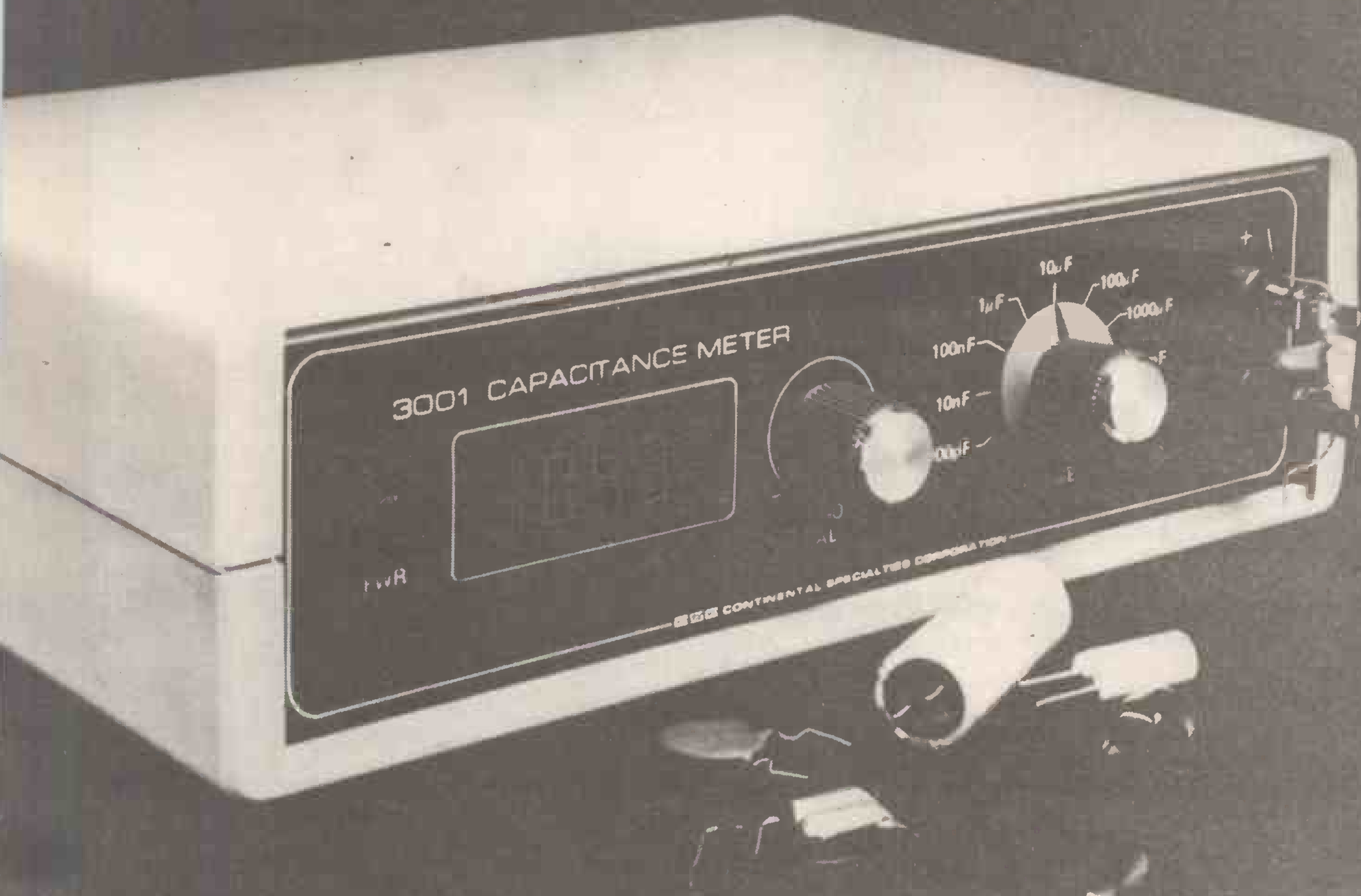
The Thinking Cap



Now you can measure, sort and check capacitance in less time, with more accuracy.

The new 3001 Digital Capacitance Meter is yet another superb instrument from C.S.C. Designed specifically for professional laboratories, test and production benches, it offers outstanding accuracy with features and accessories to match. All in a well designed, rugged unit for only £155*

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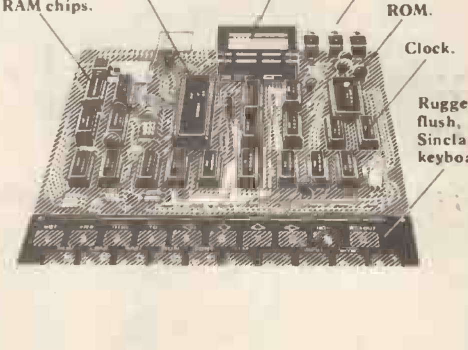

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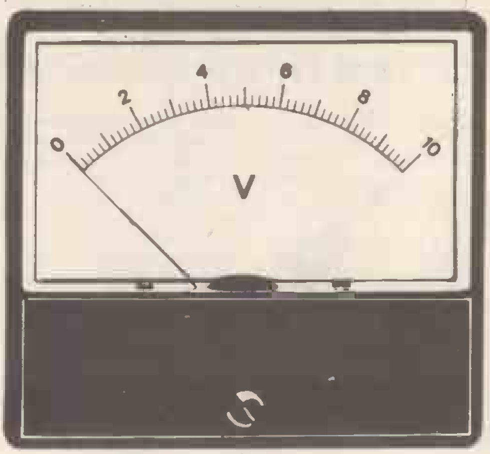

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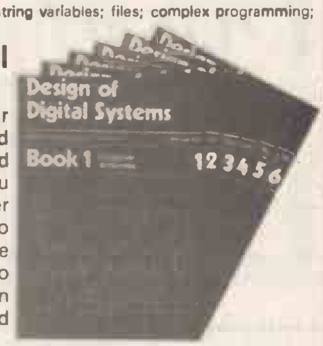

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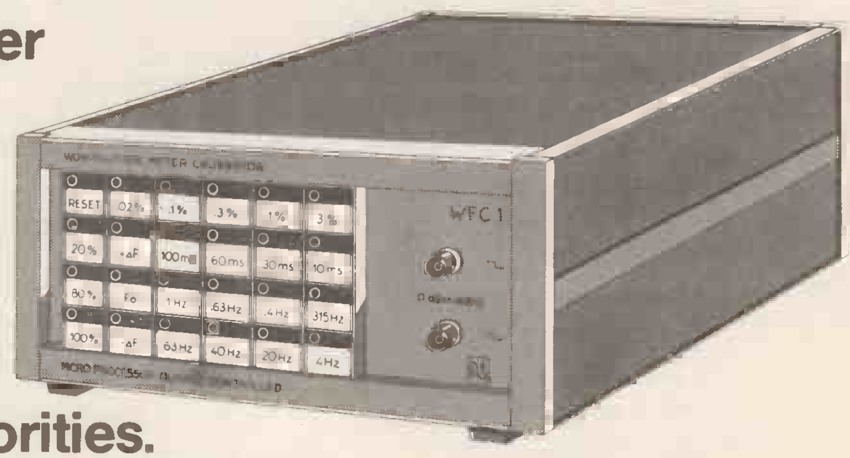

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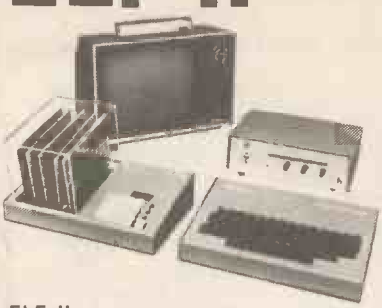

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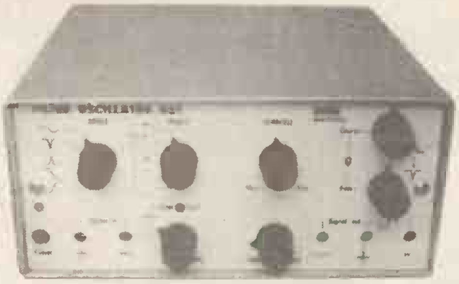

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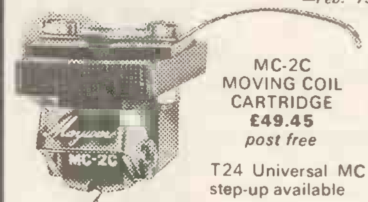

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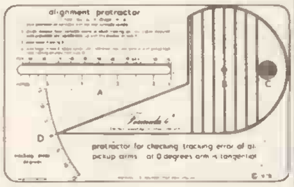

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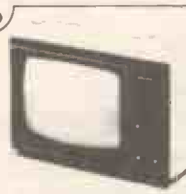

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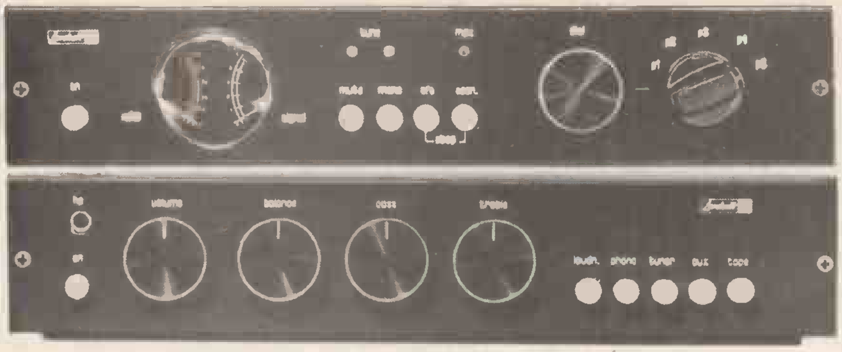

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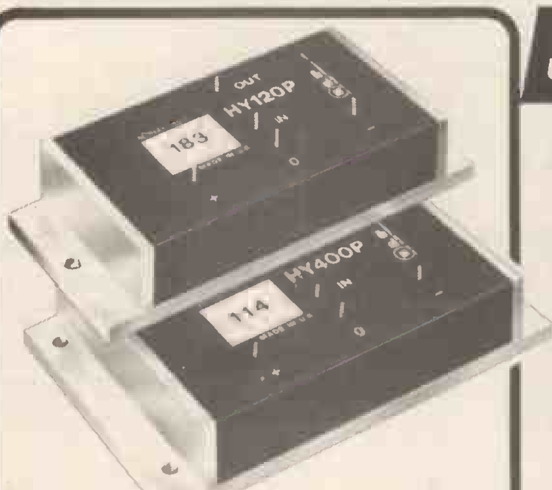

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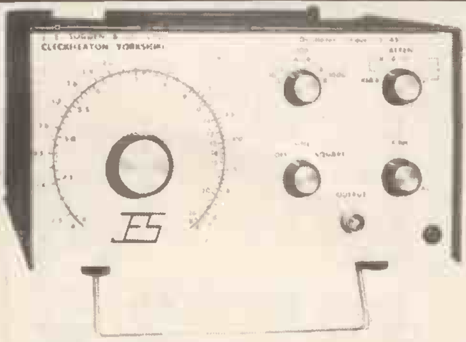

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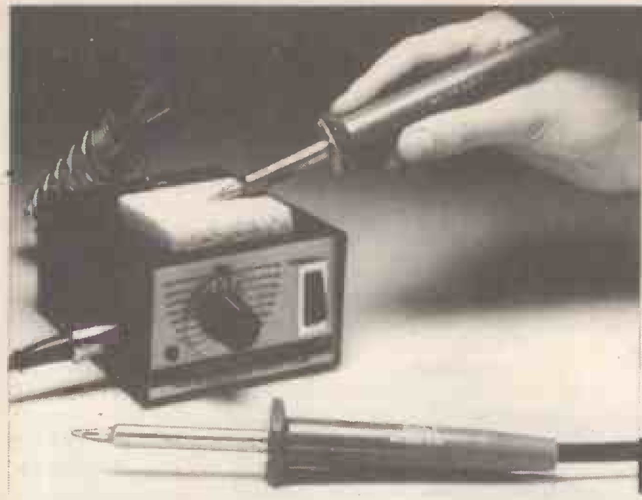

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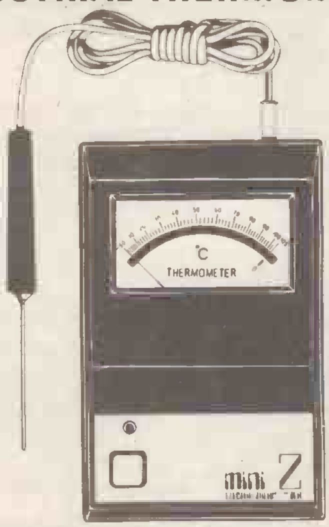

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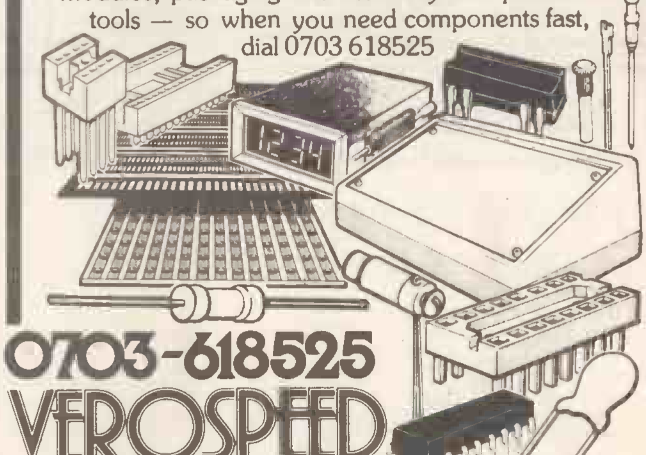

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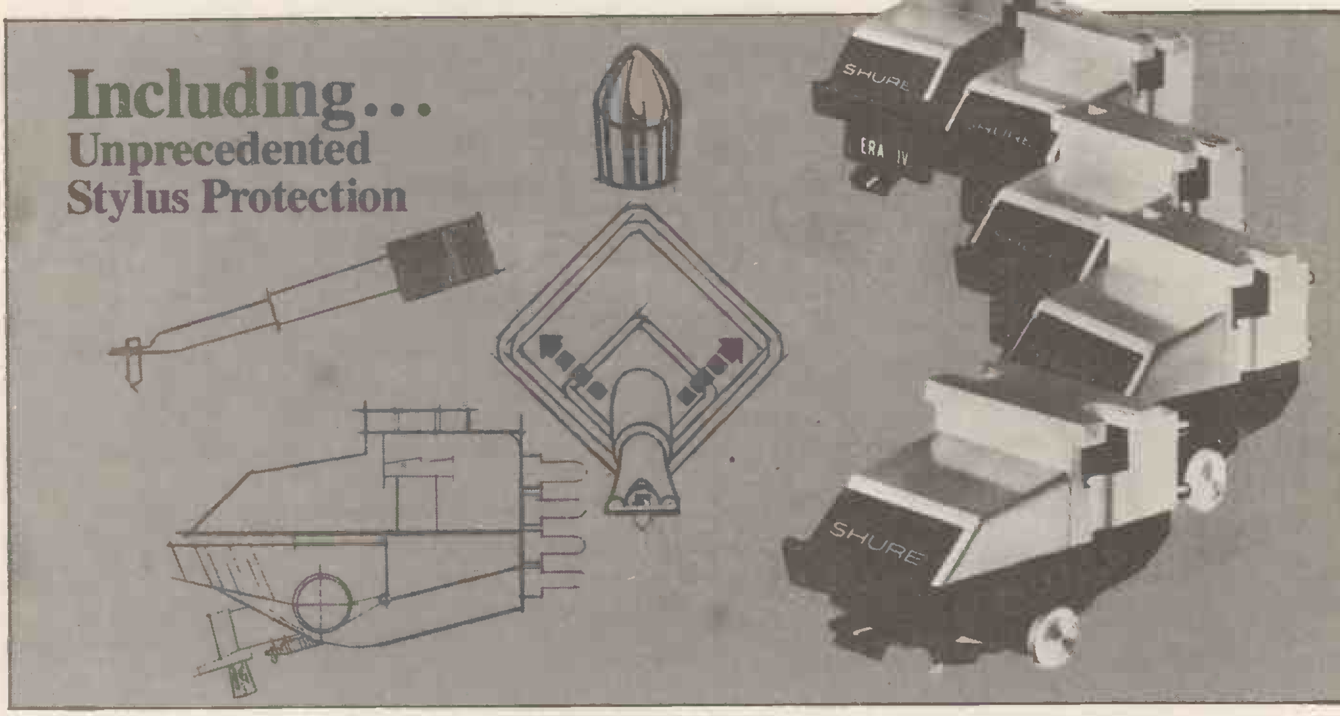

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M97HE	Nude Hyperelliptical	¾ to 1½ grams	Highest fidelity where light tracking forces are essential.
M97ED	Nude Biradial (Elliptical)	¾ to 1½ grams	
M97GD	Nude Spherical	¾ to 1½ grams	
M97EJ	Biradial (Elliptical)	1½ to 3 grams	Where slightly heavier tracking forces are required.
M97B	Spherical	1½ to 3 grams	
78 rpm Stylus for all M97's	Biradial (Elliptical)	1½ to 3 grams	For 78 rpm records.

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Education for integration

Since a television programme put the cat among the pigeons and made the world at large believe that Karel Capek's view of the future was to materialise in about a fortnight at the very latest, engineering persons have become accustomed to hearing references to 'chips' from the unlikeliest of sources. Cabinet ministers, trade union leaders, industrial writers, popular magazine and newspaper columnists, television commentators — all kinds of non-engineering person never seem to tire of discussing integrated-circuit technology and its impact on society in terms that imply total familiarity with semiconductors in all their manifestations.

It is quite difficult to discover the received picture of modern electronics possessed by people whose interests do not include engineering. The crescendo of strident and frequently doom-laden prophecy, initiated by the adoption of 'the chip' as a sort of 1970s Spinning Jenny substitute, coupled with saner (because better informed) comment from engineers, must have generated considerable confusion among those whose only present involvement is the direct or indirect provision of finance.

The integrated circuit in question is, of course, the microprocessor. Most of the others have arrived at the stage where they are thought of as components, and are consequently not newsworthy: decade counters, operational amplifiers and phase-locked loops are used in a manner almost as abandoned as were discrete transistors ten years ago, But the microprocessor has an aura of sanctity about it which its lineage and capabilities do not warrant, and which may well be not only technically but politically perilous.

A Ludditic reaction to 'new technology', fuelled by badly disseminated information and mass news posing as information, is one possibility; the newspaper industry has already seen an illustration. The alternative is to demonstrate the respectability of the microprocessor as a down-to-earth, extremely useful, but entirely non-occult electronic component in a programme of education carried out by people who really do know what they are talking about. We have seen far too many newspaper and television pieces whose aim has been to describe the applications of integrated circuits in the 'wonder of modern science' manner, heightening in a most irresponsible way modern man's ingrained and well-founded suspicion of single-minded, but accident-prone technocrats.

The attitude of mind which impels otherwise reasonable people to walk out on strike when 'new technology' is discovered in the offing is unlikely to be of much assistance to anyone. If an organisation is compelled by a lack of understanding to stick to outmoded methods of working, its customers will simply go to another source of supply which has taken advantage of modern developments. Many people will no doubt need to change their skills, but there is no reason to think that a smaller total workforce will be needed in the society of the next decade.

The microprocessor is not an invention of the Devil, but in the face of sensational reporting it will tax the skill of educators to prove it.

Pulse induction metal detector

Experimental system for overcoming magnetic viscosity effects

by J. A. Corbyn

Because the author considers buried "treasures" to be the most lasting and potentially most informative repositories of human history, he feels that their detection and excavation should be restricted to approved organisations. This article describes an experimental metal detector, originally developed for detecting gold in Western Australia (so far unsuccessfully), that can be adapted for archaeological or military applications. Particular emphasis is placed on magnetic viscosity and how to eliminate this undesirable effect.

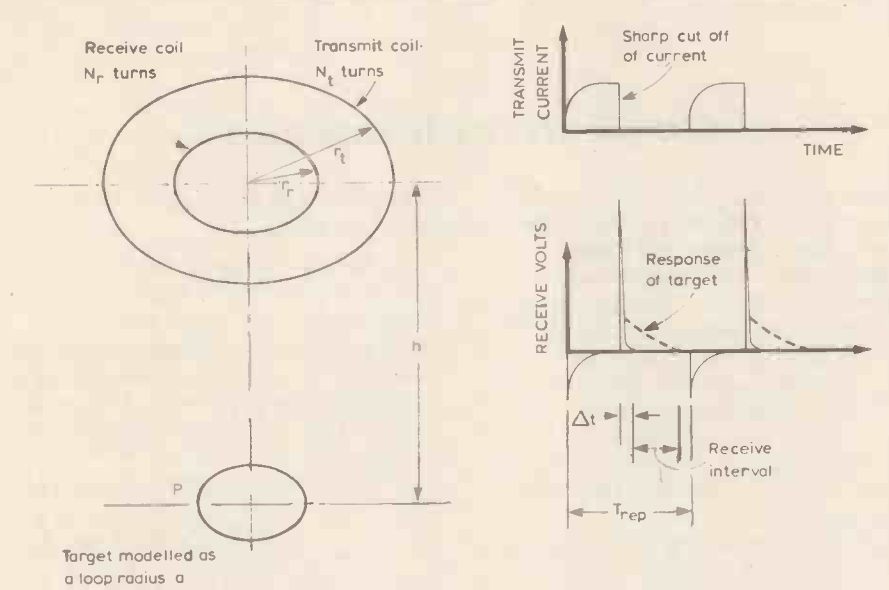


Fig. 1 Elements of a pulse induction system.

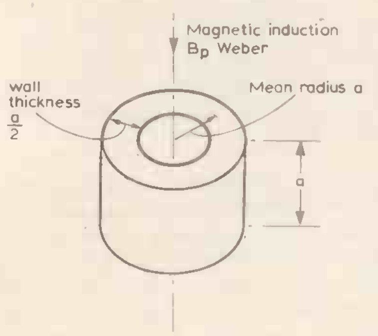


Fig. 2 Standard cylinder target.

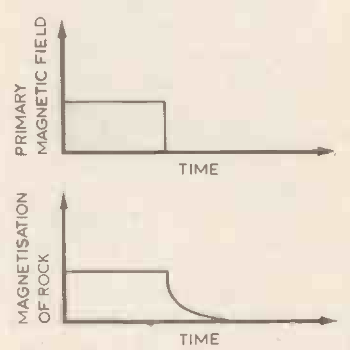


Fig. 3 Response of soil or rock when the primary magnetic field is switched off.

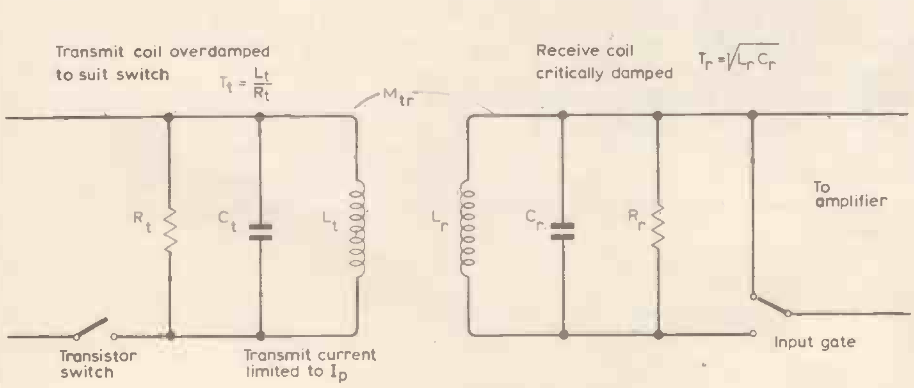


Fig. 4 Equivalent circuit of the transmit and receive coils.

Metal detectors used in searching for buried metallic objects are similar in concept to those used for geophysical exploration. All such instruments depend on the measurement of a magnetic field associated with eddy currents induced in the target by a primary magnetic field. The two main groups of metal detector are the continuous wave type where normally a sinusoidal primary magnetic field produces eddy currents in the target, and the pulse induction system where the primary field is a series of pulses. In a continuous wave detector, coupling between the transmitter and receiver is effected by the geometry of the system which must be rigid for detecting small metallic targets such as archaeological artifacts. Rigid geometry is not so important in a pulse induction system because there is no direct coupling between the transmitter and receiver.

Early metal detectors were mainly continuous wave types because simple circuits could be used. However, pulse induction systems have been described in the geophysical context by Grant and West[1], and in the archaeological context by Colani[2].

In a conventional pulse induction system a primary magnetic field is switched off and induces eddy currents in a conductive target. Voltages induced by the decay of these eddy currents are detected and then displayed. Fig. 1 shows a system comprising circular primary and receive coils which are coaxial with a target illustrated as a conducting loop. Fig. 2 shows the case where a magnetic flux of B_p Weber is normal to a loop of radius a and effectively falls to zero in time Δt. If L is the self inductance of the loop, R the resistance and i is the current then

$$iR = -\frac{d}{dt}[B_p \pi a^2 + Li] \qquad (1)$$

If $B_p = B_0$ at $t=0$, $B_p = 0$ at $t = \Delta t$ and $i_{\Delta t}$ is the current at $t = \Delta t$,

$$i_{\Delta t} = \frac{\pi a^2}{L} B_0 - \frac{R}{L}\int_0^{\Delta t} i\,dt \qquad (2)$$

If $\Delta t \ll L/R$, equation (2) can be approximated by

$$i_{\Delta t} \approx \frac{\pi a^2 B_0}{L} \qquad (3)$$

If the target is given a standard form of a cylinder with radius a, height a and wall thickness a/2, L can be calculated from an adaptation of Wheeler's formulae

$$L = a \times 2.07 \times 10^{-6}\text{H} \qquad (4)$$

Although equation (4) is an approximation it is sufficient for practical purposes because targets are rarely standard shapes. The resistance can be calculated from

$$R = \frac{0.289 \times 10^{-6} \times k}{a}\Omega \qquad (5)$$

where it is assumed that the specific resistance of the metal is for gold ($0.023 \times 10^{-6}\Omega$m) and k is the specific resistance in relation to gold. When the primary magnetic field is removed the current in the target decays exponentially with a time constant.

$$T = \frac{L}{R} = \frac{7.16a^2}{k}\text{s} \qquad (6)$$

The eddy current induced in the model target is then

$$i = \frac{\pi a^2 \mu_0 H_0}{a \times 2.07 \times 10^{-6}} e^{-\frac{t \times k}{7.16a^2}}\ \text{A}$$

and setting μ_0 at $4\pi \times 10^{-7}$ H/m

$$i = 1.907aH_0 e^{-\frac{t \times k}{7.16^2}} \qquad (7)$$

In the pulse induction system of Fig. 1 the primary magnetic field at P is approximately

$$H_0 = \frac{\pi r_t^2 N_t I_p 2}{4\pi h^3} = \frac{r_t^2 N_t I_p}{2h^3}\text{A/m} \qquad (8)$$

The voltage at the receiver coil is determined by the rate of change of flux linkage originating from the target and is given by

$$\frac{r_t^2 N_t I_p}{2h^3} 1.907a \left(\frac{-k}{7.16a^2}\right) e^{\frac{-tk}{7.16a^2}} \frac{\mu_0 a^2}{2h^3} \pi r_r^2 N_r$$

therefore,

$$V_r = 0.262 \times 10^{-6} r_t^2 r_r^2 N_r N_t I_p \frac{ak}{h^6} e^{\frac{-tk}{7.16a^2}} \qquad (9)$$

If the received signal is integrated the mean output signal level V_m will be

$$\frac{1}{T_{rep}}\int_0^\infty V_r dt =$$

$$1.875 \times 10^{-6}\ \frac{r_t^2 r_r^2 N_t N_r a^3 I_p}{T_{rep} h^6} \qquad (10)$$

where T_{rep} is the repetion interval defined in Fig. 1 and $T_{rep} \gg T$.
As an example, consider the case where T_t is 0.6m, T_r is 0.45m, N_t is 54 turns, N_r is 68 turns, a is 0.04m, h is 1m, I_p is 1A and T_{rep} is 0.016s. Equation (10) gives a V_m of 1.1μV and for $k=1$, $T=5.7$ms. This is very approximate because h is not much greater than r_t.

The time constant of a non metallic material in the vicinity of a metal detector can be calculated by appropriate modifications to equation (6) as

$$T = \frac{1.64 \times 10^{-6} a^2}{S}\text{s} \qquad (11)$$

where S, is the specific resistance of the material. Substituting $a = 1$m and $S = 0.2\Omega$m, the approximate specific resistance of sea water, the time constant is 0.8μs.

Most rocks and soils have a specific resistance much higher than this so an effective separation can be made between signals due to metallic targets and conductivity effects in the ground by

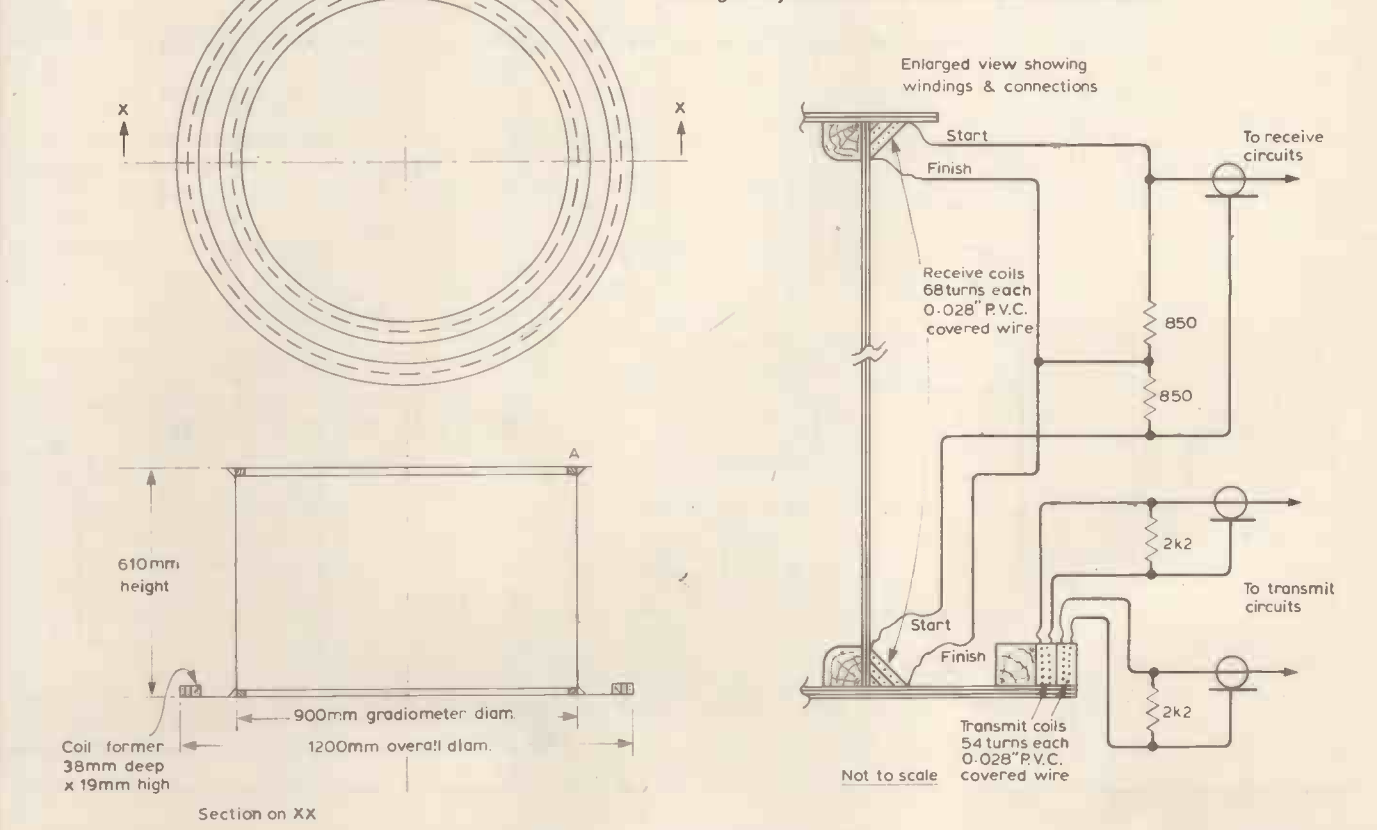


Fig. 5 Metal detector transmit and receive coil assembly. The coils are connected to the circuits by tv type coaxial cables which can be plaited. The cylinder is constructed from plywood and softwood with glued joints and no metal nails or brackets.

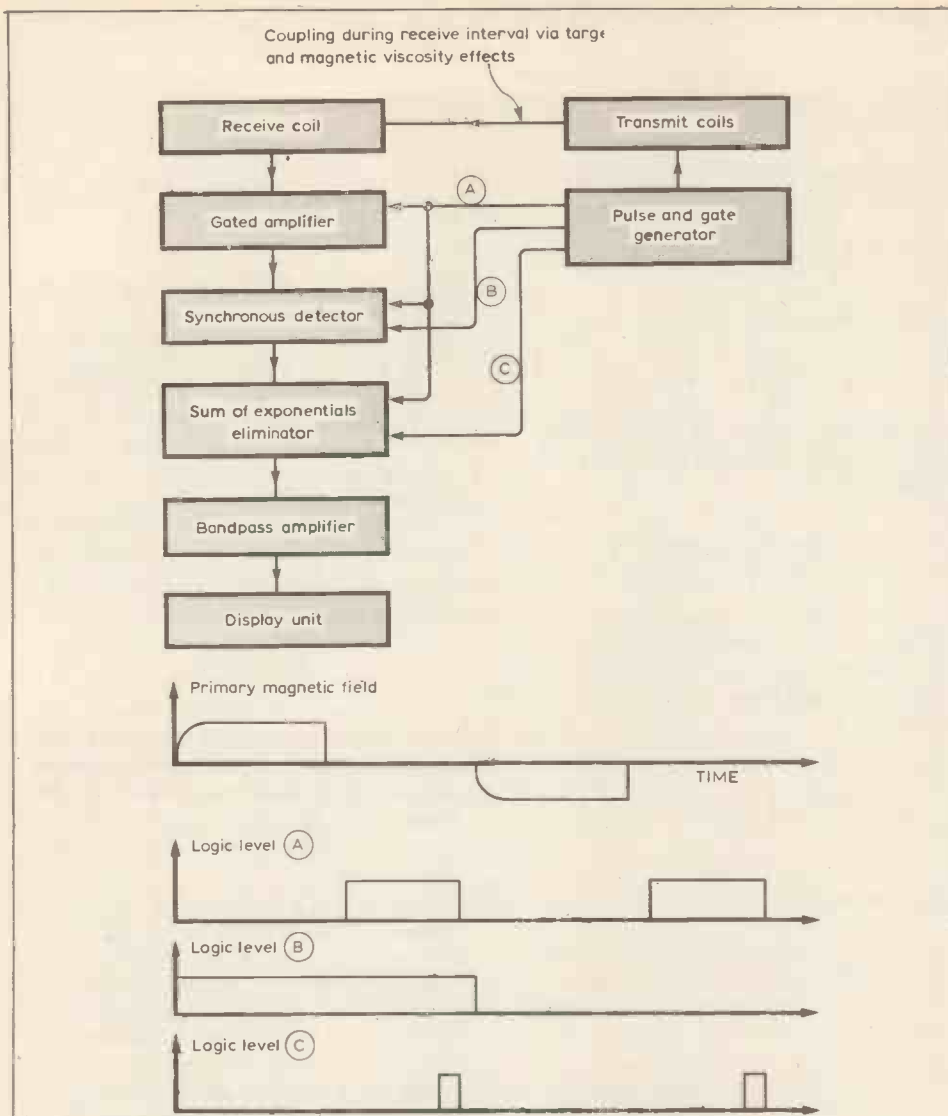


Fig. 6. Circuit block diagram. ▲

introducing a delay Δt between switch off of the transmitter current and observation of the returned signal. In practice delays from 40μs to 300μs are suitable.

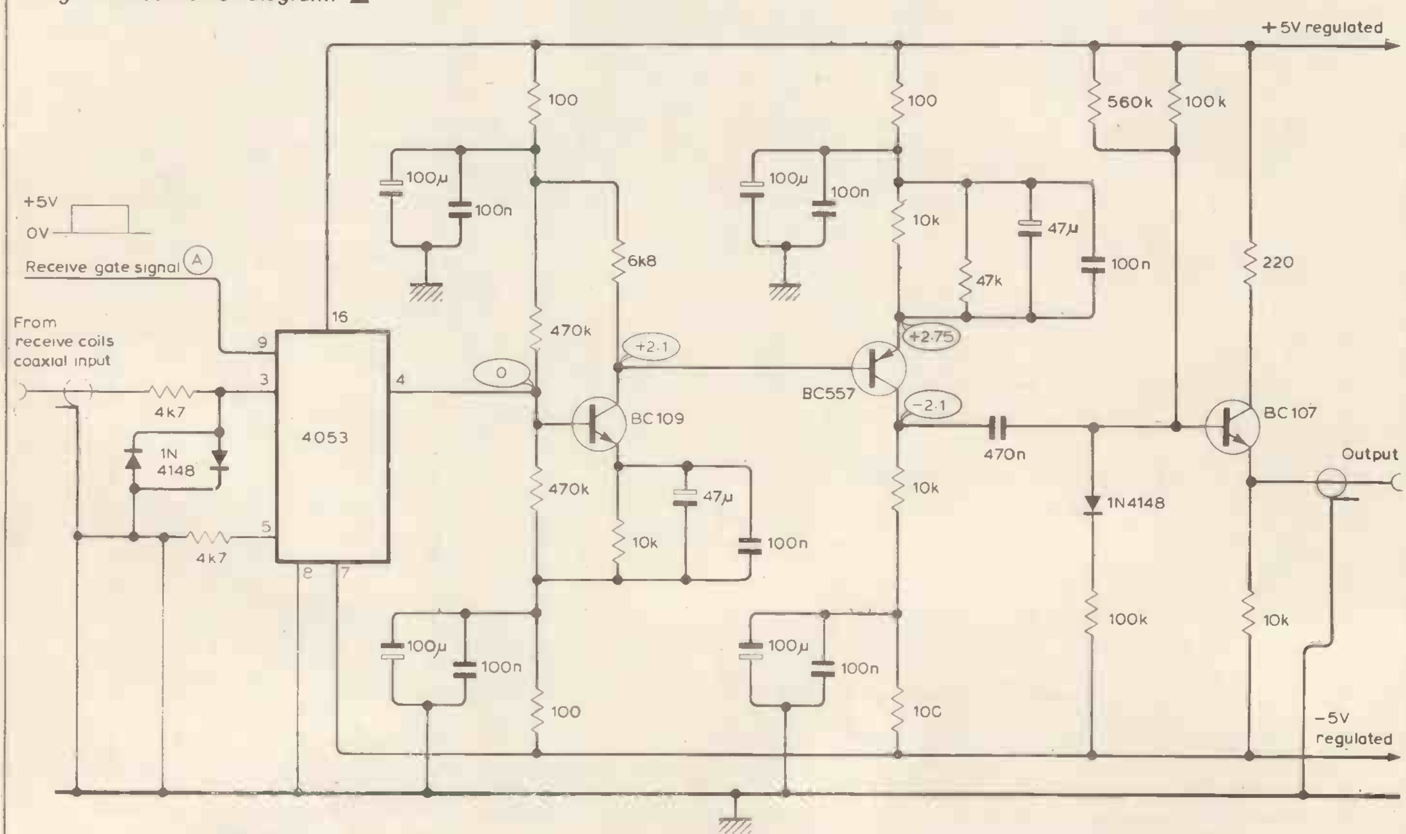
Magnetic viscosity effects

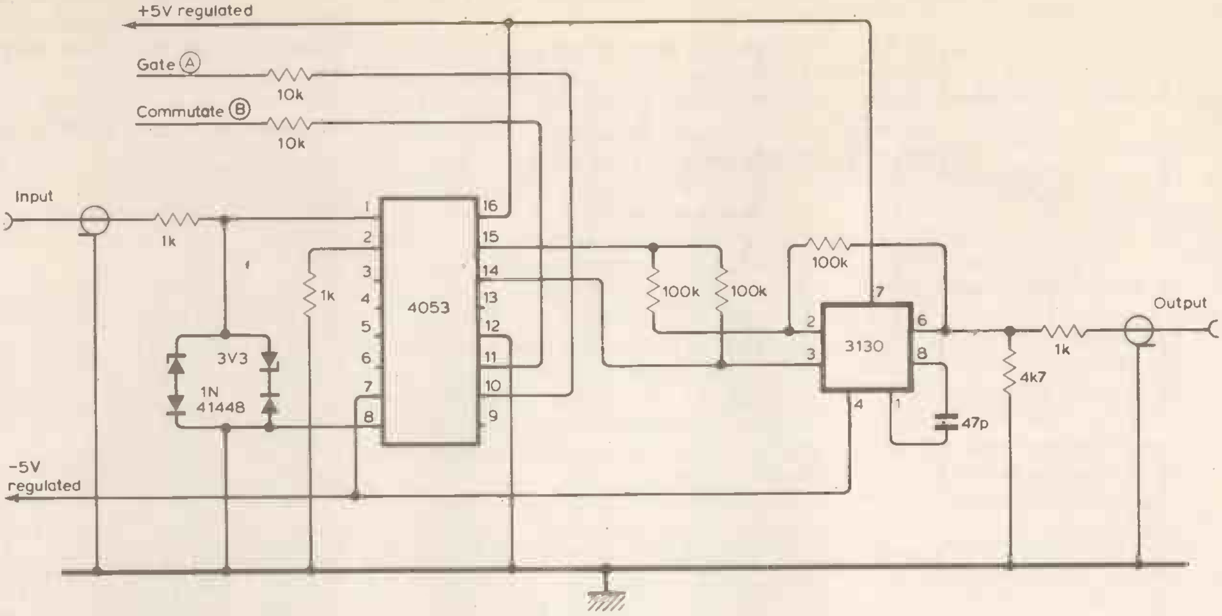
The magnetic properties of soils and rocks are mainly attributable to magnetite and maghaemite. These minerals exhibit a magnetic viscosity effect because their magnetization does not instantaneously follow an applied magnetic field. Magnetic viscosity is qualitatively similar to the effects of a conductor on a metal detector. The direction of temporary magnetization is the same as the primary magnetic field and the magnetic flux in the conductor being detected. Although there is no comprehensive theory of magnetic viscosity, Tropin[3] has critically reviewed Neel's theory which is described by Stacey and Banerjee[4]. Useful data for metal detector design has been provided by Colani and Aitken[5].

When designing a pulse induction metal detector it is necessary to know the response of soil or rock to a decreasing step in magnetic field. A general equation is

$$M \propto K \Delta H g(t) \qquad (12)$$

Fig. 7 Gated amplifier. Note that only one section of the 4053 is used, all unused inputs should be connected to ground. All voltages are d.c., measured with a high impedance meter. All capacitors are ceramic or aluminium electrolytic types.





where $\bar{K}$ is the magnetic susceptability and M is the magnetic moment per unit volume of material resulting from a change ΔH in the magnetic field at time t after this change. Equation (12) is linear in that g(t), which describes the decay of the magnetization, is independent of the primary magnetic field. At $t=0$, g(t) should be finite and as $t \rightarrow \infty$ g(t) should go to zero. Furthermore, g(t) from practical experiences should be a decreasing function of t. Fig. 3 shows the response of a soil or rock to a decreasing step in magnetic field. A review of available literature and some experimental work shows that g(t) can be expressed as a sum of two exponentials. An electronic system was constructed to simulate the sum of exponentials and compare the result with the response of soil or rock. A satisfactory model for the derivative of g(t) is

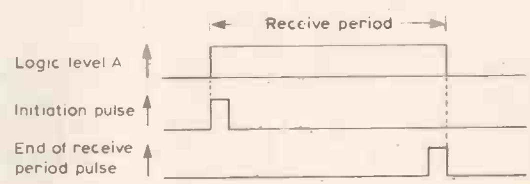
$$g^1(t) = (1-P)e^{-t/T_1} + Pe^{-t/T_2} \qquad (13)$$

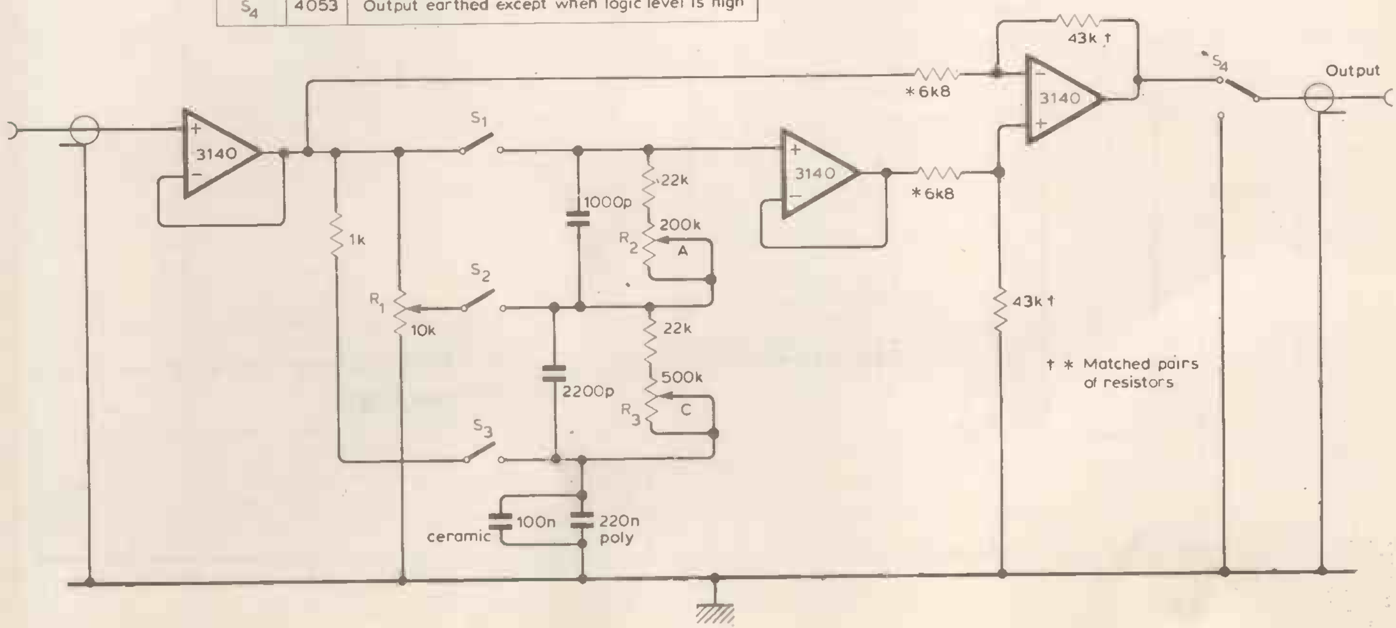
where T_1 is 75μs, T_2 is 550 to 800μs and P is in the range 0.08 to 0.30. These observations apply to lateritic soils in the goldfield region of Western Australia. The function $g^1(t)$ does not depend on the physical dimensions of the material being magnetized and the form of the decay due to a conductive target is generally a simple exponential decay as in equation (7). I therefore decided to construct a ground effect elimination system for a pulse induction metal detector by determining the difference

Fig. 8 Synchronous detector. The regulated power supply is shared with the gated amplifier. The 47pF compensation capacitor is soldered directly to the 3130 leads.

Fig. 9 Sum of exponentials eliminator. Resistor R_1 controls the mixture of exponentials, R_2 controls the decay constant T_1, and R_3 controls the decay constant T_2. Production of the initiation pulse from logic level A is shown in Fig. 10.

Switch	Type	Control
S_1	4016	Both closed only when initiation pulse is present
S_2	4016	
S_3	4016	Closed during end of receive period pulse
S_4	4053	Output earthed except when logic level is high





between the response of the ground and the observed response, assumed to be due to magnetic viscosity.

Coil design

Design objectives for the coil system are to maximise the primary magnetic field at the target and the voltage induced in the receiver coil by eddy currents in the target. The noise level due to variations in the earth's magnetic field and movement of the gradiometer over the ground is about 1μV with a coil of 25 turns, an area of 1 m^2 and with a similar coaxial coil 1 m away. This limitation was determined for a receive system with a centre frequency of 200 Hz and a bandwith of 10 Hz. The major noise contribution is from normal variations in the earth's magnetic field and does not account for man-made electrical interference.

The time constant of a critically damped gradiometer constructed with the above limitation is generally under 10μs for a coil diameter above 1 m.

Transmitter coil design is controlled by the decay resistance required to prevent an excessive voltage being applied to the transistor switch, see Fig. 4. Neglecting coil capacitance, the decay of current I through a coil of self inductance L_t and decay resistance R_t is

$$I = I_{to} e^{-t/T_t} \qquad (14)$$

where T_t is the decay constant R_t/L_t and I_{to} is the initial current through the transmit coil. If M_{tr} is the mutual inductance between transmit and receive coils and V_p is the peak voltage permitted at the switch, the voltage decay at the receive coil due to the current decay through the transmit coil is, for $I_r \ll I_t$,

$$V_r = V_p \frac{M_{tr}}{L_t} e^{-t/T_t} \qquad (15)$$

If V_e is the maximum permitted voltage at the receive coil at time Δt

$$\Delta t = T_t \log_e \left(\frac{V_p M_{tr}}{V_e L_t}\right) \qquad (16)$$

With V_p = 750V, V_r = 1μV and $M_{rt}/L_t = 0.1$, equation (16) gives $\Delta t/T_t = 18.1$.

Equation (16) shows that the minimum value of Δt is determined principally by T_t. In practice T_t cannot be much greater than 5% of Δt, depending on the ability of the circuit to reject a background decaying voltage during the receive period.

A circular metal detector array with coaxial receive and transmit coils is shown in Fig. 5. The receive coils are arranged in a gradiometer configuration and the bottom winding is coplanar with the larger transmit coils. Increasing the size of the transmit coils reduces the magnetic viscosity effects due to a relatively intense primary field close to them.

In addition to this array, various circular types have been constructed with diameters from 0.05 to 2 m, and rectangular versions up to 2 m long for searching large areas. For the larger arrays it is desirable to keep coil capacitance as low as possible by careful winding design. As previously noted, rigid system geometry is not essential for a pulse induction system and the simple wooden structure described is sufficient.

Circuit design

A block diagram of the metal detector circuit is shown in Fig. 6. An alternating primary magnetic field is used to avoid magnetic polarization of the ground and to improve the overall signal-to-noise ratio. The gated wideband amplifier in Fig. 7 consists of a high voltage protection network, a c.m.o.s. analogue switch and a transistor amplifier designed for fast recovery from saturation. The 4053 grounds the amplifier input except during the receive period when the receive coils are connected. The passband of the amplifier is 20 Hz to 100 kHz and the gain is approximately 4000. It is not practical to use a higher gain due to instability and amplifier saturation caused by the decay of current in the transmit coils.

The synchronous detector in Fig. 8 recognises a pulsed alternating signal with a unity-gain sign switched amplifier. The op-amp provides an output of +1 or −1 and the 4053 grounds the input when a useful signal cannot be received. The rise-time of the detector for a square wave is about 25 μs.

A sum of exponentials eliminator is shown in Fig. 9. This circuit takes samples of 60 μs duration at the beginning and end of the receive period and simulates the magnetic viscosity effect of the ground by inserting a function as shown in equation (13). The simulated ground effect is subtracted from the input signal to give an output when the response does not match that caused by the ground. The parameters T_1, T_2 and P can be changed to suit the ground conditions. RC combinations are used for the simulation and a 0.32 μF capacitor stores the background level to which the sum of exponentials decays. With the components shown the range for T_1 is 20 to 240 μs (typically 80 μs), for T_2 50 to 900 μs (typically 800 μs) and P is from 0 to 1.

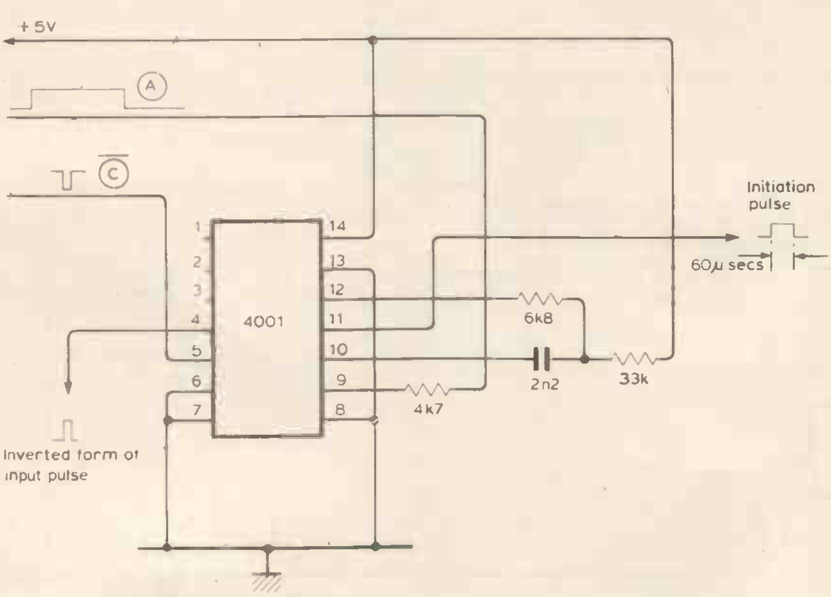


Fig. 10 Interface, buffer and initiation pulse generator. A 4001 inverts the end of the receive period pulse and derives a 60 μs initiation pulse from the receive period signal.

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To be continued

February cover — correction

The thyristor stack pictured on our February issue front cover was made by Powerstax Division of The House of Power, of Orpington, Kent, not by Pinnacle Electronics Ltd as stated in the caption. We apologise to both companies and to readers for any invonvenience that may have resulted from this error.

Non-echoic acoustic measurement with the H-P 3582A

New Hewlett-Packard spectrum analyser uses digital signal processing

by R. N. Grubb, Auris of Boulder, Colorado

The HP3582A is a recently announced audio spectrum analyser using fast Fourier transform analysis. A number of its features can be exploited in the measurement of loudspeakers and microphones in non-echoic conditions. These are described and some practical examples of its application given.

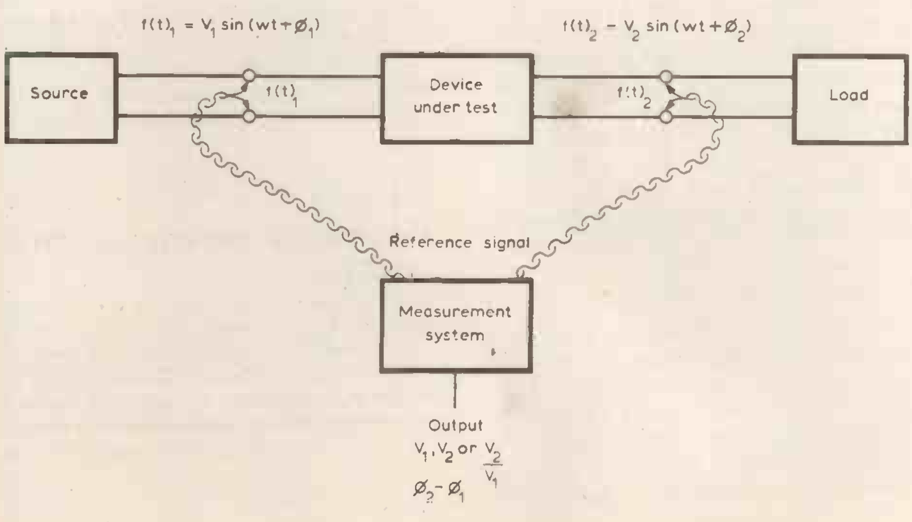
THE RECENTLY announced model 3582A spectrum analyser by Hewlett-Packard is an example of the new generation of instruments which depend on microprocessor technology to provide powerful capabilities at a lower price than has previously been possible. In this case, digital signal processing technology is used to implement a flexible 0.02 Hz-25.5kHz spectrum analyser, using the fast Fourier transform (FFT) of the digitized input signal to calculate the signal spectrum in the frequency domain from a sample of the input signal in the time domain. Although the instrument is a computer system, the mechanics usually associated with the use of a computer are completely transparent to the user, who is presented with a fairly conventional-looking front-panel control layout. The program is, of course, contained in read-only memory.

The 3582A is not a real time third octave analyser. In fact, one thing which may put off the average audio engineer is the lack of anything but linear frequency-scale presentations. However, it is inherent in the fast Fourier transform approach that a linear, equally-spaced set of spectral estimates is produced. The resolution and bandwidth of each estimate depends on the length and shape of the time window used to select the signal sample for analysis. Thus a logarithmic presentation of the data would necessarily be only cosmetic, information at the higher frequencies being lost, if a constant proportional resolution were displayed. As the available frequency ranges of the instrument are very extensive, all the information is available, although it is perhaps more time consuming to obtain.

By audio spectrum-analysis standards, the capabilities are unconventional, including measurement of phase, measurement of transfer functions and time-domain signal averaging before analysis.

