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JUNE 1981 60p

L.e.d. millivoltmeter

Morse code lock

Remote computer keyboard

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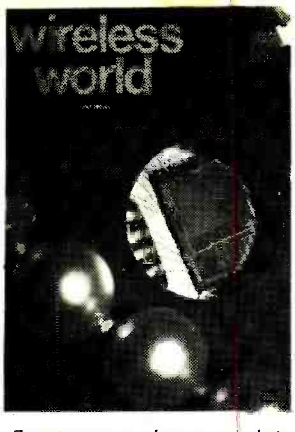

Front cover shows an Intel microprocessor chip, incorporating a-to-d conversion, compared with a string of pearls. Photographer Paul Brierley.

IN OUR NEXT ISSUE

***Microprocessor trainer* is a new version of the Nanocomp which uses a newer micro, the 6809, and a cassette interface.**

***Digital speech storage and analysis.* The start of a series which explains the techniques of handling digital signals.**

***New coaxial cable development.* A cross between conventional coaxial cable and waveguide offers lower losses and better power handling.**

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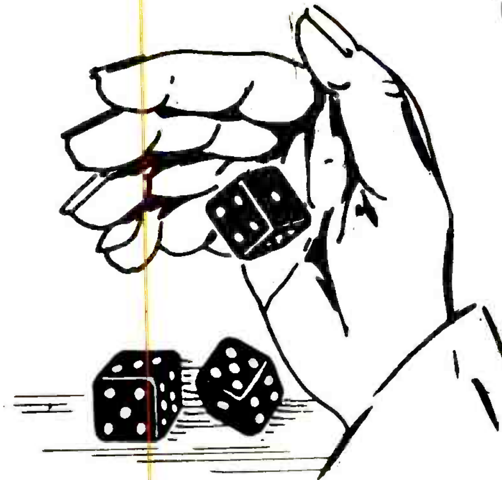
ELECTRONICS / TELEVISION / RADIO / AUDIO

JUNE 1981 Vol 87 No 1545



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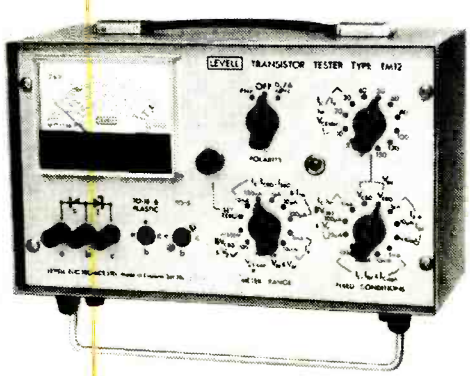

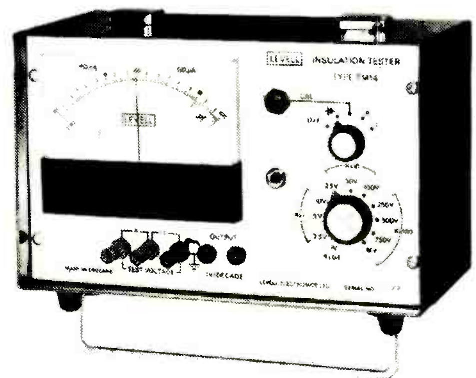

Tests bipolar transistors, diodes and zener diodes. Measures leakage down to 0.5 nA at 2V to 150V. Current gains are checked from 1µA to 100mA. Breakdown voltages up to 100V are measured at 10µA, 100µA and 1mA. Collector to emitter saturation voltage is measured at 1mA, 10mA, 30mA and 100mA for I_C/I_B 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 **£160**

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.

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100k Ω to 100G Ω at 2.5V, 5V and 10V.
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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 **£170**

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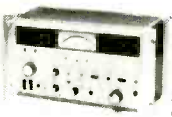

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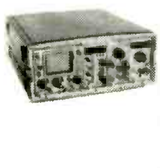

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EQUIPMENT~AS

.... **June 1981** .... **Latest Computer Equipment** ....

PDP11 SYSTEMS

DEC

PDP11/34A 128KB MOS, KY11-LB Programmers Panel, DL11W Interface, 2 x RL01 Disk Drives and Controller, 6ft. Cabinet, VT100 Console **£11,500.00**

PDP11/34A 128 KB MOS, KY11-LB Programmers Panel, DL11W Interface, RK05J and RK05F Disk Drives and Controller, 6ft. Cabinet, DECwriter IV Console **£9,950.00**

PDP11/34A 256KB MOS, KY11-LB Programmers Panel, DL11W Interface, 2 x RK07 Disk Drives and Controller, 6ft. Cabinet, VT100 Console **£19,750.00**

PDP11/34A 128KB MOS, KY11-LB Programmers Panel, DL11W Interface, 2 x RL02 Disk Drives and Controller, 6ft. Cabinet, VT100 Console **£12,750.00**

PDP11/60 System with 2 RK07 Disk Drives and Controller, choice of Console .... **P.O.A.**

PDP11 C.P.U.s

DEC.

PDP11/03-SD Processor in 3½" chassis complete with 16KW MOS memory and EIS option.
BRAND NEW — ONLY **£1495.00**

PDP11/04 Processor in 10½" chassis complete with 16KW MOS memory and DL11W interface.
BRAND NEW (can be enhanced to 28KW) **£3950.00**

PDP11/34A Processor, 10½in. chassis 128KB MOS, KY11-LB Programmers Panel, DL11W Interface **£6,250.00**

PDP11 MEMORY

DEC.

- MF11L 8KW core memory c/w 9-slot system unit **£975.00**
- MM11L 8KW core memory **£795.00**
- MM11LP 8KW parity core memory **£750.00**
- MM11DP 16KW core (ex DEC-maintained 11/34 systems) BARGAIN OFFER — ONLY **£395.00**
- MM11UP 16KW Parity core memory complete with 9-slot system unit **£1500.00**
- MM11UP 16KW parity core memory (pre-requisite MF11UP) **£1250.00**
- MS11JP 16KW MOS memory **£675.00**
- MS11-LB 128KB MOS **£1,995.00**
- MS11-LD 256KB MOS **£3,500.00**
- MSV11C 16KW MOS memory (LSI11) **£495.00**
- MJ11-BE 64KW 11/70 memory **£4500.00**
- MK11-BE 64KW MOS memory for 11/70 .... **£3950.00**
- MS11-MB 256KB ECC MOS memory for 11/44 (NEW) **£3942.00**

DISKS

DEC.

RK05J add-on disk drive 2½ meg. Exchangeable cartridge type. From **£1,500.00**

- RK06-ED Add-on 14 Meg disk drive **£2,750.00**
- RK611-ED Unibus Controller + 1 RK06 drive **£4,500.00**
- RK07-ED Add-on 28 Meg disk drive **£4,750.00**
- RK711-ED Unibus Controller + 1 RK07 disk drive **£6,500.00**
- RM03-Add-on 67 Meg disk drive **£7,500.00**
- RX11-BD RX01 Dual floppy + Unibus Controller **£1,350.00**
- RL01-AK Add-on 5 Meg disk drive **£1,975.00**

Controllers usually available for above drives.

MAGNETIC TAPE

DEC.

Available from time to time — TU10, TU45, TE16 TS03 etc

PDP11 OPTIONS

DEC.

- AA11D VT01 Controller with 4-slot System Unit **£125.00**
- BA11-KF expander Box **£1,395.00**
- DD11A 4-slot System Unit **£125.00**
- DD11B 4-slot System Unit **£150.00**
- DD11-DK 9-slot backplane **£465.00**
- DL11 Serial interface **£250.00**
- DL11WA/B Serial Interface/Line Clock **£395.00**
- DR11C General Purpose Interface **£250.00**
- DRV11B 16-bit Parallel Interface **£225.00**
- DZ11A 8-line EIA MUX **£1395.00**
- DZ11-B 8-Line Expander MUX **£995.00**
- FP11A Floating Point **£1750.00**
- KL11 TTY Interface **£150.00**
- KW11L Real Time Clock **£150.00**
- KW11P Programmable Clock **£345.00**
- M105 Device Selector **£30.00**
- M792 ROM Diode Matrix **£195.00**
- M920 Unibus Connector **£12.00**
- M9301-YB Bootstrap **£325.00**

POWER SUPPLIES

DEC.

H720 Power supply for BA11 Expander Box, BRAND NEW SURPLUS **£175.00**

PDP8A C.P.U.

DEC.

PDP8A Processors, systems and add-on memory usually available.

PDP8A MEMORY

DEC.

- MM8AA 8KW Core **£750.00**
- MM8AB 16KW Core **£995.00**

PDP8E CPU, MEMORY, OPTIONS

DEC.

- DP8EB Communications Adaptor **£395.00**
- KA8E Positive I/O Bus **£95.00**
- KD8E Databreak **£145.00**
- KL8E Asynchronous interface **£250.00**
- KP8E Power fail/auto restart **£95.00**
- MM8E 4KW Core memory stack **£350.00**
- TA8E Dual Cassette Drive and Controller **£525.00**
- VT8E Set graphics Control Modules **£250.00**

TERMINALS

DEC.

LA34 DECwriter IV 30cps desk-top terminal, 132 columns, upper/lower case ASCII **£495.00**

LA36 DECwriter II Keyboard Printer Terminal. The Terminal that has become an industry standard, with 132 column upper/lower case printing and switch-selectable speeds of 10, 15 & 30cps. Available with either 20mA or RS232 interface. NOW ONLY ... **£595.00**

VT 52 SPECIAL PURCHASE of this outstanding Video Display Terminal featuring full upper/lower case ASCII character set, 24 × 80 display, auxiliary keypad, direct cursor addressing and tabulation, scroll or hold screen mode with X-off facility, 9 switch-selectable baud rates (75-9600 baud) choice of 20mA or RS232 interface. BRAND NEW SURPLUS. ONLY **£450.00**

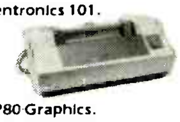
LS-120 High speed keyboard terminal, 132-column printer with adjustable tractor feed and full upper and lower case ASCII printing (7 x 7 dot matrix), 180 cps print speed and operator-selectable baud rates up to 4800 baud. Integral stand. RS232 interface. BRAND NEW SURPLUS (limited quantity). ONLY **£750.00**

VT100 — limited quantity in as-new condition **£650.00**

DECwriter IV Desktop terminal complete with tractor feed, paper-out, cable and keypad options **£495.00**

PRINTERS

Centronics 101.



Heavy Duty Matrix printer with 64 ASCII upper case character set. 165 cps operation, 132 print positions with adjustable tractor feed. Parallel input. ONLY **£495.00**

GP80 Graphics.

NEW

BRAND NEW — LOW COST MATRIX PRINTER IDEAL FOR MICROPROCESSOR USERS SUCH AS HOBBYISTS & EDUCATIONALISTS OR ANY LOW-BUDGET APPLICATION

- ★ Full upper/lower case ASCII PLUS GRAPHICS Mode
- ★ 80-column printing with adjustable tractor feed
- ★ Standard and double-width characters (12 cpi and 6 cpi)
- ★ 30 cps print speed with 1-line buffer
- ★ Standard parallel (Centronics-type) interface
- ★ Optional interfaces available for RS232, IEEE488, Tandy, PET, Apple II
- ★ ONLY .... **£199.00** (Mail order total ..... £240.35)

GP80 Optional Interfaces:

- RS232 .... **£55.00**
- IEEE **£55.00**
- PET **£55.00**
- Apple **£55.00**
- Tandy **£35.00**

GP80 Fanfold Paper

Box of 2000 x 8in sheets **£15.00**

GE Terminet 1200.

RO printer, 80 columns, tractor feed, upper/lower case, ASCII, 20mA interface **£325.00**

Hazeltine.

Thermal printer, 80 columns, 30 cps silent RO with parallel TTL input **£395.00**

Tally 1602.

Matrix printer, parallel input, upper/lower case, tractor feed, as new **£995.00**

Teletype.

Reconditioned ASR33 Teletype Terminals with paper tape punch and reader, even parity keyboard and RS232 interface.
SPECIAL OFFER — CASH AND CARRY ONLY **£295.00**

Low Cost Printer Offer.

Teletype 33 printer mechanism including case but no keyboard or electronics. 64 upper case ASCII, 10 cps, pinfeed platen, ideal for the electronic hobbyist ONLY ... **£85.00**

Texas.

745 Portable Data Terminal including keyboard, printer, integral acoustic coupler and carrying case. Total weight only 13 lbs **£750.00**

Texas.

733 ASR terminal utilising high performance twin cassette drive for fast time-saving transmission and off-line storage.

- ★ Silent operation
- ★ Switch-selectable transmission speeds 10, 15, & 30 cps
- ★ Full tape editing capability
- ★ High-speed duplication and rewind
- ★ Standard RS232 interface **£1375.00**

745 LIGHTWEIGHT (13lbs) terminal with integral acoustic coupler, 10/30 cps, carrying case **£750.00**

Electronic Brokers

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SED COMPUTER NEW CONDITION

June 1981 ....

Latest Computer Equipment

PAPER TAPE PUNCHES

Digitronics.
P135/20 paper tape punch. Solenoid-actuated unit capable of punching 5 to 8 channel tapes at speeds up to 35 cps. Pulse amplitude 27 VDC. Compact table-top unit **£95.00**

Facit 4070.
The top quality punch that has become an industry standard. Asynchronous 75cps operation. Adjustable for punching 5, 6, 7 or 8 level tape. Self-contained desk-top unit incorporating supply and take-up spools, chad box, and TTL-compatible control logic .. **£650.00**

KEYBOARDS

George Risk.
New ASCII Keyboards
New Low Prices

NEW

KB771 Super 71-station ASCII keyboard incorporating separate numeric/Cursor control pad and installed in custom-built steel enclosure with textured blue enamel finish. Ideal for the VDU builder. Case dimensions: 17¼" x 7½" x 3⅜".
Total weight 4kg. PRICE .. **£85.00**
Mail Order Total £103.50

KB756 56-station ASCII keyboard mounted on P.C.B. **£39.50**
Mail Order Total £47.15

KB756MF as above, fitted with metal mounting frame for extra rigidity **£45.00**
Mail Order Total £53.48

KB710 10-key numeric pad, supplied with connecting cable .. **£8.00**
Mail Order Total £9.78

KB701 Plastic enclosure for KB756 or KB756MF **£12.50**
Mail Order Total £15.24

KB702 Steel enclosure for KB756 or KB756MF **£18.00**
Mail Order Total £23.00

KB2376 Spare ROM encoder **£12.50**
Mail Order Total £15.24

KB15P Edge connector for KB756 or KB756MF **£3.25**
Mail Order Total £4.31

DC-512 DC convertor to allow operation at 5V only (plugs in to P.C.B.) **£7.50**
Mail Order Total £9.20

DB25S Mating connector for KB771 .... **£4.25**
Mail Order Total £5.46

PERK 56-station ASCII keyboard for PET complete with PET interface, built-in power supply and steel enclosure **£95.00**
Mail Order Total £115.00

Discounts available for quantities.

PROGRAMMABLE CALCULATORS

Hewlett Packard
9830A with 8K Memory. Extended I/O ROM. String Variables ROM. 1 Serial and 3 parallel interfaces **£1695.00**

MODEMS

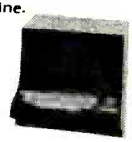
Racal Milgo.
Modem 26 Isi 1200/2400 baud, 2 or 4 wire, full/half duplex .... **P.O.A.**

GENERATORS

Mawdsley.
45KVA Generator system comprising AC Induction Motor, AC Generator, AC Exciter and Emreg Regulator.
The alternator comprises of a screen-protected rotating field, complete with built in over-hung exciter of the brushless pattern. It is wound for 415V, 3 phase, 50Hz, 4 wire and developing 45KVA at 0.8 P.F. when running at a speed of 1500 rpm.
The alternator and exciter are used in conjunction with the automatic transistor sed voltage regulator, incorporating 3-phase sensing. The regulator is so designed that when the alternator is on balanced 3-phase load and with one phase switched off or disconnected, the phase voltage will not vary more than ± 6% under any conditions **£1250.00**

VDUs

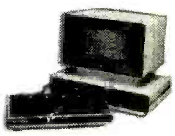
Hazeltine.



H1000 The low, low priced teletypewriter-compatible video display terminal, offering your choice of transmission speeds up to 9600 baud as well as parity generation and checking. 12 x 80 display upper case ASCII, RS232 interface, choice of baud rates. SUPER VALUE **£199.00**

Standard baud rates either (a) 110/300 or (b) 300/1200. (£25 surcharge for other combinations up to 9600 baud).

H2000 Superb spec. including full XY cursor addressing and edit facility, 27 x 74 display, upper case ASCII, RS232 interface, switch-selectable baud rates **£299.00**



H2000C NOW ALSO AVAILABLE with 25 x 80 line format and C-MOS logic **£375.00**

Modular One. Now with upper/lower case, XY cursor addressing, 24 x 80 line display, dual intensity detachable keyboard, choice of 8 transmission rates up to 9600 baud **£399.00**

FLOPPY DISK DRIVES

Shugart SA400.
5¼" MINI-FLOPPY (NEW)

NEW

- ★ Transfer rate: 125/250 kilobits/sec.
- ★ Capacity (unformatted): 110Kb (single density) 220Kb (double density)
- ★ Average access time: 463ms.
- ★ Read/Write and Write Protect electronics
- ★ Power requirements +5VDC + 12VDC Dimensions 5¾" x 3¼" x 8", weight 3lbs

Supplied complete with technical manual.
Application notes are available on interfacing the SA400 to Intel 8080A, Motorola etc **£195.00**

Shugart SA450.
Double-sided, double density minifloppy providing 440KB unformatted storage capacity, yet the same compact size and weight as the SA400 .... **£299.00**

Shugart SA801.
8" FLOPPY (NEW)

- ★ Capacity (unformatted): 400Kb (single density) 800Kb (double density)
- ★ Transfer rate: 250/500 kilobits/sec.
- ★ Average access time: 211ms
- ★ Read/Write and Write Protect electronics
- ★ Power requirements +24VDC +5VDC −5VDC Dimensions 4⅝" x 9½" x 14¼"

Supplied complete with technical manual **£395.00**

Hours of Business: 9 a.m.-5 p.m. Mon-Fri. Closed lunch 1-2p.m.
ADD 15% VAT TO ALL PRICES
Carriage and Packing charge extra on all items unless otherwise stated.

WW-201 for further details

Electronic Brokers is the largest specialist buyer and seller of used computers in Europe.

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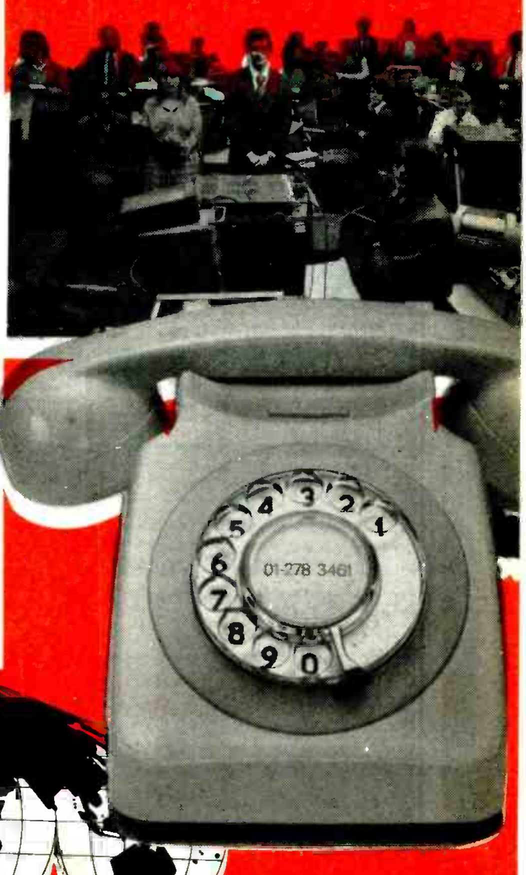
Our customers come from the fields of industry, education, research, government and general commerce. We have met their needs time and time again.

Whether your requirements are quick replacement, low cost development systems, additional capacity for existing equipment, or a cost-effective used configuration — we are only a phone call or telex away.

Call us on 01-278 3461 and speak to one of our skilled sales specialists familiar with your equipment needs.



Electronic Brokers Limited
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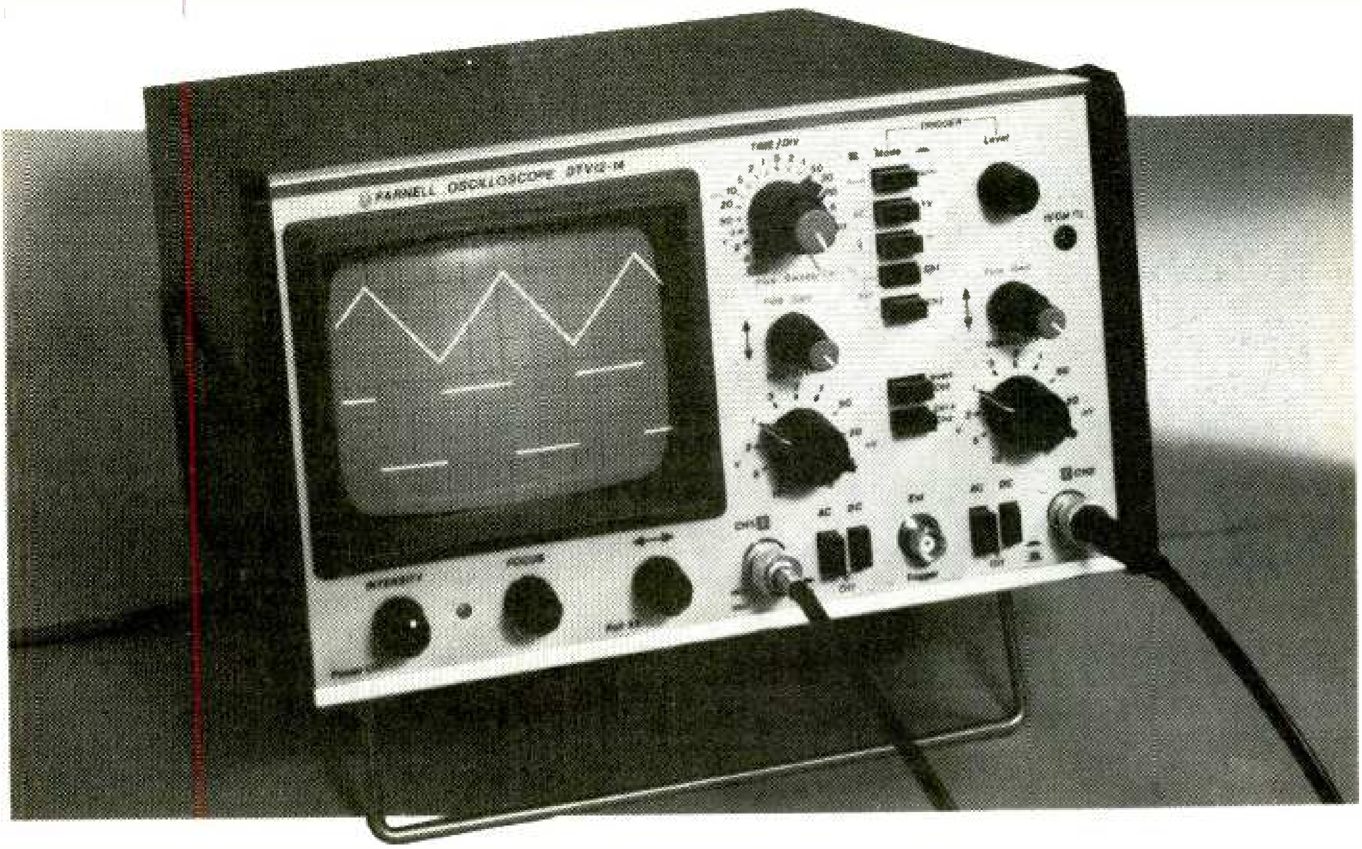

THE SMALLER 'SCOPE WITH THE BIG SCREEN

now has extra features (model DTV12-14)...

Fine sweep control | Fine gain controls | Invert channel 2
Sum and difference channels 1 and 2 | Fully passive attenuator

plus all the features of the DT12-5 model...

Large screen. Full 5'' diag. display. Internal graticule eliminates parallax error

Small size. Only 12'' deep x 11'' wide x 6¾'' high overall. Occupies little bench space. No need for trolley. Weighs only 15½lbs

Bandwidth d.c. to 12MHz

Sensitivity 5mV/cm to 10V/cm

Accuracy ±3%

XY mode. Horizontal signal via channel 1

Timebase .5us/cm to .5s/cm plus x5 expansion

Trigger internal from channel 1 or channel 2 or external. Internal TV frame or line. Auto ensures sweep in absence of signal

Calibrator output for probe compensation or Y amplifier calibration

Alt/Chop automatic

Send for details now to:–

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FARNELL INSTRUMENTS LIMITED

Farnell MADE IN GREAT BRITAIN

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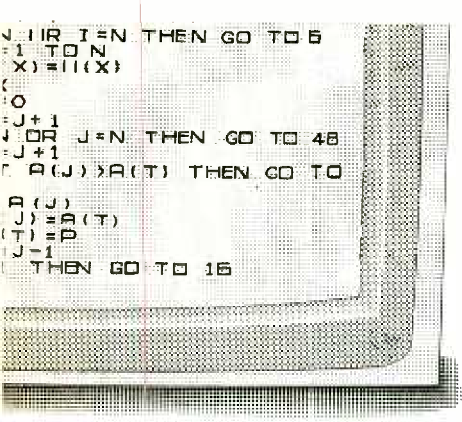
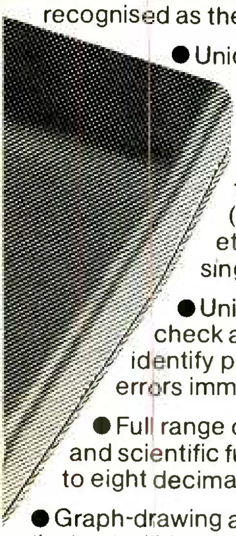


ew, improved specification

Z80A micro-processor – new faster ersion of the famous Z80 chip, widely recognised as the best ever made.



- Unique 'one-touch' key word entry: the ZX81 eliminates a great deal of tiresome typing. Key words (RUN, LIST, PRINT, etc.) have their own single-key entry.
- Unique syntax-check and report codes identify programming errors immediately.
- Full range of mathematical and scientific functions accurate to eight decimal places.
- Graph-drawing and animated-display facilities.
- Multi-dimensional string and imerical arrays.

Up to 26 FOR/NEXT loops.

Randomise function – useful for games well as serious applications.

Cassette LOAD and SAVE with med programs.

1K-byte RAM expandable to 16K tes with Sinclair RAM pack.

Able to drive the new Sinclair printer ot available yet – but coming soon!)

Advanced 4-chip design: micro-ocessor, ROM, RAM, plus master chip nique, custom-built chip replacing ZX80 chips.

sinclair ZX81

inclair Research Ltd,
Kings Parade, Cambridge, Cambs.,
2 1SN. Tel: 0276 66104.
g. no: 214 4630 00

If you own a Sinclair ZX80...

The new 8K BASIC ROM used in the Sinclair ZX81 is available to ZX80 owners as a drop-in replacement chip. (Complete with new keyboard template and operating manual.)

With the exception of animated graphics, all the advanced features of the ZX81 are now available on your ZX80 – including the ability to drive the Sinclair ZX Printer.

Coming soon – the ZX Printer.

Designed exclusively for use with the ZX81 (and ZX80 with 8K BASIC ROM), the printer offers full alphanumerics across 32 columns, *and* highly sophisticated graphics. Special features include COPY, which prints out exactly what is on the whole TV screen without the need for further instructions. The ZX Printer will be available in Summer 1981, at around £50 – watch this space!

16K-BYTE RAM pack for massive add-on memory.

Designed as a complete module to fit your Sinclair ZX80 or ZX81, the RAM pack simply plugs into the existing expansion port at the rear of the computer to multiply your data/program storage by 16!

Use it for long and complex programs or as a personal database. Yet it costs as little as half the price of competitive additional memory.

4

How to order your ZX81

BY PHONE – Access or Barclaycard holders can call 01-200 0200 for personal attention 24 hours a day, every day.
BY FREEPOST – use the no-stamp-needed coupon below. You can pay by cheque, postal order, Access or Barclaycard.
EITHER WAY – please allow up to 28 days for delivery. And there's a 14-day money-back option, of course. We want you to be satisfied beyond doubt – and we have no doubt that you will be.

To: Sinclair Research Ltd, FREEPOST 7, Cambridge, CB2 1YY. **Order**

Qty	Item	Code	Item price £	Total £
	Sinclair ZX81 Personal Computer kit(s). Price includes ZX81 BASIC manual, excludes mains adaptor.	12	49.95	
1	Ready-assembled Sinclair ZX81 Personal Computer(s). Price includes ZX81 BASIC manual and mains adaptor.	11	69.95	69.95
	Mains Adaptor(s) (600 mA at 9 V DC nominal unregulated).	10	8.95	
	16K-BYTE RAM pack(s).	18	49.95	
	8K BASIC ROM to fit ZX80.	17	19.95	
	Post and Packing.			2.95

Please tick if you require a VAT receipt ☐ **TOTAL £** 72.90

*I enclose a cheque/postal order payable to Sinclair Research Ltd, for £ ______

*Please charge to my Access/Barclaycard account no. ______

*Please delete/complete as applicable. Please print.

Name: Mr/Mrs/Miss ______

Address ______

FREEPOST – no stamp needed. WRW06

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Mura

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

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

For only £89 + VAT
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 £125
Carriage and insurance £3.00
A handsome soft carrying case is included (this model only)

OFF THE SHELF DELIVERY ON THESE

FLUKE®

DIGITAL MULTIMETERS

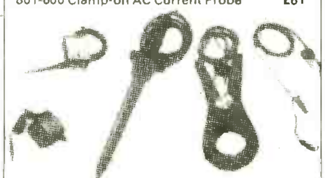
BRAND NEW FROM FLUKE!!!
NOW AVAILABLE
THE 8024A HAND HELD DMM

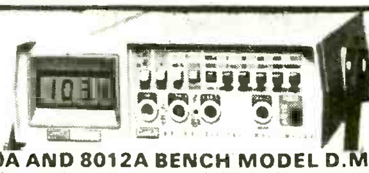
This model incorporates all the features of the 8020A but in addition has:
- A peak hold switch which can be used in AC or DC for volts and current functions.
- Audible continuity testing and level detection for sensing logic levels.
- A temperature (°C) range for use with a thermocouple. **£155**

Carriage and Insurance £3

The following accessories are in stock now

Y8008 Touch and Hold Probe	£29
80K-40 High Voltage Probe	£51
81RF RF Probe to 100 MHZ	£35
80T-150C Temperature Probe (C)	£66
801-600 Clamp-on AC Current Probe	£61





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

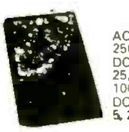
The 8010A is a general purpose, bench/portable digital multimeter with more functions and features than ever offered for such a low price. Its companion, the 8012A, has identical characteristics except that it has two additional low resistance ranges, 2Ω and 20Ω to replace the 8010A's 10 ampere current 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 £167 **8012A £218**
Carriage and insurance £3
The 8010A is also available with two rechargeable Nicad size C batteries installed in option 8010 at £193.00.

LOW COST, AUTORANGING MULTI-FUNCTION COUNTER MODEL 1900A

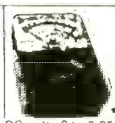
- Autoranging in both frequency and period measurement modes
- Wide Frequency range —5 Hz to 80 MHz
- High sensitivity —25 mV, typically 15 mV
- Six digit LED display with leading zero suppression, automatic annunciation and overflow
- Optional internal battery pack providing 4 hours continuous operation
- Autoreset on all gate times, all function switches
- Four manually selected gate times providing resolution to 0 1 Hz
- Event counting to 10^6 events with overflow indicator
- Signal input conditioning with switchable 1 MHz low pass filter and attenuator
- Rugged moulded case with convenient tilting/carrying handle
- Optional parallel data output with decimal point and annunciation
- Traditional high Fluke quality
- Self check

£235 Carriage and Insurance £3



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, 250mA.
Resistance 0.3k ohms, 300k ohms, 3 meg ohms.
Decibels −20 − +63dB
Dims 127 × 90 × 32mm.

£14.95 (inc. VAT)
P&P £1



TMK500
30,000 OPV
A sturdy and reliable instrument. Has internal buzzer
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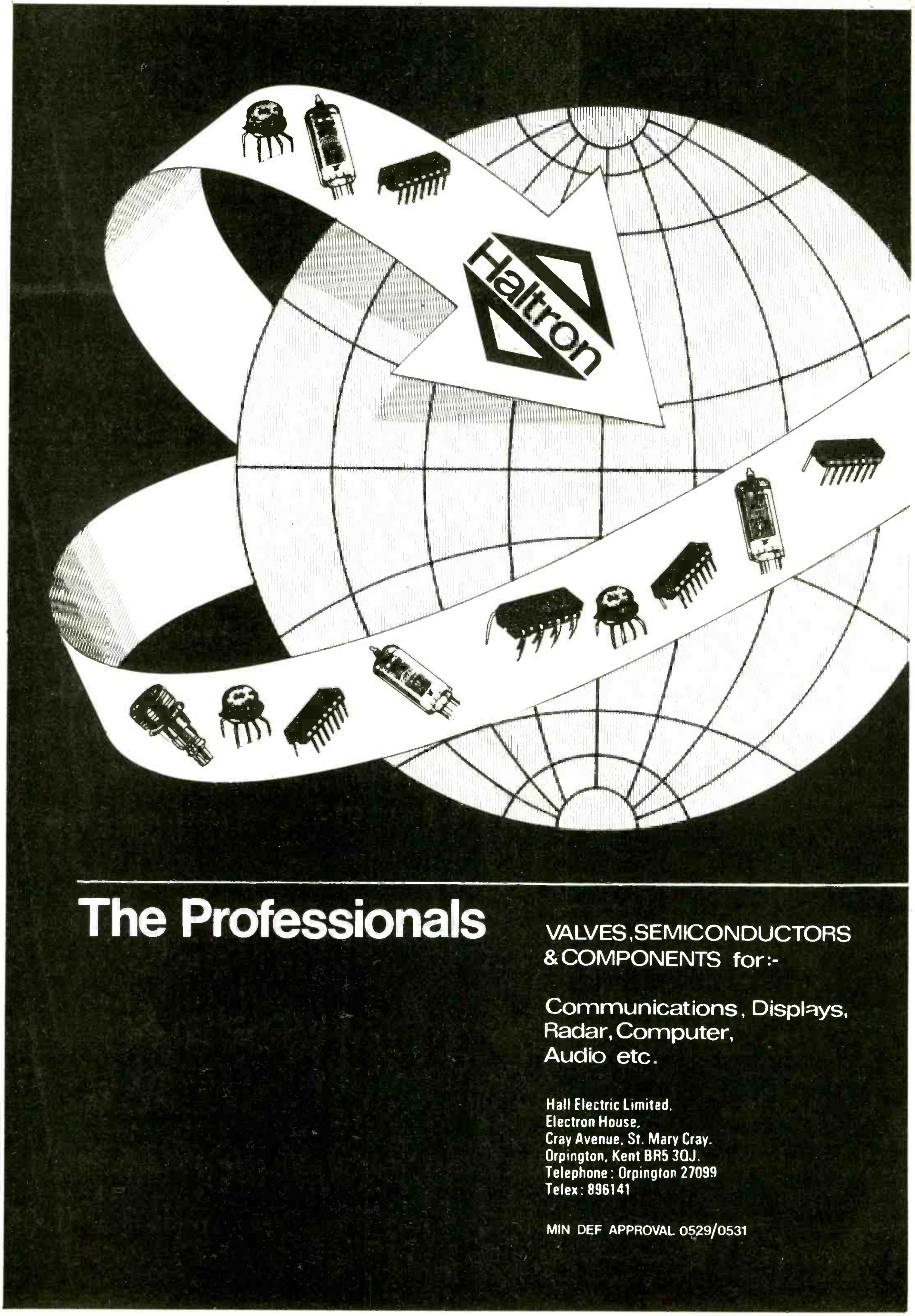

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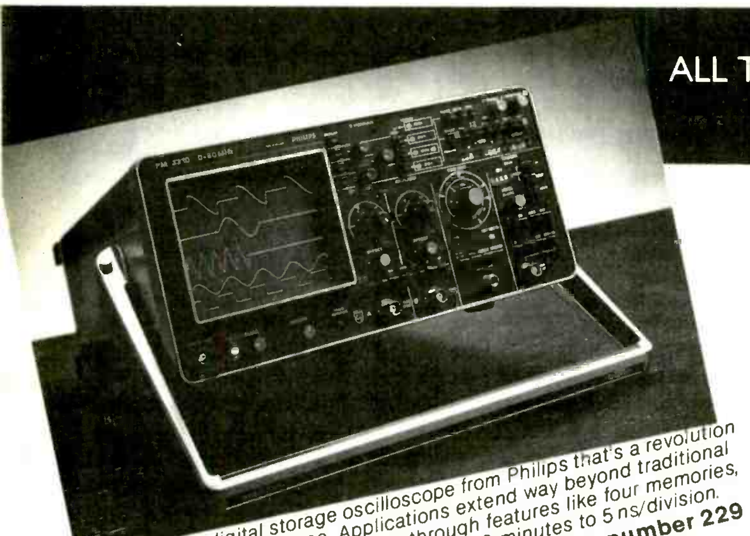

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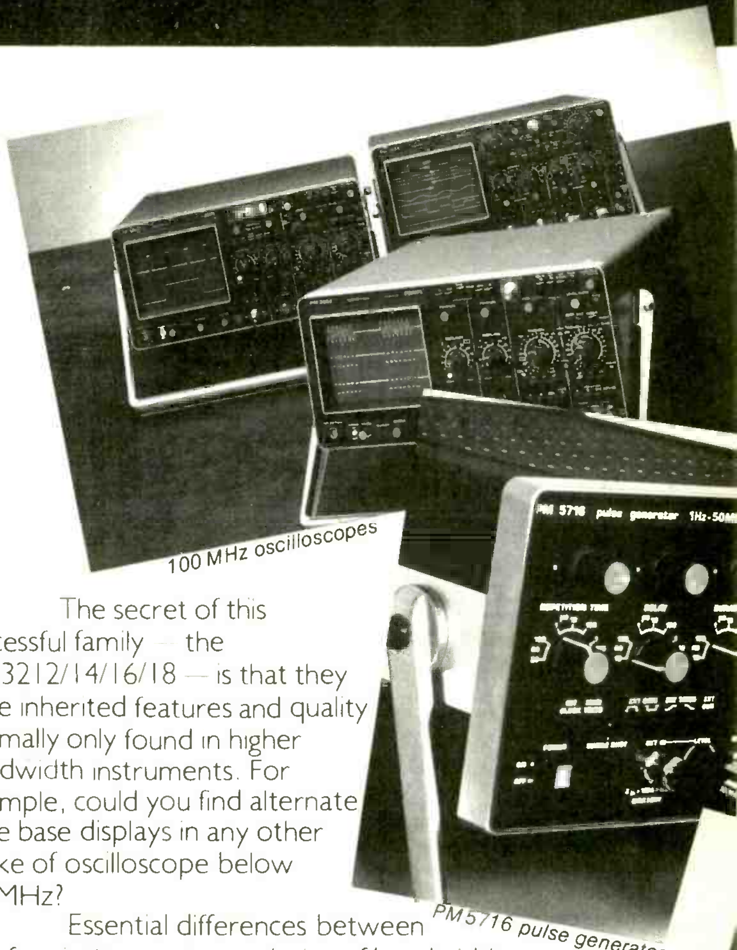

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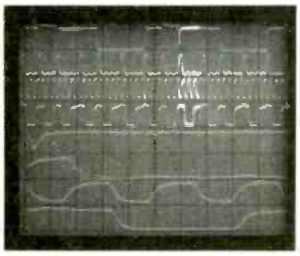

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Those whose fears have been raised or augmented by recent television and press comment on the alleged prevalence of telephone tapping by police and government officers will not find much for their comfort in Lord Diplock's report on the interception of communications. It is a bland, uncritical and evidently unreasoned assertion of satisfaction that the existing procedure for the authorization of official interception, mainly of telephone traffic, is adequate. The report says that random checks have shown that the public's right to privacy is protected in practice, as well as in theory, but does not mention the ways in which the checks were made or, indeed, how many checks were made. It is not concerned with unofficial interception, and was not asked to be.

Whatever the eventual effect, apart from the signing of Council of Europe Conventions, of Sir Norman Lindop's report on data protection, and notwithstanding Lord Diplock's glow of satisfaction, there is a widespread belief in the public mind that much telephone tapping and misuse of computer data takes place without the knowledge of responsible officials. There is also a nagging suspicion that such activities are virtually impossible to prevent.

The suspicion is very probably well founded. It is a common delusion amongst those in administrative cocoons that the executive arms of their organizations carry out their functions with the 'book' in one hand and the other at the salute. Clearly, such a posture makes it extremely difficult to do anything very constructive and is frequently abandoned in favour of a more practical approach. Regulations imposed by administrators are often so at odds with reality that they must be unofficially modified in the light of common sense. They are also, of course, ignored completely by persons of nefarious intent.

It is the organization that employs complicated equipment, difficult for the untrained to understand, that is most vulnerable to uncontrolled operation. A piece of information lodged in a large computer could be impossible to find if an accomplished operative wished to prevent its retrieval. Similarly, if it were required to destroy certain information – at the request of a member of the public, for example – it would hardly be possible to ensure that the data really was destroyed. The adoption of the new System X telephone system will make telephone tapping a matter of software manipulation and control by remote computers: audit trails and access logs may exist, but it seems unlikely that determined rule benders would be indefinitely foiled.

A data protection Act and some kind of legislation to reduce authorized telephone tapping and stop the illicit kind would possibly go some way towards easing the doubts that exist in the public awareness – fears that the gathering and storing of data is becoming so efficient that a bureaucracy with enormous power is coming into being almost unnoticed. But, since there could be no certain way of checking that protective legislation was being complied with, such enactments would provide no permanent solution.

Ultimately, the use of computers and data storage has to be entrusted to trained operators and technical people. Their work could be checked by trained supervisors, who in turn might be subject to the scrutiny of more supervisors but, at some point, all these people have to be trusted not to misuse data for their own, or more sinister purposes. There must be a stage at which an untrained politician or administrator asks to be assured that all is well – and he will take the answer on trust, for he will have no choice.

There is no way out of this problem. Computer memories grow larger, and usually faster, and information gathering techniques become more efficient every year. We cannot prevent the expansion of personal information storage to the ultimate degree, where free text retrieval systems provide collated information about every facet of our lives.

The future of free societies does not, from here, seem safe from attack.

Millivoltmeter with l.e.d. display

Rapid-response, peak-reading instrument for 0-30kHz

by **D. H. E. King,** M.I.E.R.E.

If one owns an oscilloscope it is easy to measure small voltages and waveforms from zero to audio frequencies. The rather less expensive millivoltmeter, whether having a moving-pointer or digital display, suffers from a slowness of response and the calibration is either r.m.s. (assuming a purely sinusoidal waveform) or peak-reading, this often being waveform dependent. This instrument occupies the gap between the conventional voltmeter and the oscilloscope to indicate peak voltages, and consideration was given to speed, size and cost, though not necessarily in that order. The recent availability of 'bar/dot l.e.d. driver' i.cs has simplified the design and package quantity considerably.

The aim was towards a single-dimension oscilloscope-type display with the following points:

- battery operation, minimum consumption, portability
- four to six vertical (or 'Y') divisions
- a dot rather than a bar display
- the 'zero' dot to be fully adjustable, over-travel not causing disappearance or extinction of the dot
- a maximum sensitivity of 10mV/div., range variations being in a 1-2-5 ratio
- an input impedance (resistance) approximately 1MΩ on all ranges
- the amplifier input to be a.c. or d.c. coupled, or earthed for zero setting
- a calibration waveform, 1V peak-to-peak, to be available.

A resumé of the dot/bar driver i.c. may be useful to some readers. The dual 9-pin package of Fig. 1 has ten outputs; pins 1 and 10-18 drive the ten l.e.ds from a nominal 5V supply. Between pins 4 and 6 is a string of ten resistors (nominally 1kΩ each) from which are fed the reference voltages to the ten comparators, their common input being taken from pin 5, the 'signal' voltage input pin. As this voltage is increased, the l.e.ds are energized in turn; pin 9 will be connected to select only a dot display. From pin 7 is available an on-chip reference voltage of about 1.25V, the current passing to zero or chassis via a resistor that also defines the l.e.d. current(s) when lit. The 1.25V reference voltage may be made to ride or 'sit' upon any voltage impressed upon pin 8 but in this instance the pin will be connected to zero. The positive

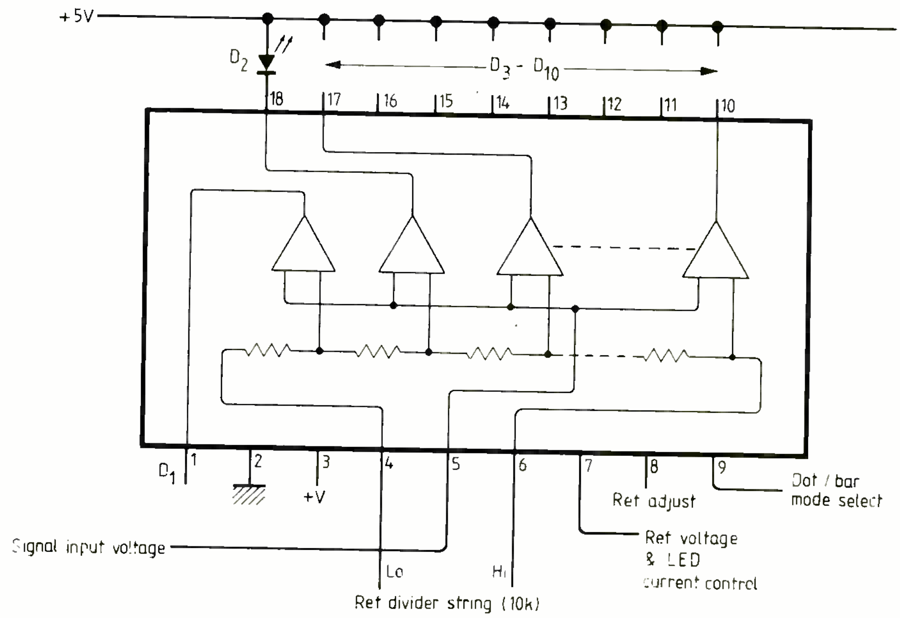


Fig. 1. Working of LM3914 dot/bar driver i.c.

supply to pin 3 needs to be no greater than 6V for this application, although, if a large signal voltage is to be displayed, and so require a large voltage at both inputs and feeds to the comparators, then up to 15V might be needed.

Two 'chained' dot/bar drivers will allow 20 l.e.ds to be employed, giving four divisions, at five l.e.ds per division. Up to ten driver i.cs could be used if more divisions are desired but the string of l.e.ds could easily become unwieldy and would give little benefit in terms of brilliance or upper frequency limit of the instrument. A little thought shows that a conventional scale marked 1-10 has also a '0' digit or mark, a total of *eleven* points. The two drivers give twenty points but *no* zero; an external comparator therefore is used with this design to observe when none of the '1-20' l.e.ds are lit and then to energise the 'zero' or 'off-scale' l.e.d.

If the potential divider strings of the dot/bar drivers are connected in series and pin 6 of IC_2 is connected to pin 7, as in Fig. 3, the overall sensitivity of the basic 20-l.e.d. scale is 1.25V. For the suggested 10mV/div. (which could easily be amplified to 1 or 2mV/div. if required) at maximum sensitivity, the 10mV input must be amplified to drive one-quarter of the divisions within the 1.25V span, i.e. to about

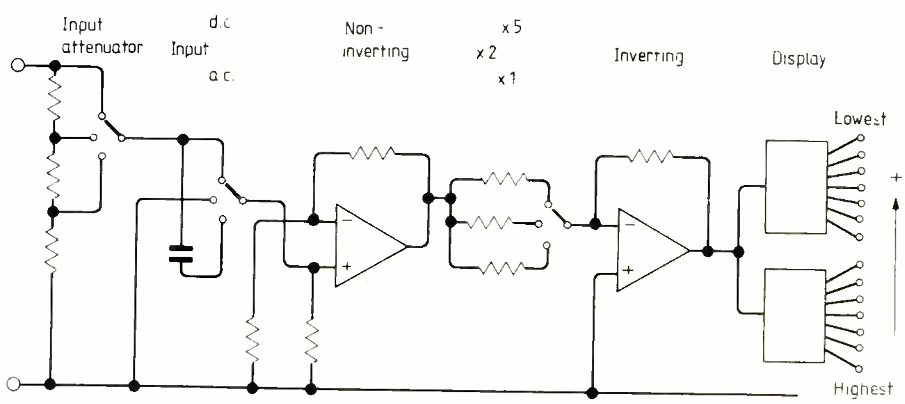


Fig. 2. Block diagram of millivoltmeter.

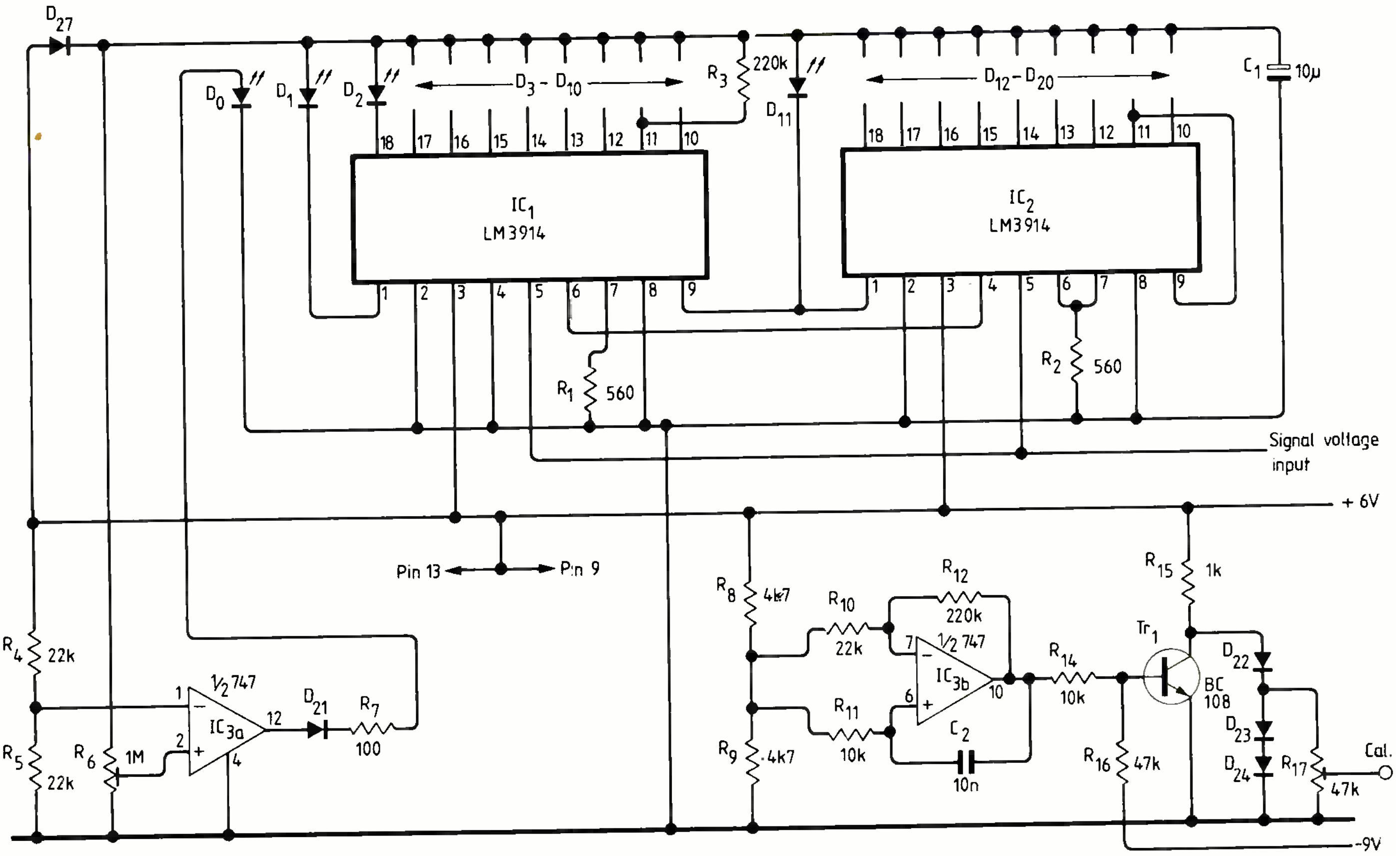


Fig. 3. Display circuit and calibration oscillator (IC_{3b} and Tr_1).

320mV. Thus a gain of only 32 is needed and to avoid problems with the gain-frequency product of a single-stage op-amp. it was decided to employ a dual op-amp, a f.e.t. input avoiding input damping problems. Although the input offset voltage for a type LF353 is quoted as 5mV and there are no nulling pins fitted, no problems were encountered using the overall gain needed of about 32. The gain of a single stage is about six; the first stage has a set-gain control at the front panel while the second stage has gains selected in the ratios ×1, ×½, ×1/5 by a 3-position front panel switch. In conjunction with the 1-10-100 etc. 6-position attenuator the input voltage sensitivities thus match those of a typical oscilloscope's 1-2-5-10 ratios.

The simplified diagram of Fig. 2 shows that there is an overall inversion of polarity between the input and the dot/bar drivers; a positive-going signal could thus produce a display with the dot travelling 'downwards' and care must be taken to get the l.e.ds in the correct order on the front panel if the 'positive-upwards' convention is expected. The voice of experience speaks here – between back and front of a p.c.b., then back and front and top or bottom of a control panel there is needed a mental agility that sometimes falters – my face matched the red l.e.ds!

Circuit design

The display drivers in Fig. 3 are shown virtually as they appear on strip- or matrix-board, a very simple interlinking with only three resistors allowing power to ge applied early on in the construction and a variable signal voltage then causing the dot to move smartly along the row of l.e.ds. The brightness of any l.e.d. is determined by the current flow and this is programmed by the values of R_1 and R_2 at pins 7; for about 10mA use 1kΩ values, for 20mA use 500Ω and so on. (If a bar display were used the battery consumption would be considerable.)

The 6V supply from four 1.5V cells is used to feed most circuits and the PP3 9V is only needed for a negative feed to the signal amplifier op-amps. A 6V oscillator/rectifier system was considered and tried for the negative supply but the large physical size, cost and the low efficiency proved the PP3 type to be preferable. The 6V is reduced to the nominal 5V for the 1-20 l.e.d. feed by the series diode D_{27} and the reduction in volt-drop across D_{27} when none of these l.e.ds is lit is used to drive the comparator IC_{3a}; when pin 2 is 'low' the output at pin 12 is around +2V and insufficient to cause current flow via the

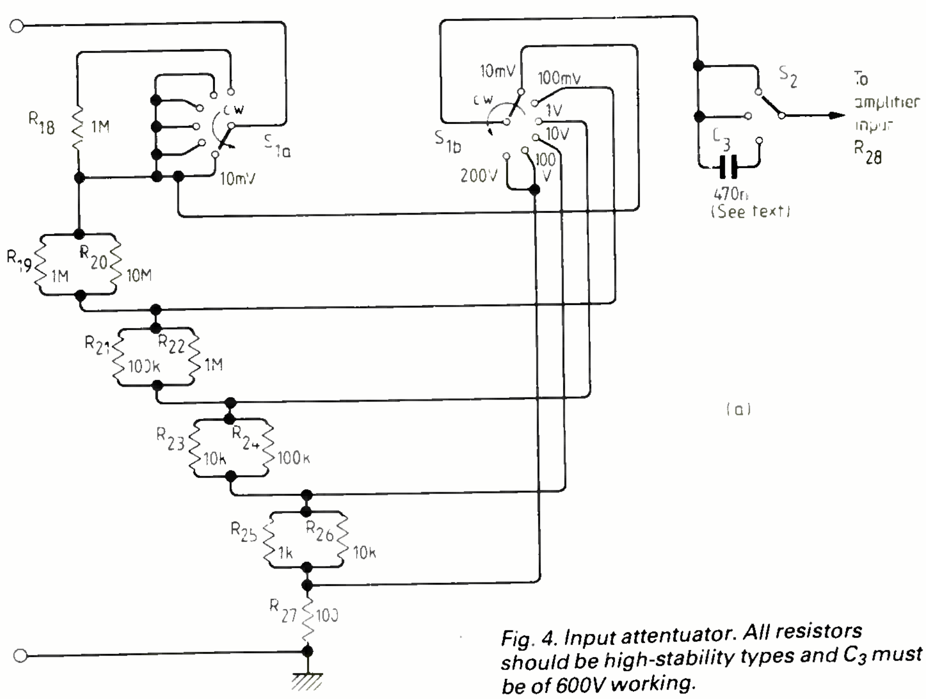


Fig. 4. Input attentuator. All resistors should be high-stability types and C_3 must be of 600V working.

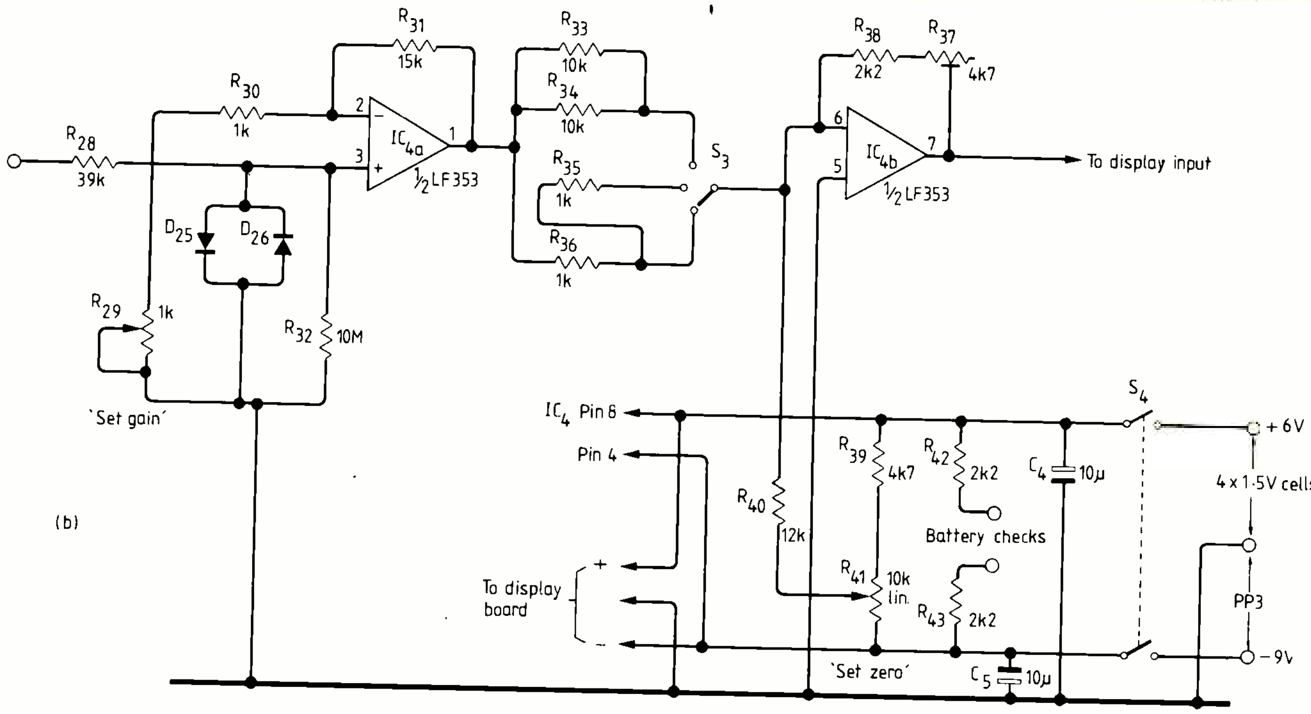


Fig. 5. Signal amplifier. Resistors R_{30} to R_{40} are of high-stability, and R_{41} is a linear, wirewound, 1W component.

2.6V needed across D_0 and D_{21}. With a 'high' pin 2, the output is about +4V and D_0 lights.

The calibration square-wave is generated at about 1kHz by IC_{3b}. Driving Tr_1 fully off and on results in the saturated collector voltage being nearly, but not quite, zero; D_{22} removes this small $V_{CE(SAT)}$ when zero voltage is placed across R_{17}; when Tr_1 is not conducting, then D_{23} and D_{24} act as a simple (1.2V approx.) voltage regulator system, allowing a 1V peak-to-peak voltage to be preset and available at the calibration socket, truly referred to zero.

For the input attenuator in Fig. 4, 'standard' values are used in a series-parallel arrangement; 10kΩ shunted by 100kΩ is often a more convenient way of obtaining 9.1kΩ rather than trekking from dealer to dealer for the elusive 9.1kΩ value. Since I have some interest in back e.m.fs generated by inductors, a 200V/div. position was added, but any constructor must recognise that the apparent ability to display voltages with scale factor of 200 × 5, i.e. 4kV for a full-length display, would severely stress insulation and circuitry and also constitute a hazard to one's own health and safety. Label the 100V and 200V switch positions in red and use sparingly and carefully.

The appropriately attenuated input voltage is fed in Fig. 5 via R_{28} to IC_{4a}, D_{25} and D_{26} only conducting in the event of an over-large input voltage. When a.c. coupling is selected by S_2, R_{32} allows the input of IC_{4a} to be referred to zero without seriously affecting the instrument input resistance. A large value for C_3 allows frequencies of down to 0.05Hz to be displayed with an a.c. coupling, but the instrument does then need some time – 10 seconds or so – for the display position to stabilize, due to the large time-constant involved. The value of C_3 may, of course, be reduced say to 0.01µ for faster settling and an a.c. response still adequate down to about 2Hz.

The signal amplifier is both tame and simple, no special precautions apart from reasonable tidiness and spacing being used in the prototype; tantalum supply-line decoupling capacitors were added as a routine provision rather than as a necessity, while R_{42} and R_{43} ensure that the batteries are short-circuit-proofed against careless use of the battery-check facility.

Display frequency and accuracy

The upper frequency limit is not wonderful at first sight, being limited to around 20-30kHz. Brief calculations show that a 20kHz sine-wave occupies only 50µs per cycle, a half-wave only 25µs and in this time a display of a ten-l.e.d. stripe, (up *and* down for the half-wave) would allow only some 1µs or so per l.e.d. flash, apart from the waveform peak, which might be expected to be on for a little longer and hence to produce slightly brighter 'tips' for a sinusoidal display. The comparator op-amps within the display driver i.c. are obviously approaching their frequency and slew-rate limits at about 20kHz and only if the instrument voltage sensitivity is reduced is it possible to hope for a reasonable display accuracy at the higher frequency of 30kHz.

The accuracy of voltage indication d.c. or a.c., is of course determined by the number of segments or increments per voltage level, and at 1V/div. there are only five points of light to define the levels – a basic accuracy (or inaccuracy) of 0.2V in one volt is the best that may be hoped for – ±10% of the input sensitivity. If all 20 l.e.ds are in use *and* the scale linearity is good the accuracy is better; linearity requires that the divider string of resistors in IC_1 has the same value as that in IC_2. If an a.c. display length of, say five l.e.ds appears to expand or contract in being moved by means of the set-zero control from one end of the display to the other it is possible to adjust the overall scale linearity by a trial-and-error shunting of pins 4, 6 of either IC_1 or IC_2 with a resistor, possibly 100kΩ or so.

Construction

The low gain and simplicity of the circuit gave no stability problems; the original layout used strip- or matrix-board attached at right-angles to the front panel, so that both sides of the circuit were available for checking, preset adjustments and connexions to the various controls. Separate 'display' and 'signal' boards were constructed and then linked during assembly beneath the panel. The box and panel were of plastic to allow easy drilling and insulation although no screening. Whatever size container is selected, lay out the panel carefully for minimum wiring lengths. Internal screening may be fitted after calibration. Resistors of 1MΩ and over should be 0.5W types and R_{28} must be a 1W carbon component; all the rest can be 0.25W resistors. D_2 should be a 1N4000; D_{21}-D_{26} can be small silicon junctions such as OA202, 1N4000 or emitter-base junctions of BC108.

Setting-up and use

This, assuming careful construction, requires only a d.c. voltmeter and a 1.5V cell. You will already have checked that the set-zero control is able to move the spot up and down the scale; monitor the signal input to the display, at pins 5 of IC_1 and IC_2, and set this voltage to zero or even slightly negative. Adjust R_6 so that D_0 is lit and satisfy yourself that it extinguishes when any other l.e.d. is lit.

Connect a 500Ω-to-5kΩ potentiometer across a 1.5V cell, and set the control to produce 1V as accurately as your voltmeter will allow. Apply this voltage to the instrument input terminals and, with R_{29} (front panel) set to about mid-value, the sensitivity set to 1V/div. and ×1, adjust R_{37} (internal) for a one-division jump of the lighted l.e.d. when the input is switched on or off, or if S_2 is changed from 'd.c.' to 'earth'. Check that the operation of S_3 is as expected; the same 1V input will give a two-division jump of the display if the input is set for 100mV ×2 sensitivity.

The calibrated display may be used to adjust R_{17} to provide a 1V peak-to-peak voltage at the CAL socket. A d.c. voltmeter will indicate some 0.5V (average) at this socket but no especial care has been taken to provide a 1:1 mark: space ratio, so the voltmeter may not quite agree; this is probably not important in view of the previously argued accuracy that is available. A side effect or use that was not envisaged but has since been turned to advantage is the availability of the CAL 1kHz waveform via an attenuator and waveshaping capacitor as an amplifier input signal. The output voltage in Fig. 5 is of course simply monitored by the voltmeter both at the amplifier input and on its way through.

The instrument has proved most useful for observing the output voltage of microphones and pick-ups, the hum levels in power-supply circuitry and assorted other small signals that would otherwise demand the use of the writer's rather hefty and immovable oscilloscope. The isolation from the mains supply inspires confidence when measuring the effectiveness of coupling and decoupling capacitors in suspect equipment and, as with an oscilloscope, there is freedom from worry about pointer-bouncing should the wrong range have been selected. With an input diode and capacitor the instrument is preferable to a moving-coil type for r.f. detection and alignment purposes, due to the sensitivity and speed of response, and with correct choice of capacitor the modulation can be seen riding upon the detected carrier of an a.m. signal. The ability to use a centre-zero voltmeter is a boon in many circuits employing the typical +/0/− type d.c. supply, again due to the indication speed.

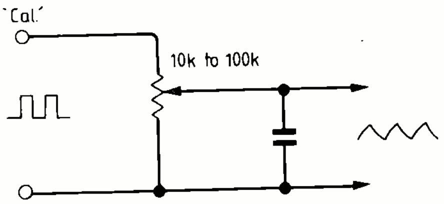


Fig. 6. Use of the Cal. waveform as amplifier test signal.

Experience allows some interpretation of the input waveform from relative brightness levels; sinewaves have slightly brighter tips than the main length; triangle or ramp waves have evenly distributed brilliance; pulse or square waves produce only high and low dots although the relative brilliance of these allows some idea to be gained of the mark-space ratio. Waveforms taken from coils where transients might be expected, as with s.c.rs or some power supplies, may need virtual darkness ar at least good shading of the display if the peak voltages are to be observed; do not expect the display to compete with bright lighting or sunlight – an oscilloscope trace cannot cope, either!

The prototype has given many hours of useful operation and appears only to suffer from calibration errors if the +6V and −9V supplies droop to 4V or 6V respectively, showing this to be a pleasingly economical circuit.

Finally, do consider safety. The mains supply does indeed produce a 700V peak-to-peak indication but the majority of exposed-metal components at the front panel will *not* have this high insulation or working voltage. Switch off the mains to the apparatus under test; connect the l.e.d. display voltmeter, selecting sensitivity range; switch on the mains; do not touch whilst observing; switch off the mains before adjusting or altering controls. These precautions must be observed with high-voltage work; otherwise use the instrument as you would any other voltmeter.

BOOKS

Mini and Micro Computers, by Fabian Monds and Robert McLaughlin. 144pp, paperback. Peter Peregrinus, £9.00.

As an introduction to small computers and their use, this book, which is published by the Institution of Electrical Engineers, could hardly be improved upon. A tutorial style is adopted, and readers with no experience of either electronics or computing are led from an explanation of the word 'bit', by way of descriptions of several commercial systems, to the elements of computer peripherals, interfaces and software. The final chapter takes the form of a short course on programming in BASIC.

The authors are both at the Queen's University of Belfast and have written the book against a background of teaching computing. It stands out from an abundance of small books for which similar claims are made, and is recommended.

Tape Music Composition, by David Keane. 159pp, paperback. Oxford University Press, £5.95.

Despite its title, and the author's insistence that he has written on the *use* of sounds as well as their method of generation, this book is principally about the technique of using tape recorders to produce sounds which can be used in composing electronic music. Taken in this light, the book is of considerable value. It is addressed to those with no technical knowledge of recording equipment and develops into an easily readable guide to most of the techniques used, in detail but without delving into electronic technicalities. All the mechanical tricks of handling tape, microphones and recorders are explained, and there are chapters on mixers and various types of sound processing device. Sound synthesis is dealt with quite briefly, and there is a short piece on setting up a studio. The one chapter on 'basic aesthetic considerations' occupies fifteen pages.

Electronic Manufacturers UK. 462pp, paperback. David Rayner, £55.50.

Eurolec 56 is the latest in the long series of guides to the electronic industry, now compiled by microcomputer. It covers the makers of electronic equipment in the UK, excluding those who make electronic instruments. The listing is alphabetical by company name, and each entry contains much detail on company make-up, products, staff and related organizations.

The use of Rayner's own program for the compilation may be responsible for the confusing appearance of the pages: they are quite difficult to scan and contain rather a lot of redundancy which could, perhaps, have been reduced by abbreviation. Nevertheless, the listing appears to be thorough and presents a great deal of information which is often difficult to obtain in a convenient form. There are no indices in this edition.

Sound Recording, by David Tombs. 222pp, hardback. David and Charles, £7.95.

Mr Tombs is a sound recordist with the BBC Natural History Unit and is therefore concerned professionally with the operation of recording equipment, rather than with its engineering. This book is not, however, for professionals, but is intended for the amateur who wishes to use quite simple equipment in a creative way.

Chapters on microphones and recorders are useful guides through the confusing mass of published data, describing the main types of instrument in use, with their characteristics. Recording in stereo is allotted a chapter and in four succeeding sections the author presents practical information on the recording of talks and interviews, drama, music and wildlife. The final chapter describes the home studio, the selection of equipment, processing and editing.

This is a completely 'practical' book on the subject. Technical descriptions of the equipment are maintained at a level where they can be easily understood by the layman, and are only introduced where necessary. The author points out that it is not necessary to spend a fortune on hardware, and emphasizes that the choice and use of microphones, with a few tricks used by professionals to avoid unwanted sounds, is much more important than expensive machinery.

WORLD OF AMATEUR RADIO

Dead as a triode?

A problem that increasingly faces anyone who attempts to provide technical information for newcomers to amateur radio is to decide what attitude to take towards the thermionic devices that so many of us grew up with – and, at least on the h.f. bands, are still used in the vast majority of amateur stations. Several years ago, thermionic devices were expunged from the Radio Amateurs' Examination and already there must be some thousands of v.h.f. enthusiasts who have forgotten, if they ever knew, the relative simplicity of valve circuitry used for the generation of r.f. power; and also the ease with which fault-finding could be carried out and new valves substituted when emission began to sag. They may also have never become aware of the dangers of high d.c. potentials. For them, diodes and triodes may seem old-hat and as dead as a dodo. They would point out that while solid-state devices have no inherent wear-out mechanisms, a thermionic device shows a progressive change of characteristics from the moment electrons begin to be torn from its cathode.

Curiously, in practice, even today, valved equipment often proves more reliable than solid-state: it is so easy to kill off r.f. power transistors from over-voltages, from mismatched loads, from parasitic oscillation. A recent 'owners' report' (*Ham Radio*, March 1981) on the long-established Collins KWM2 and KWM2A h.f. transceivers – a valve equipment designed in the late 1950s – shows that virtually every owner of these admittedly fairly high-cost equipments praise their remarkable reliability: some 37 per cent of owners listed this as its best feature, while 25 per cent praised its stability (a characteristic so often claimed for solid-state rigs).

Reading through the comments makes one wonder just what the amateur (with a domestic h.f. station) has really gained from the 'silicon revolution' except the ability to make lightweight, portable equipment for mobile and portable operation. An Australian amateur, Al Rechner, VK5EK has recently commented: "Good applied engineering is concerned primarily with securing a stipulated design objective in the simplest and cheapest manner". He severely criticises the current rash of complex, solid-state constructional projects as, in some cases, "solid-state technology gone berserk" adding that such technology: "affords commercial manufacturers cheap, large-scale production and is ideally suited to logic and non-linear applications. But for transmitters, transverters, receivers and converters of practical simplicity, valves remain incomparably superior for one-off, home-built projects." He firmly believes that more amateurs could be encouraged to return to the idea of building their own equipment if more simple projects were presented in the journals and other periodicals, for example using valves and components still readily available when salvaged from old television receivers, etc. The problem is that, rightly or wrongly, many amateurs are firmly convinced that valves will become virtually unobtainable except at "collectors' prices" in a very few years' time.

Here and there

An amateur radio link between Gavin Payne 5N3PJR in Nigeria and Bob Cox, G3PLP in Solihull led to the urgent air-freighting of a rare drug to Lagos for a woman who had had a miscarriage. The drug was not available in Nigeria but Bob Cox passed the message to his local police who, once satisfied there was a real requirement for the drug, with the help of a local priest, traced a supply in Elstree, Hertfordshire. The Metropolitan police arranged helicopter transport to Gatwick where it was put on a scheduled British Caledonian flight whose departure had been held for 25 minutes.

Australian amateurs are being urged by the Region 3 Intruder Watch to write to Radio Peking complaining of the high-power broadcast transmissions by the Chinese within the frequency band 7000 to 7100kHz, drawing attention to Resolution CR of WARC 1979: "that the broadcasting service should be prohibited from the band 7000 to 7100kHz and that the broadcasting stations operating on frequencies in this band shall *cease* such operation". The new Radio Regulations come into force next January and it is believed that the Radio Peking management is becoming sensitive to such complaints.

Two Canadian amateurs, VE3QB and VE3PD, using the 'commercial' callsigns VE9LFZ and VE9LIN have been specially authorised to operate daily on 10,101 and 10,149kHz, near the edges of what will become the new "30-metre" amateur band next January.

The RSGB has announced that the society will continue to bring to the attention of the Government the problems associated with the licensing of 27MHz for citizens band (though it considers the choice of frequency modulation is the right one). Concern is expressed that a.m. equipment and high power amplifiers will continue to be used and will give rise to significant levels of interference to domestic entertainment equipment.

Contests with a purpose

While one certainly hears criticisms of the way in which so many weekends on the amateur bands have degenerated into mindless swapping of contest serial numbers (of which the RST report is now almost invariably 599 no matter how strong or weak the signals) there are still a few contests that genuinely encourage the development of novel equipments and/or skills. Among these must surely be included the long-established "Swiss National Mountain Day" in which a complete 3.5MHz station, including batteries and aerial, has first to be man-handled many metres up the Swiss Alps, so that weight is all important. A recent design by Urs Hadorn, HB9ABO and Urs Lott, HB9BKT has got the weight down to a remarkable 300g (just over 10oz) made up of: transceiver (including earpiece) 113g, batteries 78g, and aerial (84m wire delta-loop with carrying frame) 109g. Some thirty years ago, the NMD rules (for valve equipment) specified a total weight of not more than 6kg. The winning station in 1950 (HB9J) used six miniature (B7G) valves, split three each for transmitting and receiving); operating from a height of 1800m, of which the final 300m had to be made on foot, some 26 contacts were made. From almost 6kg down to 0.3kg is a measure of the advantages for portable operation with a handful of transistors having no power-consuming filaments!

The American magazine *Ham Radio* is attempting to revive the idea of a "world championship" to discover a Morse operator capable of challenging the 40-year-plus record of Ted McElroy, ex-W1JYN. On July 2, 1939 he copied Morse on a typewriter at a speed of 75.2 words per minute. I feel it will take some doing to beat this record.

In brief

UK FM Group members have been unlucky recently: soon after the loss of the West London repeater station to thieves, two transceivers and other equipment were stolen from members' cars during one of the Group's regular meetings in the West End of London . . . The RSGB National Amateur Radio Exhibition is at Alexandra Palace, north London from May 28 to 30 . . . Forthcoming mobile rallies include: May 24, East Suffolk Wireless Revival, Ipswich and Plymouth Radio Club Rally (Tamar Secondary School, Paradise Road, Stoke near Plymouth); June 7, Hull University; June 14, RNARS 21st Birthday (HMS Mercury) and Elvaston Country Park; June 21, Shelley High School, nr Denby Dale.

PAT HAWKER, G3VA

Designing with microprocessors

8 – Interrupt-driven circuits

by **D. Zissos** Department of Computer Science, University of Calgary, Canada

Because mistakes in real-time applications are becoming progressively more costly, in both human terms and equipment, it is necessary for systems to be sensitive to their environment if timely action is to be taken to avoid catastrophe. The use of interrupts allows the designer to build into his system varying levels of sensitivity to the environment. This and the following article describe the basic concepts and step-by-step procedures for the design and implementation of interrupt-driven circuits.

In the mode of operation described here an external event signals the microprocessor that it wishes it to suspend execution of its current program and to execute instead a different set of instructions, at the end of which the interrupted program is resumed. This is analogous to a subroutine call, except for the fact that the execution of a different set of instructions is evoked not by the current program but by an external event. To allow the program to be resumed correctly after the interruption, all the information belonging to it, program counters, register contents and states of flags, which are collectively referred to as **the re-entry point**, must be preserved during the interruption.

Interrupt-driven systems are mainly used in real-time environments, where predetermined responses to certain events must be evoked automatically, particularly in emergency situations where the operator's responses cannot be predicted because of stressful conditions. In such sensitive situations microprocessor-based systems can readily take over from the operator and initiate appropriate action, such as display on c.r.ts, evacuation procedures to be followed by personnel in the vicinity, alert fire, ambulance, police services. See Fig. 1.

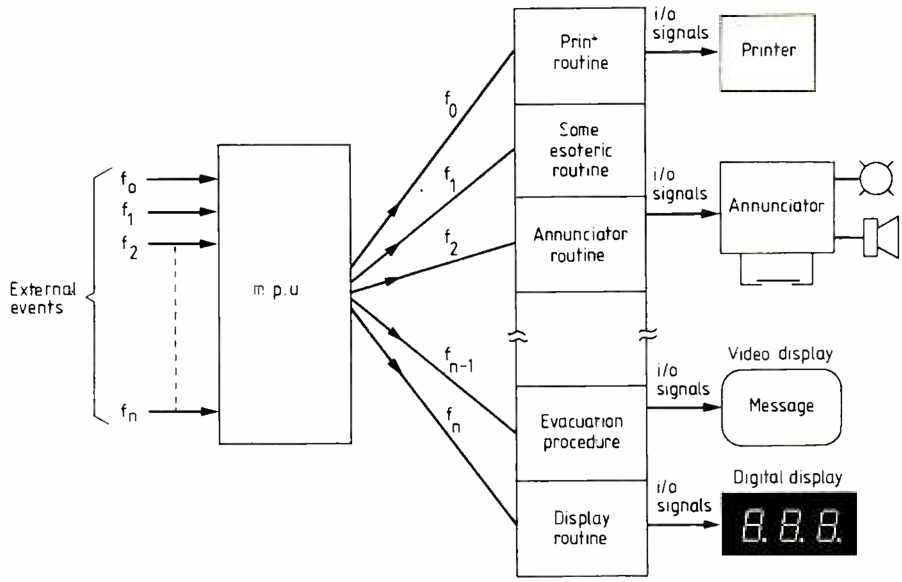


Fig. 1. Block diagram showing software response to external events – note the i/o signals.

With present-day methods and technology, the design and implementation of such systems requires primarily sound management of resources, unlike a few years ago when only highly-trained specialists could tackle such problems.

Basic concepts

When a device wishes to establish communication with another device, it generates an **interrupt flag.** This is a signal generated and used by a device to inform some other device that it wishes to communicate with it. The called device responds by generating a **'go ahead'** signal, as shown in Fig. 2 unless of course it chooses to ignore the flag, in which case no inter-device communication is established. We shall refer to the calling and called devices in Fig. 2 as device 2 and 1, respectively.

As we have already explained in Article 4 (September 1980 issue), communication between devices is controlled by an interface. In the case of our two devices the block diagram of a basic interrupt configuration is shown in Fig. 3. Its step-by-step operation is as follows. The interface monitors the status signals of device 2 and generates an interrupt flag when device 2 wishes to communicate with device 1. If device 1 decides to respond to the flag, it

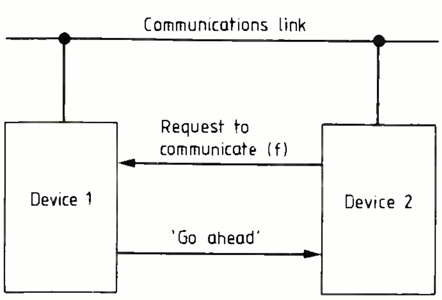


Fig. 2. Block diagram showing how communication between two devices is established using flags.

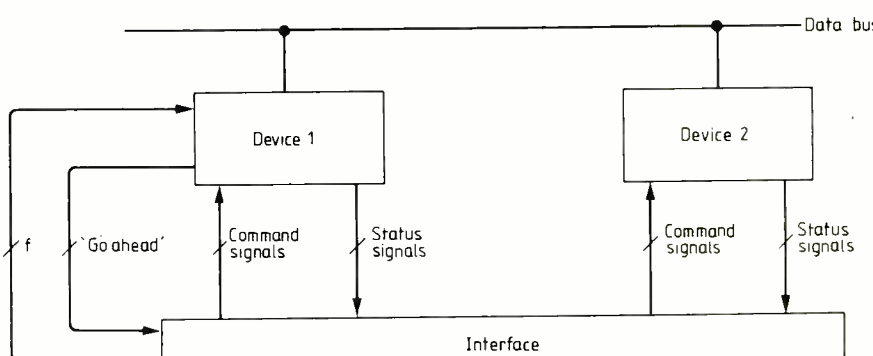


Fig. 3. Basic interrupt configuration.

sends a **'go ahead'** signal to the interface. At this point the interface generates the appropriate sequence of command signals that allow the two devices to communicate with each other.