Measurement of the phase response of audio systems, particularly of loudspeakers, has recently become of interest in the quest for the more realistic reproduction of transients. The 3582A provides in one box the means to make response measurements, including phase, on loudspeakers and other audio trandsucers, without requiring an anechoic chamber, or the roomful of minicomputer used by loudspeaker manufacturers to make such measurements.

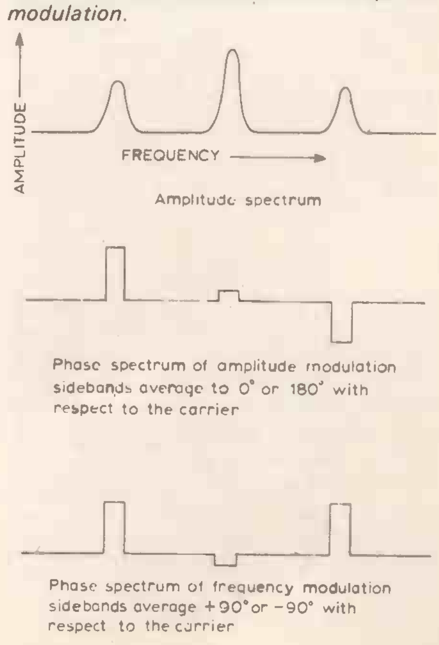
Fig. 1. Arrangement required for phase measurement.



Phase

Before proceeding to explain how to use the analyser for this hurpose, it may be useful to some readers to review what is meant by phase response and in particular how it can be measured by a spectrum analyser. The phase response of a device refers to a measurement of relative phase, usually the difference between the input and the output of the device. Unlike amplitude, or spectral amplitude, which is measured with a single connexion to the system under test, two separate connexions are needed to measure phase response as in Fig 1. Thus, although a spectrum analyser is normally a single-input device, with analysers like the 3582A, one must think in terms of two inputs to measure phase. Simply feeding in a composite signal to one channel of the instrument will give a perfectly good amplitude spectrum, but the phase answer computed will be different for each time sequence analysed because of the lack of a reference. This may not matter in some applications. For instance, if we want to know whether sidebands observed on a carrier are due to amplitude or phase modulation, their phase relationships to the carrier itself as seen in Fig 2 and a single sample

Fig. 2. Identifying amplitude or phase modulation.



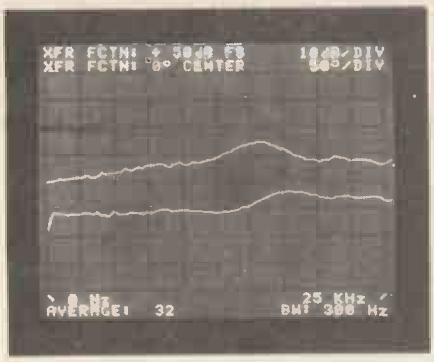


Fig. 3. Comparison of two AKG C451 microphones. Lower trace-amplitude. Upper trace-phase.

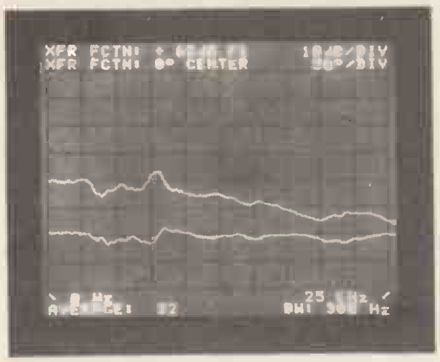


Fig. 4. Comparison of two 1in diameter capacitor microphone capsules in a stereo coincident pair configuration. Lower trace-amplitude. Upper trace-phase.

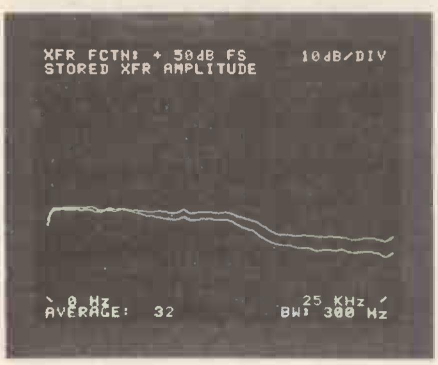


Fig. 5. The effect of a foam windshield on a C451. Upper trace — without windshield. Lower trace — with windshield. (Scales are the same as Figures 3 and 4).

analysis will give us the answer we want.

Transfer function

The most straightforward mode of operation to give repeatable phase measurements is that of the transfer function measurement. The two channels of the analyser are connected across the input and the output of the device to be tested and one of the two built-in noise sources connected to the input. The analyser now plots the ratio of the amplitudes and the difference in the phase of its two inputs versus frequency.

This transfer function measurement capability can be applied very neatly to the measurement of microphones. By connecting two microphones, one of which is to be regarded as the standard, to the two inputs of the analyser and placing them close together and in the sound field of a loudspeaker fed from the analyser noise source, their responses can be compared directly and very quickly. Figure 3 shows the result of comparing two nominally-identical C451 microphones with CK1 capsules. This disclosed the interesting information that although the microphones are well matched up to 15kHz, the two differed by nearly 6 dB at 17.5KHz. In this case, since neither microphone could be regarded as a standard, it was not possible to say which microphone or whether one or both was at fault. Exchanging the capsules on the microphone bodies showed the problem to be in the capsules and not in the microphone electronics or the amplifier chains.

The upper trace shows the phase difference. The constant phase slope at low frequencies shows that the "test" microphone was slightly in front of the reference microphone and it was possible by careful adjustment of the relative microphone position to make the phase slope zero. It is interesting that the difference between the capsules shows up in the phase at a lower frequency than in the amplitude. One thing to note in this and in most of the other examples shown is that the lowest-frequency point plotted by the analyser in the zero frequency start mode is in fact actually 0Hz, i.e., d.c. and the position of this point depends on the analyser amplifier d.c. offsets or externally applied d.c. In this case, of course, the microphone amplifiers are a.c.-coupled, so the zero frequency point is quite meaningless.

Figure 4 shows another comparison of two microphones, in this case two 1in capacitor capsules mounted one above the other in the same case and designed to be used as a coincident stereo pair. The lower trace is the magnitude again. This showed a good match at all frequencies, except in the region 3-9kHz, where there are 2-3dB differences. Some experiment and the use of another microphone as a comparison standard showed that the irregularities were only present in the lower of the two capsules and were very sensitive to the angle of the microphone in the vertical plane/to the direction of the incident sound field. This seemed to show that the problem was due to diffraction effects at the microphone case, the lower capsule being much closer to the case than the upper.

Yet another interesting comparison is shown in Fig. 5. This is the pair of C451s again, but this time the stored trace facility has been used to show the effect of the standard foam windshield on one of the microphones. The effect is easily measurable and amounts to nearly 3dB at 15kHz (unfortunately, I forgot to illuminate the graticule for this photograph!)

Impulse testing

All the preceding three examples were measured in a normal room with some acoustic treatment, but nevertheless far from anechoic. Thus, the sound field at the microphones being compared is composed of direct and reflected components. The comparison results have to be based on the assumption that the microphone polar responses are similar. It is only possible by this method to compare a cardioid microphone with another cardioid or an omnidirectional one with another omnidirectional microphone, etc. Providing the pair of microphones is not too far from the source compared with the dimensions of the room, and that the room is reasonably non reverberant, then small errors in polar response should have little effect on the comparison. However, we can do this kind of measurement in a non-anechoic room without these restrictions by using the capability of the instrument to analyse the impulse response of loudspeakers and microphones and present the results in the more familiar terms of amplitude and phase and it is to this, probably least familiar, mode that I now turn.

Fourier transform theory tells us that a zero width pulse contains equal energy per unit bandwidth (power spectral density — p.s.d.) at all frequencies, i.e., it possesses an infinite bandwith. Of course, this is a mathematical abstraction because, unless the impluse is infinitely large in amplitude its energy in any particular bandwidth will be infinitely small. Fortunately for any given audio bandwidth, it is easy to produce an impulse sufficiently narrow for the p.s.d. to be flat. The theory tells us that the power spectrum of a pulse of width t is

$$P(f) = \left(\frac{A \sin \pi f t}{\pi f t} \right)$$

This function, the familiar sin x/x, is plotted in Fig. 6. By choosing t to be small enough, we can make the p.s.d. as flat as we wish over the working bandwidth. For instance, it is easy to calculate that a 1µs wide pulse is only 0.01dB down at 25 kHz, the maximum band-

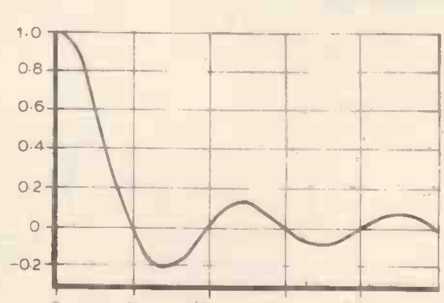


Fig. 6. The function sin x / x.

width of the analyser. A 10μs pulse is only ≈ 1dB down. At the rear of the 3582A is a t.t.l.-level impulse output. This gives a positive-going pulse which is ≈ 1μs long at the widest analysis bandwidth (25kHz) and which increases in width as the analysis bandwidth is reduced. If this output is connected to the input of the analyser, the displayed amplitude spectrum will show the first of the problems of impulse analysis which has to be carefully considered in order to obtain valid results. Indeed, the analyser shows a flat spectrum but, as the sensitivity is increased to bring the observed spectrum above the baseline the input channel overload light rapidly comes on. In fact, it is impossible to get more than a 20dB measurement range above the noise floor. This, of course, is because the test signal has a very high ratio of peak to mean value, and the analyser input dynamic range, which is set by its analogue to digital converter, only permits this limited range in the spectral domain. This situation can be improved considerably, however, if an external impulse source is used. As calculated above, a pulse of ten times the width (10μs) is about 1dB down at 25kHz. This gives another 20dB of analysis dynamic range, which is adequate for nearly all acoustic testing; it is easy to correct for the small loss at high frequencies of the test signal, if 1dB is important.

Phase

Having developed the test signal, the next question to consider is what is meant by the phase of the test signal and how the analyser measures it. The reference, in this case, is set in the time domain by the position of the time window, in which the analyser samples the input signal. At a time t_o one can think of all the reference frequencies starting simultaneously at zero phase (zero amplitude for a cosine wave). If the impulse is positioned at t_o, then its spectrum consists of all frequencies also starting at zero phase and the analyser will read 0° at all frequencies. If the impulse is displaced from t_o then there will be a progressive displacement, increasing with frequency, in the analysed phase expressed by the formula for the group delay introduced by the displacement

$$\frac{\Delta\phi}{\Delta f} = \Delta t \times 360°$$

(ϕ in degrees, f in Hz.)

where $\Delta\phi/\Delta f$ is the phase slope with frequency. For a positive delay (signal later than t_o) the phase of the higher frequencies lags the lower and vice versa. Note that a linear rate of change of phase implies only a delay and no waveform distortion.

In the 3582A, t_o is set at the middle of the time window when the 'flat top' or Hanning passband shape is selected, or at the start of the time window when the 'uniform' passband shape is selected. The latter is the passband intended for transient analysis. In the former cases, the passband shape is set by amplitude weighting in the time domain so that a transient at the beginning or end of the time window would not be analysed correctly. To be able to interpret the phase readout from the analyser, it is necessary to place the impulse close to t_o, because a large phase slope due to a time difference will obscure the properties of the system under test and, if too large, renders it discontinuous, because the discrete samples computed by the analyser are not close enough together to resolve the rapid phase change. To adjust the timing, the analyser can be operated in two ways and can be thought of more like an oscilloscope. In fact, the time-domain sampled waveform can be selected for display on the c.r.t.; this is an almost indispensable mode for setting up the analyser for transient analysis. In the free-run mode, the instrument repeatedly starts new time windows as soon as it is ready to analyse new data. The rear-panel impulse outout occurs at the start of each time window. Alternatively, the analyser can be triggered like an oscilloscope by an input signal on channel A or by a t.t.l. level pulse at a rear-panel input.

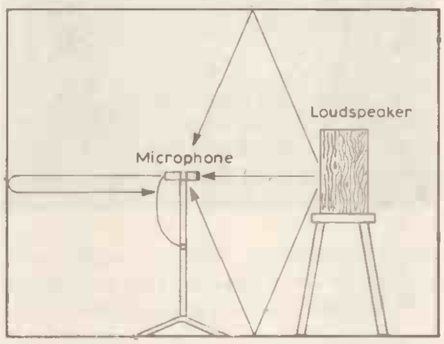


Fig. 7. Sound paths for direct and reflected sound in a small room.

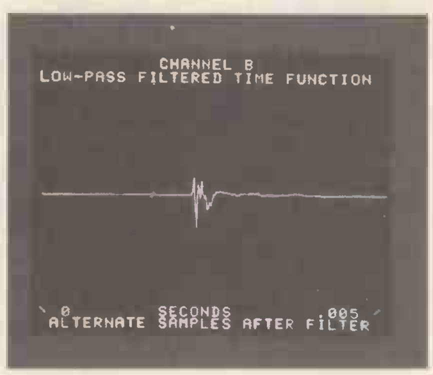
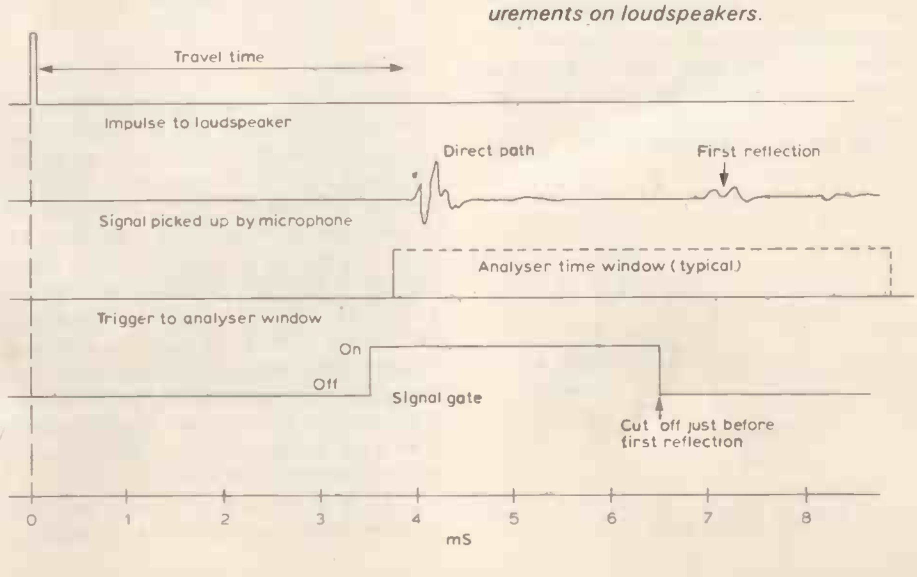


Fig. 8. Typical loudspeaker time domain response when driven by an impulse.

Echo gating

The advantage of using a transient signal to analyse the response of acoustic devices is that it is possible to suppress the effect of room reflections entirely without having to work in an anechoic room. To a close approximation, sound travels 1 foot per millisecond: the typical response of a loudspeaker to a 10μs wide impulse is over in 2-3ms, depending on the physical size of the cabinet. Even in a quite small room with a loudspeaker 3 to 4 feet from the floor and the measuring microphone 8 feet away, the first room reflection will arrive at the microphone 3-4ms later than the direct sound. Figure 7 shows the situation. A typical time domain response of a loudspeaker to a 10μs wide impulse is shown in Fig 8, which was taken from the analyser screen, with the instrument set on the 0-25kHz range. On this range the time window is ≈ 5ms long and, by controlling the trigger time, the transient picked up by the measuring microphone can be positioned near the centre of the time window with the first reflection just outside the window. This enables the amplitude response to be obtained, but as explained above, the transient should really be positioned near the start of the time window if the phase response is desired. Since the time window gets longer as the analysis bandwidth is reduced (necessary if the

Fig. 9. Timing diagram for impulse measurements on loudspeakers.



low frequency response is to be examined in detail), an electronic signal gate is needed so that the first direct-path signal can be isolated. To do this, and to be able to adjust all the delays correctly and generate the test impulse required some auxilliary equipment in addition to the analyser itself. This is unfortunate because it seems that it would have been quite simple to build all the required functions into the analyser in the first instance.*

Figure 9 shows the overall timing and gating required. Because the analyser time window must be started later than the impulse sent to the loudspeaker, it is best to generate the measurement repetition rate externally. This should be set to the highest rate which allows all room responses to die out before the next pulse.

Two delayed trigger pulses are then needed – one to start the analyser time gate at the correct time with respect to the transient picked up by the measurement microphone, and one to start the signal gate. A convenient way to get the first delay is to use a second microphone slightly closer to the loudspeaker under test and feed its amplified output to channel A of the analyser as the trigger signal. The measurement microphone output is fed to channel B. The delay is adjusted by setting the relative distances of the two microphones to bring the received transient just at the start of the time window on channel B. Channel A should also be examined to make sure that the trigger point on the transient is a stable one.

It is very important to make sure that all the significant energy from the transient radiated by the loudspeaker is included in the time gate. This can be checked both by inspection in the time domain and by changing the signal gate window over a small range and seeing if it affects the transformed frequency and phase response. With high quality loudspeakers of small dimensions, it seemed the response died essentially to zero after about 3ms, and it seemed to be possible to get a clean separation between the direct arrival and the first reflected arrival in a room with a smallest dimension of 8 feet. With larger loudspeakers or units with pronounced resonances, this may not be possible and it would be necessary to use a larger room.

The delay mechanism for the signal

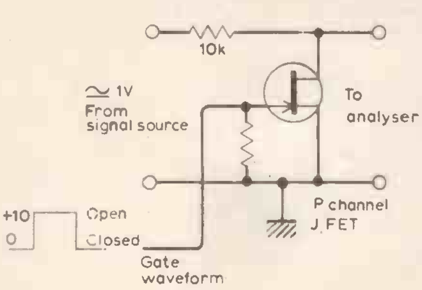


Fig. 10. F.e.t. signal gate.

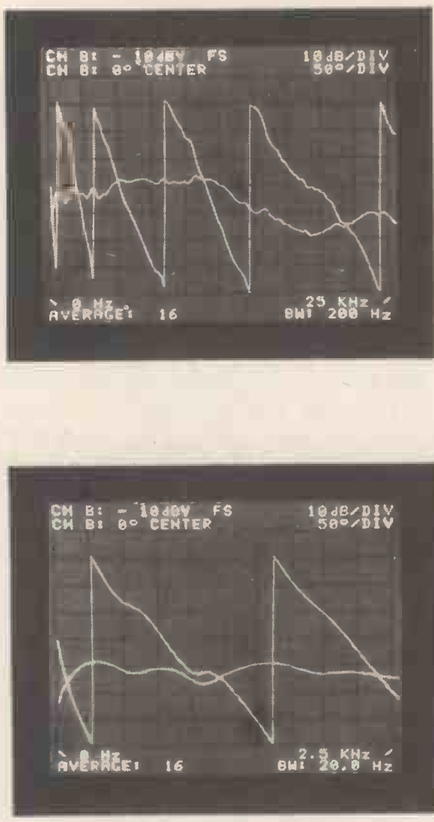


Fig. 11. Frequency and phase response of a Spendor BC1 loudspeaker measured with an impulse, a) 0-25kHz, b) 0-2.5kHz.

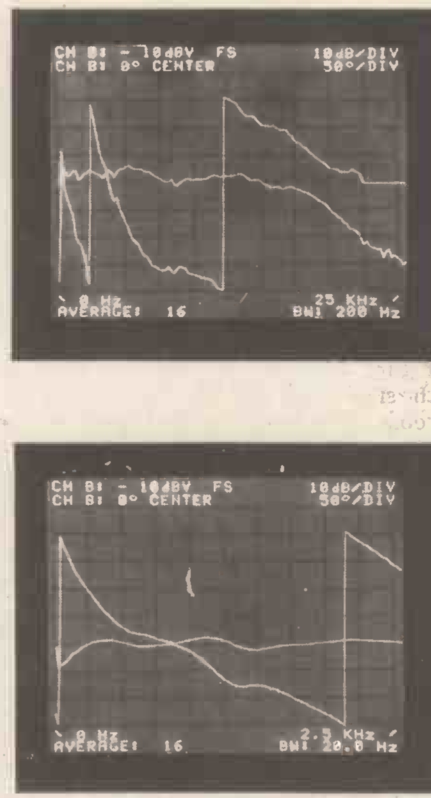


Fig. 12. Frequency and phase response of a Chartwell LS3/5A loudspeaker measured with an impulse. a) 0-25kHz, b) 0-2.5kHz.

gate and the signal gate itself need to be electronic. Commercial pulse generators can be used to generate these and the basic impulse and its repetition rate or, with the aid of a few digital i.cs, a special generator and controller could be assembled. Some commercial signal gating devices may be satisfactory in this application – a simple shunt f.e.t. switch such as is shown in Fig. 10 works well. It is most important that the switch does not introduce appreciable transients itself in the signal path. When the analyser bandwidth is reduced, the time window becomes longer and it may be necessary to readjust the system repetition rate. Also, as discussed previously, the impulse length must be increased proportionately to preserve approximately constant spectral power density.

Practice

Unfortunately, no measuring technique is completely free of disadvantages and the gating-out of room reflections is no exception. The problem is that of determining whether the initial response of the loudspeaker really has died away or not. It turns out that the use of a time sample of length t produces an uncertainty in the value of the spectral amplitude points for all frequencies roughly less than $1/t$ in frequency. Why the effect is an uncertainty and not just a calculable loss can be seen by considering a couple of simple examples. If the device being analysed is perfect (i.e. a piece of wire) then locating the time window would clearly have no effect, because the input impulse signal has a zero value at all times except for a small interval near zero time. However, if the device had a low-frequency cut off caused by the equivalent of a single pole RC network, then its response to the impulse would have an overshoot following the impulse which returns to the baseline exponentially with a time constant of RC seconds. In this case, a significant error will be made in the low-frequency response measurement unless the time window is maintained for 5 or 6 time constants, so that the response has reached zero for all practical purposes. Locating the impulse response at a point where the net remaining area under the response is negative will result in an apparent enhancement of low frequencies well below $1/t$ and vice versa. Thus the effect of the truncation depends entirely on the exact form of the impulse response.

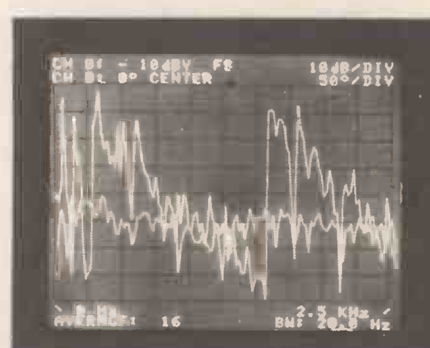


Fig. 13. Apparent response of a BC1 with the signal gating disabled and the first room reflection included.

Figures 11 and 12 show typical results obtained in the author's studio with a Spendor BC1 and a Chartwell LS3/5A. The phase responses clearly show the effects of the crossover in the case of the Chartwell as a change in time delay (phase slope) starting at ≈ 3kHz. With a little more flexible arrangement, the average phase slope could have been brought closer to zero with resultant ease in interpretation. In all cases, the measurement microphone was about on axis and 6 feet from the loudspeaker. Figure 13 shows the effect of disabling the signal gate and allowing some of the room reflection to be analysed! I found that these loudspeaker measurements were relatively unaffected by the microphone used, providing it was a capacitor type and of professional quality, since these microphones invariably have a much flatter response than monitor loudspeakers. If a standard measuring microphone is not available, then a ½in diameter, omnidirectional capacitor microphone such as the AKG C451 with a CK2 capsule would be the best second choice. The examples shown were made with this same microphone but with a CKI capsule, which probably does affect the results somewhat. In all cases the low frequency response below about 2-300 Hz appears to be attenuated compared with the published responses of these particular speakers, so it must be assumed that some truncation of the impulse response was taking place.

Care should be taken not to overdrive the loudspeaker with the impulse: A few watts peak power should be all that is required. The sound should be that of a quite quiet tick similar in volume to that of a typical alarm clock. If the measurement conditions are quiet, then the response can be obtained with only one impulse. However, if you don't live in the country or have a well isolated studio handy, there is no need to despair; use the last unique feature of the analyser, time domain averaging. This adds together, algebraically, each successive sample at the same time with respect to the trigger. The wanted signal is preserved but non coherent background noise cancels itself on the average. Thus, not only do you not need an anechoic room to make loudspeaker measurements, you do not even need a quiet one. The examples in Figs. 11 and 12 used a signal average of 16 impulses.

All the comparison tests of microphones described earlier can be better done using a loudspeaker excited by an impulse with the appropriate delays and gating. In this case, since both signal channels will be needed for the measurement, the rear-panel t.t.l.-level trigger input must be used. Absolute measurement of microphone response requires an acoustic impulse generator of known characteristics. It has been reported in the literature that a high-voltage spark discharge or an exploding wire forms a useful source for this purpose, providing the construction of the electrodes is such that the sound radiation is unimpeded. However, the author has not yet tried this.

* It is possible to do the signal gates within the instrument using the IEEE 488 bus programing input. However, this means significant additional complication and expense.

References

[1] Hewlett Packard Application Note, Understanding the HP3582A Spectrum Analyzer.

[2] J. M. Berman and L. R. Fincham. The Application of Digital Techniques to the Measurement of Loudspeakers. *Journal of the Audio Engineering Society*. June 1977, Vol 25, No. 6, pp. 370, 384.

Abridged specification

Input channels

2n 1MΩ + 60pF impedance, sensitivity +30dBV to −50dBV in 10dB steps. Overload indicator light.

Frequency spans

1 Hz to 25 KHz full scale in zero-start mode, 1-2.5-5-10 sequence. Bandpass mode 5Hz-25kHz span in 1-2.5-5-10 sequence.

Frequency resolution

256 spectral points are calculated in the single-channel mode, 128 in the dual-channel mode. The resolution depends on the passband selected. There are available, a "Flat top" optimised for harmonic analysis of tone signals, a "Hanning" passband optimised for general random noise measurement and a "Uniform" passband intended for transient analysis and use with the built-in periodic noise source.

Display

The digitally driven c.r.t. has infinite storage capability. It can display up to two traces of data from either the current measurement or from up to two traces stored from previous measurements. It provides an alphanumeric readout of trace calibration, a cursor readout of trace values in engineering units and error messages. Amplitude display 10dB or 2dB per division (8 divisions vertically) or linear. Phase ± 200° Frequency displayed linearly.

Measurement modes

1. Frequency spectrum, amplitude and phase
2. Transfer function, ratio of input channel amplitudes and difference in phase.
3. Coherence function, the degree of coherence (0-1) between the input channels.

Signal sources

1. Random noise. This is generated digitally and adjusts automatically with the frequency range selected to maintain a constant power output in the analysis band.

2. Periodic noise. This is also generated digitally and is arranged to have a "comb" spectrum which exactly matches the calculated spectral points. This gives the same effect as a tracking generator in a conventional swept analyser with the advantage over random noise that no frequency domain averaging is needed to get an accurate answer.

3. Impulse. This varies in width depending on the frequency range selectedm It is timed to occur at the start of each analysis time window.

Averaging modes

1. Frequency Domain

a) r.m.s. average of calculated spectral points with 4-256 points averaged or an exponential "running average" mode.

b) Peak, 4-256 points or peak hold in a continuous mode.

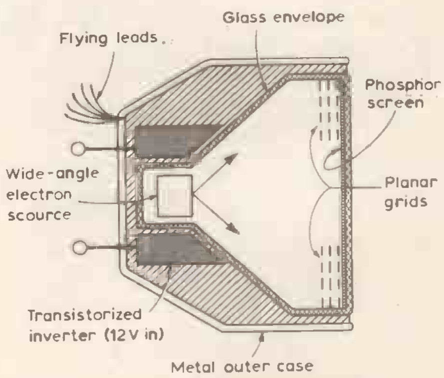
2. Time domain.

4-256 input signal time sequences averaged. The zero time is set by a trigger circuit on input channel A or by an external trigger input at t.t.l. level.

EEV provides bright lights for ATV games

A large scale, computer-controlled electronic display board supplied by English Electric Valve Co. can be seen by television viewers of the Bob Monkhouse "Family Fortunes" panel game on Sunday evenings.

The main body of the display consists of 300 "character display tubes" (a form of c.r.t. costing about £100 each), which EEV say offer very high variable brightness, low power consumption and electronic switching with low level logic. The control logic, including a keyboard and v.d.u. control console, includes an Intel single board computer and the complete installation is said to have cost ATV about £80,000.



Cross-sectional view of the EEV character display tube. The flying lead grid connections are for multiplexing; the "expected life" of the tube is 40,000 hours or about five years.

Clock timer — 2

Memory circuit, construction and testing

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

Numerical data from the keyboard is encoded to b.c.d. and fed to the memory data inputs. Four of the memory address pins are used to address an alarm time and are driven by a 4-bit binary counter. Two of the pins address the four digits of the alarm time and are connected directly to the A and B multiplex control lines from the clock. In the Set mode the alarm key clocks the counter and accesses the memory locations which store the next alarm time. In the Run mode, control line C clocks the counter so that the alarm times are scanned at one every 6ms. The read/write control circuit ensures that only the correct memory locations are used.

The memory input circuits are shown in Fig. 5 and Fig. 8. To set an alarm time, S_2 is switched to Set and S_3 to Alarm which takes Y low. This transition is differentiated by C_{10} and R_{25}, see Fig. 8, and takes pin 12 of IC_{17b} momentarily low. The output of IC_{17b} goes low which sets both Q outputs of IC_6 high and also resets IC_7 via IC_{19e}. In Fig. 5, if no key is pressed, the outputs of IC_1 are all high and data valid is low. If a numerical key is pressed, an inverted binary code of the number appears at IC_1 output, data valid goes high and the first monostable in IC_{23} is triggered which in turn triggers the second. This produces a 15ms write pulse at pin 5 of IC_{23} and, because the first monstable has a period of about 150ms, the second monostable cannot be retriggered by contact bounce, see Fig. 9. The write pulse clocks IC_{6a} in Fig. 8 and the $\bar{Q}$ output goes high which clocks IC_{6b} whose Q output goes low. The Q outputs of IC_6 are compared with the multiplex control lines A and B by exclusive NOR gates IC_{15a} and IC_{15b}, and the output is high only when the control lines are both low. The write pulse from IC_{23} is delayed by R_{27} and C_{11}, to allow IC_6 to be clocked, and is gated to the memory r/w pin if data valid is high and all three multiplex lines are low. Data present at the memory inputs is then written into the tens-of-hours locations for the first alarm time. Pressing a second key clocks IC_{6a} again so that its Q output goes high. Therefore, writing

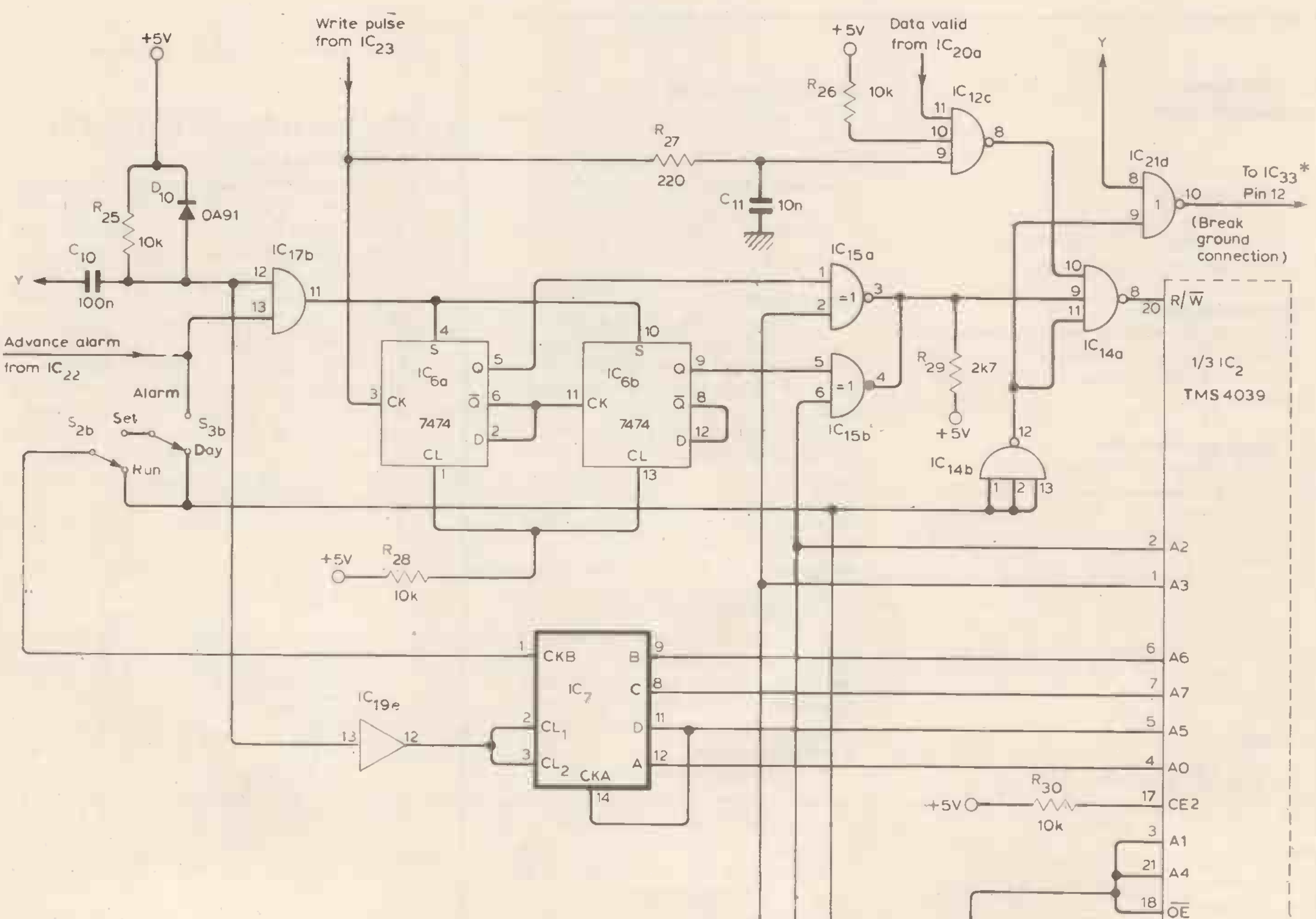


Fig. 8. Memory control circuit. Components marked with an asterisk refer to the Rugby clock designed by A. F. Cross.

can only occur when control line A is high and B, C are low which means that the data is written into the hours location of the memory. This procedure is repeated for the tens-of-minutes data. If a mistake is made, pressing four more keys overwrites the incorrect data. When the first alarm time has been set, the alarm key is pressed which triggers the second monostable in IC_{22} and produces a low advance-alarm pulse at the $\bar{Q}$ output. This pulse is gated through IC_{17b} to the set inputs of IC_6 so that the Q outputs are high. The advance-alarm pulse also clocks IC_7 via S_{2b} and S_{3b} so that the memory locations corresponding to the second alarm time are addressed, see Table 2. If a numerical key is released in less than 15ms the data-valid line goes low to force the memory r/w pin high and prevent the writing of false data.

Memory output circuit

A display selector switches the actual time or the alarm time and is controlled by the Run-Set and Alarm-Day switches. A comparator compares the actual time with the output from the memory and the comparison detector recognises an agreement if the alarm is enabled. The output circuit then drives a relay or other suitable device. Because the output drive capability of the memory is only one t.t.l. load, each output is buffered and inverted to produce non-inverted b.c.d. as shown in Fig. 10. Data is selected from the memory or the b.c.d. time output from the clock by IC_4. When Y is low in the Set-Alarm mode the alarm times are displayed as they are set. As only the hours and minutes are set, seconds are blanked by IC_{21d}. When Y is high in the Run mode the output of IC_{21d} is low and the time is displayed normally. The memory output data is compared with the multiplexed time from the clock by

Table 2 Memory truth table

Time (m.s.)			A2	A3	A5	A7	A6	A0	D	C	B	A	
0–1	Tens of hours	0	0	0	1	0	0	1	1	1	1	0	1 inverted
1–2	Hours	0	0	1	1	0	0	1	1	0	1	0	5 inverted
2–3	Tens of minutes	0	1	0	1	0	0	1	1	1	0	0	3 inverted
3–4	Minutes	0	1	1	1	0	0	1	1	0	0	0	7 inverted
4–5	Tens of seconds	1	0	0	1	0	0	1	X	X	X	X	Undefined
5–6	Seconds	1	0	1	1	0	0	1	X	X	X	X	Undefined

Adresses: A2–A0; Data: D–A. First three columns (C B A): Multiplex control lines. A5 A7 A6 A0: Alarm time No. 10 (9+1). Time is 15.37

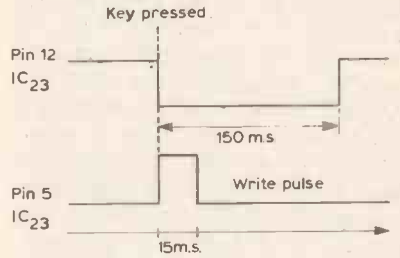
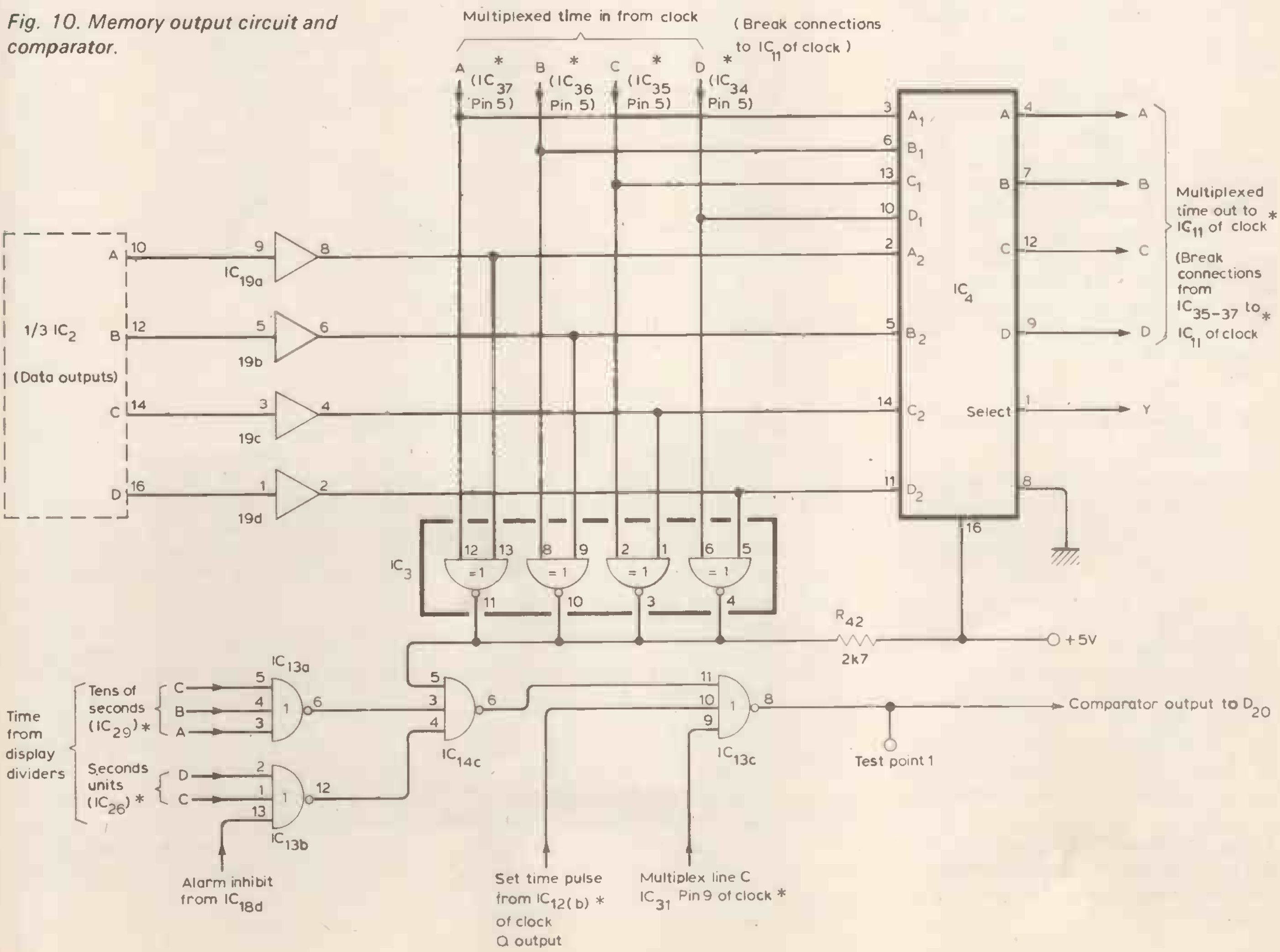


Fig. 9. Single write pulse.

Fig. 10. Memory output circuit and comparator.



IC_3. Normally, IC_7 is clocked by control line C via S_{2b} so that the alarm times are fed out from the memory in sequence at one every 6ms. This sequence repeats after 16 × 6 i.e. 96ms. The comparator output in Fig. 10 is high when all four bits of a digit in the time agree with the memory data. The two inputs to IC_{14c} are high only when the alarm is enabled by IC_{18d} output going low, and during the first four seconds of a minute, i.e. tens-of-seconds A, B and C, and seconds C and D are all low. The output of IC_{13c} is high only when the above conditions are met, control line C is low, i.e. tens-of-seconds or seconds data is not being processed, and the clock is not being updated at 100kHz i.e. the set-time-pulse line is low. Therefore, if a true comparison between the stored alarm time and the displayed time exists, a 4ms high pulse appears at the output of IC_{13c}. The 4ms pulse is repeated at 96ms intervals until four seconds past the start of the minute. However, during this time shorter pulses may appear at IC_{13c} output such as a 3ms pulse produced by agreement of three consecutive digits in one alarm time. Pulses which are not 4ms long are rejected by the comparison detector in Fig. 11. The comparator output goes low for 2ms every 6ms when control line C goes high. Capacitor C_{16} therefore discharges through D_{20} to around 0.7V in the 2ms period, and then charges via R_{43} when the comparator output goes high. Resistor R_{43} is adjusted so that C_{16} charges sufficiently to switch Tr_9 on if the comparator output remains high for 3.5ms. When the collector of Tr_9 goes low, the 555 monostable triggers and produces an output pulse adjustable from 4 to 15s by R_{46}. This method of detecting the 4ms pulse provides high noise immunity and is easy to adjust although an error of up to 96ms can be produced in any serial alarm-time output. A simple relay driver for the comparison detector output is shown in Fig. 12. Diode D_{22} protects Tr_{10} and R_{49} limits the voltage across the relay. Resistor R_{46} can be used to adjust the duration of the alarm.

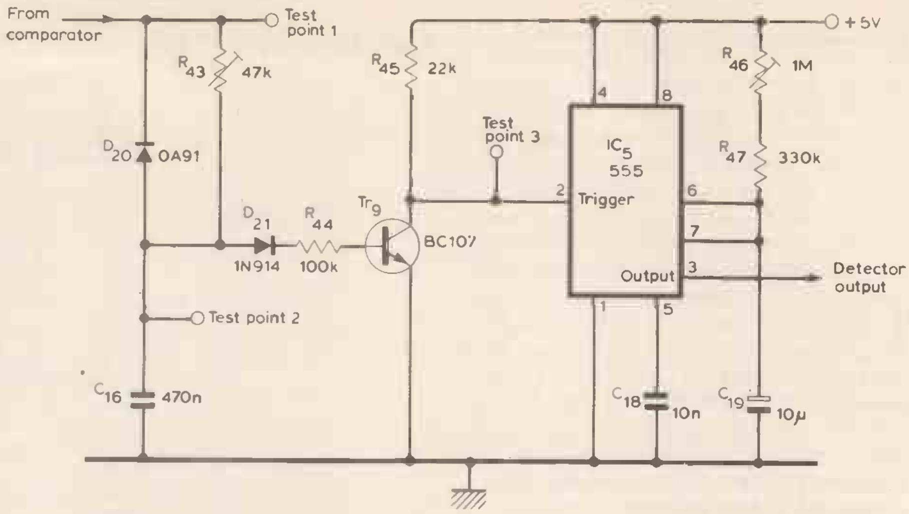


Fig. 11. Comparison detector. Resistor R_{43} is adjusted so that pulses shorter than 4ms are rejected.

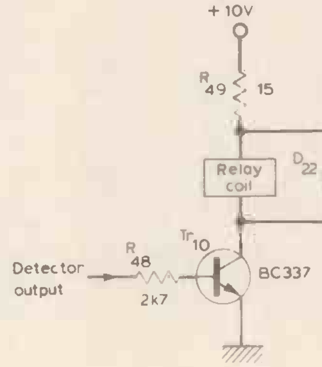
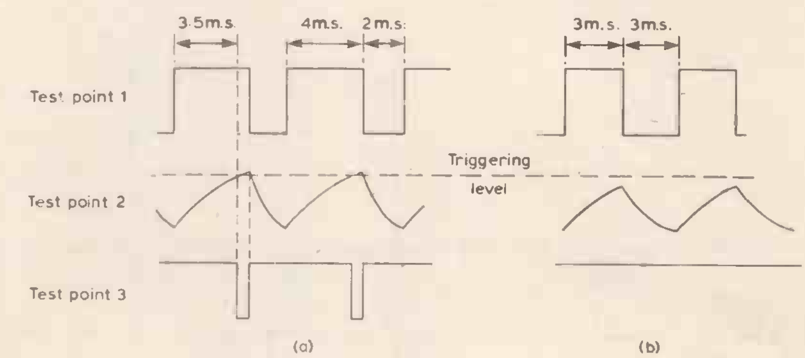


Fig. 12. Relay driver.

Fig. 13. Circuit waveforms.



Construction alignment and testing

Construction of the timer depends largely on how the clock has been built. In the prototype a Rugby clock was assembled on two 8×8in boards and the timer was built on a third board. The keyboard and day indicator were mounted on the board inside a case to prevent unauthorised setting. The remaining components were positioned carefully to minimise wiring. The memory must be handled carefully to avoid damage by static charges and the 5V supply to the i.cs should be decoupled at regular intervals with 10nF capacitors.

Alignment and testing is best carried out on individual sections. After constructing the power supplies check that no switching spikes are present on the battery charger and control circuit when the mains is switched on and off. Adjust R_1 until the charging current is about 45mA and then disconnect the battery. Next, construct the keyboard encoding and debouncing circuit and insert all of the i.cs except for the memory. Check that pins 4 and 12 of IC_{22} give single 150ms pulses when the respective keys are pressed and only when S_2 is switched to Set. Check that pin 5 of IC_{23} gives a 15ms pulse when any numerical key is pressed.

Assemble the day-of-the-week-indicator and check that the day advances each time the day key is pressed. To test the midnight-pulse circuit, set the clock to 23.59 by injecting pulses into the divider chain with the clock aerial disconnected, and check that the day indicator advances by one when the display changes to 00.00.00. Construct the alarm-enable/inhibit section and set the switches to Set Day. Test that the alarm-enable l.e.d. switches on by pressing key 1, and off by pressing key 0. Check that the data is recycled correctly by pressing the Day key seven times.

Construct the read/write control circuit and comparator, then modify the clock for display blanking and switch-on-reset as shown in Fig. 8 and Fig. 4 respectively. Insert the memory, check that the time is displayed with S_2 at Run and that only hours and minutes are displayed with S_2 at Set and S_3 at Alarm. These digits will be random due to the unprogrammed memory. Pressing a numerical key should write into the

continued on page 67

Microwave radar alarm

Improvements to the 1977 design

Accumulated experience since publication of Mike Hoskings design (July & August 1977) has led to a number of useful comments being received on the operational performance which, when combined with some circuit re-design, has resulted in a generally improved alarm system. This article presents the new system, which still has Home Office type approval for indoor use.

The alarm operates on the Doppler effect whereby a frequency shift occurs when a signal source and a receiver are moved relative to each other. For a given source frequency, the Doppler shift depends only on the relative radial velocity and is expressed by $f_d = 2V/\lambda$, where V is the radial velocity, and λ is the source wavelength. In this intruder alarm, the source and receiver are combined together into a single module, which then operates like a single radar.

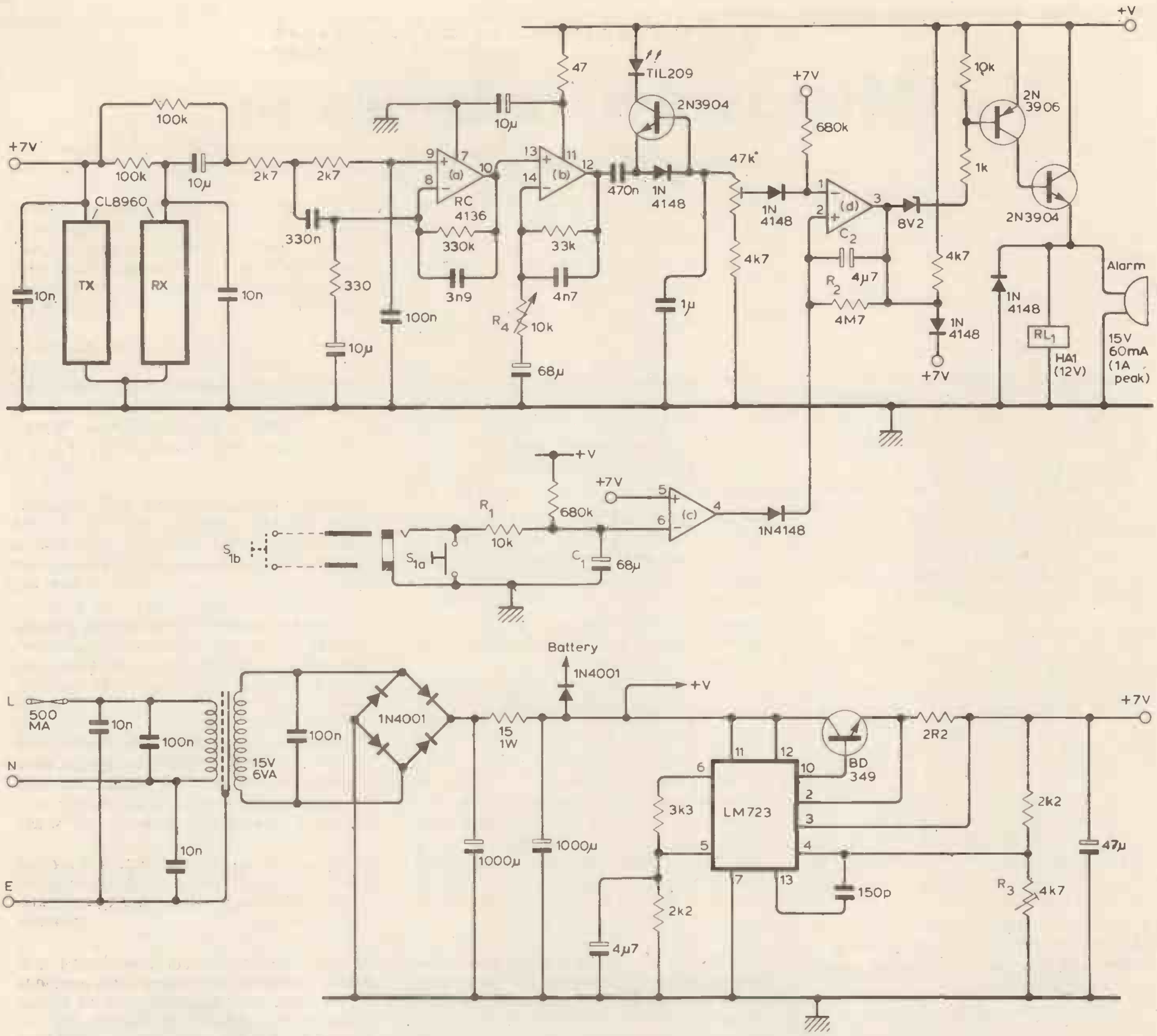
The transmitter is a Gunn device mounted in a resonant cavity and produces a c.w. signal. This signal spreads out over a wide beam and when positioned in a room portions of the signal are reflected back into the receiver. The receiver front-end consists of a single Schottky-barrier mixer diode, operating as a superhet by mixing a directly-coupled portion of the transmitter power with the reflected signal. A difference or beat frequency is then extracted from the mixer output terminals.

When no movement is present, the received radar signal is at exactly the same frequency as that transmitted and so there is no output frequency (only a rectified d.c. level) from the mixer. As soon as any movement occurs, such as from an intruder, a Doppler frequency shift is imposed upon the reflected signal and appears at the mixer output. The appearance of such a signal can then be used to operate a remote alarm system.

Such is the basic simplicity of the alarm, but when account is taken of false alarms, transient movements, r.f. interference and special triggering requirements, then careful circuit design is necessary. It is in the amplifying, filtering, triggering and control sections that the up-dates and improvements to this intruder alarm have taken place.

In this country, the emission characteristics of the radar module are specified by the Home Office and for this application, the transmitter frequency is 10.687GHz. From the equation, the linear relationship between Doppler frequency and radial velocity is 71.25Hz for each metre per second (or 31.85Hz per mile/h).

In the complete circuit of the alarm shown the power supply is essentially the same as the previous supply to the radar module and provides an adjust-



able, highly stable output voltage with low ripple. This aspect is important as it minimizes the a.m. and f.m. content of the transmission. The main differences from the original version are

- –fewer components
- –conversion to a single-sided supply rail, making battery operation more convenient
- –active filtering
- –modification to the diode pump circuit to give increased immunity to interference and transient responses
- –automatic switch-off and alarm re-set after sounding for a period.

At the heart of the electronics is the RC4136 quad op-amp. Each individual op-amp is similar to the popular 741, but has a lower input noise figure. The first stage is used as a filter with a fixed gain of about 60dB, leading into a variable-gain second stage. Following the second stage is the diode pump, with the addition of a transistor to act as a fast discharge path and so prevent the circuit charging up on short-lived inputs such as might be generated by interference, insects or twitching curtains. This, together with the mains and i.f. input filter gives an excellent immunity to false alarms and ensures reliable triggering on more sustained movement.

A feature of the original circuit which is retained, but implemented differently is a built-in delay of about 45 seconds from the time of initial switch-on to when the alarm will start to respond. This allows one to leave the room after switching on the alarm. The delay is provided by the charging time constant of R_1 and C_1 to switch the output level of IC_{2c}, and hence the correct non-inverting input of IC_{2d}. Conversely, a new feature is now provided by the R_2, C_2 feedback combination which will automatically switch off the subsequent transistors after they have been on for about half a minute. This is a relatively long time for a loud alarm to sound and is considered sufficient to scare off an intruder. It also removes the embarrassment of returning home after a weekend away only to face one's neighbours, sleepless after an incessantly ringing alarm. After the re-set action, the alarm is, of course, returned to the "on-guard" state. Finally, the alarm circuit suggests a relay, with the coil connected in parallel with the sounder, so that a set of contacts may be provided for activating additional external circuitry.

Printed circuit board for this improved version of the 1977 intruder alarm is available from Intignex Ltd, Portwood Industrial Estate, Church Gresley, Burton-on-Trent, Staffs DE11 9PT, for £3.75 plus v.a.t.

Switch S_{1a} is a push-button type which will manually re-set the alarm and is also connected to a jack socket for connection to a remote switch. Thus, one has the choice of deliberately triggering the alarm on entering the room and re-setting at the alarm itself thereby providing a check that it was functioning satisfactorily, or else re-setting from some other, concealed, position.

A printed circuit board has been designed for the new alarm and all the components are intended for board mounting. The original idea has been maintained, enclosing this board with a chassis and fitting it with a cover to disguise the complete assembly as a book. The alarm thus becomes smart in appearance and can be situated unobtrusively on a bookcase or table.

Constructional points

The mixer diode in the radar module is easily damaged by static and similar precautions to the handling c.m.o.s. devices should be taken. As supplied, a shorting link is attached which should only be removed after assembly is finished.

Wiring associated with the input circuitry should be kept as short as possible to avoid noise pick-up.

The Gunn transmitter will be permanently damaged by a reverse polarity. Set the +7V supply to within ±0.1V, using R_3 with a dummy load resistor of 47ohm, 1W in place of the Gunn device and then remove the dummy load and connect to the transmitter.

When the complete alarm is reassembled, the final operation is to set the sensitivity using R_4. This is done by observing the l.e.d. flash in response to movement in front of the alarm. It continues to flash whilst the gain is increased with R_4, until a point is reached when self-oscillation begins and the l.e.d. remains permanently on. Decrease the gain from this point until the l.e.d. just remains off when no movement is present and the alarm will be at maximum sensitivity.