If device 1 is a program-driven device, such as a microprocessor, it responds to the external flag by suspending execution of its current program and executing instead a different program, **the interrupt routine**, at the end of which the interrupted program is resumed, as shown in Figure 4.

The reader's attention is drawn to the following:

1. Because the resumption of a partially executed instruction is extremely difficult, a program can be interrupted only at the end of an instruction cycle, unlike cycle stealing which takes place at the end of a memory cycle.
2. The arrival of external interrupts is normally unscheduled, and therefore not synchronized with the operation of the microprocessor.
3. The interrupt terminal is automatically disabled (masked) when an interrupt routine is entered. It is therefore necessary for the programmer to re-enable (unmask) the interrupt terminal in his interrupt routine —at the beginning for nested interrupts, otherwise at the end.
4. At the end of an instruction the program counter (p.c.) points to the memory location that contains the first byte of the next instruction.

If the instruction that would have been executed, had the program not been interrupted, is stored in memory location A_r and the first instruction of our service routine is stored in location A_v, the switch from the main program to the interrupt routine is clearly implemented by displacing the contents of the program counter A_r by A_v. We shall refer to A_r as a **return address,** and to A_v as a **vectoring address** – see Fig. 4. If the interrupted program is to be resumed at the end of the interrupt routine, it is necessary for the return address to be saved, that is to be stored in a memory location from which it can be copied back (loaded) into the p.c. at the end of the interruption, as shown in Fig. 5. The section of memory storing the return address is typically referred to as **a stack.**

The p.c. is pushed onto the stack automatically, but a software instruction, RETURN, must be executed to pull it out of the stack and copy it into the p.c. The return address is clearly the minimum information needed for an interrupted program to be resumed.

In addition to the program counter, it is also necessary to save the state of other internal registers which hold the information belonging to the interrupted program. PUSH and POP instructions are used in such a case, as shown in Fig. 6.

The basic functions of any interrupt-driven system are:

1. To accept and identify unscheduled external requests for service.
2. To resolve contention problems (if and when they arise).
3. To evoke pre-determined responses.

The basic configuration of a microprocessor system implementing these functions is shown in Fig. 7. The interrupt flags are fed into **the interrupt controller,** whose function is to generate the **interrupt request signal** (IRQ) when one or more flags are present, and to provide the microprocessor, when interrupted, with

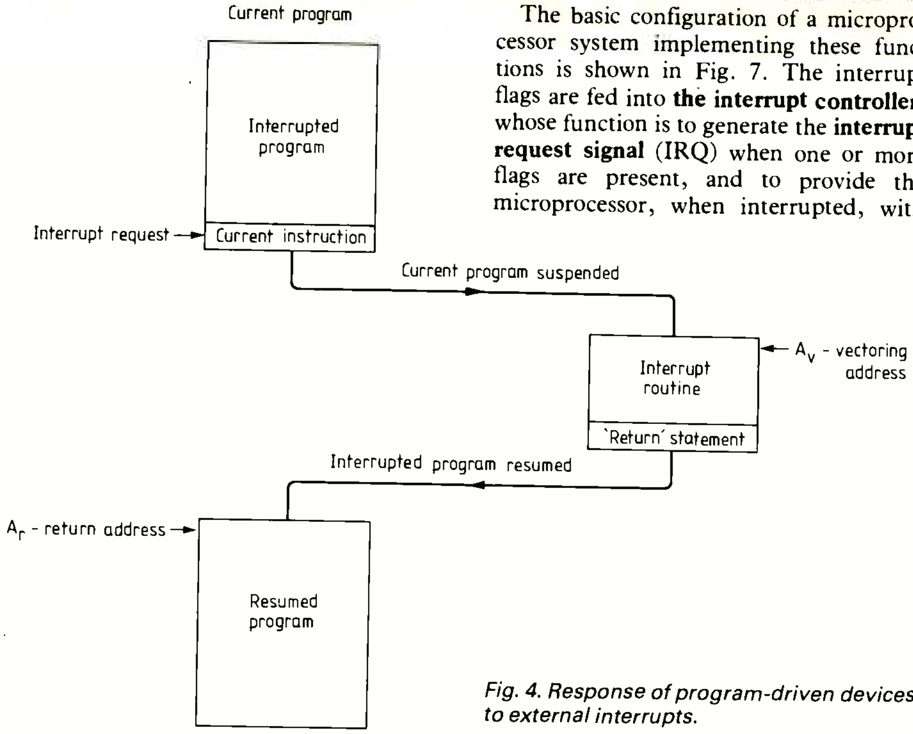


Fig. 4. Response of program-driven devices to external interrupts.

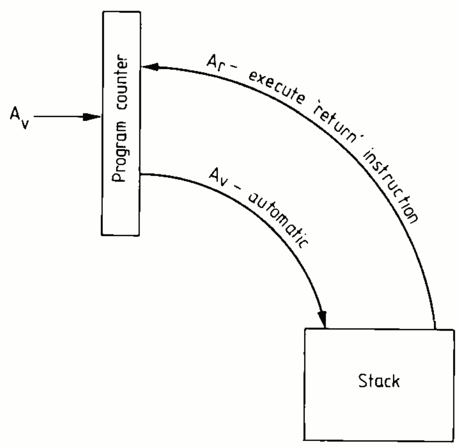


Fig. 5. How the program counter is saved and restored before and after interruptions.

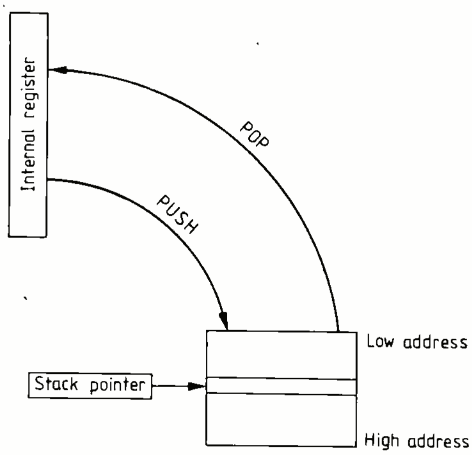


Fig. 6. Execution of POP and PUSH instructions.

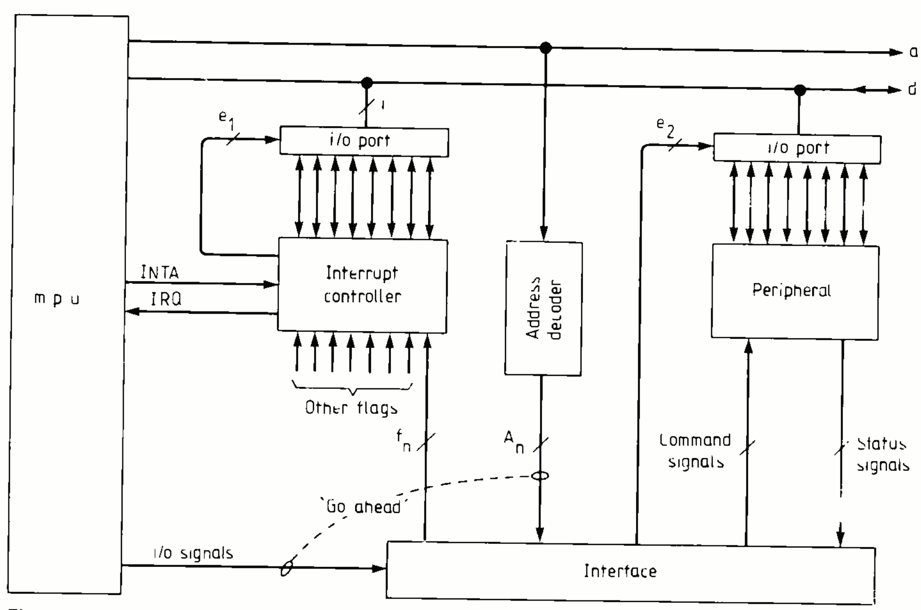


Fig. 7. Basic configuration of an interrupt system.

some meaningful information, denoted by variable *i*. The nature of the meaningful information supplied by the interrupt controller varies in complexity from a copy of the interrupt flags to the vectoring address, as shown in Fig. 8. In the first case it is left to the microprocessor to identify the source of interruption and to solve any contention problems, whereas in the second case contention problems are resolved and the vectoring address is generated prior to interrupting the microprocessor. Depending on whether the source of interruption is identified prior to or after program interruption, interrupts are classified either as **vectored** or **non-vectored.** Since no software is required to identify the source of interruption, the response time of vectored interrupts is shorter. This method, in addition to shortening the response time, simplifies the software.

Our **'go ahead'** signal in the case of microprocessors consists of i/o signals and an i/o address, A_n – see Fig. 7. The reader will recall that the i/o and address signals are generated during the execution of an i/o instruction. From this point of view the function of **interrupt interfaces** is to monitor external events, generate an interrupt request flag when the process or the peripheral being monitored wishes to do so, and wait for the microprocessor to respond. When the microprocessor responds, it generates the appropriate signals needed by the process or the peripheral.

The step-by-step operation of our basic system, shown in Fig. 7, is outlined next. The interrupt controller, which monitors the flags, generates interrupt request signal IRQ when one or more flags are raised. This signal simply informs the microprocessor that some external event has occurred, to which it is requested to respond. If the microprocessor does not wish to respond, it continues with its task without acknowledging the interrupt request. Otherwise, it completes its current instruction and responds in the following manner.

1. It generates an interrupt acknowledge signal, denoted by INTA in Fig. 7, to indicate that the program has been interrupted.
2. Within the microprocessor chip, a flip-flop, referred to as mask flip-flop and shown in Fig. 9, is set. Setting the flip-flop desensitizes (masks, disables) the interrupt request pin, IRQ. We shall refer to this as **interrupt masking.**
3. The return address, A_r, is stored in stack automatically.
4. The source of interruption is identified by inputting *i*, the meaningful information generated by the program controller in Fig. 7.
5. The status of the working registers, that is registers which hold information belonging to the main program and used by the interrupt routine, is stored in stack using PUSH instructions as shown in Fig. 6, unless this is done automatically at the beginning of each interrupt cycle as in the case of the Motorola 6800.
6. The request is serviced.
7. The interrupt flag is cleared.
8. The status of the working registers prior to interruption is restored using POP instructions – see Fig. 6.
9. Interrupts are enabled using a program instruction, typically referred to as ENABLE INTERRUPTS or CLEAR INTERRUPT MASKS. Execution of this instruction resets the flip-flop in Fig. 9, by routing a pulse to its clear terminal.
10. The interrupted program is resumed by executing a RETURN instruction, which loads the program counter with the return address, A_r – see Fig. 5.

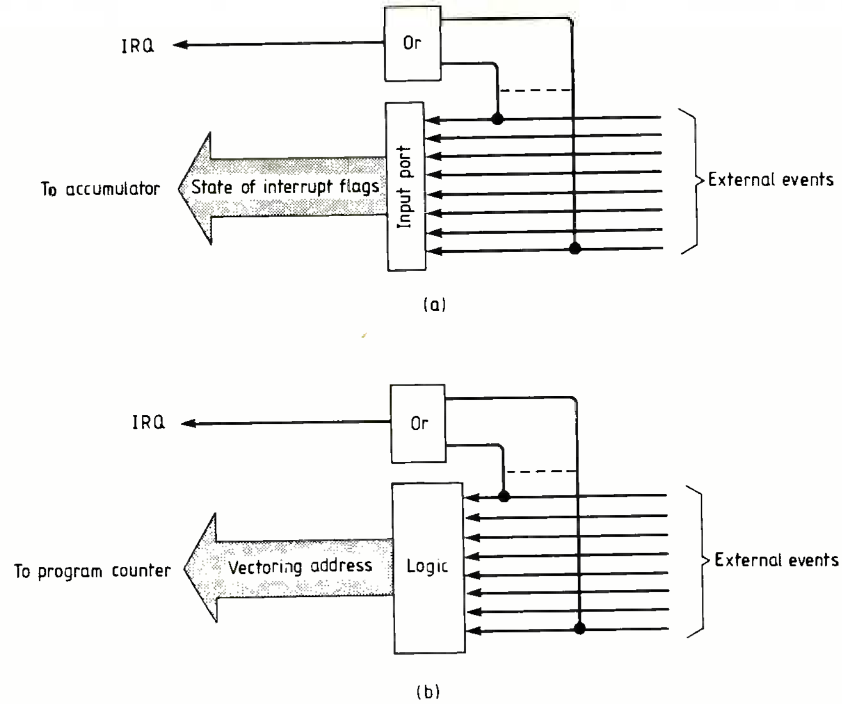


Fig. 8. (a) Non-vectored interrupts; (b) vectored interrupts.

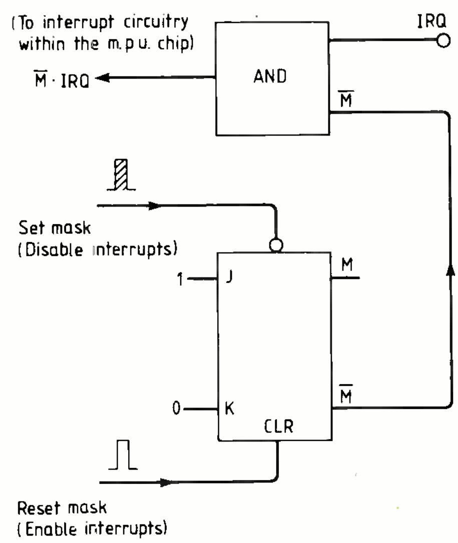


Fig. 9. Flip-flop for masking interrupts.

For ease of reference see Fig. 10.

Variations in the execution of the individual steps exist in practice, depending on which microprocessor chip is being used. For example, in the case of the Motorola 6800, all the m.p.u. registers and condition flags are automatically stored in stack, thus eliminating the need for steps 5 and 8 in our sequence. In the case of the Intel 8080 on the other hand, because only the program counter is saved automatically in stack, all our steps must be executed.

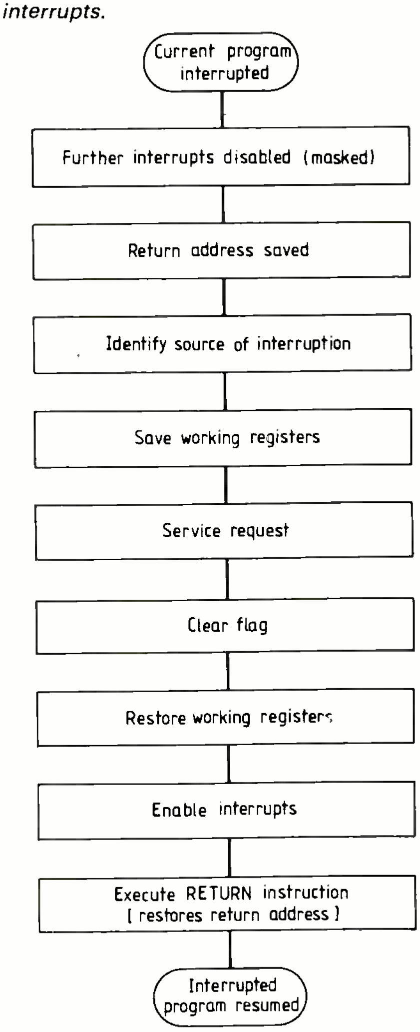


Fig. 10. Step-by-step operation of interrupt-driven systems.

It is the programmer's responsibility to ensure that during a program interruption all information necessary for the correct resumption of the interrupted program is preserved and restored.

Morse-code lock

Battery powered microprocessor uses serial "key" code

by **J. Hruska,** B.A.

Although the design of a conventional digital lock is reasonably straightforward, a high security device requires around ten i.cs. By using a microprocessor the hardware can be reduced to two i.cs and the flexibility can be enhanced. This design uses a 8748 microprocessor with a 4001 c.m.o.s. i.c. to reduce the standby current. The 8748 is programmed with up to 16 Morse code signals, and these must be repeated serially via a single switch to energise an electric lock.

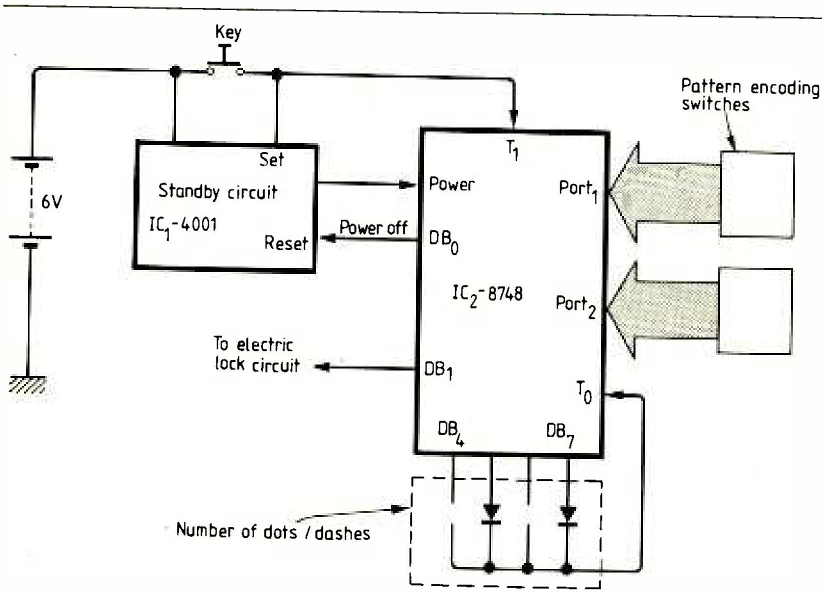
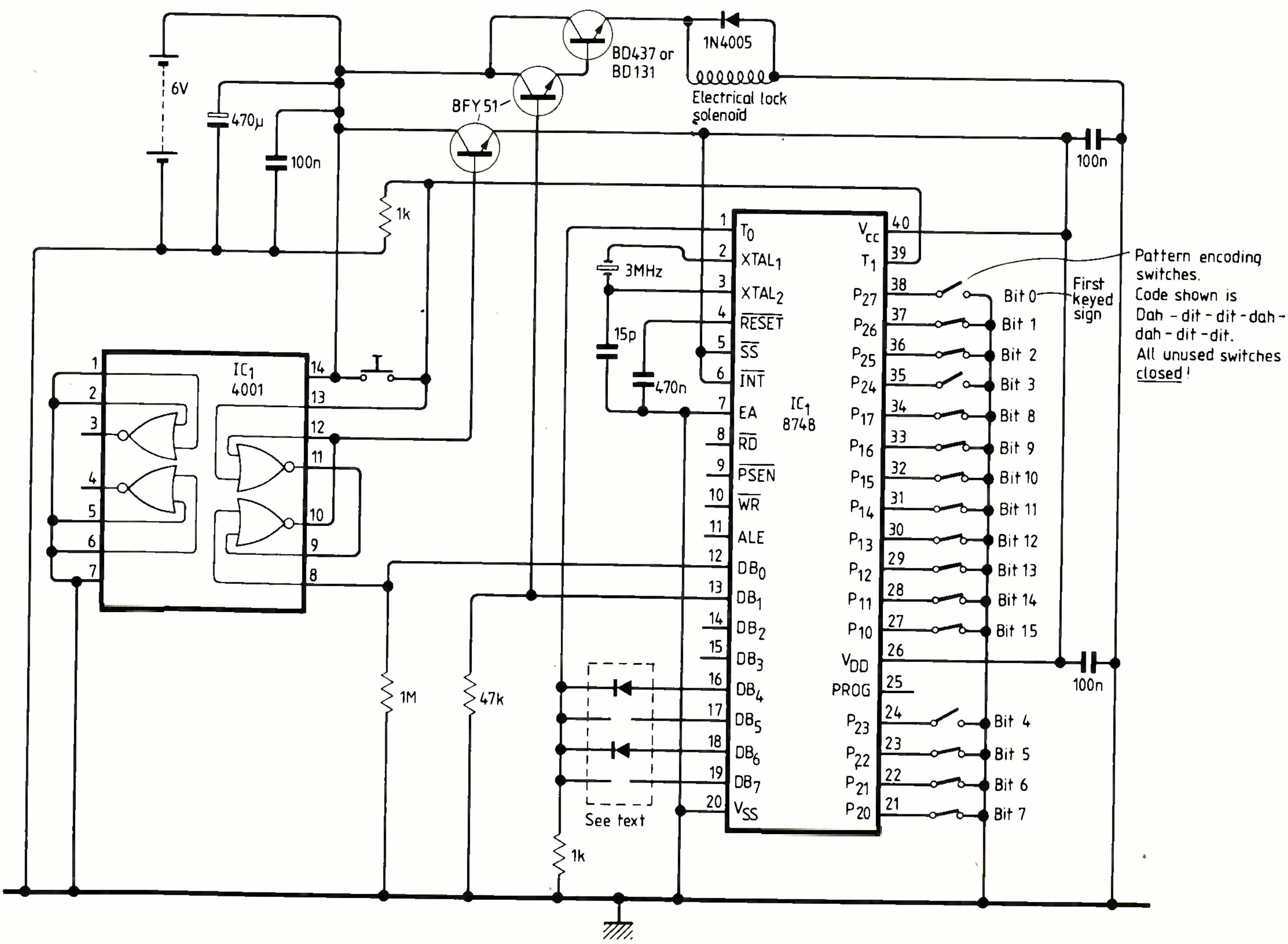


Fig.1. Block diagram of the electronic lock.

Fig.2. Microprocessor connections and standby circuit.



The 8748 belongs to the MCS-48 family of microprocessors which contain an 8-bit c.p.u., 1 or 2K of program memory (r.o.m. or e.p.r.o.m.), 64 or 128 bytes of data memory, 27 I/O lines and an 8-bit timer/event counter. Cycle times range from 1.36 to 5μs depending on the version, and over 90 instructions are provided in the set. The program memory of the 8748 is an e.p.r.o.m. which can be programmed like a standard 2708 or 2716 and, if modifications need to be made, the memory can be erased by u.v. light. The I/O lines comprise two 8-bit ports (p10 to p17 and p20 to p27), an 8-bit data bus, T0 and T1 inputs and an interrupt input.

Two NOR gates form a flip-flop which is set when the key switch is pressed, see Fig. 1, and switches power to IC_2 via Tr_1. A signal from IC_2 resets the flip-flop which then switches the power off. Current consumption of the circuit in the standby mode is about 1μA at room temperature and about 60mA when IC_2 is operating. The electric lock requires a further 600mA while operating, so battery life depends on how often the lock is operated. With four standard HP2 cells, and assuming 12 operations a day, the projected battery life is about one year[1]. The key switch is also used to imput the code but, because IC_2 is switched on by the first dot/dash, this does not form part of the code.

The Morse code pattern is set on 16 d.i.l. switches connecting ports 1 and 2 to ground. A closed switch, binary 0, represents a dot and an open switch, binary 1, represents a dash. Unused switches must be closed. The length of the code is set by connecting one to four diodes from the data bus to the T0 input as shown in Fig. 2. A connection represents a binary 1 and, using DB4 as the l.s.b., the binary number should be one less than the code length.

When operating, the 8748 sets DB1 high if the keyed-in code matches the programmed code. The signal from DB1 operates the electric lock[2] via a Darlington emitter follower, and when the processing is finished DB0 goes high to switch the 8748 off. Data-bus lines 2 and 3 and the interrupt input are not used, but could be connected to provide other I/O functions.

A flowchart for the software is shown in Fig. 3. To fully comprehend the program the architecture and assembly language of the 8748 must be understood [3]. When IC_2 is switched on it starts to execute the program at location 0. The number of dots/dashes are read in by feeding a binary 1 to DB4, 5, 6 and 7 in turn, and checking the input T0. The timer is then started and timekeeping is achieved by incrementing register 6 (location 7). The processor executes a jump-to-subroutine starting at location 7 at every timer-interrupt, therefore, with the 8478 running at 3MHz, this occurs every 40.86ms. The 8478 then monitors the keying-in of the code, provides a software debounce period and records the length of time the key has been pressed. Five seconds is the maximum period permitted and one second is the maximum time between successive dots/dashes. If these times are exceeded, the i.c. switches itself off. Note that no resetting is necessary if a wrong code is entered because the 8478 will switch itself off after one second and the code can then be re-entered. These periods were found to be the most suitable after simulations of the Morse code input algorithm were carried out.

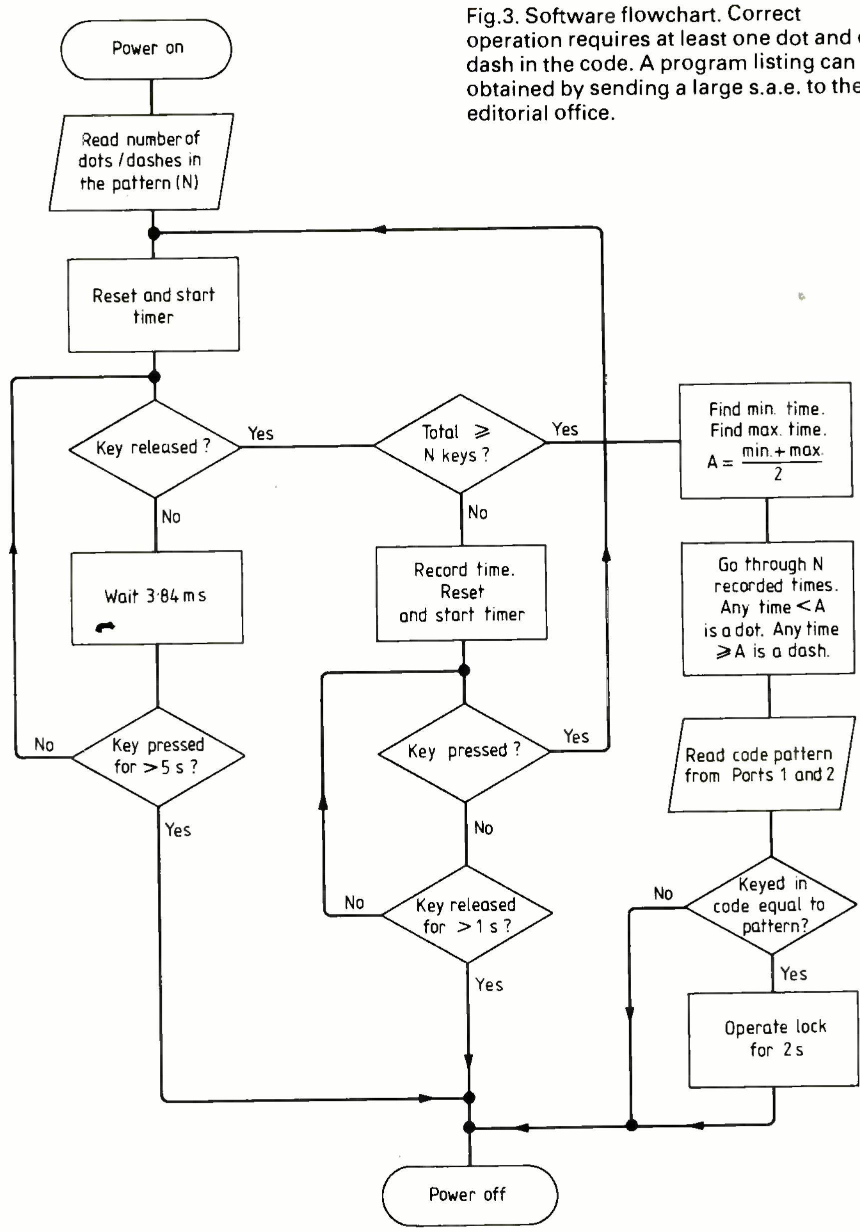


Fig.3. Software flowchart. Correct operation requires at least one dot and one dash in the code. A program listing can be obtained by sending a large s.a.e. to the editorial office.

After the code has been keyed in and the corresponding key depression times stored in the data memory, the program finds the minimum and maximum times. The average is calculated and signals with a recorded time shorter than the average are accepted as dots and signals which are longer than or equal to the average are accepted as dashes. A 16-bit binary equivalent of the input code is formed in registers 2 and 3 where 0 represents a dot and 1 represents a dash. Unused positions have their corresponding bits set to 0. The code, programmed by the switches connected to ports 1 and 2, is then read and compared with registers 2 and 3. If they match, line DB1 goes high for two seconds to operate the lock and the 8748 then switches itself off by feeding a 1 to DB0. If there is no match, the i.c. switches itself off without operating the lock. With this method of recognition, the code must contain at least one dot and one dash, and the unused switches must be closed.

Construction is simple and the circuit can be mounted on a small piece of Veroboard. Code programming can be conveniently achieved using two or three d.i.l. switches which also save space.

The easiest method of programming the e.p.r.o.m. is with an Intel development aid but, with some care, this can be achieved with other e.p.r.o.m. programmers. Alternatively, Rapid Recall, Wooburn Industrial Park, Wooburn Green, Bucks, will program or supply ready programmed 3MHz 8748 devices.

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Video system for diffraction interference pattern display

Intensity profiles are displayed alongside direct images

by **E. Hywarren** and **P. D. Loly**, Ph.D., University of Manitoba

The linear intensity response of a video pickup tube is used to extract an intensity profile of diffraction patterns that can be presented alongside the direct image in a split-screen presentation. Still shots are used to illustrate *N*-slit diffraction profiles and the resolution of two sources according to the Rayleigh criterion. The rapid response of the whole video system also allows a dynamic representation of intensity changes.

Demonstrations of diffraction and interference are commonplace in courses covering physical optics. The advent of lasers has made these demonstrations easier to mount, and the light and dark regions of constructive and destructive interference are now quite familiar: however, the difficulty of measuring the intensity of the light in these regions still leaves a gap between theory and experience. Comparative photometers are rather cumbersome and, in common with modern, solid-state photocells, only give spot measurements, so that they must be moved across the interference pattern in some controlled manner.

It so happens that most well equipped television recording studios monitor line-scan intensity profiles, as a matter of routine, to provide for the evaluation of video waveforms – a process which amounts to the dynamic recording of intensity variations along a line. In this article, we report results obtained by setting up a number of diffraction experiments in a television studio and simultaneously recording the direct image and the intensity profile.

Procedure

The arrangement of the principal components is shown in Fig. 1. A red, helium-neon laser provides the beam, which is picked up by a standard Philips LDK-2 colour television camera, only the red output signal being used. The laser illuminates a vertical slit, which produces a horizontal splay of rays, these being reflected by a beam-splitter to a highly directional reflecting screen[1], back through the beam-splitter and into the camera lens.

The camera converts the light-intensity variations of the interference pattern into a video signal, whose strength represents the intensity. This signal modulates the beam current of a display c.r.t., which is scanned synchronously with the camera tube, the display ('direct' image) corresponding to the original interference pattern.

To obtain a 'graphical' representation of the interference-pattern intensity variations, a Tektronix 529 waveform monitor is used, with its timebase running at 60Hz (50Hz in UK) and the output of the colour camera applied to its Y amplifier. A low-pass filter reduces the bandwidth of the Y signal. The two displays – the graphical display at the output of the monochrome camera and the direct intensity display from the colour camera – are switched by a video production switcher[3] to provide a side-by-side presentation of the two, which can be recorded on tape.

Results

Figure 2 shows displays generated by the diffraction of beams by multiple slits. The histograms from $n = 1$, 2 and 4 show excellent agreement with calculated intensity profiles seen in many texts[4].

Remaining examples are concerned with the resolution of two sources (each represented by a laser) with a single-slit aperture representing the objective lens of an optical instrument. The slit width is varied in Fig. 3, and the angular separation of the sources is varied in Fig. 4.

The Rayleigh resolution[4] criterion for distinguishing two equally bright point sources of the same wavelength by the average human eye gives the limit of resolution when the first zero of one pattern falls under the main peak of the other, resulting in a 20% dip in intensity between the peaks. Figure 3(c) has a smaller dip of about 10%, which is not resolved in the direct image.

Figure 4 shows the results of a more difficult experiment, where the angular separation of the two sources is varied. The fixed and moveable beams were required to fall on the same slit and this was accomplished by the arrangement shown schematically in Fig. 5. The fixed slit was mounted on the projected axis of a rotatable table. One laser was mounted on that table and its beam was reflected twice in order to pass through the rotation axis, and therefore also through the slit. The second laser was mounted independently of the rotating table and its beam fell on the same

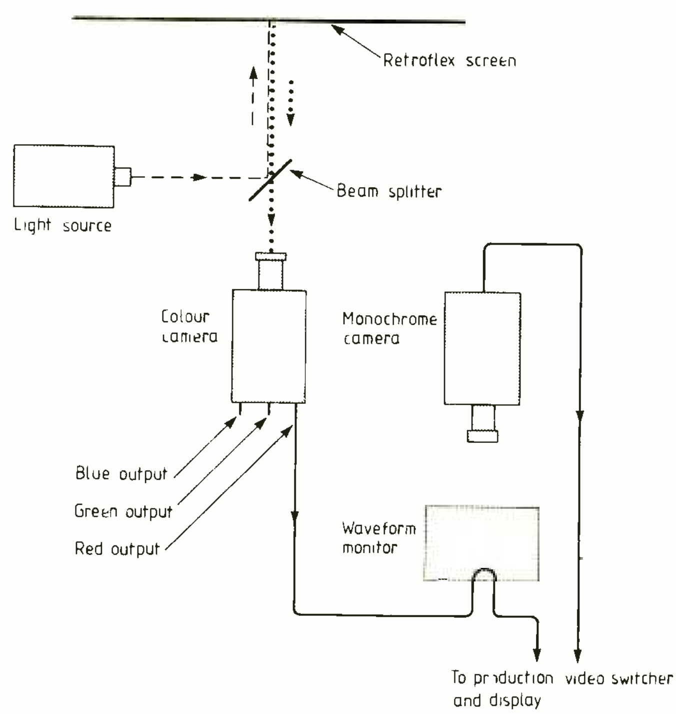

Fig 1. Schematic view of the principal television components.

PLUMBICON

The camera employed in this work is fitted with a Plumbicon[2] or lead-oxide vidicon, which exhibits an extremely linear intensity response. It appears, for this purpose, to possess advantages over the older vidicon, which uses a different photosensitive element, and the image orthicon.

In essence, the photoconductor of a Plumbicon consists of three layers, the middle one being almost pure lead oxide, which is an intrinsic semiconductor. On the gun side of the intrinsic layer is a p-type semiconductor and the other side is doped n-type by a thin, conducting film of silicon oxide, which forms the transparent photocathode. Since the two doped layers are thin in comparison to the thickness of the lead oxide, the tube is more sensitive than older types. In the intrinsic region, the conductivity is low and the electric field strength high, so that if the target potential is high enough, all the liberated charge carriers contribute to the current.

The planar p-i-n diode formed by the photoconductor is reverse biased by the acceleration voltage of the electron beam; the current flows in the external circuit, which is completed by the beam. A signal voltage is developed across a resistor in the current path, which is proportional to the illumination of each segment of the photocathode diode. This, essentially continuous, array of photodiodes produces a very small dark current and a linear response.

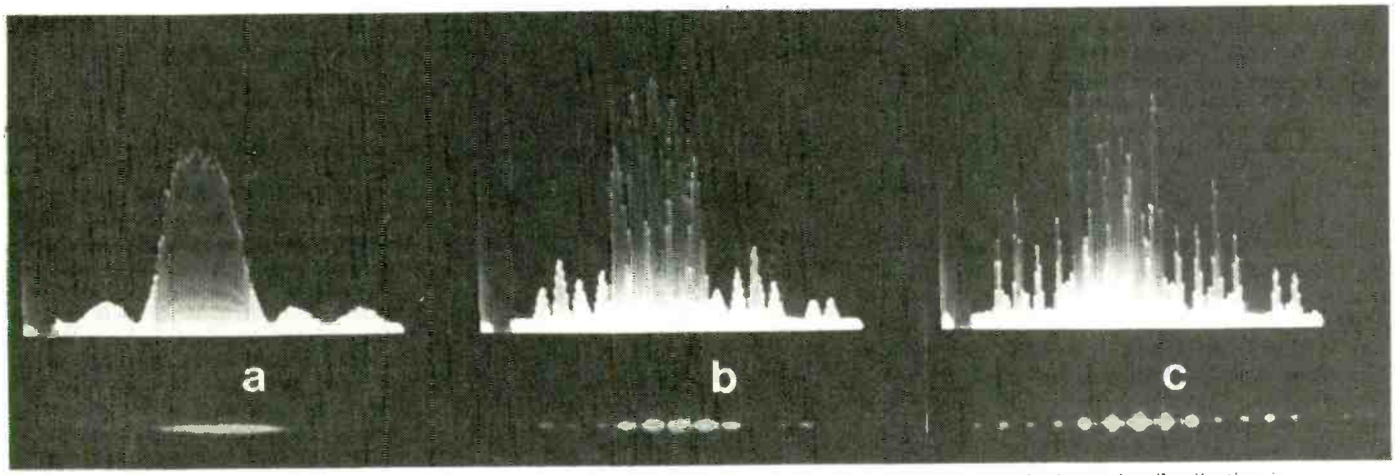

Fig 2. n-slit diffraction (a) n=1, (b) n=2, and (c) n=4. The direct image is seen in the lower portion, and the intensity distribution in the upper portion of each frame.

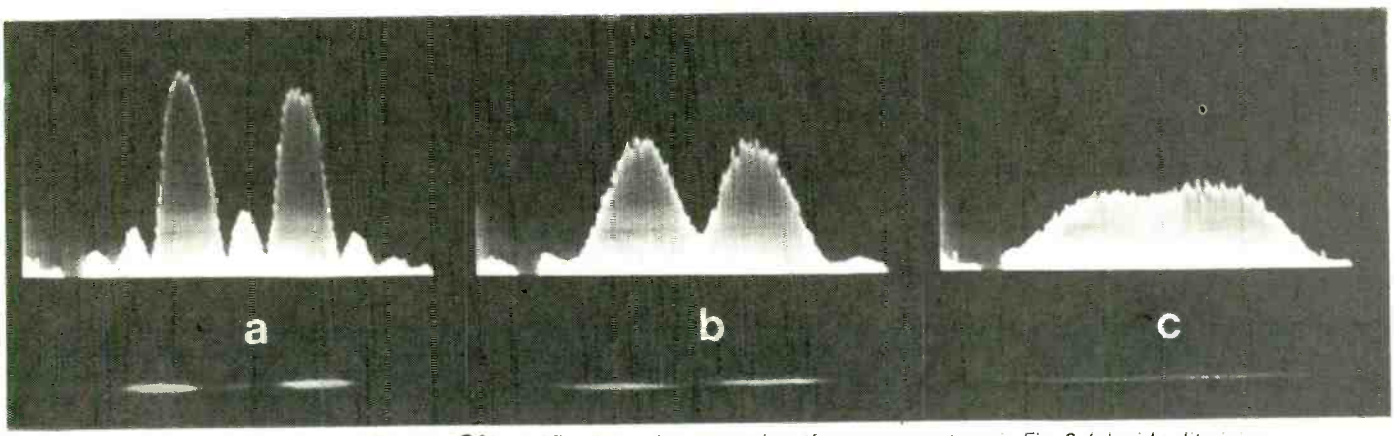

Fig 3. Two-source resolution for variable slit width and fixed angular separation, the components as in Fig. 2. (a) wide slit giving clear separation, (b) narrower slit giving br[illegible]omponents and some overlap, and, (c) narrowest slit with a 10% dip in intensity between peaks.

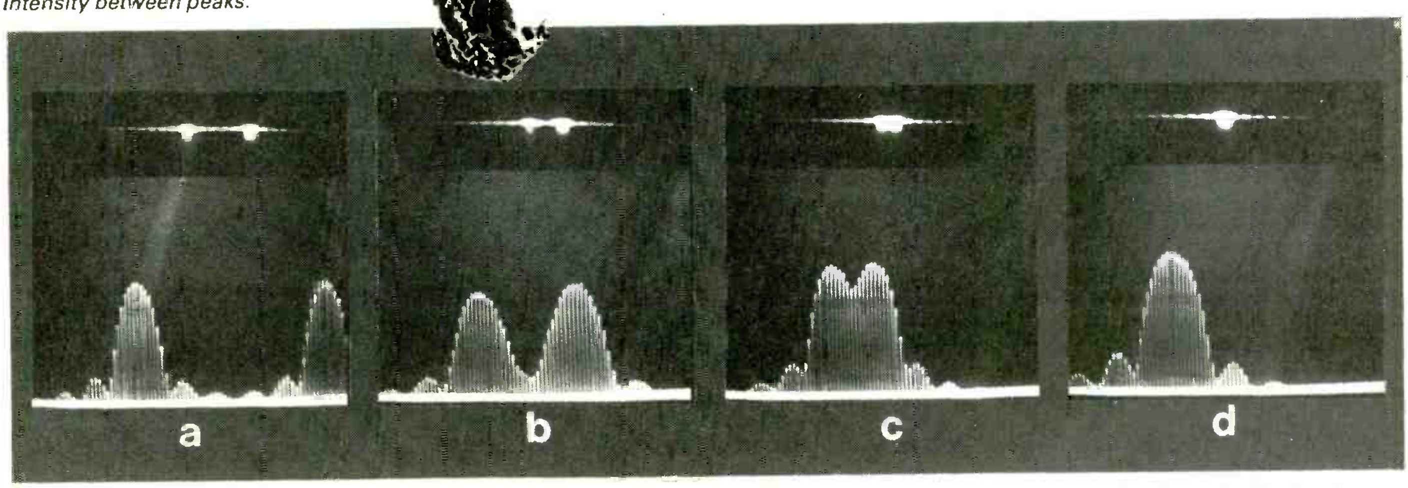

Fig 4. Two source resolution for variable angular separation and fixed slit width. The direct image is now above the intensity distribution.

slit, after passing through the half-silvered upper mirror used to reflect the first laser beam. It was then quite a simple matter to vary the angular separation of the two sources and follow the overlapping of their respective diffraction patterns. Figure 4(c) shows the Rayleigh limit and Fig. 4(d) shows the sources at a smaller angular separation.

Some brief comments on the differences between Figs. 2 and 3 are in order. In arranging the final picture it was deemed desirable to maximize the ordinate of the intensity profile by placing it along the long axis of the television screen. The vertical splay of diffracted beams used in the first experiments (Figs. 2 and 3) was then placed on the side opposite to the intensity base line. In contrast, the later experiment with rotating beams gave a horizontal splay of diffracted rays. The diffraction pattern was then picked up by the main camera, displayed on a video monitor rotated 90 degrees to give a vertical pattern, and then picked up by another camera whose output was fed to the waveform monitor. The pronounced histogram appearance of the intensity distributions in Fig. 4 resulted from this extra step, and is probably responsible for some spurious reflections or haloes on the lower edge of the direct images. In all cases the raw results are presented without any retouching whatsoever.

It may be possible, as an alternative to the method described, to use a dual-beam oscilloscope, applying the colour camera output to a Y input and the Z input simultaneously, switching the Z signal on and off on alternate sweeps. This would give a curve, rather than a histogram presentation, but would provide a portable and economical system.

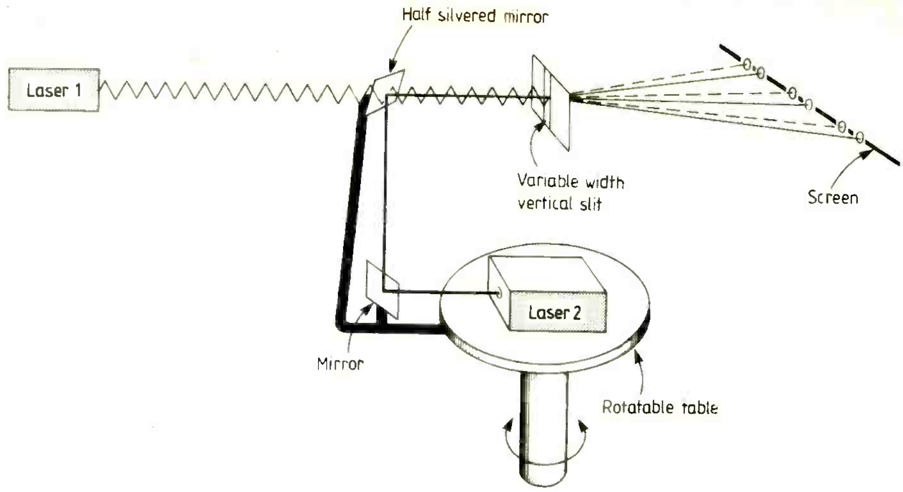

Fig 5. Schematic view of the assembly for varying the angular separation of two laser sources.

We would like to thank the staff of our Instructional Media Centre, especially Jack Campbell and Rudy Dahl, as well as Ian Cameron and Gary Smith of the Physics Department.

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3. RCA-TS40 Video Production Switcher with a Ball Bros. Mark 7E Special Effects Generator.

4. See e.g. F. A. Jenkins and H. E. White, "Fundamentals of Optics", McGraw-Hill 1957; R. S. Longhurst, "Geometrical and Physical Optics", Longmans 1960.

The authors

Elmer Hywarren gained an extensive background in television with stations CKSO (Sudbury) and CFTO (Toronto) in Ontario, Canada, and since 1967 has been with the University of Manitoba as a tv producer/director specializing in the use of tv for educational and instructional purposes.

Peter Loly obtained his Ph.D. in 1966 from the University of London (at Q.M.C. and I.C.) and is now Professor of Physics at the University of Manitoba with research interests in theoretical solid-state physics, especially low-temperature magnetic excitations (spin waves or magnons) and electronic properties of highly anisotropic conductors, as well as pedagogical aspects of oscillations and waves.

IN OUR NEXT ISSUE

Microprocessor trainer
Construction of an uprated version of the Nanocomp published in January. It uses a 6809 device, a more recent and advanced addition to the 6800 family of micros. Also a cassette interface which can be used with either version.

Digital speech storage and analysis
First of a series of articles which uses the speech waveform in a down-to-earth way of explaining the latest processing techniques for handling digital signals. Normally mathematical, they are not widely understood. 1. – Storing waveforms digitally.

New coaxial cable development
Lower losses and improved power handling are offered by a cable structure which is a cross between conventional coaxial design and waveguides. Using an outer screen and an inner cylindrical group of parallel wires, it transmits in the dipole mode.

On sale 17 June

LETTERS TO THE EDITOR

MULTI-PATH DISTORTION

Pat Hawker's writings are always interesting and to the point and his return to the question of multi-path distortion in your April issue is no exception. He cites the NHK study which re-emphasises the sometimes underrated importance of these effects and quotes the German IRT/WDR paper in the *EBU Review*, which casts doubt on the wisdom of adding a vertical component to existing horizontally-polarised v.h.f. radio transmissions.

In the BBC we have of course studied the EBU paper carefully, and perhaps anxiously, in the context of our plans for v.h.f. development. Broadly speaking, these plans aim at:

(a) Improving v.h.f. reception for users of portable and car radios, while leaving reception on fixed aerials unaffected.
(b) Filling gaps in our existing coverage by the provision of additional relay stations.
(c) Provision of additional v.h.f. radio networks to avoid the current necessity of sharing by different programme interests.

Addition of a vertical component, equal in power to the existing horizontal radiation, is intended to satisfy only requirement (a). If we wished to benefit existing listeners with fixed roof-level aerials, then a doubling of the horizontally-polarised power would be better than provision of a vertical component.

Pat Hawker, quoting the EBU paper, makes the point that vertically-polarised signals are more subject to long-range reflections, and this is certainly true. Curves in the EBU paper show, however, that with a horizontal receiving aerial there is little (about 1 dB) increase in distortion and stereo crosstalk with mixed-polarisation transmissions as compared with purely horizontal transmission. In other words, a listener staying with his existing horizontal roof-level aerial will be quite well protected against multi-path distortions arising from addition of a transmitted vertical component.

Turning now to car radio reception, the EBU paper shows that with mixed-polarisation transmissions, received signal levels on a vertical rod aerial are significantly increased, while the transmitted polarisation makes little difference to distortions arising from reflected signals. The EBU paper, surprisingly, makes no reference to use of portable v.h.f. receivers in the home. With vertical rod aerials used in this case also, the findings concerning car radio reception are presumably applicable, although in a building the received polarisations may be significantly different from those transmitted. Certainly it is BBC experience that a vertical component is of considerable benefit to the home portable user, and indeed there could well be a reduction in multi-path distortion since the ratio of direct to reflected signals would often be improved.

The EBU paper lays some stress on the poor propagation of vertically-polarised signals, due to diffraction losses: figures are quoted showing vertical component received signal strengths between 3 and 6 dB less than the associated horizontal component. The relative loss of vertical component is said also to increase as overall signal strength decreases, i.e. towards the limits of the service area. In this respect, BBC findings are at variance with the German experience: for example, tests in South London on the circularly-polarised Capital Radio transmissions show no particular difference between horizontal and vertical component propagation, nor any relative variations with overall field strength.

To sum up then, multi-path distortion is a factor to be taken very seriously into account in v.h.f. radio network planning. There are indeed uncertainties as to the precise effects and benefits of a vertically-polarised component, which we have weighed up very carefully. Having done this, we conclude that our initial development at Wrotham will bring significant improvement in the overall reception of v.h.f. in the South-East. As development proceeds in other areas, users of portables and car radios will reap similar benefits; but we shall seek to reassure ourselves that multipath distortion will not prove a greater problem in more rugged terrain.

D. P. Leggatt
Engineering Information Department
BBC
London W1

Pat Hawker comments:
To such kindly criticism it would be ungracious to cavil at mere technicalities! But I take the opportunity of stressing, as I thought I had made clear, that the viewpoints expressed in my article were entirely personal, seen very much from a "learning" situation. The vast majority of broadcast engineers remain fully in favour of mixed polarization, despite the German conclusions. However: (a) the German trials used audio tones at a maximum of 5kHz, Mitsuo Ohara's work indicates that distortion would have appeared significantly greater had higher audio frequencies been used; (b) in Takeda *et al*, "FM Multipath Distortion in Automobile Receivers" *IEEE Trans on Consumer Electronics*, vol. CE-26, August 1980, the rather striking opening sentence reads: "Multipath interference is one of the most serious problems for mobile receivers"; and (c) the additional path losses of vertically-polarized v.h.f. signals have been shown, elsewhere than in Germany, to depend very much on local conditions and to be most severe where the path crosses coniferous trees (not an outstanding feature of the South London landscape!) – see for example *IEEE Trans Ant & Prop*, vol. AP-28, No. 6, November 1980, where Frank H. Palmer's measurements in North-West Canada indicate that the presence of "trees and perhaps other types of ground cover" not only increases path losses by about 5dB at both v.h.f. and u.h.f. but also *greatly reduces cross-polarization losses*, a factor that may prove significant in this context for national coverage networks. Indeed it has been recognised for many years that trees cause considerable scattering and polarization shifts on v.h.f. signals, if vertically polarized.

Nevertheless I share (with some personal reservations) Mr Leggatt's hopes that in practice mixed polarization will bring benefits to car listeners without undue degradation of domestic reception. Axeman spare those trees!

COMPUTER ARCHITECTURE AND PROGRAMMING

The photocopy of your February editorial "The new bureaucracy" having completed its tour of the building and having arrived back at my desk today has reminded me that I intended to comment on it. It is fully in line with the refreshing air of naîvety that has blown through the editorials lately and as such is welcome. The more political essays have already been commented on in your columns but I would like to add a few points to your attack on the Von Neumann architecture and the "programming bureaucracy."

The application of the serial Von Neumann architecture has been not only downwards to the microprocessor but also, and perhaps more inexplicably, upwards into the most powerful of the computers available today: the array processors where parallel processing has been sought only by connecting many Von Neumann serial processors in parallel. This attitude can also be found in designers' reactions to the problem of fault-tolerant computers; I work on the implementation of a computer-controlled telephone exchange where 100% availability is essential: clearly a case for parallel processing. The problem is, of course, solved by connecting a plethora of serial processes in parallel: with no resulting synergism.

The questions of the "programmer class" (to which I belong) are explained when it is understood that programming is simple enough to require no extensive training but, paradoxically, cannot be carried out by most people. I have met and worked with many programmers in my time and have on occasions, normally when recruiting, toyed with the puzzle of the (lowest) common denominator. The only one seems to be a certain "childishness"; a willingness to play games. Programming is mysterious because it is one of the few occupations that, although simple, cannot be done well by everyone. This is enough for those who can build a mystique around the profession to exclude those who cannot. And once the mystique has been accepted, as it clearly has by the general public, it is only human nature to feel important if one is in the chosen few.

C. W. Hobbs
Bern
Switzerland

"OPEN CHANNEL" FREQUENCIES

The statistical report emanating from Philips Research Laboratories, Redhill (February letters), reminds me of the definition of statistical analysis as being the drawing of a straight line from an unwarranted assumption to a foregone conclusion.

I assume that the monopole antennas mentioned were in effect $\lambda/4$ mounted on the roof of the van, the roof acting as a ground plane. The comparison between 27MHz and 958MHz operations was thus with antennas of heights of 270cm and 8cm respectively. Hardly a fair comparison!

It would be interesting to know what is the power gain of a co-linear antenna for 958MHz of height 270cm.

I would like to see the tests repeated with, for example, a simple slotted cylinder vertical antenna (B.P. 515684 by A.D. Blumlein (1938) of 2λ height (a mere 2 feet) having omni-directional horizontal polarisation at both transmitting and receiving ends.

I. J. P. James
Pinner
Middlesex

MAGNETIC RECORDING

In the March issue James Moir states that the problems of storing analogue signals on tape do not differ in any basic way from the problems of storing information in digital form on magnetic discs. Although the principles of both are the same, being bound by the same laws of physics, I would submit that the problems are quite different.

It is shown that loss of head-medium contact produces intolerable losses for analogue recorders, yet all disc drives with any pretence to access speed or transfer rate employ flying heads which are typically 1/10 wavelength above the medium. There is thus no wear mechanism. Saturation recording is used, requiring no erase or bias process, and the harmonic distortion produced is of little consequence. These conditions put rather different constraints on the oxide and binder characteristics.

The phenomenon of peak shift distortion, where densely packed transitions tend to spread into less dense areas, requires special precompensation – a problem absent in analogue tape recording. Media defects in tape recorders result in dropout, which is seldom fatal, whereas in digital recording a corrupt machine instruction could result, which is intolerable, and therefore special hardware and software are necessary in order to make surface defects transparent to the system.

John Watkinson
Reading

I would like to clarify the interplay between coercivity and remanance of magnetic tape coatings as discussed in "Magnetic Recording Review" by J. Moir in the March issue.

Coercivity has not increased as a by-product of the search for increased remenance as the article seems to suggest. The major problem when trying to record short wavelengths at high levels on tape is that the elemental "bar magnets" laid down on the tape have low proportionality factors or length/thickness ratios (i.e. they are short and fat). Much of the field, conventionally taken to circulate from N to S poles, produced by such a magnet flows within the magnet itself and its direction is such as to cause partial demagnetisation, to an extent dependent on the amount of the flux (i.e. the recording level) and the coercivity of the magnetic material. High coercivity materials require to be driven harder by the record head as Mr Moir says, but by the same token they are more resistant to demagnetisation.

The maximum output obtainable from a reproduce head at low and medium frequencies is proportional to the tape remanence. Coatings are achievable with high remanence, or retentivity as it is often called in the data sheets, but low coercivity. The high frequency output of such coatings at high recording levels is, however, severely limited by demagnetisation. The magnetic medium is not saturated at h.f. in the usual sense, but is simply unable to support its normal remanent flux density due to the unfavourable magnet shape. The effect is clear when one compares typical cassette recorder frequency response plots at the often quoted 0VU = 200 nWb/m (Dolby level) and −20VU = 20 nWb/m levels.

The various "high energy" tapes ameliorate the problem by using particles with higher coercitivities than the 26kA/m (325 Oe) typical of γFe_2O_3 but the retentivity of these more recent tapes is not very different from the 100mT to 120mT (1000G to 1200G) of their iron oxide predecessors.

One further point relates to the "grinding" process mentioned by Mr Moir. The mixes which are destined to become tape coatings are milled to ensure thorough dispersion of their constituents, not to grind up the magnetic particles! The chemistry of particle production is largely orientated towards maintaining the acicular particle shapes Mr Moir mentions. The last thing a manufacture wants to do is to break up the carefully grown particles during milling. Broken particles in fact exhibit low coercivity and are a particular nuisance from the point of view of print-through.

J. D. Underwood
Wokingham
Berks.

The author replies:
The comments of Messrs Watkinson and Underwood add some valuable information on the details of tape coating design and digital recording techniques to my contribution on magnetic recording. Having spent some early years involved in the problem of keeping replay heads in good contact with magnetic tape I have often admired the skill of the designers of disc data recording equipment in being able to hold the replay heads so consistently close to the rotating disc and yet out of contact.

I do not think that there are any really significant differences on points of fact in any of the aspects they discuss, but just differences that reflect our respective professional involvements.

James Moir

WW IN 1915

Hugh Pocock's mention in April letters that he was not editor of *Wireless World* between the years 1914 and 1918 prompted me to look out my copy for April 1915 and indeed the editor's name never appears in that issue.

It is interesting to note that even in those early (and wartime) days the magazine, while soundly technical, was not without humour. The following appeared under the heading "War Notes":

> **"Kindness of British Tommies**
> On several occasions recently our soldiers have helped the German aeroplane operators to get a good earth. Strange to say, the operators, when picked up, have shown very little gratitude."

Again we have:

> **"Misconception of Wireless Possibilities**
> Two German workmen had been arrested as spies, and there had been discovered, hidden beneath the hearthstone of the kitchen in their two roomed (Glasgow) tenement house, a complete wireless installation capable of transmitting messages to Berlin.
>
> "Mr Gibson comments that it *is* possible to send wireless messages as far as from here to Berlin, but not with apparatus that can be stowed away beneath a kitchen hearthstone – or even contained in a large room."

The issue is full of excellent photographs and cartoons – possibly as padding since there must have been severe restriction on technical articles.

G. Johnson
Livingston
West Lothian

STOP COMMENT ON THE USES OF ELECTRONICS?

I have been dismayed for some time at the damage done to the high reputation of *Wireless World* by the political take-over of your editorial and correspondence columns. This has lately turned into a party-political take-over, and impelled me, against all my inclinations, to join the correspondence.

In doing this, I believe I may be representing the great majority of the readership, who, as correspondents, will remain grossly under-represented in comparison with the relatively few political activists.

No one disputes the importance of the issues raised, nor the necessity for them to be critically considered. What you and your politically activist correspondents seem to miss, however, are: (a) the issues *are* raised in the press, radio, and television – volubly, voluminously, stridently, incessantly and some would say ad nauseam; there is not the slightest need to recruit the pages of *Wireless World*; (b) your readership *does* think about and consider these issues at least as much and as deeply as by the activists, without, however, wearing their hearts on their sleeves.

May I beg you, therefore, to keep the discredited world of politics out of *Wireless World*, and to stop trying to push your bleeding heart down the throats of your readers.

R. I. Baker
Newton Abbot
Devon

I have been interested to read in recent issues some protests about controversial political matters being introduced into the pages of *Wireless World*. My own contributions have been controversial but were certainly not intended to be political since my own opinion is that I doubt very much whether the problems of this country and of the world are going to be solved by politics as we know them at present.

I suspect that this is another attempt to stifle legitimate discussion of subjects which are of concern to us all, whether engineers or not, but more particularly to engineers because we are expected and usually able to deliver the goods (or the bads as the case may be) in the modern world.

Personally I have never been able to split life up into sacred and profane parts whether in the matter of my professional or my spiritual life. To me life is a unity, I do not do my daily work just for the money, handy though it is, but also because I believe that it will be of benefit not only in this country but also world wide to some extent.

It seems to me that *Wireless World* is an enrirely suitable place where we should be able to discuss as concerned electronics engineers national and international matters of importance. These matters are at least as important as the adverts and no one seems to object to these.

Wilfred Laycock
Abingdon
Oxon

INTERFERENCE FROM MICROS

With reference to Hugh Ford's letter in the March issue, I would confirm strong interference from the Pet 3032 computer on radio and Band I television reception. It is impossible to use a scanner receiver when the Pet is operating.

J. Bruyndonckx
Herentals
Belgium

In March letters Hugh Ford complained about interference from microelectronic devices in toys, trainers and so on. Might I draw his attention to a bigger nuisance, namely television line timebases? The Home Office have seen fit to ignore the interference from television sets, presumably because they feel impotent to deal with such a source. Aren't they (the Home Office) similarly impotent vis-a-vis microelectronic devices? Any shortwave listener would doubtless welcome the compulsory screening of televisions and computers and anything else that oscillates as part of its normal operation.

L. J. Devaney
London W3

ETHICS IN ACTION

I have read every issue of *Wireless World* since about 1935, and have subscribed since 1945. Your November editorial coincided with my notice to renew my subscription for 1981. When I consider the number of electronics engineers who died in the course of ensuring that you should have the freedom to write material suggesting that electronics engineers eschew defence research, I grow thoughtful – so thoughtful that I am now cancelling my subscription.

D. J. Dewhurst
Electrical Engineering Department
University of Melbourne
Australia

I note that your "Microchips and megadeaths" editorial in the November 1980 issue is still causing comment. Mr J. S. Linfoot (April letters) seems to believe that the defence electronics engineer has only the dole as an option.

My personal experience does not bear this out. I used to be a microwave engineer heavily involved in major military contracts. After years of growing disquiet, I found myself being pressured to work on a project I found totally unacceptable: a military communications system for the South African Arms Bureau. This had slipped through a loophole in the arms embargo. I blew the whistle and resigned. Yes, I did spend six months on the dole; extensive national publicity did not help the job hunting. However, within eighteen months I was designing again, and have been since, but exclusively for peaceful purposes. No doubt my decision cost me money, but it did cause the loophole to be blocked. More to the point, I can now work without fear of the consequences for us all.

I feel that any engineer of use in military technology is likely to find himself to be of equal value to an employer producing equipment of real use to society. The choice exists.

Jock Hall
Braintree
Essex

AERIALS OF LIFEBOAT SETS

A. K. Tunnah (March letters) asks for information about the performance of low powered ships' lifeboat transceivers during actual distress conditions at sea. I can provide the following examples:

(a) The survivors of the *Schiedijk*, from a lifeboat, in conditions of sleet and snow and rough seas, maintained contact with Tofinoradio (Vancouver Island) from a distance of at least 150 nautical miles on 500kHz using Radio Holland portable equipment.

(b) On the other hand, the radio officer of the Lebanese sheep carrier *Farid Fares*, which sank off the Australian coast in March 1980, wrote: "I attempted to contact other vessels with the life-boat set, but was unsuccessful. The set appeared to load the aerial on 500 kHz and 2182 kHz satisfactorily, but after a short period of time water was all over the insulator . . ."

What might be achieved with the 4 or 5 watts available would seem to depend on the quality of the aerial. As Mr Tunnah mentions, the aerial most commonly provided is only a short telescopic mast or a bit or wire hung on a pole. It seems likely that the *Schiedijk* equipment had a long kite or balloon supported aerial and a well shielded insulator.

It is not only lifeboats that suffer from inadequate aerials. J. J. Boyd (December 1980 letters) had to feed 1.5kW into two 9-metre lengths of wire, the electrical equivalent of trying to pump 10,000 gallons per minute through a ¼-inch leaking pipe. It is absurd that on a supertanker a quarter of a mile long it is "impossible" to hang up a good aerial because "there is no room". Similarly, balloon or kite supported aerials should be provided with *all* lifeboat equipment.

John Wiseman
London E3

TWINS PARADOX OF RELATIVITY

I was surprised to discover that *Wireless World* had, without giving me prior notice, published an article by the late Professor Herbert Dingle "The twins' paradox of relativity" (October 1980 issue) in which my name is frequently mentioned. I do not think it was wise to publish the article: Professor Dingle died in 1978 and cannot defend himself if the controversy which he aroused is started up again.

Professor Dingle's article asserts that there has been a general lack of published debate on his critique of Special Relativity, and goes on to describe this as a "scandal". From the article it would appear that, at least by implication, Professor Dingle believes me to be party to this "scandal", as I did not publish my replies to his criticisms in 1977. Sir, too much has already been published on the Dingle question, and the time is long past to call a halt to this whole business. I was the last, and one of the least distinguished, of a 20-year long succession of physicists who answered, in public or in private, Professor Dingle's questions about Special Relativity. These scientists did not convince him of his errors and, not surprisingly, neither did I. In the panel accompanying his article, Professor Dingle is described as an expert on relativity. My first, succinct answer to his question was couched in terms intelligible to any physics undergraduate, yet he dismissed it as "technical jargon". I then expended a lot of time, effort, and paper in explaining my answer in non-technical terms. I was unable to establish the ground on which Professor Dingle rejected my explanation. Before corresponding with him, I carefully read Professor Dingle's book and examined all the published literature on this point. Despite complaints about the debate being stifled, very many papers have been published. I emerged from our correspondence with a much deeper understanding of Special Relativity, and an unshakable conviction that Professor Dingle's criticisms are wholly without foundation.

Apart from the personal benefit of my deepened understanding, our correspondence discovered nothing new or original on the question. We were as far from agreement at the end as we had been at the beginning. It therefore seemed futile to me then to publish another tract on a subject which had been well-ventilated in the literature. I am still of that opinion. Most academic journals have for some years rightly viewed the matter as settled and regarded more discussion of it as a waste of paper.

Professor Dingle was a distinguished historian of science. He started to question relativity after he had re-read Einstein's first paper on the subject. Although I do not have German enough to verify this myself, it may be that there is an error or ambiguity in one of the examples Einstein gave in the paper (comparing clocks at the north pole and the equator). Instead of regarding this, if it be true, as an interesting insight into how Einstein himself had not fully thought out the implications of relativity at that time, Professor Dingle chose to regard that paper as a canonical definition of the theory and used it as the spearhead of his attack. As the discoverer of a possible mistake by Einstein, Professor Dingle might have written an illuminating chapter on the history of science; as Einstein's dogged, but mistaken, critic, he has written himself into that history.

His struggle against the scientific establishment lasted over 20 years. By his energy and persistence, he tempted many scientific heavyweights to step outside their narrow fields of expertise and commit themselves to print in simple everyday terms. Some were wise enough to resist this temptation and, like Nobel prize-winner Max Born, couch their answers in technical terms whose meanings were precise and well-defined. Some of those who did venture an answer in layman's terms tripped themselves up on the imprecision and ambiguity of everyday words. In the face of a critic who scrutinised every word as a theologian does the Bible some scientists showed themselves to be very poor writers, and Professor Dingle triumphantly attributed the obscurities of their explanations to the contradiction he claimed to see in the theory. Where then can one turn to for a definitive statement of the theory? Not to the original papers – for as we have already seen these are the first published thoughts on the subject, and second thoughts may change the author's mind; or can we look to the textbooks – for some of these are well-written and some badly, they are all written for different readerships and their function is to teach, not to define. This lack of a simple verbal expression of the theory is not fatal as it might seem, for science is not theology; scientists criticise theories by performing experiments, not by examining texts as if they were Scripture.

In my case, the language of relativity is geometry, not English or German. There is a double irony here, for Professor Dingle's own critique is formulated in everyday terms and he has himself tripped up on the imprecision of our normal vocabulary. Professor Dingle was quick to point out verbal errors by his opponents, yet his criticism of relativity is itself founded on a confusion of language. Perhaps the whole issue of how a scientific theory can be properly expressed might form an interesting research topic for some future historian or philosopher of science.

Professor Dingle did not succeed in conquering the citadels of science. The measure of his failure was the length of his struggle. For what happened to all the bright research students who were young in the 1950s when Professor Dingle first published his criticism of relativity? Some are now Nobel prizewinners, but the prize which they won is recognition of many years of painstaking labour – albeit illuminated by occasional flashes of inspiration – in the patient obscurity of a specialised field of physics; no-one of this high calibre was attracted by the thought that, if a physicist demolished Einstein's relativity, his name would overnight become a household word. The scientific establishment of the 1950s might have had a vested interest in opposing change, but the younger generation then did not. Other ideas have been overthrown in the last 20 years, but relativity remains. Yet what credit, what fame, would have accrued to the physicist who dethroned Einstein! That no young student over the last 20 years has seen the chance to make his name by developing Professor Dingle's ideas is eloquent testimony to the erroneousness of these ideas.

In the commentary which accompanies Professor Dingle's article, Professor McCausland poses the questions "Why not discuss relativity?" and "Why is criticism of relativity so resented?". I have deliberately chosen in this letter *not* to discuss relativity but to treat this whole business as an episode of historical interest. The Special Theory of Relativity is as well established as the theory that the earth goes round the sun. Both theories have consequences that are contrary to commonsense: for example it is a matter of elementary observation that the earth is flat and stationary and that the sun moves round the earth – it requires many precise experimental measurements and a sophisticated theoretical apparatus to arrive at the opposite (and correct) conclusion. Professor Dingle's criticism was not as crude as this example, it merited some attention: it has received too much.

No journal would be accused of suppressing criticism if it ignored a paper asserting the earth was flat, there is no scandal in refusing to publish papers on the geocentric theory of the universe; in the same way, there is no scandal in refusing to discuss further Professor Dingle's critique of relativity.

Criticism of relativity is not resented, only the vain repetition of an empty argument is irksome. Like every other scientific statement, relativity (both special and general) is at the mercy of future experience. Sooner or later an experiment will crop up whose result will be incompatible with relativity and a new theory will be devised to replace it, just as Einstein's theory replaced Galileo's. And just as there was a long struggle against Einstein's relativity, a struggle in which Professor Dingle was the last protagonist, so the scientific establishment of the future will fight against relativity's successor. If the academic journals of the future display to the new theory, when it arrives, the tolerance they have shown to Professor Dingle, the scientific establishment of the future will lose that fight.

Too much has been written on this matter already. Please, let it rest.

Thomas D. B. Wilkie
International Atomic Energy Agency
Vienna, Austria

The above letter, and those of other readers who have responded to Professor Dingle's article, will be dealt with in a composite reply by Professor McCausland in the next issue. – Ed.

AUDIO KITS

As a manufacturer of hi-fi kits I feel I must comment on the points raised by Mr M. J. Evans (November letters) and Mr M. G. Taylor (March letters) questioning the value and worthiness of these kits.

I would agree with Mr Evans that, generally speaking, hi-fi kits should be avoided. Some kits that I have come across seem doomed to failure – the basic design being unsound. Many kits advertised in electronics magazines arise in the following way. An enthusiastic constructor 'designs' a circuit configuration, and produces one-off, at most a few off, to test the design. The next step is that a component supplier will then be offering kits of the published design, with commonly available parts. The problems arise in many areas. One needs to produce a fairly large batch to be sure that h.f. instability will not occur with a set of 'worst case' components. Next, a change of manufacturer of semiconductors for instance (even of the same transistor number) can give similar problems. It is worth remembering that 'bulk' transistors contain dead or u/s devices – and I don't know how the amateur constructor is expected to locate them. Lastly, having built the kit the constructor often has the suspicion that it may not be 100% perfect – but without good test gear he does not know.

Suppliers of non-assembled p.c.b. kits have very little obligation in law to give any sort of back up service should a kit of parts be non-functional. Suppliers often take the attitude that 'correctly built' the kits always work – the logic thus extends to point that all repairs must be paid for, sometimes referring the customer to an independent firm specialising in repair work.

The pre-assembled p.c.b. type of kit gives the customer the assurance that this major item of the kit is fully tested and carries a guarantee to the minimum of that required by law in the 'Sale of Goods' act, if not more so by many manufacturers.

To conclude I would agree with Mr Taylor that the constructor should have basic knowledge of electronics and should choose and *build* with care.

B. E. Powell
Crimson Elektrik
Leicester

ENERGY FROM SPACE?

I enjoyed reading M. G. Wellard's "Appreciation of James Clerk-Maxwell" (March issue) with his penetrating analysis of modern theoretical physics. The criticisms he makes in a general way were clearly in Vallée's mind when he developed his uniform field theory referred to in my earlier article (October 1978 issue). Vallée starts with a model of space and, in view of the obvious presence of various forms of electromagnetic waves, he makes the assumption that all the energy in space, including gravitational energy, is in an electromagnetic form. Realising too that the mathematical equation relating to the waves are continuous and that the superposition of waves would eventually lead to infinite values of the field, he postulates that there is an upper limit of field at which the properties of space alter so as to prevent any further increase.

With these two assumptions added to Maxell's theory he develops a comprehensive unified field theory which furnishes the results generally accepted from other theories but without their contradictions, and also contains many new features, such as physical models for the photon, electron, fundamental particles, the origin of cosmic rays, and the dual nature of light. However, the most important prediction, which could have a profound effect on our future, is the possibility of reconstructing β radioactive elements without using the energy they liberate on disintegration but by absorbing energy directly from the electromagnetic gravitational medium.

There has long been some evidence that energy could be obtained from space. In 1927, Wolfgang Pauli observed the apparent violation of the law of the conservation of energy in the case of β-emissions. In 1931, Niels Bohr stated that the concept of energy appeared to be inapplicable to sub-atomic phenomena and that in the sun and the stars energy appeared to be provided from nothing. The energy unbalance in the case of β-emissions was attributed to the presence of a new particle – the neutrino; but attaching a name to the phenomenon does not help to explain it.

The ultimate test of a theory is its ability to explain existing experimental results and to predict new ones which are capable of experimental confirmation.

According to Vallée the first experimental evidence was provided by the production of β-radiation of six million electron volts in the torus of the "Tokamak" nuclear fusion equipment at the Kurchatov Institute. Similar results were obtained in a specific experiment made with a Tokamak torus at the Department of Plasma Physics, C.E.N., in 1974.

Then what he believes to be the most startling confirmation is provided by the explosion of the French atomic bomb at Mururoa on 25th July, 1979. Its effects, including the emission of an enormously intense electromagnetic wave, were quite different from those of any previous explosion.[1]

Vallée had hoped that his idea might lead to the deveolpment of a safe, cheap and universally available source of energy which could provide mankind with a hope for the future. His work was discouraged but there is now the suggestion that it has been developed in secret to provide a new weapon of destruction. It is to be hoped that we have some scientists who are sufficiently open-minded to study Vallée's theory and its possible application to the peaceful production of energy.

L. Essen
Great Bookham
Surrey

Reference

1. R. L. Valle'e. *Synergetique* (Bulletin of the S.E.P.E.D.) No. 28, Jan./Feb. 1981.

PAYING FOR GOODS

Perhaps the "large public utility" which Mixer was referring to in Sidebands of February 1981 was British Telecom. I met recently the same situation as the engineer he mentioned, in being unable to persuade a supplier to send the goods until payment had been received and being unable to get the Post Office to part with the cash until I had signed for receipt of the goods.

The first time I took the risk myself and signed in advance, but then I asked the clerical person if there was a better way. He explained that I only had to ask the supplier for a proforma invoice and payment would then be made immediately.

I tried it and it worked. Where there's a will there's a way.

Brian Castle, G4DYF
British Telecom
London WC1

INVENTION OF STEREO RECORDING

In the UK the engineering profession has long attributed to Alan Blumlein the invention of many basic concepts, including the 45/45 system of stereo recording.

My fellow readers will be aware of the issue of some recordings by the Bell Telephone Laboratories of experimental work done between 1931 and 1932, which includes stereo disc recordings made at the time. A friendly dispute has arisen between myself and an American colleague in which he avers that the Bell work predates that of Blumlein's, both in a practical sense and the basic patents.

Now I have been very carefully through all the evidence and in my mind, the information on Blumlein's work is quite explicit; on the other hand, that from the Bell Laboratories which makes no mention whatsoever of work done elsewhere, is obfuscatory in the extreme. The demonstrations do not mention whether they were 45/45 or hill and dale and whilst the patents do mention the 45/45 concept, their relevance to stereo recording is somewhat vague.

However, I am attempting to keep an open mind and I am sure that we would all wish to be fair to Alan Blumlein or, if it turns out to be so, to the work of A. C. Keller at Bell who may not be getting the public credit he may deserve. So may I appeal to my historically knowledgeable fellow readers to come to the rescue and settle it once and for all?

Reg Williamson
Norwich

PICKABACK SPARKS

I find that the very diversity of content in the letters published in *Wireless World* provides far more stimulation than the very worthy articles which sandwich them. The three letters on pickaback sparks (November, March and April) served to remind me that I have never attempted a literature survey on the triggering of arcs and sparks; and it would certainly be of interest to establish any contribution it made to the technology of early wireless transmitters. Use of an air blast in a.c. discharges goes back well before wireless usage, to Tesla and to Thomson in the 19th century; and it would not surprise me to find that all the possible variations of series and parallel triggering techniques go back a long way too. Certainly, when I was developing light sources for high speed photography in the 1950s (e.g. *Jour. Phot. Sci. 10* (1962), pp. 271-9) it seemed almost impossible to invent anything that didn't derive from the work of Mach, or at least Cranz, both pioneers in ballistic photography. My only advantage seemed to lie in the greater variety of available electrical components, and more and better insulating materials; so that series and parallel triggering transformers, triggered gaps etc. were either easy to get made in the workshops or could be purchased.

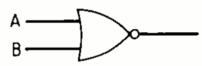
Books like "High Voltage Laboratory Techniques" by Craggs & Meek on the library shelf, and the later compilation by Frungel, made triggering *sound* easy enough; but sympathetic discharging of multiple gaps was not unknown. Despite this, I didn't experience the cascade catastrophe of John T. Lloyd until the early sixties; the company electrician was both pardonably annoyed and slightly incredulous when he came to mend the fuse. Co-users of the laboratory were even more disenchanted by the noise from my open air-gap discharges; a tip worth remembering is that the Marconi Company enclosed one of their marine spark-gaps in a stout wooden box. I put mine in a large bore Pyrex tube and closed the ends with loose corks; the result was a quiet pop instead of a loud bang, followed by bad language as I searched for the corks.

Desmond Thackeray
Music Department
University of Surrey
Guildford

LOGIC DIAGRAMS

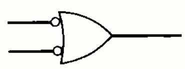
It is unfortunate that the common usage term Nor means (a) Or the statements and then (b) invert the result, rather than the other way round. The logic gate which did (a) an Or followed by (b) an Invert was therefore correctly, but most unfortunately, called "Nor" (rather than the more accurate Orn):

	A	$\bar{A}$
B	0	0
$\bar{B}$	0	1



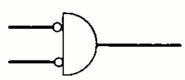
Had there been no common usage term Nor, we would have called the gate below a Nor.

	A	$\bar{A}$
B	0	1
$\bar{B}$	1	1



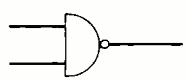
I am old enough to remember my horrified reaction when the bastard term Nand began to be used to mean, not the expected Invert followed by And:

	A	$\bar{A}$
B	0	0
$\bar{B}$	C	1



but rather And followed by Invert:

	A	$\bar{A}$
B	0	1
$\bar{B}$	1	1



I knew then, in 1960, that we would have to pay for this slovenly development in our terminology. We're paying for it now. See *Wireless World*, February 1981, page 50.

Changing the subject a little, Tony Cassera's article in November 1980 should have referenced U.S. MIL STD 806B, which originated the philosophy he described. (I am willing to supply copies of this standard at cost. The controlling committee refuse to do so, having merged it now with the very much inferior A.S.A. standard. However, U.S. MIL STD 806B, the best standard in the world, remains the de facto world standard. For the worst, see British Standards.)

Ivor Catt
St Albans
Herts

FAILURE OF DISTRESS SIGNALS AT SEA

Mr J. J. Boyd's letter in the December 1980 issue states: "This is only an emergency installation and is a back-up to the ship's main m.f. transmitter which, today, has a p.e.p. output in the region of 1.5kW."

It may be that the main transmitter on Mr Boyd's vessel does have a p.e.p. output of 1.5kW on m.f. I think, however, if he refers to the specification for his main transmitter he will find that on m.f. in the A1 mode of transmission (c.w.) it has a power output of 500W, and in the A2H mode of transmission (m.c.w.) the power output is 320W. The designation p.e.p. usually refers to s.s.b. A3A or A3J modes of emission used on the h.f. bands, and on h.f. s.s.b A3J on 4, 6, 8 and 12MHz, the main transmitter does have a p.e.p. of 1.5kW. But s.s.b. A3A or A3J modes of emission are not used on the m.f. bands. A2H m.c.w. is the usual mode of emission on m.f.

Personally, I would not share Mr Boyd's optimism that in most emergencies at sea the ship's radio officer would have access to his main w.t. transmitter, this being either supplied by power generated on-board by the ship's main or emergency generators. In any emergency at sea, there is a fifty/fifty chance of all locally generated power failing, particularly in the case of fire on-board, thus placing complete reliance on the battery powered emergency transmitter.

I would concur, however, with Mr Boyd, regarding his remark on the comment of one shipping superintendent on costs, at being asked "to foot the bill for a re-designed aerial system". Such remarks by the ship owner or those he employs ashore are typical. Without doubt all ships do conform to the statutory safety rules and regulations, and so long as they do that seems all the owner is concerned about. But one can only ask, is there not room for a complete revision and up-grading of these regulations? This to include all the electronic equipment carried by ships, whether such equipment be compulsorily fitted or not. It makes one wonder, do ship owners write SOLAS (Safety of Life at Sea) as $O£A$? Is the ship owners' lack of response to recent letters in *WW* to be taken as a measure of their interest or concern?

The letter of Mr P. J. W. Sawyer (December 1980) seems to imply that not all aerial insulators are kept clean. This may or may not be so. All I can say is that the losses of power referred to in my letter of May 1980 occurred with clean insulators. The answer to this problem lies in the better engineering design of ships' aerial systems.

A. K. Tunnah
Sydney
N.S.W., Australia

CURRENT DUMPING ANALYSIS

Mr Malvar's article on current dumping (March issue) appears to assume that the output impedance of the non-linear amplifier (B) is zero. In the common case where B is a push-pull common collector stage this will not be true for small signals.

In fact his results are independent of this assumption, as I am sure he realises. Using his notation

$$V_1 = A(V_S - kV_2)$$

$$\frac{V_0}{R_p} = \frac{V_1}{R_3} + \frac{V_2}{R_4}$$

and hence $\dfrac{V_0}{R_p} = \dfrac{AV_S}{R_3} + \left(\dfrac{1}{R_4} - \dfrac{kA}{R_3}\right)V_2$

When $kA = R_3/R_4$ the gain is AR_p/R_3 and is independent of V_2.

Mr Malvar's use of "B" as a non-linear operator is mathematically unsound since it leaves the question of the amplifier's output impedance undefined. The analysis above shows that his results are true in any case.