In common with all devices that emit r.f. signals, approval to operate is required from the Home Office. In this instance, the complete alarm system has been granted Home Office type approval and provided the circuit shown is used, a licence will be granted on application (see page 82). □

Performance specification

Transmitter frequency	10.687GHz± 12MHz
Transmitter output power	10mW max.
Antenna gain	5dB above isotropic
Out-of-band radiation	40dB below carrier
Operating temperature range	−5 to +40°C
Range	approx 10m against a man-sized object
Switch-on delay	approx 45s
Automatic re-set after	approx 30s

Literature Received

Range of professional electron tubes, cathode ray tubes, vacuum capacitors and special products such as reed capsules and gas detectors are described in the EEV/M-OV abridged data book for 1980/81. An equivalents index is included. Available free of charge in response to requests on company letter heads.

A colour brochure on the production and design processes used in the CELLMOS integrated circuits by GEC is available free from GEC Semiconductors Ltd, East Lane, Wembley, Middx HA9 7PP WW 401

Catalogue of edge connectors is produced by Molex Electronics Ltd, Holder Road, Aldershot, Hants. WW 402

A leaflet giving details of a range of toroidal power transformers rated up to 130VA, in p.c.b. or leadout style can be obtained from Avel-Lindberg Ltd, South Ockenden, Essex RM5 5TD. WW 403

A suite of modules forming STATUS — an information retrieval system for use with many types of computer — is described in a leaflet by BNF Metals Technology Centre, Grove Labs, Dechworth Road, Wantage, Oxfordshire OX12 9BJ. WW 404

BS4739, entitled "Expression of the properties of cathode-ray oscilloscopes," is identical with IEC351 and is in two parts. Part 1 deals with general-purpose types, Part 2 being concerned with storage instruments. Part 1 at £12.50 and Part 2 at £4.50 can be obtained from BSI Sales Dept, 101 Pentonville Road, London N1 9ND.

A booklet on the Telpro range of hand tools and production equipment for electronics can be had from Tele-production Tools Ltd, Stiron House, Electric Avenue, Westcliff-on-Sea, Essex SS0 9NW. WW 405

Three IEC publications have recently been received; IEC147 details a measuring method standard for i.cs; IEC 430 is on test procedures for high-purity Ge detectors, and IEC647 is concerned with dimensions for magnetic oxide cores. They are obtainable from the International Electrotechnical Commission, 1211 Geneva 20, Switzerland at S.fr.70 (147), S.fr. 32(430) and S.fr. 16 (647).

The first issue of a monthly newsletter from Rapid Recall, intended to be of interest to anyone concerned with micro-processors or memories, can be had from 6 Soho Mills, Woodburn Industrial Park, Wooburn Green, Bucks. WW 406

A method of using a computer to write programs for a computer has been developed by Compelec, who call it Instant Software. A leaflet describing the facility and how customers can make use of it is obtainable from Compelec Electronics Ltd, Fourth Floor, 14-15 Berners Street, London W1P 3DE. WW 407

A film entitled "The challenge of choice," written by David Weir and directed by James Hill for STC, examines the effect of developments in telecommunications on people's lives. A brochure containing the script is available from STC at STC House, 190 Strand, London WC2R 1DU. WW 408

A bulletin on the various sound systems which can be assembled from equipment made by Millbank, describing several specimen installations, is obtainable from Millbank Electronics Group Ltd, Uckfield, Sussex TN22 1PS. WW 409

Connectors of various types, including those for printed boards, modular connectors and other multi-way and single-pole kinds, are illustrated and briefly described in a leaflet from Hypertac Connectors, Chronos Works, North Circular Road, London NW2 7JT. WW 410

A vapour deposition system for production work on semiconductor materials is the subject of a leaflet, available from Metals Research Ltd, Melbourn, Royston, Herts SG8 6EJ. WW 411

Multiplexed monitoring and control systems made by Vindicator is described in a leaflet from the UK representatives, Fieldtech Ltd, London (Heathrow) Airport, Hounslow, Middx. WW 412

Performance optimization, fault-finding and evaluation of minicomputer using logic analysers is the subject of an application note from Hewlett Packard Ltd, King Street Lane, Winnersh, Wokingham, Berks. WW 413

Analogue and digital test-meters made by Sanwa are described in a catalogue from Quality Electronics Ltd, 24 High Street, Lydd, Kent TN29 9AJ. WW 414

An introduction to laser velocimetry and details of systems and components available are offered in a publication from Biral, Bristol Industrial Research Associates Ltd, PO Box 2, Portishead, Bristol BS20 9JB. WW 415

Weighing cells type Z7, which are shear-beam transducers for tensile and comprehensive loading, are the subject of a leaflet from the manufacturers, HBM, Stonefield Way, Ruislip, Middx HA4 0JT. WW 416

The 1980 catalogue from Livingston Hire is now available from Shirley House, 27 Camden Road, London NW1 9NR. WW 417

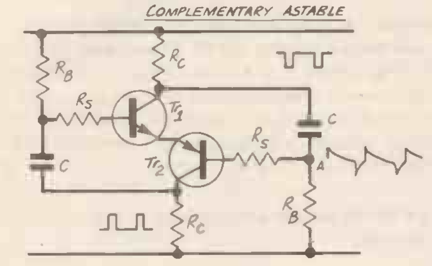
'Radio navigation and radar'

The article on 'Radio Navigation and radar' in the January issue, p 47, contained an error, pointed out to us by LCDR R. E. Burke, Jr. The description of the Loran-C hyperbolic system on p 48 was in reality that for Loran-A. Loran-C is also a pulsed system, working on a 100 kHz carrier, but the time differences are measured on the carrier itself, giving errors of 50 to 300 feet from the starting point on a return trip. Ground wave, LCDR Burke tells us, extends up to 1000 miles, with a position accuracy of 0.25 nautical mile. We apologise for the mistake.

Alternative astable circuits

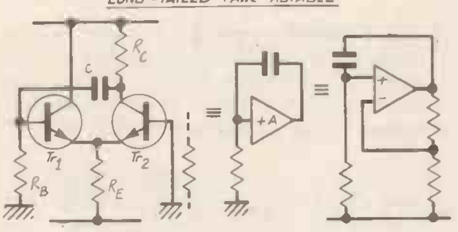
by **Peter Williams** Ph.D. Paisley College of Technology

COMPLEMENTARY ASTABLE



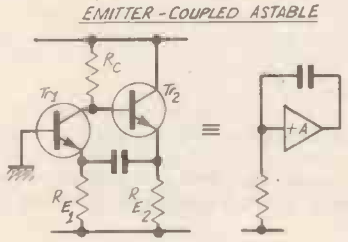
These have generally been designed for special rather than general purpose use. Both transistors go off and on simultaneously. In circuits such as the one shown a long space is obtained by making $R_B \gg R_C$. Hence the current is only on for a small part of the time and the mean current is low. Similarly astables based on the complementary pair shown earlier in the unijunction model have been used as pacemakers for heart stimulus. In these applications a space to mark ratio of up to 10,000:1 is needed to prolong battery life. Such circuits have an additional advantage in that the mean dissipation is also reduced for a given peak output current. The basic principle of the circuit shown is seen by assuming both devices are conducting though not saturated and then switch off. Point A rises sharply because of the positive step at Tr_1 collector while B corresponding falls. The capacitors then recover with $R_C + R_B$ determining the rate of recovery and A and B approach and then pass each other. When the difference is about 1V the transistors just begin to conduct and regenerative switching forces A down and B up. The base currents are dependent on the current gains and the pulse duration is relatively short but ill-defined.

LONG-TAILED PAIR ASTABLE



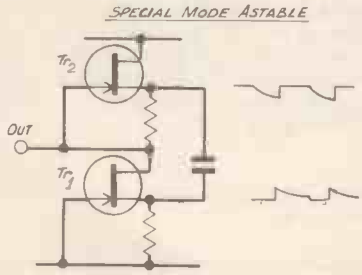
The two-transistor astable is often advocated because it can provide anti-phase and square-wave outputs. That facility is easily attainable with logic gates and flip-flops from almost any astable or pulse generator and more attention is due to such alternators. The long-tailed pair is the basis of a current-switching astable which operates at much higher speeds because neither transistor need be saturated. In this it is closely linked to the e.c.l. gate with which it can be implemented. The emitter resistor is sometimes replaced by a true constant-current circuit but this is not critical. Provided $R_C \ll R_E$ the circuit will not saturate; keeping R_C low reduces output pulse size, but generally improves the speed of response. Assume Tr_2 goes into conduction. The fall in collector voltage drives the base of Tr_1 negative and Tr_1 cuts-off transferring all of R_E's current to Tr_2. As the base of Tr_1 recovers toward zero the amplifier enters its linear region. Tr_1 begins to conduct and current is diverted from Tr_2. Its collector voltage rises and regenerative switching carries it up to +V. All the current in R_E now flows in Tr_1 until the base of Tr_2 again returns to its linear region and the cycle recommenced. The long-tailed pair is a non-inverting amplifier of finite gain and the circuit is equivalent to a known form of op-amp astable.

EMITTER-COUPLED ASTABLE



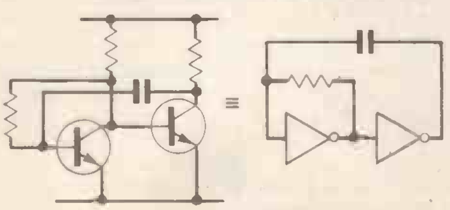
A similar conclusion can be drawn about the emitter-coupled astable if it is considered as cascaded common-base and common-collector stages. The long-tailed pair comprises cascaded common-collector and common-base stages. The non-inverting combination having both $A_v > 1$ and $A_i > 1$ consists of a pair of cascaded common-emitter stages and this example is treated later. The analysis of this astable is easiest if R_{E1} and R_{E2} are replaced by constant-current sources I_1 and I_2. The capacitor must change its p.d. by equal and opposite amounts during succeeding portions of the cycle as the p.d. must always return to its original value at the start of each cycle in any stable oscillator. When the emitter of Tr_2 goes high, Tr_1 is cut off and the current in C is I_1. When Tr_1 conducts it pulls the base of Tr_2 below its emitter cutting it off and the current in C is I_2. Hence $I_1 t_1 = I_2 t_2$ and the mark-space ratio is unity for $I_1 = I_2$. If $R_c \ll R_{E1}$, R_{E2} the voltage steps on the resistors are small compared to the mean values and the waveforms and frequency differ little from the constant-current case. The circuit is again non-saturating and is capable of high speed.

SPECIAL MODE ASTABLE



Current-operated circuits extend the range of possibilities as compared to the restriction of voltage operation. A halfway house is provided where active devices are operated in series from a voltage supply. These are again a specialized sub-group of astables, but can be simple and effective. The version shown is a serial form of the emitter-coupled astable though implemented with junction f.e.t.s as this eliminates a number of bias components.

SINGLE CAPACITOR ASTABLE



This circuit has been referred to above and can be approached in more than one way: as a conventional astable in which one of the capacitive couplings is replaced by a direct connection, as one of the two-amplifier single capacitor astables similar to a c.m.o.s. astable, or as equivalent to a single positive-gain amplifier with CR feedback. In this last interpretation the two inverting stages perform the same function as the two non-inverting stages of the long-tailed pair and emitter-coupled astables. This emphasizes the danger of "is" statements in electronic circuits. To say that a given circuit "is" a particular type refers only to the way in which the designer or user has decided to partition it. Each redrawing or repartitioning may reveal a new pattern, a new way of classifying it, or even a new class of which it is the first member. This particular astable has still greater significance when related to the classic two-transistor monostable.

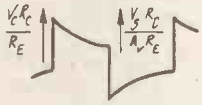
Alternative astable circuits

THEORY

● From symmetry then, when the transistors are conducting, the emitters are both at $V_S/2$ with the bases $\pm$ 0.6V about that level. The timing is imprecise depending **inter alia** on h_{FE}. It is only one of a number of such complementary astables and no analysis is offered though the period is primarily defined by R_BC.

● In this circuit the output voltage step is of magnitude V_SR_C/R_E for a supply of $\pm V_S$ as the current in R_E is switched between Tr_1 and Tr_2. If the circuit were to have a linear voltage gain A_v then the switching thresholds would be at $\pm V_SR_C/R_EA_v$ and the appropriate values of V_1, V_2 are

$$V_1=V_S\left(1-\frac{R_C}{R_EA_v}\right)$$



$$V_2=\frac{V_SR_C}{A_vR_E}$$

$$t_2-t_1=\tau\log_e\left[\frac{1-\frac{R_C}{A_vR_E}}{\frac{R_C}{A_vR_E}}\right]$$

$$\tau\log_e\left[\frac{A_vR_E}{R_C}-1\right]$$

For R_E, R_C comparable $A_v \gg 1$

$$T\approx 2\tau\log_e\left[\frac{A_vR_E}{R}\right]$$

A more accurate analysis uses the transistor exponential characteristics to derive the non-linear transfer function $V_0=k\tanh[V_1.]$ From this the condition $dV_0/dV_i=1$ can be obtained, fixing the switching threshold accurately.

● Assume $R_C \ll R_{E1}$, R_{E2} so that voltage swing is small. Then charging and discharging currents are approximately constant at V_S/R_E for supply $\pm V_S$ and $R_{E1}=R_{E2}=R_E$.

Hence the transitions are separated by a time interval governed by $\Delta V \approx R_CV_S/\tfrac{1}{2}R_E$ (since for Tr_1 conducting, R_C carries currents in both tails while for Tr_2 conducting the current in R_C is negligible) while the current in the capacitor in each case is V_S/R_E. Thus $T\approx 2\,.\,C\Delta V/I=4CR_C$.

The above involves a number of approximations that make the result useful as a guide to the behaviour but not an accurate one. It suggests that neither R_E nor the negative supply rail have any significant effect on the frequency of oscillation though they directly control the amplitude.

● Circuit behaviour is strongly dependent on the variable fet characteristics.

● The voltage step at Tr_1 collector is $V_{BE}(sat)_2 - V_{CE}(sat)_1 \approx 0.5V$. The voltage available to control the current in the capacitor is too small for a stable well-defined frequency to be achieved. An additional resistor in the base of Tr_2 helps.

EXAMPLE

A long-tailed pair astable has $R_C=R_E$ and supply voltage of $\pm$ 5V. Assume that the differential output current (I_0) of a long-tailed pair is given by $I_0/I=\tanh[V/2kT/q]$ where V is the large-signal differential input voltage and I is the tail current. Determine the value of V at which the open-loop voltage gain from input base to output collector falls to unity. Hence determine the amplitude of the waveform at the base and the frequency of oscillation in terms of $\tau=R_BC$.

The gain will be half that for the differential output condition i.e. the latter is derived and equated to 2.

$$V_0=I_0\,.\,R_C=IR_C\tanh\left(\frac{V}{2kT/q}\right)$$

But $I=\dfrac{V_S}{R_E}$ for a supply of $\pm V_S$

$$\therefore \frac{dV_0}{dV}=\frac{V_SR_C}{\frac{2kT_{RE}}{q}}\,.\,\operatorname{sech}^2\left(\frac{V}{2kT/q}\right)$$

$kT/q \approx 26mV$ at room temperature and substituting for $dV_0/dV=2$ etc

$$2=\frac{5\times10^3}{52}\operatorname{sech}^2\left(\frac{V_1}{52.3}\right)\text{, where V is in mV}$$

$$\therefore \cosh^2\left(\frac{V}{52}\right)\approx 48,\ \cosh\left(\frac{V}{52}\right)\approx 7$$

but $\cosh\theta=e^{\theta}+e^{-\theta}$

$$\therefore \frac{V}{52}\approx 1.95$$

$$V\approx 100mV$$

The circuit should thus switch when the input base reaches about +100mV and again at −100mV giving a peak-peak amplitude of 200mV.

The collector step voltage is V_S. This might lead to saturation and a slowing of the response; reducing R_C to $R_E/2$ avoids this but reduces the threshold to 80mV and the peak-peak amplitude to 160mV.

For a step of V_S, the resistor voltage is raised from $-V$ to $-V+V_S$ i.e. from −0.1 up to 4.9V, decaying to +0.1V before initiating the switching action again.

$$\therefore t_2-t_1=\tau\log_e\left(\frac{V_1}{V_2}\right)\approx 3.9\tau$$

From symmetry $f=\dfrac{1}{T}=\dfrac{1}{2\times3.9\tau}=\dfrac{1}{7.8\tau}$ assuming $R_B \gg R_C$.

For $R_C=R_E/2$ the step size is reduced making $V\approx 2.4V$ but the gain is also reduced

$$\cosh^2\left(\frac{V}{52}\right)=24$$

$$\frac{V}{52}\approx 1.54$$

$$V\approx 80mV$$

$$\therefore t_2-t_1\approx\tau\log_e\left(\frac{2.4}{0.08}\right)=\tau\log_e 30=3.4\tau$$

This is a reduction of about 13% for a 50% fall in resistance. This is reasonable stability for a fast and simple circuit.

WORLD OF AMATEUR RADIO

What's cooking?

The reluctance (for whatever reasons) of the Home Office to introduce a low-power citizens' band radio facility in the UK is in marked contrast with the open-ended permission given to the public to install crude, high-power transmitters in their homes in the form of microwave ovens. Radio-astronomers at Jodrell Bank have investigated (*Nature*, Vol 282, 6 December 1979) the amount of broadband spurious "out-of-band" emission from typical ovens and have confirmed that this is sufficient to cause interference to extra-terrestrial signals when picked up on the sidelobes of large radio-telescopes at distances up to 20km or more on some frequencies.

Ovens generally use the "rectified a.c." form of pulsed, self-excited microwave generators on the i.s.m. (industrial, scientific, medical) frequency of 2.45GHz with a power output of the order of 1-2kW.

The primary source of leakage of unpolarized radiation is, the report states, from the seals around the oven door: "The seals are non-contacting and seem to consist of a resonant, quarter-wavelength choke nominally tuned to 2450MHz, followed by microwave absorbing material." It is emphasised that while this form of sealing is sufficiently effective at 2.45GHz to satisfy the UK safety regulations (i.e. exposure to microwave radiation), It fails to give adequate out-of-band suppression to prevent possible interference with other radio services authorized to operate within the 1-6GHz spectrum. Elsewhere it has been suggested that harmonic emission from ovens could prove to be the major source of interference to 12GHz reception of television from direct-broadcast satellites.

The use of large numbers of microwave ovens in residential areas could also prove a major problem for radio amateurs interested in the development of microwave communication at low signal levels.

The Jodrell Bank team complain that for the past ten years they have been urging the Home Office to specify permitted levels of out-of-band spurious radiation from ovens.

A boom in the hobby

Amateur radio in the UK experienced a sharp boom during 1979 and a record 26,981 licences were current in December. The number of new licences issued by the Home Office during the year amounted to 3155, of which 1054 were Class A (all modes, all bands) and 2101 Class B (v.h.f./u.h.f., no morse). Some 2400 people passed the first "multichoice" Radio Amateurs' Examination held in May 1979 and a considerable number sat the December examination.

The RSGB reports a 10.5 per cent increase in membership with some 4145 new members enrolled during 1979.

It remains to be seen whether these exceptional increases in the hobby were part of a long term trend or were partly the result of the unusual amount of media coverage during 1979 which included the "Open Door" and "Nationwide" programmes. The British electronics manufacturing industry, however, has benefited only marginally from this boom, with the overwhelming majority of factory-built equipment coming from overseas. While there appear to be no figures on the total UK amateur market, *Electronics* estimates the US market as worth \$23-million in 1979, rising to an estimated \$26-million in 1980.

Topics in the air

The New Year brought forth a flurry of "new prefix" activity. East German amateurs appeared under the guise of "Y2" instead of the long familiar "DM" in what seems likely to be a permanent change. A selected 200 Russian amateurs in Moscow, Leningrad, Tallinn, Kiev and Minsk introduced a series of prefixes to mark the country's hosting of the Olympic Games, using RX, RZ, RK and RU prefixes for what are termed "special Olympic ham operations." Club stations in Moscow and Tallinn will similarly change prefixes on July 1st and those in Leningrad, Kiev and Minsk on July 15th. These special prefixes end on August 3rd.

The first complete break in 50MHz long-distance propagation in more than two months came on December 15th, 1979 when the expected decline in solar flux took effect. A feature of the period of high solar activity was its remarkable freedom from geomagnetic disturbances, normally expected at sunspot maxima. An aspect of v.h.f. propagation in the USA that does not appear to occur in the UK is a regular winter Sporadic E season affecting signals on 28 and 50MHz.

A 432MHz amateur television repeater is in operation in the Wellington area of New Zealand, providing opportunities for tv transmission over distances of 60 to 100 miles, with several more in the planning/construction stage. An estimated 50 such repeaters are now operational in various parts of the world. A special "intruder watch" callsign – ZL61W – has been issued by the New Zealand Post Office but will not be used for normal contacts.

A new reciprocal operation agreement between Canada and the USA came into force on January 21st with exceptionally liberal terms. It allows amateurs of either country while visiting the other to operate without needing to obtain prior written permission. However, since US-type novice and technician licences are not issued in Canada, US amateurs with such licences are still not permitted to operate in Canada.

The Vojvodina Amateur Radio Federation of Yugoslavia has more than 10,000 members and its basic aims are: "to maintain radio links, teach and train young people in electronics and telecommunications and train all members for all-people's defence and social self-protection". The national amateur society in Yugoslavia is SRJ (Savez Radioamatera Jugoslavija).

Special event callsigns in the UK in the series GB4 plus two or three letters are being issued through the RSGB; the GB3 plus two letter calls will in future be used for repeater stations, and GB3 plus three letters for beacons. Special event callsigns in the series GB2 and GB8 continue to be issued.

A number of FCC employees who received callsigns in a manner stated to have been "inconsistent" with official procedures are to be allotted new calls. This follows an investigation into fraudulent upgrading and licensing of stations in recent years.

A special Certificate of Membership has been presented by the Royal Naval Amateur Radio Society to 87-year-old Mrs F. V. McKenzie, OBE, former VK2FV who was Australia's first YL operator, first qualified woman electrical engineer and founder of the Women's Emergency Signalling Corps (later Women's Royal Australian Naval Service) which trained about 11,000 Australian, American and Indian radio operators during World War 2.

In brief

A new RSGB award for microwave operation will require confirmation of contacts with five "large QTH locator squares" on any of the bands between 1.3 and 24GHz. . . . FCC is expected soon to permit American rtty enthusiasts to use ASCII. . . . A regular moonbounce newsletter is being organized by the Oxford University EME Group (G3WDG, 10 The Crescent, Pattishall, Towcester, Northamptonshire) . . . Rev G. C. Dobbs, G3RJV, Hon. Secretary of the "G-QRP-Club" has changed address to 17 Aspen Drive, Chelmsley Wood, Birmingham B37 A linear translator (repeater) on the 1296MHz band is operating in San Jose, California.

PAT HAWKER, G3VA

Impedance mismatching

A pitfall to be avoided when using Thevenin and Norton equivalent sources

by **F. J. Lidgey,** Ph.D., B.Sc. Oxford Polytechnic

Power transfer from a source into a load is frequently discussed in circuit theory. Also a parameter of interest is the transfer efficiency (η) defined as the ratio of load power P_L to total power delivered by the source P_S. The proposal of this article is to outline a common error made in calculating η which stems from an incorrect assumption regarding the power delivered by a Thevenin or Norton equivalent source.

With transfer efficiency in mind it is easy to show that a 'mismatching' of load to source impedance reduces power dissipation in the source impedance. For example, in Fig. 1:

$$P_L = i_L{}^2 R_L = v_s{}^2 \frac{R_L}{(R_s+R_L)^2}$$

$$P_s = v_s \cdot i_L = i_L{}^2(R_s+R_L) = \frac{v_s{}^2}{(R_s+R_L)}.$$

$$\text{Thus } \eta = \left(\frac{R_L}{R_s+R_L}\right).$$

η tends to zero for $R_L/R_s \ll 1$ and η tends to its maximum value of one for $R_L R_s \gg 1$. If for example $R_s = 50\Omega$ then 80% efficiency of transfer of power into R_L occurs for $R_L = 200\Omega$ and $P_L = 64\%$ of P_{Lmax}. However, there is obviously no optimum choice, as can be seen from the plot of Fig. 2, which shows that for η of 100%, i.e. no power dissipated in the source, then no power flows in the circuit, since $R_L/R_s \to \infty$ and $i_L \to 0$.

All this seems quite reasonable and as one would expect, if R_s and v_s are *really* known in any circuit. At first sight, it appears that they are: all that seems necessary is to generate the Thevenin equivalent source, which gives R_s and v_s; hence, η may be obtained from the expression given previously. This, however, is a fallacy, which can be exposed by the example of Fig. 3.

Taking the special case of $v_1 = 2v_s$ and $R_1 = 2R_s$, then applying Thevenin's Theorem, the source can be replaced by a voltage source of v_s and a source resistance of R_s, exactly as in the circuit of Fig. 1. Clearly, P_L is the same but is P_s?

For Fig. 3:

$$P_s = (2v_s)^2 / \left(2R_s + \frac{2R_sR_L}{2R_s+R_L}\right)$$

$$= \left(2 + \frac{R_L}{R_s}\right)\frac{v_s{}^2}{(R_s+R_L)} = P_{s3}.$$

For Fig. 1:

$$P_s = \frac{v_s{}^2}{(R_s+R_L)} = P_{s1} = \frac{P_{s3}}{\left(2+\dfrac{R_L}{R_s}\right)}$$

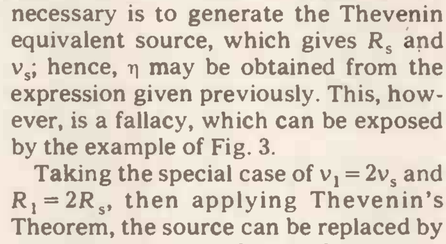


Fig. 1. Simple series circuit with $\eta = R_L/R_L + R_s$

Fig. 2. For maximum η no power can flow.

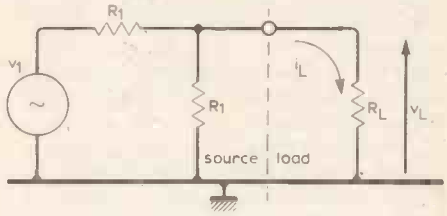


Fig. 3. Thevenin equivalent of this circuit gives different η to circuit of Fig. 1.

and so $P_{s3} > P_{s1}$ whatever the choice of R_L/R_s.

Unless the circuit is a Thevenin type source we cannot use the expression for η derived earlier, so what is going wrong? The mistake lies in the use of Thevenin's Theorem. In deriving the Thevenin equivalent source the current and voltage at the terminals of the equivalent source are exactly equal to those of the original source. But there is no one-to-one correspondence between the previous sources and the new Thevenin equivalent voltage source which depends on both the terminal voltages and all the source resistors, and so the power delivered from the Thevenin source is in general different to the power from the original source. The difference between P_s and P_L must be the power flow in the source resistance P_D, i.e., $P_D = P_s - P_L$. As already stated, in obtaining the Thevenin equivalent source P_L remains the same, so $P_s - P_D$ must remain the same; since the source powers are different, P_D is different in the two circuits; *the power dissipated in the source resistance of the Thevenin equivalent source is not equal to the power dissipated in the original source.*

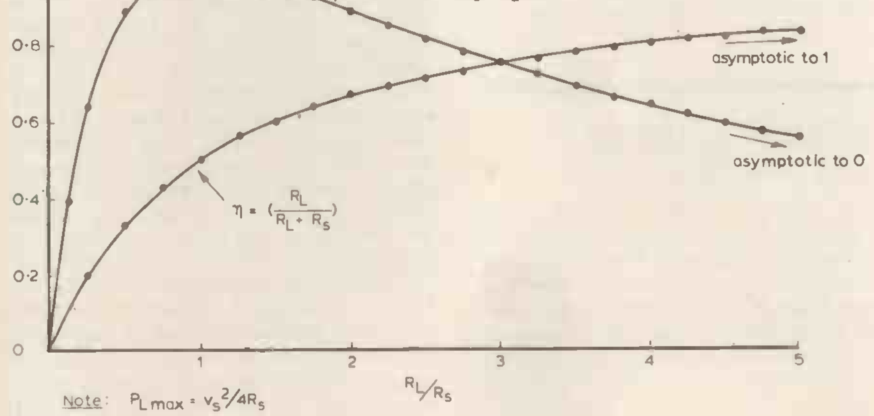
The same argument applies if a current source is substituted for the voltage source, as in the circuit of Fig. 4, which is a Norton equivalent of Fig. 1.

$$P_L = i_L{}^2 R_L = \left(\frac{v_s}{R_L+R_s}\right)^2 R_L$$

$$P_s = i_s \cdot v_L = \left(\frac{v_s}{R_s}\right)^2 \left(\frac{R_L R_s}{R_L+R_s}\right)$$

$$= \frac{v_s{}^2}{(R_L+R_s)}\frac{R_L}{R_s}$$

$$\eta = \frac{P_L}{P_s} = \frac{R_s}{R_L+R_s}$$



Note: $P_{L\,max} = v_s{}^2/4R_s$

Continued on page 78

LETTERS TO THE EDITOR

STATUS OF ENGINEERS

Regarding the status of engineers, as discussed in your editorials and correspondence. One factor seems to be overlooked, viz, that the status and respect given to doctors and lawyers increases exponentially with age, right up to their 70s, whereas that of an engineer, however experienced, reaches a plateau at 25 and then drops off rapidly beyond 35. How many jobs offered in *WW* advertisements are open to anyone over 30? Precious few!

Nor is this exclusive to Britain, but has already spread to the USA and is now beginning to be felt in Japan.

In countries devoted to production in support of the almighty deutschmark, engineers are still accorded some degree of respect in their middle years, but one wonders how long it will stay so when production there also falters, as indeed it must eventually in a world of resource shortages.

The sad fact is that engineers don't stay engineers long enough to get status! It would be interesting to know what old engineers do, for a living. Is there a suitable subject for a survey there? (They can't *all* retire at 40!)

A final word: no matter how much headway young engineers make, the days when they might have made it socially have gone. Yet, somehow, I don't ever expect to see aged doctors or lawyers being thrown out of work by computers or young graduates!

Ronald G. Young
Peacehaven
Sussex

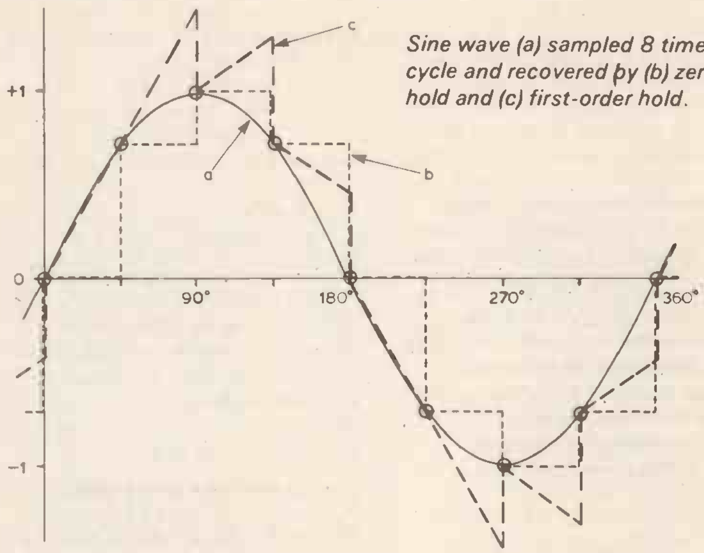
DIGITAL FILTERS

Perhaps, following Mr Gray's letter in your January 1980 issue, I could raise a point which is not always well-made in text books and which space did not permit me to touch on in my article on simple digital filters in the July 1979 issue.

A digital filter algorithm performs calculations and outputs certain values at fixed intervals of time. Strictly speaking, the output values are only meaningful at those exact instants, and what happens in between is not defined; hence the plots of the points only in Figures 2 and 5 of my article.

This, however, is not particularly helpful in practice since we generally wish to produce some analogue waveform for further use or inspection on an oscilloscope. As soon as we do this we enter the field of waveform recovery and make implicit assumptions about the technique involved. Most frequently, as Mr Gray's Fig. 1 implies, a zero-order-hold is assumed, the properties of which have been well discussed by Zuch[1] and include an average delay of half the iteration interval and a linear phase response equal to 90° lag at the Nyquist frequency. If Mr Gray finds a phase *advance* of half the iteration interval, I would suggest he has made an error in interpreting or plotting his results.

Other methods for waveform recovery are, however available. A first-order hold retains the value of the previous iteration as well as the present one, and uses this data to



Sine wave (a) sampled 8 times per cycle and recovered by (b) zero-order hold and (c) first-order hold.

generate a slope which will, one hopes, lead towards the point where the next sample will arrive as shown here. This method effects a significant reduction in the delay terms. A second order hold is also possible and this will generate sections or parabolae. I do not know of any applications in real time where this technique is used, but it is not uncommon for curve generation in the computer numerical control of milling machines, for example.

These factors are of importance to the practical engineer, since they imply that the exact response obtained from a digital filter as we approach the Nyquist frequency may owe as much to the waveform recovery technique as to the filter itself.

Incidentally, the reference to Nyquist derives from the communications field; it may be of interest to note that in the process industries virtually the same law is known as Shannon's Theorem[2] but the formulation places greater emphasis on the exclusion of frequencies higher than ½t.

P. A. L. Ham
NEI Parsons Ltd
Newcastle-upon-Tyne

References

1. E. L. Zuch: "Designing with a sample-hold won't be a problem if you use the right circuit." *Electronic Design* 23, November 8, 1978, pp. 84-89.
2. E. I. Lowe & A. E. Hidden: "Computer Control in Process Industries." Peter Peregrinus Ltd 1971, pp. 180.

AUDITORY CUES IN STEREOPHONY

We were most interested in Philip Vanderlyn's article on auditory cues in stereophony in the September 1979 issue. The whole piece begs one particular question — what does the current craze of multimiking do for our stereo perception? Perhaps Mr Vanderlyn could be persuaded to relate his research experiences in this aspect. I, for one, would be interested in a researcher's views of this particular debasement of Alan Blumlein's original ideas.

But more immediately I would question Mr Vanderlyn's attribution of "in the head" sounds to dummy head derived stereo, listened to on headphones. We are currently marketing a number of binaural records and would claim that "in the head" sounds are the last things being achieved. Real distance "out of the head" effects are clearly discernible on many parts of our discs. True, it is easier to get distance, side and rear effects as opposed to "out front" images, but to describe the effect as "in the head" clearly defeats the reason for the marketing of our discs.

M. G. Skeet
Whitetower Records
Milton Keynes

The author replies: First of all multimiking is not a current craze; it has been going on almost from the introduction of stereo records. Secondly, it owes nothing to research, so I have no experience of it in that context. Thirdly, my personal opinion of it is not for publication, but I would agree with him that it represents a debasement of Blumlein's conception. There is a fourth aspect, the economic one. Very early in the practice of stereo recording using "pure Blumlein" techniques it was found difficult and time consuming to get a good musical and spatial balance. It also called for much patience and understanding on the part of musicians and conductors. It was thus very expensive and the multimiking technique came into being, which permitted subsequent editing and which produced a colourable imitation of "real" stereo. I did wonder at one time whether it fell foul of the Trade Descriptions Act, but because the definition of stereophony in BS 661 is so widely drawn it appears it can unblushingly be called stereo. Nonetheless it is a fact that, in this way, many very satisfying stereo records have been made that would not or could not had it been necessary to keep to theoretically rigorous methods. We have to bear in mind, as I am sure Mr Skeet does, that record companies exist to sell home entertainment rather than to demonstrate scientific truths.

My comments on headphone stereo were based on early experiences when it was found impossible to create a convincing image using dummy head techniques. The expression "in the head" was a form of words used to describe the vivid but unnatural effects produced. At that time the only headphones readily available were those affectionately known as "cans" — excellent for reading Morse code signals but not really suited for serious listening. Now that there are many excellent high quality headphones the situation is different and it is possible to listen with pleasure to all types of programme material. I must admit that on more than one recent occasion I have heard realistic external sounds, but these have been from special recordings which preserved possible cues due to the pinna. I am inclined to think that the role of the pinna, which has only recently been studied in detail, has hitherto been underrated. However, I still feel that the head rotation cue is an essential part of any convicingly external image, at any rate over an appreciable period of time, and there seems to be no possible way to provide this using transducers held in a fixed relationship to the ears.
Philip Vanderlyn

RUMBLE CANCELLATION FILTER

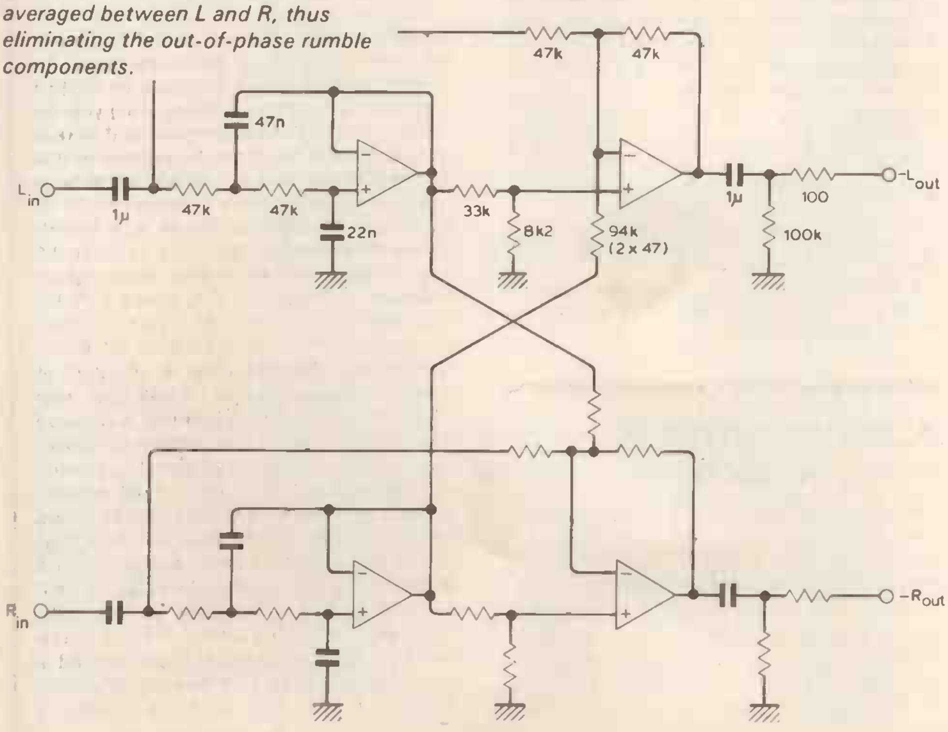
Congratulations to J. P. Macaulay for his elegant method of removing rumble from stereo disc reproduction without degrading the deep bass response (Circuit Ideas, September 1979 issue). The concept of turning the lowest bass into a mono signal is so beautifully simple that one wonders why this technique is not widely used.

After having studied the discrete circuit design, I decided to build a simplified and improved version, making use of today's superior integrated op-amps. The diagram shows how a TL074 quad op-amp i.c. is used together with a simpler matrixing system to form a rumble cancellation filter (as I prefer to call it) with near ideal characteristics. The TL074 exhibits a performance, in terms of extremely low distortion coupled with high slew-rate and bandwidth, that is hard to beat using even complex discrete designs. Expected figures will be around 10μV noise, d<0.002%(to 20kHz) and $f_u \approx$ several MHz.

In his filter Mr Macaulay uses equal C-values (33nF); this will not give a Butterworth characteristic. For this a ratio of 2:1 is required, hence my corrected values of 47 and 22nF.

It should be kept in mind that the rumble filter inverts the polarity of the input signal. If it is ever to be installed in a system where it may be switched in or out of service, inverting gain-of-one buffers must be used for the polarity convention to be preserved.
Jens Langvad
Ring Instrument
Vanlose
Denmark

High performance rumble cancellation filter. Channel separation is maintained only down to 100Hz. Lower frequencies are averaged between L and R, thus eliminating the out-of-phase rumble components.



TRICKLE DOWN OR TRICKLE UP?

Referring to the November editorial, I thought that in general the "trickle down" theory of reducing poverty by development was discredited, though there are exceptions. Where a country has a resource which can be turned into cash, as for example Britain's North Sea oil, there is a case for using the cash for capital investment in industry. This was also the Shah's policy in Iran; and no-one who has seen the traffic jams (of private cars) in Teheran would suppose that the beneficiaries of this policy were very few in number, though they might well be a minority of the whole population. On the issue of intermediate technology versus capital-intensive technology, there is also the prestige consideration which may be rationalised in the form: "If we are going to buy machinery from abroad, we should obviously buy the most up-to-date."

Those who are seriously interested in under-developed countries should see a book such as "Income Distribution Policy in Developing Countries" by Irma Adelman and Sherman Robinson.* Much of this book is concerned with the technicalities of constructing a computer model (for South Korea); but the authors do discuss various economic policies and conclude that the most effective single way to reduce poverty in such countries is to assist agriculture.

A pocket calculator is of no use to an under-nourished family; and such things as radio communication to call a doctor improve the amenities but do not reduce the poverty. The positive contribution of electronics is through computer simulation of the economy, which makes it possible to answer the question "What will happen if we do such-and-such?" without actually implementing an experiment which might prove to be disastrous. "Chips with everything" may be all right for developed countries, but we should be modest enough to admit that high technology alone cannot solve all the world's problems.
D. A. Bell
Walkington
Beverley
Yorks

*Published for the World Bank by Oxford University Press, 1978. There are many books on income distribution, but this one (a) is concerned with developing countries and (b) has a computer model, based on continuing processes rather than extrapolation of past data, which appears to match reality successfully.

3D TELEVISION

K. P. Wood (October 1979 letters) suggests that it is impossible to provide stereoscopic viewing of a moving object on a flat screen without viewer discomfort. This he claims is because of conflict between focusing and convergence clues received by the viewer. However, his claims are pure hypothesis without any attempt to provide qualitative or quantitative evidence.

A major factor he omits to mention is perspective, a subject all painters and photographers have to fully comprehend to master their arts and crafts. A very strong illusion of depth is conveyed in mono pictures whether paintings or projected kinematograph films by the correct use of perspective in images on a flat surface. If Mr Wood is correct there would be a strong case for supposing that viewing of painted pictures with strong perspective would cause viewer discomfort. Surely he would not sustain this argument?

It is true that viewing of red/green anal-glyph 3D images is tiring, but this is because it is quite an abnormal situation for one eye to see only deep red images whilst the other sees only green.

It is also true that viewing of a large number of early 3D polaroid colour films produced headaches and eye strain. However, it has now been established, as a result of research and a better understanding of the subject, that this was not due to the factors postulated by Mr Wood. It was because the camera men and directors who made the early 3D films did not properly understand the rules that apply to stereocinematography and both in camera work and subsequent editing produced visual cue conflict situations much worse than Mr Wood postulates.

There is now no reason to believe that a correctly photographed and edited 3D stereo film of the colour/polaroid type will produce any viewer discomfort even over long periods. If there is any scientific evidence to the contrary I shall be most interested if Mr Wood will quote the basis of it.

Meanwhile, recommended reading for those interested in factual accounts of work done in this field is: "Introduction to 3D" by H. Dewhurst, Chapman & Hall, 1954; and *American Cinematographer*, (special 3D issue), April 1974, 1782, North Orange Drive, Hollywood, Calif. 90028.

A. E. Lott
Reading
Berks

HERE BE DRAGONS

In his piece on audio in your 'Into the 'eighties' feature (January issue), Adrian Hope expresses his surprise that so many people "are prepared to venture so far north into the provinces as to make Harrogate an annual success . . .". If *Wireless World* were to consider holding a 'Remark that could have been better put' competition, then I am confident that Mr Hope would stand every chance of winning first prize.

Attacks by marauding bands of savage Yorkshiremen, in their distinctive flat caps, on traffic on the A1 have lessened markedly in recent years, and many travellers from the south have claimed that it is now relatively safe to venture north — even well beyond Watford. The only real danger lies in any reckless suggestion to one of the natives that Harrogate is a curious place to hold a national exhibition: black puddings can be unpleasant, particularly when stuffed whole into unlikely places.

W. Dampier
Wallington
Surrey

THE "WHY?" OF ELECTRONICS

I was just reflecting on our good fortune in having in *Wireless World* a high quality technical journal which (unlike the numerous trade journals) is not afraid to discuss the why? and what for? of electronics as well as the how? when I came across Mr Greenwood's letter (January issue) calling for an end to "political rhetoric" in your editorials.

Unlike Mr Greenwood I think it needs more than a few "delightful moments of humour" to "demonstrate that technical people can be human." Technology is changing society now faster than at any other time: some changes are for the better, some for the worse. The people who find their lives changed as a result of the engineers' combined efforts will not think us "human" if we blindly and mechanically create what we're told to without sparing so much as a comment in a technical journal on the desirability of what we are creating. Technology has great potential for improving the quality of life – if applied sensibly. As technologists we must make our contribution to the discussion of how to apply it sensibly, rather than allow its control to pass unquestioned to those primarily concerned with financial gain in the short term.

So, long may *Wireless World* continue its perceptive and searching editorial comment, followed I hope by vigorous discussion in the letters pages.

P. A. D. Bird
South Brent
Devon

"TRIVIAL" AMPLIFIER DESIGNS

In reply to Mr Duncan's letter "Trivial amplifier designs", in the January issue, whilst I am in general agreement with his views on psycho-acoustics, I feel he may have missed the object of my article ("Low distortion amplification," October 1979).

The nature and control of distortion and other important parameters in a.f. amplification are generally misunderstood, resulting in the growth of jargon and mysticism (as witnessed by Mr Duncan). The aim of my article was to combat this by defining the problems in engineering terms and using the solutions as design criteria for a gain cell block. Although the article described its use in a domestic sound reproduction system it could have equally been applied to a laboratory amplifier, low distortion oscillator, distortion factor meter etc.

To take Mr Duncan's objections to their logical conclusion, should design in any one field of engineering be terminated due to imperfections in another?

B. J. Codd
Medical Physics Department
Leicester Royal Infirmary

FAILURE OF DISTRESS SIGNALS AT SEA

I was surprised on reading the letter by R. Philpot (November) and a previous letter by John Wiseman (June) about the problems encountered at sea operating at 500 kHz. In theory a solution of salt and water effectively earths the r.f. power present in the aerial's insulator, which makes electrical contact with the wire.

The practical solution is the use of e.h.t. cable, so that there is no electrical contact with the conductor. A 150-watt input has been used, but much higher levels are believed possible. In the experiment, RS Components 18kV e.h.t. cable was used.

I feel sure that this is a late, but effective answer, and with lives at stake the cost is very small.

Peter C. Gregory, G4 HXV
Ashton-under-Lyne
Lancs

Mr Wiseman replies:

The use of e.h.t. cable would be similar in principle to the naval practice of using p.v.c. coated whip aerials. However, the statement that ". . . a solution of salt water effectively earths the r.f. power . . ." is an oversimplification. I have letters from people at sea reporting severe problems with 'wet insulators' at 500kHz but less effect at 2182kHz and similar, and very little at all at h.f. in the 4 to 21 MHz marine bands, and my own experience confirms that. Since Mr Gregory gives an amateur call sign, the experiments he refers to will have been carried out in the amateur bands 1.8 to 30 MHz. A ship's main aerial is invariably greater than ¼ wave-length at h.f., and why h.f. is almost unaffected I leave to others to explain, but at 500kHz the antenna is always *less* than ¼ wavelength and its capacitance forms part of the pi-coupler resonant tank circuit. It is, in my opinion, change in antenna capacitance due to Kohlrausch Effect that is the cause of the problem at 500 kHz. For reasons of economics, the pi-coupler range of adjustment will be much less at 500 kHz than at h.f., due to the size of components required. The pi-coupler may be able to accommodate changes in aerial parameters at h.f. which it cannot accommodate at 500 kHz.

E.h.t. cable of the automotive kind would present some problems. Coated with salt water it might become a concentric capacitor, aggravating pi-coupler problems. It would lack mechanical strength and would not stand up to rough treatment; once the insulation was cut or bruised it would be rendered ineffective, and it does not lend itself to easy repair if broken by a wharf crane, for example.

John Wiseman

PROGRAMMABLE NOTES FOR MUSICAL INSTRUMENTS

Mr Waters is incorrect on several points in his letter in your January issue.

The system of temperament that was discarded when equal temperament was adopted about 140 years ago (not 250 as Mr Waters states) was mean tone temperament, not natural or just temperament. Mean tone temperament is based on natural temperament with a few judicious changes which produce harmonious music in 6 major keys and 3 minor keys. The remaining keys suffer from the effects of the changes and have rough harmonies. Handel and Bach had instruments tuned to this system. Equal temperament is an artificial system not based on the natural system at all. The result is that all keys have equally rough harmonies but music can be played in all keys.

The system I am proposing uses natural temperament, which sounds best, and allows modulation to any key. Surely, had such a system been available to Bach he would have adopted it in favour of equal temperament. I would be interested to find out in which ways Mr Waters's musician friends consider my proposal is retrograde since it has not been possible hitherto!

M. Robins
Bilton
Rugby

I was very interested in M. Robins's letter "Programmable Notes for Musical Instruments" in the November 1979, issue since I did some research on the possibilities a couple of years ago for my own amusement. I would like to mention, for anyone interested in pursuing this subject, the excellent treatise "On the Sensations of Tone" by Helmholtz, which is published by Dover with many extra appendices and tables; the theoretical work on harmony and tuning has never been bettered.

The information required by an instrument to perform a perfect job of just tuning is more complex than merely the key of the music. It requires some skill in analysing harmonies to derive the data, and more than a few extra keys to enter it into the instrument. I do not believe that performers would welcome additional manual input to the instrument of this complexity.

My research concerned a computer model of an instrument which would analyse the music in real time and tune from the knowledge gained. Actually, it is theoretically impossible to make a perfect job of this in real time, as M. Robins probably knows, because the context of the harmony must be known, including what follows. My work showed that only about half of the job could be done this way, and it would not be cheap, given the amount of computer power it consumes.

Just temperament is interesting, but it is not obvious that it is musically desirable all the time. Unaccompanied singing, such as the close harmony which I have done, tends to go flat, for good reasons related to the tuning changes that occur when modulating in just temperament. This would be unacceptable in an instrument. Further, the sound of chords in just temperament is very smooth and restful, lacking the high frequency beats which are normal in any other temperament. These are important, since they add "life" to the instrument, which would be dull and monotonous without them. The power of indefinite modulation, which arrived with equal temperament, is now such a central feature of music that it cannot be discarded, as would prove necessary with the progressive flattening otherwise encountered in just temperament.

I believe that just temperament is not a marketable feature, since the research and development costs would be considerable, as my work has shown. Nevertheless, it would be nice to see some organ manufacturer offer it as an optional (and no doubt very expensive) feature. Otherwise it should remain what it has been for the last few hundred years — a guide used by musicians, but not blindly followed, in aiming at acceptable compromises in tuning.

Michael C. Bailey
Winchester
Hants

C-D IGNITION PROBLEMS

Recent letters in *Wireless World* on motor cycle c.d. mentioned "false triggering" and "cross talk". My problem does not involve motor cycles but misbehaviour of c.d. ignition in cars of various units built. This shows up as a slight roughness in the engine at about 2000 r.p.m.

My first unit which showed this problem was the Marston, but a cure was effected by changing the triggering circuit to a unijunction circuit. Perfect operation was enjoyed for some months until the h.t. lead worked its way out of the coil, causing the thyristor and the unijunction to expire. Upon fitting new components, the unit once more worked but with this irritating misfire. Many hours of work produced no cure, so the Marston unit was regretfully removed. The distributor was even removed from the car as well as the coil and driven by a lathe while monitoring the h.t. voltage with a good oscilloscope, but this showed only a perfect train of sparks.

Then I came across an article in *Electronic Engineering* of December 1974 written by Jorgen Hoyer of Motorola, who advanced a most interesting theory as to the cause of this erratic misfire – to quote: "Very often the petrol/air mixture is far from being ideal. It may be too rich or too weak and usually is very unevenly mixed, in fact, an ignitable mixture may not have even reached the spark gap at the time the first arc occurs. Under these conditions an arc must be maintained for the lucky event where inflammable gas happens to move into the spark gap." Mr Hoyer goes on to describe a simple method of increasing the period. This he accomplished by connecting a suitable diode across the ignition coil primary.

However, this made no difference at all when tried on my car. Also a unit which would not function correctly on my car would perform well on a different make of car.

Another peculiar point is that tests were done on three identical units built on p.c.bs with machine wound inverter transformers. Two gave the same erratic miss but the third worked perfectly. No discernible differences could be found in the units, which were all factory built.

If any of your readers have had similar problems, I would like to hear from them as this is a problem I would dearly like to solve.

D. J. Bruyns
Witbank
Republic of South Africa

INTERFERENCE WITH MSF RECEPTION

A popular student project is the reception of the Rugby transmitter (MSF) which puts out time and frequency standards and can be used to drive a self-setting clock.

The service area is large; it is claimed[1] to include most of Europe but in some areas interfering signals may cause trouble. There is a powerful transmitter 1800 hertz away from MSF and in the Manchester area it is 10dB larger than MSF. In Preston it is 20dB larger. A relatively wide band receiver is needed to make use of the coded time signals and this project has defeated several of our students.

May we suggest that anyone considering the problem should do a few measurements in his area before building the complete clock? It would be interesting to know if your readers have ever had trouble with commercial equipment in this area.

Another source of interference is the fourth harmonic of the tv line timebase but this can be solved by moving the receiver.

T. G. Izatt
Preston Polytechnic
M. D. Samain
University of Salford

Reference
1. *Mullard Technical Communications*, Volume 14, Number 40, October 1978.

We understand that the interfering transmitter (on 61.8kHz) is in fact H.M.S. Inskip, between Preston and Blackpool. – Ed.

MAGAZINE PROJECTS AND KITS

It occurs to me that many of your readers may be puzzled as to why different companies quote such widely differing prices for kits of parts for projects in the magazines, and possibly a few words explaining this might be of interest.

The fact is that when engineers design/build projects, they use any materials which happen to be at hand, and then when the project is finalised, a list of parts is sent out by the magazine to the leading companies for pricing.

If completely standard parts, normally carried in stock by the firms concerned, are specified, then there is no problem, and all companies should be able to offer competitive prices. Unfortunately, this is seldom the situation, and very often special non-stock items have to be obtained. Even this in itself would be unimportant if one knew how many kits were going to sell, but it is usually pure crystal-ball gazing, and because of this the special parts have to be costed on a one-off basis.

Another problem is that for convenience a designer often uses a purely trade source to obtain his parts. This would not be particularly important if retailers were able to buy competitively from these sources, but one of the best and most reliable trade sources offers no discount for the retailer, and will not sell direct to retail customers, which means the retailer has to add his margin, and the end product becomes very expensive.

This letter is not meant as a criticism of designers or magazines, but might assist designers to provide economical kits. There is no doubt that if there was more liaison at the design stage with the retailers concerned many of these problems could be overcome.

J. N. Shipton
A. Marshall (London) Ltd
London NW6

HIJACKING CARFAX?

D. P. Leggatt of the BBC (October letters) in replying to Peter Manson's letter expresses optimism that the designers of the Carfax service have adequate means to control the security and authenticity of the information broadcast. Surely such a system is fundamentally vulnerable to hijacking for the following reasons.

Firstly, inexpensive Carfax decoders are going to be manufactured in large quantities; therefore their principles of operation cannot be inordinately complex. Secondly, some 80 genuine transmitters throughout the country will be quite openly broadcasting the "secret" initiation code every few minutes. Thirdly, test generators producing the appropriate signals will, no doubt, be extensively used in service workshops.

But, perhaps, traffic wardens will have their duties extended to ensure that no obscene, humorous or alien messsages are being transmitted.

Mandy Peterson
Swindon
Wilts

The BBC replies:
Mandy Peterson will not let me get away with my rather generalised statement on Carfax security, and she makes some very relevant comments.

Certainly 'secret' initiating codes would have their limitations, but there are other techniques available including comparisons between the originated and transmitted signals.

As ever, it will be difficult to ensure absolute security and I must confess that our obscenity detector is not yet perfected!

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

REVERSE POLISH NOTATION

Concerning the comments on Reverse Polish notation by W. H. Powell in August letters, I for one certainly prefer the normal Basic notation as opposed to its Reverse Polish form. The last-mentioned may be useful when minimising keystrokes on a calculator, but my policy is to make the machine do the work.

However, the notation for formulae is not of great significance. Far more controversial is Mr Powell's belief that languages should use Reverse Polish notation throughout (presumably including key words like IF, ELSE) for efficiency. I would suggest that his notions of efficiency are concerned purely with the output from a compiler (i.e. smaller, faster) and should not influence the appearance of the written program, which one hopes is a clear, readable document making use of control and data structures (Pascal perhaps?). Apart from certain high-speed, real-time applications, I have no objection to clearly readable programs with a few inefficiencies.

Michael Parr
Barnsley
West Yorkshire

DIGITALLY CONTROLLED ATTENUATOR

I read the Circuit Idea on the digitally controlled attenuator by Mr S. R. Taylor, in the December issue with interest. The AD75XX series of c.m.o.s. d-to-a converters are all inherently 4-quadrant multiplying devices. They can all therefore be used for audio applications, one of which Mr Taylor describes. It is not a large step of course to implement a stereo balance and volume control system using two such circuits running from updown counters fed serially.