K. G. Barr
University of the West Indies
Bridgetown
Barbados

Electronic thermometer

Simple sensing diode provides accurate and reliable temperature measurement

by A. S. Henderson

Although several designs for electronic thermometers have been published, most of these have either been complicated or low performance devices. This design has been kept simple for reliable operation, and offers an accuracy within 1% of f.s.d.

The most important part of an electronic thermometer is the sensing device which, in most cases, should be small, have a low thermal capacity, generate a large signal, respond linearly to temperature variations, abstract or dissipate very little energy and have a long life. Several devices such as thermistors, transistors and special i.cs were considered, but the most attractive device appeared to be a miniature signal diode. It is generally accepted that, with a constant current, the forward voltage across a silicon diode reduces by 2mV per degree increase in junction temperature.

This can be expressed as

$$\Delta V = \frac{kt}{q} \ln V_f$$

where k is Boltzmann's constant and q is the charge on the electron. As k and q are fixed, the change in voltage must be linearly connected to temperature, and the physical constants of silicon give 2mV/°C.

To test this parameter, six batches of 100 miniature signal diodes were evaluated as shown in Fig. 1, using a 9 to 15V d.c supply connected in series with a 10kΩ resistor, a multimeter and a diode. The diode under test was cycled from 0°C to 100°C with a forward current of exactly 1mA at 0°C. As there was no detectable change in forward current, this was assumed to be constant. The forward voltage drop, V_f, of each diode was measured at ambient temperature to record the spread in V_f within a batch. These values were grouped in 5mV steps, and the distribution of V_f within six batches of 100 silicon devices is shown in Fig. 2.

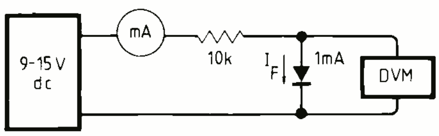


Fig. 1. Test circuit to measure V_f.

From each type, two devices from the outer distribution spread, ignoring the odd wild values, and three from the central concentration were assembled into probes and tested for V_f at 0°C and 100°C. The correlation between V_f at 0°C and the voltage excursion, ΔV, over 100°C for four types is shown in Fig. 3. The 1N3063, 1S44 and 1N4154 showed no apparent correlation and have been omitted.

A batch of germanium diodes, type 1N3470, was also tested and Fig. 4 shows the distribution of V_f(amb) for these devices. An ideal device, indicated in Fig. 3 by a dotted line marked 2mV/°C, has a

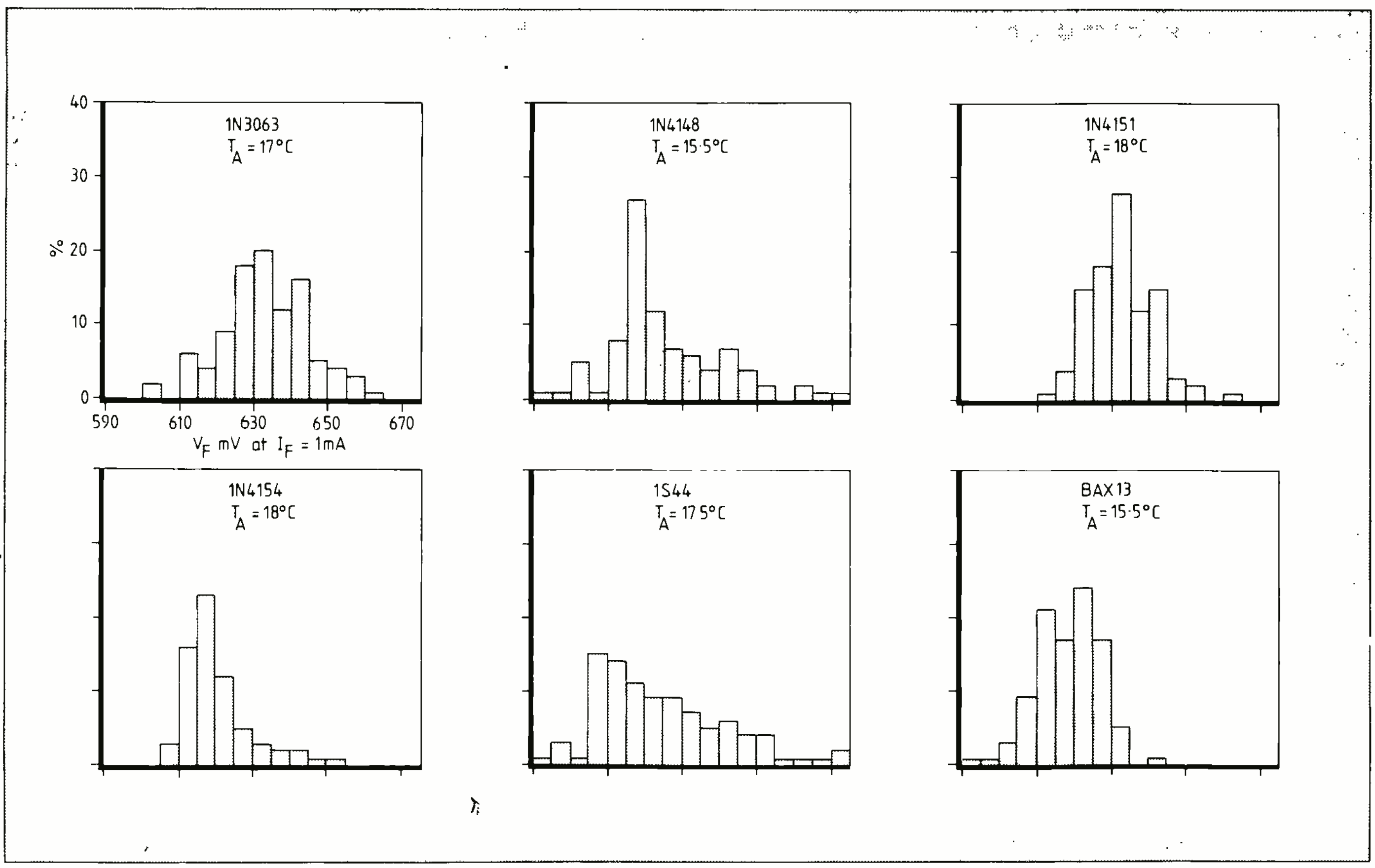


Fig. 2. Distribution of V_f (amb) for six types of silicon diode.

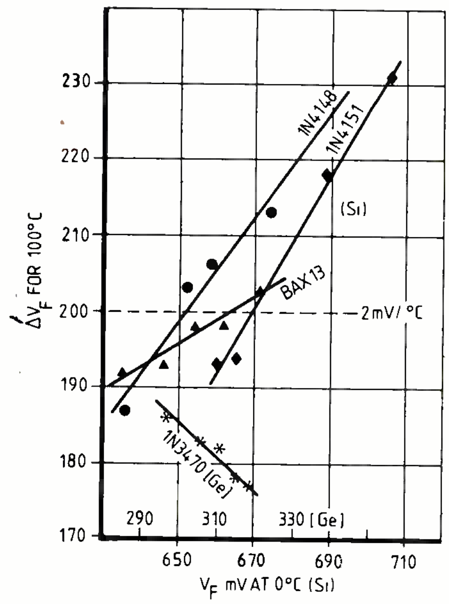


Fig. 3. Correlation between V_f (0°C) and ΔV_f (100°C).

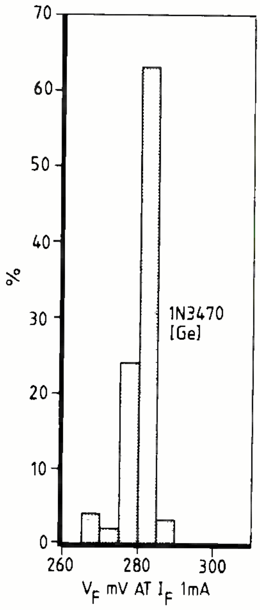


Fig. 4. Distribution of V_f (amb) for a germanium diode.

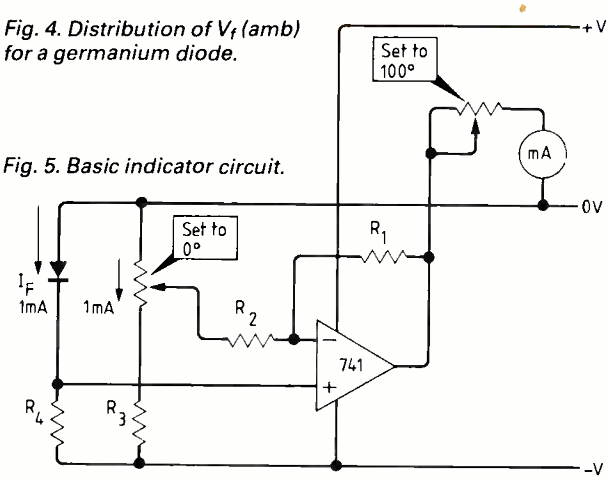


Fig. 5. Basic indicator circuit.

horizontal slope which is independent of V_f at 0°C. The closest slope to the ideal is shared by the BAX13 and 1N3470 silicon and germanium devices respectively.

From the distribution figures it is clear that very few diodes in a batch of 100 will give an exact 200mV excursion for a 100°C change in temperature (180mV for the 1N3470), therefore the range of the indicator needs to be adjustable. If the 0° and 100° readings are set by potentiometers, it is possible to achieve accurate and reliable temperature measurement.

The circuit shown in Fig. 5 uses a diode sensor with its anode connected to 0V and a 1mA bleed resistor to the negative supply. The junction of the diode and resistor feeds the non-inverting input of an op-amp, and the inverting input is connected to an identical negative voltage from the set −0°C cermet potentiometer. Therefore, with the circuit adjusted, when the diode is at 0°C the output from the op-amp is 0V. As the temperature is increased V_f at the non-inverting input reduces, i.e. becomes more positive, and the output goes positive. A closed-loop gain of around 5 gives an output of about 1V. If a 1mA meter is connected from the output via a 1kΩ potentiometer to 0V, the 100°C signal can be adjusted for f.s.d. Alternatively, f.s.d. can be set for any intermediate output to give a wide choice of scale values. Other meter sensitivities can easily be used by altering the value of the set −100°C potentiometer.

To avoid problems with drift, the instrument requires a regulated power supply as shown in Fig. 6, which also provides a temperature-stabilized reference voltage of around 7V. The V_{ref} terminal is used for 0V and is connected to earth. The main regulator controls the positive rail at double V_{ref}. The complete circuit shown in Fig. 7 uses an alternative voltage adjustment network which provides a smoother and less critical adjustment of the output voltage.

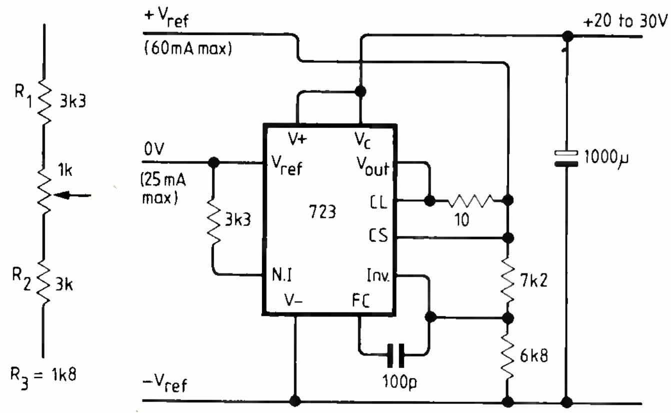


Fig. 6. Stabilized power supply. The resistor network allows adjustment of the positive rail to exactly twice V_{ref}.

For battery operation in a portable unit, the 723 regulator cannot be used because it requires a 9V input and a slight voltage drop causes trouble. The circuit in Fig. 8 overcomes this problem by using a 7V2 and a 3V6 Zener diode for stabilizing the positive and 0V rails respectively. One drawback, however, is the loss of temperature compensation provided by the 723.

In applications which require a switched output, such as the control of a heating element, a simple modification is to remove the feedback network from the op-

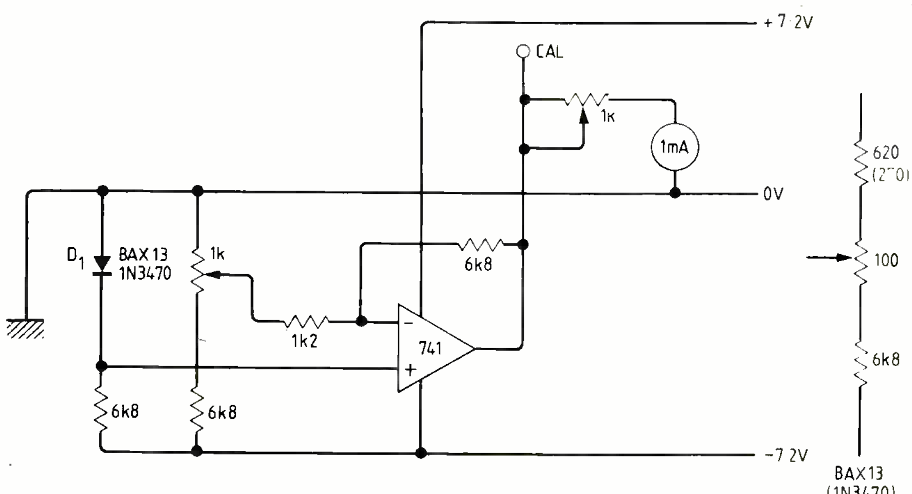


Fig. 7. Prototype circuit using a silicon or germanium diode.

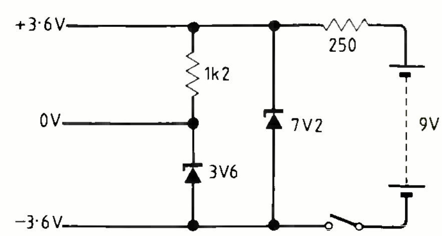


Fig. 8. Simple regulator for a battery supply.

amp in Fig. 7 and use it as a comparator. However, because the change in temperature is proportional to temperature difference, the probe will not quite reach the ambient temperature and over the last fraction of a degree the output changes very slowly. This will cause the op-amp to oscillate for several seconds before switching and may permit switching by thermal noise. Introducing hysteresis by positive feedback is an effective way to stop the oscillation, but this produces an unacceptable dead band. The problem can be overcome by using a dual op-amp with one half connected as in the original circuit and the output signal fed to the second half connected as a comparator with positive feedback. As the output signal is more than five times greater than the input, the dead band is reduced to less than 0.5°C. The combined indicator and comparator circuit is shown in Fig. 9. In the prototype some 741 op-amps did not switch off the transistor. If this occurs, a signal diode should be connected in series with the emitter to raise the base voltage.

Because this is a low-gain, low-impedance circuit, construction is not critical and earthing the 0V line enables a cheap and simple probe to be assembled as shown in Fig. 10. To prevent mains hum a screened lead should be used with the probe.

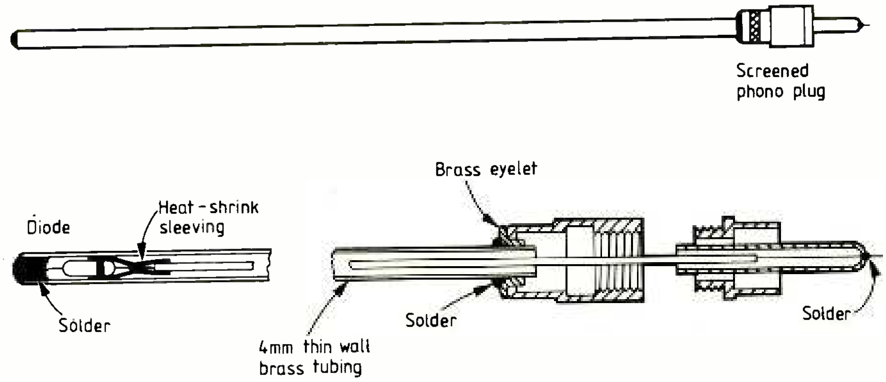


Fig. 10. Temperature probe assembly.

Multi-channel operation

As explained earlier, diodes of the same type do not exhibit exactly similar characteristics so multi-channel operation is not straightforward. Using several meters or cermet potentiometers is expensive, and wire-wound types suffer from poor resolution. Matching the diodes provides a low-cost solution and the test circuit in Fig. 11 enables the devices to be sorted into 0.5mV or 0.25°C groups very quickly. The test circuit does not measure V_F directly but the differences in V_F compared with a preset value, which permits the use of the most sensitive voltage range.

When switching two or more probes at the input to the indicator circuit, the switch must be a make-before-break type so that the op-amp input is always connected. For special applications it is easy to modify the circuit. Closely matched op-amps as in the 747 minimise temperature drift even in a high-sensitivity differential circuit.

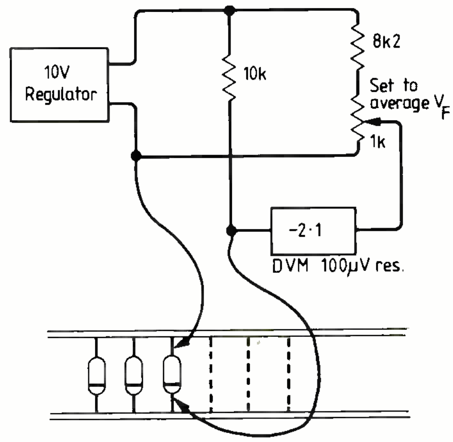


Fig. 11. Test circuit for matching sensing diodes.

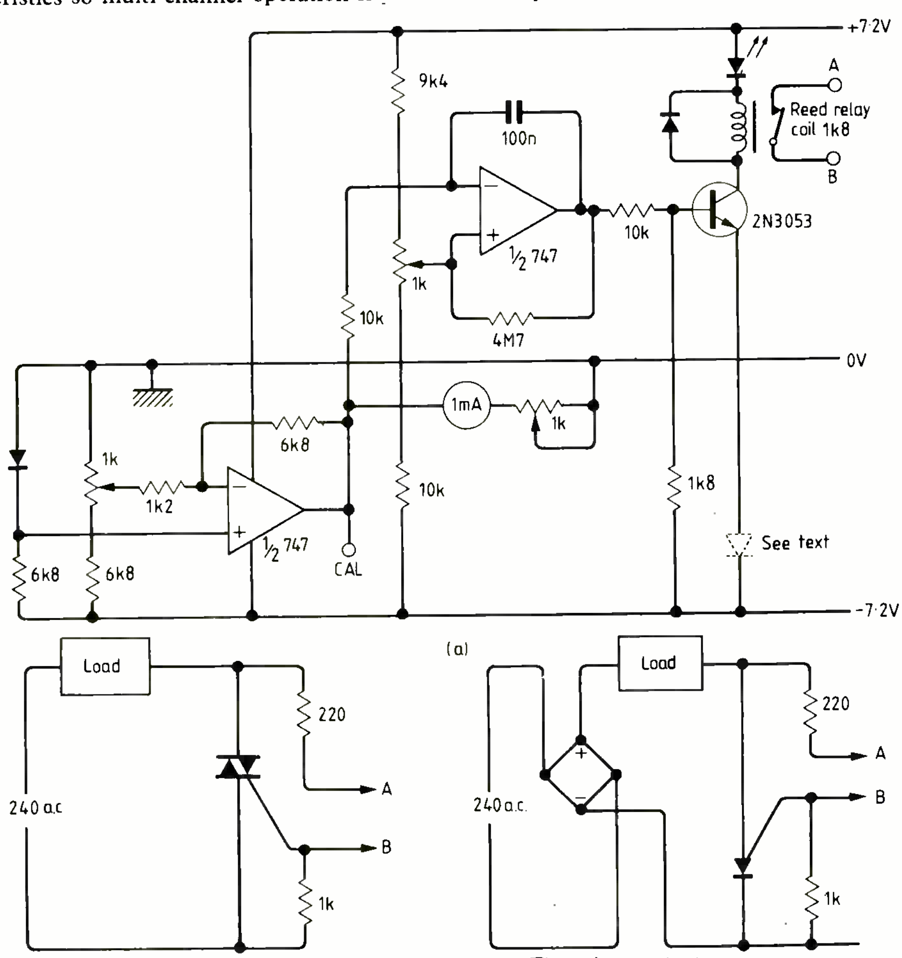


Fig. 9. Temperature indicator and comparator switch. The relay contacts can switch a small load or trigger the optional triac/s.c.r. circuits.

Calibration

Calibration is simple and only requires distilled water. Prepare a tray of ice cubes from the distilled water, half fill a suitable container with the ice cubes and add the same amount of cold tap water. Stir thoroughly until the ice cubes are about half their original size, insert the probe and, when the meter reading stabilizes, adjust the 0°C control so that the meter reads zero. The mixture should be stirred again and the adjustment checked. Next, boil some distilled water, insert the probe and repeat the procedure for the 100°C control.

For intermediate scale lengths such as 0 to 40°C, proceed as above with a voltmeter connected between the cal point and 0V. Note the voltages at 0°C and 100°C, the output voltages at intermediate temperatures will be exactly proportional. Although diodes do not have the same temperature coefficient of forward voltage, the voltage changes linearly with temperature. When calibrating an intermediate scale always start at the bottom end with water about 5°C hotter than the minimum value. Insert the probe and calculate from the calibration cycle the output voltage at the minimum value. When the voltmeter agrees with the calculated value, adjust the 0°C control for zero. Repeat for the maximum value and adjust the 100°C control for full scale. It is better to use the cooling cycle rather than the heating cycle because cooling takes place more smoothly and uniformly. □

WAVES

By Ariel

Stratospheric or catastrophic?

It doesn't seem all that long ago that we were being told that tv broadcasting by satellite on a global scale would soon be as common as the Chinese take-away on the corner. Since then we haven't heard much more. I wonder why?

No doubt money or the lack of it lies at the root. It's a safe bet that development and building costs would call for at least another pound on the price of a pint, which is unthinkable. And the cost of actually launching satellites into space would be astronomical – if you see what I mean. Why, even down here on good old terra firma a 40-mile trip in a Mini costs around £1.60 in petrol alone.

Never mind, once we've got the Tories, the Labour Party, the Liberals, Roy Jenkins' lot, inflation and the Royal Wedding out of the way, and Marks and Spencer have taken over at Westminster, things are bound to improve. And a heartened and revitalized tv industry, rising from the ashes of the old, will doubtless resume work on the project.

Certainly the prospect is a dazzling one. Who would resist the idea of sitting at home in the suburban semi watching programmes zooming in from everywhere via that tiny man-made twinkler in the sky? Not me, for one.

But the concept is not without its problems. One of them is fine tuning. And, if that's not licked, you could find yourself getting stations coming in from all directions simultaneously. The situation is further complicated by the fact that, as you know, many countries transmit localized equivalents of our own past or present national favourites.

Among these offerings are *Z-Rickshaws* from Hongkong, *Loudly-Loudly* from the US (where they believe in making their ears work for a living), *Abdication Street* from the USSR (where coronations are forbidden) and *Bottom Of The Pops* from, as you may have expected, Down Under. Then there's that delightful children's series, *Black Peter*, from Lagos, and those two workmanlike versions of *Mr and Mrs*, entitled *Herr Und Frau* and *Sahib & Memsahib* from Berlin and Bombay respectively.

This means that, unless you're firmly locked on to the right frequency, there could be a sudden change of the received programme without your immediately realising it. For instance, seconds could elapse before you cottoned on to the fact that you'd been transported without warning from The Rover's Return to a remarkably similar local in Leningrad.

Time and geographical differentials, too, have to be considered and you must be prepared to make some swift and radical mental adjustments as you view. Let me give you a few examples. Some of our overseas friends put out virtual carbon copies of our own *Tomorrow's World* and *This Week*. Those countries on one side of the international dateline call their shows *Yesterday's World* and *Last Week*. On the other side they're known as *The Day After Tomorrow's World* and *Next Week*. By the same token that fine series, *When The Boat Comes In*, emerges either as *When the Boat Goes Out* or *Now The Boat's Come In*, depending on tidal variations. *News At Ten* is available in the full range of hours from one to 24.

Well, so much for the programmes. The real trouble starts when you get down to the equipment for receiving them. One thing you can't do without is a parabolic or dish aerial. OK, I know that set-top job that's been bringing you pictures of near-photographic quality from Granada for years is neat and unobtrusive. But it just won't do. Signals from space need a lot more room to land on.

The parabolic comes expensive if only because of its size. (How big? Have you seen pictures of that one at Goonhilly? Well, then . . .) Also, if you want the best reception it has to be mounted on the roof. This is sure to be unpopular with the neighbours and you may also attract the attention of the Town Hall bureaucrats who'll write you stiff letters about planning permission and adjustment of rateable value.

Leaving these incidentals aside, your first task is to get the dish up to chimney level. There are two methods open to you. One is to hire – at ruinous cost – an RAF air-sea rescue chopper, complete with crew, who will lower your aerial by cable. There's one snag about this method. These RAF types have odd ideas about priorities and are quite liable to drop you – and your dish – if they get a sudden call to save some incompetent dinghy-paddler in trouble off the Lizard. New roofs come expensive, too.

The second, and by far the cheapest and most practical, solution is to invite your mother-in-law for the weekend. Then you lush her up with lots of choice food, good wine and compliments. When she has reached the right stage of recklessness, you tactfully suggest she might be able to do you a good turn. Before she's had time to question this proposal, you must swiftly strap the dish on to her back and ease her gently up the ladder you have placed in position previously. With all that booze swilling about inside her, she's bound to enter into the spirit of the thing. And, as she will resemble an adventurous turtle, she cannot fail to provide lots of fun for the onlookers as well. Just one point. Don't take the ladder away. She may want to come down again.

All right, so you can't afford to hire a helicopter and you don't have a mother-in-law. In that case you'll have to find some way of accommodating your dish inside the house. The experts don't, I'm told, favour the living room. This is because once you've got your dish in there's no room for anything else – not even the tv set. And that makes the exercise pointless.

However, there is one more thing to think about before you finally decide, when the time comes, to view the world. Signals from satellites have a long way to come and inevitably they meet with objects on their journey, like aircraft, for instance. This has a deflecting effect which could louse up your picture. So consider all the pros and cons well. Unless, of course you live in the middle of the Sahara. You wouldn't have any problems there.

What's all this 'ere then?

It's been suggested that the BBC's traffic information service, Carfax, should be run by the Metropolitan Police. Never mind the politics, this sounds a sensible plan which would open up the possibility of a number of refinements to the service, hitherto undreamed of and backed by the full majesty of the law. Imagine something like this.

You get into your car in the morning, switch on and out comes a courteous, friendly, but authoritative voice: "Good morning, sir or madam, as the case may be. Now, we're going to drive with due care and attention this morning, aren't we? No cutting up old ladies in even older bangers or trying to squeeze between two tankers, eh? And we have heard of speed limits, haven't we? Good." You can almost hear the thumbs being hitched into the belt.

Then, at midday, when you're setting out for an expense-account lunch with that important customer the other side of town, you might hear something like this. "Well, sir or madam, according to sex, it's time to look after the inner man or woman, depending on gender. If we're having sandwiches from home or meat and two veg. in the canteen we've nothing to worry about, have we? But, Oh dearie us if we're planning to consume alcoholic beverages. They can work out so expensive if we have more than we can carry, can't they?"

Come the cool of the evening, you flick the radio switch just once more before bedding down the car for the night. That helpful voice is still at it. "If we've finished motoring for the day, we will be sure to lock the car doors and switch off the lights, won't we?" I think our policemen are wonderful.

Optics and communication theory

Few electrical engineers study optics using a communication theory approach

by V. Srinivasan, Ph. D. University of Singapore

For electrical engineers, a fascinating approach to understanding the behaviour of lenses and other optical elements is by an application of their knowledge of systems and communication theory. Optics provides a fresh insight into several mathematically well-defined signal processing operations such as Fourier transformation, convolution and filtering. Linear system theory on the other hand offers an alternative means of interpreting basic optical phenomena such as diffraction and interference. With the help of a few examples this article explores several analogies between optical and communication systems.

Consider a point object located on the optical axis of a lens with perfect spherical surfaces. A two dimensional impulse function $\delta(x,y)$ is used to represent the signal i.e. photons emanating from o in Fig. 1. These photons are scattered in all directions and only a fraction falling within a cone of apex angle θ are collected by the lens. The resulting image at I is not an impulse function $\delta(x',y')$, but a circularly symmetric distribution of intensity called an Airy disc:

$$i(r') = |J_1(kr')/kr'|^2$$

where r' is the radical coordinate in the image plane, $k = A/2\lambda v$, A is the aperture diameter of the lens, λ the wavelength, v the image distance and J_1 a first-order Bessel function. The physical process producing this effect is called diffraction.

Communication theory provides an alternative interpretation: the impulse function $\delta(x,y)$ has an infinite *spectral bandwidth* and the lens with a finite aperture of diameter A transmits only a part of this spectrum. As a consequnce the photons constituting the image distribute themselves in the form of an impulse response function or Airy disc. Unlike time domain signals, characterized by a one-dimensional frequency spectrum is a two-dimensional complex valued function.

A useful feature of the optical system is the direct accessibility of the frequency space: for example, to modify the impulse response function of a lens the transmittance of the aperture has to be changed. The Airy disc can be made narrower by increasing the aperture of the lens: this is the reason for operating a camera at a small "f-number" to record fine details in an object. In communication terminology, a system with a larger bandwidth has a sharper impulse response function. A lens is a low-pass filter for spatial optical signals.

As a filter, a lens has a transfer function called the modulation transfer function (m.t.f.). For a lens with perfect spherical surfaces the impulse response function is the intensity distribution

$$i(r') = i_A \cdot i_A^* = |i_A|^2$$

where $i_A = J_1(kr')/kr'$ is the amplitude distribution in the Airy disc, i_A^* is its complex conjugate. Light being an electromagnetic radiation is characterized by a complex field distribution consisting of magnitude and phase parameters. What our eye responds to is the intensity of the field.

The m.t.f of a lens is the Fourier transform of $i(r)$. From the last equation, this is equivalent to the convolution between the transforms of i_A and i_A^*. Intensity i_A is the field produced when a plane wavefront, whose extent is limited by an aperture A, is brought to focus by a lens. As a matter of fact i_A is the Fourier transform of a function

$$\begin{aligned} F_A(\omega) &= 1 \text{ for } 0 < \omega > A \\ &= 0 \text{ for } \quad \omega < A \end{aligned}$$

This is known as the pupil or aperture function in optics. The m.t.f. of a lens may be viewed as the convolution between two circular unit amplitude functions shown in Fig 2. The area of overlap $F(\omega)$ represents the magnitude of the m.t.f. at a spatial frequency ω. In the case of circularly-symmetric systems (most optical systems are) all these functions have a single varia-

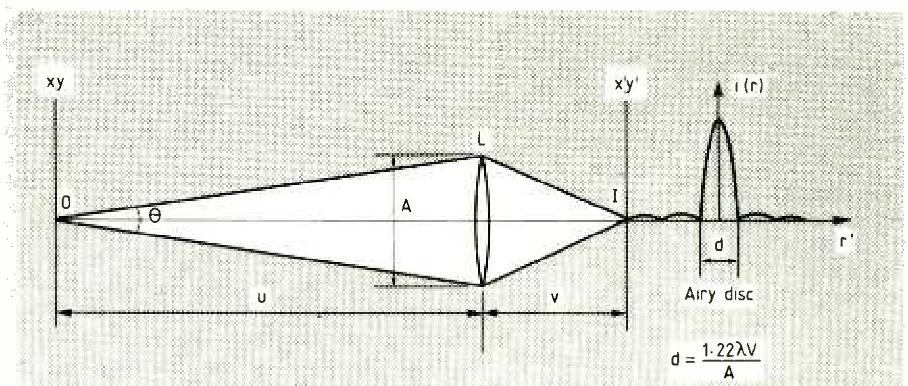


Fig. 1. Image of a point object is a circularly symmetric distribution of intensity called an Airy disc.

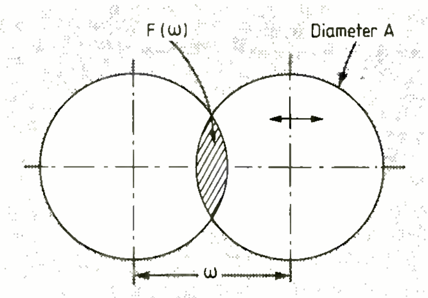


Fig. 2. Modulation transfer function of a lens may be viewed as an auto-convolution of the aperture function. Area of overlap represents magnitude of the m.t.f. at spatial frequency ω.

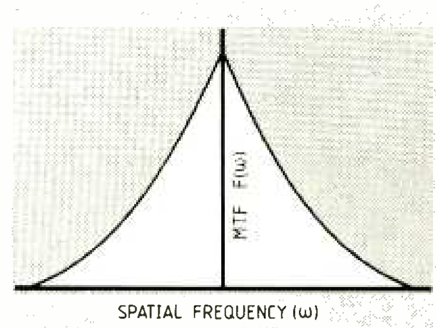


Fig. 3. High quality lenses have an m.t.f. close to that of an ideal or diffraction-limited lens.

ble – the radial coordinates – and they are real-valued because of the symmetry. An ideal or diffraction limited lens has an m.t.f. shown in Fig 3. High quality lenses have an m.t.f. close to that of an ideal lens.

If $f_0(x,y)$ represents the intensity distribution of an object illuminated by ordinary light, then the intensity distribution in its image formed by a lens is

$$f_i(x',y') \circledast i(x,y)$$

where $i(x,y)$ is the impulse response function of the lens and $\circledast$ indicatesconvolution.

In communication systems most often a frequency domain analysis is used to predict performance. A similar technique is to compute the transform of an object, multiply by the m.t.f. and by an inverse transformation the image can be predicted. This is a very useful method of evaluating a lens designed for imaging special types of objects, such as precision mask patterns used in the fabrication of intergrated circuits. These mask patterns have a significantly high frequency content as they consist of sharply defined black and white regions.

For illumination with ordinary or incoherent light, every point in the object $f_0(x,y,)$ creates an intensity distribution in the image plane, $f_0(x',y')$. Intensity $i(x-x',y-y')$ and all such intensity distributions add up to produce an image $f_i(x',y')$. A unity magnification factor between the object and image has been assumed for convenience. For illumination with coherent light from a laser, images are formed by the addition of complex field distribution where both magintude and phase are involved. The imaging is by the addition of complex valued amplitude, instead of intensities which are real and positive. Many important effects, such as the creation of the Fourier transform of a function $f(x,y)$ using a simple lens, are observed when illumination is by coherent light from a laser.

Coherent optics

Two narrow slits, illuminated by a plane wavefront from a laser and placed in the front focal plane of a lens, produce an interference pattern in the back focal plane, see Fig. 4, whose amplitude distribution is

$$A(x') = A_0 \cos(x' X/\lambda f)$$

where A_0 is a constant determined by the intensity of the incident plane wavefront, λ is the wavelength and f is the focal length of the lens. From Fourier transform theory, it is known that a cosine function has a transform consisting of a pair of impulse functions in the frequency space. The double-slit experiment clearly demonstrates the Fourier transformation property of a lens: the amplitude distribution in the front and back focal plane of a lens constitute a Fourier transform pair; the two slits approximate impulse functions. In a laboratory experiment the slits would have widths and as a result the interference pattern falls off in intensity as we move away from the centre.

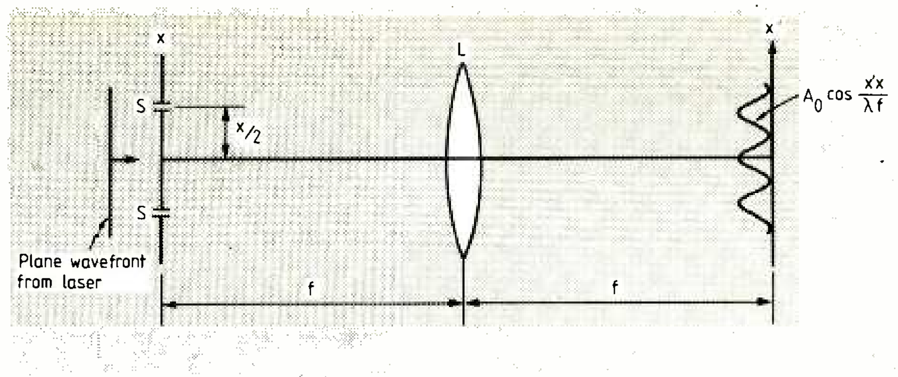


Fig. 4. Amplitude distribution in the front and back focal plane constitute a Fourier transform pair; the slits approximate impulse functions.

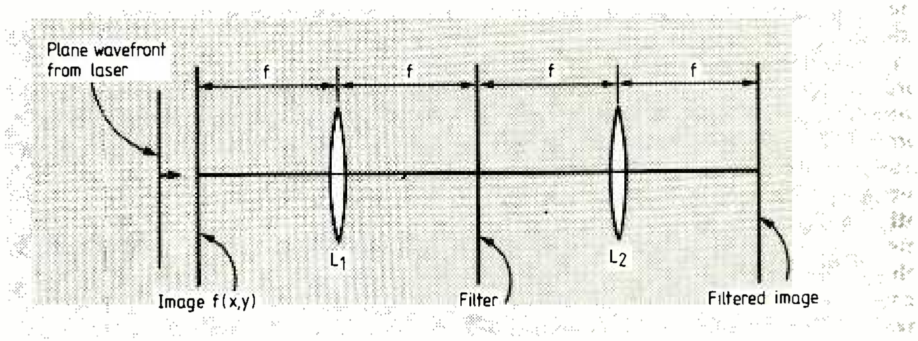


Fig. 5. Optical image processing system operates on the Fourier transform of an image by spatial filtering.

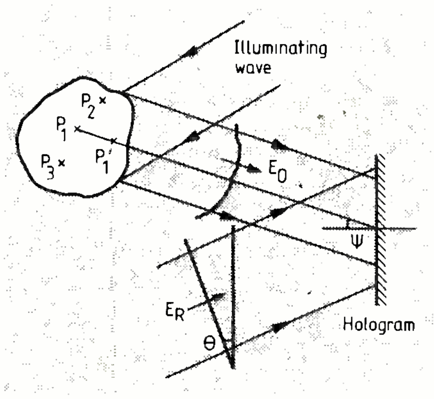


Fig. 6. Two-dimensional intensity distribution at the hologram is a combination of angle and amplitude modulation.

This can also be explained using the concept of convolution: the input signal consisting of two slits may be viewed as a convolution between two ideal impulse functions (located at $x/2$ and $-x/2$) and a function representing the transmittance of a single slit of finite width. In the transform what one obtains is an amplitude $A_0\cos\ (x'x/\lambda f)$ multiplied by the transform of a single-slit transmittance function. The last mentioned falls off in amplitude away from the centre and as a result only a few periods of the interference pattern are clearly visible. The diffraction of light by a grating is a complementary effect: light transmission by a simple grating is mathematically equivalent to a square wave signal and when placed in the front focal plane of a lens it produces an array of impluse functions in the back focal plane.

If the double slit is replaced by a more general amplitude transmission function $f(x,y)$, such as that created by an image recorded in the form of a transparency, one obtains its transform $F(u,v)$ in the back focal plane. When a screen is placed in this plane what the eye perceives is $|F(u,v)|^2$. The two-dimensional signal $f(x,y)$ can be looked on as a synthesis of sinusoidal amplitude distributions, each with a different spatial frequency and relative position in the signal space. In effect this is a Fourier series representation of $f(x,y)$. Every spatial frequency component creates a transform consisting of a pair of impulse functions, whose magnitude defines the spectral value at that frequency. In this manner the complete transform of the input is generated.

Optical image processing

The low cost and simplicity of the method of Fourier transformation using a lens provides a means of implementing, in an elegant form, an image processing system. One lens is used for the Fourier transformation and a filter designed to perform a desired operation is placed in the back focal plane of the lens. A second lens is used for the inverse transformation as shown in Fig. 5. A filtered image is recorded in its back focal plane. This technique is called spatial filtering.

Filters which operate on the magnitude as well as the phase of the image spectrum can be constructed using holographic methods. Spatial filtering is used for image deblurring (rectifying pictures recorded out of focus or by a moving system), pattern recognition and image enhancement. As a simple example, consider the case of filtering to eliminate the scan lines in a photograph recorded from a television screen. On Fourier transformation by a lens, the scan lines in such a picture would produce a pair of bright peaks in the filter plane. A simple blocking filter can be used to prevent their transmission to the second lens.

In holography, popularly understood as a means of reproducing three-dimensional images, a photographic recording is made of the intensity distribution $I(x,y)$ created by the interference between a wavefront E_O emanating from an object and a reference wavefront E_R (Fig. 6):

$$I(x,y)=|E_O+E_R|^2.$$

When this photographic recording is illuminated by a reference wavefront E_R the original object wave is reconstructed. Naturally, to create the interference pattern and for reconstruction, the wavefront required must be coherent i.e. derived from a single laser.

In one type of hologram, the reference wave is a plane wave incident at an angle θ, with respect to the hologram recording plane, Fig. 6. Consider the recording of the holograms of a single point P_1 located on the distant object. The wavefront produced by P_1 at the hologram plane would be approximately a plane wave, subtending an angle ψ. The intensity distribution in the interference pattern between this wave and the reference plane wave has a certain periodicity T and contrast C, see Fig. 7. Points P_2, P_3 . . . in the object, depending on their position and scattering intensity, produce in a similar fashion interference patterns with different period and contrast. A superposition of all these patterns is the hologram.