Perhaps I could emphasize one or two general points with regard to such audio applications. Compared with analogue-controlled electronic attenuators, digitally-controlled attenuators offer some distinct advantages. Total harmonic distortion figures are significantly better, bandwidth is significantly wider and noise immunity greatly improved. In addition, such systems have the facility for remote operation under touch-switch or microprocessor control.

Could I also make a recommendation with regard to Mr Taylor's circuit? The selection of the operational amplifier should be done with care. The output resistance of the d.a.c. changes with code-setting (as does its capacitance). This means that an amplifier with a large input-offset should be avoided as a code-dependent variable output-offset will result. This may produce significant noise during code change. As the d.a.c. has a few pF output capacitance typically 37-120pF (depending on code), capacitive feedback-compensation must be employed when using wide-bandwidth amplifiers. This is usually about 10-20pF depending on the amplifier.

Instability may occur at some code settings if no compensation is used. Mr Taylor shows a gain-adjust potentiometer in the feedback loop of his system. I would suggest a fixed, low noise, resistor of value 1kΩ in the feedback loop and include a 2kΩ adjustable resistor in the in the input line to the AD7520. (However, I suspect that there is only a limited need for a full scale absolute accuracy of better than 0.1% in anything other than test equipment).

In conclusion, perhaps to back up the above comments, Mr Taylor and other audio engineers may be interested to know that Analog Devices intend introducing a device specifically aimed for the audio field, the AD7110, in mid March 1980. The AD7110 is a monolithic c.m.o.s. digitally controlled attenuator in a 16-pin d.i.l. package. The analogue output voltage decreases logarithmically as the 6-bit digital-input code increases. The attenuation range is 0 to 88.5dB (plus full muting facility) in 1.5dB steps. The total harmonic distortion is better than −98dB (0.002%) and the signal-to-noise ratio is 124dB. When tested with a commonly available audio op-amp, a bandwidth of 0 to 250kHz was observed.

M. I. Stephenson
Analog Devices B.V.
Limerick
Republic of Ireland

WHAT'S SO NATURAL ABOUT e?

I would like to suggest two thoughts on the article "What's so natural about e?" by J. C. Finlay in your December 1979 issue. First, perhaps I have missed something, but I do not see how memorising or writing a "trick" such as 193/71 for e is easier or simpler than memorising or writing e itself. Particularly since if you have memorised e to five decimal places (2.71828) you have also memorised it to nine decimal places (2.718281828) because of the repetition of the "1828" digits.

Second, I agree that it is a nice touch for some calculator manufacturers to print values such as e on the calculator. However, we are not limited to what the manufacturer may print on the calculator. I find it convenient to keep a small data booklet in my calculator case, and to consider the booklet as an accessory for the calculator.

In closing, I enjoyed reading the article, and the rest of the issue, and look forward to receiving *Wireless World* each month.

Tenny Lode
Englewood
Colorado, USA

AND NOW THE PICOBEL

Contrary to Anne King's letter (November 1979), the millibel has immediate and important application in musical recording/reproduction systems. In fact, a lengthy article in *International Audio Review* 3 was devoted entirely to the ear's sensitivity to 2-5 millibel deviations in frequency response, and the consequent need for very precise RIAA de-emphasis in phono preamplifiers.

This article discussed how those traditional experiments, which established the entrenched belief about our hearing insensitivity to *loudness* changes on *single tones* of less than 1 dB, are irrelevant to our hearing sensitivity to *frequency response* deviations on *broadband signals*, such as music.

Our experiments have established that we can hear frequency response differences in the 2-5 millibel area, as has empirical work by our friend Stanley Lipshitz and others. Not only can we reliably detect that there *is* a difference (which is a sufficient criterion to establish an auditory threshold). The difference is so clearly perceivable that we can correctly *describe* it, qualitatively, and, yet more remarkably, quantitatively.

For example, we aurally compared one pre-amplifier against a straight wire on music. In spite of the masking presence of the pre-amplifier's distortion byproducts, which seemed to add distorted bright energy to music above 5kHz, we also heard what seemed to be a purely tonal balance anomaly. We aurally judged this anomaly to be a plateau hinged at the 2120Hz RIAA breakpoint, and estimated its magnitude at 20 mB. Only then did we measure the pre-amp. Its actual RIAA frequency response was flat – save for a plateau hinged at 2120Hz that measured 20 mB in magnitude (±1 mB). The pre-amplifier's designer and manufacturer, who witnessed this experiment, asked why we even bothered with measurements, if the human ear could be that perceptive and calibrated.

Incidentally, our measuring technique presented in *IAR 3* can reliably measure down to about 0.2 millibels, unlike the 0.5 dB limitation of Ms King's meters. And since *IAR 3* we have extended our measuring sensitivity (using differential techniques) into the *picobel* region. Therefore, and in sympathy with Mr Marks' desire to end decimal point confusion, I herewith enter a plea for the picobel as the standard unit of commerce! Also, if we are to capitalize engineering unit names in deference to the scientists they honour, let us do the job right and revert from bel to Bell, not Bel. That bell which tolls is hardly ever capitalized, so the confusion should be minimal.

J. Peter Moncrieff
International Audio Review
Berkeley
California, USA

In the UK it is standard practice to use capital letters for the abbreviations of unit names but not for the full names. – Ed.

LIQUID-STATE AMPLIFIER

The late Professor Fleming's account of the thermionic diode (November 1979 issue) reminded me of a little search for the 'missing' counterpart of the vacuum gas and solid-state devices – the liquid-state amplifier.

Although it might be argued that this is the biological amplifier of choice, as, for example, in the form of the 'cochlear microphonic' signal generator available in the mammalian ear (a signal capable of driving an ordinary audio amplifier), I was interested to find that a liquid 'ionic diode', at least is easy to arrange. A diode made with a platinum wire and a silver/silver-chloride wire dipped in dilute sulphuric acid gave a forward to reverse conductance ratio better than 25:1 for signals of less than ±100mV amplitude d.c. Moreover, Professor Fleischmann (Southampton) was able to describe a two-membrane 'ionic triode' which he constructed as a research student in 1947.

Considering the speeds of the various charge carriers estimated below:

$> 10^5$ m.s^{-1} in a hard valve,
$< 10^{-2}$ m.s^{-1} in a copper wire,
$\sim 10^{-7}$ m.s^{-1} in an ionic liquid,

for an electric field of 1V.m^{-1}, I expect the frequency response of the wet triode is, well, wet.

B. Whatcott
Addlestone
Surrey

Electronic combination lock

Non-volatile logic devices give easy programming and long-term storage

by Alan Oakley, B.Sc. Plessey Semiconductors

This article describes how an ordinary key operated mechanical door lock can easily be converted to a 4-digit, multi-code electronic security lock, using non-volatile logic devices. The data in these devices can be altered easily but once entered can be retained for a considerable time even in the absence of applied power. The 4-digit combination codes are easily programmed and the versatility of the design means that the system does not need clearing down. It is a simple matter to extend the system from a 4 digit code (some 65,000 odd combinations) to any greater number of codes by adding more quad latches. Apart from the normal door latch such a system could find application anywhere where access is to be restricted, and could also be converted to be remote controlled.

The MN9102 quad latch is one of the NOVOL range of integrated circuits produced using the Plessey 'metal-nitride-oxide-silicon' (m.n.o.s.) process. This is essentially a p-channel, metal-gate process, but with the additional feature that variable-threshold memory transistors may be fabricated alongside conventional fixed threshold m.o.s. transistors. These memory transistors can be used to retain data even in the absence of applied power and therefore provide the facility of non-volatile data storage in standard m.o.s. circuits.

Data may be stored in the MN9102 for at least one year, in the absence of applied power, over a 0°C to 70°C temperature range. The device runs off standard m.o.s. supplies of +5V and −12V which are used internally to generate the high-voltage supply normally associated with m.n.o.s. memory devices, and requires only a single external capacitor to act as a charge reservoir for supplying current when writing into the memory. The data that is applied to the four inputs is written into the memory when the SAVE control is taken to a logic 0 level and the data subsequently appears on the four outputs. Typically, ten million 'save' operations may be made before the performance of the device is impaired. The stored data is automatically restored to the outputs whenever power is reapplied. An output enable is also available which, when taken to a logic 0 level, presents a high-impedance state on each data output line, thus permitting multiplexed operation.

The digital security code system uses the MN9102 quad latch to store hexadecimal digit data in the absence of applied power. When this data is interrogated with the correct incoming data from a keyboard there is a 2½ second delay before an electro-mechanically operated mortice catch is opened for 2½ seconds. The delay and opening times may be varied easily and are included to improve security and conserve power. The number of digits in the security code is totally dependent on the number of quad latches.

Data is entered into the system via a hexadecimal keyboard with a diode/resistor decoder, if a 16, single-pole output keyboard is used. Alternatively, the data may be entered using a 16 key encoder (74C922) if a 4 × 4 matrix output keyboard is in use. Either system generates the four data signals and 'anykey,' which is normally low but goes high when a key is pressed; this signal is used to generate the timing pulses. The four data signals are fed into a c.m.o.s. quad D-type flip-flop (74C175) which is clocked by SRCLK, generated from two monostables gated with 'anykey' to prevent any keyboard bounce effects. Once clocked, this data is then compared with the stored data in the MN9102 using a c.m.o.s. four-bit magnetic comparator (14585). If the keyboard data is the same as the stored data, then the A=B output of the comparator will go high. For more digits the quad latches, comparators and flip-flops are cascaded as follows. The outputs of the *n*th flip-flop are connected to the inputs of the $(n+1)$th flip-flop, with all the 74C175 connections the same: i.e., SRCLK to CLK, clear held high, and all the Q outputs unused. The outputs of the *n*th flip-flop are also connected to the inputs of the *n*th quad latch (for use in programming), and to the 1st set of inputs of the *n*th comparator. The outputs of the *n*th quad latch are connected to the second set of inputs of the *n*th comparator, of which the *n*th A=B output is connected to the $(nth+1)$th A=B comparator input. Other common connexions are A>B and A<B held low with their respective outputs unused for the 14585, and output enable held high and Save inputs common for programming on the quad latch.

When a 4-digit code is stored the following sequence of events will occur when the code is interrogated. If, for example, the code stored was 9102, the data stored would be with 2 in latch A, 0 in latch B, 1 in latch C and 9 in latch D. The 9 when entered would be clocked in to the output of flip-flop A and compared

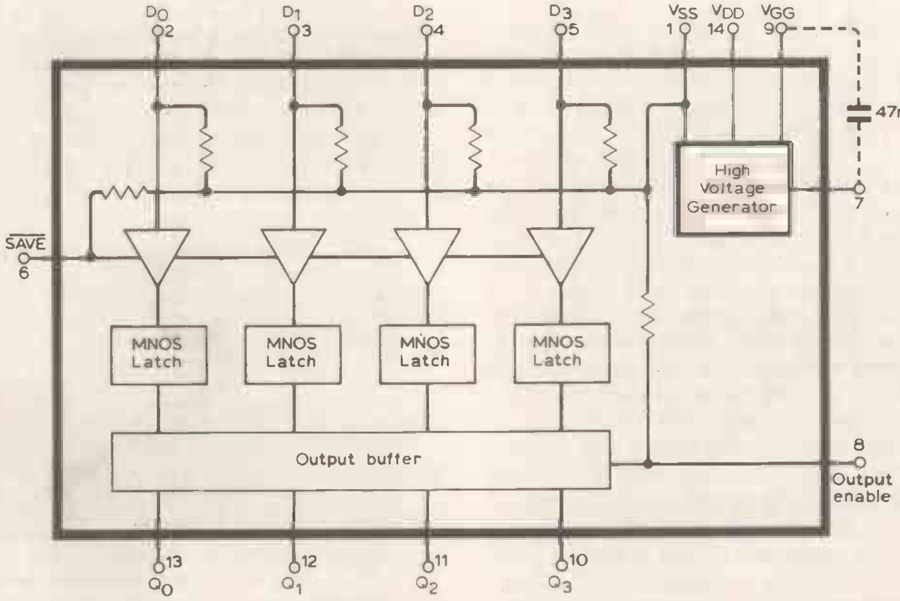


Fig. 1. Internal block diagram of MN9102 quad latch.

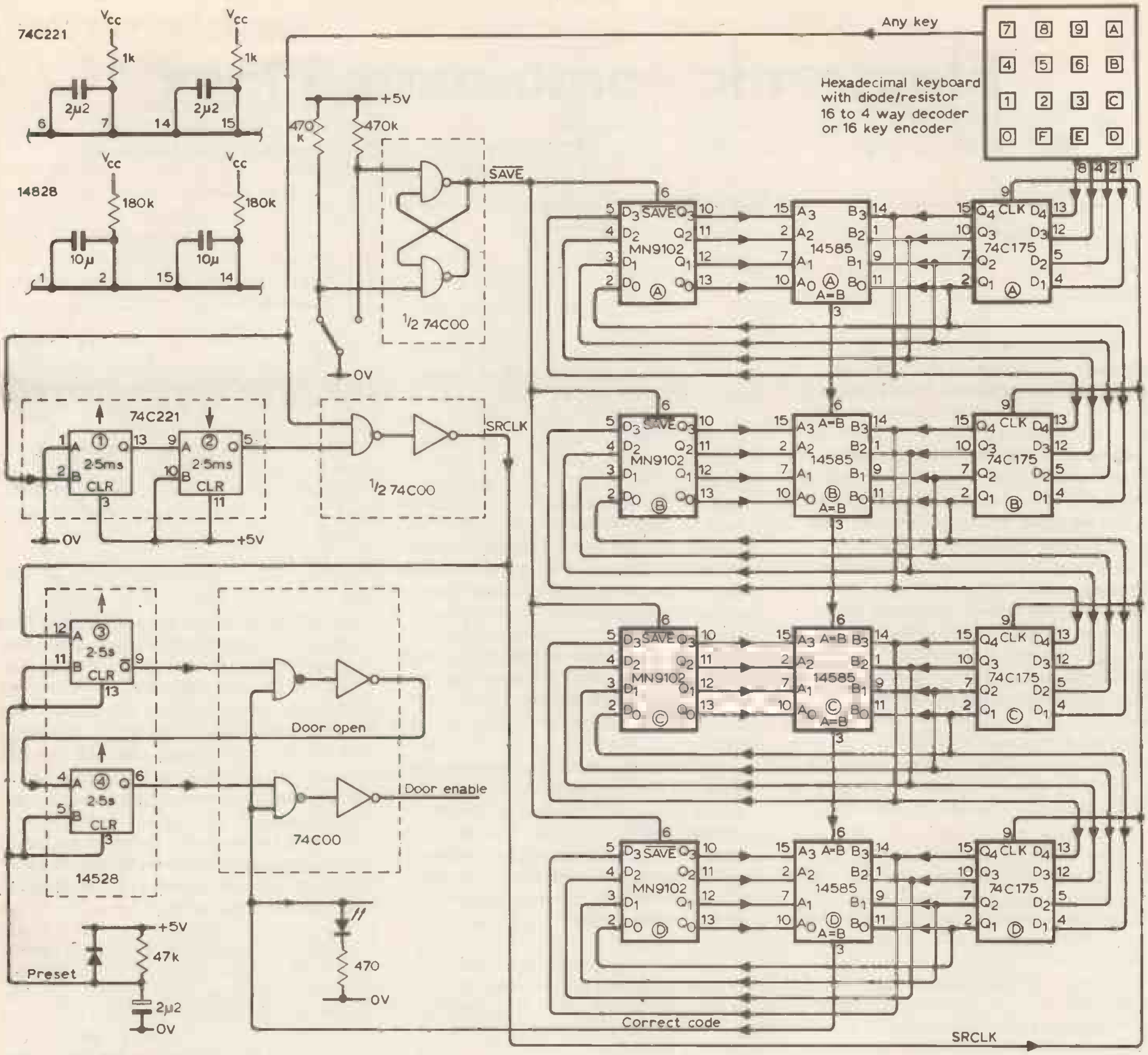


Fig. 2. Circuit diagram of lock logic.

with 2 in latch A, giving A = B on comparator A as a low level. When the 1 is entered, the 9 is clocked to the output of flip-flop B and compared with the 0 in latch B; hence A = B out of comparator B will also be low level. The 1 will be at the output of flip-flop A and will be compared with the 2 in latch A, so the A = B output on comparator A will remain low. The third digit 0 will cause the 9 to be clocked to the output of flip-flop C, the 1 to the output of flip-flop B and the 0 to the output of flip-flop A. The A = B output of comparator C will be low, as will the outputs of the other two comparators. The final digit 2, when entered, will cause the correct digits to fall in place with the stored data, hence the 2s will match in position A, the 0s in position B, the 1s in position C and finally the 9s will match in position D: the A = B outputs of all comparators will go high, indicating that the code was correct.

To program a new code, it is entered and the Save inputs to all latches are held low for at least 10ms, by pushing a switch for that time. The switch poles are connected to the inputs of a bistable, which have pull up resistors to +5V, and the centre pole is at 0V. When the switch is operated, the outputs change state, giving a high-to-low transition on on one of the bistable outputs, going high again when the switch is released: it is this signal which is used as the common Save.

To make the system more secure

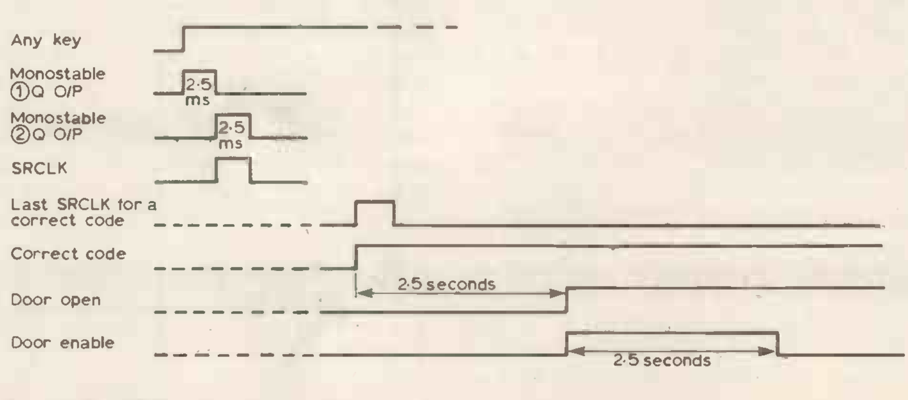


Fig. 3. Timing diagram of logic.

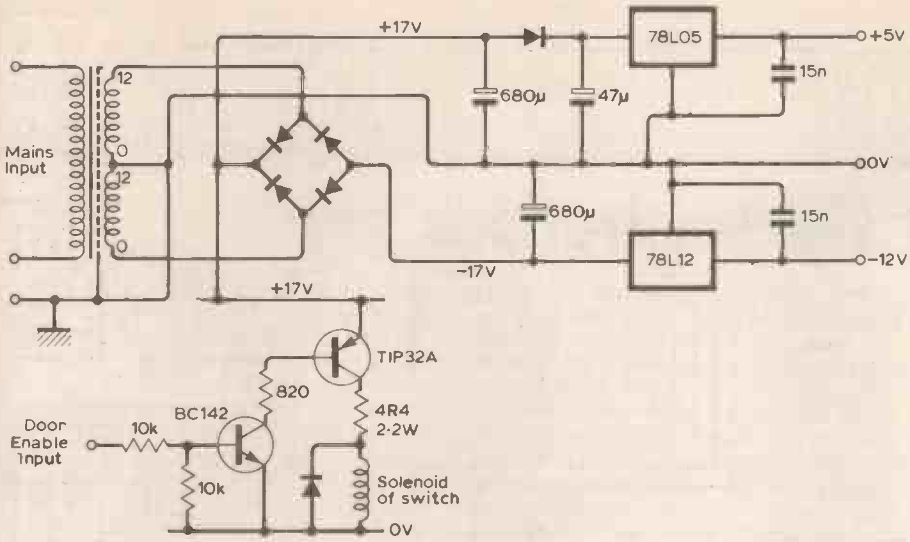


Fig. 4. Power supply and switch driver.

there is a 2½ second delay after the correct code has been found. This is achieved by means of a 14528 retriggerable c.m.o.s. monostable, which is positive-edge triggered from SRCLK, and initially preset with a delayed power-up pulse. When Q goes high again it is ANDed with 'Correct code' to give 'Door open', which is normally low but which goes high 2½ seconds after 'Correct code' goes high. The positive edge of 'Door-open' triggerrs another 14528 retriggerable monostable whose Q output, when it goes low again after 2½ seconds, is ANDed with 'Correct code', thus producing a 'Door enable' pulse. Although this signal is normally a low level, going high 2½ seconds before going low again, the values of the resistors and capacitors on the monostables may be varied to give different 'Door enable' delays and widths. The 'Door enable' signal is used to drive two bipolar transistors, which in turn activate the electromechanically operated mortice. The second inverter consists of a high-power p-n-p transistor, which is designed to switch between the unregulated supply and zero volts to provide 1.5 for the solenoid. A l.e.d. and resistor are used to indicate when the door is open

Further modifications may be made to the outlined system with provision to activate an alarm when more than three incorrect codes are entered or possibly control the logic remotely, depending on the user's requirements. The system described would need only the minimum modifications. □

Clock timer — 2

continued from page 52

memory and change the display accordingly. Pressing more than four keys should repeat the writing process. Pressing the Alarm key should access the memory for the next alarm time. Incorrect times may be entered such as 30.15 to fill up unwanted space if sixteen alarm times are not required. Alternatively, the alarm times may be repeated.

Assemble the comparison detector and relay driver and with IC_{13} omitted, connect pin 5 of IC_{14} to test point 1. Set an alarm time to the actual time, leave the switches at Set Alarm and display test point 1 on an oscilloscope which should follow Fig. 13(a). Display test point 3 and adjust R_{43} until the negative going edge occurs 0.5ms before the negative edge at test point 1. Set an alarm time so that only tens-of-hours, hours and tens-of-minutes digits agree with the real time. Leave the switches at Set Alarm and check that the waveforms agree with Fig. 13(b). Insert the remaining i.cs and adjust R_{46} for a suitable output pulse length. Note that if the value of R_{46} is too low, IC_5 is retriggered and produces a double output pulse. If the timer does not operate correctly when the tested circuits are connected together it is probable that 100Hz ripple on the 10V supply is turning Tr_2 off every 10ms which produces spikes on the power fail line. This is easily cured by increasing the value of C_3.

Modifications

The output of the 555 timer is t.t.l. compatible and can directly drive a variety of interface units. A simple flip-flop enables an external circuit to be switched on at one alarm time and off at the next. A counter and decoder allows the system to be expanded for the control of several different devices. The alarm-enable/inhibit circuit can be modified to select one of two different alarm-time programmes by taking the alarm-inhibit line to a spare address input on the memory, pin 3 or 21, and grounding pin 13 of IC_{13b}.

Up to 64 alarm times can be obtained by adding two flip-flops to the chain in IC_7 and connecting the two new outputs to the spare memory address pins. If the alarm-enable/inhibit section is not required, the circuit can be omitted except for IC_{21c}. Alternatively, if the alarm-enable/inhibit section is duplicated and the two alarm-inhibit lines are connected to the spare memory address pins, four alarm-time programmes are obtained. If this modification is made, the control logic IC_{16b} and IC_{16c} must be altered so that keys 0, 1, 2 and 3 select the appropriate programmes.

The timer can be used with a conventional digital clock which has a suitable multiplexed display and multiplex control lines coded in binary. A midnight pulse and the inputs to IC_{13a} and IC_{13b} have to be decoded from the display. The five inputs to IC_{13} can be replaced by the tens-of-seconds C bit driving a monostable to give a pulse of at least 100ms duration at the start of each minute. If switch-on-reset is not needed the set-time-pulse input is grounded and the circuit around Tr_7 Tr_8 omitted.

Acknowledgements

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NEWS OF THE MONTH

Finniston — what the Institutions say

The long-awaited Finniston Report (see p36 Jan., p88 March and p46 June, 1978 issues) has now been officially published, some weeks after much of it had been leaked. Having had time to consider the proposals in the report, the professional institutions are welcoming it, but they also have reservations.

The Council of the IERE was disappointed to find that the Finniston Committee had little to say about what the IERE considered to be the root cause of the inadequate performance of the nation's manufacturing industry, namely the general lack of enthusiasm for work at non-professional levels and the consequent low standard of industrial relations within many areas of British industry. They also regretted that the summary report failed to give credit to the engineers concerned with the design and manufacture of electronic equipment and with systems engineering, and that it did not reflect "the high regard in which the British electronic and radio engineer is held overseas."

This institution particularly endorsed the committee's recommendations to improve and extend the balance of theory and practice in the pattern of education and training for the engineer of the future. The Council also welcomed the formation of the British Engineering Authority, and in particular the proposal that this would endeavour to bring together groups such as working engineers, employers, engineering teachers, public agencies and the Government, who have common interests but who, at present, tend to act in relative isolation from each other because there is no active mechanism for linking them.

Concern was felt about the proposal that the Authority would maintain an "expert staff" to implement its policies. This proposal, they thought, could deny the Authority direct access to the institutions, which according to the IERE are "the focal points of the best expertise available in each of the engineering disciplines at both Board and working levels". It is the IERE Council's view that this would also create an unnecessarily expensive new area of bureaucracy for the registration of engineers in place of the present self-financed resources available in and through the engineering institutions. However, the Council was pleased to note the recommendation that the learned society task of the institutions might be advantageous to the profession as a whole. "This", the council said, "reflected the point made by the IERE President, Professor Gosling, in his 1979 Inaugural Address, that it was perhaps time that they gave careful consideration to whether the engineering profession was not now two professions — the old with its scientific basis of Newtonian mechanics and the new, as represented by the IERE, whose business was founded on quantum mechanics and the new concepts of network theory, control theory and information science".

Finally, the IERE was relieved to see the Finniston team's unanimous view that the new statutory register must embrace the current stock of engineers as well as the engineers of the future. They were, however, very concerned to note that the Committee could not agree on how this should be done.

The IEE particularly welcomed the proposed distinction between courses for students and engineering students, each involving substantial cooperation between industry and the schools of engineering. They also welcomed the committee's hope that registration by the engineering authority would become in effect a licence to practice, but regretted that the Committee had not put forward firm proposals for legislation to implement that view. "If registration does not open avenues of employment in limited areas otherwise closed to engineers, the authority will be deprived of the strength needed to implement its policy", said an IEE report.

The Chairman and Officers of the CEI, after discussions with the presidents of member institutions and the chairman and senior members of the Engineers Registration Board (ERB), made a statement in which they endorsed the Finniston Report's analysis of the ills of the British manufacturing industry and its broad objectives for recognising and improving the contributions to be made by professional engineers. The council particularly supported the view that employers must be encouraged to look on their engineers as valuable investments to be developed, rather than assets to be exploited; and the need for thorough practical training for engineers in industry. The CEI, however, had reservations about the proposed methods of attaining these objectives, and the relevance of these proposals to the practical and urgent needs of manufacturing industry, they thought, would require critical examination.

According to the CEI, the benefits to industry claimed by the Finniston Report could be achieved much more cheaply and quickly by an evolutionary process — that of developing the already existing machinery of the engineering institutions to meet the broad objectives set in the report — rather than by the revolutionary process of replacing this machinery, which operates in the public interest under the authority of the CEI's Royal Charter, by the British Engineering Authority.

The CEI was strongly opposed to the recommendation that all members of the proposed BEA should be appointed by the Secretary of State, as they saw this as having their affairs taken out of their hands — it is characteristic of all professions in the UK that they are mainly self-regulating and consist of members who have been elected or nominated by the profession itself.

Being aware that the new engineers — products of the proposed education arrangements — could not become fully qualified engineers before the late 1980s, and that for the next half-century the majority of practising engineers will be those who now exist or who are under training by the present methods, the CEI warn that unless the morale of these engineers and international confidence in their ability are fully maintained, very great damage would be caused to the national interest.

The CEI considered that the report's failure to make any proposals for improving the education, training and progression of engineering technicians was a serious weakness.

A union view

Ken Gill, General Secretary of the Technical, Administrative and Supervisory Section of the AUEW was disappointed with the Finniston Report because the Committee of Enquiry had failed to deal with the pay and status of engineers. "It is surprising that in a report of 253 pages only about six pages are devoted to engineers' pay and the role of the trade unions in the engineering industry", he said. TASS, he said in a recent report, blamed the engineering professions' lack of status on inadequate salaries and the lack of rational salary structures. "If urgent consideration is not given to raising the salary and status of engineers, the British manufacturing industry will fail to attract and recruit a large enough number of new engineers", he added.

"In the beginning......"

Analysis of the cosmic microwave background radiation left over from the "big bang," the primordial explosion which it is believed began our universe, suggests the existence of clusters of galaxies containing hundreds of millions of stars. Data collected by NASA's U-2 aircraft in the upper atmosphere from remnants of radiation points to the conclusion that the Milky Way galaxy, of which we are a part, is hurtling toward the constellation Virgo at more than a million miles an hour, under the gravitational influence of a "supercluster" around it.

University of California scientists believe the supercluster contains 30 to 40% more galaxies than are normally found in the same volume of space and that it may be 2 billion light years across.

The supercluster would account for about 1% of the volume of the observable universe, which extends through 10 billion light years of space. Dr. George Smoot has pointed out that not enough time has elapsed since the "big bang" for such a supercluster to have formed, which implies that such a gigantic concentration of mass dates back to the beginning of the universe: "If one such huge concentration of matter exists," says Dr. Smoot, "there are probably others."

The new findings introduce an element of doubt into the previously accepted idea that the event which started the universe about 15 billion years ago was a powerful but tightly controlled expansion of matter in all directions at a uniform speed. The supercluster's existence implies that the primordial fireball was "lumpy" and that the vast forces released were by no means uniform in their effects.

BBC responds to WARC '79 frequency proposals

In a recent engineering press statement the BBC outlines its reactions to the WARC '79 frequency allocations, those for Region 1 having been given in our February 1980 issue.

The Corporation's response is generally favourable where domestic broadcasting is concerned, but is "less happy with the implications for external services on the h.f. bands." For domestic radio broadcasting, extension of the v.h.f. band II to 108 MHz is welcomed. Although formal international agreement does not provide for complete clearance for broadcasting use until 1995, some additional programme channels can be made available much earlier than this, and services which now have to share the three national v.h.f. channels can be separated. The band II extension is also welcomed for the future development of local radio services.

Allocation of the sub-band 519.5-526.5kHz is welcomed for use with the BBC Carfax motoring information system, but such use is subject to non-interference with navigational beacons in neighbouring countries; the BBC would have been happier with an exclusive allocation.

Extension of the v.h.f. television band III by two 625-line channels will be of value if this band is to be re-developed after closure of the 405-line service. The current WARC proposals require the closure of this service by 31st December 1986, although the Annan report suggested a phased programme of closure beginning in the early 1980s. On the u.h.f. television bands the provision of up to four additional channels will considerably ease the planning of further extensions of u.h.f. coverage throughout the country.

Allocations for s.h.f. satellite links are also welcomed, but the rearrangement of the h.f. bands for overseas broadcasting falls considerably short of the BBC's wishes, especially at frequencies below 9MHz where no extensions have been agreed.

The statement ends with the BBC asserting its support for the reservations entered by the UK and the USA delegations to the conference, retaining the right to "take whatever steps may be necessary to maintain the effectiveness of our external services."

Scripts by wire at Bush House

Two mini-computers and an array of disc storage units form the heart of a "scripts by wire" system now in operation at the BBC's Bush House, the Overseas Broadcasting department's headquarters.

Some 30 million scripts covering news stories, talks and features can now be distributed each year by electronics to more than 200 outlets in the complex. The central newsroom contains 39 v.d.u.s and journalists dictate their stories to operators who type them into the system. Once written, the story can be directed by the computer to specific language sections and can be printed out in individual offices.

Both short pieces and longer talks can be written into the system which can accommodate items of up to 5000 words; news stories are kept on file for seven days, current affairs talks for 14 days and general features for 100 days.

A selective "list" can be drawn up on the v.d.u. according to subject matter, or the full list of talks may be checked. On the other hand, stories which only apply to a particular part of the world may be called up for display.

The electronic distribution system is controlled by two General Automation 16/440 mini-processors. Both are in continuous operation and receive the same input, but only one provides output. If a fault occurs, the standby processor can take over immediately. Each processor is associated with a 2 megabyte fixed-head disc and a 24 megabyte disc pack drive. New material is entered on magnetic tape and later transferred to microfiche for archive storage.

Each of the 137 v.d.u.s distributed around the building can undertake full text editing, but only those in the news, talks and features areas are free to amend stories in the central store. Hard copies are available from 85 printers strategically placed amongst the offices.

Ken Clayson, engineering manager in charge of the new system says, "The system is saving an enormous amount of time and paper and it lets us make far wider use of the material we prepare. Every one of the broadcasting sections at Bush House now has access to every script prepared here. In the days when we relied entirely on paper that was just not possible."

The hardware was provided by the data system division of ITT Business Systems to a specification set up by the BBC's Capital Projects Department.

Microwave unit detects cancer

An instrument containing a sensitive radiometer capable of measuring temperature variations of less than 0.1° Celsius (0.2°Fahrenheit), part of a microwave applicator made by Microwave Associates, an American company, is being used to locate and possibly destroy cancerous tissue. The equipment has located tumours in 14 known cancer patients and has detected a cancerous site in one patient which was not revealed by the use of conventional techniques.

The principal advantages offered by the new instrument are that it does not emit harmful radiation, can be used outside the body and could become relatively inexpensive if mass-produced.

Cancerous tissue is hotter than healthy surrounding tissue and conventional methods such as infra-red thermography can detect tumours near the surface of the skin, but the new method permits checking at a much deeper body level.

If the instrument proves itself effective, after an extensive series of hospital and laboratory tests, it could become standard equipment in doctor's surgeries. Patients could be quickly and easily tested for many forms of cancer, just as they are now tested in a routine manner for heart malfunction by means of an electrocardiograph.

The treatment side of the new instrument's use would involve microwave heating of a tumour to destroy cancer cells. Tumours have a relatively poor vascular system (compared with healthy tissue) and researchers believe that a tumour will heat faster and remain hot longer than surrounding tissue because there are fewer blood vessels to carry the heat away.

The next stage in the instrument's test programme will be its use on cancers in large animals in the Norfolk, (Virginia) Medical School laboratories.

Mullard to "axe" 900 jobs

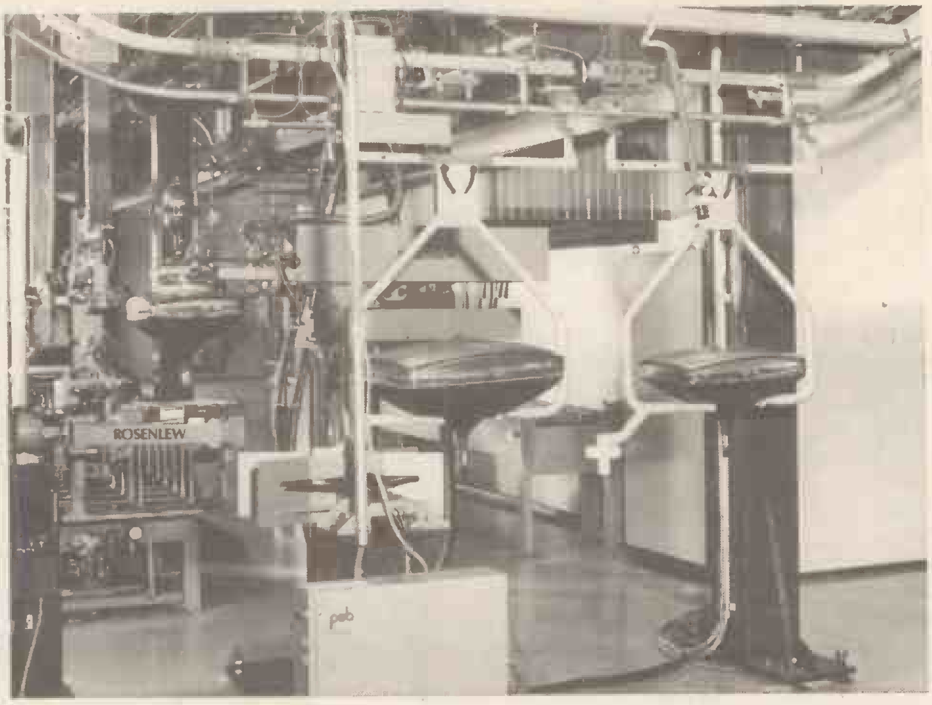
Mullard's decision to "streamline" its tube production business will, according to a report in *The Times*, 16th Jan 1980, result in the loss of 900 jobs at its Durham and Simonstone, Lancashire works.

The main changes, to take place over the next two years, will involve further automation and alterations to quality control departments; these moves are seen as necessary to compete with the high output of quality tubes and tv receivers from Japanese manufacturers and in the face of the development of domestic products using tv-like tubes.

The National Economic and Development Office has recently identified certain trends in the tv and components industries and a study of production costs of colour television sets in the UK, Japan, South Korea and W. Germany has shown that Japan in particular gains a high cost advantage from its overall higher level of investment in advanced automated plant, superior efficiency in manufacturing and design and more rigid quality control of components.

The Mullard decision reflects an awareness of these findings and also links up with NEDO's main recommendations which include the "rationalization" of UK tv production into larger units producing five times the current number of receivers, more involvement directly with Japanese technology, to improve and introduce more new designs and to carry out more research and development.

Only about 100 of the threatened jobs will go in 1980 and Mullard says that it "intends to continue to invest substantially in the picture tube business."



A modern tv tube production line in Finland using "Japanese" technology, in this case a Hitachi range of 20in, 22in and 26in tubes of the "in-line" variety, featuring quick-start heater, 110° deflection angle, temperature-compensated shadow mask, electrostatic focusing and self-converging integrated neck components. This automated plant, operated by the Automation Group, Valmet Oy, Finland is expected to be producing about 500,000 tubes by the end of 1981.

Multi-l.e.d. aircraft instruments under test

A 4in by 3in screen incorporating more than 49,000 l.e.ds, providing a resolution of 64 lines per inch is currently being evaluated by the USAF Flight Dynamics Laboratory as part of a joint project between the USAF and the Canadian Department of Industry, Trade and Commerce.

The device is intended as a replacement for the mixture of dials and c.r.t. displays at present found in aircraft cockpits; it is computer-controlled and is designed to provide the pilot with information on various subsystems, such as navigation or weapon delivery. This information can then be called up at the flick of a switch, the data being depicted on the l.e.d. screen.

Walter Melnick, of the Flight Dynamics Laboratory says that the new display system is an advance on the c.r.t. form due to its less cumbersome nature and higher reliability — he estimates a c.r.t. display life of 500 hours and an l.e.d. display life of 10,000 hours. Furthermore, while all information can be lost in the event of tube failure, even if several thousands of l.e.ds fail, the display can still be read.

Several technical solutions to the problem were examined before deciding on the l.e.d. method, and this was eventually selected because it is adaptable to the "building block" mode of construction, where one inch squares of the diodes can be assembled into a variety of display sizes.

Bowmar Instruments, of Weybridge, are the UK representatives of the makers of the display, Optotek Ltd. of Canada.

Getting wise to electronic mail

According to a report from Mackintosh International and Communications Studies and Planning Ltd, organizations which rely on post and telecommunications services should urgently review their communications needs to take account of the opportunities presented by "electronic mail."

The report, entitled "Electronic Mail: user alternatives in the 1980s" stresses that it is not too late to take advantage of the cost-effectiveness of equipment and services currently available. However, prompt action is necessary, says the report, because users must take transitional measures over a period of time to ensure that the benefits of the new equipment, such as communicating word processors, text and graphic terminals and the next generation of "facsimile," are realised.

One of the report's main aims is to advise non-technical business users about the scope and benefits of electronic mail equipment and services on offer from manufacturers and telecommunications authorities. It also stresses that users should prepare for the introduction of the enhanced telex service, to be known as Teletex, which begins operation in Germany and Sweden sometime in 1980.

Disobedient spacecraft

Radio contact with Voyager 1 was lost on 3rd January just after the spacecraft had been commanded to turn in space and fire thrusters for a trajectory correction. The manoeuvre apparently took place but the antenna alignment was not entirely successful. However, later in the day NASA controllers received confirmation that command signals intended to switch on the low-gain antenna and place it in a two-way reception mode, had been received and executed.

Efforts are being made to correct the antenna/Earth alignment, the problem requiring some analysis to ensure that attitude control fuel is not wasted.

Voyager 1 was launched in September 1977 and flew past Jupiter in March 1979. The spacecraft is now 660 million miles from Earth and is scheduled to encounter Saturn in November 1980. Voyager 2, a sister craft, is due to encounter Saturn in August 1981.

News in brief

The FCC is proposing to award additional frequencies for c.b. use on s.s.b. operation and may also liberalize rules on the distances c.b. stations are permitted to work over. The use of variable frequency oscillators may also be permitted.

Car to telephone service launched in Norwich

A new car telephone service, claimed by Air Call Ltd. as the first of its kind in England, was started in Norwich on the 21st January 1980.

This service, known as "interconnect", enables direct two-way communication between a car telephone user and subscribers to the public telephone network and is now available to Air Call's East Anglian customers. The company's branch manager, Derek Cunningham, says that Interconnect will be available to subscribers in addition to the existing range of services, which includes message handling, "talking bleeper" and telephone answering services.

In order to house the additional equipment required, the Norwich control complex has been moved to larger premises in the city centre, and plans have been drawn up to extend the Interconnect service to most of the company's 34 control centres during the coming year.

Car telephone users can take advantage of the new service without necessarily changing the equipment in use; the cost of all messages and inland telephone calls is included in the rental charge.

ITT researcher wins award

Paul Barton, a research engineer with Standard Telecommunication Laboratories, has received the William E. Jackson award from the Radio Technical Commission for Aeronautics (USA).

Mr Barton won the award, consisting of an honorarium and commemorative plaque, for his thesis, "Airborne Signal Processing for the Microwave Doppler Landing System," submitted for a Ph.D degree from University College, London. He graduated from Churchill College, Cambridge with an honours degree in mechanical sciences and joined STL in 1965, working with the late Alec Reeves on pulse code modulation and electro-optic systems.

In 1971, he began work on the microwave landing system (MLS) programme, being particularly concerned with the design of the Doppler scanning system and in 1976 began the work which led to the winning thesis. He holds some 20 patents in the MLS and radar fields and is currently leading a team working on radar and adaptive systems at STL.

The award is a memorial to William E. Jackson, a pioneer in the development and implementation of the present airways, air traffic control and aviation communication systems.

Personal computer

The Sinclair Research ZX80 computer measures 218 x 170 x 50mm, weighs 12oz and features a 1kbyte memory, claimed to be "equivalent to 4kbytes in a conventional computer." How the latter trick is accomplished is not explained in the otherwise useful literature which comes with the computer, and which includes BASIC programming instructions, presented in a lighthearted manner, ideal for the beginner to the mysteries of programming.

A cassette player can be used directly to store programs, and the unit dispenses with the need for a dedicated v.d.u. by virtue of the "plug in to your tv aerial socket" facility. A further useful feature, especially for the beginner (and the unit seems particularly suitable for use in schools, where "computer science" is becoming a popular subject) is the syntax error check. This ensures that only syntactically correct lines can be added to the program list at the top of the page. A marker identifies a syntax error and thus helps to speed up the production of an error-free program.

The display format is 24 lines of 32 characters; the unit costs £99.95 inc. v.a.t. fully assembled, becoming available in March, or in kit form at £77.95 inc. v.a.t. Prices include the cost of the programming manual, but exclude mains adaptors, which cost £8.95 extra.

News in brief

The *British Amateur Electronics Club*, which claims that it is the only national amateur electronics club, is seeking help from established local electronics groups, its main problem being difficulty in finding premises for meetings. The mainly scattered nature of the membership adds to the problem and if local groups are willing to welcome BAEC members to their meetings, they would be prepared to pay an affiliation fee. The chairman of the BAEC will send out a copy of a simple questionnaire to any reader who is interested enough to contact him: Cyril Bogod, "Dickens", 26 Forrest Rd, Penarth, S. Glam., or telephone 0222 707813.

The IEETE have the following lecture events planned for March 1980:
5th March, J. J. Fallon of MK Electric will present "Standardisation of the proposed international plug and socket system" at the Duke of Cornwall Hotel, Millbay Rd, Plymouth, at 8 p.m.

17th March, "Robots and telechirs for Industry", presented by Prof. M. W. Thring at the IEE Building, Savoy Place, London, at 6 p.m.

20th March, G. W. Lord, Merlin Gerin (UK), will present "Up-to-date development in moulded case circuit breakers", at the Y.E.B. Staff Restaurant, 161 Gelderd Rd, Leeds 12, at 2 p.m.

27th March, "Lasers and their uses" will be presented by J. Dawson of the REME School of Engineering, at the REME School of Electronic Engineering, Aborfield, Reading, at 7.30 p.m.

28th March, G. Simpson, Champion Fire Defence Ltd, will lecture on "Developments, standards and future of automatic alarm systems" at the Royal Dublin Hotel, O'Connell St, Dublin, at 8 p.m.

The IERE propose to hold the following conferences in 1980: 22-25 April, "The electronic office", at 99 Gower St, London WC1; 3-4 July, "Re-training in the electronics industry for the microprocessor age", at 99 Gower St, and 16-18 Sept., "Electromagnetic compatibility", at the University of Southampton.

The IEE will be running a conference on "Radio transmitters and modulation techniques" from 24 to 25 March, 1980. The conference programme and application forms are available from the IEE, Savoy Place, London, WC2. Hotel booking forms are available from Exp-O-Tel, Strand House, Great West Rd, Brentford, Middlesex.

The 22nd International Festival of Sound will be open to the public from Wednesday 5th to Sunday 9th March 1980 at the Palais des Congres, Porte Maillot, Paris. Doors open from 10 a.m. until 8 p.m., open late on Saturday the 8th — until 10 p.m. Trade days are from 2nd to 4th March inclusive. On Monday 3rd March two conference debates will be held on the subjects "tapes and high fidelity" and "standardization and high fidelity".

An exhibition to mark the 50th anniversary of Baird's 30-line tv transmissions from the BBC's transmitter at Brookmans Park (March 1930) is being staged by the Science Museum, Kensington, beginning 27 March 1980, running for six months.

The show is called "The Great Optical Illusion" and the introductory exhibit will illustrate first principles of television. The "illusion" theme will be set up by other demonstrations, including "chromakey", an electronic overlay method which will show visitors as performing a feat of aerial daring, while "front axial projection" will insert them optically into a projected scene.

There will be a range of exhibits outlining the development of television since the opening of the 405-line service in 1936 and period room settings will show a montage of contemporary programmes on restored receivers of appropriate vintage; these will include a pre-war receiver with a five-inch tube and a projection set of the early 'fifties.

Frequency change for BBC's Ventnor Radio 3 Transmitter

In order to escape interference from the French transmitter at Caen in Normandy, the BBC's Ventnor v.h.f. transmitter has changed frequency (on 1st February). The previous frequency of 91.6MHz has been changed to 91.7MHz, but no change will be made to the shared Radio 1/2/4 frequencies also relayed by this transmitter.

The station is located at St. Boniface Down, on a height above the town, serving about 6,000 people in the Ventnor and Bonchurch area and also relays the tv services of BBC1, BBC2, and ITV on 625 lines (u.h.f) and the 405-line BBC1 service. Listeners will only have to change the tuning of their receivers by a very small amount.

More frequency allocations

WARC 79 decisions for 10GHz to 275GHz in Region 1

Last month we published a list of frequency allocations, as decided at the 1979 World Administrative Radio Conference, Geneva, for radio services up to 10GHz. We now present the remainder of the frequency allocations made at WARC 79, from 10GHz up to 275GHz. This, of course, is the microwave region of the electromagnetic spectrum (centimetre and millimetre wavelengths) and is occupied mainly by services such as radar, satellites, and radio astronomy. These highly specialized activities are of interest to only a small number of *Wireless World* readers, but in fact this 10-275GHz region is also available for amateur radio, while the satellite allocations include broadcasting satellites, which of course will eventually bring new types of domestic receivers and aerials to homes everywhere (see January 1979 issue, pp 38-42).

As in the February issue, the list is restricted to Region 1 as defined by the International Telecommunication Union (Europe, Africa, Middle East and Russia) and does not include the numerous footnotes giving additions, qualifications etc for particular countries. Nor does it distinguish between the three categories of service, primary, permitted and secondary (see February for definitions); but as a rough guide the first code letter, to the immediate right of the frequency band, is almost always a primary service, while the remainder, reading from left to right are divided among primary, permitted and secondary services in that order. Where secondary services are allocated they are always on the extreme right.

In the previous frequency plan, embodied in the Radio Regulations resulting from the WARC of 1959, the following bands were not allocated to any services: 48-50GHz, 71-84GHz, 152-170GHz, 200-220GHz and 240-250GHz. It will be seen from the list that these are now occupied. Neither the 1959 nor the 1979 conference attempted to allocate anything to the region above 275GHz (which, after all, goes into wavelengths of less than a millimetre) but this remains available for individual governments to permit experimentation. In particular a need has been identified for making spectral line measurements at various frequencies from 278GHz to 381GHz.

An outstanding feature of the present list is the large amount of spectrum space now allocated to satellites – communication, broadcasting, Earth-exploration and so on. It will be seen from the key to the code letters that, of the traditional categories of terrestrial radio services (fixed, mobile broadcasting, amateur etc.), there are now seven which also have a corresponding service provided through satellites. The coming of the satellite was first recognized officially by the ITU at an Extraordinary Administrative Radio Conference in 1963 and there have been others devoted to satellites since then. The results of a 1971 space conference were already embodied in the Radio Regulations before WARC 79 took place, and now, following WARC 79, three further ITU conferences devoted to space services have been planned or requested.*

As we reported earlier, the UK Home Office had recommended that allocations for communication satellites should be increased in the 10-11GHz band. This proposal has in fact been generously implemented by a doubling of the spectrum space available. The original allocation was 500MHz, split into two separated bands at 10.95-11.2GHz and 11.45-11.7GHz, but now, as will be seen from the list, there is a new, uninterrupted 1GHz band from 10.7 to 11.7GHz in which, in fact, communication satellites are a primary service (although this band is shared with fixed and mobile primary services). In the space-to-Earth direction of communication this is a world-wide allocation. In the Earth-to-space direction, however, for Region 1 countries this band is also reserved for use by feeder links ("uplinks") to broadcasting satellites (see later).

The needs of the maritime mobile-satellite as well as the aeronautical mobile-satellite services have been provided for and as a result these systems will be able to develop without hindrance. Also, in principle, it was agreed to provide for the feeder links to these services in the bands allocated below 10GHz. A mobile-satellite service has been introduced and frequencies have been provided for this.

Passive sensing in the Earth exploration-satellite and space research services have been identified as important activities in the future, so provision has been made for these services. Furthermore, in some parts of the spectrum where the fixed and mobile (except aeronautical mobile) services operate under a footnote provision, agreements have been reached to either limit or phase out the fixed and mobile services over a period of time with the intention of providing exclusive bands for the passive services. Increases have been made to the spectrum space allocated to Earth exploration satellites and space research. In addition, provision has been made for the operation of radars on board spacecraft in these services (e.g. in the band 35.5-35.6GHz).

*The first, in mid 1983, will be a Regional Administrative Radio Conference for detailed planning (channel assignments, orbit positions etc.) of broadcasting satellite services in the 12GHz band and associated uplinks in Region 2. The second, in late 1983, will be an Administrative Radio Conference for planning uplinks to broadcasting satellites operating in the 12GHz band in Regions 1 and 3. The third will be a World Administrative Radio Conference for space services in general; it is expected to be held in two sessions, possibly in Autumn 1984 and early 1986, but detailed arrangements will be decided later by the ITU.

Key to code letters in list

A	Amateur
AR	Aeronautical radionavigation
AS	Amateur — satellite
B	Broadcasting
BS	Broadcasting — satellite
BSL	Broadcasting satellite feeder link
F	Fixed
FS	Fixed — satellite
IS	Inter satellite
ISM	Industrial, scientific, medical
LMS	Land mobile — satellite
M	Mobile
MA	Meteorological aids
MS	Mobile — satellite
RA	Radio astronomy
RL	Radiolocation
RN	Radionavigation
RNS	Radionavigation — satellite
S	Space research
SAT	Earth exploration satellite
SFTS	Standard frequency and time signal – satellite

Additional spectrum has been allocated to the fixed-satellite service in the Earth-to-space direction near 100GHz, keeping in mind the allocation to the broadcasting-satellite service in the band 85-86GHz (see later).

The pattern of allocations to the inter-satellite and the fixed-satellite services follow, in general, that laid down by the 1971 space conference, i.e., with the former concentrated in the absorption bands so as to take advantage of the atmospheric attenuation to provide shielding between the space and the surface (or low-altitude) systems, and the latter located in parts of the spectrum between the absorption bands.

In certain combinations of space and terrestrial services the conference concluded that there was inadequate information on sharing. Footnotes were therefore added to reflect this uncertainty and the subjects were referred to the CCIR for further study.

The three bands for direct broadcasting from satellites remain substantially unchanged. 11.7-12.5GHz is completely unchanged (and it will be recalled that 40 channels within this band were assigned at the 1977 satellite braodcasting conference – see January 1979 issue, p.41). However, the original 41-43GHz satellite broadcasting band has now been shifted slightly downwards to 40.5-42.5GHz. This has been done to give better clearance for various radio astronomy frequencies around 43GHz which are used for spectral observations of silicon monoxide. Furthermore the band is now shared with three other services – terrestrial broadcasting (on a "permitted" basis) and fixed and mobile communications (secondary basis). The third band for satellite broadcasting, 84-86GHz, is unchanged in its band limits, but, whereas in the 1977 frequency plan written into the Radio Regulations it was exclusively for this use, it is now shared with primary fixed, mobile and terrestrial broadcasting services. (Although there is a footnote saying that these three must not cause harmful interference to broadcasting satellites to which frequencies are assigned.)

What is completely new in relation to broadcasting satellites is the set of frequencies chosen for the uplinks to them – the communication channels which convey the programme signals to the satellites' transmitters. These were not planned at the 1977 space conference. At WARC 79 a wide range of proposals came from different countries. For example, the official British proposal was 21.2-22GHz (which the Scandinavians objected to because of rain attenuation at their northern latitudes), while the Indian proposal was 14.5-15.35GHz (which the USA and UK objected to because it conflicted with fixed communication services including military systems). In the end a world-wide compromise was found which did not conflict too seriously with the other services sharing allocations with it (see list), and this was 17.3-18.1GHz. At the same time the door was left open for two other bands to be used in particular areas. Outside of Europe and for Malta, 14-14.8GHz may be used for the uplinks, with the lower end, 14-14.5GHz, "subject to co-ordination with other networks in the fixed-satellite service". And in Region 1, the uplinks may, as mentioned above, use the new 10.7-11.7GHz allocation which is otherwise intended for communication satellites, fixed and mobile services.