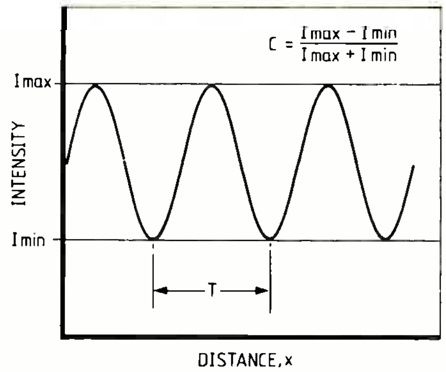


Fig. 7. Superposition of interference patterns, with different period and contrast, between a reference wave and a multiplicity of object waves is responsible for one kind of hologram.

From communication theory, one can deduce the reason why a hologram is able to reproduce the object wavefront. The information about the object is stored as a two-dimensional intensity distribution $I(x,y)$. Intensity $I(x,y)$ is a modulated signal: the nature of modulation is a combination of frequency modulation phase modulation and amplitude modulation. The presence of f.m. can be understood by considering three points P_1, P_2, P_3 in the object, each subtending a different angle at the hologram plane. The interference pattern due to each of the points would have a different frequency. Phase modulation occurs because two points, say P_1 and P_1', subtending the same angle ψ produce an interference pattern with the same frequency, but shifted relative to each other. Amplitude modulation results from differences in relative scattering intensities of the points forming the object; this affects the contrast C of the interference pattern.

Another interesting property of a hologram of this type is the redundancy of the coding process: even a small piece of the original hologram can reconstruct the complete object, though with a lower resolving power. The redundancy property arises because every region of the hologram receives light from all the points in the object and thus contains information about them. The three-dimensional object has a certain scattering intensity distribution along its visible surface and possesses, in a mathematical sense, four degrees of freedom. From the earlier description of the modulation process, one can recognise five degrees of freedom: the recording is on a two-dimensional plate and three types of modulation are involved. This is one way of understanding the redundancy property of the hologram. □

Further reading

More detailed description of optical systems and their theoretical analysis, based on communication theory, may be found in several books and papers.

E. L. O'Neill, Introduction to Statistical Optics, Addison-Wesley, 1963.

J. W. Goodman, Introduction to Fourier Optics, McGraw-Hill, 1968.

A. Papoulis, Systems and Transforms with Applications in Optics, McGraw-Hill, 1968.

K. Preston, Coherent Optical Computer, McGraw-Hill, 1972.

G. W. Stroke, Optical computing, *IEEE Spectrum*, vol. 9, Dec. 1972.

A. B. Van der Lugt, Coherent optical processing, *Proc IEEE*, vol. 62, Oct. 1974.

S. H. Lee (Editor), Optical Information Processing, Springer-Verlag, 1978.

Literature received

A list of over two hundred books on **microprocessors and computers,** with short descriptions and prices, is available free from March Communications, 7 Victoria Terrace, Liverpool L15 5BH WW401

A guide to the range of **technical publications** produced by Mullard, which includes much of interest to the amateur engineer, as well as the professional, is obtainable from Mullard House, Torrington Place, London WC1E 7HD. WW402

New catalogue from the reorganized Anglia Components is now available. Active and passive components (particularly strong on i.cs, linear and digital) tools and instruments are stocked for the industrial and retail customer. Free from Anglia Components, Burdett Road, Wisbech, Cambs. PE13 2PS. WW403

Instruments from Ailtech, briefly described in a new brochure, include frequency synthesizers, spectrum analysers, noise-figure instruments and receivers and sweep oscillators – all compatible with the IEEE-488 bus – and several others. Copies can be obtained from Eaton Ltd, EID, Sherwood House, High Street, Crowthorne, Berks. WW404

Two brochures from 3M describe **thermal cut-off** devices. The D series is intended for general use in electrical appliances and the MTP type is designed to protect motors and transformers. Both are based on the use of chemical pellets which melt at the design temperature and allow contacts to open. The brochures can be obtained from Ron Freeman, Industrial Electrical Products, 3M (UK) Ltd, 3M House, PO Box 1, Bracknell, Berks RG12 1JU WW405

A 12 bit **data acquisition** system, in a single 40 pin package, contains input multiplexer, amplifier, track-and-hold amplifier, a-to-d converter, timing and logic. A brochure describing the Micro Networks MB7140 is available from Pascall Electronics Ltd, Hawke House, Green Street, Sunbury-on-Thames, Middx. TW16 6RA. WW406

Two brochures, published by TRW, describe a range of small motors and actuators. Catalog No 1000 is on the subject of **stepping motors** for incremental motion control, while Catalog 103 concerns itself with precision miniature a.c. and d.c. **motion systems,** both rotary and linear. The brochures can be obtained from MCP Electronics, 38 Rosemont Road, Alperton, Wembley, Middlesex HA0 4PE. WW407

Flow measuring elements working on the differential pressure principle, and turbine flowmeters are detailed in two publications from Tekflo Ltd, Albany Road, Granby Industrial Estate, Weymouth, Dorset DT4 9TH. WW408

Brochures from Imhof-Bedco show a wide range of cabinets and enclosures racks and accessories and small tools for board and enclosure assembly. The firm has also developed Image 90, a range of desk enclosures for minicomputers, word processors and test stations, which is described in a separate leaflet. Imhof-Bedco Standard Products Ltd, Ashley Road, Uxbridge, Middlesex UB8 2SQ. WW409

A very useful little guide is published, free of charge, by the Association of Franchised Distributors of Electronic Components (AFDEC). In three columns, it lists a large number of manufacturers, the names of distributors of their components and the manufacturers' product ranges. It can be obtained by writing to AFDEC at Owles Hall, Buntingford, Herts. WW410

The March issue of **Systems Technology,** which is the Plessey house journal, is entitled The Silicon Age. It is beautifully produced and gives an insight into the manufacture and application of integrated circuits, setting out some of the background to Plessey's current work, which began in the early '50s. A limited number of copies is available on request from J. C. Smith, Editorial Department, Plessey Telecommunication and Office Systems Ltd, Edge Lane, Liverpool L7 9NW. WW411

The Quad ESL-63 full range electrostatic doublet puts an end to rumour and speculation.

The Quad ESL-63 has a very light plastic diaphragm positioned between two sets of acoustically transparent concentric annular electrodes. Signal is fed to the electrodes sequentially via a delay line. The resultant sound pressure pattern is a facsimile of that which would be produced by an ideal point source positioned some 30cm behind the plane of the diaphragm; completely phase true, very aperiodic, with a level response and near perfect directivity index devoid of all side lobes.

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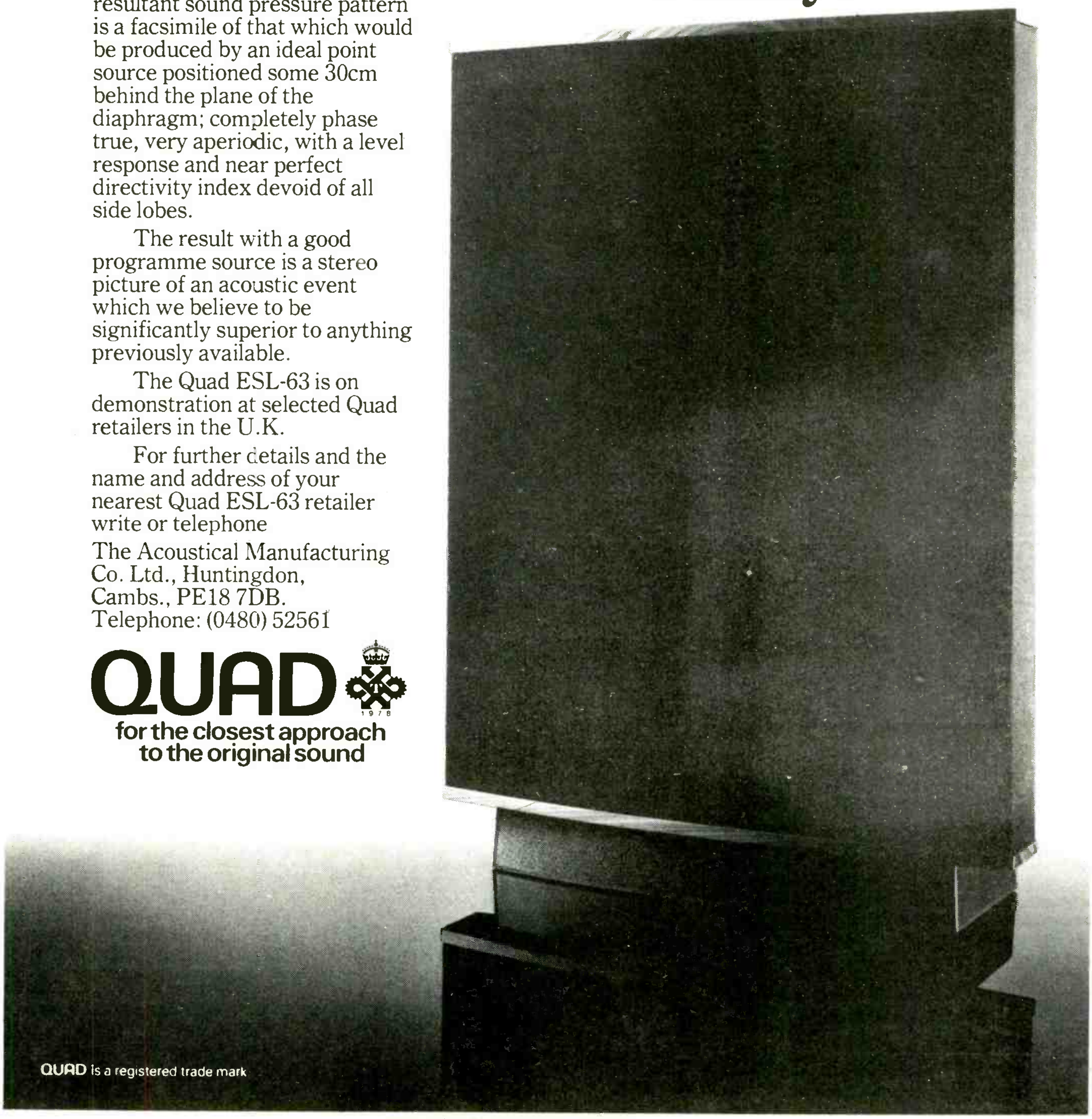


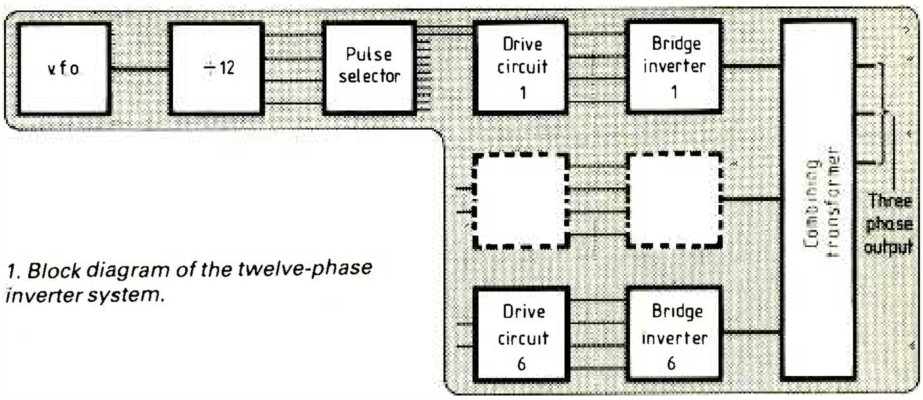
WW – 005 FOR FURTHER DETAILS

Variable frequency inverter

– traction motors controlled using a 12-phase thyristor bridge

By **B. M. Banerjee and S. Chowdhury,** Saha Institute of Nuclear Physics, Calcutta

Traction motors need a high starting torque. Brushless, polyphase induction motors are reliable and efficient, but they need a large starting current and at the time of starting they have poor torque and efficiency. If the supply frequency could be reduced, the torque at stall would be increased and the motor would become more efficient, especially in applications such as railway traction. Converters and inverters using thyristors are efficient and we describe here the design and the results obtained from the development of such a system.



1. Block diagram of the twelve-phase inverter system.

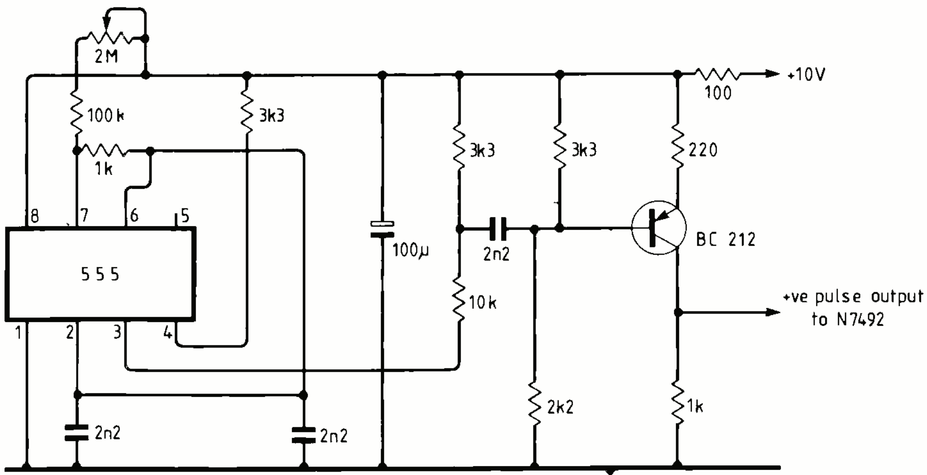
The block diagram of the system is shown in Fig. 1. A variable frequency oscillator is followed by a divide-by-twelve circuit. A pulse selector delivers twelve pulses, sorted into pairs at intervals of 30°, which are applied to six transistor drive circuits. The drive circuits are used to switch twenty-four thyristors in six impulse-commutated bridge inverters. Outputs of these inverters are combined systematically in nine transformer secondaries to produce a near sine-wave, stepped waveform. The maximum output is 3kW. The frequency can be varied continuously from 10 to 200Hz, and can be readily increased to the kHz range for centrifuge operation.

Fig. 2 shows the variable frequency oscillator that uses a 555 linear integrated circuit. Its frequency can be readily varied by the 2MΩ potentiometer over the range of 10 to 200Hz and 30 to 600Hz. Its output, inverted by a BC212 transistor, is used to trigger the digital i.c. 7492, shown in Fig. 3.

The 7492 is a divide-by-twelve circuit, comprising four flip-flops, giving outputs at A, B, C and D. These go to the 74154 decoder, which is a four-line to 16-line decoder which sorts out individual positions in the 12-pulse sequence, which are 30° apart in phase angle. Starting from left, we get the selected pulses at their 'proper' output positions, from zero up to the fifth.

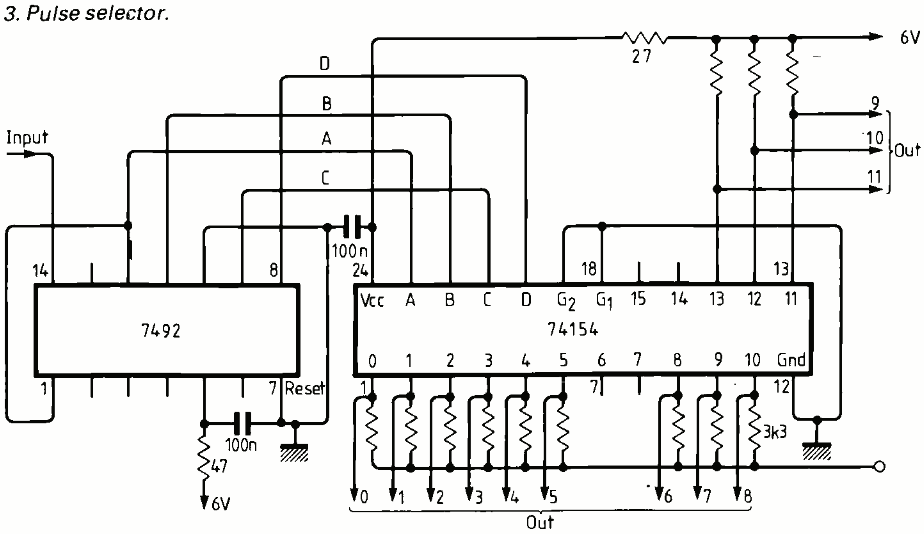
We get the sixth pulse at position 8, seventh at position 9, corresponding to the states of the 7492 flip-flops. At the 12 pulse, 7492 reverts to the zero position and subsequent pulses begin the next sequence.

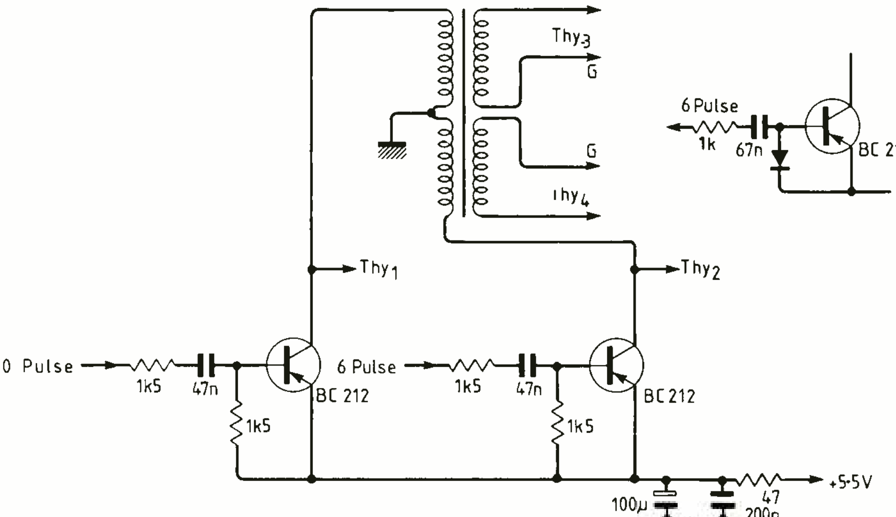
The output of the decoder is a negative step lasting until the next pulse arrives. This is applied to the drive circuit shown in Fig. 4. The negative pulses, in pairs with 180° phase difference are applied to



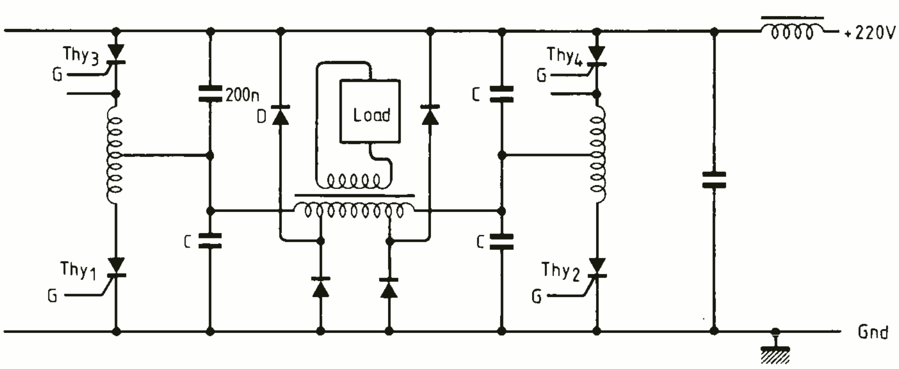
2. Variable frequency oscillator.

3. Pulse selector.

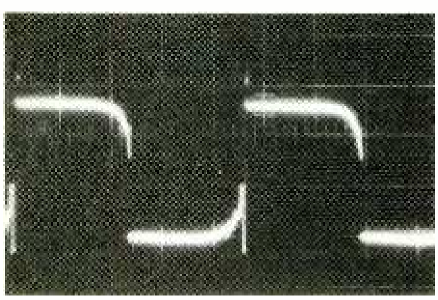




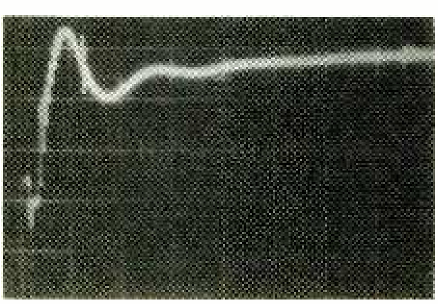
4. Drive circuit for single-phase bridge inverter.



5. Bridge inverter. The commutation transformer may be wound with 28 SWG insulated wire, 130 turns centre-tapped, on a ferrite pot with a 12mm centre core and an outside diameter of 37mm. The power transformer has a 220V primary and a 220V secondary tapped at 10, 110 and 210 watts. The prototype used 30 SWG wire with 5 turns/volt.



6. Th_1 output waveform.



7. Turn off waveform.

the p-n-p transistors, BC212, which conduct alternately for a period corresponding to a 30° phase angle. The pulse transformer supplies outputs of correct polarity with adequate amplitude and duration to the four thyristor gates of the corresponding bridge inverter circuit.

The bridge inverter circuit is shown in Fig. 5. This takes power directly from the 220V d.c. mains (which may be derived from a rectified a.c. supply). Th_1 and Th_2 are at the negative side of the supply, while Th_3 and Th_4 are at the positive side, with the commutation transformer in between. Current must flow through the power transformer from right to left when Th_4 and Th_1 are conducting. When conduction commences in the Th_2 and Th_3 pair, Th_1 and Th_4 are automatically turned off by the discharge of the condensers through the other halves of the commutation transformers. Conduction in Th_3 and Th_2 causes current flow in the power transformer from left to right. The application of pulses to the thyristor pairs causes alternation hof current flow in the power transformer, generating a.c. with rectangular waveform. Power may be drawn from the secondary or from across the primary.

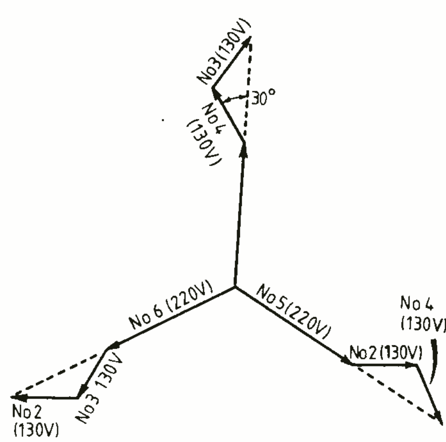
With ferrite core commutation transformers, pulses of short rise-time and duration will secure fast (~10μsec) turn-off in the thyristors. The rise time attainable with ordinary sheet core transformers measures 100μsec, so turn off cannot be achieved in a smaller time. As a consequence, the commutation capacities have to be increased five times to prolong their discharge.

The commutation process is not simple, but the principles are explained in detail in the book by Bedford and Hoft[1]. The design of both commutation transformers and power transformers are involved. Specifications for this design are given with Fig. 5.

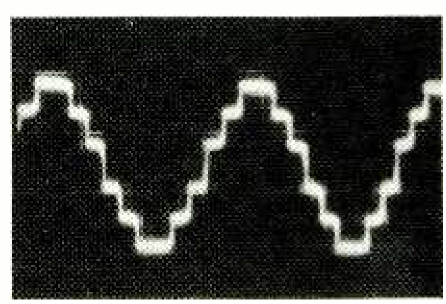
The rectangular waveform obtainable at the anode of Th_1 (or Th_2) is shown in the oscillogram, Fig. 6. The turn off wave form can be seen at the faster sweep in Fig. 7. The voltage initially drops to a high negative value, stays negative for the turn off interval and then rises through zero to the full amplitude. The superimposed oscillations are due to shock excitation of the commutation transformer winding with its stray capacitance.

Fig. 8 shows the scheme of vector addition of the nine windings of six inverters in the system. The three-phase combined output, Fig. 9 will show a six-step near-sine waveform (oscillogram). The lowest harmonic present in such waveform has a frequency eleven times the fundamental. When only three inverters are worked, the output contains the fifth harmonic as the lowest, as multiples of two and three are nulled.

We have used 2N4444 thyristors which are rated "5 Amps a.c." and peak forward and inverse voltages of 600 volts. They can be safely loaded to a little over two amperes d.c. flowing through each inverter. The power obtainable in six inverters is, therefore, 2.4 kilowatts. The power is also limited by heating and saturation in the communication transformers. Thyristors failure results probably because of the high



8. Vector addition of the inverter windings.



9. The combined output of six inverters.

peak currents (30A) that are encountered due to core saturation while commutating high voltages.

The outputs of three inverters were applied to a quarter h.p. three phase induction motor. Its windings are star connected and nominal speed 960 rpm at 50 Hz supply. With 2 μF power factor correcting condensers across the lines, the motor would follow the frequency from 10 Hz to 80 Hz, the speed changing from 200 to 1600 rpm. The torque at 10 Hz is good. The total power drawn from the D.C. supply was 250 watts.

An adjustable frequency inverter system for 50 kVA (Flairty, 1961)[2] has been reported. This report, however, presented only the outlines of the plan, with no details of the design or components. Scaling up the power level may cause snags, but these can surely be overcome. For railway traction, motors must have a power of 100 kW.

For variable speed applications, at present, d.c. motors are generally used. For stability of speed and for precise control, a sophisticated system is required. The variable frequency inverter motor is a modern alternative with a promise of superior performance, superior reliability and reduced complexity.

The authors are indebted to Professor D. N. Kundu, Ex-Director of S.I.N.P., for his kind interest and support. It is also a pleasure to record the interest taken by Professor A. K. Saha in this work.

References

1. Bedford, B. D. and Hoft, R. G. "Principles of Inverter Circuits", Wiley, 1964. pp190-206.
2. Flairty, C. W. "A 50kVA Adjustable Frequency 24-phase Controlled Rectified Inverter". AIEE Industrial Electronics Symposium, Boston. September, 1961. (See also Ref. 1 pp 264-278).

Science research embraces engineering

Uncertainty about what is to be called science and what technology will be increased by the recent renaming of the UK's Science Research Council as the Science and Engineering Research Council. The name has been changed to recognize "the increasing importance SRC has placed on ensuring that engineering research departments in universities and polytechnics have the necessary resources to produce the innovative technology and highly qualified manpower urgently required by UK industry". The Engineering Board's expenditure in universities and polytechnics rose, for example, from £9m in 1973-74 to £27m in 1979-80. Its proportion of the total SRC budget rose in the same period by 50% at a time when the budget, in real terms, was falling. The major element of that growth, according to the new SERC, has been "applied to stimulate and support research programmes chosen to be of the greatest potential benefit to the national economy in such areas as marine technology, polymer engineering, manufacturing systems, energy, microelectronics and materials".

Spectrum analysis – and more

"Much more than a spectrum analyser" is Solartron's way of describing their new 1200 and, to emphasize the fact, they call it a signal processor. The description could be confusing to those who work with data loggers, but the instrument itself is one of the most comprehensive dispellers of confusion we have seen for some time.

In its main function of spectrum analysis, the 1200 possesses two input channels for simultaneous time and frequency domain measurements, autoranged from 10mV to 300V, with rectangular, flat-top or Hanning weighting. The pretrigger display is up to 100 per cent and the display can be externally synchronized. If an expanded-trace facility is exercised, the 500 line resolution corresponds to 0.002Hz per line, and this can be done while the other half of the screen displays the unexpanded version of the presentation. The frequency base is linear, logarithmic or in octave divisions.

Stimulus to a passive system is provided by a choice of three noise sources: a pulse, a pseudo-random binary sequence or a novel multi-sine source, which consists of all the relevant frequencies to correspond to the 500 lines. In this way, since control over each frequency is available , examination along the frequency base is precisely controlled and large resonances, which would otherwise mask smaller ones, can be eliminated.

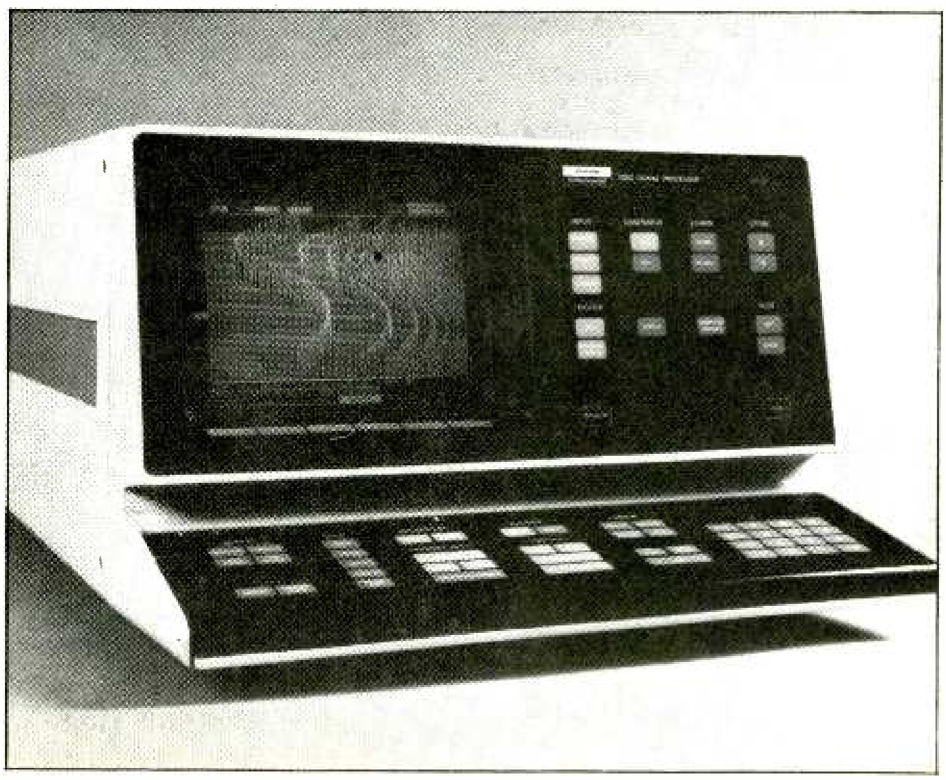
Unusual, and possibly unique in one instrument, are the facilities for Nyquist diagram plotting and cepstrum analysis, which enables the investigation of echoes and harmonics.

The 9in display is a raster-type, with cursors, and a particularly interesting presentation of time-varying spectra is the waterfall, in which a sequential series of displays is laid on the screen in a vertical array to provide a spectral 'history'.

The 1200 is thoroughly digital in concept. An array processor, designed by Solartron, calculates the Fast Fourier Transform that is the basis of this instrument. The FFT requires a greatly reduced amount of calculation in comparison with the Direct Fourier Transform, but still needs four complex multiplications and two additions per line: the processor carries these out in 300ns. Two other 16 bit micros are used for the display and for housekeeping: the total memory capacity is 250kbytes. The 1200 is compatible with the IEEE 488 bus.

Mechanically, the instrument is somewhat unusual in that it possesses not a single knob or switch of the conventional variety. All controls are membrane switches, 'analogue' functions being of the 'stepping' kind. Selecting a measurement function on the main keyboard brings into play a series of so-called 'soft' keys immediately adjacent to and in alignment with the display. A 'menu' of actions associated with the function selected is shown on the screen and indicates which of the soft keys has been selected. By this means, the operator is relieved of much of the effort of setting up the instrument to perform its range of functions. Control settings can be stored and recalled by the use of one key.

It is clear that a great deal of work has been done on the control layout of the 1200. Without the simplified function controls, range settings and soft keys, an operator would probably spend much of his time manipulating the instrument itself: as it is, the 1200 is 'transparent' to the user. As Solartron say, "it is user-friendly."



NEWS OF THE MONTH

Electronics in the defence estimates

"The pace of technological advance, with the rising cost of exploiting it, puts inescapable financial pressure on our defence budget" says the 1981 Defence Estimates, presented to Parliament in April. This is bad news for the British taxpayer but good for the UK electronics industry, where rapid "technological advance" is a constant feature of what it manufactures, especially in weapons. It is nowhere more true than in "electronic warfare" where, as the Estimates point out, the electromagnetic spectrum itself becomes a battleground, with "electronic support measures" (for intercepting and analysing transmissions) "electronic countermeasures", and "electronic counter-countermeasures".

Overall the Ministry of Defence "buys some 20% of British electronics output", a quantity which can be calculated as worth about £1700 million per year to the industry. Although the Estimates do not reveal the precise amounts paid to particular electronics contractors, they do state for example that, in 1980, GEC, Plessey and British Aerospace Dynamics Group each received "over £100m" for equipment supplied. Also, EMI and Ferranti each earned between £50m and £100m, while Racal and Lucas were each paid between £25m and £50m. A list of 32 companies receiving in 1980 amounts between £5m and £25m includes Cable & Wireless, Chloride, Cossor, Decca (now Racal), Gresham Lion, Philips, Smiths Industries, STC and Thorn.

In recent years, state the Estimates, about 75% of military equipment expenditure has gone to national contracts placed with British firms. For 1981/82 the MoD plans to spend £5,352 million on equipment. This is 44% of the total defence budget of £12,274m and is 4% up on last year's proportion (News, June/July 1980 issue). Much of it will go on ships, tanks, artillery, aircraft and other mechanical engineering products. Some of the electronics content is within amounts identified as: £442m for land equipment (described as "guided weapons and electronic equipment"); £590m for air equipment ("guided weapons and electronic equipment") and £528m for sea equipment ("weapon systems etc."). An analysis of the money spent on different categories of equipment in 1979/80 includes £540m for "radio, radar and electronic capital goods"; £84m for radio and electronic components; £145m for "other electrical engineering"; and £93m for instrument engineering.

In addition to their business with the Ministry of Defence, many of the above-mentioned firms export military electronics equipment to the armed services of foreign countries. This is done through the Defence Sales Organization of the MoD, which reckons that receipts from all transactions in 1981/82 will reach about £1,500m (some 2½% of total British exports). The Estimates state that a "significant proportion of defence sales consists of high-technology products with a high added value" and of course electronics must be prominent among these. For 1980, these exports are listed as £55m for radio communication and radar equipment and £25m for guided weapons and missiles, but this is unlikely to be the whole story, considering that SBAC records for 1979, also reported, included £155m in the category "other military electronics." (Other than what? one must ask.)

The 1981/82 estimates also include the substantial amount of £1,682 million for research and development, and it can be safely assumed that the electronics industry will benefit from the £1,088m of commercial contracts in this kind of work. For example, it is mentioned that anti-tank weapons will be improved by current research on "detector and microprocessor systems for application in precision-guided sub-munitions which are dispersed from the main projectile to strike accurately at a number of separate targets". The Estimates identify £223m to be spent on R & D for guided weapons and £259m for "other electronics". Military research is now being organized through a number of "technology boards" which deal not only with industrial firms but also with academic establishments. In spite of the opposition of some students who have held protest meetings recently, British universities and further educational establishments will be receiving £6m for military research and development, 50% up on last year's figure.

Some £8m of EMI's income from military contracts (see above) will be earned by designing and manufacturing an electronic system to analyse data from flights of the RAF's Nimrod MR Mk 2 maritime patrol aircraft. These aircraft, intended for use against surface vessels and submarines, carry multi-track instrumentation and video tape cassette recorders for continuously recording data received or generated by all their on-board navigation, communications, radar and acoustic sensing systems. The new EMI equipment, on the ground, will replay the tapes and process the data. Information obtained will be used to establish the validity and accuracy of target information, to update situation displays, to revise current and planned sorties and to brief other crews. The system will also be used to evaluate tactics and the performance of crews and aircraft systems.

● Footnote to our November 1980 editorial: The Defence Estimates report that preliminary work has started at Greenham Common, Berkshire, for the reception of 96 electronically guided cruise missiles, expected to be deployed there by the USA by the end of 1983.

Safety in automation

Under the title *Microprocessors in Industry*, the Health and Safety Executive have published a guide to safety measures important in manufacturing processes which use computer control. It points out that many processes remove dangers formerly present in manual production: it is unnecessary for an operator's hands to be in contact with the cutting or machining surfaces of machine tools; with automatic indicators more information is available to provide operators with greater knowledge to increase the controllability and safety of the machine or plant; it checks and validates signal received from sensors; alarms are built in and a record of events can be compiled which may be studied if anything does go wrong. Automatic equipment can also take over from human operators in hostile working conditions, in fumes, dust, heat or radiation for example.

The booklet lays down guidelines to ensure that safety factors are included in any programmable electronic system. The control unit itself should be protected from any environmental hazards such as heat, electromagnetic or static interference, transient mains supply interference and atmospheric pollution.

Programs should have built-in safety checks, reviewed at regular intervals. The programs need to be protected against possible corruption.

The level of reliability required must be designed into the system as must any back-up needed in the event of failure.

Control equipment needs to be checked for speed of response, the ability to cope with failure including power failure, and the adequacy of control during start-up or shut-down.

Back-up and emergency systems are dealt with in a separate section, as are operations and maintenance, and the need for adequate staff training. The guide is available through H.M.S.O.

C.c.d. telecine

Telecine is a system for converting the information on cine film into a signal suitable for transmission by tv or for storage on a video tape. Early devices were quite primitive and worked by televising the output from a cinema projector. Most machines in use today are a sophisticated version of the same system, using photoconductive tubes or flying spot scanners.

The Bosch FDL 60 telecine is claimed to be the first machine to use charged coupled devices. The solid state image sensing elements are able to replace the conventional tubes used in the past. Each element consists of a flat crystal which contains thousands of individual sensory points. Each point can store the brightness and colour information corresponding to a single dot on the tv screen, and by means of a microcomputer which reads the information passing through each dot, an electronic signal corresponding to the information contained on the film is obtained.

The system eliminates the need to scan the film by a sideways moving beam, and the inherent geometric deflection errors, to provide high quality reproduction. Other advantages include lower maintenance costs, reduced setting-up time with no need for high voltage supplies.

The FDL 60 can provide pictures from the telecine in all modes of running – forwards, backwards and stop. Instantaneous switching between the modes is possible, as is viewing the film at up to thirty times the normal speed. This feature is important to technicians and editors in reducing the time spent in searching for relevant film sequences. The machine can handle 16 and 35mm film gauges and all combinations of sound track.

Microcomputers in school

At last the Government has announced a scheme to introduce a microcomputer into every secondary school. The Department of Industry is to spend up to £4m to match funds provided locally towards the purchase of the computer for each school; in other words they will pay half and expect the Local Education Authority to provide or raise (through PTAs and local industry) the other half of the cost.

At the launch of the scheme in London the Prime Minister emphasised that this was only the beginning of a comprehensive programme to introduce the 'technology of tomorrow' into education and that there would be a number of areas where activities enable a wider understanding of computers amongst the children of today who would be at work well into the 21st century.

Further details were published in a strategy document for the Microelectronics Education Programme, produced by Richard Fothergill, the Director of the Programme. In it, he details three main areas for support; curriculum development, teacher training, and resource organisation and support.

The scheme follows on from a very disjointed train of events which commenced in 1978 when the Labour Government of that time ordered reforms of the schools curricula to ensure that children would be aware of the changes, and their importance in working life. A five-year £12m programme, announced in March 1979 was reconsidered by the new Government and a year later they came up with their own programme to spend £9m over four years. Richard Fothergill was appointed Director of the scheme in September 1980. (Events and dates reported by Peter Large in *The Guardian*).

Two computers have been chosen as worthy of the DoI's support. The 380Z from Research Machines Ltd, and the recently announced BBC/Acorn microcomputer. There has been some criticism of the RML 380Z as being too expensive at £1,680 and although developed in conjunction with a Local Education Authority, Berkshire, it is too powerful, giving minicomputer facilities when a micro is all that is necessary. The BBC machine, not yet generally available, seems to fit the bill better. But a question mark hangs over Clive Sinclair and the Sinclair ZX81 micro; again it has been rejected in favour of the 'established' manufacturers' products, and yet it would be possible to purchase about 24 ZX81s for the price of one RML 380Z.

Mr Sinclair has countered by announcing his own subsidy scheme for schools. He will offer the ZX81 to schools at half the retail price i.e. £45 for the computer and a further £25 for a printer.

● Although it was stressed at the launch of the scheme that it was only a beginning, and that there would be further expansion, it may be argued that the provisions of the scheme are still woefully inadequate. Imagine the frustration of pupils eagerly queueing to use the only school computer. Surely the provision of a roomful of micros or of some form of terminals on the lines of a language laboratory would be a more realistic approach to providing our children with adequate knowledge of computer technology.

Pupils at Cheney School, Oxford grouped around a RML 380Z, one of the machines selected by the Department of Industry for use in schools

16 bit pact

The Philips/Signetics group has signed an agreement with Motorola to embark on a five-year programme for the development of 16-bit microprocessors. The Philips group will provide an alternative source for the M68000 and will produce pin-for-pin compatible support products as well as develop new devices which may then be manufactured by either participant. At least three Signetics peripheral data communications chip designs are to be added to the M68000 family by the end of the year. Both Motorola and Philips/Signetics will produce software including operating systems, language processors and application packages, as well as development system tools. It is anticipated that over twelve designs are to be added to the M68000 family over the next two years.

Motorola are hoping that the agreement will boost production and through sheer availability will help to establish the M68000 products as 'the leading 16-bit family in the industry'.

Philips have said that they specifically chose the M68000 family because it 'covers the full spectrum of 16-bit applications and can be expanded to cover 32-bit applications while maintaining software compatibility'.