An unusual type of satellite uplink, pioneered by the IBA in Britain, is a road transportable earth station on a trailer designed for sending television outside broadcasts from any location straight up to a communications satellite (see picture in January issue, p. 42). It has already been used, in fact, with the OTS satellite. Largely through the IBA's initiative, supported by the BBC, a decision was made at WARC 79 to allocate

Table of frequency allocations for Region 1

GHz	Services	GHz	Services
10.0-10.45	F, M, RL, A	36.0-37.0	SAT, F, M, S
10.45-10.50	RL, A, AS	37.0-37.5	F, M
10.50-10.55	F, M, RL	37.5-39.5	F, FS, M
10.55-10.60	F, M, RL	39.5-40.0	F, FS, M, MS
10.60-10.68	SAT, F, M, RA, S, RL	40.0-40.5	F, FS, M, MS
10.68-10.70	SAT, RA, S	40.5-42.5	BS, B, F, M
10.70-11.70	F, FS, M	42.5-43.5	F, FS, M, RA
11.70-12.50	F, B, BS, M	43.5-47.0	M, MS, RN, RNS
12.50-12.75	FS	47.0-47.2	A, AS
12.75-13.25	F, FS, M, S	47.2-50.2	F, FS, M
13.25-13.40	AR	50.2-50.4	SAT, F, M, S
13.40-14.00	RL, RN, SFTS	50.4-51.4	F, FS, M, MS
14.00-14.25	FS, RN, S	51.4-54.25	SAT, S,
14.00-14.50	LMS	54.25-58.2	SAT, F, IS, M, S, RL
14.25-14.30	FS, RN, F, M, S	58.2-59.0	SAT, S
14.30-14.40	F, FS, M, RNS	59.0-64.0	F, IS, M, RL
14.40-14.47	F, FS, M, S	61.0-61.5	ISM
14.47-14.50	F, FS, M, RA	64.0-65.0	SAT, S
14.50-14.80	F, FS, M, S	65.0-66.0	SAT, S, F, M
14.80-15.35	F, M, S	66.0-71.0	M, MS, RN, RNS
15.35-15.40	RA, SAT, S	71.0-74.0	F, FS, M, MS
15.40-15.70	AR	74.0-75.5	F, FS, M
15.70-16.60	RL	75.5-76.0	A, AS
16.60-17.10	RL, S	76.0-81.0	RL, A, AS
17.10-17.20	RL	81.0-84.0	F, FS, M, MS
17.20-17.30	RL, SAT, S	84.0-86.0	F, M, B, BS
17.30-17.70	FS, RL	86.0-92.0	SAT, RA, S
17.30-18.10	BSL	92.0-95.0	F, FS, M, RL
17.70-18.10	F, FS, M	95.0-100.0	M, MS, RN, RNS, RL
18.10-18.60	F, FS, M	100-102	SAT, F, M, S
18.60-18.80	F, FS, M, SAT, S	102-105	F, FS, M
18.80-19.70	F, FS, M	105-116	SAT, RA, S
19.70-20.20	FS, MS	116-126	SAT, F, IS, M, S
20.20-21.20	FS, MS, SFTS	122-123	ISM
21.20-21.40	SAT, F, M, S	126-134	F, IS, M, RL
21.40-22.00	F, M	134-142	M, MS, RN, RNS, RL
22.00-22.21	F, M	142-144	A, AS
22.21-22.50	SAT, F, M, RA, S	144-149	RL, A, AS
22.50-22.55	F, M	149-150	F, FS, M
22.55-23.00	F, IS, M	150-151	SAT, F, FS, M, S
23.00-23.55	F, IS, M	151-164	F, FS, M
23.55-23.60	F, M	164-168	SAT, RA, S
23.60-24.00	SAT, RA, S	168-170	F, M
24.00-24.05	A, AS	170-174.5	F, IS, M
24.00-24.25	ISM	174.5-176.5	SAT, F, IS, M, S
24.05-24.25	RL, A, SAT	176.5-182.0	F, IS, M
24.25-25.25	RN	182-185	SAT, RA, S, F, M
25.25-27.00	F, M, SAT, SFTS	185-190	F, IS, M
27.00-27.50	F, M, SAT	190-200	M, MS, RN, RNS
27.5-29.5	F, FS, M	200-202	SAT, F, M, S
29.5-30.0	FS, MS	202-217	F, FS, M
30.0-31.0	FS, MS, SFTS	217-231	SAT, RA, S
31.0-31.3	F, M, SFTS, S	231-235	F, FS, M, RL
31.3-31.5	SAT, RA, S	235-238	SAT, F, FS, M, S
31.5-31.8	SAT, RA, S, F, M	238-241	F, FS, M, RL
31.8-32.0	RN, S	241-248	RL, A, AS
32.0-32.3	IS, RN, S	244-246	ISM
32.3-33.0	IS, RN	248-250	A, AS
33.0-33.4	RN	250-252	SAT, S
33.4-34.2	RL	252-265	M, MS, RN, RNS
34.2-35.2	RL, S	265-275	F, FS, M, RA
35.2-36.0	MA, RL		

a band of frequencies to this type of land mobile-satellite service, as it is called, at 14-14.5GHz on a secondary basis world-wide. In Europe this type of outside broadcast link will probably work through the Eurovision transponders of the ECS satellite, which is due to be launched at the end of 1981 (see December 1978 issue, p. 63, for details).

Radio amateurs will note that amateur satellites have received an allocation at 10.45-10.5GHz. This is worldwide and on a secondary basis, the primary service in this band being, of course, 3cm radar. The amateur and amateur satellite bands between 24 and 24.25GHz remain unchanged. There is a new amateur and amateur satellite allocation at 47-47.2GHz (6mm), two more at 75.5-76GHz (primary) and 76-81GHz (secondary, sharing with radar), and a further linked pair in the 2mm wavelength region at 142-144GHz (primary) and 144-149GHz (secondary). The highest amateur bands of all to be allocated are in the previously unoccupied region 240-250GHz, and are at 241-248GHz (on a secondary basis) and 248-250GHz (primary basis), both including a satellite service. These are all somewhat different from the UK proposals for the amateur service taken to Geneva by the Home Office (December 1979 issue, p. 62).

Three new bands have been designated for ISM (industrial, scientific, medical) applications. Two significant factors in these allocations are (a) that the bands are in harmonic relationship and (b) that the use of the bands is subject to special authorization by the government of the country concerned in agreement with other administrations whose radiocommunication services might be affected.

Radiolocation allocations have been made in two distinct groups – in the absorption bands for shorter range systems with a high potential for frequency re-use, and in the radio "windows" between those bands for longer-range systems.

Additional spectrum has been made available to radio astronomy, with recognition of the nature of the observations, e.g. spectral lines. The requirement to observe emissions from extraterrestrial sources has been accepted and frequency bands are identified where these observations are likely to be made.

It will be noticed that numerous allocations for the fixed and mobile communication services run right through the list, up to the very highest frequencies. According to one Home Office official, this was the result of certain countries being "obsessed" with making their mark on the frequency plan, regardless of whether these frequencies could actually be used or not with current available technology.

Acknowledgment. We are indebted to Dr G. J. Phillips, BBC Research Department, for a great deal of help in the preparation of this article. □

BOOKS

Radio and Electronic Laboratory Handbook, by M. G. Scroggie, is probably far too well-known and respected to need much introduction. It has changed considerably, however, in the forty years since it was first published, having been continually revised to keep pace with accelerating change in the industry. It is now in its ninth edition, this one updated largely by G. G. Johnstone.

The plan of the book remains the same, information on measuring equipment being concentrated in the first half. Measuring techniques take up most of the second half of the book, and the already large reference section is extended for this edition: the piece on filter design is particularly useful. Throughout the text, references to the literature are lavishly scattered. The book is published in hard back at £17.99 by Newnes-Butterworths, and contains 592 pages.

Frequency Engineering in Mobile Radio Bands, by W. M. Pannell. Continuous expansion of land mobile radio communication makes it essential to plan allocations inside a frequency band in such a manner that interference is kept to a low level and that the spectrum is used to its fullest possible extent. The book is intended to help in the early stages of frequency planning, and is in two sections, the first dealing with general procedures and the second of a more specific nature. Mr Pannell has many years of experience in the mobile radio field, and was responsible for the Pannell Report on future spectrum requirements for mobiles in the UK. Published in hard back, at £25.00 by Granta Technical Editions, Hargrave Lodge, 7 Brooklands Avenue, Cambridge.

Audio Equipment Tests, by Gordon J. King, is intended to demonstrate the performance testing of high-fidelity sound equipment to technicians, dealers and those users who take an interest in the technicalities of their equipment. Each component of an audio chain from f.m. tuner (no a.m.) to loudspeaker is allotted a number of test procedures with a list of equipment needed, a diagram of connexions, the procedure to follow and a few clarifying remarks. The author has a long experience of writing on hi-fi subjects for the audio magazines, and of reviewing audio equipment. The book is published at £6.50 by Newnes-Butterworths, Borough Green, Sevenoaks, Kent, and has 158 pages.

BBC Handbook 1980 is now on sale. It is similar in format to earlier editions and contains the familiar tightly-packed mass of information on technical, artistic, commercial and political subjects in the broadcasting field. It is published in limp back at £3.00 by the BBC, 35 Marylebone High Street, London W1M 4AA.

The Einstein Myth and the Ives papers is, not surprisingly, an attack on Einstein's theories of relativity and a substitution of the ideas propounded by Herbert E. Ives of Bell Labs. About half of this substantial book is a series of papers and a lecture by Ives, the rest consisting of The Einstein Myth, in which one of the editors, Dean Turner, puts the case for a universal 'nowness' or simultaneity. He argues for the reality of space and time, eliminating, among other concepts in relativity, the Twins Paradox. Papers and notes by other scientists take up the rest of the book.

In essence, Ives replaces Einstein's principle of covariance (which says that physical laws must apply to systems in any kind of motion, including acceleration) with a restricted theory, in which gravitational and kinetic energy are equivalent. The book is easy to read, and seems to be aimed as much at the layman as at the physicist, only in isolated places becoming mathematical, and even then merely algebraic. The book is in hard back, is A4 sized, contains 447 pages and is published at 22 dollars 50 cents by The Devin-Adair Company, Old Greenwich, Connecticut 06870, USA.

Radio Enters the Home is a reprint, by Vestal Press, of the 1922 catalogue of RCA receiving equipment. In common with most catalogues, it contains full descriptions and illustrations of contemporary wireless sets and, most usefully, a large number of circuit diagrams of 1922 commercial receivers. The first few pages demonstrate the novelty of 'wireless', being illustrated with photographs of groups of people staring fascinated at loudspeakers as though expecting a materialization, and of malevolent infants being tranquillized by a bedtime story.

The sets described range from the Model ER-753 crystal receiver at 18 dollars to the Aeriola Grand valve detector, amplifier and loudspeaker model, complete with battery, charger, aerial and stand and covering 150-550m at a cost of 409 dollars.

In 1922, the catalogue cost 35 cents: now, it is published by The Vestal Press, 320 N. Jensen Road, PO Box 97, Vestal, NY 13850, USA at 12 dollars 50 cents, plus postage.

Entertainment Year Book

What used to be simply the Hi Fi Year Book has now been extended in scope to include reference material on colour television sets, electronic organs, video cassette recorders and television games. This is in addition to the familiar illustrated information on current audio products, including descriptions, technical data, prices (where available) and suppliers' names, addresses and telephone numbers. There are four survey articles on various audio topics. The 1980 "Hi Fi Year Book & Home Entertainment" contains over 580 pages and can be obtained from booksellers at £3.75. Alternatively it can be obtained directly from the publishers, IPC Business Press Ltd, by writing to the General Sales Manager, Room CP34, Dorset House, Stamford Street, London SE1 9LU and sending £4.25 which includes packing and postage.

Maxwell's equations revisited

A critique of orthodox electromagnetic theory

by Ivor Catt, CAM Consultants

"It was once told as a good joke upon a mathematician that the poor man went mad and mistook his symbols for realities; as M for the moon and S for the sun."

Oliver Heaviside, Electromagnetic Theory, 1893, volume 1, page 133.

". . . the universe appears to have been designed by a pure mathematician."

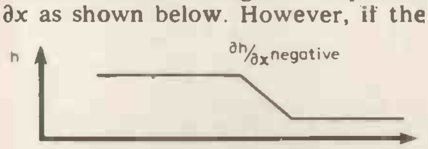
Sir James Jeans, The Mysterious Universe, 1931, page 115.

Faraday's Law of Induction, $v=-d\phi/dt$, seems to imply:

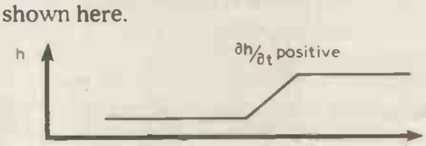
1. A causality relationship; the rate of change of magnetic flux through a surface *causes* a voltage around the circumference of the surface.
2. A reluctance, or resistance to the change of magnetic flux indicated by the minus sign.

A careful analysis of this one equation will give an insight into the bogus nature of contemporary mathematical operations in electromagnetic theory. First let us discuss the minus sign, which leads us to the idea of a Lenz's Law reluctance, or resistance, to the change $d\phi/dt$. We shall see that a minus sign can occur in an equation when no causality can be involved.

Consider a high speed (125) railway train with sloping front passing an observer. As the front face passes, the observer will see a negative slope $\partial h/\partial x$ as shown below. However, if the



observer had watched the event through a narrow slit in a fence, he would have seen a rising edge $\partial h/\partial t$, as shown here.



It would be absurd to suggest that there was a causality relationship between $\partial h/\partial x$ and $\partial h/\partial t$. They are both descriptions associated with the passage of the train. Since Newton, it is accepted that a *body* continues in its state of uniform motion without a continuing cause, or push. (However, this principle is taking a long time to be applied to electromagnetic waves.)[1,2]

Now we regard the velocity of the train $\partial x/\partial t$ as positive. This creates an anomaly when we want to write the equation

$$\frac{\partial h}{\partial x}\cdot\frac{dx}{dt}=\frac{\partial h}{\partial t} \qquad (1)$$

because the left hand side product is negative when the right hand side is positive, as in the case of the leading face of the train.

This kind of absurdity, or anomaly, is ignored when Newton's Laws are considered. It is reasonable to do so, because Newton's Laws are close to common sense and the obvious. Common sense will prevent absurd conclusions from creeping into a Newtonian theoretical framework, even though the mathematical formulation of Newton's Laws has always been slovenly in this respect.* (Another perhaps permissible slovenly aspect is the use of the = sign for numerous different, mutually contradictory meanings.)

Maxwell's Equations are not in the same class. Common sense will not save us from absurdity and nonsense if our initial formulations are ambiguous or wrong.

Let us consider an electromagnetic wave front advancing at the speed of light. When the step (or more accurately ramp) passes, as shown here

$\partial H/\partial x$ is negative. However, $\partial H/\partial t$ for the step is positive. To get the algebra right, we are forced to conclude that

$$\frac{\partial H}{\partial x}\cdot\frac{dx}{dt}=-\frac{\partial H}{\partial t} \qquad (2)$$

However, no one would propose that the minus sign indicated a *causality* relationship between $\partial H/\partial x$ and $\partial H/\partial t$.

The last equation never appears in the text books. In the books, one of the terms is first converted into a function of E according to the formula

$$\frac{E}{H}=\sqrt{\frac{\mu}{\epsilon}}$$

The result is either

$$\frac{\partial E}{\partial x}=-\frac{\partial B}{\partial t} \qquad (3)$$

or

$$\frac{\partial H}{\partial x}=-\frac{\partial D}{\partial t} \qquad (4)$$

The text books say the "solution" to this pair of equations is a sine wave! See references 3 to 7. (In fact, almost anything is a solution to these equations.)

At this stage, the whole subject starts to look sophisticated and profound. Really it is neither. The minus signs have no significance, as we have seen. B and D are introduced on the r.h.s merely to suppress μ and ϵ using the formula

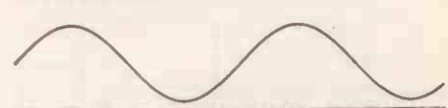
$$\frac{E}{H}=\sqrt{\frac{\mu}{\epsilon}}$$

In fact, the last two equations (3), (4) are meaningless. If the front end of the high speed train were pointed, sloping out sideways as well as upwards, and w were the term given to width (as H stands for height), exactly the same pair of equations could be constructed.

$$\frac{\partial w}{\partial x}=-\mu\frac{\partial H}{\partial t}$$

$$\frac{\partial H}{\partial x}=-\epsilon\frac{\partial w}{\partial t}$$

As with e-m theory, we could conclude with equal validity that a train's height (and width) must vary sinusoidally along its length, making our trains look like the Loch Ness monster, or more accurately, like a row of short sausages, as shown here.



It is shocking that this nonsense has survived for a century at the core of a subject as crucial as electromagnetic theory. We see now that mathematical formulation of e-m theory, far from making the subject more rigorous, has

* Even the brilliant philosopher Ernst Mach failed to notice this anomaly.

made it ludicrous and false. We see that the mathematicians are incompetent where physical reality is concerned and hide their incompetence and confuse others by conjuring up nonsensical, interrelated formulae.

When Hertz established that electromagnetic waves existed, Maxwell's equations should have been re-examined, and the large rubbish element removed. Instead physically ignorant mathematicians took over, piling garbage on garbage, frightening away those with real insight into the subject – the latter-day Faradays.

Those who try to build extensions, or additions to, the House of Newton should not assume that since the foundations were good enough for Newton's simpler theory, they are strong enough to support their own more complex constuctions. Minkowski's failure to re-examine the foundations of Newton, in particular his assumption that velocity is positive and the passage of time is positive, makes his constructions useless in the same way as Maxwell's equations are useless.

In the Minkowski sense[8] time really flows from $+\infty$ to $-\infty$, not, as he thought (and our clock faces, with their ascending sequence of numbers, think), from $-\infty$ to $+\infty$. Velocity, being the gaining of distance in return for the *loss* of time, is negative. This points to a fundamental difference between space and time, and means that the "space-time continuum" as Minkowski formulated it is bogus. At best, we see his pronouncements as oracular, similar to the answer that Delphos gave when being asked about the sex of an unborn child, "Girlnoboy". This remark could well be interpreted as true, but really it has no content.

Einstein failed to consider the problem of the sign of time and of velocity. Also[9], he never succeeded in fighting his way through the mass of mathematical garbage surrounding electromagnetic theory.

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This article is taken from "Electromagnetic Theory" published by C.A.M. Publishing, 17 King Harry Lane, St. Albans. □

Impedance mismatching

continued from page 59

Thus, for maximum power transfer efficiency from the Norton source, the load must be such that $R_L/R_s \to 0$ (the opposite of the voltage source case). A similar set of arguments to those used above can be used to show that the expression for η is meaningless unless the actual circuit is a simple current source with source impedance.

Despite the fact that Thevenin/Norton equivalent sources do not allow calculation directly of the transfer efficiency, it is perfectly true that to attain maximum power transfer into a load, the load impedance should be chosen to match the Thevenin or Norton source impedance (they are the same) but to say that this means 50% of the power from the source is lost in the source resistance is in general not true; often the power loss in the source resistance is higher!

Despite the cautions outlined in this paper the notion of transfer efficiency is not without its uses, since a number of frequently encountered circuits behave as true Thevenin or Norton circuits; for example, the common emitter amplifier shown in Fig. 5. Neglecting the bias-resistance loading effects and assuming that all capacitors are short circuits, the mid-band voltage gain is given approximately by

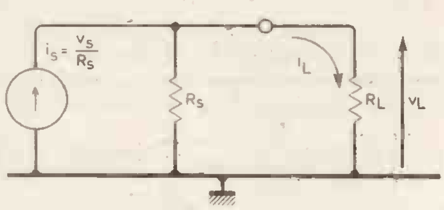
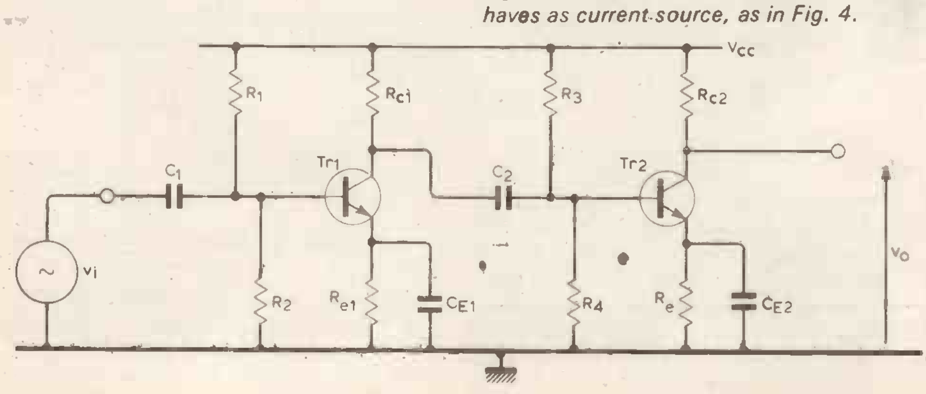


Fig. 4. Current equivalent to Fig. 1.

Fig. 5. Amplifier inter-stage coupling behaves as current-source, as in Fig. 4.



$$A_v = \frac{v_0}{v_i}\left(\frac{-R_{c2}}{r_{e2}}\right).\ \left(\frac{-R_{c1}\beta_2 r_{e2}}{R_{c1}+\beta_2 r_{e2}}\right).\left(\frac{1}{r_{e1}}\right)$$

$$A_v = \left(\frac{R_{c2}}{r_{e1}}\right)\left(\frac{\beta_2}{1+\frac{\beta_2 r_{e2}}{R_{c1}}}\right)$$

$$A_{vmax} \sim \left(\frac{R_{c2}}{r_{e1}}.\beta_2\right),$$

which occurs when the input impedance of Tr_2 is much less than the collector resistance of Tr_1, i.e. $\beta_2 r_{e2} \ll R_{c1}$. The output of Tr_1 is a current source of impedance R_{c1} and the Norton transfer efficiency result obtained above tells us that $R_L/R \to 0$ for good transfer efficiency, i.e. $\beta_2 r_{e2}/R_{c1} \ll 1$.

In conclusion, I would stress that extreme care should be taken to interpret the components of a Thevenin or Norton equivalent circuit correctly especially in deriving expressions for losses in power transfer. □

Microwave intruder detector — 2

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 that allows the alarm to be set up easily and reliably in terms of a low false-alarm probability.

The complete intruder alarm circuit designed for use with the Mullard CL8960 module is shown in Fig. 9. It requires a nominal 12 volt power supply able to produce at least 300mA during switch-on but in general less than 200mA unless a high current relay is used (about 160mA plus the relay). This supply can be a car battery with the usual voltage variation during charging such as up to 16 volts. The minimum voltage is safely 11 volts with a 7.5 volt V_g (or 10.5 volts with a 7.0 volt setting). With a selected 748 as in the text, this can be reduced by up to another 0.5 volts. However, with supply ripple, these represent an alarm risk level and should be avoided.

Supply ripple within these restrictions can be up to 1V pk-pk without affecting performance and some prototypes have tolerated 5V pk-pk with a 13 volt supply and a V_g of 7.5 volts.

The radar sensitivity is limited entirely by that of the microwave module, afterwards just called a module, rather than the circuit design. However, to realise this, due regard must be paid to the use of short screened leads at the amplifier input, because of the gain the circuit has to 50Hz and 100Hz signals.

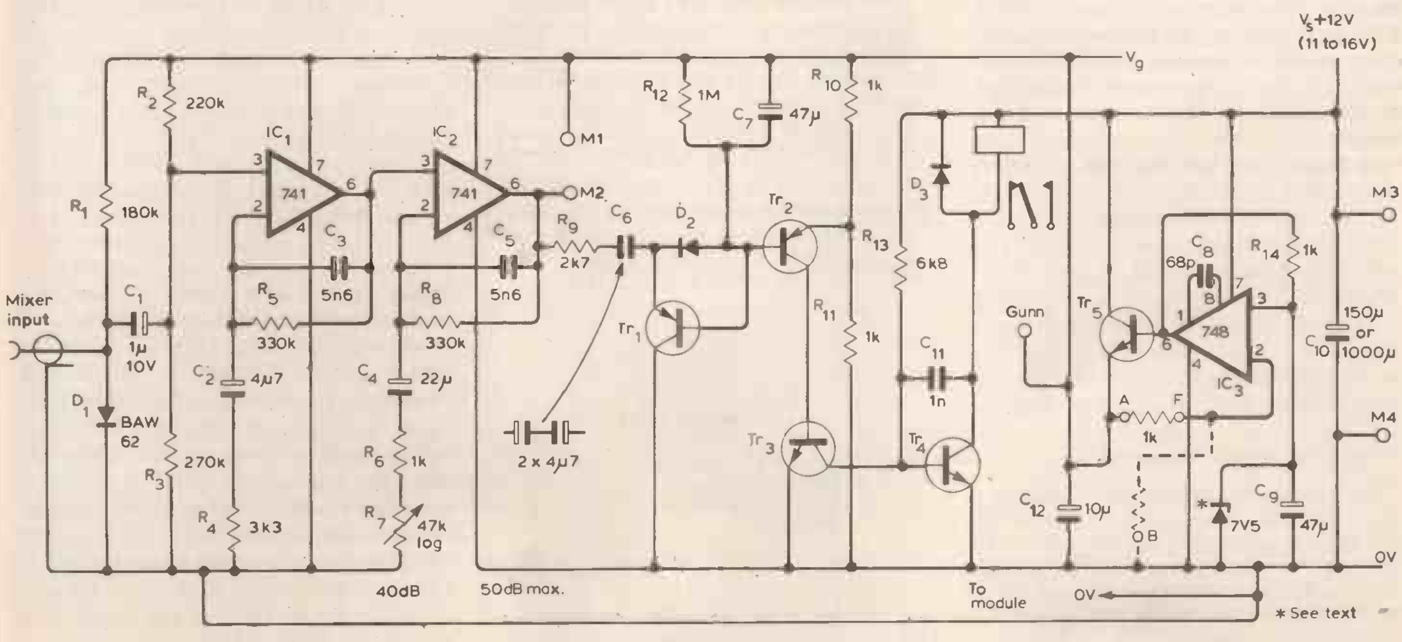
Two 741 op-amps are used as the main Doppler amplifier. These can be a single (twin) 747, if required. Thus the complete circuit uses one 1.5 watt power transistor, four small transistors and three cheap i.cs. Much of the circuit is directly connected which saves on components.

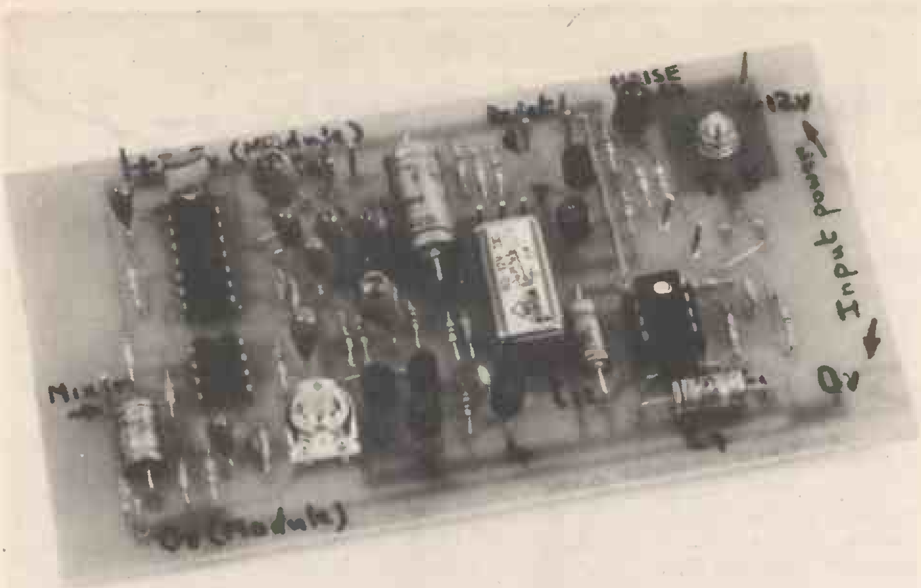
The microwave module requires some cautionary remarks because the mixer contains a diode of extremely small electrical proportions so as to respond to the 10.687GHz frequency. If the mixer, or its lead to the amplifier, is touched with a measuring lead or an object which has not been grounded to the module metalwork it could be destroyed by static discharge. If a shorting clip across the mixer is supplied leave it *in situ* until connections have been made.

Fig. 9. Components: Tr_1, BC557, Tr_3, Tr_4, BC547 or BC107, Tr_5, BC135 or BFY51, with 50°C/W fin. Capacitors: Bead tantalum maximum leakage C_4, 2μA, C_7 1μA at t_{max}. Resistors: all 0.1W. R_2 and R_3 are 2% the rest 5% or could be 10%.

Connect the module to the amplifier circuit as follows. Use a screened input lead and make the amplifier connection first. The braid is connected to 0V at only the amplifier end. Keep exposed unscreened ends down to about 12mm. Next make the amplifier 0V connection to the module 0V metalwork. Then clip a lead with crocodile clips between the soldering iron bit and the module metalwork to equalize potentials. If the iron is not earthed, make a second lead between the module and earth. The lead from the amplifier which is to be connected to the mixer should now be touched on the module metalwork just prior to connection. Maintain one finger on the metalwork while the joint is being made to discharge and prevent the build-up of static also on the solder. Remove any shorting clip while the metalwork is being contacted and after making the connections.

Should it be necessary to measure the mixer direct voltage while it is working contact the metalwork beforehand and while the leads are being handled; but make the 0V connection first. To ensure no static, fit a 10kΩ resistor to the end of the measuring lead and touch on the metalwork just prior to the measurement. Mixer failure is evident by loss of sensitivity and by little or no direct voltage when passing a direct current, such as the 40μA bias current.





◀ *Circuit board for combined alarm and monitor circuits of Figs. 9 & 11 includes noise indicator on board for demonstration use Board pattern appears on page 81 with location diagram on page 84.*

Circuit description

The circuit supplies about 40μA of current via R_1 for mixer d.c. bias. Mixer bias will be about 300mV with no microwave energy and ideally about half this with the optimum mixer power. However, voltages from about 90 to 270mV with a 300mV diode will only cause a 1.5dB loss in signal-to-noise ratio at the extremes but require 5dB more gain for the same signal at the upper bias point. Observe the precautions mentioned when measuring mixer voltage to avoid static discharge damage; nothing must inadvertently touch the live mixer-to-amplifier lead.

The mixer power for the CL8960 is obtained by leakage across the two waveguides outside the module. Thus during measurement it is best to point it upward and have no obstruction in front for at least 300mm. Covering the module requires special material (see data sheet) which is near-transparent to microwaves.

A hand moved slowly at about 150mm in front of the module should move the bias by a few tens of mV and confirm that microwaves are present and that the mixer is probably good. A bias voltage of 50mV or less together with 5mV or less of movement suggests a faulty mixer.

A 2mm screw can be used to reflect power and to either set the correct bias or, at another spaced distance, cancel an over-reflection from a covering to bring the bias back to a correct level,* provided the reflection is not excessive, such as causing the voltage to be more than about 100mV negative without the screw. The best position for this screw is in the front shroud supplied with the module, Fig. 10, at a position in line with the centre web, such as between 4 and 8mm out from the shroud-to-module interface joint (without the plastics cover).

The supply voltage to the amplifiers is also used for the Gunn microwave oscillator in the module and so should lie between 7.25 and 7.75V. Lower voltages than 7.0V may not allow the oscillator to work properly, although will cause no damage. Voltages above 8.0V risk damage; the life at 10V can be just a few seconds. Thus the 7.5V line should be checked before connection.

Using a 7.5V zener diode with IC_3 will usually produce a voltage within the above spread. Lower voltages can be corrected using the 1kΩ resistor across link AF, with a second resistor of higher value across FB. For instance a 10kΩ resistor will raise the voltage by about 10%. No adjustment exists for too high a voltage other than changing the diode. Alternatively a 6.8V zener may be fitted, in which case the resistor FB will lie between about 3.9 and 18kΩ.

The module produces audio frequencies in response to radial movement, the relationship being 32Hz per 1 mile/h. Movement across the 140° beam will produce a much lower frequency, or even zero at perfect constant radius with no change in target reflection properties during the movement. Range depends on the target size and is about 10 metres or could be more if C_2 were increased and R_4 decreased. But a high sensitivity has false alarm risk due to extraneous movement.

Signals from the module are coupled in via C_1 and amplified by IC_1 and IC_2 to produce a clipped "square" sinewave of 4 to 5V pk-pk amplitude out of IC_2 or less at long range. This drives the following circuit which counts beat cycles and is set to alarm when the voltage across C_7 reaches about four volts. This will take about 600mm of travel with C_7 of 47μF or 300mm with 25μF. Capacitor C_6 is used as a bucket to discharge into C_7 once for each beat cycle. A cycle occurs for each 14mm of radial distance change towards or away from the radar. The larger C_7 the greater one single-movement distance can be before an alarm is given. The method affords protection against an alarm from odd spurious pulses and short single events.

The result of movement is stored in C_7 to prevent an approach by a series of short movements. The memory is discharged by R_{12} to prevent built up to an alarm by odd spurious events. C_7 will ideally have a leakage current less than R_{12} for a long storage time. At four volts (4μA per 1MΩ) Tr_2 and Tr_3 will conduct and Tr_4 will be turned off thus setting the contacts for an external alarm.

The floating change-over contact is intended to be used for a more powerful external relay operating an audible warning device such as a bell or door opener. The relay is a low current type to preserve battery life during mains failure and its contact rating must be observed. If this is not required a more powerful relay may be fitted with a coil current up to 100mA. A diode across the relay absorbs inductive voltage and protects the transistor at switch off. If a relay is used with this already fitted, the coil must be connected the correct way round, otherwise both the diode and the transistor may be destroyed. A shorted diode will mean a useless relay unless it can be burnt away.

Sensitivity is set by R_7, which should be a log.-law potentiometer for smooth control and with the low resistance end the last to be shorted. A standard log. pot. will increase gain anti-clockwise.

The d.c. working point of IC_1 and IC_2 is set by 2% tolerance resistors R_2 and R_3. The design centre voltage from IC_1 and IC_2 is 3.9 to 4.4V with a 7.5V line and roughly in proportion for other voltages. Voltages above about 4.8V can infrequently occur due to end-of-spread leakage current in C_2 and C_4 and if this happens a selected component should be used. An inaccurate d.c. level will limit the output voltage swing from IC_2. Leakage has limited the value of these capacitors and they would otherwise have been increased by a factor two.

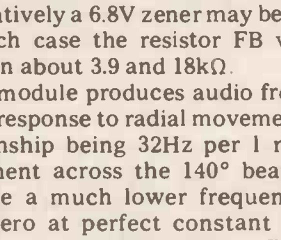


Fig. 10. Mixer power can be adjusted by fitting a 2mm screw in shroud.

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*The intended optimum mixer power will occur naturally if the module is bolted to a 160×43mm aperture in a 1/16in plate, such the side of a box, provided the plate is sandwiched between the front shroud, Fig. 10 and the rest of the module. The shroud and module are supplied together.

Setting the sensitivity

Setting the sensitivity can be done using an oscilloscope, but the noise monitor circuit of Fig. 11 is strongly recommended. The alarm starts to operate when the signal output from IC_2 reaches 1.5V pk-pk and 2.0V pk-pk will usually lead to an alarm. The sensitivity should be set for no more than 0.5V pk-pk from IC_2 to leave a margin for unforeseen events. This noise level will be entirely due to extraneous disturbance as the noise level of the alarm itself in a perfectly "quiet" room with the circuit values shown will be several times less than this.

Setting the sensitivity without either an oscilloscope or the circuit of Fig. 11 is more difficult if it is important that a false alarm should not occur. By shunting R_{12} with 100kΩ the memory can be shortened and an indicator l.e.d. can be fitted to the relay contacts and a walk-about test carried out. Fitting the 100kΩ will shorten the memory time to five seconds to 37% of previous movement stored in C_7. However, to be sure that there will not be a build up to an alarm with the 100kΩ removed the gain of the amplifiers really needs to be increased by 3 or 4 times or more as a test. This could be done by reducing R_4 to, say, 1kΩ and increasing C_2 to 22μF to maintain the low speed response, but precautions must be taken to see that an alarm is not false due to the introduction of hum with long unscreened wires and that the leakage of the 22μF does not cause the voltage out of IC_2 to go above 5V.

It is much better, and there will be more reliability, to build the noise monitoring circuit given. This will also monitor the MID environment and give warning that the safety factor is insufficient.

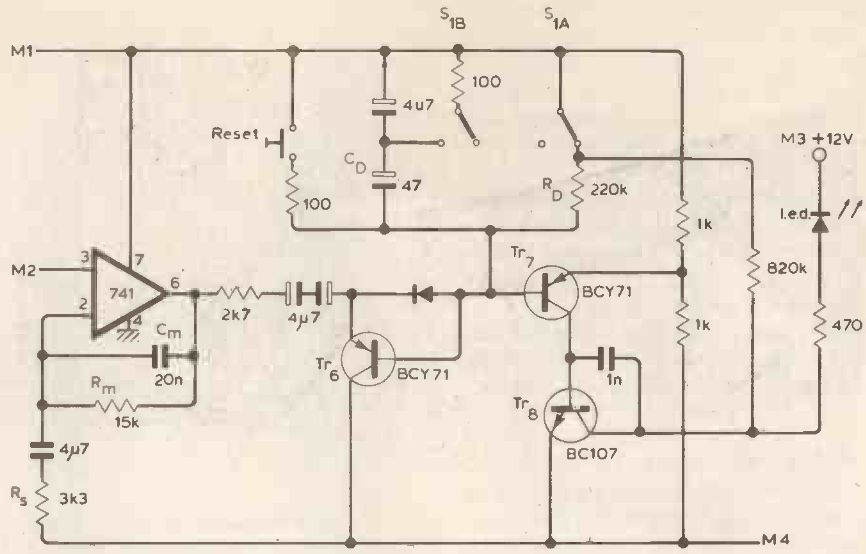


Fig. 11. Noise level monitor uses l.e.d. to indicate when noise level exceeds safe limit as well as simplifying setting-up procedure. Switch is shown in setting-up mode.

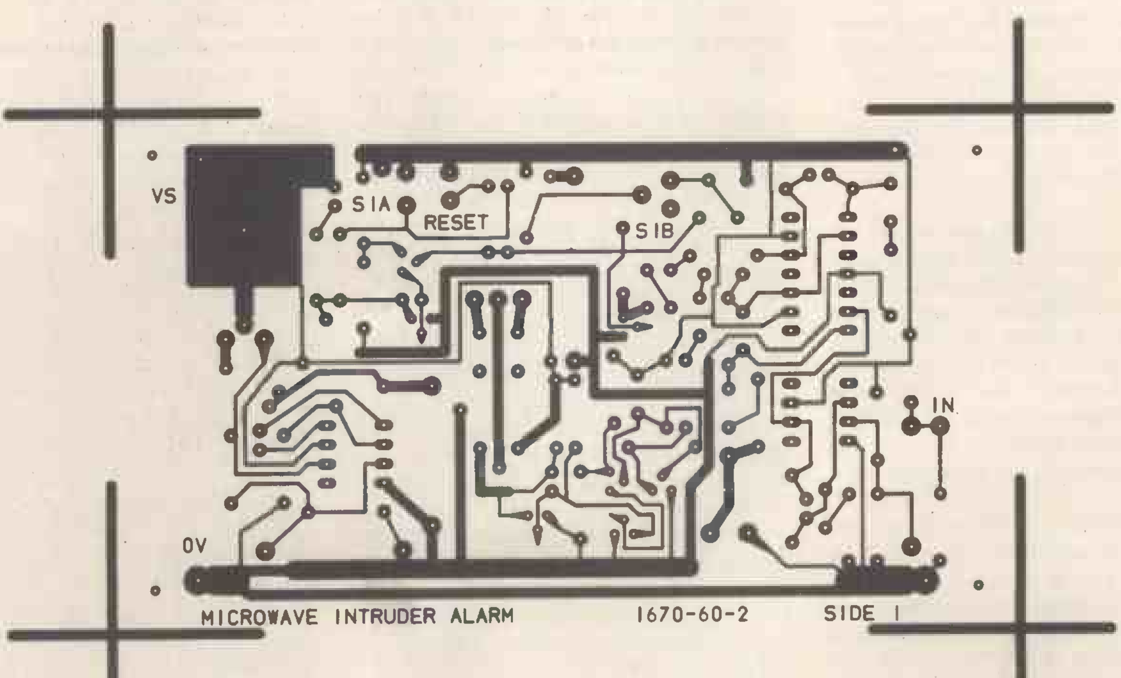
For instance, with a lot of extraneous interference it may be necessary to accept a lesser degree of protection from the alarm and reduce the value of R_{12}. Where the alarm is intended as an automatic door opener the distance walked may be very short and the value of C_7 may be reduced to, say, 22μF. Storage time is reduced with a reduced C_7 but also R_{12} can be reduced. Thus the values may be suited to the application. With large values of C_7, so as to tolerate a large single infrequent movement without an alarm, the leakage current should be selected to be low so as to get the desired time of storage.

False alarms

The MID circuit should be well screened from 50Hz pick-up and preferably in a metal box with a good fitting lid. There should be no mains transformer nearby to induce 50Hz voltages.

The alarm should not be used in the same room as fluorescent lamps while they are on as the gas in these ionizes at 100Hz to become a fluctuating reflector. Fans inside equipment, having apertures through which microwave energy can pass, will cause signals. These apertures can be screened with gauze of, say, not more than 6mm mesh size, and tested by placing the radar fairly close.

The alarm sensitivity should not be greater than necessary bearing in mind that radar signals grow very quickly as range is shortened. The rate is four times in voltage per range halving and so if a target is detected occasionally at one range it will be detected most positively at half that range.



Flat metal surfaces should be treated as mirrors via which the radar may be able to see a movement or fluorescent lamps. Radar signals pass through glass, although weakened, and through dry plaster board. Any testing must include walking outside windows.

Short flapping movements can lead to an alarm. A flap of less than about 14mm can give rise to one pulse into C_7 and an extra pulse for each 14mm approach and recede travel.

Movement across the beam has less effect than when radial and may be used to advantage in the siting of the radar.

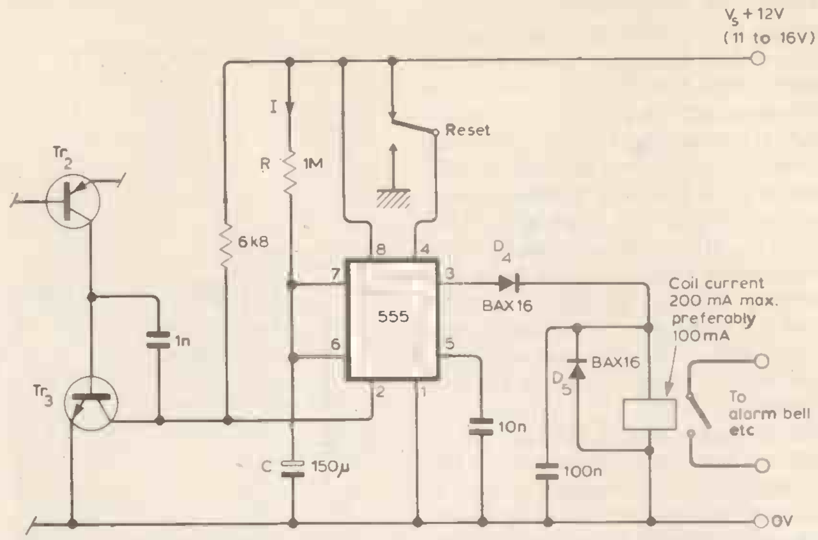
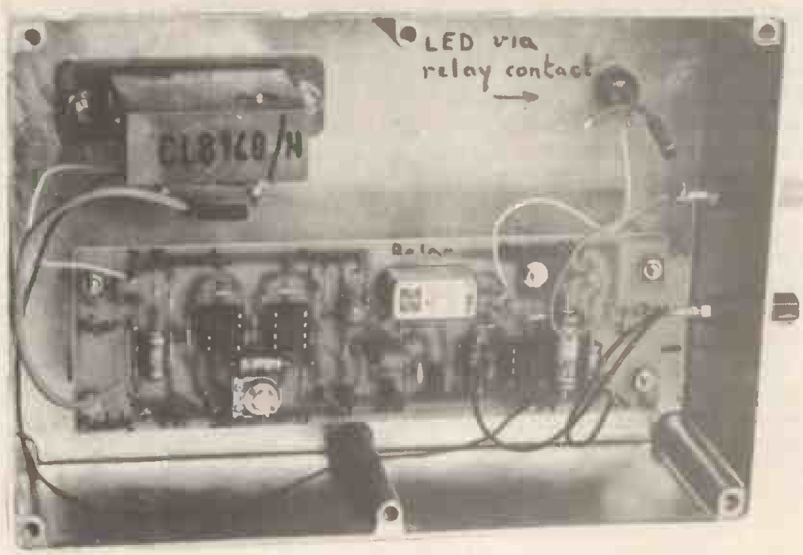


Fig. 12. To give a limited alarm time, say 2-5 min, use a 555 timer as suggested in Fig. 8, part 1, but with a diode and capacitor combination across the relay to prevent retriggering.



Internal photograph of demonstration model shows circuit board using Fig. 9 circuit only.

Circuit construction

In constructing the circuit treat it as you would a high gain audio amplifier. Screen the input lead and mount the circuit preferably inside a metal box with just the business end of the module protruding. Avoid earth loops and don't spread out the circuit. Insulate the box from the circuit and connect to the 0V line by only a single connection. Ideally the module metalwork would be insulated from the box, but if this is not so the module metalwork is already 0V and no other 0V connection should be made to the box.

If the box is bonded to earth, as preferred, leave the power supply floating so as to be earthed via the 0V and the box. Preferably use the same bolt to earth the box as used for the 0V connection inside the box. If both must have separate earth wires do not use the box as a conductor for 0V, nor take the earths for the box and that of the power supply to two different ground points.

Avoid long leads in circuit wiring associated with transistor connections because these high frequency devices can produce h.f. oscillation. In the case of Tr_4 a capacitor of 1nF is fitted across it and close to it to prevent this being caused by the relay inductance. The 0V lead from the regulator and IC_3 is three separate leads to each part of the circuit to avoid possible earth loop problems.

Apart from the 2% tolerance resistors R_2 and R_3, which set the d.c. working point of the i.cs resistor tolerance is not critical and 5% or even 10% can be used if they must.

Transistor Tr_5 dissipates about 1.5 watts and requires a small heatsink of 50degC/watt or better. This could be a fin of say 15 × 25mm or an area of printed board copper of say 12mm square, and could have the transistor bolted to it. In each case use heatsink compound or silicon grease in the joint.

The microwave module can be obtained from RS Components who also send out a licence form with it. Unfortunately they do not deal with the public and it is necessary to find a shop or someone who has an account with them. The cost depends on the mark up put on by the shop. For single units a price of about £33 should be aimed at, as of September 1979. An alternative supplier might be found in one of the Tottenham Court Road shops. People forming themselves into groups may be able to deal more directly with stockists and obtain them for about £25 plus v.a.t.

The open ends of the microwave module should preferably be covered to keep out dust which may eventually degrade performance. However, such a cover must not reflect appreciable microwave power or this will upset the mixer working. A simple and effective covering is to sandwich a very thin polythene membrane between the module shroud, Fig. 10, and the rest of the module, Fig. 1. Ordinary plastic bag material is suitable; the thinner the better. A capacitor of about 10nF should be soldered across the Gunn connection to the module metalwork to prevent high frequency oscillation on the Gunn supply lead due to the negative resistance of the Gunn diode.

Microwave intruder alarms are required to be licensed so that the Home Office is aware of their location should there be an interference problem with other equipment. A licence costs £1.40 and last for 5 years and is called a Telapproach Licence. Normally only finished equipment is approved as a production equipment. However, as the microwave module is set at the factory to meet Home Office requirements, the Home Office will issue a licence on the understanding that the frequency-setting screws on the module are not disturbed from their factory settings and the equipment is operated only indoors. When applying for a licence the module should be described as the Mullard CL8960/H, the H signifying the use by a home constructor, as opposed to a professional manufacturer with frequency measuring equipment. The address is, Radio Licence Department, Home Office, Waterloo Bridge House, Waterloo Road, London SE1 8UA.

Provided that the frequency setting is not disturbed the possibility of interfering with other services is extremely remote. Some mutual interference with another alarm in the vicinity is a possibility where the two microwave frequencies drift through each other to produce a spurious signal. Where two must be operated in these circumstances it is normal practice to install as pairs having their frequencies staggered by about 5MHz.

False alarm confidence indicator

The intruder alarm circuit of Fig. 9 seems to be about the simplest that can be produced and still achieve the standard considered necessary in a microwave intruder alarm. But unless it can be readily set up to work as intended with a low false alarm risk, it is likely to remain a novelty. Thus some attempt should be made at providing a setting up and monitoring circuit for completeness.

Basically what is needed is an amplifier with about five times voltage gain to follow the last amplifier of the previous circuit and which will show by means of an l.e.d. whether the noise level of the MID, with its chosen setting of sensitivity, is too high to be reliable from a false alarm point of view. This would not only monitor the noise due to the alarm circuits themselves but also the environment in which the alarm worked.

There are really two requirements. One for a quick response for setting-up the installation, and a second which allows the equipment to be monitored to see that the noise level stays within safe limits. The monitor should have an amplifier but ideally should also be followed by indentical bucket counting as in the main part of the MID circuit. Furthermore, the long-term monitor should have an l.e.d. indicator which stays on once it is lit until reset manually with a push button.

A circuit with a two-way switch, S_1, is shown in Fig. 11 for these purposes. It has been built and tested on a one-off basis and worked extremely well. The connections M1 to M4 go to the similarly marked points on the MID Fig. 9. As shown the switch is in the setting-up mode and the values of R_D and C_D are 220kΩ and 4.7μF for quick response and extinguish. When the switch is thrown these are increased to approximately 1MΩ and 4.7μF, as in the main MID circuit. Also the capacitor discharge resistor is taken to the collector of Tr_8. The l.e.d. then locks-on and the reset button has to be pressed to extinguish it. The lock-on mode may also be preferred for setting up, as this can then be done by one person; in which case S_{1a} should just short out the 820kΩ from Tr_8 collector.

Setting up the MID is now easy. Check that the monitor is working by walking in the protected area. Turn the

COMPONENTS

Description		Type	Value	Rating	Tol. %	Make
R1	All carbon	CR16	180k	All 0.2W	5	All Mullard
2		,,	220k		2	
3		,,	270k		2	
4		,,	3k3		rest 5	
5		,,	330k			
6		,,	1k			
7	Variable	90H	47k			(AB Metal)
8		CR16	330k			
9		,,	2k7			
10		,,	1k			
11		,,	1k			
12		,,	1M			
13		,,	6k8			
14		,,	1k			
R_{AF}		,,	1k			
R_{FB}		,,	Selected			
16	Noise monitor	,,	3k3			
17(R_m)	,,	,,	15k			
18	,,	,,	2k7			
19	,,	,,	100			
20 (R_D)	,,	,,	220k			
21	,,	,,	100			
22, 23	,,	,,	1k			
24	,,	,,	820k			
25	,,	,,	470			
C1	Electr. LV	015 90001	1.5μ	63V	−20 +80	Mullard
2	Tantalum	101-793	4.7μ	35V	±20	RS
3	Ceramic	630 02472	4.7n	100V	±10	Mullard
4	Tantalum	101-838	22μ	16V	±20	RS
5	Ceramic	630 02472	4.7n	100V	±10	Mullard
6A, 6B	Tantalum		4.7μ	10/16V		
7	Tantalum	102 724	47μ	16V	±20	RS
8	Ceramic	632 34689	68p	100V	±2	Mullard
9	Electr. LV	015 14479	47μ	10V	−20 +80	,,
10	Electr. LV	016 15151	150μ	16V	−20 +80	,,
11	Ceramic	630 02102	1n	100V	±10	,,
12	Electr. LV	015 16103	10μ	25V	−20 +80	,,
13 (C_m) Fig. 11	Ceramic	629 02223	22n	63V	−20 +80	,,
14 to 17 ,,	Tantalum	101-793	4.7μ	35V	±20	RS
18 (C_D) ,,	Tantalum	102-724	47μ	16V	±20	,,
19 ,,	Ceramic	630 02102	1n	100V	±10	Mullard
RL1	Relay	RS12				National
IC1		μA741				Signetics
2		μA747				,,
3		μA748				National
Tr1		BC557				Mullard
2		BC557				,,
3		BC547				,,
4		BC547				,,
5		BD135				,,
6	Noise monitor	BC557				,,
7	,,	BC557				,,
8	,,	BC547				,,
D1		BAW62				Mullard
2		BAW62				,,
3		BAW62				,,
4		BAW62				,,
		BZY88	Selected 7V5, or 6V8 with selected resistor R_{FB}			,,

Voltage rating of capacitors is that of components used by author. They need be no more than 16V in practice.

sensitivity to maximum, set the monitor switch as shown and carry out tests by walking outside windows etc, thumping walls to simulate vibration (and therefore possible MID movement) and see if the l.e.d. can be made to indicate. If the l.e.d. indicates or the sensitivity is higher than needed, reduce the sensitivity.

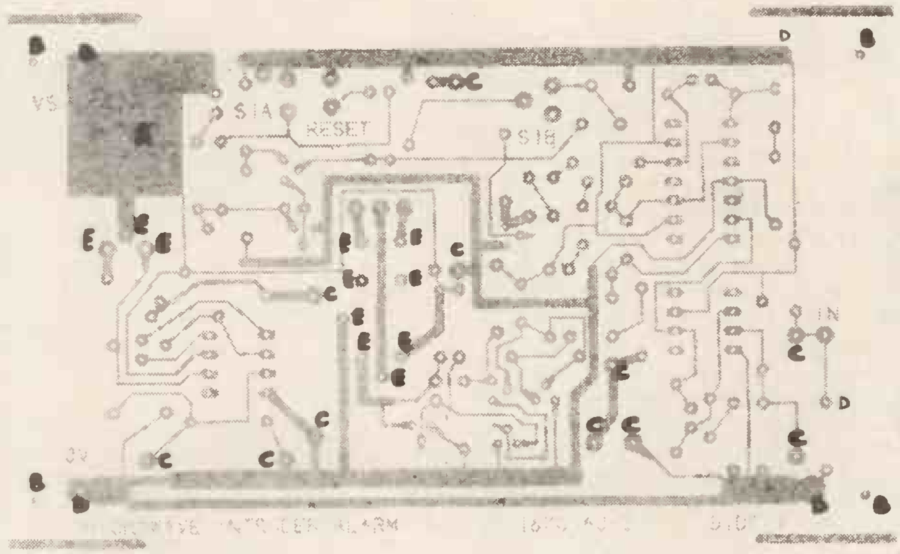
In the setting-up mode the circuit responds much faster than the main MID circuit and also has less memory time, which speeds the setting-up process. Having established a safe sensitivity setting, it remains to check that the MID is sensitive to an intruder. In doing this there is no need to be too critical as signals increase in voltage by a factor of four each time range is halved. Thus occasional detection at one range becomes most positive at 70% of that range.

It is a good idea to mount the l.e.d. outside the protected area, so that with the monitor switched to the long time constant, the safety factor can be monitored without intruding the protected area. Any tendency to approach a risk situation will be latched in by the l.e.d. staying on until reset. In the case where the MID is set to sound an alarm for five minutes and stop if there is no further movement, it is worth fitting a second latched l.e.d. by the side of the first to show that the main MID circuit has alarmed. This will help sort out the situation where the monitor l.e.d. is latched. For instance, was this due to an intruder or a noise problem? If the main MID indicator is out then it is most likely, though not certain, that it is an interference problem to be aware of.

The above setting-up does not cover the case where the MID appears to have a safe setting but in fact is close to making the l.e.d. indicate and so a second attempt has to be made to get it correct; after perhaps one day seeing the l.e.d. indicating. This would need some two-stage gain control so that the alarm is first set up and then the gain is reduced even more to ensure a once-only setting up. An alternative, well worth considering, is to give the monitor circuit a higher gain in the setting up mode than in the monitor mode. Perhaps seven times for setting up and four as a monitor. The gain is $1 + R_m/R_s$ and the reader can choose the value of R_m to suit.

One can carry on increasing the complexity of MID's almost indefinitely. For instance, a clock could be included to show the time of the intrusion. But the above system in my opinion is the least that should be provided in any professional equipment. A great advantage of such monitors is that it allows the MID to go on test for a few days without being connected to an alarm bell.