British Association – 150 years old

The British Association for the Advancement of Science is returning to York, the place of its foundation in 1831, for a special Anniversary Meeting in place of the usual Annual General Meeting. The meeting is to be held at York University between 31st August and 4th September. In addition to the usual lectures and addresses by many leading scientists, there will be a special Celebrity Day with a procession to York Minster where the President of the B. A. H.R.H. the Duke of Kent, will give a Presidential Address. On the afternoon of the same day, 2nd September, there will be held four Review Symposia in the physical, biological, earth and social sciences. In the evening there will be four special dinners each with a guest speaker. Applications for those wishing to attend should be addressed to the British Association at Fortress House, 23 Savile Row, London W1X 1AB.

Open Radio station

Plans have been published for a campaign to create a 24-hour, participant-controlled radio station in London to be known as London Open Radio. It would not be 'censored by public opinion or political pressure and would allow participants to create their own standards of broadcasting'. All types of contribution would be welcome; comedy, music, drama, news, public affairs or whatever, and scheduling would result from the decisions of all interested broadcasters. The organisers are not short of ideas.

They are short, however, of technical expertise and would be grateful to any engineers who can advise them on frequencies, transmitter design, maintenance, studio design and purchase. They also need help in lobbying Parliament and the Home Office to get a change of law to make such a system legal.

It is planned that the station would be financed by public subscription and contributions, and a target of £300,000 has been set for commissioning the station with an estimated running cost of £30,000 a year. Although this is a large scale, ambitious project, similar stations already exist in Australia, Italy and the USA.

We believe that such a project would be much more useful than, for example, all the hot air that is being expended over c.b. radio – a community service available to all and not just those with personal rigs.

The organisers would be grateful for all contributions of ideas, advice and, of course, cash and may be contacted at London Open Radio, 2 Warwick Crescent, London W2. Telephone: 01-289 7163.

Growing awareness of Prestel

By the end of 1980, Prestel, the public viewdata service run by British Telecom, had more subscribers than any other computer based information service in the world, according to Richard Hooper its director. Writing in the April issue of our sister journal Viewdata and Tv User, he said that registrations of 2,035 at 1st January 1980 grew to 7,387 by 1st January 1981. The Prestel audience, however, consisted mainly of business users (6,443 or 87%) because high costs were "a major obstacle to significant penetration of the residential market".

During the year awareness of Prestel among the UK population had risen from 12% to 29%. Among business men – known technically in the marketing world as ABC1 males – awareness had risen to 60%. The Prestel computer network had grown from three computers serving 30% of UK telephone subscribers to 17 computers serving 62% of subscribers. By the end of the year the system comprised 1,500 ports. The number of main information providers had not risen so rapidly, however, being 133 at the beginning of the year and 140 at the end. Also, the number of frames filled by these information providers during the year had increased from 152,000 to only 174,000.

Elsewhere the journal suggests that the information potential of Prestel will be greatly helped by a new scheme called Gateway which in 1982 will allow users to be linked to third party private databases. In other words Prestel will act merely as a network for accessing, or a gateway to, information which it does not itself provide. Although Gateway was developed by a British firm, Systems Designers Ltd, it has not been used publicly in the UK – only by the West German PTT in trials for their Bildschirmtext public viewdata system (see November 1979 issue, p.49) in which ten third-party databases were linked to the system.

One commentator, Emma Bird, quoted in the journal, thinks this is the way to put Prestel on a good business footing. "If Prestel redefines itself in this way it can capitalise on the growth of private viewdata systems and its new job of acting as the gateway to both private viewdata and other computer systems should enable it to achieve sound economic viability". Sometime before Gateway was unveiled Wireless World proposed this kind of approach in its editorial of February 1978 entitled "Viewdata needs encouragement".

Micro controls the mighty

Giltspur Microprocessor Systems have been awarded a contract to design and build a microprocessor-based control and monitoring system for a 14,000 ton press belonging to Doncasters Monk Bridge Limited of Leeds. The press is used to forge fan blades and discs by one, two or three blows whose energy level is pre-set by the microcomputer system before each blow. The products formed are destined for use in the aircraft industry and details of the forging process must be printed out as a quality record for each individual product. In addition, other information is generated for maintenance purposes on the press itself, for example, velocity profiles can be produced to help diagnose malfunctions.

The system consists of a master microcomputer, located in the control room, communicating with a remote slave microcomputer located adjacent to the press. The master prompts the supervisor for product information, gathers and stores temperatures, pressures and other relevant data during the forging process, prints the billet certificate and archives data on to a dual magnetic cartridge unit. The slave unit provides local data input and readout for the press operator, plus high speed data gathering during the pressing operation. Some of the press instrumentation transducers have also been specified and supplied by Giltspur Microprocessor Systems, and a press load monitoring unit previously supplied by the company is to be integrated into this system.

On the eve of closing down the 405-line v.h.f. television service, George MacKenzie, BBC's Chief Engineer, Transmissions together with two former holders of that title, Eric Varley (centre) and Maurice Crawt (right), celebrates the 25th anniversary of the Crystal Palace transmitting station. They are posing in front of one of the two transmitters which were first brought into service in March 1956 when the 405-line service was transferred from Alexandra Palace. Also worthy of celebration but not appearing in the picture is the 750 ft tower which has dominated the South London skyline for 25 years.

News in brief

An interesting conflict arose between different areas of our relationship with the Eastern bloc. The BBC wanted to improve its shortwave service to eastern Europe by locating a new transmitter at the disused Henstridge airfield in Somerset. Unfortunately, this was quite close to the Royal Navy air station at Yeovilton and it was thought that the BBC transmissions might affect the operation of the air station and the Ministry of Defence lodged a formal objection. The BBC withdrew the proposal. In effect, military hardware was considered more important than the 'friendly persuasion' of the BBC external service.

The world's most powerful v.h.f. tv transmitter is claimed for WXIA-TV, Channel 11 in Atlanta, Georgia, USA who have installed a Harris 100kW TVD-100H which is transmitting through a twelve-bay circularly polarised antenna. As the transmitter consists of two 50kW transmitters combined, one half can be maintained while the other continues transmission at 80% of the total power.

Another record is claimed by GEC Telecommunications who are to supply the two **longest digital transmission systems in the U.K.** to British Telecom. Each system will operate at 120Mbit/s with a capacity of 1680 speech circuits each. They will link Mondial House, the international switching centre in London, with Madley satellite earth station in Herefordshire. The two systems will operate through coaxial cable on alternative routings over a joint distance of more than 600km (373 miles) and will be ready for service late in 1982. The digital system was chosen for better quality of transmission, improved stability, and much greater flexibility of network management.

The launching of the **Amsat Phase 3B amateur band satellite** is scheduled to take place in February 1982 when it will be carried on Ariane L07.

A tentative allocation of the frequencies to be used are:

U-transponder	
Uplink	435.150 to 435.300MHz
Downlink	145.820 to 145.970MHz
Engineering beacon	145.990MHz
General beacon	145.8125MHz
L-transponder	
Uplink	1,269.950 to 1,269.150MHz
Downlink	436.150 to 436.950MHz
Engineering beacon	436.020MHz
General beacon	436.040MHz

The **12th International Television Symposium and Technical Exhibition** will take place at the Maison des Congres, Montreux, between 31st May and the 4th June. Thirty-five British companies will be exhibiting as part of a British Overseas Trade Board Joint Venture, sponsored by the Electronic Engineering Association.

C.b. specification published

We have received a copy of the draft specification for the performance of 27MHz radio equipment for use in the citizens' band radio service. We include here the main parameters and provisions of the specification. All equipment must be covered by a licence and it is a condition that the equipment conforms to and is maintained to certain minimum standards set out in the specification. The specification sets out these standards for 27MHz f.m. equipment; 934MHz f.m. equipment is subject to a separate specification.

The manufacturer, assembler or importer of the equipment is responsible for testing the equipment and for ensuring that it conforms with the specification. A reputable test establishment may act on his behalf.

The output r.f. power of the transmitter is limited to 4W. With the antenna permitted this will give an effective radiated power of 2W. If the antenna is mounted at a height exceeding 10m the licence will require a reduction in transmitter power of 10dB. A 10dB attenuator should be provided as a standard accessory for this purpose.

The equipment shall provide for transmission and reception only of frequency modulated emissions on one or more of the following r.f. channels: Channel 1 at 27.60125MHz up to Channel 40 at 27.99125MHz each channel being 10kHz from the next. Equipment shall not contain facilities for transmission of any other radio frequencies. Only equipment which employs frequency or phase modulation and has no facilities for any other form of modulation will meet the requirements of the specification.

The equipment shall be provided with a clear indication of the type number and the name of the manufacturer. In addition, compliance with the specification should be indicated by the authorised mark stamped or engraved on the front panel of the equipment. The mark is shown here and should have minimum diameter of 6mm and a minimum figure height of 1mm.

Controls which, if maladjusted, could affect the interference potentiality of the equipment, should not be easily accessible.

The power supply should maintain its voltage to within 3% of its nominal value. Frequency error; the deviation in carrier frequency from its nominal value, should be less than 1.5kHz. Frequency deviation, the difference between the instantaneous frequency of a modulated signal and the unmodulated carrier frequency, should be less than 2.5kHz.

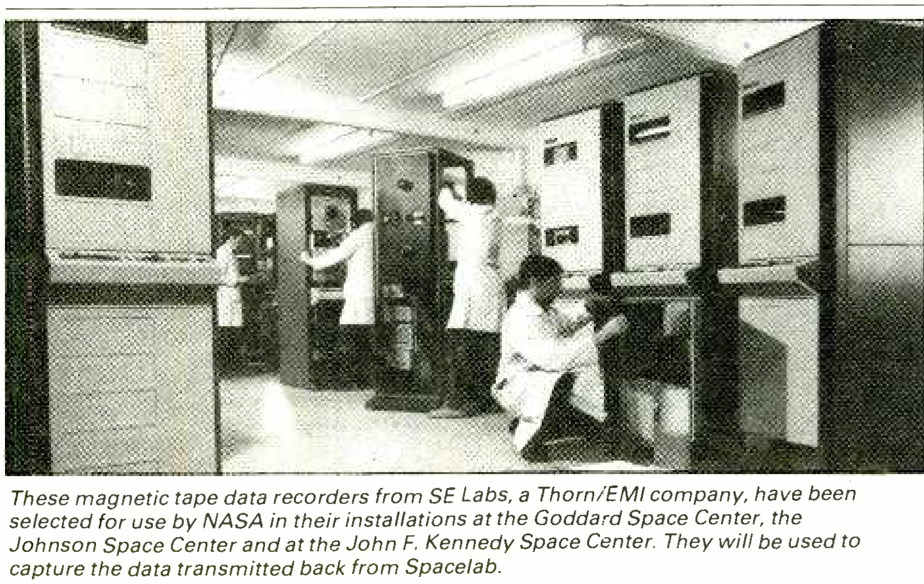
Adjacent channel power, the power output at a frequency of 10kHz above or below the nominal frequency in use, should not exceed 60dB below the carrier power of the transmitter, without the need to be below 2μW.

Spurious emission, emissions at frequencies other than those of the carrier and sidebands associated with normal modulation, should not exceed 50nW in the frequency bands of 80-to 80MHz, 87.5 to 104MHz, 108 to 118 MHz, 135 to 136MHz, 174 to 230MHz and 470 to 862MHz. The power of spurious emissions at other frequencies should not exceed 0.25μW. All emissions from a receiver should be less than 20nW on any frequency.

The specification also lays down the equipment and test conditions to be used when testing the equipment and the accuracy of measurement needed.

The above specification has already raised howls of indignation amongst existing (illegal) c.b. users. The National Committee for the Legalisation of Citizens' Band Radio have noted that the channels suggested by the specification do not correspond to frequencies used for c.b. anywhere else in the world. This means that equipment would have to be specially designed and built for the U.K. and would therefore be very expensive. The National Committee would like to adopt the specification drawn up by the Joint Council for Legalisation of 27MHz c.b. radio, which corresponds quite closely to the equipment at present in use in the United States and in illegal use here.

We note that the chosen frequencies avoid the ISM; industrial, scientific and medical band as designated by the 1979 World Administrative Radio Conference, but share a fixed and land mobile band. The only information we could get from the Home Office was that the frequencies had been selected 'to avoid conflict with radio modellers' and were 'offset to avoid any harmonic interference with the 102 to 112MHz frequencies used for approach and landing at airports'.



These magnetic tape data recorders from SE Labs, a Thorn/EMI company, have been selected for use by NASA in their installations at the Goddard Space Center, the Johnson Space Center and at the John F. Kennedy Space Center. They will be used to capture the data transmitted back from Spacelab.

Shuttle electronics

After all the ballyhoo of the launch and landing of the first space shuttle *Columbia*, it may be of interest to look at some of the contributions the electronics industry has played in this venture.

At the Kennedy launch site operational intercommunications runs on two systems; OIS-RF is a 112 channel system connected to 1,200 terminals, with total conferencing capability, using a 480kHz band to carry the channels over coaxial cable. All the voice communications channels can be networked into the one integrated system. In addition numerous 21-channel, four-wire multi-terminal systems serve small geographical complexes, with one or more channels connected to the main system.

The public address and area warning systems are made from standard distribution amplifiers and indoor and outdoor speakers arranged to allow for paging by geographical area or all areas simultaneously, with a capability to over-ride from several remote locations.

Also at the Kennedy Space Centre are fifteen v.h.f. base support radio networks, a communications link between the astronauts and the control centre with connections to the medical staff, various directors and, via leased lines, to the Johnson Space Centre.

Data and television transmission facilities link up 29 sites with 1,400 terminals. When the shuttle system is fully operational there will be an additional 400 data modems and data switching equipment to support cargo operations. The system provides the means for transmission of colour and monochrome operational and network tv and other analogue or digital data for distribution through the OIS-RF system. Data includes spacecraft command and telemetry, meteorological and other measurements and the computer system data.

The launch needs to be carefully monitored and there are no less than sixty monochrome tv cameras located on the launch pad all remotely controlled from the launch control centre 3½ miles away.

NASA's public affairs office has all the facilities necessary to provide live television coverage of the launch for release to national and international public tv networks.

The major instrumentation systems include a microwave scanning landing system, a precision laser tracking system which is used to calibrate the landing systems and also serves as a source of reference during commissioning and flight inspection tests of each landing site. There is also a catenary wire lightning protection system and a lightning voltage measuring system.

All this is on the ground at the Kennedy launch site, and all the equipment mentioned has been supplied by one division or another of RCA. They have also provided satellite communications through the two American satellites which provide 11 wideband data links, 28 voice and data narrowband and television broadcast links. Each shuttle orbiter has several tv cameras with remote controls. The radios contained in the astronauts back-packs provide a number of services in addition to voice communications, they monitor the astronaut's heartbeat and the life support systems.

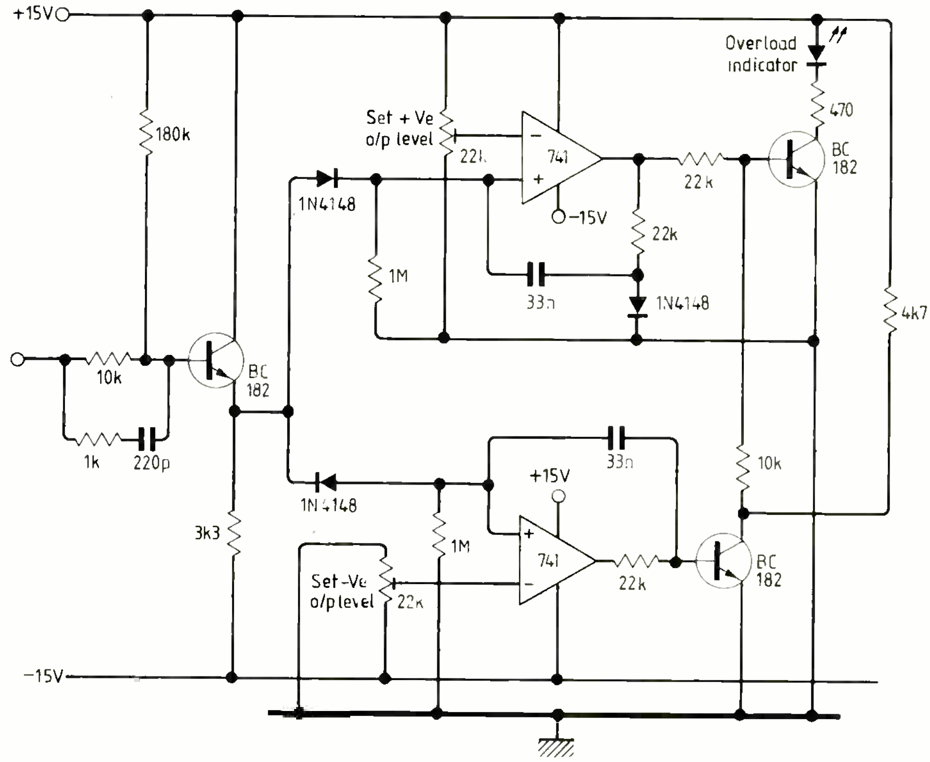
And this is still only a part of the whole; Mission Control at Houston, Texas was built and is operated by Ford Aerospace and Communications Corp. a division of Ford Motors, and electronics control and communications permeate the whole enterprise.

CIRCUIT IDEAS

Overload indicator

Overloads of either polarity are indicated by a single l.e.d. with signals from dc to 1MHz. Each overload detector operates as a comparator/monostable and, if the reference voltage is exceeded, the monostable is triggered for approximately 30ms which turns the l.e.d. on. The monostable can be re-triggered, so if the overload persists the l.e.d. remains on and does not flicker.

R. W. Darlington
Worsley
Manchester



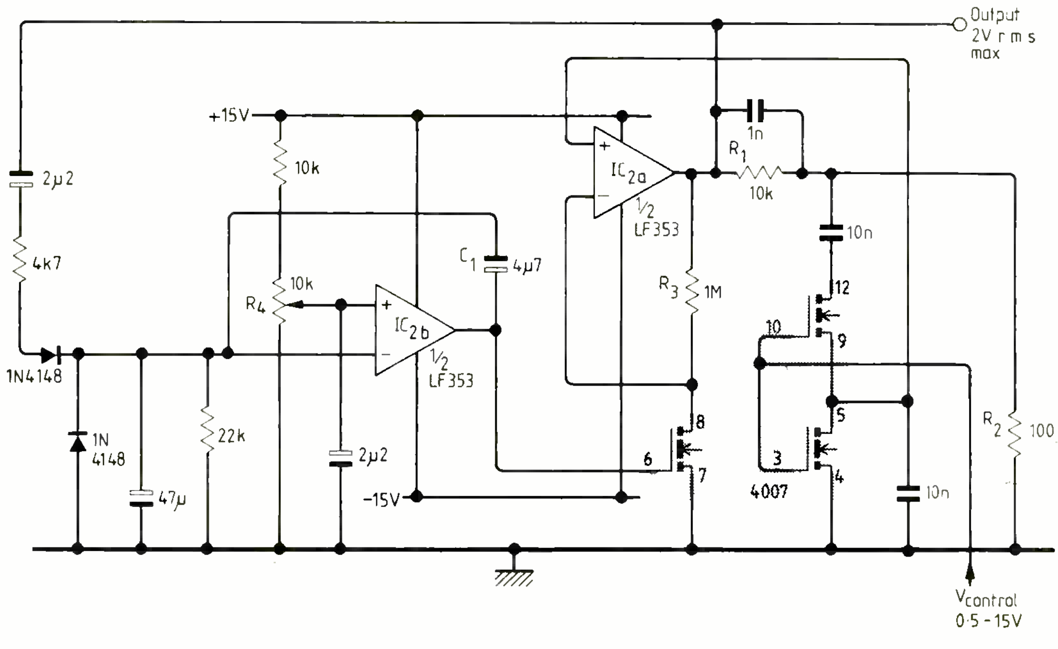
Contributions for circuit ideas should be typed and include a day time phone number if possible. We now pay a minimum of £20 for all ideas which are accepted for first publication in Wireless World.

Voltage-controlled oscillator

The n-channel f.e.ts within a 4007 package, when used as voltage controlled resistors, track sufficiently well to be used in a voltage-controlled Wien bridge oscillator. Two f.e.ts are used in the Wien network, and the third is used for amplitude control. Because the 4007 protection diodes cause signal distortion with input levels above a few hundred millivolts, IC_{2a} drives the network with a few tens of millivolts. This requires a wide bandwidth device to sustain maximum output at 20kHz.

Output amplitude is maintained by a f.e.t. and R_3 used as a variable potential divider controlling the feedback to IC_{2a}. IC_{2b} controls the f.e.t. by comparing the dc level set on R_4 with a direct voltage proportional to the ac output signal. With the components shown, a sweep from 100 Hz to 20kHz is obtained with a control voltage from 0.5 to 10V. Maximum distortion at 5kHz for various samples of IC_1 was 3%. Below 500Hz, 50Hz hum pickup can be troublesome because the f.e.ts are operating at around a megohm so screening of the circuit is advisable.

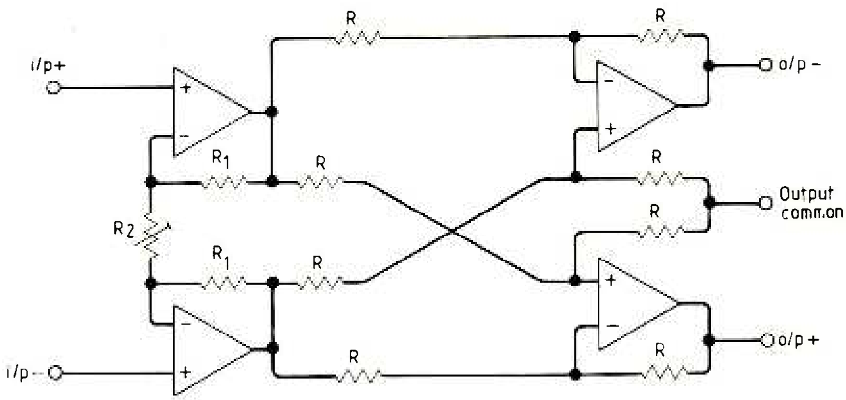
J. D. Jardine
Dewsbury
Yorks.



Matching complementary transistors

By simultaneously displaying I_C versus V_{CE} for complementary transistors, matched devices can be quickly selected. Equal collector voltages are provided by identical halves of a power supply. Although the potential at point A or B is not exactly equal to V_{CE}, due to the voltage drop across the emitter resistors, the approximation is acceptable. Both transistors have the same I_B set by a photocoupled germanium diode. The high reverse current of the photodiode ensures that I_B is reasonably constant with small voltage variations produced by different values of I_C.

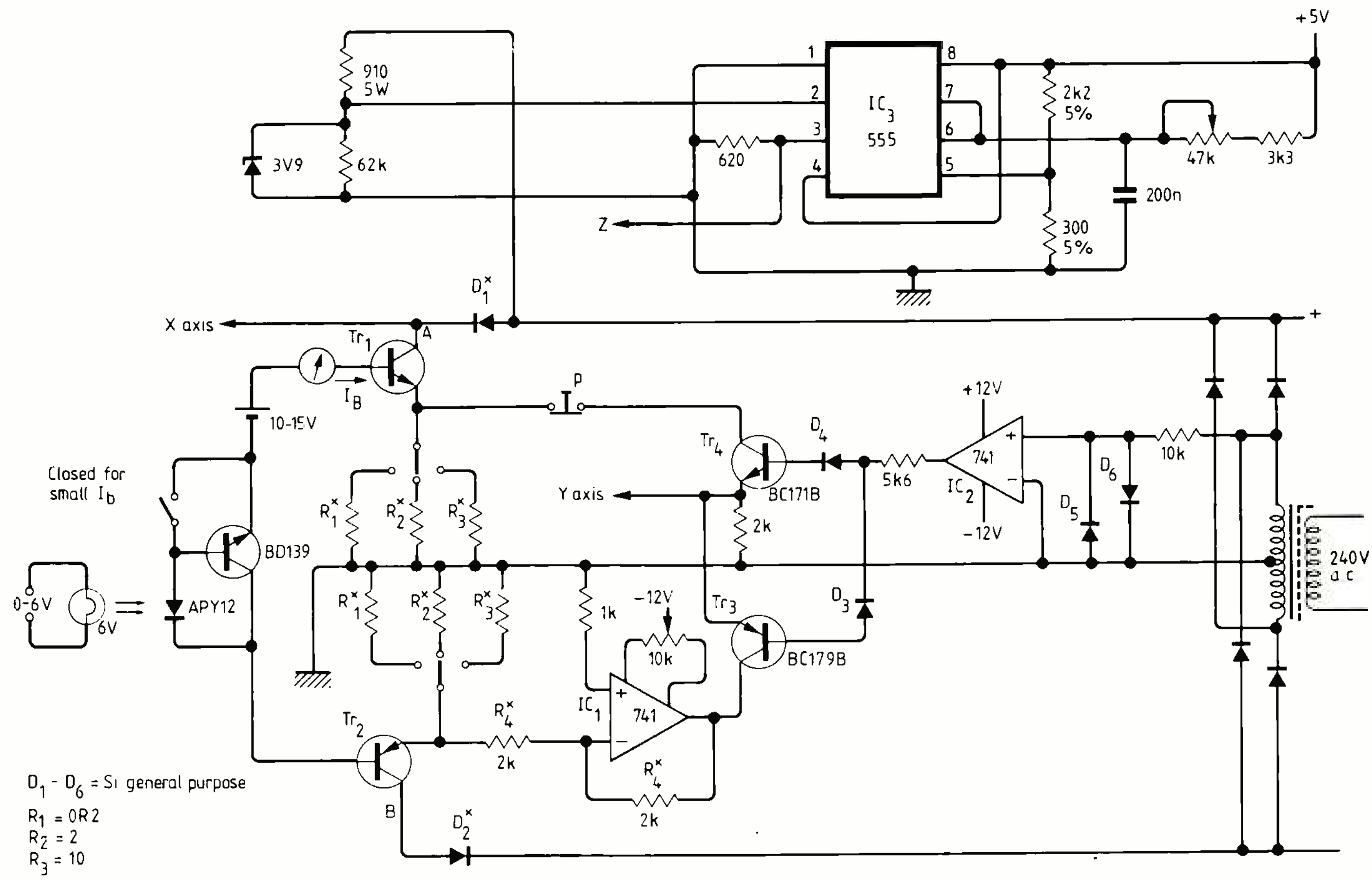
Transistors Tr_3, Tr_4 and IC_2 form a simple switch for the Y axis. Because the curves displayed for increasing and decreasing values V_{CE} do not coincide, IC_3 blanks the first one. The 555 timer is triggered near to the zero-crossing point of V_{CE} and generates 5ms pulses for driving the Z input of the oscilloscope. As IC_3 is triggered before V_{CE} reaches zero, D_1 and D_2 are included to prevent a small part of the trace from being missed close to the origin. The push-button permits identification of the traces. Accuracy of the circuit can be increased if the corresponding components marked x are matched.
I. Safta
Romania



Isolation amplifier

A quad op-amp such as the TLO74 can provide an amplifier with a high-impedance differential input and a low-impedance differential output which is balanced about a third terminal. The circuit can be used to overcome earth loop problems in instrumentation and audio systems. Several amplifiers can be powered from one supply without interaction provided the total signal plus common-mode voltage does not exceed the supply.

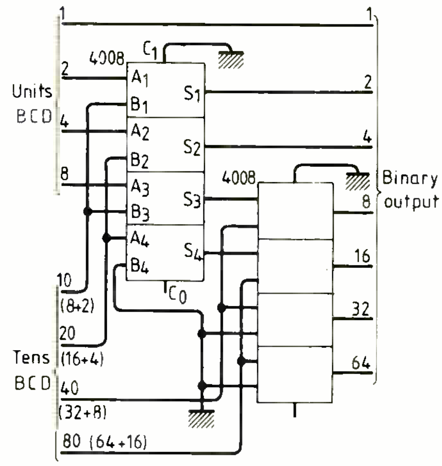
Overall gain is set by R_2 which, with an open circuit, is unity. Resistors R_1 and R should be matched for accurate balance.
M. R. Hadley
Southampton
Hants.

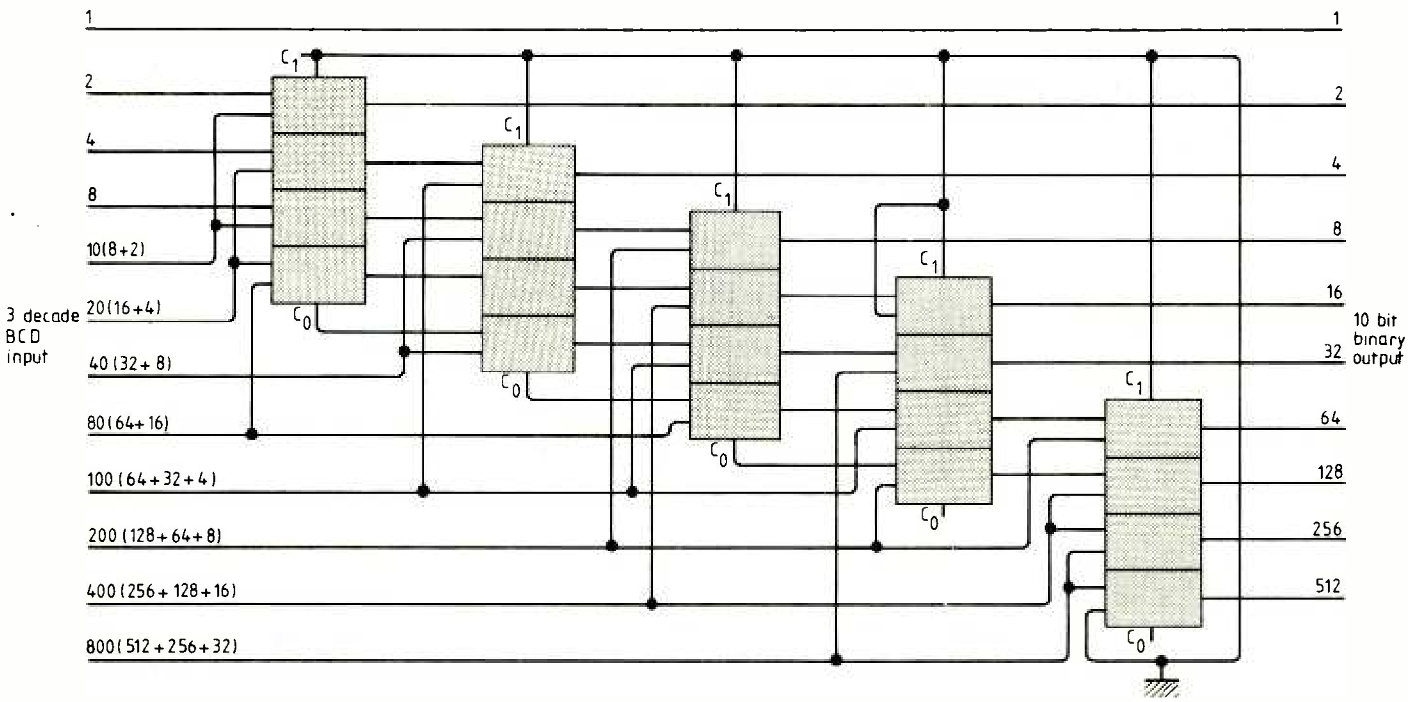


B.c.d.-to-binary conversion

Two-decade b.c.d.-to-binary conversion with, for example, thumbwheel switches can be achieved with two i.cs. Alternatively, the circuit can easily be extended as shown for three or more decades.

J. A. Fox
Redhill
Surrey





Temperature compensation for varicap diodes

When a varicap diode control is used in a v.h.f. oscillator as shown in Fig. 1, the positive temperature coefficient of the diodes cannot be completely compensated for with n.t.c. capacitors. The circuit in Fig. 2. overcomes the problem by using a familiar V_{BE} multiplier in series with the supply voltage to the diodes. This method of temperature compensation is particularly useful with a switched-frequency oscillator because the compensation depends on the amount of reverse bias applied to the diodes.

T. K. Wong
Edmonton
London

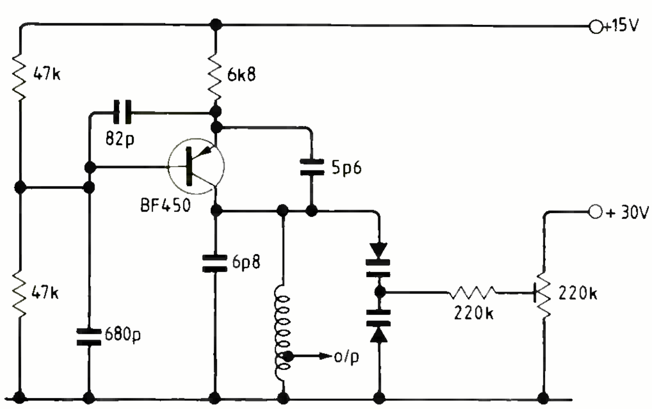


Fig. 1

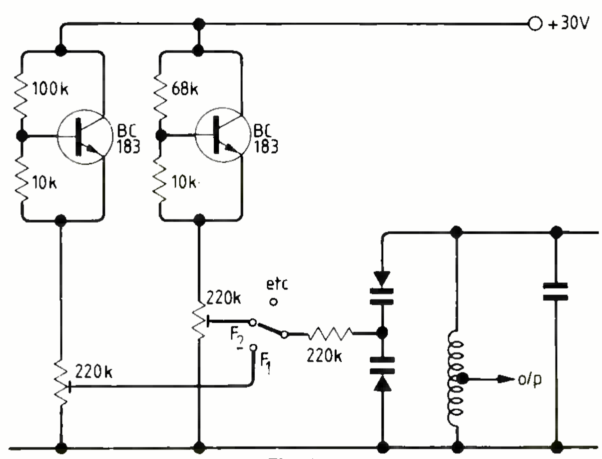


Fig. 2

Accurate sine-wave oscillator

Step-by-step calculation means no limit to low frequency range

by N. Darwood

This oscillator does not contain any inductors or capacitors. It is an arithmetic unit that continuously computes sine and cosine values. The output is a sequence of numbers, in binary, which represents the amplitudes of a continuous sine-wave. This sequence of values is an ideal medium for digital signal-synthesis. Two or more such sequences are readily added, multiplied, scaled etc. A digital-to-analogue converter is used if the output required is an analogue waveform.

The computation performed by the arithmetic unit of this oscillator to produce a sine-wave sequence of values is: (a) to the current value of sine add a fraction of cosine; and (b) from the value of cosine subtract a fraction of sine. For example, if sine value = 0.4, cosine value = 0.6 and the fraction chosen is 1/10 then the computation performed is as follows:
(a) New sine = 0.4 + (1/10) 0.6 = 0.46
(b) New cosine = 0.6 − (1/10) 0.46 = 0.6 − 0.046 = 0.554
Computations (a) and (b) form one step. One step produces a new value for sine and a new value for cosine. Fig. 1 shows how the sine and cosine values progress, step by step, as the pair of computations (a) and (b) above is continuously repeated with a fraction of ½. (Fig. 1 is explained in detail later.)

The mathematically minded will quickly see that the computation is an approximation:
Given that $\sin(n + \omega) = \sin n \cos \omega + \sin \omega \cos n$ (1)
$\cos \omega$ approximates 1 for small ω (2)
$\frac{\sin \omega}{\omega}$ approximates 1 for small ω
$\sin \omega$ approximates ω for small ω (3)
Substituting (2) and (3) into (1),
$\sin(n + \omega) = \sin n + \omega \cos n$ (4)
where ω is a fraction of a radian.

In words equation (4) means that a new value of sine can be found by adding a fraction of cosine. Similar reasoning shows that a new value of cosine can be found by subtracting a fraction of sine. A further example is shown below.
Current value of sine = 0.2
current value of cosine = 0.9
(a) next value of sine = 0.2+(1/10) 0.9 = 0.29
(b) next value of cosine = 0.9−(1/10) 0.29 = 0.9−0.029 = 0.871
It is easier for the hardware to first calculate the new value of sine than take this new value for the calculation in (b).

To become familiar with the oscillator let us work through one cycle of oscillation. Assume the sine amplitude is zero and the cosine amplitude is 100, see Fig. 1. Let the fraction be ½. Finally abbreviate
sine at step n = $\sin(n)$
sine at step $n+1$ = $\sin(n+1)$
cosine at step n = $\cos(n)$
etc.

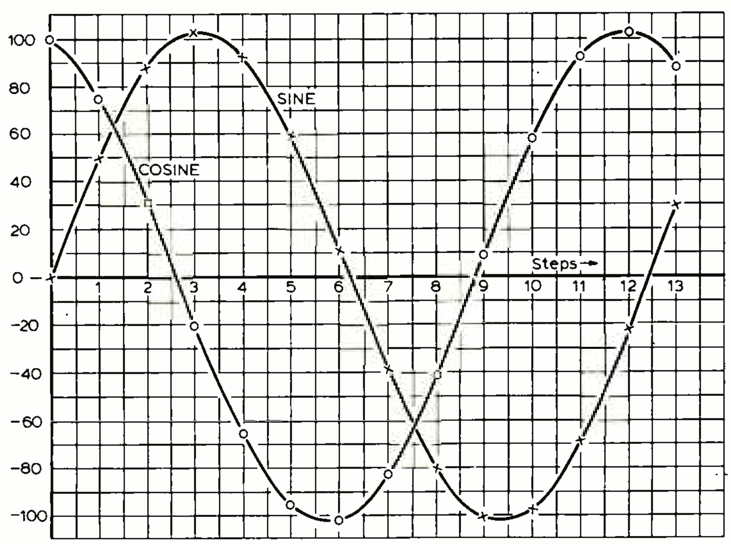


Fig. 1. Graph of computed sine and cosine values from Table 1

where n is a multiple of a fraction of a radian.

Table 1 lists the results of continuously performing
(a) $\sin(n+1) = \sin(n) + (½) \cos(n)$
(b) $\cos(n+1) = \cos(n) - (½) \sin(n+1)$
Sine and cosine values are then plotted as shown in Fig. 1.

A fraction of ½ was chosen for ease of working although we could have chosen any value, say 3/297. But then, because of the amount of work involved, we need a computer to simulate the hardware by continuously performing:
(a) $\sin(n+1) = \sin(n) + (3/297) \cos(n)$
(b) $\cos(n+1) = \cos(n) - (3/297) \sin(n+1)$
(c) go back to (a)

The fraction is a systems parameter. It is hardware wired. A fraction of ½, ¼, ⅛ or 1/16 etc. is readily achieved in terms of hardware by a right shift. The fraction is called omega (ω); it defines the number of steps in one cycle of oscillation. The smaller ω is: the smaller the step size; the more steps there are per cycle; the longer it takes to complete one cycle; the lower the frequency; and the less the error.

For $\omega = ½$ the error is about 7%. For $\omega = 1/32$ the error reduces to about 0.5% (Note in Fig. 1 how one cycle is completed between two steps.) However, there is no cumulative error over many cycles. In fact the error appears to be sinusoidal with a period of $1/\omega$ cycles. A formal knowledge of the errors, fundamental and truncation (i.e. the effects of rounding off), is not known.

The period of oscillation is evaluated as the product of (the number of steps per cycle) × (the time for one step). The time for one step is determined by the hardware architecture, in particular, the number of bits in a word, a serial or parallel arithmetic unit, and the clock rate.

The step size i.e. the number of degrees or radians moved by one step (not the time of one step) is determined solely by the fraction ω. From Table 1 and Fig. 1 one step = ω radians. In this instance, because $\omega = ½$, one step = ½ radian, 2 steps = 1 radian.

Generally, one step = ω radians
$1/\omega$ steps = 1 radian
$2\pi/\omega$ steps = 2π radians = 360° = 1 cycle

That is, 1 cycle = $2\pi/\omega$ steps.

See Fig. 1 where one cycle takes $2\pi/\omega = 2\pi/(½) = 4\pi = 12.56$ steps

A further example could be where $\omega = 1/1000$. One cycle is completed by

$2\pi/\omega=(1000)\ 2\pi=6{,}283.2$ steps. Hence the step size is 0.057°. An accurate continuous sine-wave oscillator with any period is now practical. For example, a device consisting of two 100-bit shift-registers, an adder/subtractor and a clock of 100kHz and with $\omega = 2^{-60}$ gives a continuous sine-wave with a period of 10 years.

Implementation

The oscillator can be built with nine i.c. chips. Sine and cosine are each held in a shift register. This is shown in the block diagram of Fig. 2, which also shows the adder/subtractor and control logic.

Ignore for the moment the "sign extension" and "complementer" blocks. Suppose the left hand shift register L, which is of 8 bits, say, holds 100 and R holds zero. Let $\omega=1/8$. This means, in terms of hardware that the input to the adder/subtractor is taken from the output of bit 3 of L. Hence the input to the adder/subtractor is L/8, that is, L right shifted 3 places. The resultant output from the adder/subtractor becomes the new value in L as shown in Table 2. Obviously this is just a mechanization in hardware of the illustrative example of Fig. 1, but with a different fraction.

First note, in Fig. 2, one step takes a complete rotation of both shift-registers, i.e. 16 clocks. In the first half of each step, i.e. for the first 8 clocks of each step the adder/subtractor is in the add mode. For the second half of each step the adder/subtractor is in the subtract mode.