For a long time there has been a need for this type of monitor circuit. True an oscilloscope can be used to look at the noise level in a particular installation, but this is no substitute for proper monitoring. Poor design in the past has been one reason for the growth of companies which now intercept alarm calls before passing these on to the appropriate security people. Of course, the problem of protecting a warehouse, where the roof may rise and fall in the wind, is much more difficult than a house or shop, and such problems may be helped by a security house who know about the difficulty. So would a wind meter which turned down the sensitivity in a storm. □



DRILLING DETAILS
A HOLES DRILL 3.4mm 1-OFF
B HOLES DRILL 3.2mm 4-OFF
C HOLES DRILL 1.1mm 11-OFF
D HOLES DRILL 1.0mm 8-OFF
E HOLES DRILL 0.9mm 11-OFF
OTHER HOLES DRILL 0.8mm

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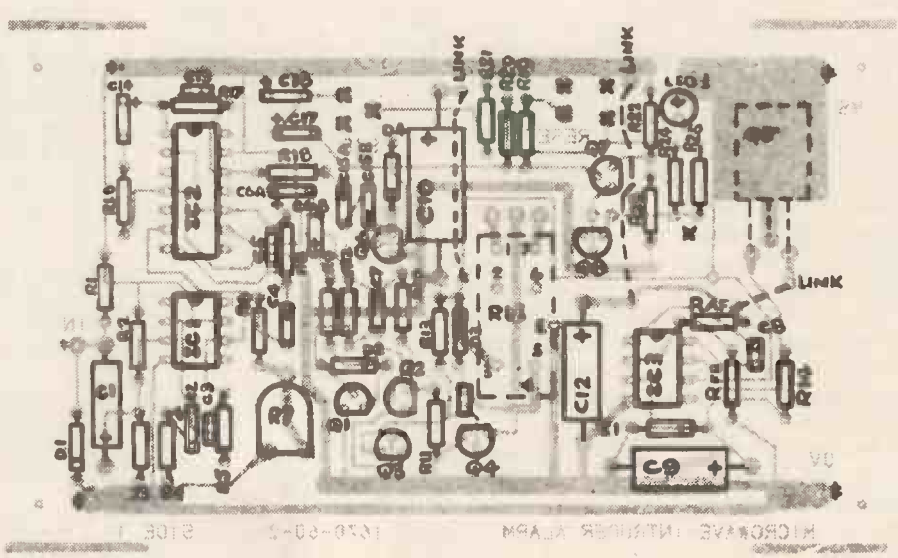

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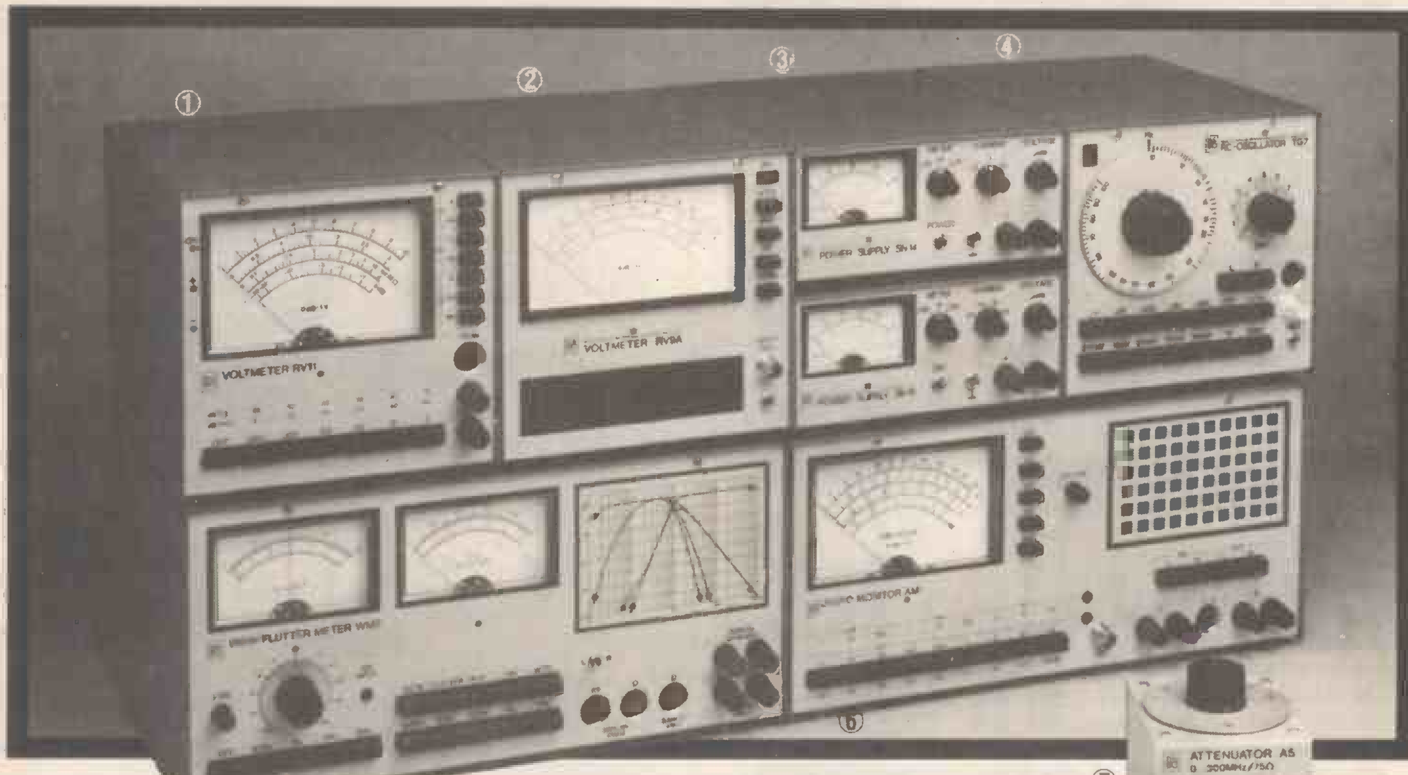

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② RV9A Voltmeter, with fully automatic and manual selection of 100μV–316 V AC and 10Hz–10MHz. Easy-to-read scale and illuminated range indicator. Doubles as a measuring amplifier; bandwidth 10MHz ± 3dB, gain −50 to +60dB in 12 steps.

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④ TG7. A low-distortion RC oscillator for testing high-specification AF amplifiers. Provides both sine and square waves. Output adjustable by push-button in 10dB steps.

⑤ WM2 Wow/Flutter meter. Professional standard instrument for record players and tape mechanisms. Separate filters for wow and flutter measurement. Analog outputs for oscilloscope, pen recorder, analyser etc.

⑥ AM1. AF Monitor/Wattmeter/AC Voltmeter. Measuring range 10nW–140W/4Hz–500kHz.

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Microelectronics and the Third World

An argument against labour intensive technology for less developed countries

by **S. Jacobsson** Research Policy Institute, University of Lund, Sweden

Microelectronics based technologies are now spreading into economies with already high unemployment levels. After discussing the possible implications of this technical change for employment in these countries, the author argues against the widespread view that the solution to the problems of the less developed countries lies in labour intensive manufacturing. Human labour has natural limitations and cannot match the abilities of the new electronic machines and the superior technologies that result from them.

Concern about the effect of microelectronics on future employment is now strengthened by the fact that microelectronic based technologies are being diffused into economies with already high unemployment levels. In the OECD (Organization for Economic Co-operation and Development) area the level of unemployment in the second half of the 1970s was the highest ever since the second world war[1] and, more importantly, it stayed at a high level also in the post-recessionary period of 1975-8.[2]. While this situation in the OECD area is serious enough to warrant more attention than is given to it today, it is nevertheless rather insignificant in comparison with that of the less developed countries (LDCs). In the rest of this article I shall outline some possible effects of technical change induced by the diffusion of microelectronics on the employment situation in these economies.

The prevalent view on the evolution of the employment structure in the development process has suggested that the manufacturing sector would gradually absorb the rural labour force and transform the employment pattern in LDCs into something similar to that which prevails in the industrialized world of today. Table 1 gives a rather interesting perspective on this hypothesis. (A similar table is found in Stewart (1978).[3]). It shows that, on the basis of past trends, not even the yearly addition to the labour force has been absorbed by the expanding manufacturing sector in *any* of the countries. Indeed, apart from the Republic of Korea, the jobs provided by the manufacturing sector were *extremely* inadequate in relation to the number of jobs required as a result of *only* the growth of the labour force, not to mention the already vast number of unemployed. (The figure of 1 billion has been mentioned by the ILO.).

Now it seems reasonable to ask whether this inadequate employment generation potential will prevail also in the future and, if so, what implications will it have. While there are several factors which may determine the answer to this question, e.g. rate of population growth and capital accumulation, we shall deal with only one factor, namely technical change, as this is the one most strongly associated with the diffusion of microelectronics.

The overwhelming majority of the world's technology is produced in the OECD area and there is nothing that points to any significant reduction in the LDCs' technological dependence on the developed countries in the future. What happens here is therefore of greatest relevance for the LDCs.

Table 1: Manufacturing employment and labour force in LDCs

	$\frac{\Delta Em}{Em}$ (1)	$\frac{Em}{Et}$ (2)	$\frac{\Delta L}{L}$ (3)	Inc Need (4)
Philippines	2.0	11.4	2.8	24.5
India	2.6	9.5	2.1	22.1
Rep of Korea	12.7	13.2	1.8	13.6
Peru	4.1	13.2	2.9	21.9
Brazil	4.9*	17.8	2.9	16.2
Kenya	6.5	16.3**	3.5	21.4

*Only Sao Paolo area. **Wage employment excluding agriculture

$\Delta Em/Em$ is the yearly increase in manufacturing employment. Em/Et is manufacturing labour force as percentage of total labour force. $\Delta L/L$ is the labour force increase. "Inc. need" column is $\Delta Em/Em$ needed to absorb $\Delta L/L$.

Sources: (1)—ILO[14] except for Brazil. For Brazil, Boletin do Banco do Brazil[17]. The years covered are: Philippines 1960-1975; India 1961-1975; Republic of Korea 1963-1977; Kenya 1967-1975; Peru 1963-1972 and Brazil 1967-1975. (2)—Morawetz (1974)[15] table 1. (3)—World Bank (1977)[16]. (2) was from 1970 and (3) from 1970-1975.

Table 2: Annual average rates of change of employment and output in percent per annum

Years	55-60	60-64	64-69	69-73
Employment	2.58	1.66	0.53	0.72
Output	6.85	6.55	6.51	5.39

Source: Jones (1978)[18]

In Table 2 we have reproduced data on trends in manufacturing output and employment in the 'EEC-five' countries. (The same trends exist also in Britain; see Clarke (1979).[4]).

The table reveals that in the postwar period and in particular since the early 1960s, there has been a strong downward trend in employment generation for a given rate of change in output. While the data covers only the period up to the 1973 'oil crisis', the trends have continued also in the post-recession period. Thus, the manufacturing output did not only recover but increased after 1975, while manufacturing employment has fallen in *absolute* numbers in most OECD countries.[5].

While part of the change in labour input versus output can be explained by a structural shift of relatively labour intensive processes to the LDCs, for example in garment manufacturing, the magnitude of the change strongly suggests that the figures reflect an intensified process of labour saving technical change, that is, a jobless growth[1, 4]. This trend is important for LDCs for two reasons. Firstly, it would not be unreasonable to suggest that the LCDs experience a time lag in the vintage of their technologies. This implies that the recent strong labour saving bias has not yet been fully transplanted to the LDCs. Secondly, and most importantly, the trends reflected in Table 2 will most likely continue, and perhaps in an intensified way by the diffusion of microelectronics into industry. The important implication of this is that the already extremely insufficient labour absorptive potential of the manufacturing sector will decline even further in the future.

Before elaborating on the implications of this statement, we have to examine the very widespread suggestion that it is possible to reverse these trends and develop economically efficient labour intensive technologies on the scale needed,* i.e. technologies which are deemed to be more 'appropriate' in labour abundant economies.

This I believe is wrong, since the basis for the proposal that labour intensive technologies can be developed on a large scale is the neoclassical economist's conceptualization of alternative technologies in terms of different *quantities* of capital and labour. I would instead suggest that there are extremely important *qualitative* differences between the two factors of production. To my knowledge the first economist or social scientist who pointed out the *qualitative* differences between capital and labour was Marx. The distinctive feature of what he called large scale modern industry was that the characteristics of the worker and his physical limitations did not constitute a limiting factor in the design of the production processes. In line with his analysis, it is simple to argue that the physical properties of labour are quite different from those of a machine. In relation to a machine a person is first of all variable, which implies uneven quality; secondly he is weak, which has obvious implications; thirdly, he cannot achieve the same precision, which is absolutely basic in any machine-making activity; fourthly, he cannot stand extreme heat, and heat is essential in key processes such as steel and chemical production; fifthly he is slow, which implies that any industry which produces above a certain minimum level of output will use machines instead of people. From studying the history of technical change one may, as Marx did, draw the conclusion that technical change is to a very large extent a process of overcoming the restrictions set by these properties of human labour, through increasing the capital intensity of the production process.

Today developments in electronics mean that it is not so much human muscle as human intelligence[6] which is replicated and extended.

Thus any system which involves the processing of data, decision making, or control of systems and equipment – in short, any task involving logic – is a candidate for the application of electronics. A list (not exhaustive) of these tasks includes:[7].

– controlled movement of materials, components, products
– control of process variables
– shaping, cutting, mixing, moulding, etc. of materials
– assembly of components into sub-assemblies and finished products
– control of quality at all stages of manufacture by inspection, testing or analysis
– organisation of the manufacturing process, including design, stock-keeping dispatch, machine maintenance, invoicing and the allocation of tasks.

*From the figures in Table 1, we can see that if *only* the yearly addition to the labour force were to be absorbed by the expanding manufacturing sector, the labour intensity of new investment projects would on *average* have to increase by a factor of 12.25 in the Philippines, 8.5 in India, 5.3 in Peru and 3.3 in Brazil and Kenya.

This all-embracing character of electronics will probably have important implications for the application of more labour intensive technologies in LDCs and thus for the possibility of absorbing a greater proportion of the labour force in the manufacturing sector through reversing the trend towards more capital intensive technologies.

The reason behind this assertion is that the cause of increased competitiveness through using electronically based innovations lies not only in their labour saving nature (which is less important in cheap labour economies), but also in probable savings in investment, materials and also in producing a better quality product, thus leading to superior technologies.[8, 2]. The labour saving nature has been amply dealt with in the public debate, but the last-mentioned characteristics need some elaboration. I shall give examples from two sectors which traditionally have been very labour intensive, the mechanical industries and the garment industry.

Mechanical Industries. In metalworking industries batch production dominates over flow-line techniques, with an associated low efficiency through poor machine utilization. Numerically controlled machine tools (n.c. machines) constituted a first attempt to increase the efficiency in this sector. With these machines, the control signals containing the information needed to produce the part are fed into the machine as the operation is performed. The control signals imitate the instructions given by a skilled machine operator, but with much greater speed and precision. By changing the control tape, an n.c. machine can be quickly switched to the next job which may involve a totally different sequence of operations. In this way the downtime – the setting time – of the machine tool is reduced, which is very important for machine utilization in small batch production work. By replacing the still relatively inflexible hard-wired circuitry in the n.c. machines by software in mini- or micro-computers – i.e. producing computerized numerically controlled machine tools (c.n.c.) – the versatility and flexibility of the machine tools are considerably enhanced.[9].

The capital saving nature of technical change in this sector stems not only from increased machine utilization. C.n.c. and direct numerical control (which involves one computer controlling several machine tools) also increase quality, for example in precision lathing. They also increase the throughput and reduce inventories, which saves capital embodied in materials. Furthermore they allow for in-process quality control, which makes possible early discovery of mistakes, and correction of process variables through electronic feedback systems. The latter source of capital saving is of considerable importance for process flow techniques also, for example in paper pulp and glass production, where work in progress often constitutes a very substantial part of total capital cost. Finally, the fixed investment costs are reduced by price cuts in the cost of control systems. According to one Japanese[10] source, "today's n.c. systems are priced at a quarter of those of ten years ago".

Garments. The clothing sector has been characterized by having capital costs among the lowest in manufacture[6]. The complexity of the production process and ever changing fashions have not justified purpose built equipment except in some cases. However, with microelectronics both a high flexibility and a high degree of automation are made possible. As Dr Juan Rada explains[6],

> "The use of self-programming robotic arms for cutting, and computerised systems for design, producing patterns, monitoring quality of fabric and guiding laser beam cutters, is changing the face of the industry. Microprocessors are being used to control knitting heads (instead of the centuries old Jacquard's card), to control ink-injectors with high flexibility to change design and colours; they are used to control sewing patterns and fast stitching. These are part of a growing number of applications – the trend being towards a "total system concept" which means the use of computerised techniques to detect flaws, keep track of patterns and orders, monitor the progress of work throughout the plant, automate the matching of patterns and the cutting and sewing. These applications save labour, skills and materials (in the case of cutting, the saving ranges from 8 to 15 per cent)."

The investment saving nature of microelectronic based innovations in this sector has been particularly emphasized by Raphael Kaplinsky[2]† who gives the example of a UK firm who produced an electronic pattern machine for a circular knitting loom. This machine cut down time in the change-over of knitting patterns by more than 50% "as well as lowering the hardware costs of the control system (itself at 20% of the total loom cost) by 50 percent".

Thus, because of the breakthrough made possible by microelectronics, in the near future the competitive edge in garments manufacturing will probably no longer be labour costs but technology.

All in all, it seems therefore very unlikely that more labour intensive technologies may be chosen in LDCs to the extent that the trends towards more capital intensive techniques may be altered or reversed.

The transformation of the technology

†Kaplinksy, together with Kurt Hoffman, Howard Rush and Luc Soete at IDS and SPRU, University of Sussex, is working on the implication of microelectronics on developing countries. I have greatly benefited from discussions with them.

in some traditional industries, i.e. not only garments but also textiles, leather and shoes[2], may have particularly severe implications for LDCs. The contribution to the total increase of manufacturing employment in the period 1968-1975 from these industries accounted for 30% for all LDCs and nearly 38% for the Asian LDCs[11].

Furthermore in some Asian countries such as the Republic of Korea and Hong Kong, manufacture for exports accounts for a sizeable part of total employment[11]. For example, it has been estimated that more than one half of the total increase in manufacturing employment during 1963-1970 in the Republic of Korea was due to an expansion of exports[11]. (This may partly explain Korea's exceptional performance as shown in Table 1.) The important point is that it is particularly in these economies where textiles, garments, leather and footwear products account for a considerable part of manufacturing exports[2].

Two implications can be drawn. Firstly, these traditional industries which account for a considerable part of yesterday's and today's employment generation in LDCs will probably fail to do so in the future. Secondly, as R. Kaplinsky has pointed out[2], the export oriented growth and employment strategy – much cherished today among both LDCs and Western economists – which so successfully has guided the industrialization strategy of the Republic of Korea, will probably not be able to be duplicated by other LDCs in the future. This is essentially so since cheap labour will probably lose its importance as a factor in determining international trade. Of course, some more advanced LDCs with the necessary skills and 'industrial environment' might be able to pursue a growth strategy based on the new technologies, but the employment impact will then be marginal. (It could be argued, as has convincingly been done by R. Kaplinsky, that the high and possibly increasing unemployment figures in the OECD area will restrict the market for these countries.)

The implication of the previous analysis is that the manufacturing sector in most LDCs will not be able to absorb the growing labour force, not to speak of *transforming* the structure of employment in a way similar to what has happened in the OECD area. While the urban-based service sector may improve the employment situation slightly, the only possible way out seems to be that the agricultural sector will have to absorb the main part of the labour force *permanently*. This sector has greater potential to fulfil this task as it is much more flexible in the degree of mechanisation than the manufacturing sector – mainly due to the fact that the human limitations of precision/speed/quality etc. are not so critical in agriculture as in industry.

Well, what is the problem then? one may ask. Why not let a very 'modern' industrial sector coexist with a very labour intensive agriculture?

There are at least two very considerable ones.** Firstly, institutional changes – mainly concerning distribution of land – need to be implemented if agriculture is to absorb a growing proportion of the labour force. This is widely recognized – even by the World Bank – so I will not elaborate on it. Secondly, even if the employment problem were to be solved in this way, the LDCs would experience a gigantic distributional problem since they would be faced with vastly different labour productivities in the industrial and agricultural sectors. (I was first made aware of this problem by C. Edquist at the Research Policy Institute, Lund, Sweden.) To take China as an example, as she has undertaken the most far reaching institutional changes in recent decades, the pressure on the agricultural sector to absorb the growing labour force has been associated with a decreasing marginal productivity of labour between 1959 and 1975[12]. Indeed, this occurred in spite of massive capital formation projects such as irrigation schemes. Thus, while the agricultural sector may absorb the labour force, the price to be paid for it, as noted already by the classical economists, is a very low and possibly decreasing labour productivity.

The very important point here is that as the industrialization process continues and the agricultural sector is charged with the job of absorbing the labour force, the political problem of transferring income from the high productive, and geographically concentrated, industrial sector to the low productive agricultural sector will take on increasingly stronger dimensions. This distributional issue will probably be one of the key ones for developing countries to deal with.††

This article is a revised version of an article 'Technical Change, Employment and Distribution' which was attached to the Lund Letter of Science and Technology for Basic Human Needs, 13 June, 1979, published by the Research Policy Institute, University of Lund, Sweden. We are indebted to both the Salen Foundation and to SAREC for financial support for that essay. The Salen Foundation also generously sponsored 'the Lund workshop on technological change in industrialized countries and its consequences for developing countries', held in Lund in May 1979. Part of the content of this article has greatly benefited from discussions in the workshop. In addition, many people have contributed with very helpful comments on earlier drafts. In particular, we would like to thank Claes Brundenius, Kurt Hoffman, Howard Rush, Jon Sigurdson and John Wilton, but also Enrique Bautista, Richard Conroy, Charles Edquist, Christopher Freeman and Hans Gustafsson.

**I will not, due to space limitations, treat the problems of surplus production by a labour intensive agriculture, which is needed if the industrial sector is to grow. See Jacobsson (1979), reference 8.

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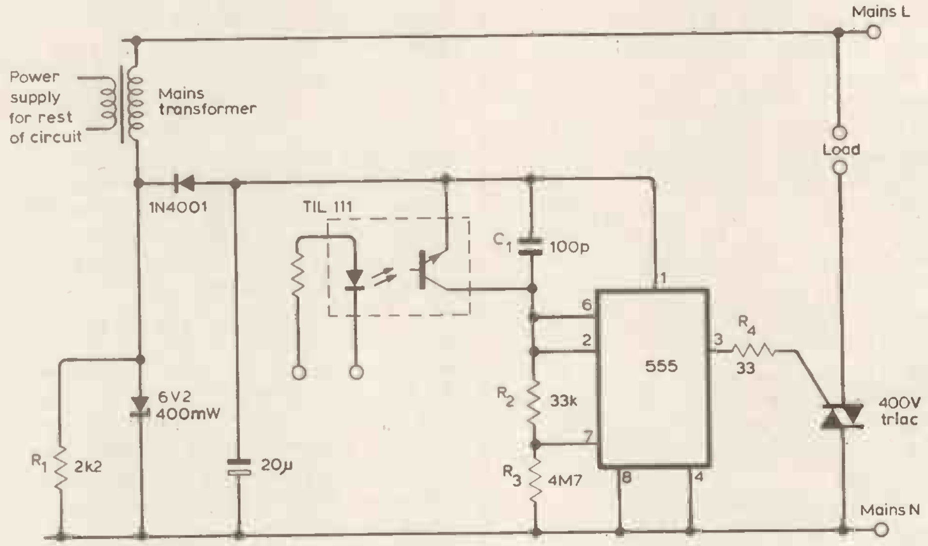
††Indeed, as the absolute number of people engaged in industrial production in the OECD area declines, the very same problem of taxing this sector in order to provide employment and income in other sectors — mainly public services where microelectronics is likely to displace proportionally little labour — may become (is?) a major problem.

CIRCUIT IDEAS

Optically-isolated triac control

A common problem with optical isolators is that a separate power supply is required. A tapping from a mains transformer primary can be used, but this is not always available, particularly on small transformers. A simple solution is to use the transformer primary as a current limiter for a suitable low voltage supply. However, triacs often require a gate current of around 50mA, which is more than this type of supply can provide. To overcome this problem, gate current is pulsed with a duty cycle of about 10%. The current required by the l.e.d. to turn the triac off is about 250μA, so it can be directly driven by c.m.o.s. logic. Resistor R_1 is included for protection in case the Zener diode goes open circuit.

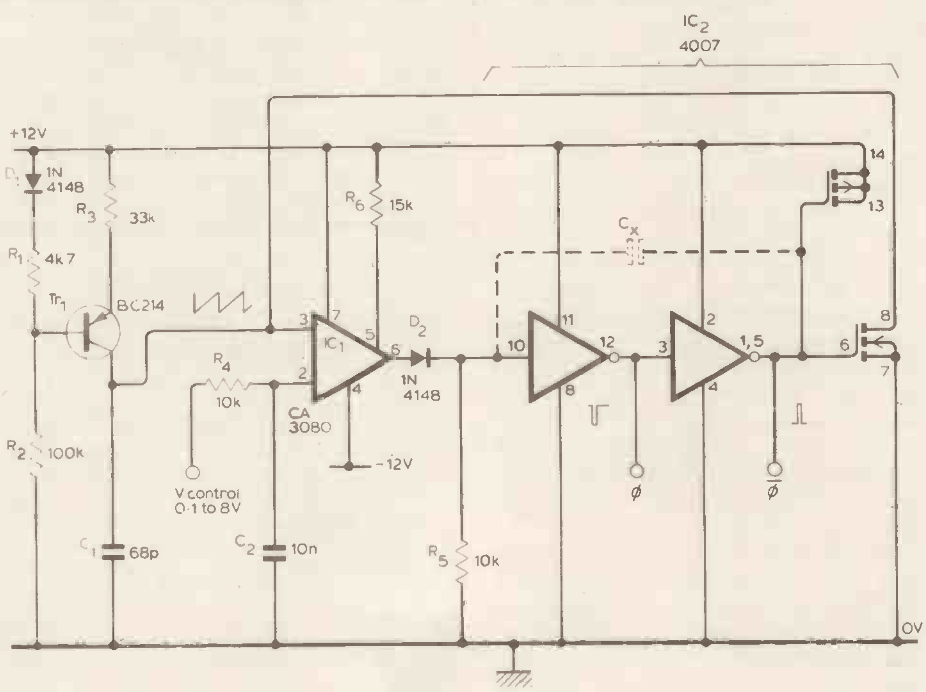
G. R. Rulter
Woking
Surrey



Voltage-to-period converter

In some circuits it is more convenient to have an oscillator whose period, rather than frequency, has a linear relationship to the control voltage. This circuit was developed to drive an analogue delay line for audio signal processing. Resistors R_1, R_2, R_3, diode D_1 and Tr_1 form a reasonably temperature-stable current source, which charges C_1 until the ramp voltage exceeds the control voltage. The comparator is biased by R_6 for high current and fast slew rate, and R_4, C_2 decouple the control input and prevent spurious triggering. The output is taken via D_2, R_5, which prevent negative bias, to a c.m.o.s. buffer and discharge circuit. With the values shown, antiphase outputs equal to the reset pulse width are available from pins 12 and 1 of IC_2. The reset pulse width of around 100ns is determined by propagation delays in the i.cs. If a longer pulse width is required, C_x may be used to form a monostable with a period of approximately $C_x R_5$. If low-frequency operation is required, C_1 must be completely discharged and C_x should be equal to $C_1/6$. The value of C_1 is limited by the ability of IC_2 to discharge it without damage and, in the prototype, a 100nF has been successfully used. With the values shown the period varies from about 0.5 μs to 30 μs for control voltages from 0.15 to 8V.

E. J. Leonie-Smith
Royston
Herts

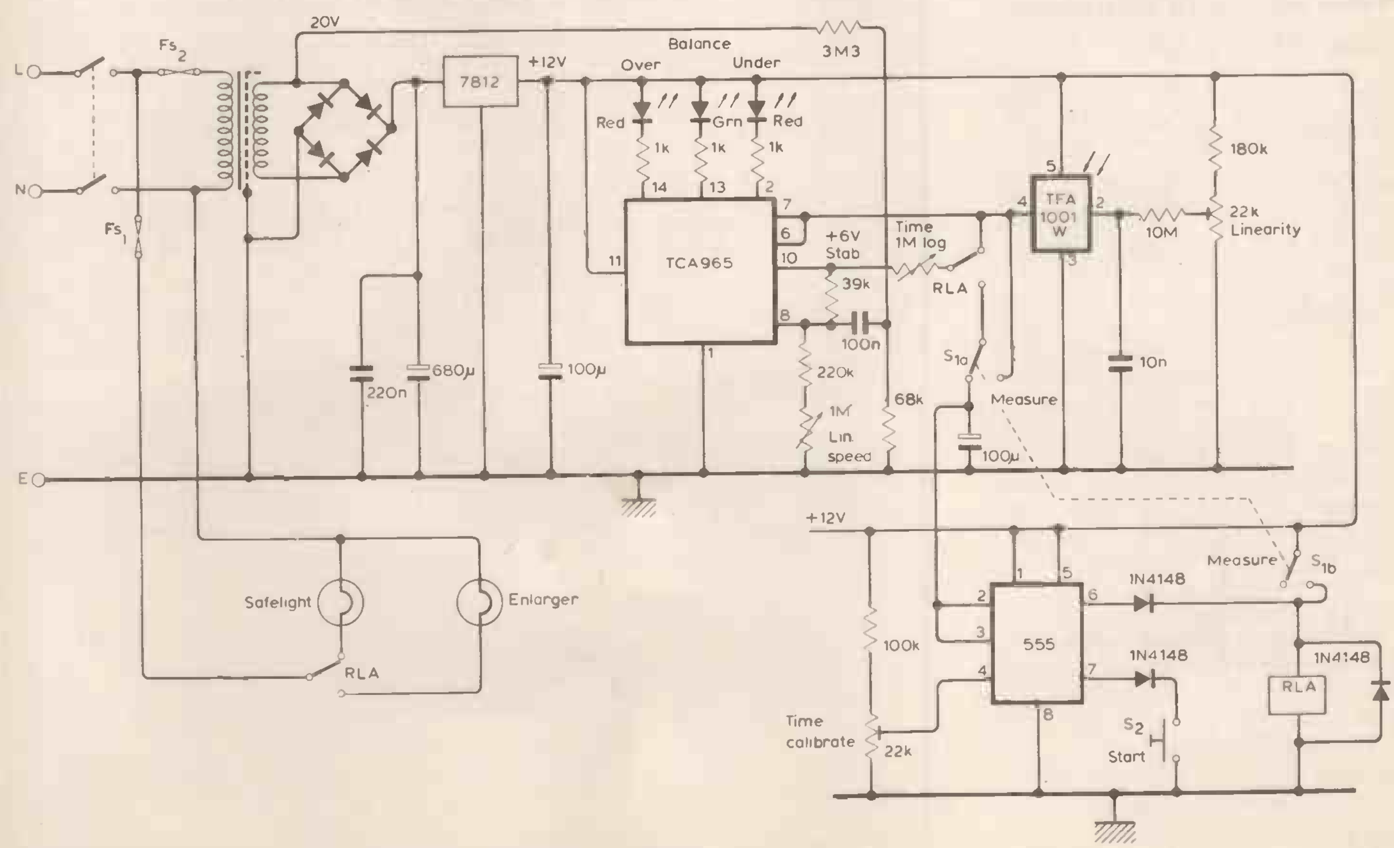


Enlarger analyser

This analyser uses a recently introduced silicon-blue photoamplifier i.c. to achieve high linearity at low light values. A bridge circuit measures the current drawn by an open-collector output of the TFA 1001W and a set-time control converts this current into a voltage which is compared with a reference level. The reference is set by a speed control for various brands of printing paper. Bridge balance is indicated by a TCA965 window discriminator and three l.e.ds. The bridge is fed with a few millivolts of a.c. from the transformer to overcome hysteresis. At balance the set-time control is used with the 555 timer to expose the paper. S_1 turns the enlarger on for focussing and measurement, or allows S_2 to start the exposure. Times from 2 to 140 s with paper speeds from 80 to 400 ANSI can be selected after speed calibration using test strips.

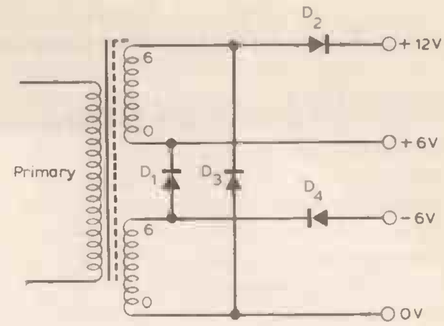
In the prototype, the photoamplifier was housed in a potting box together with the linearity control, associated components and twin-screened lead to the main circuit. Linearity is adjusted, with a d.v.m. across the time control set to 1MΩ, by using the halving values obtained from progressively stopping the lens. Judicious setting of linearity can compensate for reciprocity failure. Note that linearity setting only applies at low light values and the components may be omitted if higher levels only are used.

R. I. Harcourt
Thornton Heath
Surrey



Economic three rail supply

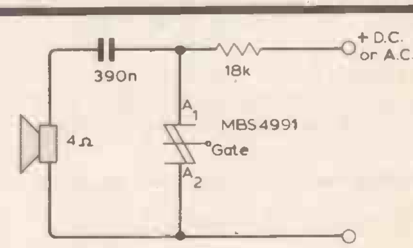
In t.t.l. circuits which use 710 type comparators, power supplies of +5V, +12V and -6V are needed. The common arrangement is inefficient and costly compared with this circuit, which provides the voltages required from a single standard transformer. Although the 5V rail may have to provide a substantial current, the other supply rails only need to deliver small currents which can be provided by half wave rectification. During positive half-cycles the lower winding feeds the +6V rail via D_1, and the two windings in series feed the +12V rail via D_1 and D_2. Diodes D_3 and D_4 are biased off. During negative half-cycles D_1 and D_2 are biased off and the windings are isolated. The top winding now feeds the +6V rail with a return via D_3 and the lower winding feeds the -6V rail via D_4. Therefore, the +6V rail is fed during both half cycles by the two secondary windings alternately and both low current rails are fed on alternate half-cycles. The voltages shown increase when capacitors are connected to provide an adequate margin for the regulators.



R. M. Adelson
Hornby
Lancaster

Simple oscillator

A silicon bilateral switch, s.b.s., is a useful component for producing a simple, economic and versatile audio oscillator. With a 12V d.c. supply the circuit oscillates at 100Hz and draws only 400 μA. Direct or alternating supplies can be used and with suitable component values, mains operation is possible. Frequency modulation or on/off control is achieved by feeding a voltage or pulse to the gate. Minimum direct supply voltage is about 10V but an 18kΩ resistor between the gate and A_2 reduces this to around 3V. An 8Ω speaker can also be used with a small reduction in output power.

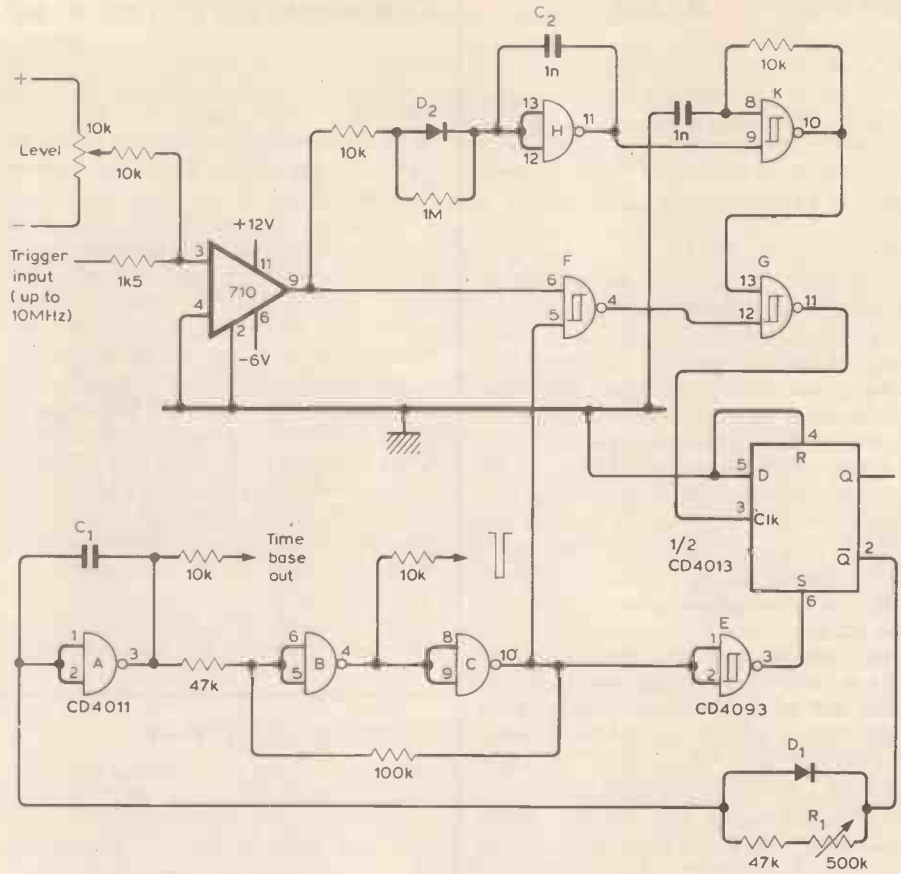


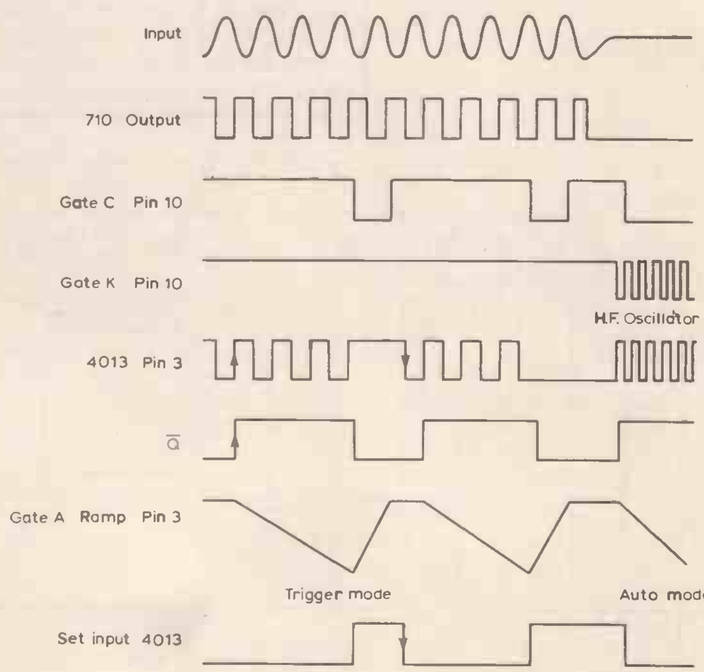
D. Di Mario
Johannesburg
S. Africa

Triggered timebase

High-quality oscilloscopes with sweep rates up to 0.1 μs/cm use special components, such as fast f.e.ts and tunnel diodes, together with logic i.cs. This timebase provides a wide sweep range with trigger hold-off and bright-line functions and does not require any expensive or uncommon devices. Three NAND gates generate a ramp waveform, and a Schmitt trigger shapes and inverts the square wave from gate C. When the flip-flop is set the output goes low and C_1 discharges via D_1 to provide the flyback at pin 3 and a pulse at pin 4. Ramp rate is varied by R_1, and C_1 is switch-selectable for a wide range of sweeps. The trigger input is shaped by a 710 and gated by a Schmitt trigger, so the flip-flop is only clocked when the output of gate C is high. This sets the output high and charges C_1 linearly. The 710 output also goes to D_2 and an integrator, which negatively charges C_2 and disables the oscillator around gate K. When disabled, the oscillator output is high and therefore enables gate G to clock the flip-flop. When no input signal is present, the oscillator feeds the clock input of the flip-flop and provides automode operation for the timebase.

K. Padmanabhan
Madras
India

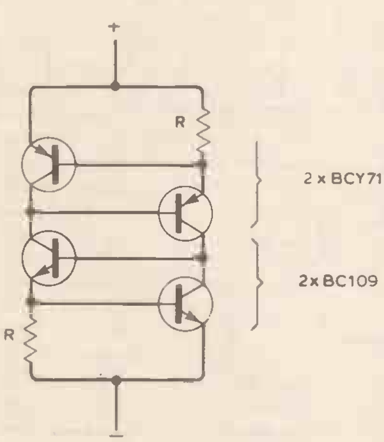




Two terminal constant current source

Most constant-current sources require output, ground and supply connexions to a circuit. However, a two-terminal arrangement can be obtained by combining two standard sources, of opposite polarity, back-to-back. In the circuit diagram the current is $2V_{be}/R$.

J. J. Ellis
Cambridge



NEW PRODUCTS

Prestel / Viewdata printer

The Olympia International NMP 40 mechanism, incorporated in a printer terminal, forms one of the first screen image printers to appear in the UK. A hard copy of displayed Prestel/Viewdata images can be made with the printer which Dataplus, the equipment's distributor, claims as "very quiet" in operation. The unit will print alphanumeric characters and graphics at high speed and paper loading is simple. The printhead consists of 240 discrete electrodes equally spaced across the 127mm wide paper and each is spring-loaded, obviating the need for adjustment. The rubber platen is driven by a small d.c. motor, this being the only moving part. Overall dimensions of the terminal are 250mm wide × 360mm deep × 150mm high. Production quantities of the unit will be available in late 1980 as will the full drive electronics to suit UK television receivers. Dataplus Ltd, 39-49 Roman Road, Cheltenham.

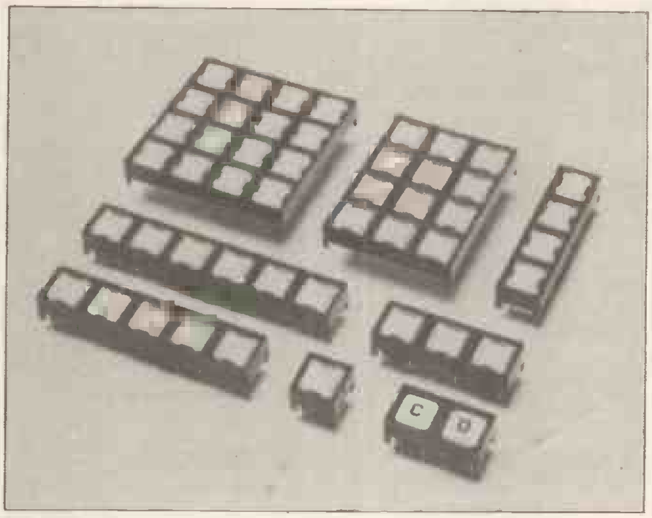
WW301

WW301

D.i.y. keyboards

Individual keys, rows of keys or groups of keys, elements of the series 87 family of switches, can be used to create keyboard forms for prototypes, short runs or volume production, according to the makers, Highland Electronics. Legending of switches is achieved by hot stamping of the buttons to customers' requirements before delivery, although for prototype work, versions of the switches are available with snap-on caps. In this event a legend sheet is supplied and each legend is placed under the cap. The series 87 employs snap-dome contacts previously used on Highland series 83, 84 and 86, all 16 button keypads. A typical circuit for these switches is single-pole/common-bus and the 3 × 4 and 4 × 4 keypads are also available with matrix switching. Highland Electronics Ltd, Highland House, 8 Old Steine, Brighton, East Sussex.

WW302

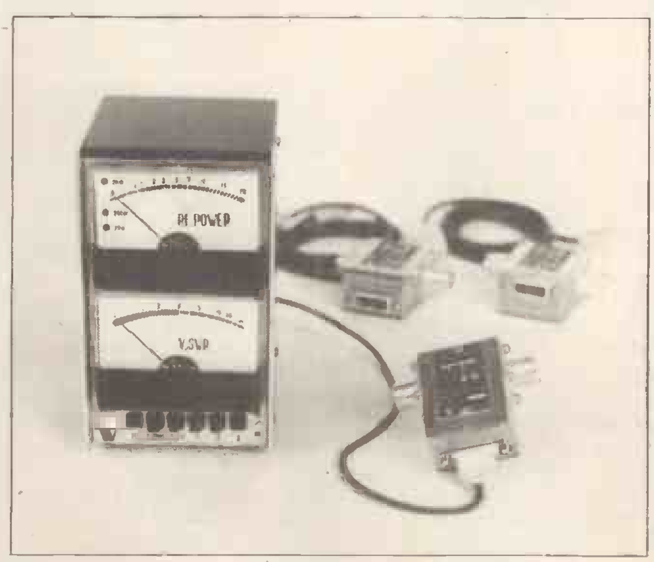


WW302

V.s.w.r. / power meter

Direct reading of v.s.w.r. and output power without the need for interpolation is one of the capabilities of the v.s.w.r./power meter offered by Zycomm Electronics. The unit is autoranging for power output measurement, covering 20W to 2kW in three ranges for 1.8 to 30MHz and 50 to 150MHz, and 2W to 200W for the 430 to 470MHz range. V.s.w.r. from 1:1 to infinity can be measured. Separate sensing heads are supplied to cover each frequency range and these can be connected at any point in the feed line, including the masthead, for precise radiated power indication. Push switches on the front panel permit the selection of the appropriate head and the display of forward or reverse power as either peak or r.m.s. readings. The electronic comparator included in the unit permits constant readout of v.s.w.r. irrespective of power variation, thereby giving true indication during speech on s.s.b. The unit is for operation on 240v 50Hz mains. Zycomm Electronics Ltd, 47, 49 and 51 Pentrich Rd, Ripley, Derby DE5 3DS.

WW303



WW303

Digital slow scan transceiver

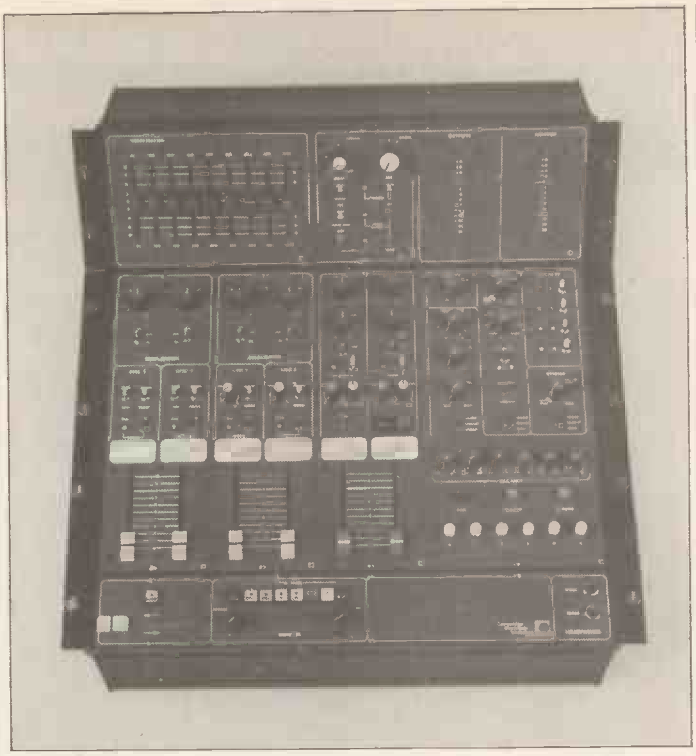
The Colorado Video model 285 is intended to provide "quality" tv picture transmission over data channels and is available as a receiver, a transmitter or transceiver. Features incorporated are "frame freeze", a repeating "freeze and scan" mode for surveillance applications and continuous display at the receiver as each new image wipes off the previous image. The unit accepts tv signals from camera, v.t.r. or video disc recorder and also produces a signal for viewing on c.c.t.v. monitors. Transmission is in the synchronous serial digital form at rates up to 500 k/bits/s and the equipment requires no adjustment when changing rates, the unit itself tracking the modem clock rate. The operator may select left-to-right or top-to-bottom scanning to suit the item scanned and may transmit either a single field (shorter transmission time at reduced resolution) or a full frame, i.e. normal transmission time at full resolution. Transmission times vary according to the grey-scale levels chosen, either 64 levels (6 bit) or 256 levels (8 bit) depending upon the bit rate. Data may be encrypted for security purposes. Prices start at $9,000, this being the price for the receiver only. Colorado Video, Box 928, Boulder Co, 80306, USA.

WW304

Music processor/ mixer

The Cambridge Electronic Workshop music processor is a full broadcast specification mixer intended as an off-the-shelf item for club and mobile use, built in standard 19in rack units in modular form. The technical complement includes transformer-coupled inputs with phantom powering, microphone limiters, plastic track faders with remote start for external tape or disc transport mechanisms, and separate equalization for two disc units, two line inputs and both microphone inputs. Outputs are complete with a stereo limiter, "voice over," adjustable voice switch from the d.j.'s microphone and a nine-band graphic equalizer. Also featured is a built-in comprehensive lighting control which is compatible with Pulsar equipment and contains a six-channel sound-to-light chaser, strobe drive and four independently controlled mains terminals. Cambridge Electronic Workshop, 4 Water Lane, Oakington, Cambridge CB/4 5AL.

WW305



WW305

High temperature contact adhesive

Excellent acid resistance, high moisture resistance and good dielectric strength are properties which Aremco Products International attributes to its Aremco-Bond 570, an elastomer-phenolic adhesive intended for the bonding of ceramic, glass and metallic materials at temperatures up to 315°C. A further characteristic is its good shock resistance due to a small degree of flexibility being present after curing, thus allowing bonding of materials with a dissimilar coefficient of expansion. The adhesive is applied in the usual manner to both surfaces, which are allowed to dry before pressing together and final heat cure under pressure will produce a high temperature high strength bond. Aremco-Bond 570 costs £21.50 per pint, plus carriage costs. Photograph shows the adhesive being used to bond together two ceramic bushes. The Meclec Company, 5-6 Towerfield Close, Shoeburyness, Essex SS3 9QP.

WW306

Spark gap c.r.t. protectors

The focusing electrode of a c.r.t. can be protected from the damaging effects of excessive e.h.t., by the spark gap series 5389, manufactured by Welwyn Electric. These units can also be used to protect v.d.u. tubes, oscilloscopes and photomultipliers from high voltage discharges and transients. The three items in the series cover the "popular" (perhaps not so for the tv service technician!) breakdown bands of 7 to 9kV, 8.5 to 10.5kV and 10 to 12kV all with current handling up to 1500 amps. These spark gap protectors meet BS2011 ("Components for printed circuit applications,") and are flame retardant in accordance with BS415-14/4. Welwyn Electric, Bedlington, Northumberland NE22 7AA.

WW307

Radio i.cs

Two new i.cs which the makers claim will considerably increase the level of integration possible in professional radio equipment, are available in 8 lead TO5 or 8 lead d.i.l. plastic packages. These two circuits, the SL6270 and the SL6310, are additions to the recently introduced Plessey SL6000 series of linear radio circuits. The SL6270 is a microphone amplifier with integral gain control, the control circuit providing a constant output level whether the level of the incoming speech signal is high or low, making it suitable for use in the fields of tape recording and public address. The SL6310 is an audio i.c., designed to avoid the high quiescent current consumption typical of portable receivers. A "mute" signal switches off the circuits in weak or noisy signal conditions, the normal standby current being 5mA while still maintaining an output power of 500mW. Plessey Semiconductors Ltd, Cheney Manor, Swindon, Wiltshire.

WW308

"Crowbar" s.c.rs

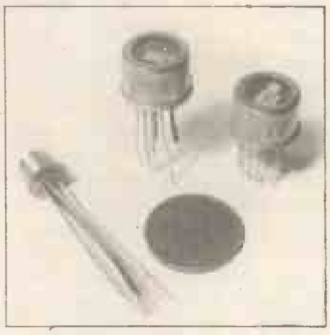
A range of s.c.rs which the makers, Motorola, describe as "the first in the industry to be specifically characterised and specified for "crowbar" applications, is accompanied by data sheets giving a graph detailing peak capacitor discharge current. This plot indicates peak discharge current as a function of power supply discharge time, permitting power supply designers to select a specific s.c.r. whose peak current characteristics are suited to a particular supply circuit. Each item in the MCR67-71 range of s.c.rs is capable of dumping peak currents of 300 to 1700A, thus discharging the power supply output capacitors and clamping the voltage to the on-state voltage of the s.c.r. until a fuse or circuit breaker opens. Gate trigger current for the series is 2mA minimum and 30mA maximum. The s.c.rs are available in both metal and plastic packages with operating voltages between 25 and 100V. Motorola Ltd, Semiconductor Products Division, York House, Empire Way, Wembley, Middlesex HA9 0PR.

WW309

Infra-red detectors

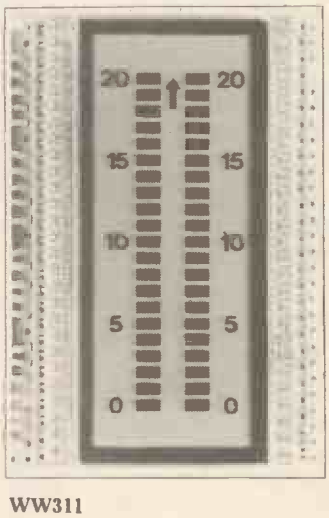
A range of lead sulphide and lead selenide infra-red detectors manufactured by the American Optoelectronics Inc, is now being marketed by Wentworth Laboratories. These detectors are available in single element or multi-array packages incorporating standard units made up from elements in sizes from 1 to 5mm square. Detectors for use at room temperatures are included and these can be provided as standard units or units with an optional built-in thermoelectric cooler. Thermistors may be used in conjunction with the detectors for the monitoring of detector temperature and to allow closer control of performance. Wentworth Laboratories Ltd, Sun St, Potton, Beds, SG19 2LR.

WW310



Bar graph l.c.d. unit

Numerical annunciation and over-range/under-range indication are features included in the 20 element bar-graph liquid-crystal display unit from Hamlin Electronics. Each bar has a separate backplane enabling each of the two bars to be driven independently. The display is available with pins for d.i.l. mounting or with snap-on terminal strips. An applications note, including a drive circuit for the display, is also available. Hamlin Electronics, Diss, Norfolk.

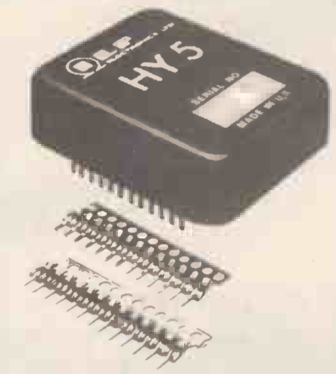


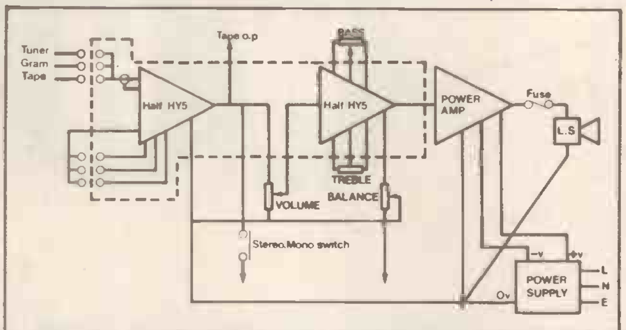
WW311

and staying there

PERFORMANCE MODULAR UNITS

HY5 PRE-AMPLIFIER





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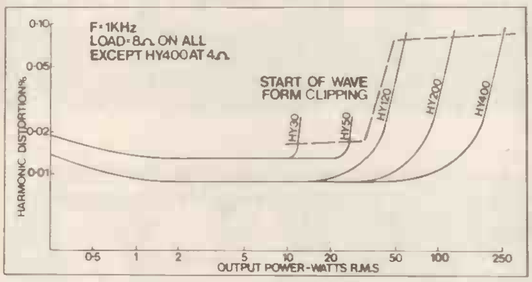
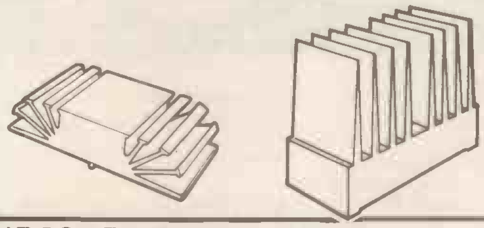
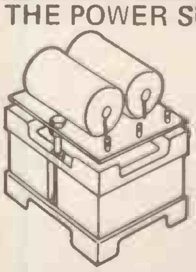


Model	Output Power R.M.S.	Distortion Typical at 1KHz	Minimum Signal/Noise Ratio	Power Supply Voltage	Size in mm	Weight in gms	Price + V.A.T.
HY30	15 W into 8 Ω	0.02%	80dB	-20 -0- +20	105x50x25	155	£6.34 + 95p
HY50	30 W into 8 Ω	0.02%	90dB	-25 -0 +25	105x50x25	155	£7.24 + £1.09
HY120	60 W into 8 Ω	0.01%	100dB	-35 -0- +35	114x50x85	575	£15.20 + £2.28
HY200	120 W into 8 Ω	0.01%	100dB	-45 -0- +45	114x50x85	575	£18.44 + £2.77
HY400	240 W into 4 Ω	0.01%	100dB	-45 -0- +45	114x100x85	1.15Kg	£27.68 + £4.15



Load impedance — all models 4 - 16Ω
Input sensitivity — all models 500 mV
Input impedance — all models 100KΩ
Frequency response — all models 10Hz - 45Hz - 3dB

THE POWER SUPPLY UNITS



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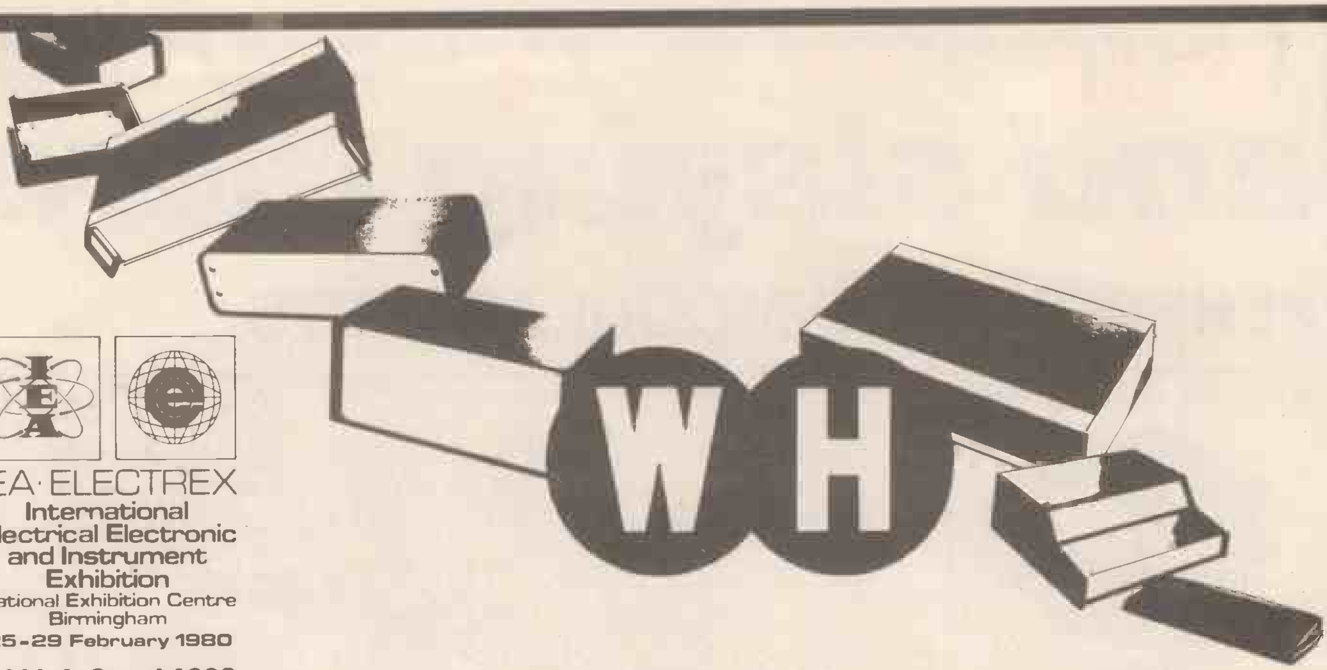

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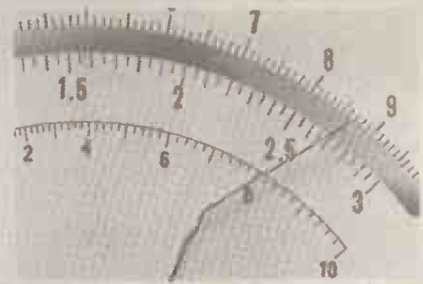

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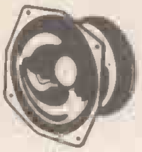

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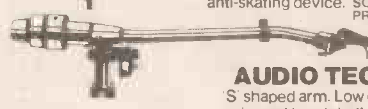

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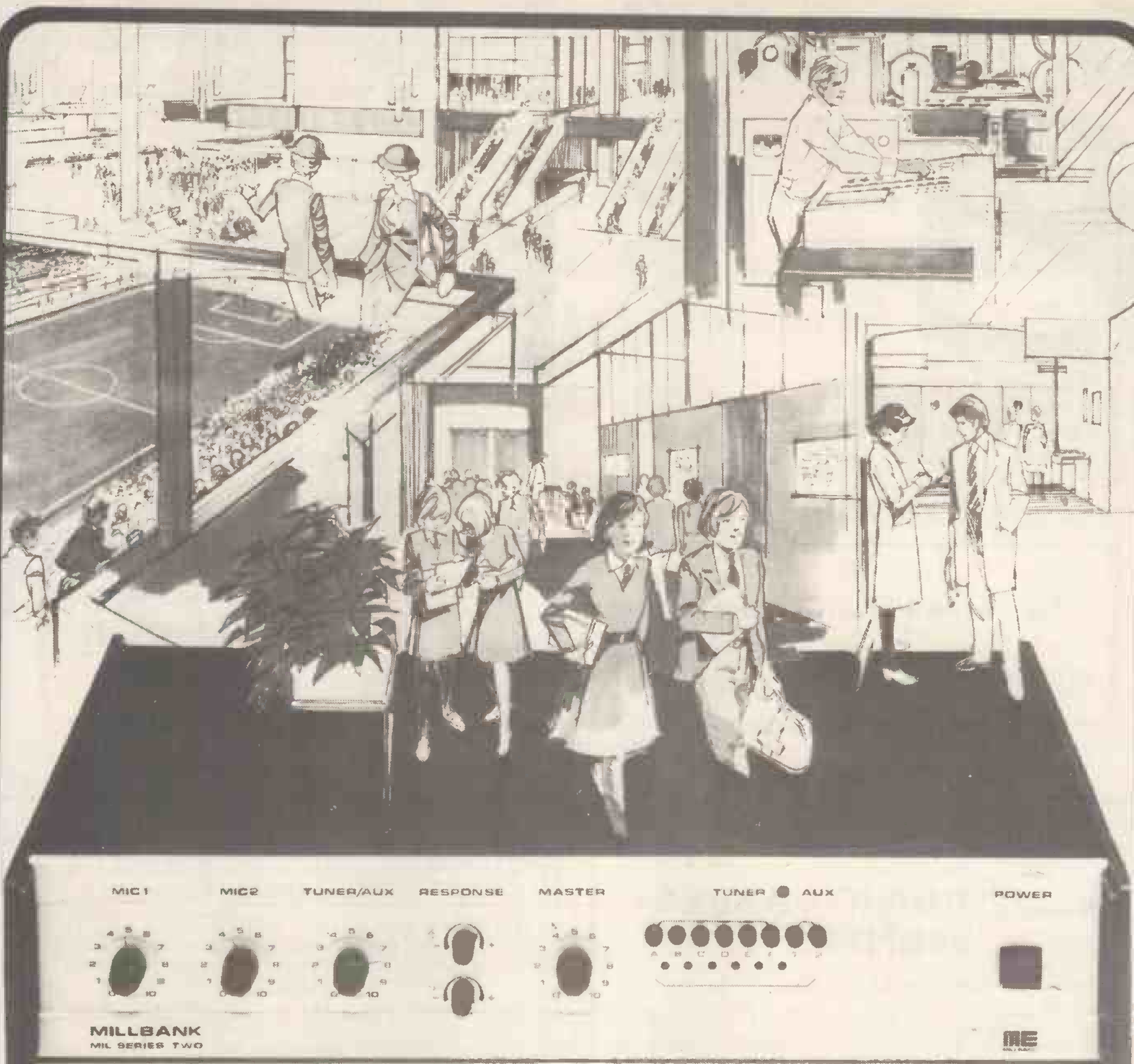
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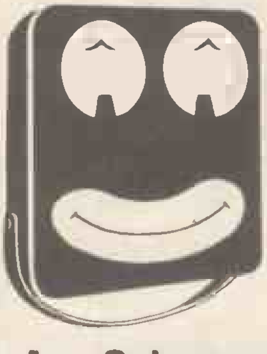

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LM3900	£0.50	TAA621A	£1.80	uA711	£0.26
MC1310P	£0.85	TBA120B	£0.60	741P	£0.16
NE555	£0.18	TBA641A	£1.10	TAA661	£1.25
NE556	£0.55	TBA800	£0.75	TAA661B	£1.25

SPECIAL OFFER

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O/NO	Quantity		£ p
SJ1	200	Resistors mixed values	0.50
SJ2	200	Carbon resistor s ¼-½ watt preformed	0.50
SJ3	100	¼ watt resistors mixed values	0.50
SJ4	60	½ watt resistors mixed values	0.50
SJ5	50	1-2 watt resistors mixed pot values	0.50
SJ6	50	Precision resistors 1-2 tol. mixed	0.50
SJ7	30	5-10 watt wirewound resistors mixed	0.50
SJ11	150	Capacitors mixed types & values.	0.50
SJ12	60	Electrolytics all sorts mixed	0.50
SJ13	50	Polyester / polystyrene capacitors mixed	0.50
SJ14	50	C280 type capacitors mixed	1.00
SJ15	40	High quality electrolytics 100-470mf	1.00
SJ16	40	Low volts electrolytics mixed up to 10v	0.50
SJ17	20	Electrolytics transistor types mixed	0.50
SJ20	2	Large croc clips 25A rated	0.30
SJ21		Large 7½" 'Mains Neon Tester' screwdriver	0.85
SJ22		Small pocket size 'Mains Neon Tester'	0.55
SJ23		Siemens 220v AC Relay DPDT contacts 10amp rating — housed in plastic case	1.00
SJ24		Black PVC tape (⅝) 15mm × 25m — strong tape for electrical & household use	0.35 per roll 1.50 5 rolls
SJ25	100	Silicon NPN transistors all perfect & coded — mixed types with data & equivalent sheet	2.50
SJ26	100	Silicon PNP transistors all perfect & coded — mixed types and cases data and equivalent	2.50
SJ27	50	Assorted pieces of SCR's diodes & rectifiers incl stud types all perfect — no rejects fully coded — data incl.	2.50
SJ28	20	TTL 74 series gates — assorted 7401 — 7460	1.00
SJ33		PC Board — mixed bundle PCB fibreglass paper single & double sided — super value!	0.75
SJ34	200	sq. ins. (approx) copper clad paper board	0.80
SJ37	100	sq. ins. (approx) copper clad fibre glass	0.80
SJ47	8	Dual gang carbon pots log & lin mixed values	1.00
SJ50	20	Assorted slider knobs — chrome/black	1.00
SJ51	1	Switchbank 5 way incl silver knobs	0.50
SJ53	1	Mammoth IC Pack: approx 200 200pcs assorted fall-out integrated circuits including logic 74 series, linear-audio and OTL many coded devices but some unmarked — you to identify	1.00
SJ54	20	Slider pots mixed values & sizes	1.00
SJ56	6	100K lin 40mm slider pots	0.50
SJ57	6	100K log 40mm slider pots	0.50
SJ58	6	1K lin 40mm slider pots	0.50
SJ60	4	5K log 60mm single	0.50
SJ61	4	100K log 60mm single	0.50
SJ62	5	15mm chrome knobs standard push fit	0.50
SJ63	1	Instrument knob — black winged (29 × 20mm) with pointer ¼" standard screw fit	0.15
SJ64	1	Instrument knob — black/silver aluminium top (17 × 15mm) ¼" standard screw fit	0.12
METAL CASE DUAL SLIDER POTS: 45mm travel			
SJ65		10K log	0.25 each
SJ66		100K lin	0.25 each
SJ67		Chrome slider knobs to fit	0.10 each
SJ68	30	ZTX300 type transistor NPN pre-formed for P/c Board colour coded blue — all perfect	1.00
SJ69	30	ZTX500 type transistor PNP pre-formed for P/c Board colour coded white — all perfect	1.00
SJ70	25	BC107 NPN to 106 case perfect transistors code C1359	1.00
SJ71	25	BC177 PNP TO106 case perfect transistors code C1395	1.00
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SJ73	6	TO64 SCRs 5 amp assorted 50v-400v all coded	1.00
SJ74	8	Way ribbon cable — colour coded individually PVC insulated solid tinned copper conduction	0.2 metre
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SJ77	A5	pin DIN 180 chassis/normal socket incl. DPDT switch	0.20
SJ83	5	Germ. OCP71 type photo transistors	1.00
SJ84	10	BD131 NPN transistors low Hfe rejects	0.50
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16169	2	Tuning gangs MW/LW	0.50
16170	50	Meters asst. colours single strand wire	0.50
16171	0	Reed switches	0.50
16172	3	Micro switches	0.50
16173	15	Assorted pots	0.50
16177	1	Pack assorted hardware	0.50
16178	5	Main slider switches assorted	0.50
16179	1	Pack assorted tag strips	0.50
16180	15	Assorted control knobs	0.50
16181	3	Rotary wave change switches	0.50
16182	2	Relay 6-24v	0.50
16184	25	Assorted fuses 100mA-5A	0.50
16185		An assortment PVC sleeving markers	0.50
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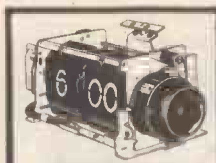

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London, E8 2AZ Tel: 01-249 5624

ADV 030 ADV 025

Model No.	ADV 030	ADV 025
Output Current	5 Amp	10 Amp
Output Volts	2-30 DC	0-25 DC
Input Volts	115-230-250 A/C	115-230-250 A/C
Tolerated Mains Variation	15%	15%
Ripple On Load	.05%	.05%
Load Regulation Better Than	.5%	.5%
Protection	Both Models. Internal Fold Back. Overload. Thermal and short circuit Protected.	
Guarantee	Both Models. 2 years	
Dimensions	Height. 130 M/M mm Width. 250 M/M mm Depth. 170 M/M mm	177 mm 335 mm including 294 mm handles

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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 3¼in. Below motor board 2½in. with Ceramic Stereo cartridge.

£20 Post £1.60

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Cut out for most BSR or Garrard decks. Post £1.60
Silver grey finish.
Model "B" Size 16 x 13¾ x 3in. **£4.50**
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GARRARD AUTO CHANGER CC10A

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

BSR P163 BELT DRIVE QUALITY DECK

Manual or automatic play. Two speeds. Precision balanced arm. Slide in head, cueing device. Bargain price
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Suitable magnetic cartridge £6.50.

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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

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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 **20p.** SOCKETS **25p.**
LINE SOCKETS **45p.**
OUTLET BOXES **85p.**
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. **£10.95** Post 75p
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

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

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VARICAP FM TUNER HEAD with circuit & connections. Some technical knowledge required **£4.95.**
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TAPE OSCILLATOR COIL. Valve type, **35p.**
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TOGGLE SWITCHES SP **30p.** DPST **40p.** DPDT **50p.**
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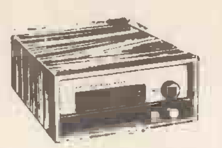
SONOTONE 9TAHC Diamond **£3.75.** V100 Magnetic **£6.50.**
RESISTORS. 10Ω to 10M. ¼W, ½W, 1W, 20% **1p;** 2W **10p.**
HIGH STABILITY. ½W 2% 10 ohms to 1 meg. **8p.**
Ditto 5%. Preferred values. 10 ohms to 10 meg. **3p.**

MAINS OPERATED SOLID STATE AM/FM STEREO TUNER



200/240V AC Mains. F.M./A.M. Stereo Tuner. Covering M.W., A.M. 540-1605KHz. V.H.F., F.M. 88-108MHz. Ferrite rod aerial for M.W. Full AFC and AGC on A.M. and F.M. Stereo Beacon Indicator. Built-in Pre-amps with variable output adjustable by pre-set control. Max. o/p Voltage 600mV R.M.S. into 20K. Simulated Teak finish cabinet. Will match almost any amplifier. Size 8¼in wide, 4in. high x 9½in. deep approx. Only **£28** Post £1.60

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RCS STEREO PRE-AMP KIT. All parts to build this pre-amp. Inputs for high, medium or low imp per channel, with volume control and PC Board **£2.95**
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2 amp. 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 25 and 30V	£6.00
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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
066	
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30V, 2 amp	£3.60
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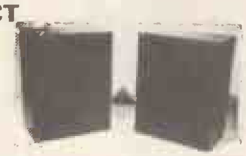

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11×8½×7in
50 to 14,000 cps.
15 watts 8 ohm
£20 pair Post £2

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1, 2, 4, 5, 8, 16, 25, 30, 50, 100, 200mF 15V **10p.**
500mF 12V **15p;** 25V **20p;** 50V **30p.**
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6Q7G	954	PCL82	PY80	ECC84	EM85
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12Q7GT	35Z4GT	PL81	PY83	ECL80	EY51
12K8M	PCC84	PL82	EB91	ECL82	EY86
25Y5G	PCC89	PL83	EBC81	EF41	EZ4D

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Post £1.50 ea.

MODEL	SIZE IN	OHMS	POWER WATTS	TYPE	OUR PRICE
MAJOR	12	4-8-16	30	HI-FI	£12
DELUXE MK II	12	8-16	15	HI-FI	£14
SUPERB	12	8-16	30	HI-FI	£22
AUDITORIUM	12	8-16	45	HI-FI	£20
AUDITORIUM	15	8-16	60	HI-FI	£30
GROUP 35	12	4-8-16	40	PA	£12
GROUP 45	12	4-8-16	45	PA	£15
GROUP 50	12	4-8-16	60	PA	£20
GROUP 50	15	8-16	75	PA	£30
GROUP 75	12	4-8-16	75	PA	£24
GROUP 100	12	8-16	100	PA	£29
GROUP 100	15	8-16	100	PA	£35
DISCO 100	12	8-16	100	DISCO	£29
DISCO 100	15	8-16	100	DISCO	£35

BAKER 50 WATT AMPLIFIER

£63 Post £1.60
Ideal for Halls/PA systems, Discos and Groups. Two inputs. Mixer, Volume Controls, Master Bass, Treble and Gain Controls. 50 watts r.m.s. Three loudspeaker outlets 4, 8, 16 ohms.

BAKER 150 WATT MIXER/AMPLIFIER

Professional 4 inputs with volume controls. Will mix mics, decks, musical instruments, etc.
£85 Post £1.60
Slave version available **£69**

FAMOUS LOUDSPEAKERS "SPECIAL PRICES"

Post £1.50 ea.

MAKE	MODEL	SIZE	WATTS POWER	OHMS	OUR PRICE
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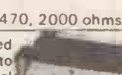

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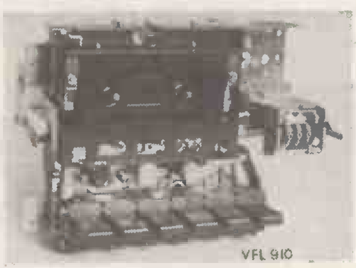

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The kit for this outstandingly practical design by John Adams being published in a series of articles in Wireless World really is complete!
Included in the PSI COMP 80 scientific computer kit is a professionally finished cabinet, fibre-glass double 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"

Value Added Tax not included in prices

PRICE STABILITY: Order with confidence! Irrespective of any price changes we will honour all prices in this advertisement until April 30th, 1980, if this month's advertisement is mentioned with your order. Errors and VAT rate changes excluded.

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POWERTRAN COMPUTERS

(a division of POWERTRAN ELECTRONICS)
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High intensity, multi turn, high voltage neon glow discharge flash tube. Designed for ignition tuning, etc. £1.50 P&P 25p (**£2.01** inc. VAT). 3 for **£3.** P&P 50p (**£4.03** inc. VAT & P).

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MULTI RANGE METERS Type MF15A. AC/DC volts 10. 50. 250. 500. 1000. Ma. 0-5. 0-10. 0-100. Sensitivity 2000V. 24 ranges, dimensions 133×93×46mm. Price **£7.00** plus 50p P&P (**£8.63** inc, VAT & P).

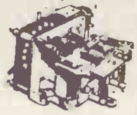
TRIAC.
Raytheon tag symmetrical Triac. Type Tag 250/500V 10 amp 500 piv. Glass passivated plastic triac. Swiss precision product for long term reliability **£1.25** P&P 10p (**£1.55** inc. VAT & P) (inclusive of date and application sheet). Suitable Diac **22p**.

MERCURY SWITCH

Size 27m×5mm, 10 for **£5.00** P&P 30p, total including VAT **£6.10.** Min. quantity 10.
Heavy duty type 36 × 15 × 10mm. Minimum quantity 10. **£7.50** post paid (**£8.83** inc. VAT & P). N.M.S.

230 VOLT AC FAN ASSEMBLY

Powerful continuously rated AC motor complete with 5 blade 6½" or 4 blade 3" aluminium fan. New reduced price **£3.00** P&P 65p (**£4.20** inc. VAT & P). N.M.S.

21-WAY SELECTOR SWITCH with reset coil

The ingenious electro mechanical device can be switched up to 21 positions and can be reset from any position by energising the reset coil. 230/240V AC operation. Unit is mounted on strong chassis. Complete with cover. Price **£5.50** P&P 75p (**£7.19** inc. VAT & P). N.M.S.

A.E.G. CONTACTOR
Type LS6/L11. Coil 240V 50Hz. Contacts — 3 make: 600V: 20 amp. 1 break: 600V: 20 amp. Price: **£5.50 +** 50p P&P (**£6.90** inc. VAT & P) N.M.S.

ARROW-HART MAINS CONTACTOR
Cat. No. 130A30
Coil 250V or 500V AC. Contacts, 3 make 50 amp up to 660V AC 20hp at 440V 3 phase 50Hz. Price **£7.75 +** P&P £1.00 (Total inc VAT & P **£10.06**). N.M.S.

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220/240V AC Aperture 10×4½cm overall size 16×14cm. Price **£3.75** P&P 75p (incl VAT **£5.18**).

SMITH BLOWER
Type FFB1706. Small quiet smooth running. 240V AC operation. Output aperture 45×40cm. Overall size 135×165mm. Flange mounting. Price **£4.25.** P&P 75p. **£5.75** incl. P & VAT. Other types available. SAE for details. N.M.S.

24V DC BLOWER UNIT
USA made 24V DC 0.8 amp blower that operates well on 12V 0.4 amp DC producing 30 cu ft min at normal air pressure. Maximum housing dia 110mm, depth inc motor 75mm, nozzle length 19mm, dia 22mm. Ideal for cooling mobile equipment, **car**, caravan, etc. **£4.50** P&P 75p (**£6.04** inc VAT & P). N.M.S.

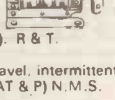
BLOWER/VACUUM PUMP
3 phase AC motor, 220/250V or 380/440V, 1,425 rpm ⅛ hp cont. Direct coupled to William Allday Alcosa carbon vane blower/vacuum pump. 0.9 cfm 8 hg. Price **£22.00** P&P £2.00 (**£27.60** inc. VAT & P). N.M.S.

MINIATURE UNISELECTOR

12V 11 way 4 bank (3 non-bridging, 1 homing). **£3.00** P&P 35p (**£3.85** inc. VAT & P).

MICRO SWITCHES

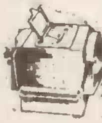
Miniature roller micro switch. 5A C/O contacts. Mf by Bonnello. Price: 10 for **£2.00.** P&P 25p. Total incl. VAT & P **£2.59.** As above less roller 20 for **£1.80.** P&P 25p. Total incl. VAT & P **£2.36.**
D.P. C/O lever m/switch, mfg. by Cherry Co, USA. Precious metal, low resistance contacts. 10 for **£2.50.** P&P 30p. Total inc. VAT **£3.22** (min 10). N.M.S.

HEAVY DUTY SOLENOID

Mfg. by Magnetic Devices. 240V AC. Intermittent operation. Approx. 20lb pull at 1.25in. Ex. equip. Tested. Price **£4.75** P&P 75p (**£6.33** inc. VAT & P). R & T.

PYE EYTHER
240V AC solenoid. Approx 1lb pull, ¼" travel, intermittent rating. Price **£1.00** P&P 20p (**£1.38** inc VAT & P) N.M.S.

WESTOOL TYPE MM8 MODEL 2
240V AC. Approx. 1¾ lb pull at ½ inch. Rating 1. Price **£1.50** P&P 20p (**£1.96** inc. VAT & P). N.M.S.

TYPE AG/TG
18-24V DC 70 ohm Coil Solenoid. Push or Pull. Adjustable travel to 3/16in. Fitted with mounting brackets and spark suppressor. Size: 100×65×25mm. Price: 3 for **£2.40** P&P 30p (min. 3 off) (**£3.10** inc. VAT & P)

INSULATION TESTERS (NEW)

Test to IEE spec. Rugged metal construction, suitable for bench or field work, constant speed clutch. Size L. 8in, W. 4in, H. 6in, weight 6lb.
500 VOLTS 500 megohms
£49.00 Post 80p (**£57.27** inc. VAT & P)
1,000 VOLTS 1,000 megohms **£55.00**
Post 80p (**£64.17** inc. VAT & P). SAE for leaflet.

YET ANOTHER OUTSTANDING OFFER
New IMFD 600V Dubilier wire ended capacitors. 10 for **£1.50** P&P 50p. (**£2.30** inc. VAT + P&P). (Min. 10). N.M.S.

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VARIABLE 0—260V

200W 1 amp inc a.c. voltmeter	**£14.50**
0.5 KVA (2½ amp MAX)	**£17.00**
1 KVA (5 amp MAX)	**£22.50**
2 KVA (10 amp MAX)	**£37.00**
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17 KVA (75 amp MAX)	**£260.00**


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3-PHASE VARIABLE VOLTAGE TRANSFORMERS

3 KVA (max. 15 amp)	**£106.43**
6 KVA (max. 30 amp)	**£159.37**
10 KVA (max. 50 amp)	**£327.43**

CARRIAGE PACKING & VAT EXTRA

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0.6V/12V at 20 amp **£14.70** P&P £1.50 (inc. VAT **£18.63**)
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0-6V/12V at 10 amp **£8.25** P&P £1.25 (inc. VAT **£10.93**)
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0-10V/17V/18V at 10 amp **£10.50** P&P £1.50 (inc. VAT **£13.80**)
Other types in stock; phone for enquiries or send SAE for leaflet.

POWER RHEOSTATS

New ceramic construction, vitreous enamel embedded winding, heavy duty brush assembly, continuously rated.
25 WATT 10, 25, 100, 150, 250, 500, 1k, 1.5k ohm **£2.40** Post 20p (**£2.99** inc VAT & P). **50 WATT** 250 ohm **£2.90** Post 25p (**£3.62** inc VAT & P). **100 WATT** 1/5/10/25/50/100/250/300/500/1k/1.5k/2.5k/5k ohm **£5.90** Post 35p (**£7.90** inc VAT & P).
Black Silver Skirted Knob calibrated in Nos 1-9, 1½in dia brass bush. Ideal for above Rheostats **24p ea.**

STROBE! STROBE! STROBE!

HY-LIGHT STROBE KIT Mk. IV
Latest type Xenon white light tube. Solid state timing and triggering circuit. 230/240V AC operation. Speed adjustable 1-20 fps. Designed for large rooms, halls, etc. Light output greater than many (so called 4 Joule) strobes. Price **£22.00** post £1.00 (**£27.03** inc. VAT & P). Specially designed case and reflector for Hy-Light **£9.00** Post £1.00 (**£12.08** inc. VAT & P).

ULTRA VIOLET BLACK LIGHT FLUORESCENT TUBES
4ft 40 watt £8.70 (callers only **£10** inc VAT). **2ft 20 watt £6.20.** Post 75p (**£7.99** inc. VAT & P). (For use in stan bi-pin fittings).
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Complete ballast unit for either 6", 9" or 12" tube 230V AC op. **£3.50** plus P&P 45p (**£4.54** inc. VAT & P). Also available for 12V DC op, **£3.50** plus P&P 45p (**£4.54** inc. VAT & P).
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PROGRAMME TIMERS
240V AC operation, 12 cam model. **£7.50 +** 75p P&P (**£9.49** Inc. VAT).

REED SWITCHES
Size 28mm×4mm dia. Price: 10 for **£1.00 +** P&P 20p (total incl. VAT **£1.38**). 100 for **£8.00 +** P&P 30p (total inc. VAT **£9.55**).

WIDE RANGE OF DISCO LIGHTING EQUIPMENT
SAE (Foolscap) for details

XENON FLASH GUN TUBES
Range of Xenon tubes available from stock. SAE for full details.

RELAYS

Wide range of AC and DC relays available from stock. Phone or write in your enquiries.

230/240V AC Relays: Arrow, 2 c/o. 15 amp **£1.50** (**£1.96** inc. VAT & P). T E C. open type 3 c/o 10 amp **£1.10** (**£1.50** inc VAT & P).
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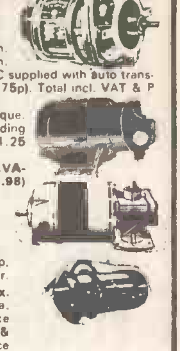
DC Relays: Open type 9/12V 3 c/o 7 amp **£1.00** (**£1.38** inc. VAT & P) Sealed 12V 1 c/o 7 amp octal base, **£1.00** (**£1.38** inc. VAT & P). Sealed 12V 2 c/o 7 amp octal base, **£1.25** (**£1.67** inc. VAT & P). Sealed 12V 3 c/o 7 amp 11-pin, **£1.35** (**£1.78** inc. VAT & P) 24V Sealed 3 c/o 7 amp 11-pin **£1.35** (**£1.78** inc VAT & P) (amps = contact rating). P&P on any Relay 20p.
Very special offer. 0-12V DC. 2 make contacts, new ITT 3 for **£1.75 +** 25p P&P (inc. VAT **£2.30**)
Diamond H heavy duty AC relay 230/240V AC. two c/o contacts 25 amps res at 250V AC **£2.50** P&P 50p (**£3.45** inc VAT + P&P). Special base **50p.**

METERS (New) — 90mm DIAMETER

AC Amp. Type 62T2. 0-1A, 0-5A, 0-20A. **AC Volt.** 0-15V, 0-300V **DC Amp.** Type 65C5, 0-2A, 0-10A, 0-20A, 0-50A. **DC Volt.** 0-15V, 0-30V. All types **£3.50** ea + P&P 50p (**£4.60** incl. VAT). 0-50A DC, 0-100A DC. Price **£5.00** + 50p P&P (**£5.94** inc. VAT).

GEARED MOTORS

4½ rpm SIGMA motors approx 35lb inch.
7½ rpm KLAXON motors approx. 25lb inch.
28 rpm WYNSCALE motors approx. 20lb inch.
71 rpm WYNSCALE motors approx. 10lb inch.
Above four motors are designed for 110V AC supplied with auto transformer for 240V AC operation **£7.75** (P&P **75p**). Total incl. VAT & P **£9.78.** N.M.S.
19 rpm FHP 220/240V a.c. reversible torque. 14.5kg. Gear ratio 144—1 Brand new. Including capacitors, mf. **CITENCO.** Price **£14.25 +** £1.25 P & P (**£17.83** includ. VAT). N.M.S.
30 rpm 230/240V a.c. 50lb. in mf. **PARVALUX.** Price **£15.00 +** £1.50 P & P (**£18.98**) includ. VAT) N.M.S.
56 rpm. 240V a.c. 50lb. in 50Hz 0.7 amp. Shaft length 35mm. Dia. 16mm. Wt. 6kg. 600g. Mf. **FRACMO.** Price **£15.00 +** £1.50 P&P (**£18.98** includ. VAT). N.M.S.
100 rpm 110V a.c. 115lb in. 50Hz. 2.8 amp. single phase split capacitor. Immense power. Totally enclosed. Fan-cooled in-line gearbox. Length 250mm. Dia. 135mm. Spindle dia. 15.5mm, length 145mm. Tested. Price **£12.00 + £1.50** P&P (**£15.53** inc. VAT). **R & T.** Suitable Transformer for 230-240V op. Price **£8.00 +** 75p P & P (**£10.06** inc. VAT).
200 rpm 35lbs in 115V 50Hz
Price **£16.00 + £1.50** P & P (**£20.13** includ. VAT). N.M.S.
Suitable Transformer for 230-240V a.c.
Price £8.00 + **£1.00** P & P (**£10.35** includ: VAT). N.M.S.
12V. D.C. type SD2 Shunt 1/30th ph continuously rated 4,000 rpm. Mf **PARVALUX.** Price **£10.00** + P&P (**£12.35** includ VAT) N.M.S.
1 RPM 230/240V. a.c. Synchronous geared Motor. mf. **HAYDON. 2 rpm** 230/240V. a.c. Synchronous geared Motor. Mf. **CROUZET.** Either type **£2.90** + 30p. P&P (**£3.68** includ VAT). N.M.S.
1,400 rpm 115V. a.c. Motor. HP 1/30th continuously rated. Fitted with anti-vibration cradle mounting. Mf. **FRACMO.** Supplied complete with Transformer for 230/240V. a.c operation. Price **£10.00** + £1.00 P&P. (**£12.65** include VAT). N.M.S.

COMPRESSOR

Precision built USA. Horizontally opposed twin head diaphragm type producing 20lbs. Plus P.S.I. per head. 3.5 plus C.F.M. Output virtually pulse free. Powered by 110V A.C. motor size 30x23x15cm, weight 7 kilos. Price **£24** P&P £2. (inc. VAT **£29.90**).
Suitable transformer for 230/240V A.C. **£8.00** P&P £1.00 (inc. VAT **£9.72**).

REDUCTION DRIVE GEARBOX
Ratio 72.1. Input spindle ¼ × ½in. Output spindle ⅜ × 3in. long. Overall size approx: 120×98×68mm. All metal construction, ex-equip. tested. Price: **£2.00** + 50p P&P (**£2.88** inc. VAT & P)

AC Wkg TUBULAR CAPACITORS
Fraction of maker's price. Motor start etc:

1.5 mfd.	440V AC	60p	10 mfd.	400V AC	£1.75
2 mfd.	250V AC	60p	14 mfd.	400V AC	£3.00
2 mfd.	450V AC	75p	15 mfd.	250V AC	
2.2 mfd.	440V AC	75p	(block)		£1.50
3 mfd.	440V AC	£1.00	19 mfd.	280V AC	£2.00
4.1 mfd.	440V AC	£1.00	20 mfd.	250V AC	£2.25
5 mfd.	400V AC	£1.25	50 mfd.	370V (block)	
5.3 mfd.	160V AC	60p			£5.00
5.4 mfd.	280V AC	75p			
6.5 mfd.	280V AC	£1.00			
7.5 mfd.	200V AC	£1.00			
10 mfd.	250V AC	£1.00			

P&P, up to 2.5 mfd. 25p. 3 mfd. to 20 mfd. 50p 50 mfd. £1.50. All plus VAT.

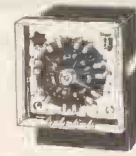
'VENNER TYPE' ERD TIME SWITCH

200/250V AC 30 amp. 2 on/2 off every 24 hrs. at any manually pre-set time. 36-hour spring reserve and day omitting device. Built to highest Electricity Board specification. Price **£9.00** P&P 75p. (**£11.21**). R & T.

SANGAMO WESTON TIME SWITCH
Type S251 200/250V AC 2 on 2 off every 24 hours. 20 amps contacts with override switch, diameter 4"×3", price **£8.00** P&P 50p (**£9.78** inc. VAT & P). Also available with solar dial. R & T.

AEG TIMESWITCH
200/250V AC 1 on/1 off every 24 hours, 80 amp contact (ideal storage heaters). Spring reserve **£10.00** P&P 50p (Total **£12.08** inc. VAT). R&T.

MINIATURE PROGRAMMER
Crouzet 1 rm. 115V AC Motor operating 2 Roller Micro switches (4 amp). Can be used on 240V AC with either 0.25 mfd 250V Condenser or 5.6K wirewound Resistor 7 watt supplied. Price **£2.50** + 50p P&P. (**£3.45** inc. VAT P&P). N.M.S.

MINIATURE 24-HOUR TIMESWITCH

(German mfr.) 240V AC operation. Spring reserve. 10 amp contacts, one on-off every 24 hours. Calibrated in two hour steps. Minimum on-off period 6 hours. **Day Omission.** Unusual feature with these switches is that trips may be removed at will enabling individual days to be programmed as required. Size only 3"×4". Depth 2¾". Price **£6.50** + 50p P&P (**£8.05** incl. VAT & P). N.M.S.

N.M.S. — New Manufacturers' Surplus
R.&T. — Reconditioned and Tested

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Phone 01-437 0576

S-2020TA STEREO TUNER/AMPLIFIER KIT

SOLID MAHOGANY CABINET

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

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

PRICE: £59.95 + VAT

NELSON-JONES Mk. 2 STEREO FM TUNER KIT

A very high performance tuner with dual gate MOSFET RF and Mixer ready built front end, triple gang varicap tuning, linear phase I.F. and 3 state MPX decoder.

PRICE: £69.95 + VAT

NRDC-AMBISONIC UHJ SURROUND SOUND DECODER

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

Complete kit, including licence fee **£49.50** + VAT or ready built and tested **£67.50** + VAT

S5050A STEREO AMP

Very high performance kit

50 watts rms channel. 0.015% THD. S/N 90 dB, Mags/n 80 dB. Output device rating 360w per channel.
Tone cancel switch. 2 tape monitor switches. Metal case — comprehensive heatsinks.

Complete kit only **£63.90** + VAT

INTRUDER 1 Mk. 2 RADAR ALARM

With Home Office Type approval

The original "Wireless World" published Intruder 1 has been re-designed by Integrex to incorporate several new features, along with improved performance. The kit is even easier to build. The internal audible alarm turns off after approximately 40 seconds and the unit re-arms. 240V ac mains or 12V battery operated. Disguished as a hard-backed book. Detection range up to 45 feet.
Complete kit £49.50 plus VAT, or ready built and tested **£64.50** plus VAT.

Wireless World Dolby noise reducer

Trademark of Dolby Laboratories Inc.

Typical performance
Noise reduction better than 9dB weighted.
Clipping level 16.5dB above Dolby level (measured at 1% third harmonic content)
Harmonic distortion 0.1% at Dolby level typically 0.05% over most of band, rising to a maximum of 0.12%
Signal-to-noise ratio: 75dB (20Hz to 20kHz, signal at Dolby level) at Monitor output
Dynamic range >90dB
30mV sensitivity

Complete Kit **PRICE: £43.90** + VAT

Also available ready built and tested .... **Price £59.40** + VAT
Calibration tapes are available for open-reel use and for cassette (specify which) .... **Price £2.40** + VAT
Single channel plug-in Dolby (TM) PROCESSOR BOARDS (92 x 87mm) with gold plated contacts and all components .... **Price £9.00** + VAT

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

All kits are carriage free

Please send SAE for complete lists and specifications

INTEGREX LIMITED

Portwood Industrial Estate, Church Gresley, Burton-on-Trent, Staffs DE11 9PT
Burton-on-Trent (0283) 215432 Telex 377106

WW — 109 FOR FURTHER DETAILS

ELECTRO-TECH COMPONENTS LTD.

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

JVC-VICTOR HIGH FIDELITY STEREO CASSETTE TRANSPORT MECHANISM

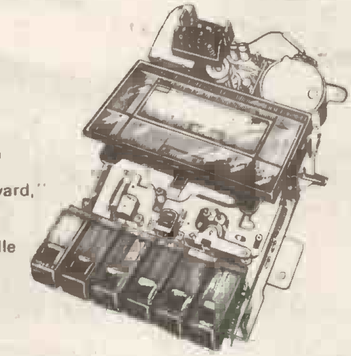
ELECTRO-TECH COMPONENTS have secured a very large quantity of cassette transport mechanisms, equipped with all the latest improvements, as well as "SEN-ALLOY" type 1.5 micron record/replay heads, and solenoid-controlled auto-stop action. These were manufactured by JVC/VICTOR of Japan to specification 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. S.A.E. please.

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

Plus £1 P&P



Trade and Export Enquiries Invited

CHROME DIOXIDE CASSETTES

Limited quantity only. Excellent quality little known brand (Italian). Satisfaction guaranteed. C90s only. Price per six (minimum quantity) **£6** inc. VAT. P&P 75p any quantity.

FERRIC OXIDE CASSETTES

Excellent quality (Italian) C120s only. Price per 6 (min. quantity) **£5** incl. VAT. P&P 75p any quantity.

This offer only applies while stocks last

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 mv-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.

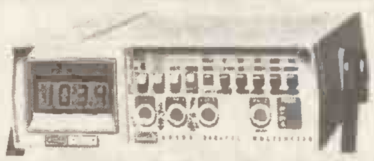
Audible continuity testing and level detection for sensing logic levels.

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

£135
Carriage and Insurance £3

The following accessories are in stock now

Y8008 Touch and Hold Probe	....	£18.00
80K-40 High Voltage Probe	....	£45.00
81RF RF Probe to 100 MHZ	....	£32.00
80T-150C Temperature Probe (C)	....	£55.00
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

...e 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
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- Rugged moulded case with convenient tilting/carrying handle
- Optional parallel data output with decimal point and annunciation
- Traditional high Fluke quality
- Self check

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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

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

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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 EN 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

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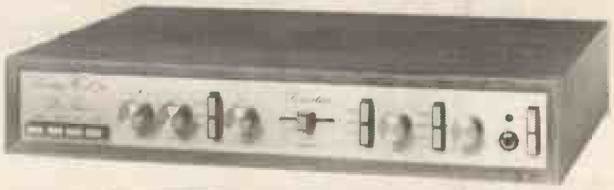
ELECTRONIC KITS OF DISTINCTION FROM POWERTRAN

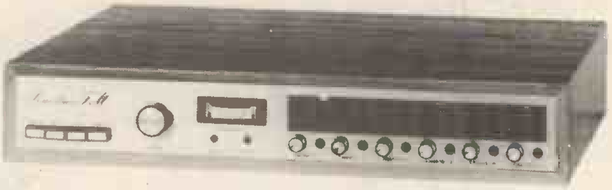
DE LUXE EASY TO BUILD LINSLEY-HOOD 75W STEREO AMPLIFIER £99.30 + VAT

This easy to build version of our world-wide acclaimed 75W amplifier kit based upon circuit boards interconnected with gold plated contacts resulting in minimal wiring and construction delightfully straightforward. The design was published in Hi-Fi News and Record Review and features include rumble filter, variable scratch filter, versatile tone controls and tape monitoring whilst distortion is less than 0.01%.



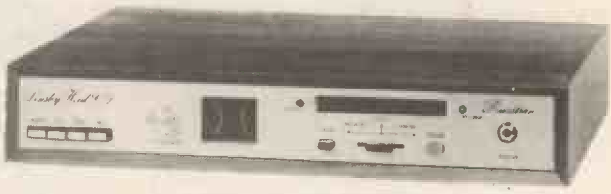
WIRELESS WORLD FM TUNER £70.20 + VAT

A pre-aligned front-end module makes this Wireless World published design very simple to construct and adjust without special instruments. Features include an excellent a.m. rejection push-button station selection as well as infinitely variable tuning and a phase locked loop stereo decoder, incorporating active filters for "birdy" suppression.



LINSLEY-HOOD CASSETTE DECK £79.60 + VAT

This design, published in Wireless World, although straightforward and relatively low cost provides a very high standard of performance. There are separate record and replay amplifiers and switchable equalisation together with a choice of bias levels are also provided. The mechanism is the Goldring-Lenco CRV with electronic speed control.



TRANSCENDENT 2000 SINGLE BOARD SYNTHESIZER

As featured in Electronics Today International

Cabinet size 24.6"x15.7"x4.8" (rear) 3.4" (front)

The kit includes fully finished metalwork, fully assembled solid teak cabinet, filter sweep pedal, professional quality components (all resistors either 2% metal oxide or ½% metal film!) and it really is complete — right down to the last nut and bolt and last piece of wire! There is even a 13A plug in the kit — you need buy absolutely no more parts before plugging in and making great music! Virtually all the components are on the one professional quality fibre glass PCB printed with component locations. All the controls mount directly on the main board, all connections to the board are made with connector plugs and construction is so simple it can be built easily in a few evenings by almost anyone capable of neat soldering! When finished you will possess a synthesizer comparable in performance and quality with ready built units selling for between £500 and £700!

COMPLETE KIT ONLY £168.50 + VAT!

Comprehensive handbook supplied with all complete kits! This fully describes construction and tells you how to set up your synthesizer with nothing more than a multi-meter and a pair of ears!

CHROMATHEQUE 5000 5-CHANNEL LIGHTING EFFECTS SYSTEM

This versatile system featured as a constructional article in ELECTRONICS TODAY INTERNATIONAL has 5 frequency channels with individual level controls on each channel. Control of the lights is comprehensive to say the least. You can run the unit as a straightforward sound-to-light or have it strobe all the lights at a speed dependent upon music level or front panel control setting or use the internal digital circuitry which produces some superb random and sequencing effects. Each channel handles up to 500W and as the kit is a single board design wiring is minimal and construction very straightforward.

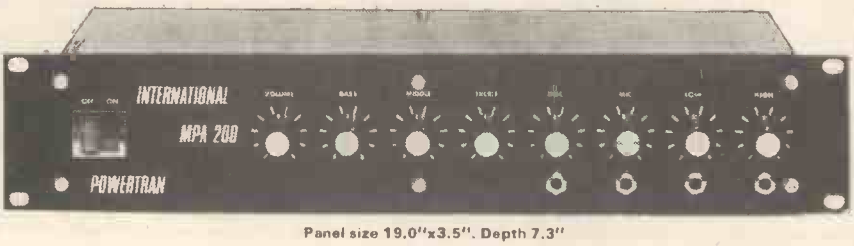
Kit includes fully finished metalwork, fibreglass PCB, controls, wire, etc. — Complete right down to the last nut and bolt!

COMPLETE KIT ONLY £49.50 + VAT

Panel size 19.0"x3.5". Depth 7.3"

MPA200 100W MIXER/AMPLIFIER

Featured as a constructional article in Electronics Today International the MPA 200 is an exceptionally low-priced but professionally finished general purpose, rugged, high-power amplifier which has an adaptable range of inputs such as disc, microphone, guitar, etc. There are 3 wide range tone controls and a master volume control. Mechanically the design is simplicity in the extreme with minimal wiring making construction very straightforward. Kit includes fully finished metalwork, fibreglass PCB's, controls, wire, etc. — Complete right down to the last nut and bolt!



Panel size 19.0"x3.5". Depth 7.3"

COMPLETE KIT ONLY £49.90 + VAT

Most kits also available as separate packs (e.g. P.C.B. component sets, hardware sets, etc.). Prices in FREE CATALOGUE.

SOUTHEAST ENGLAND'S ELECTRONICS CENTRE

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Oncagain a limited Minisy release enables us to offer yothis fine piece of equipment. TheF 995A/5 has a continuously vaable range in five bands from 1.5o 220 MHz-F.M. deviation is also ariable from 0-15 KHz. Output voltagesdjust from 1µV to 200mV. Outputnd deviation are displayed on anasily read meter. Other features such asTAL calibrator, small size, etc. makesis a snip at only . . .

£225 carr. + VAT

Full manual avaible.

Note: All units are sted and working prior to despatch, but alsold unguaranteed.

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RACAL C10 "Supergrade" cassettes complete with library cases 66p each 10 for £5.45

VERBATIM 5¼ soft sectored mini disks £3.45 each 10 for £31.63

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TIL 119/OC72 Darlington opto isolator 3 for £1·00.

TIL305 0.3" 7 x 5 matrix LED alphanumeric readouts £3.75 each.

PHOTO TRANSISTOR

Fairchild FPT-100 NPN silicon 30v 25ma. 4 for £1.00

4k x 12 RAM static Memory card

Complete 4K x 12 bit memory system on one PCB. This ex computer memory card contains all relevant decoding. read write and control logic for coupling to your MPU or mini computer system. TTL in and out make interfacing a "cinch". We understand that by reading the outputs correctly, the memory can be organised as a 6K x 8! Features include fast 250ns max. access time. Standard +12v, −12v+5v power rails compact construction, non volatile memory, data remains even when power switched off!

Original cost over £800 each, supplied complete with full data and circuit manual, at an unbelievable price of **£39.95** P.P. £1.75

Note: Memories are removed from working equipment but supplied untested, unguaranteed.

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Grade I complete tested anworking £275.00 + VAT

Grade 2 complete less somkeytops £250.00 + VAT

Grade 3 condition asseen described £175.00 + VAT

Although grade 1 sold worhg no guarantee is offered. Carriage extra. New ramsvailable 95p each. P.S. Anyone with circuits or muals please contact us.

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All I.C.'s and Transistors by well known manufacturers and fully guaranteed. No fall outs. Comprehensive data on I.C.'s 15p per type.

2N4351 N channel MOS FET.
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60p each £1.00 per pair.

HIGH VOLTAGE NPN POWER SWITCHING transistors BVcbo 600v BVceo 500v BVebo 15v 1c 5 amps Pc 125 watts HFE 60 typ ft 2.5 mhz ideal invertors, etc. TO3 £1.60 each 4 for £5.40.

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MJ1000 NPN 60v 90w 8 amps TO3 95p each
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G.E. 12 amp 600v TO220AB 95p each 10 for £8.75
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14 O.I.L. 14p each 8 for £1.00
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TMS3114 DUAL MOS 128 bit static shift reg OC. 2.5 MHZ £1.50 each 4 for £4.25
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GE424 zero voltage switch, triac SCR relay driver TO5 can £1.10 each 7 for £6.50
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FPQ3725 4 NPN 50v 500ma transistors in 14 O.I.L. pack 70p each 2 for £1.00

SCOOP OF THE YEAR HAZELTINE H1200 V.D.U. TERMINAL

Due to a fantastic bulk purchase, we are now able to offer this superb terminal at a price almost below the cost of manufacture!! Features include: 12" screen, 55 key TTY keyboard, full ASCII, RS232 interface, adjustable baud rate 75 to 9600, 12 lines x 80 characters (upgradable to 24 x 80), cursor control, lower case option, plus many other features.

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FULL Technical Manual available

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1500mf	100v 60p*	300mf	40v 50p
3300mf	63v 70p*	mf	600v MYLAR 28p
10,000mf	15v £1†	2,000mf	16v £1.10†
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*Ex equipment tested †P.P. 40p

PLESSEY EDGE STACKABLE DECADE THUMBWHEEL SWITCHES

Gold plated contacts dimensions 2" x 2" x ¾" 85p each 8 for £5.35.

Miniature Continental Series 12VDC 4c/o plug in relays £1.30 each.

AMPHENOL 50Ω BNC plug 50p. 50Ω BNC plug right angled 60p.

C90 Audio Cassettes screw type construction 45p each 3 for £1.00.

Bulbs 24v 14 watt white frosted S.B.C. 8 for £1.00.

Bulbs 12v 100 watt clear, base similar S.B.C. 45p each.

S.B.C. Bulb Holders All steel cad. plated panel mount easily fixed via nut and round hole, ideal disco displays, scoreboards, etc. 4 for £1.10.

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Red L.E.D.'s full spec. 0.2 14p each. 10 for £1.25.

Red L.E.D.'s 0.125 10p each 10 for 80p)

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TO5 HEATSINKS "Thermaloy" black anodised press on aluminium finned type 18p each. 8 for £1.00.

HARDWARE PACK Don't be stuck for the right nut and bolt for the job. Pack contains B.A. Metric, Unified, Self Tap, etc. Nuts, Bolts, Screws, Washers, etc. in Brass Bronze and Steel. All steel items plated. Average contents 400 600 pieces. Sold by weight, 2lb bag. **£2.65**

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POWER SUPPLY UNITS

5 VOLT 2.5 AMP T.T.L. P.S.U.

Made for T T L this compact ex computer systems unit features a 10 amp transformer with D.C outputs of 5 volts @ 2.5 amps and 7.5 volts @ 5 amps. The 5 volt output is fully regulated and smoothed and has electronic current limiting. May be easily moded for 5 volts @ 7 8 amps, believed working but untested 240v A C input

Complete with circuit **£8.25** P.P. £1.60

KEYBOARD

A special bulk purchase enables us to offer the above keyboard at a lowest ever price. 49 coded keys encoded into a direct TTL compatible 7 bit output. Features such as delayed strobe, 5 volt O.C. single rail operation and rollover protection make this an absolute must for the MPU constructor! Supplied complete with connection diagram and edge connector, at a secondhand "no time to test" price of only **£20.00** + P.P. £1.60

SUPER CASED VERSION Same as above spec. but housed in attractive two tone moulded, free standing case. Unit also includes an all TTL parallel to serial convertor (no details) etc.

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50 + BAG £2.95 10 + BAGS £5.15

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ideal equipment cding etc. tested, ex-equipmet.

240v 50-60 HZ £6.5 + p.p. 45p
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Oue to our massive bulk pchasing programme which enables us to bring cu the best possible bargains, we have thousandof I.C.'s Transistors, Relays, Cap's., P.C.B.'s, Subassemblies, Switches, etc etc surplus to our requements. Because we don't have sufficient stocksif any one item to include in our ads., we are pcking all these items into the "BARGAIN PARCL OF A LIFETIME" Thousands of components agiveaway prices! Guaranteed to be worth at lest *3 times* what you pay plus we always include mething from our ads. for unbeatable value!! Sold by weight

7lb £ 5.25	4lb £ 7.95
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CRYSTALS

FREQUENCY	CASE	PRICE
100.00 KHZ	HC6 U	£2 95
1.00 MHZ	HC6/U	£2 75
2.00 MHZ	HC6/U	£2 35
2 50 MHZ	B7G	£2 35
5.00 MHZ	HC18 U	£2 25
8.00 MHZ	HC18/U	£2 25
10 00 MHZ	HC18/U	£2 25
11 20 MHZ	HC6 U	£2 25
20 00 MHZ	HC18/U	£2 50
33.339 MHZ	HC18/U	£1 75
UART Xtal 38.40 KHZ*		£2 80

SAE for latest XTAL stock list

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HP 240v pri. sec 2 x 30v @ 4 amps 2 x 18v @ 1 amp £11.00 + p.p £1.60 dimensions 4⅞ x 2⅞

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TM 240v 110v pri sec 15 0 15 8vA dimensions 2½ x 1" £1.95 + p.p 30p.

All voltages measured off load.

ISOLATED 240v 4 AMP & 10 AMP SOLID STATE RELAYS

Interface your MPU etc, withe outside world made by the famous "Astralux" Co. They consist of a miniature plastic module wi mounting holes containing a reed relay for isolion, choke and triac. 12-20 volts D C at a few illiamps enable on/off control of A.C loads up to10 amps! The 10 amp version should be mounted n a heatsink. 100's of uses including power controlighting, etc, etc.

Dimensions: 4 amp, 1½" x 1" x". 10 amp, 1⅞" x 1½" x 1".

4 amp £1.45 10 amp £2.11 complete with circuit

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HIGH EFFICIENCY SMITHS RADIAL BLOWERS

Are your hot parts sweltering? Then keep them cool with our high efficiency radial snail type blowers. Made by Smiths, designed for continuous use in expensive electronic equipment very powerful and quiet, gives massive air flow to prolong component life and reliability. Easily mounted, air aperture 2½" x 3". Ideal linears etc.

Please state 240v or 110v operation. 50hz only.

BRAND NEW **£4.55** P.P. £1-10

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1 **VDU GLASS TELETYPE** 20MA & RS232 £150
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5 **RANK COLOUR TV MONITOR** £30
6 **CALCOMP DRUM PLOTTER** £800
7-9 **SCOPEX SCOPES** type 4D10 DC-10MHZ Double beam £195 ea
10-13 **FACIT MATRIX PRINTER** Size 15 × 9 × 6" approx. 80 Char line. As new £175 ea
14-16 **TELEQUIPMENT SCOPE** S54A DC-10MHZ Single beam. Solid State £240 ea
17 **ADVANCE SCOPE** OS1000A DC-20MHZ DB. Solid State £275
18 **ADVANCE SCOPE** OS250 DC-10MHZ DB. Solid State £225
19 **S.E. LABS** EM102. DC-15MHZ DB. Solid State £175
20-23 **SOLARTRON SCOPE** CD1400 DC-15MHZ DB £140 ea
24-25 **POLARAD SPECTRUM ANALYSER** UPM84 10MHZ-40GHZ One unit (Plug-ins not required for this coverage) £350 ea
26 **H.P. SAMPLING SCOPE** type 185B £120
27-36 **MARCONI WAVE ANALYSER** type TF2330 20HZ-50KHZ £275 ea
37 **H.P. AC CONVERTOR** type 3461A £175
38 **H.P. SCOPE** 120B. Single Beam. As New £190
39 **H.P. PULSE GENERATOR** 214A £60
40 **RACAL 500MHZ AUTO FREQUENCY CONVERTOR** 803R £60
41 **MARCONI** TF10668 AM/FM Signal Generator £350
42 **G & E BRADLEY RF MILLIVOLTMETER** type 112 £120
43 **ADVANCE AF SIGNAL GENERATOR** J2 15HZ-50KHZ £30
44 **SOLARTRON DVM** JM776 £70
45 **COHU DC VOLTAGE STANDARD** Model 303B £350
46 **WEIR DVM** type 500Mk111 £30
47 **FLUKE AC-DC VOLTMETER** 823A £60
48-50 **AIRMEC 314 ELECTRONIC VOLTMETER** 300mV to 300V £50 ea
51-53 **AIRMEC 314A ELECTRONIC VOLTMETER** 300mV to 300V £90 ea
54 **HEATHKIT V7AU VALVE VOLTMETER** £25
55 **MARCONI TF1066B AM/FM SIGNAL GENERATOR** £300
56 **HEATHKIT TV ALIGNMENT** GEN HFW1 £30
57 **HEATHKIT AUDIO ANALYSER** 1M-48 £45
58 **HEATHKIT HARMONIC DISTORTION METER** 1M-58U £40
59 **HEATHKIT CAPACITANCE CHECKER** 1T28 £25
60-62 **AVO RF SIGNAL GENERATOR** HF135 100KHZ-240MHZ £120 ea
63 **WAYNE KERR AF SIGNAL GENERATOR** S121 10HZ-120KHZ £70
64-69 **WAYNE KERR COMPONENT BRIDGE** B521-CT375 £75 ea
70 **WAYNE KERR UNIVERSAL BRIDGE** B221-CT530 £120
71-72 **TAYLOR RF SIGNAL GENERATOR** 68A 100KHZ-240MHZ £120 ea
73 **MARCONI AC MICROVOLTMETER** TF1375 15microV to 15V £30
74 **MARCONI RF POWER METER** TF1152/1 50 ohm £45
75-77 **TAYLOR MODEL 128 TEST METER** £20 ea
78 **SOLARTRON TRUE RMS VOLTMETER** VM1484 300mV-300V plus db Scale £120
79-80 **TEKTRONIX 1L30 SPECTRUM ANALYSER PLUG-IN** 925MHZ to 10.5GHZ £425 ea
81 **LABGEAR COLOURMATCH** CM6004PG £60
82 **AIRMEC OSCILLATOR** Type 304 50KHZ-100MHZ £30
83-86 **MARCONI UNIVERSAL BRIDGE** TF868 £60 ea
87-88 **ADVANCE LF OSCILLATOR** SG65A SINE & SQUARE 10HZ-100KHZ £85 ea
89 **PHILLIPS FM STEREO GENERATOR** PM6456 £140
90 **MARCONI AM SIGNAL GENERATOR** TF801B 10MHZ-470MHZ £75
91 **RADFORD LOW DISTORTION OSCILLATOR LDO** Series 3 10HZ-100KHZ £175
92 **MARCONI AF OSCILLATOR** TF2102M1 3HZ-30KHZ £120
93 **ADVANCE SIGNAL GENERATOR** J4A 10HZ-100KHZ £100
94-95 **WOELKE WOW & FLUTTER METER** ME105 £175 ea
96-97 **AVO PRECISION METER AC/DC** £60 ea
98 **ADVANCE AC VOLTMETER** VM77E 1mV-300V £100
99 **COSSOR** CDU130 Scope. Small compact with batteries £240
100-102 **TELEQUIPMENT SCOPE** S51A Single beam £85 ea
103 **SOLARTRON** CT436 Scope Double beam. DC-6MHZ £120
104 **WAYNE KERR CAPACITANCE BRIDGE** 541C £75
105 **WAYNE KERR COMPONENT BRIDGE** B121 £80
106 **TELEQUIPMENT** DM53A Double Beam Scope £140
107 **MINIATURE SCOPE** CT52 £45
108 **TV SWEEP GENERATOR** TF1104/1 with display. Marconi £30
109-115 **RANK WOW & FLUTTER METER** type 1740 £35 ea
116 **ADVANCE SIGNAL GENERATOR** H1E 15HZ-50KHZ £70
117-118 **ADVANCE UHF MILLIVOLTMETER** VM79 £60 ea
119 **BRANDENBURG EHT POWER SUPPLY** 471/R 500-2500V 1mA £120
120 **R&S SELEKTOMAT** USWV BN15221/2 30-400MHZ £150
121-122 **FACIT TAPE READER** 500/1000cps £150 ea
123 **WAYNE KERR ADMITTANCE BRIDGE** B801 £50
124 **LOCKHEED TAPE UNIT** 18VDC input 4 channel Suitable audio or digital £120
125 **R & S WOBBULATOR** SWH BN4242 50KHZ-12MHZ £120
126-127 **WAYNE KERR UNIVERSAL BRIDGE** B221 with low impedance adaptor Q221 £150 ea
128 **WAYNE KERR PULSE GENERATOR** CT500 £25
129 **HEATHKIT SOLID STATE VOLTMETER** 1M-16 £30
130 **HEATHKIT FM STEREO GENERATOR** 1G-37 £45
131 **R & S UHF TEST RECEIVER** USVU BN15[illegible] 0.9-2.7GHZ £120
132 **ROCHAR UNIVERSAL COUNTER TIMER** A1149 1HZ-10MHZ £60
133 **R & S UHF STANDARD SIGNAL GENERATOR** SDAF BN41023/2 AM/FM 170MHZ-900MHZ £200
134 **SIEMENS THERMAL MILLIVOLTMETER** 50 ohm 1-500mV/0-12.4GHZ £120
135 **SOLARTRON SCOPE** CD523S.2 Single Beam DC-10MHZ £25
136-137 **SEXTANT ATTACHMENT** £60 ea
138 **R & S POLYSCOPE SWOB** BN4244 £250
139 **TELEQUIPMENT SCOPE** S51B Single Beam £100
140-143 **H.P. RMS VOLTMETERS** 3400A £150 ea
144 **WAYNE KERR AUTOBALANCE ADAPTOR** AA221 £75
145 **TEKTRONIX SAMPLING SCOPE** type 661 complete with plug-ins £350
146-149 **TEKTRONIX** Scope type 581 DC to 80MHZ Main Frame £200 ea
150-155 **TEKTRONIX** Scope 585. DC-80MHZ. Dual B. Main Frame £250 ea
156-160 **TEKTRONIX** Scope 585A DC-85MHZ. Dual TB. Main Frame £300 ea
161 **TEKTRONIX** Scope 547 DC-50MHZ. Dual B. Main Frame £300
162-164 **TEKTRONIX** Scope 545B DC-30MHZ. Dual TB. Main Frame £200 ea
165-166 **TEKTRONIX** Scope 545A DC-30MHZ. Dual TB. Main Frame £125 ea
167 **TEKTRONIX** Scope 545 DC-30MHZ. Dual B. Main Frame £100
168 **TEKTRONIX** Scope 543 DC-30MHZ Single B. Main Frame £100
169 **TEKTRONIX** Scope 541A DC-30MHZ Single TB. Main Frame £100
170 **TEKTRONIX** 536 DC-10MHZ X-Y Oscilloscope. Main Frame £100
171 **TEKTRONIX** Scope 533A DC-15MHZ Single TB with 100X Magnification. Main Frame £125
172-173 **TEKTRONIX** Scope 555 DC-33MHZ. Completely independent deflection of beams. Price included TB units £250 ea
174-176 **TEKTRONIX** Scope 551 DC-27MHZ will take two vertical plug-ins. Main Frame £150 ea
177-178 **TEKTRONIX** Scope 517A Special High Speed-bulky hence £100 ea

Plug-ins available for above Oscilloscopes

179-188 **CA DC-24MHZ** Dual Trace 50mV/cm £65 ea
189-193 **D HIGH GAIN DC** Differential 1mV/cm D-300KHZ £20 ea
194-196 **E LOW LEVEL AC** Differential 50microV/cm 3db 20KHZ £75 ea
197-201 **G WIDE BAND DC** Differential 50mV/cm DC-20MHZ £20 ea
202 **K DC-30MHZ** 50mV/cm £20
203-217 **L HIGH GAIN SINGLE BEAM** 5mV/cm £20 ea
218-219 **M 4 TRACE** 20mV/cm DC-20MHZ £200 ea
220-221 **N SAMPLING UNIT** £150 ea
222 **R FOR MEASUREMENT** of Transistor Parameters £100
223-227 **Z FOR ACCURATE** voltage measurement £100 ea
228-230 **1A4 4 TRACE** 10mV/cm DC-50MHZ £250 ea
231 **1S1 SAMPLING** to 1GHZ £350
232-239 **81 THIS ADAPTOR** is required on all 50 range main frames to enable the user to fit lettered plug-in £50 ea
240-245 **82 DUAL TRACE DC-80MHZ** 10mV/cm £100 ea

The following plug ins can be purchased separately L; D; G; M; N; Z; 1A4; 1S1.

The remaining plug-ins CAN ONLY BE PURCHASED WITH MAIN FRAMES.

246 **TEKTRONIX PULSE GENERATOR** type 109 £75
247 **MID CENTURY WAVE GUIDE ASSEMBLY** £50
248 **HATFIELD RF BRIDGE** 300A/1 £50
249 **H.P. DIGITAL RECORDER** type 5050B £150
250 **SOLARTRON DVM** type 1867 £80
251 **TELEQUIPMENT D53S** Storage Oscilloscope with two JD Plug-ins £225
252 **R&S MICROWAVE POWER METER NRD** BN3412-50. 0-3200MHZ £80
253 **R&S POWER SIGNAL SOURCE SML** BN4105 £160
254 **BRIDGE MEGGER** Series 2 500 Volt £50
255 **LABGEAR COLOURBURST GENERATOR CM6052/CB** £90
256 **LABGEAR COLOURBURST GENERATOR CM6037/DB** £90
257-261 **SOLARTRON DVM** type LM 420 £40 ea
262 **R&S SIGNAL GENERATOR SCR BN83-16** £120
263-270 **RICOH** small conpact **TAPE READER**. Japanese. New Boxed 240V 50HZ input Mystery interface £30 ea
271-274 **ROBAND TWIN POWER UNIT** Metred 0-30V 1Amp £25 ea
275 **WAYNE KERR AF SIGNAL GENERATOR S12 110HZ-120KHZ** £70
276 **PHILIPS POWER UNIT 0-30V TWIN** 1Amps £25
277 **R&S SIGNAL GENERATOR SMLR BN41001** 100KHZ-30MHZ £120
278 **WAYNE KERR UNIVERSAL BRIDGE** B221 with low Impedance Adaptor Q221 £150
279-281 **HEATHKIT SIGNAL GENERATOR RF U** 100KHZ-200MHZ £25 ea
282 **MARCONI SIGNAL GENERATOR TF801D/1** Light Grey front £150
283 **HEATHKIT TV ALIGNMENT GENERATOR 1G-52** £30
284 **PHILIPS ELECTRONIC MULTIMETER PM2401** £30
285 **ELLIOTT CURVE TRACER,** requires G Scope £25
286 **AVO TRANSISTOR ANALYSER Mk2** with mains PU £30
287 **MARCONI TF893 AUDIO POWER METER** £25
288 **R&S MICROWAVE POWER METER NRD BN3412-50 0-3200MHZ** £120
289 **3 EMI CAMERAS** with Sync Units & Control units — no linking cable — hence the lot £50
290-291 **PHILIPS POWER UNIT 0.35V 3 Amp** metered £30

Due to factors outside our control it has been decided to sell off the excess stock of Test Gear at Norwood Road. This additional page carries the majority of such equipment. In our endeavour to sell this equipment we are prepared to accept the best offer received by the close of business on Saturday, March 15th provided that the offer received is relative to our original cost. To place an order PLEASE PHONE. In the event of you offering the full price and the item being still available it will be booked to you and a reasonable time allowed for your monies etc. to be received. If you offer below the listed price it may be possible to immediately accept and again book the item to you. In the event of your offer being too low, time must elapse to allow us to obtain more acceptable offer. If your offer was the best received by the 15th March we would be inclined to accept subject only to the previous provision. A supplementary list will be available.

OLIVETTI PRINTER & KEYBOARD type Te 300

with PUNCH & READER. Upper case ASCII with V24 Interface. 240 volt operation.

£125 each

INFRA RED IMAGE CONVERTER type 9606 (CV 144)

1¾" diameter. Requires single low current 3KV to 6KV supply. Individually boxed. With data

£12.50 each P&P 75p

Infra Red Lamps also advertised

WEATHER PLOTTER

RECEIVER SET AN/GMH 5
FACSIMILE SYSTEM

Speed is switch selectable 7 rates 1200 Bauds to 4800 Bauds. Max Print width 18". Input signal digital 3KHZ nominal 2-wire 600 ohm. Max Jitter less than 0.0025". Uses 7400 range ICs on 2 boards. 200 plus ICs per board. This unit is as New and complete with Manuals.

ONLY ONE UNIT AVAILABLE **£350**

STEPPING MOTORS

200 Steps — 20-oz/in. torque. 12/24 volt input 4-wire.
£12 each. P&P £1.50

STEPPING MOTORS

200 Steps. 20 oz/in. torque. 120 volt operation 3-wire.
£4 each. P&P £1.50.

STEPPING MOTORS

North American Phillips. 5 volt 3.3 Amp operation. 2 wire PPS 0-200 revs per min 0-250 used. Tested **£16 each.** P&P £1.50.

STEPPING MOTORS

6/12 position with additional where the rotor is coils. Device can be used as a tacho. Diagram supplied. Will actually work on 5 volts. 12/24 recommended.
£1.50 each P&P 75p or 5 for **£5** P&P £1.50.

4K RAM

Signetics 22 pin with data type 2680 **65p** each. Four for **£2.**

4K STATIC RAM

Type 9140.
£4 each. 8 for **£24.**

POLARAD SPECTRUM ANALYSER

5" Display. These are supplied with STU 2 plug-in. 1 to 45 GHZ.
£125 each

TELEQUIPMENT SERVICE SCOPE MINOR

Modern style — Small size 5x7x11" approx. Circuit diagram supplied.
£55 each

KEYBOARD PAD

Size 3x2½x2" high with 12 Alma Reed Switches. Blue keys marked in green 0-9 and a star with one blank.
£4 each, P&P **£1,** or **5 for £15** P&P **£2.**

709 DIL 14-PIN OPERATIONAL AMPLIFIERS

at **8p each**
100 off 25% discount.

MINIATURE KEYBOARD

Push contacts, marked 0-9 and A-F and 3 optional function keys. **£1.75 each.** P&P 65p.

STRATHEARN AUCTION

BC337	8p	2N3704	8p	BFT60	5p		
BC327	8p	2N5447	5p	TL082CP	15p	4013	30p
BC251	5p	2N5449	5p	TIS92	10p		
BC171A	5p	2N3053	15p	TIS93	10p		
Timer 555	15p						

16 pin DIL Socket **10p.** 14 pin SIL Socket **8p.**
LED type TIL 209 Red with holder **10p** each.
SLOTTED OPT SWITCH supplied with data — normally over £2. OUR PRICE **75p** each.
ROCKER SWITCHES 2 pole c/o — **15p** each.
Spring Action TERMINALS — normally over **30p** ea. OUR PRICE **15p** each.
TOROIDAL TRANSFORMER 0-115V-230V Input; 13.5V-0-13.5V rated 8VA output **£1.70** each. P&P 75p.
Sub-min TRANSFORMER 0-120-240V Input. 12V-0-12V rated 4VA. Output **75p** each. P&P 50p.

ALL GOODS ARE GUARANTEED TO BE NEW AND FULL SPEC. DEVICES. 100 off discount 25% — other discounts by arrangements.

BLUE THERMAL PAPER

430 ft. roll 8½" wide
£2 per roll. P&P £1.75.

TRANSISTOR INVERTOR

115V AC 1.7 Amp Input. Switching is at 20Khz. Output windings from Pot Core. Can be rewound to suit own purpose or unit can be broken for host of components. Circuits supplied. **£1.25 each.** P&P **£2.**

TELETYPES

ASR; KSR; RO's with 20ma/RS232 loops. Prices from **£80.** Please enquire.

DIODES

All new full spec devices. IN3063; IN4148; IS44. 100 off **£1.50** — 1000 off **£10.**

GENERAL ELECTRIC TERMINET PRINTER

with Twin Cassette RS232 Interface. IN VERY GOOD CONDITION.

£1,200

VARIACS Ex-Equipment. Good condition. 8 Amps **£25 ea.**
20 AMPS **£35 ea.**
Some 3 phase available. Please enquire.

CRYSTALS
19.2KHZ FLAT METAL CASE — **50p each.**
10 MHZ B7G **50p each.**

EX-NAVAL 4ft dia STEEL DISHES. NEW CRATED. 1 ft. deep at centre. These are plain steel dishes with holes for various aerial options. **£22.50 ea.** Carriage **£5.** Two for **£40.** Carriage **£6.**

TRANSFORMERS — Standard Mains input
Secondary outputs.
6KV 0-125A **£15** ea.
3440V 0.66A with matching 40H Choke **£30** the pair.
5KV 300MA **£15.** 18KV 30MA **£60.**
12KV 30MA **£20.** 22.5KV 110MA **£50** ea.
3KV 50MA **£8** ea. 60KV 0.0273 **£150.**
MULTI PURPOSE MAINS TRANSFORMER 4 windings each winding 0-10-110-125 at 4 8A **£15 ea.**
425V 50HZ 2 Wire input. Output 8 5KV 2.55KVA. Could be run on 240V at ½ rating **£15 ea.**
STEP DOWN ISOLATING TRANSFORMER. Input 220. 250V 50HZ. Output 115V 1.8KVA. BRAND NEW. These are very conservatively rated **£20 ea.**
CAPACITORS
2mfd 5KV **£4 ea.** 0.5mfd 10KV **£4 ea.**
0.5 mfd 5KV **£4 ea.** 8mfd 2.5KV **£4 ea.**
CARRIAGE on these units will be charged at cost.

INFRA RED QUARTZ LAMPS. 230V 620 Watts. Size 13½" × ⅛" dia **£1.50.**
BRIDGE RECTIFIER. 2 Amp **50p ea.**
PHOTODIODE DETECTOR 4" fly leads, **25p ea.**
AMPHENOL. 17-way chassis mount edge connectors 0.1 spacing **15p ea.**
I.E.C. Standard **MAINS LEAD.** Moulded (3 vertical flat pins centre offset) **60p ea.**
FANS, 115V 13 Watts. Size 3¼ × 3¼ × 1½" BRAND NEW. **£4.50 ea.** Secondhand **£2.50 ea.**

MOTOROLA REGULATORS, type 7812 12V 1 amp **65p ea.**
Miniature **MOTORS** 12V with geared wheel (8 teeth 3/16" dia). Size 1¼ × ⅞" dia. New, **30p ea.**
MOTOR 12V DC with pulley and Integral semiconductor Speed Control. New, **£1 ea.**
LEDEX ROTARY SOLENOIDS. 115V DC. No switch assembly. **15p ea.**
DIAMOND H CONTROLS ROTARY SWITCH. Single pole 10-way. Printed Circuit Mount. New, **10p ea.**
DELAY LINE. 50 nanosecs. 3 connections, ground-in-out. Size 2 × 7/16 × 16" New, **25p ea.**
PULSE TRANSFORMER. Sub min. Size ½ × 5/16 × ¼" Secondary centre tapped. New, **20p ea.**
MOTOR by Inland Motor Corp. DC High Torque Reversible. Usable torque at 5V. Max voltage 24V **£2.50 ea. P&P £2.**
SPEAKERS 2½". 50 ohm 0.2W. New, **40p each.**
RAPID DISCHARGE capacitors 8mfd 4kV **£5 each. P&P £2.**
REMO TV TYPE MULTIPLIER. Two high voltage outputs and focus, **£1 each.**
DON'T TAKE CHANCES. Use the proper **EHT CABLE 10p per metre** or **£7.50 per 100 metre/drum.** P&P £2.
MOTOR by Eastern Air Devices Inc. 125V reversible with toothed shaft (10 teeth ¼" dia). Size 2¼ × 2⅛" dia **75p ea. P&P £1.**
PHOTOGRAPHIC LAMPS. Pearl 230V 500 watt. Screw cap **75p ea.** Box of 12 **£5.50 P&P £1.50.**
MYSTERY IC PACK. Some 40 pin — good mixture — all new devices. 25 ICs for **£1. P&P 50p.** You find out what they are and we will buy the information from you.
VACUUM PUMPS — TRAPS, ETC. Send for list.
DECOUPLING CAPACITORS. 0.05mfd 10V; 0.01mfd; 0.1mfd 50V; 0.047mfd 250V. All values 100 for **£1.**
E.H.T. CAPACITOR 500pf 8KV **20p each.**
10-WAY MULTI COLOUR RIBBON CABLE. New, **40p per metre. 10 metres for £3.**
GEC UHF 4-button tuner **£1.50 each.**
CENTUAR 115v **FANS,** 4½ × 4 × 1½" **£4.50 ea.**
EX-USED Equipment, tested **60p.**
POTTER & BRUMFIELD TIMER RELAY, 115V AC. Heavy duty, 7 pole c/s with 2 second delay. Charge R & C for different timing **50p each.**
BIG INCH Motor 110V AC 3 rpm 50 cycle. Very small **50p each.**
CONTACTORS. Heavy duty 24V DC 5 make **£1 each.**
GEC UHF/VHF 6-button tuner, **£2 each.**
DIGITAL 24-HOUR CLOCK with built-in alarm as used in Braun Digital clocks. Silent running. Large illuminated numerals. AC mains. Size 6½ × 2¼ × 2¼". **ONLY £3.75 each.**
931A PHOTO MULTIPLIER in stainless steel container with window and built-in resistor network, **£2 each. P&P £1.**
SLIDER CONTROL 500W. Log Single track. Complete with knob. Length 3½", **25p each.**
RANCO 250V 18A THERMOSTATS with Control knobs calibrated 50-200 degree C, **£2.50 each.**
SOLID STATE UHF TUNERS. 30 acs **£1 each.**
BRAND REX blue wire wraps 30 metres for **£1. P&P 25p.**

5in **SOLID RUBBER RINGS** (1" dia. rubber). Keep the kids (or dog) happy **4 for £1. P&P** £1.50 each.
TRANSFORMERS
AUTO 240V input 115V. 1 Amp output **£1.25 each.** P&P £1.25.
240V input Soc. 6V. 1.68A. Size 2½ × 2 × 2". Good quality **£1.50** ea. **P&P £1.**
240V input. Soc. 12V 0.92. Size 2½ × 2 × 2". Good quality **£1.50** ea. **P&P £1.**
240V input 12V 100MA. Size 60 × 40 × 42mm **50p each.**
240V input. Soc. 12-0-12V 50MA. Size 53 × 45 × 40mm; **£1 ea.**
115V input. Soc. 5V 250MA. Size 1 11/6 × 1.5 × 1¼". **2 for 50p.**
SEMICONDUCTORS
1N4005 **5p;** 1N4003 **3p.**
At 5p each:
BC147, BC157, BC158, BC237, BF197, OA90, OA81, BC148B, BA154, BA243.
At 25p each:
TIP31, TIP41A, 2N5296, AF139, 2TX341.
BY127 **10p.** BF181 **20p;** BD239 **40p;** BD241 **40p;** MA343AT **40p;** BD222 **50p;** BD233 & BD234 Comp Pair 25W — **80p per pr. at 50p each.**
Regulator TBA635 8 to 20V in — 5V out 100MA T05 Con. **50p each.** BF 256C **20p.**
TV AMPLIFIER TBA 120 **20p each.**
Integrated Circuits

7453	5p	74121	10p	74S02	12p	SN15862	4p
7451	5p	74122	12p	74154	70p	MC4028	60p
7401	5p	74Coo	17p	74C02	16p	7417	14p
7402	12p	74H74	12p	74C04	18p	7441	40p
7476	20p	74H51	7p	74C74	18p	74C86	50p
7495	35p	74S38	10p	75325	£1	74C161	24p

MOTOROLA DUAL in Line 6 pin Opto Coupler **30p each.** Gold plate tester version **50p each.**
EPROMS 2708 **£5.50 each.**
TELEPHONES 706 style black or grey **£5.50 each.** 746 style black or grey **£7.50 each.** Older style black **£2.50 each. P&P £1.50** per telephone.
HONEYWELL humidity controllers **50p each.**
THYRISTOR TIMER. Solid State. 15 secs adjustable (reset) in plastic relay case. Standard 7 pin base. Series delay **50p each.**
MINIATURE PC MOUNT SLIDE SWITCH. Single pole 3-way **10p each.**
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VARIACS. 2 amp Standard 240 Volts **£10 each, P&P £2.**
ELECTROSTATIC VOLTMETERS. 7 5KV **£8 each. P&P £1.50.** Other ranges available. Please enquire.
TRIMMERS. Sub min 0.25 to 1.25pf. 1 to 4.5pf. 7 to 45pf. **All at 6p each.**
CROWN replacement MOTOR for IBM GOLFBALL TYPEWRITER 115 Volt 50HZ 1350 rpm **£4.50 ea. P&P £2.**
SMITHS encapsulated transistorised AUDIBLE WARNING DEVICES 4V-12V. Can be driven from TTL **65p each.**

MINIMUM ORDER £3 VALUE OF GOODS. MINIMUM P&P £1 — where P&P not stated please use own discretion — excess refunded.
CARRIAGE ALL UNITS £5. P&P or CARRIAGE and VAT at 15% on total MUST BE ADDED TO ALL ORDERS.
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DEC PDP11/04 — SPECIAL PURCHASE

PDP11/04-BD 9-slot 5¼" Processor with 8kW MOS and DL11W interface **£3,250.**

EXAS SILENT 700

el 725KSR Terminal mounted in integral carrying case complete built-in acoustic coupler. 64 ASCII character set with 5 × 7 dot ix. 30 cps. Weight 35lbs. Dimensions 21½" × 19" × 6½".
5.00.
del 733ASR **£1,450.00.** Model 742 **£1,750.00.**
del 733KSR **£750.00**

ASR33 and KSR33 TELETYPES

Input/Output terminals with 64 ASCII character set. 110 baud operation. Paper tape punch and reader (ASR33 only). Choice of interface (20mA or RS232) KSR33 — **£425.00.** ASR33 — **£650.00.** Pedestal **£30.00.**

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IAL Aviation and Communications Systems and Services – worldwide

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University College, London

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Application forms from Room 238, Directorate of Planning, Engineering and Transportation, County Hall, Wakefield to be returned by 7th March, 1980.

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(9920)

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Marconi Space & Defence Systems (Portsmouth)

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(UNIVERSITY OF LONDON)
DEPARTMENT OF COMPUTING AND CONTROL

Applications are invited for a

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to work on an SRC funded project which involved the design of communication techniques for distribution process control, based on a network of 4LSI II microcomputers.

Candidates should have a degree in computer science or digital electronics and post graduate experience in computer communications, distributed processing, or real-time mini or micro computer systems.

The appointment will be for 2 years, with a salary on the 1A scale, £4335-£7521 (under review) plus £740 London Allowance and USS.

Applications, including curriculum vitae and the names and addresses of two referees, should be sent to Dr. M. Sloman, Computing and Control Department, Imperial College, 180 Queensgate, London SW7 2BZ, from whom additional information can be obtained.

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UNIVERSITY OF SURREY

ELECTRONIC/ELECTRICAL ENGINEERING OPPORTUNITIES

Owing to the expansion of the highly successful Industrial Electronics Group in the Department of Electronics and Electrical Engineering at the University of Surrey, vacancies exist, immediately, for technicians (engineers) who are keen to further their experience in a wide range of electronic fields and are qualified to ONC level or higher.

The work will involve operating on a project basis, covering all phases of prototype equipment manufacture, development and documentation. There is an opportunity to specialise in electro-mechanical design and draughting if desired.

The Group at present consists of a small team of Professional Engineers and Technicians who liaise closely with academic staff in problem solving for industry. Projects usually entail the development of novel instrumentation covering communication, non-destructive testing and signal processing fields with increasing emphasis on micro-processor based systems.

Commencing salary according to age and experience within the range

£3372-£4668 both under review

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Normal hours are 37½ per week and flexible working can be arranged.

Day release is possible for study leading to higher qualifications.

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An informal discussion or visit can be arranged by telephoning Mr. Matley, Head of Industrial Electronics Group (Guildford 71281, ext. 341), or write, in confidence, to: The Staff Officer, University of Surrey, Guildford, Surrey GU2 5XH. (149)

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(145)

Graduate Electrical/ Electronic Engineers–

Research and Development in telecommunications

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For further details and an application form (to be returned by 13 March 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/5308.**

Home Office

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LIVERPOOL AREA HEALTH AUTHORITY

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— (MEDICAL PHYSICS TECHNICIAN III)

Salary Scale: £4,605 to £5,952 per annum

Applications are invited from Technicians/Engineers with good general electronics experience for the above post which will involve the maintenance/development of equipment used in the Department of Nuclear Medicine at the new Royal Liverpool Hospital.

Application form available from the Personnel Department, Royal Liverpool Hospital, Prescot Street, Liverpool 7.
Closing date: March 7th, 1980.

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SOUNDOUT Laboratories, Surbiton, Surrey, who manufacture a range of professional sound equipment, are looking for an experienced

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ăgencў, n. Active operation, action. — Concise Oxford Dictionary.

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Use your C&G/ONC/HNC/Forces Training and good DIGITAL/ANALOGUE/RF experience to advantage. Working with state-of-the-art MINI/MICRO PROCESSOR; LASER; ATE; COMMUNICATIONS; NUCLEONIC; CCTV and similar equipment. Most UK areas; from Technician to Manager.

For free confidential counselling and practical career advice contact GRANT WILSON ref: GW470.

TECHNOMARK, 11 Westbourne Grove, London W2 4UA.
Tel: 01-229 9239 (01-229 4218—24 hrs).
Engineering Recruitment Consultants.

(9402)

MEDICAL EQUIPMENT REPAIRMAN

Saudi Arabia

c £7,500 tax free

The Whittaker Corporation of the U.S.A. is responsible for the staffing and management of three general hospitals in Saudi Arabia, where the task is to provide a high standard of Health Care in this rapidly developing country.

We now wish to appoint a man with 2/3 years' experience of biomedical electronics who has successfully completed a formal course in biomedical electronic equipment repair.

The benefits package includes free accommodation, life and medical insurance and return air fare. In addition, there are bonuses of around £500 after 6 and 15 months' service and an extra month's salary on completion of the 2 year contract.

Please write with full career details, or telephone 01-584 7639.

James MacDonald, Whittaker Life Sciences Limited, 199 Knightsbridge, London SW7.

Dedicated to a world of health

Whittaker
Life Sciences Ltd

(184)

Test Engineers

Pye Telecommunications are a well established company, involved in the field of radio communications, both at home and overseas. The Pye trademark is synonymous with systems that are highly reliable. To ensure that reliability, we need Test Engineers to check our VHF/UHF systems to very exacting specifications prior to delivery.

We are looking for skilled men and women with experience of fault diagnosis, alignment and testing of electronic equipment, preferably communications equipment. Formal qualifications are desirable, but less important than sound practical ability. Armed Forces experience would be particularly acceptable.

We can offer you job security and long term career opportunities, both within the company and the Pye and Philips Group as a whole. Our salaries are competitive and we offer up to five weeks' annual holiday. Attractive additional benefits include contributory pension scheme, good canteen facilities and assistance with relocation expenses where appropriate.

If you are interested please contact: **Jane Easy, Personnel Department, Pye Telecommunications Limited, St. Andrew's Road, Cambridge CB4 1DW. Tel: Cambridge 61222, ext. 755.**

Pye Telecom

(189)

Test Development Engineer

Our Test Projects Section has an opening for a Test Development Engineer. In this job he/she will be developing practical production test methods for our broad range of integrated circuits.

The work covers evaluating test methods with the designers and producing test hardware and software, through to the production of efficient test facilities for use on sophisticated computer-controlled test equipment. This requires interfacing with the production, QA and circuit design functions of our business and thus offers a unique opportunity for those who wish to broaden their knowledge of electronics.

Applicants must have a minimum qualification of HNC plus a practical engineering background.

Write or phone for an application form to Shirley Cave, Resourcing Officer, Plessey Semiconductors Limited, Cheney Manor, Swindon, Wilts. SN2 2QW. Tel: Swindon 36251.

PLESSEY

(9781)

ELECTRONIC TECHNICIANS

for

PRODUCTION
RESEARCH & DEVELOPMENT
and SERVICING

OXFORD
c£5,500

We are a small, young successful company, being the leading UK manufacturers of microcomputer systems for research and education.

We are offering the opportunity of varied and satisfying work on technically advanced equipment. We are looking for people who have some expertise working with complex TTL logic boards. Microprocessor experience is not necessarily required, but applicants must be eager to acquire expertise in this field.

A salary of around £5,500 is being offered together with good company benefits, and the possibility fo acquiring a 380Z computer at low cost.

Interested? Please phone Karen on Oxford 43244 for an application form

(135)

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FIELD SERVICE ENGINEERS BASIC SALARIES TO £8,000 + CAR

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30 Windmill Street, London, W1
01-637 5551

TOP JOBS IN ELECTRONICS

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

Phone or write: **BUREAUTECH, AGY, 46 SELVAGE LANE, LONDON, NW7. 01-906 0251.**

(8994)

UNIVERSITY OF LEEDS. ELECTRONICS TECHNICIAN — Grade 3, required in the Department of Physiology. The person appointed will be responsible to the Electronics Engineer for the development, construction and maintenance of electronic equipment associated with research and teaching of biological studies. Candidates should hold ONC or equivalent qualification in relevant subjects and have at least 3 years' appropriate experience. Salary from 1st April, 1980, on the scale £3594-£4092. Applications, stating age, qualifications and full experience, together with the names and addresses of two referees, should be addressed to Mr E. French, Departmental Superintendent, Department of Physiology, Worsley Medical and Dental Building, Leeds LS2 9JT. (181

LABORATORY TECHNICIAN Grade 4 required for undergraduate teaching laboratories providing experimental instruction for students of physics and astronomy. Qualifications C & G Laboratory Technician Certificate or equivalent and relevant experience. Some experience in electronics an advantage. Salary (under review) in range £4,487-£5,046 inc. of London Weighting. Five weeks paid annual holiday plus statutory and customary holidays at Christmas and Easter. Application form and further details from Personnel Officer (Technical Staff CJ21) University College London, Gower St London WC1E 6BT. (104

WIRELESS TECHNICIANS

We require staff, male or female, to prepare and maintain the latest in communications equipment used by the Police and Fire Brigades in England and Wales.

You will need to be qualified to at least City and Guilds Intermediate Telecommunications standard and be able to demonstrate practical skills in locating and diagnosing faults in a wide range of equipment from computer based data transmission to FM and AM radio systems. You would live near to and work from one of our service centres located at Andover, Hants; Bishops Cleeve, Gloucs; Hannington, Basingstoke, Hants; Shapwick, Somerset; Harrow, Middlesex.

Specialised courses or training are run to assist staff to keep up to date with developments and new equipment and there are opportunities for day release to gain higher qualifications. Applications from registered disabled persons will be considered.

Promotion prospects are good and the work represents a secure future with generous leave allowance and non-contributory pension scheme.

Possession of a driving licence is essential since some travelling will normally be involved.

The salary scale is as follows:— £3900; £4160; £4420; £4680; £4940; £5200; £5530.

If you are interested in working with us, then write for further details and application form to:—

Mr. C. B. Constable, Directorate of Telecommunications, Horseferry House, Dean Ryle Street, London SW1P 2AW. Telephone 01 211-5293.

Home Office

SCOTTISH HOME AND HEALTH DEPARTMENT

WIRELESS TECHNICIAN

Applications are invited for one post of Wireless Technician in the Scottish Home and Health Department.

LOCATION:
The post is in Inverness.

QUALIFICATIONS:
Candidates must hold an Ordinary National Certificate in Electronic or Electrical Engineering *or* a City and Guilds of London Institute Certificate in an appropriate subject *or* a qualification of a higher or equivalent standard.

EXPERIENCE:
3 years' appropriate experience.

STARTING SALARY:
£3,900, scale maximum £5,530.

Applicants should have sound theoretical and practical knowledge of Radio Engineering and Radio Communications equipment in HF, VHF and UHF bands. The work involves installation and maintenance of equipment located at considerable distance from headquarters. A clean current driving licence and ability to drive private and commercial vehicles are essential.

The appointment is unestablished initially but there is prospect of an established (i.e. permanent) appointment after 1 year's satisfactory service.

Application forms and further information are obtainable from Scottish Office Personnel Division, Room 110, 16 Waterloo Place, Edinburgh EH1 3DN (quote ref: PM(PTS) 2/2/80) (031-556 8400, Ext. 4317 or 5028).

Closing date for receipt of completed application forms is 18 April, 1980.

(182)

ITN

TRAINEE BROADCAST ENGINEERS

ITN needs more engineers to support its expanding programme of news coverage — expansion which is expected to continue through the '80s with the introduction of the fourth channel.

We have a number of vacancies for Engineering Trainees — vacancies which could give you the opportunity to start a career in Broadcast Television Engineering with ITV.

Firstly, we need you to have a firm interest in pursuing a career in the technical side of broadcasting.

Then you should have completed or expect to complete theoretical training in Electronic Engineering or allied subjects this academic year.

Applicants may have a wide range of acceptable initial qualifications, but those generally most suitable are either the TEC's Higher Technical Diploma, Higher Technical Certificate, HNC or HND.

After a training period of nine months you would be employed on the operation and maintenance of a wide range of studio, outside broadcast and computer type equipment at ITN's Central London studio centre near Oxford Circus from which the ITV national news programmes are networked.

Successful applicants will join ITN in the summer of 1980.

Starting salaries would depend on qualifications and experience, but would lie within the range of £3,857 (at 18) to £4,898.

Interested . . .

Please call us on 01-637 3144 for an application form quoting vacancy number 40799 or write to: The Director of Engineering, ITN House, 48 Wells Street, London W1P 4DE, with a short resumé of your interests, qualifications and experience.

(178)

DRG Flexible Packaging

DRG

INSTRUMENTS & ELECTRONICS SUPERVISOR

DRG Flexible Packaging is one of Europe's largest converters of protective packaging materials using a wide variety of sophisticated plant and machinery.

There is a vacancy for a Supervisor in the instruments and electronics section of the engineering department. The section consists of six electronics and three industrial technicians and is responsible for the maintenance and development of industrial electronic equipment including photo-electric, process control and measuring equipment and machine drives. The section works mainly double shift (although it serves a treble shift factory) but the Supervisor's job is a day position. The successful applicant will have had several years' experience in electronics and hold a relevant qualification such as City and Guilds Full Technical Certificate.

The Company offers a competitive salary, 4 weeks' holiday a year, a contributory pension scheme and other benefits associated with working for a large company.

Applications should be made in writing, giving brief career details and current salary to:

Mr. P. Hawkins
DRG FLEXIBLE PACKAGING
Filwood Road
Fishponds, Bristol BS16 3RY

A Dickinson Robinson Group Company

R & D Engineers

required to work on digital circuits for micro-processor based industrial and commercial systems.

The candidate should have a working knowledge of TTL and CMOS logic and have experience of programming at assembler language level for micro-processor systems.

Engineers should hold a degree/HNC or equivalent qualifications. Salary will be commensurate with qualifications, age and experience.

If you are seeking an enjoyable position involving both hardware and software development, write giving your career to date or telephone

Dr. G. O. Towler
(New Product Development Manager)
British Relay Electronics Ltd.
32 Biggin Way
Upper Norwood
London, SE19
Tel. 01-764 0931

(172)

British Relay Electronics

SENIOR ELECTRONICS ENGINEER

Gloucestershire

The Company, pleasantly situated on the outskirts of Cheltenham, is a leading manufacturer of aircraft gas turbine fuel systems and associated equipment. Our Electronics Laboratory has a vacancy for an experienced Electronics Engineer to join a small team engaged in the design and development of special purpose prototype instrumentation and control equipment.

Applicants, male or female, educated to at least HNC/HND standard or equivalent should have practical experience in current digital and analogue design techniques.

In addition to a competitive salary, we offer excellent fringe benefits including a self-financing productivity scheme and excellent pension scheme. Generous assistance with relocation expenses to this desirable Cotswolds area will be given where appropriate.

Please write giving details of career to date and salary expectations to: The Senior Personnel Officer, Dowty Fuel Systems Ltd, Arle Court, Cheltenham or telephone: Cheltenham 21411 Ext. 163 for further details and an application form.

(166)

DOWTY

RADIO OFFICERS

If your trade or training involves radio operating, you qualify to be considered for a Radio Officer post with the Composite Signals Organisation.

A number of vacancies will be available in 1980/81 for suitably qualified candidates to be appointed as Trainee Radio Officers. Candidates must have had at least 2 years' radio operating experience or hold a PMG, MPT or MRGC certificate, or expect to obtain this shortly. Registered disabled people may be considered.

On successful completion of 40 weeks' specialist training, appointees move to the Radio Office Grade.

Salary Scales:

Trainee Radio Officer		Radio Officer	
Age 19	**£3271**	Age 19	**£4493**
Age 20	**£3382**	Age 20	**£4655**
Age 21	**£3485**	Age 21	**£4844**
Age 22	**£3611**	Age 22	**£4989**
Age 23	**£3685**	Age 23	**£5249**
Age 24	**£3767**	Age 24	**£5559**
Age 25+	**£3856**	Age 25+	**£5899**

then by 5 annual increments to £7892 inclusive of shift working and Saturday, Sunday elements.

For further details telephone **Cheltenham 21491 Ext. 2269,** or write to the address below.

GCHQ

Recruitment Office

Government Communications Headquarters

Oakley, Priors Road, Cheltenham GL52 5AJ (109)

Rogers BRITISH HIGH-FIDELITY | CHARTWELL

We require two additional qualified

ELECTRONIC ENGINEERS

to work in our acoustics and electronics divisions on the testing and development of our prestige range of loudspeakers, amplifiers and tuners.

The electronics post is based at our factory in London S.E.6, within 20 minutes of Central London, as is the acoustics post which is based at our Mitcham Loudspeaker Division.

Both positions offer a competitive salary with fringe benefits. Applicants should apply initially in writing to:

MR. M. S. SCED
Technical Director
SWISSTONE ELECTRONICS LIMITED
4/14 Barmeston Road, London SE6 3BN

(110)

How to cut through the old boy network

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Tel: 01-579 2282 (24 hour answering service)

Our clients would like to meet men and women, aged 20-40, earning between £4,000-£8,500 in any of the following:

- TEST ENGINEERING ☐
- CALIBRATION ENGINEERING ☐
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- ELECTRONICS SALES ☐

Mr./Mrs./Miss ____________________

Address ____________________

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Stuart Tait, Lansdowne Appointments Register,
Design House, The Mall, London W5 5LS.
Tel: 01-579 2282 (24 hour answering service) WW20/2

Lansdowne

(154)

Senior Electronics Liaison Engineer

c.£8,500 p.a. + car Blackpool

Telefusion, the highly successful multi-million pound Group of companies,is developing new areas in which to use its expertise.

A separate Division has been set up to install and maintain a range of sophisticated computerised till terminal units used by the Group and other client companies to control retail cash and stock transactions.

We are now seeking a Senior Electronics Engineer to control through a small team of technicians the installation and maintenance of these terminals throughout the U.K. He or she will also be required to negotiate contracts at a senior level with equipment manufacturers and potential clients.

Ideally, aged from mid-thirties, candidates should possess a minimum HND in electronics or equivalent qualification and have detailed knowledge of micro electronics technology (preferably 8080/8085) also disc drive units and high speed printers. Experience or an interest in programming techniques would also be an advantage.

The successful candidate will be based at the Group Head Office and report to the Director responsible through the Group Technical Executive.

Candidates should write giving details of age, qualifications and career to date, to

R. M. Beaton, Group Personnel Manager,
Telefusion Limited,
Telefusion House,
Preston New Road,
Blackpool FY4 4QY.

TELEFUSION

(161)

PHILIP DRAKE ELECTRONICS

Systems Engineers *Limited*

manufacture audio equipment for the broadcast industry and have vacancies for the following staff:

PROJECT ENGINEER

To work with Philip Drake standard products, including Programme Amplifiers and Intercom Systems. The job will involve development and improvement of existing products and introduction of new product lines. The Project Engineer will be responsible for electronic and mechanical aspects of design, up to the stage of production, and experience in this field is required. Experience in the broadcast industry and a suitable qualification would be an advantage.

TEST ENGINEER

To work with the above-mentioned products. The Engineer will be required to design test jigs for standard products, and to test all company products including one-off Intercom Systems. Experience in the testing of Broadcast Audio products is desirable and qualifications would be an advantage. Product development and circuit design to a suitable applicant.

PROTOTYPE WIREMAN

To work on the full range of the company's products. Aplicants must have the ability to work from wiring schedules and circuit diagrams and must be tidy, accurate and quick. Familiarity with all aspects of electronic workshop practice is needed. Previous experience in production and installation of Broadcast Quality equipment would be an advantage, otherwise a good knowledge of audio wiring techniques is needed. The company offers a 37½-hour week with 3½ weeks' holiday minimum. Salaries negotiable dependent on experience. Apply by telephone or writing to:

Alan Brill, Philip Drake Electronics Ltd., 23 Redan Place, London W2 4SA. 01-221 1476. (150)

Electronic Engineers

Worldwide Airborne Surveys

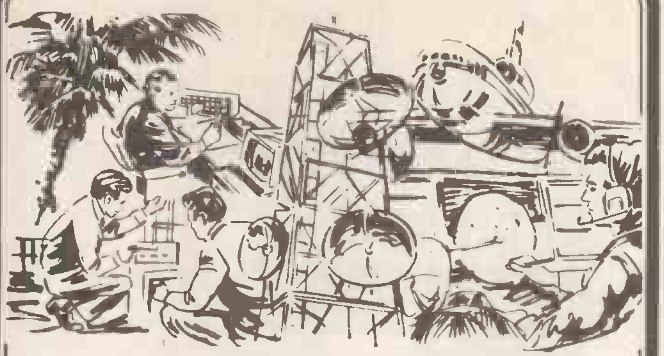
Our Engineers prepare electronic sensing and digital recording systems at U.K. base for eventual in-flight operation by themselves in fixed and rotary winged aircraft engaged on overseas geophysical projects. Typical overseas project duration is between 2 to 6 months.

A wide spectrum of electronics is covered with a growing emphasis on microprocessor based devices. Qualifications or experience to HNC standard together with a flair for fault diagnosis, solving interfacing problems and mechanical packaging ability is desired.

Persons interested in joining our teams or who require further information should apply to:

**The Personnel Manager,
Hunting Surveys
& Consultants Limited,
Elstree Way, Borehamwood,
Herts, WD6 1SB.**

(9127)



CALLING ALL ENGINEERS up to £19,000

per contract year after tax

The Communications Department of Aramco, the world's largest oil producer, based in Saudi Arabia, urgently requires

MICROWAVE ENGINEERS experienced in microwave system project management and design, with practical knowledge in one or more of the following: Telephone, mobile radio, analog-digital communications and control systems.

UHF/VHF ENGINEERS experienced in mobile UHF/VHF systems project management and design and practical experience in one or more of the following: Microwave, telephone, analog-digital communications and control systems.

SENIOR FIELD CONSTRUCTION SPECIALISTS/ FIELD CONSTRUCTION SPECIALISTS to install and commission electronic instrumentation and data acquisition systems. Experienced in trouble shooting complex digital electronics at the system, card and component levels. Familiarity with electonic test equipment, digital diagnostic test procedures and equipment as applied to mini-computers and/or other digital systems.

PLANNING & SCHEDULING ENGINEERS to evaluate schedules, implementation and control analysis and, if necessary, initiate corrective action.

There are also requirements for Engineers & Technicians in INSTRUMENTATION, ELECTRICAL & ELECTRONICS disciplines,£14,500-£19,000

All positions require at least HNC and 10 years experience.

- **Renewable contracts, single status.**
- **12 days Public Holidays per year.**
- **Leave for married men - 14, 14, 25 days after each 4 month period per contract year.**
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- **Free Medicare.**
- **Valid U.K. Driving Licence essential.**

Switch to a new wavelength with

ARAMCO

write with career details quoting ref: ww/2

(139)

PMC

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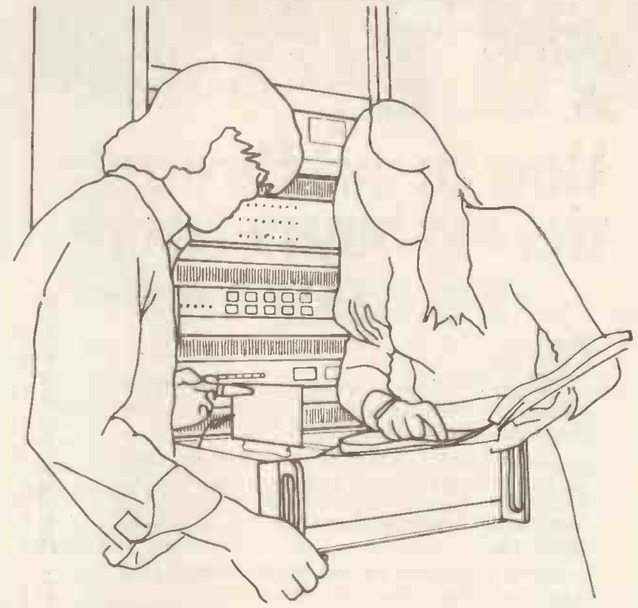
Professional Careers in Electronics



All the others are measured by us...

At Marconi Instruments we ensure that the very best of innovative design is used on our range of communications test instruments and A.T.E. We have a number of interesting opportunities in our Design, Production and Service Departments and we can offer attractive salaries, productivity bonus, pension and sick pay schemes together with help over relocation.
If you are interested to hear more, please fill in the following details:-

Name ____________ Age ______
Address ____________
____

Telephone Work/Home (if convenient) ______

Years of experience	0-1	1-3	3-6	Over 6
	☐	☐	☐	☐

Present salary	£2,500-3,500	£3,500-4,500	£4,500-5,500	over £5,500
	☐	☐	☐	☐

Qualifications	None	C & G	HNC	Degree
	☐	☐	☐	☐

Present job ____________
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Return this coupon to John Prodger, Marconi Instruments Limited, FREEPOST, St. Albans, Herts, AL4 0BR. Tel: St Albans 59292

Marconi Instruments

A GEC MARCONI ELECTRONICS COMPANY

(9200)

DEVELOPMENT ENGINEER

To work on the design of new broadcast TV studio products. Applicants should have some knowledge of television studio techniques and be qualified to HND or Degree level.

TEST ENGINEERS

At senior and intermediate level to work on our range of advanced broadcast television studio products, including colour and monochrome television studio cameras.

Applicants should have an up-to-date knowledge of digital and linear circuit techniques gained from experience working on television studio equipment, radar equipment or similar sophisticated products and qualified to HND, HNC or equivalent level.

SYSTEMS ENGINEER

You would be involved in all stages of product management on the design and building of studio and mobile TV systems and should be prepared for occasional world-wide travel. The appointment requires someone with a background in this type of work, or in the operational side of television with the ability to take charge of people and deal with problems in the field on your own initiative.

Employment benefits include excellent salary, generous holidays, free life and health insurance, pension scheme, subsidised meals and relocation expenses.

Please apply for further details and application forms to Jean Smith at the address given below.

Advanced Broadcasting Equipment

LINK ELECTRONICS

Link Electronics Limited, North Way, Andover, Hants, SP10 5AJ.

Telephone: (0264) 61345

(9968)

MEDIA RESOURCES CENTRE
GLYN HOUSE, CHURCH STREET, EWELL

The Centre is within easy reach of main line railway stations and on bus routes, convenient for shops. There is ample free parking available on site.

Field Service Engineer

(Electronic A/V Equipment) (M/F)
£4317-£4770

To carry out on-site service, including fault finding, on schools' audio visual equipment, e.g., language laboratories, TV/Video installations, radio systems, Hi-Fi, etc.
Some of the time, you will be engaged in bench service at the Centre workshop. Experience in the maintenance/repair/fault diagnosis of some, or all, of the above is essential, and practical experience is vital. You should possess City & Guilds or ONC and experience in digital equipment is highly desirable.

Installation/Field Service Engineer

(M/F)
£4317-£4770

To carry out installation/repair work of school fixed A/V systems, wiring of radio lines, aerials (not roof work), language laboratory trunking, etc. This will involve installing screens in school classrooms (drilling walls, etc.) installing study carrels, etc., relocating language laboratories, moving all services, furniture, etc. and re-installing in new positions. Also some bench work at the Centre, dealing with repair of some A/V items. You should possess ONC or City & Guilds and practical experience of installation work together with a working knowledge of A/V systems.

Applicants will be expected to use their own transport for travelling to establishments — an appropriate car allowance is payable.

Application forms from Mrs S. Goode, Administrative Officer at the Centre, Tel: 01-393 0208.

SURREY COUNTY COUNCIL

(100)

MIDDLE EAST

Precision Measuring Equipment Technicians

The Northrop Corporation, a major US aerospace company, is seeking experienced personnel for their support operations at a number of locations in Saudi Arabia.

Qualified to C & G/ONC or equivalent, you should have at least 5 years' laboratory experience on the calibration and testing of avionics systems and related ground based equipment.

This is an opportunity to secure a sound financial future for yourself and to become involved with the latest developments in electronics technology. The employment package includes:
* 1 year renewable contract * Good bachelor accommodation
* Regular home leave * Excellent recreational facilities

Please contact us quoting ref. 84 PMT.

INTERNATIONAL RECRUITMENT CONSULTANTS,
45 KENSINGTON HIGH STREET, LONDON W8 5ED.
TEL: 01-937 6586. TELEX: 21879 ATT WEBB WHITLEY.

(176)

Opportunities for Radio Hazards and Microwave Engineers

At EMI Electronics Ltd. Feltham, we are involved in the design and development of high technology equipments. Thanks largely to the high calibre of its staff, the Company is already a recognised authority in this sphere and is rapidly gaining an International reputation for its specialized equipment and expertise.

Radio Frequency Engineers

To join the existing team engaged in work associated with the assessment of the radio frequency characteristics of a variety of weapon systems. The work currently in hand includes the definition of user requirements, the generation of new analytical and measurement techniques, the development of new forms of miniature radio frequency and analogue instrumentation, and the performance of field trials.

We are looking for engineers with a relevant degree or equivalent qualifications together with up to five years' post-degree experience. Vacancies also exist for less experienced graduates with an interest in this exciting field.

Microwave Development Engineers

To join our radiation laboratory for work on the design and development of microwave components, aerials and systems for ground and airborne applications.

The people we are looking for include graduate engineers with one or two years' post-degree experience in an appropriate field. New graduates with a good degree in physics or electronic engineering and who are looking for an exciting career in the microwave field are also invited to apply.

EMI offers competitive salaries of circa **£7,500** for the senior posts, excellent experience and career prospects as well as good employment conditions and substantial fringe benefits. Relocation expenses will be paid where appropriate.

To apply, telephone or write to Lisa Kleinhorn, Personnel Officer, EMI Electronics Ltd., FREEPOST, Victoria Road, Feltham, Middlesex. (NO STAMP REQUIRED). Tel: 01-890 3600 ext 117 or 01-751 0702.

(163)

EMI EMI Electronics Limited, Feltham.

A Member of the THORN EMI Group.

ELECTRONIC SERVICE ENGINEERS

LONDON — BRISTOL — MANCHESTER — GLASGOW

Our Company specialises in both sales and servicing of Discotheque Sound and Lighting equipment. We currently have vacancies for engineers who have had previous experience of either HiFi, Studio PA or similar equipment. Excellent salary plus quarterly bonus and P.P.P.

Please telephone or write to Andree Mead, Personnel Director for further details.

Roger Squire's

Barnet Trading Estate,
Park Road, Barnet,
Herts. EN5 5SA
Telephone: 01-441 1919

(158)

TELECOMMS ENGINEERS/ TECHNICIANS

for Saudi Libya Nigeria

Salaries to £22,000 p.a.

for degreed Switching Engineers, External Plant Engineers, Microwave and Mux Engineers. Minimum qualifications must be BSc or equivalent.

Salaries to £12,000 p.a.

for Telephone Technicians with digital PABX experience, Radio Technicians, Teleprinter/Telex Installation and Repair Technicians.

All salaries are paid tax-free plus accommodation and transportation.

Please send résumé to:

ADVANCE PERSONNEL SERVICES LTD. (Agy)
The White House, 12A Lodge Road, Hendon, London NW4
Tel. 01-203 4272

(156)

RF pollution control wasn't so critical in the first crystal age

Electronics Engineers/Physicists

to specialise in interference technology

Develop your career and make a significant contribution to the control of electrical noise by moving into the increasingly important field of interference technology with Plessey Assessment Services.

Pleasantly situated in purpose-built laboratory units at Titchfield, Hampshire, we're a well-established and rapidly expanding test house and consultancy offering in-depth specialist services to a wide variety of Government and industrial organisations.

Strengthening an existing team of experts in one of the most advanced computer-aided testing facilities in Europe, you'll be responsible for evaluating the effects of across-the-spectrum electro-magnetic interference on a wide range of electronic equipment.

Ideally, you should have analogue or digital experience, together with a relevant qualification, and knowledge of radio frequency measurement techniques.

Lack of experience in interference technology should not be a bar to applicants since training can be arranged.

There are opportunities at all levels from Assistant Engineer upwards with salaries to suit up to £7,500, plus benefits including generous relocation expenses where appropriate.

Contact Richard Wyatt, Recruitment Manager, on Titchfield 0329 43031 or write to him at Plessey Assessment Services Limited, Titchfield, Fareham, Hampshire, PO14 4QA.

PLESSEY
assessment services

Inner London Education Authority
London College of Furniture
DEPARTMENT OF MUSICAL INSTRUMENT TECHNOLOGY — ELECTRONICS

LECTURER GRADE I

is required as soon as possible to teach electronics to Technician Education Council (T.E.C.) Diploma level in subjects related to electronic musical instruments and audio frequency engineering.

The person appointed should have a C & G Final or HNC/HND in electronics and a practical knowledge of electronic music systems.

Salary: On an incremental scale within the range of £3,480-£5,988 plus supplement of £6.00 per month (subject to formal approval), (plus £474 Inner London Allowance), starting point depending on qualifications, training and experience.

Application form and further details available from:—

Senior Administrative Officer
London College of Furniture
41-71 Commercial Road
London E1 1LA
Tel. No. 01-247 1953

(152)

NORTHERN REGIONAL HEALTH AUTHORITY

TECHNICAL ASSISTANTS (ELECTRONICS)

GRADE I

Applications are invited for two vacancies which involve electronic development work connected with the Hospital Buildings Programme, and involvement with problems related to the use and maintenance of electronic equipment in hospitals.

Applicants must have a wide experience in practical applications of electronics, preferably with a significant element of radio-communications.

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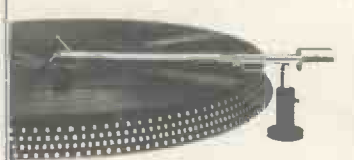

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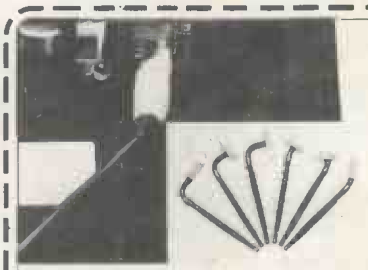

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