In fact, rather than an adder/subtractor only an adder is used. When in the subtract mode, 2s complement is formed and then

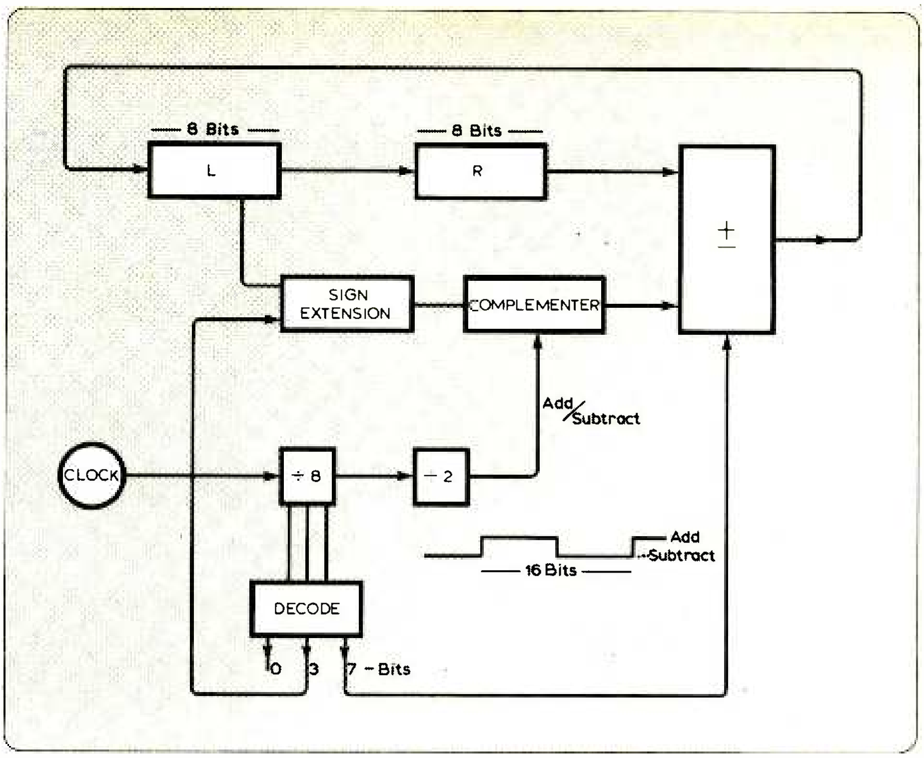


Fig. 2. Block diagram of sine-wave oscillator. Set carry for subtract mode; reset carry for add mode.

added. The 2s complement is formed in two steps. First a bit complementor (an exclusive OR) is used; this gives 1s complement. To produce the required 2s complement a 1 has to be added to the least significant bit, which is performed, as is

Continued on page 78

Table 1: Illustrative example

Step		Computation	Result
	sin (0)	0	
0	cos (0)	100	
	sin (1)	0+100/2	50
1	cos (1)	100−50/2	75
	sin (2)	50+75/2	87.5
2	cos (2)	75−87.5/2	31.25
	sin (3)	87.5+31.25/2	103.12
3	cos (3)	31.25−103.12/2	−20.31
	sin (4)	103.12+−20.31/2	92.97
4	cos (4)	−20.31−92.97/2	−66.79
	sin (5)	92.97+−66.79/2	59.57
5	cos (5)	−66.99−59.57/2	−96.58
	sin (6)	sin (5)+(½) cos (5)	11.27
6	cos (6)	cos (5)−(½) sin (6)	−102.22
	sin (7)	etc	−39.82
7	cos (7)		−82.30
	sin (8)		−80.98
8	cos (8)		−41.81
	sin (9)		−101.89
9	cos (9)		9.13
	sin (10)		−97.32
10	cos (10)		57.79
	sin (11)		−68.42
11	cos (11)		92.00
	sin (12)		−22.42
12	cos (12)		103.22
	sin (13)		29.18
13	cos (13)		88.62

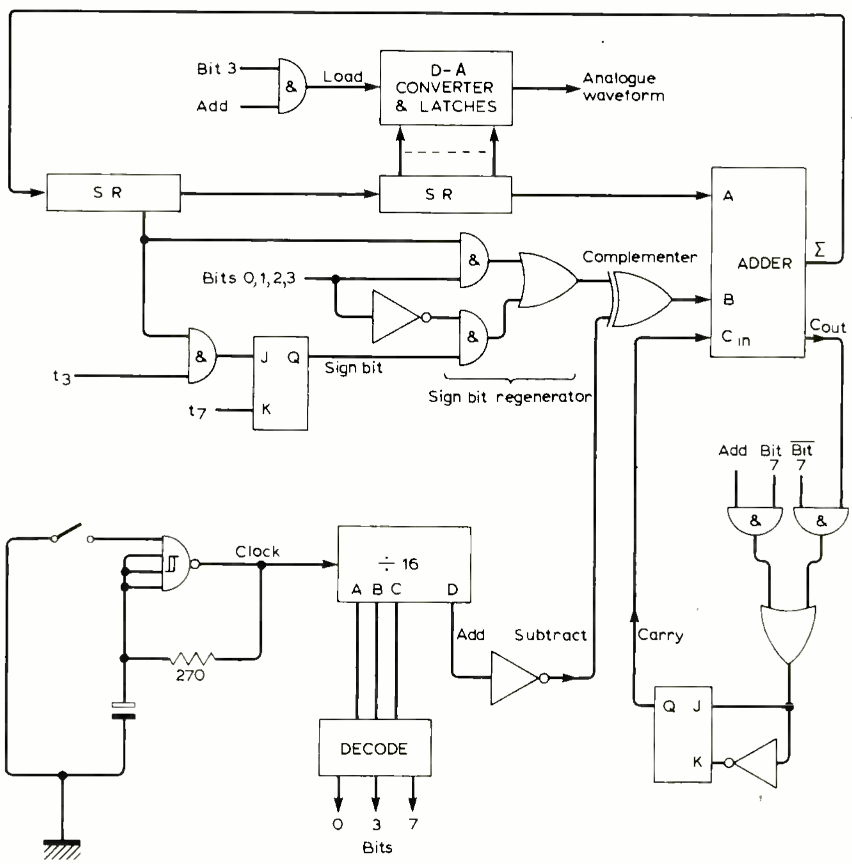


Fig. 3. Logic diagram of oscillator

Table 2: Computed by Fig 2

Step	L	R	Resultant
	100	0	0+100/8=12
1	12	100	100− 12/8=99
	99	12	12+ 99/8=24
2	24	99	99− 24/8=96
	96	24	24+ 96/8=36
3	36	96	96− 36/3
		etc	

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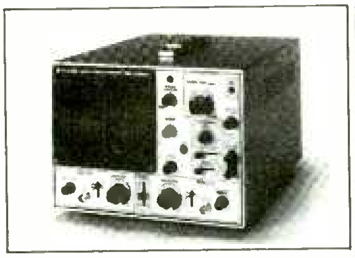

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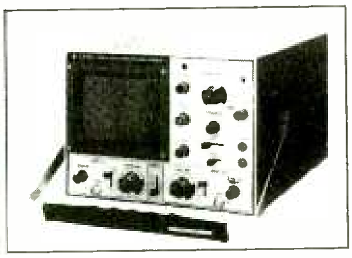

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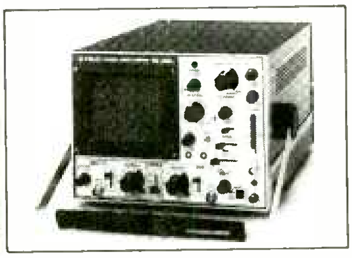

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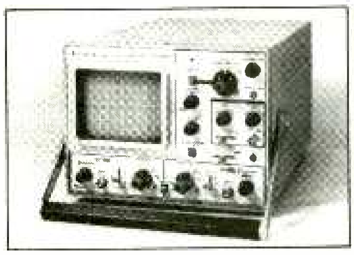

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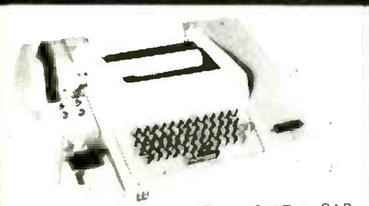

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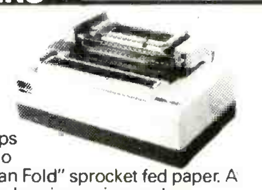

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Tracking elliptical orbit satellites

An alternative method using accurate drawings to replace involved calculations and computer programs

by J. M. Caw, G4ALV

Tracking a satellite in an elliptical orbit without pre-calculated data normally involves complex formulae, best processed using a computer. The author shows here that most of these calculations can be replaced by accurate drawings and still provide a result with an error of less than one degree. Although written with the OSCAR phase IIIs in mind, the method can be used for any satellite with an elliptical orbit, providing the initial data stated here is available.

This method involves drawing both a scaled-down version of the satellite's elliptical orbit and the satellite path, for use as an overlay on a polar projection map. After one orbit ellipse has been drawn, it can be used to make overlays for satellite paths with any apogee latitude. The latter section of the article deals with antenna elevation and range estimation.

The easiest way of illustrating the method is by means of an example, so the given information is assumed to be:
apogee height = 39,000km
perigee height = 1,460km
inclination of orbit (i) = 57°
orbital period (p) = 12 hours
The time and position of perigee, and longitude of the equatorial crossing must also be known, as will be discussed later.

Constructing the ellipse

Firstly, an ellipse needs to be drawn, as shown in Fig. 1. Half the major axis is found by dividing by two the sum of the apogee height, perigee height and diameter of the earth (12,740km). Half the major axis is thus 26,600km.

The distance between the centre of the ellipse and the centre of the earth, OS, is half the major axis minus the perigee height minus the radius of the earth, and is thus equal to 18,770km.

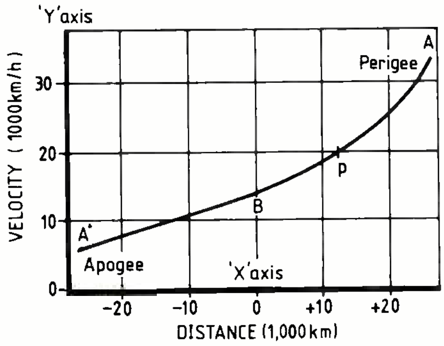


Fig. 2. This graph shows the velocity of the satellite at any point between apogee and perigee, or vice-versa, for the hypothetical orbit shown in Fig. 1. Distances shown on the graph relate to the axes of the ellipse.

Now the eccentricity of the orbit, e, can be found as follows:

$$e=\frac{OS}{OA}=0.7056$$

With the eccentricity and major axis known, half the minor axis, OB, can be found as follows:

$$OB=OA\sqrt{1-e^2}=18{,}848\text{km}$$

Now the ellipse can be plotted using the standard formula:

$$y=b\sqrt{1-\frac{x^2}{a^2}}$$

where x and y are points on the horizontal and vertical axes respectively, a is half the minor axis and b half the major axis of the ellipse.

Orbital velocities

To find the total time elapsed from perigee to a point on the orbit, the velocity of the satellite needs to be known. At any point on the orbit, the velocity of the satellite can be found from the formula:

$$v = 28{,}400\sqrt{\frac{2R}{r}-\frac{R}{d}}\ \text{km/hr}$$

where R is the earth's radius, 6,370km, r is the distance of the satellite from the centre of the earth and d is the average distance of the satellite from the earth's centre found from the formula:

$$d=\frac{AS+SA'}{2}$$

For the given values, d=26,600km. The distance r can be found by measuring from the previously drawn ellipse, Fig. 1.

A distance/velocity graph can now be drawn as shown in Fig. 2, so all that remains is to divide the periphery of the ellipse into sections (a_1-a_2,a_2-a_3, etc.), find the average velocity and distance travelled in each section, and from these results, calculate the time taken for the satellite to travel through the section. The distance travelled by the satellite in each section may be either calculated or taken from the drawing.

A collection of the data that can now be obtained, either by calculation or from the drawing, is given in Table 1. Column 9 gives the cumulative angle of the earth's rotation from the perigee to the orbit point concerned. Due to the decrease in velocity of the satellite towards the apogee, the results shown in Table 1 are only useful for periods within around one hour of perigee. Table 2 shows the same data arranged for

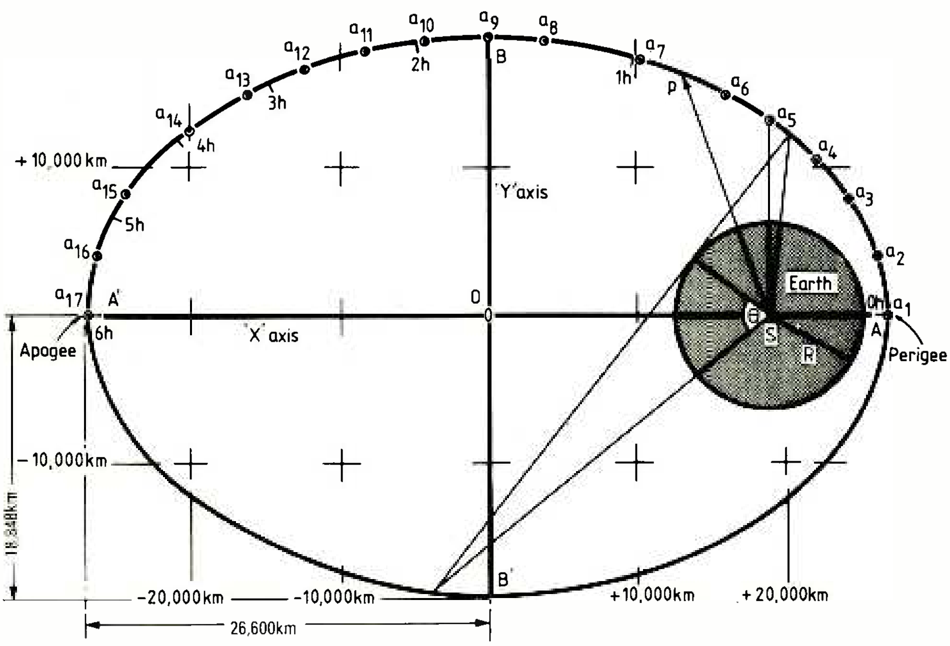


Fig. 1. The orbit ellipse. Once the ellipse has been plotted, it can be used to estimate the height of the satellite above tne earth at any point on the orbit, along with the time elapsed from either apogee or perigee to the point concerned.

Table 1: Orbit data, derived from the given example, for plotting paths at up to 1hr either side of perigee.

Orbit section (see Fig. 1)	Distance taken from orbit drawing (cm)	Equiv. distance in km	Average velocity in km/h	Time of section (t hours)	Time (T) elapsed from perigee to end of sect.	Height above earth's surface at end of sect.	Angle turned from perigee	Earth's rotation from perigee
a_1-a_2	2.0	4 000	33 000	0.12	0.12	1 650	28°	2.0°
a_2-a_3	2.3	4 600	30 900	0.15	0.27	3 300	58°	4.0°
a_3-a_4	1.55	3 100	28 200	0.11	0.38	4 750	74°	6.0°
a_4-a_5	2.1	4 200	25 400	0.165	0.545	6 850	90°	8.0°
a_5-a_6	1.65	3 300	22 800	0.145	0.690	8 900	101°	10.5°
a_6-a_7	3.05	6 100	20 000	0.305	0.995	12 750	115°	14.9°
a_7-a_8	3.2	6 400	16 900	0.379	1.374	17 500	128°	20.6°
a_8-a_9	2.0	4 000	14 700	0.272	1.646	20 250	135°	24.7°
a_9-a_{10}	2.0	4 000	13 200	0.303	1.949	23 000	141°	29.2°
a_{10}-a_{11}	2.0	4 000	11 800	0.339	2.288	25 750	146°	34.3°
a_{11}-a_{12}	2.05	4 100	10 600	0.387	2.675	28 500	152°	40.1°
a_{12}-a_{13}	2.15	4 300	9 400	0.457	3.132	31 500	157°	47.0°
a_{13}-a_{14}	2.4	4 800	8 200	0.585	3.717	34 500	162°	55.8°
a_{14}-a_{15}	3.1	6 200	7 200	0.861	4.578	37 200	169°	68.7°
a_{15}-a_{16}	2.3	4 600	6 200	0.742	5.320	38 250	175°	79.8°
a_{16}-a_{17}	2.0	4 000	5 900	0.678	5.998	39 000	180°	90.0°

equal time periods for use over the remainder of the orbit.

Ellipse rotation

An orbital ellipse rotates in its own plane unless at an inclination of 63.4°, when it remains stationary. The orbit rotates forwards for near equatorial orbits and backwards for near polar orbits. For the example data given here, the orbit ellipse moves forwards at a rate of 0.064° per day, so a new overlay will need to be plotted about once every three months, depending on the accuracy required.

The rate of movement, w, in degrees per day can be calculated using the following formula:

$$w=4.98\left(\frac{R}{a}\right)^{3.5}(1-e^2)^{-2}(5\cos^2 i-1)$$

where R is the earth's equatorial radius (6,370km), a is half the major axis of the orbit, e is the eccentricity of the orbit and i is the orbit inclination.

Sub-satellite path

Plotting of the sub-satellite path, range data, etc., is done on a transparent overlay for a polar projection map with equally spaced latitude circles as shown in Fig. 3. Firstly, not allowing for the earth's rotation, the arc of the sub-satellite path is drawn crossing 90°E and 90°W on the equator and 57°N (the orbit inclination, i) at 0° longitude. This path, marked off from 0-180 in equal parts, is the unbroken arc shown in Fig. 3, and is drawn, either directly on the map or on a separate overlay, using a compass. All sub-satellite path curves are drawn using this arc as a reference.

A piece of stiff cardboard and a drawing pin will be required to revolve the overlay paths around the map, so these can be used if the reference arc is to be drawn on an overlay, and not directly on the map, to fix the relationship between the North Pole and the reference curve.

Using this reference arc, actual satellite path curves can now be drawn using the argument of perigee (part of the initial data previously mentioned) and two sets of figures; one for the angle of the earth's rotation, and one for the angle of the satel-

Table 2: Orbit data from Table 1 tidied up by interpolation.

Time elapsed from perigee (minutes)	Angle of sat. relative to earth's centre	Height of satellite (km)	Earth's rotation from perigee
0	0.0°	1 460	0.0°
30	86.0°	6 250	7.5°
60	116.0°	12 750	15.0°
90	132.0°	19 000	22.5°
120	142.0°	23 500	30.0°
150	149.5°	27 250	37.5°
180	155.0°	30 500	45.0°
210	160.5°	33 250	52.5°
240	165.0°	35 500	60.0°
270	169.5°	37 250	67.5°
300	173.0°	38 200	75.0°
330	176.5°	38 750	82.5°
360apogee	180.0°	39 000	90.0°

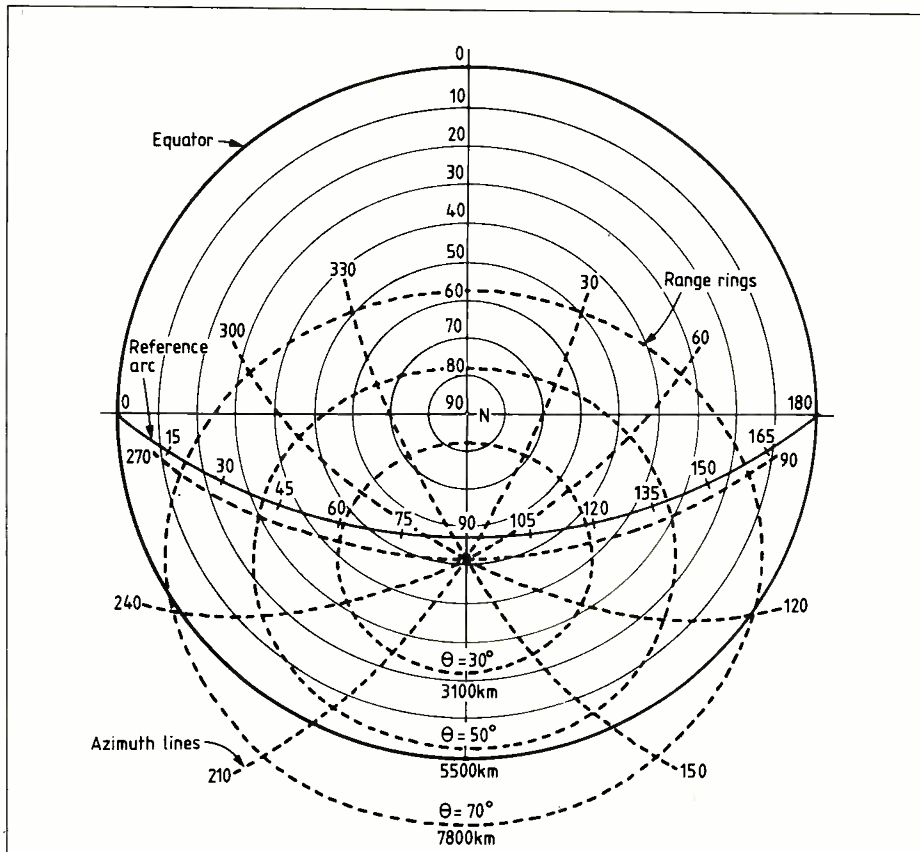


Fig. 3. A polar projection map for the northern hemisphere, with the sub-satellite path reference arc drawn in, and the azimuth lines and range rings plotted at 0° longitude, 52° latitude, i.e. London.

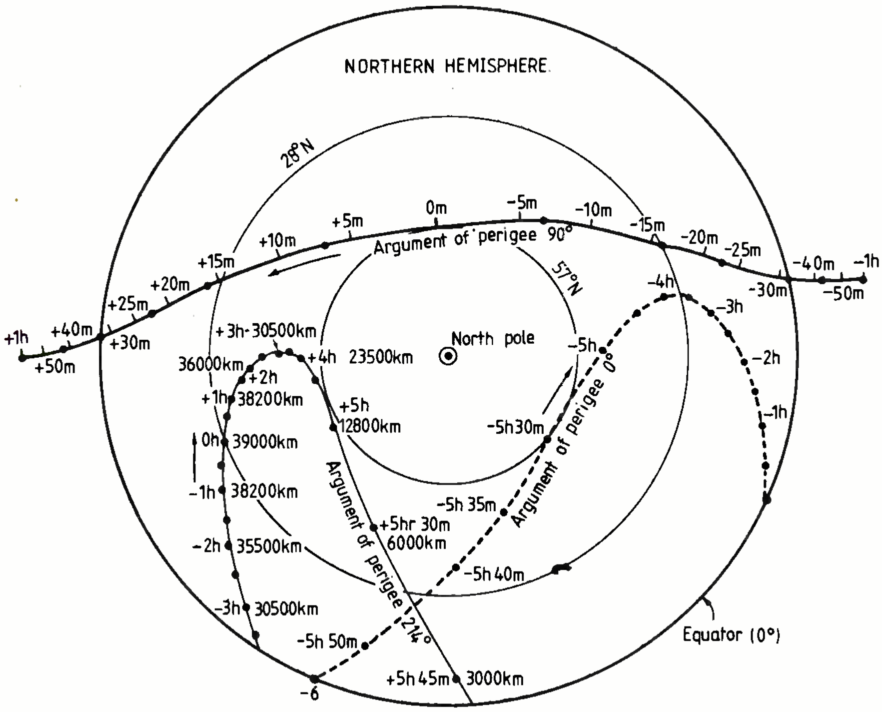


Fig. 4. Representation of the top side of a transparent overlay. These three sub-satellite paths have been plotted from the example data given in the text at three different arguments of perigee to demonstrate the method. Once a path has been plotted, it should be usable for about three months, depending on the orbit inclination and the accuracy required.

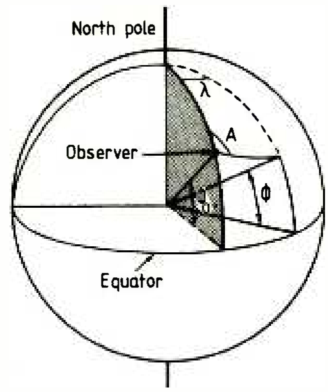


Fig. 5. Angles used in the formula for calculating azimuth lines. ϕ_0 is the observer's latitude and λ is the meridian used to calculate ϕ, the latitude cut by the azimuth line.

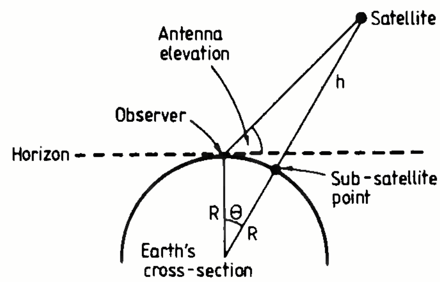


Fig. 6. The angle θ, needed to calculate the antenna elevation angle, can be found either by plotting distances on a globe, or by plotting range rings around the observer on the polar projection map.

lite relative to the earth's centre. The two sets of figures are obtainable from Table 2, and the argument of perigee is the angle measured at the earth's centre, in the plane of the orbit, between the right ascension of the ascending node and perigee.

For plotting curves in the northern hemisphere, a given argument of perigee between 0° and 180° can be used directly, but for an argument of perigee greater than 180°, the difference between 180° and the given value must be used and the curve plotted around the apogee.

Figure 4 represents the top side of a transparent overlay with three paths plotted for arguments of perigee of 0°, 90° and 214°. Taking as an example the curve for an argument of perigee of 214°, the first point of the path will be plotted on the overlay at 34 (214° minus 180°) on the reference arc of Fig. 3. This point, the apogee, corresponds to 28°N latitude.

Now the rest of the overlay curve is plotted by substituting 180° in Table 2 with 34° and working back from apogee to perigee. Each point of the curve is plotted from points on the reference arc at 34 plus and minus (to and from apogee) the difference between 180° and the relevant satellite angle of Table 2. For example, the first two points plotted after apogee will be plotted from points at 34 plus and minus 3.5° (180° minus 176.5°), i.e. from 37.5 and 30.5, on the reference arc. The third pair of points will be plotted from 27 and 41 points on the arc, and so forth.

It can be seen from Table 2 that the time interval between apogee and the first pair of points is half an hour. During this time, the earth will rotate through 7.5°, so the first pair of points of the curve are plotted by measuring off 30.5 and 37.5 on the reference arc and then marking off the two points, one with an offset of 7.5° to the west from the 37.5 point, and one with an offset of 7.5° to the east from the 30.5 point. The first of the third pair of points will be 15°W of 41 on the reference arc, and the second 15°E of 27 on the arc, and

Table 3: Azimuth line co-ordinates for various observer latitudes.

Observer's latitude	Azimuth line from observer (see Fig. 3)	Longitude of azimuth E or W: 10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170/180
		Latitude co-ordinate																
52° London, Kiev, Calgary (Canada), etc.	30/330°	60.2	65.2	68.3	70.3	71.4	72.0	72.0	71.5	70.4	68.4	65.6	60.9	53.2	39.6	16.6	−13.5	−37.7
	60/300°	54.9	56.7	57.6	57.7	57.0	55.4	52.8	48.9	43.1	35.0	23.9	9.8					
	90/270°	51.6	50.3	47.9	44.4	39.4	32.6	23.6	12.5	0								
	120/240°	47.7	41.4	32.6	20.7	6.0	−9.8											
	150/210°	37.7	13.5	−16.6														
40° Philadelphia, Madrid, Ankara, etc.	30/330°		57.3		64.5		67.2		67.1		64.3		57.0		39.0	22.0	0.9	
	60/300°		46.3		48.4		47.0		41.6		30.8		13.1		−9.0			
	90/270°		38.2		32.7		22.8		8.2		−8.2							
	120/240°		27.9		9.0		−13.1		−30.8									
	150/210°	23.5	0.9		−39.0													
26° Miami, Bahrain, Peking, etc.	30/330°		48.2		58.2		62.4		63.2		61.1		55.0		40.9	28.4	11.3	
	60/300°		34.2		38.2		38.7		35.7		28.7		17.4		2.3	−5.8	−13.4	
	90/270°		24.6		20.5		13.7		4.8		−4.8		−13.7		−20.5			
	120/240°		13.4		−2.3		−17.4		−28.7									
	150/210°	8.3	−11.3	−28.4	−40.9		−55.0											

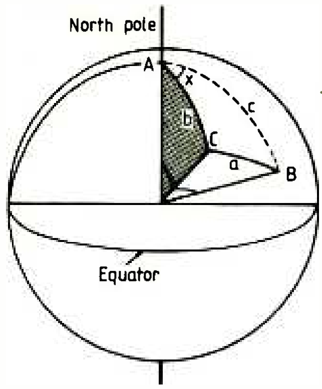


Fig. 7. For plotting range rings on the polar projection map, to aid evaluation of the antenna elevation required, angle x must be found for various latitude values using constant values of angle a. In Fig. 3, range rings are plotted for a = 30°, a = 50°, and a = 70°.

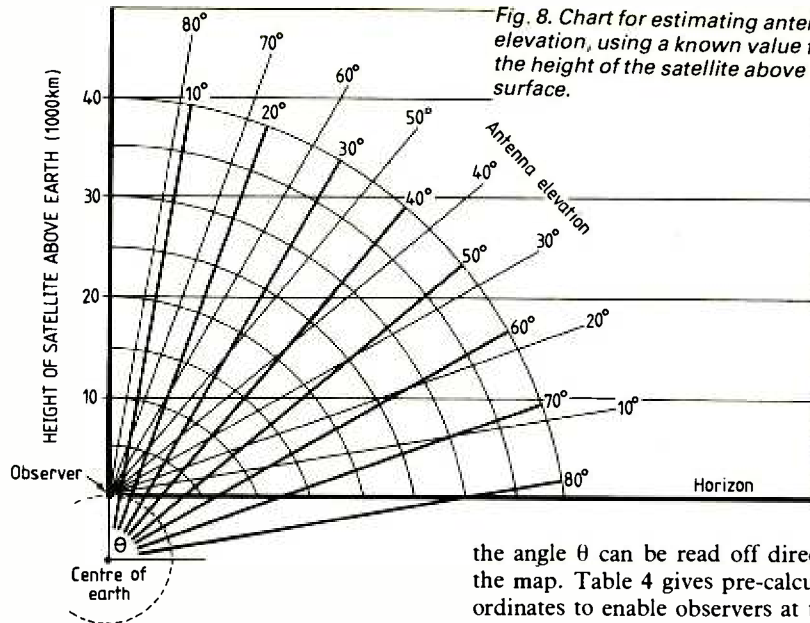


Fig. 8. Chart for estimating antenna elevation, using a known value for θ and the height of the satellite above the earth's surface.

so forth, until the equator is reached by both pre and post-apogee paths. Both the time intervals before and after apogee (or, of course, perigee) and the altitude of the satellite should be noted at each point plotted.

For an argument of perigee of 90°, the angle 90° is read off directly from the reference arc, and it can be seen from Fig. 4 that the perigee occurs at 57°N. For this curve, Table 1 should be used as the satellite is only above the northern hemisphere for about an hour. The points in this case are plotted around the perigee.

Given the equator crossing longitude and time, the overlay can now be rotated into position on the map and the curve of the sub-satellite path used to judge the position and height of the satellite at any given time, providing the satellite is in the northern hemisphere. If, say, a curve has been plotted for an argument of perigee of 214°, it can also be used for an argument of perigee of 326° if it is turned over.

Azimuth lines

Because of the type of base map used here, bearings can only be read directly from the North Pole, so azimuth lines must be plotted on the map for the observer's latitude. Co-ordinates for plotting azimuth lines for places on 52°, 40° and 26° latitude are given in Table 3. For other latitudes, the following formula, with the aid of Fig. 5, may be used to obtain co-ordinates such as those given in Table 3:

$$\tan\phi = (\sin\phi_0 \cos\lambda \pm \sin\lambda \cot A)\sec\phi_0$$

where ϕ_0 is the observer's latitude, λ is the meridian east or west, ϕ is the latitude cut by the azimuth line and A is the azimuth. Figure 3 shows the azimuth lines plotted from London at 52°.

Antenna elevation

Satellite heights at various points on the path have been noted on the overlay to simplify calculation of the antenna elevation. At a given time, the observer's antenna elevation depends on the satellite height and the distance of the satellite from the observer. The elevation angle can easily be found, as shown in Fig. 6, using θ and the height of the satellite path plus the radius of the earth. To find θ, the distance between the observer and the sub-satellite path must be known.

Owing to the type of map used here, equidistant points from an observer do not form a circle on the map, unless the observer is on the North Pole. This means that the distance must be read from a globe, or co-ordinates calculated and range rings drawn around the observer as shown in Fig. 3. If the second option is chosen, the angle θ can be read off directly from the map. Table 4 gives pre-calculated co-ordinates to enable observers at three different latitudes, 52°, 40° and 26°, to draw three range circles representing θ angles of 30°, 50° and 70° which equal sub-satellite point/observer distances of 3100km, 5500km and 7800km respectively.

The longitude values given in Table 4 are offset angles in relation to the observer, so for a given latitude value, the longitude value obtained from the table will be plotted at that latitude on the map, offset in longitude by the value obtained to both east and west.

If required, longitude values other than those given in Table 4 may be calculated. Figure 7 shows the triangle concerned, in which point A represents the North Pole, point B is the point whose longitude offset is to be calculated, and point C represents the observer. The formula for calculating the longitude offset is as follows:

$$\text{haversine } x = \frac{\text{haversine } a - \text{haversine } (b-c)}{\sin b \sin c}$$

where a is the angle between the observer and a point on the radius to be calculated measured from earth's centre, b is 90° minus the observer's latitude, c is 90° minus the latitude value to be used in the calculation for the point to be found, and angle x is the resulting longitude offset value. It should be sufficient to calculate longitude offset values for latitudes at 10° intervals.

When θ is found, the graph shown in Fig. 8 provides an easy means of obtaining the required antenna elevation, by marking off the satellite height at the angle θ and reading the antenna elevation angle from the lines originating from the observer.

Table 4: Co-ordinates for plotting equidistant points around the observer on the polar projection map.

Observer's latitude	Angle between observer and range ring to be plotted measured from earth's centre (see Fig. 3)*	Latitude												
		80	70	60	50	40	30	20	10	0	10	20	30	40
		Longitude degrees east and west of observer												
52°	30°		53.4	53.4	48.5	40.4	27.7							
	50°		117.6	97.4	84.3	73.2	62.2	49.8	33.5					
	70°				131.4	110.5	95.6	82.8	70.2	56.3	37.9			
40°	30°			36.2	40.7	39.8	34.8	26.2	0					
	50°	85.3	81.4	77.0	72.2	66.9	61.0	54.0	45.3	32.9	0			
	70°			124.2	107.8	97.0	88.3	80.3	72.2	63.5	53.0	38.7	0 27.9	
26°	30°				23.4	32.0	33.8	32.0	26.8	15.5				
	50°		41.5	54.2	57.9	58.4	57.0	54.3	50.2	44.3	35.7	20.2		
	70°	125.1	103.3	94.8	89.4	85.0	80.9	76.9	72.5	67.6	61.8	54.4	43.9	25.1

* 9° = 1000km on earth's surface

Bibliography

Satellites and Scientific Research by Howard Miles, Observing Earth Satellites by D. King-Hele and Keeping Track of Oscar by W. Browning.

Acknowledgements

The writer wishes to acknowledge the help received from two gentlemen in the Meteorological Office, Bracknell, Berkshire, who went to a great deal of personal trouble to answer questions and give advice. □

Remote keyboard interface

System allows remote and local keyboards to be used simultaneously

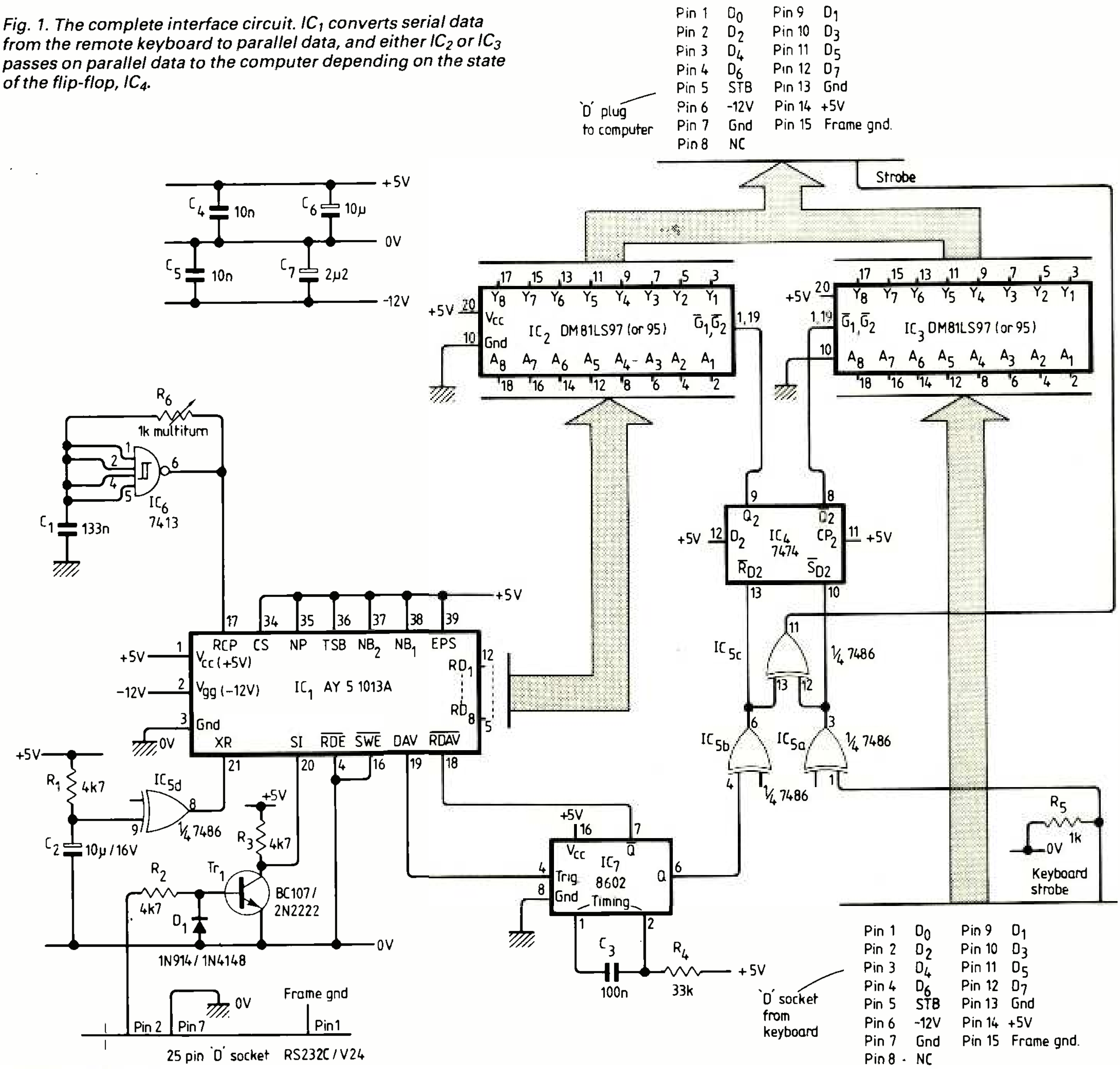
by M. D. Alger and B. Benson

This circuit was devised to enable access to a computer from a remote keyboard via a four wire link, without either writing complex software or disabling the existing keyboard. Originally designed for use with an RML380Z machine, this interface can be used with any computer which uses a parallel link for its keyboard.

A 'microcomputer' with all its peripherals is often anything but portable, so the authors set about designing an interface which would allow their computer to be operated from a separate keyboard at a remote location. A monitor link is, of course, no problem. The RS232 link used here should make it possible to operate the remote keyboard at distances of up to 1000ft from the interface and, if required, both keyboards can be operated at the same time.

Two 15-pin 'D' series plug/socket combinations are required, one pair for the break in the parallel link betwen the computer and its keyboard, and the other pair for the input and output of the interface, as shown in Fig. 1. A 25-pin 'D' socket is

Fig. 1. The complete interface circuit. IC_1 converts serial data from the remote keyboard to parallel data, and either IC_2 or IC_3 passes on parallel data to the computer depending on the state of the flip-flop, IC_4.



required for connecting the remote keyboard to the interface.

Circuit operation

Basically, the circuit multiplexes two eight-bit signals, one direct from the existing keyboard and one from the remote keyboard. The last-mentioned signal enters the interface as RS232 serial data and is converted to parallel data by the u.a.r.t., IC_1 of Fig 1. The last strobe pulse received by the interface determines which keyboard is accepted by the computer by enabling either one of the two tri-state octal buffers (IC_2 or IC_3) through the flip-flop, IC_4.

In this version, the power supply for the interface was taken from the computer, but the circuit can be powered using a 7805 voltage regulator for the +5V supply and a Zener diode and resistor for the −12V supply. Maximum current requirements for the circuit are 200mA from the 5V supply and 20mA from the −12V supply. Capacitors C_4 to C_7 should give adequate supply decoupling if distributed.

IC_1, the u.a.r.t., converts serial data from the remote keyboard, consisting of one start bit, seven data bits, parity and two stop bits, to parallel data. Tr_1, D_1, R_2 and R_3 invert the incoming RS232 signal and shift it to t.t.l. level. The power-on reset is provided by R_1, C_2 and IC_{5d}, and the u.a.r.t. clock by IC_6, R_6 and C_1. Pins 34 to 39 of IC_1 are used to set the data format, the options of which are given in Table 1.

When a complete byte is received by IC_1, pin 19 of the i.c. goes high, causing IC_7 to produce a 1.2ms pulse at pin 6, and an equivalent but inverted pulse at pin 7. The pulse at pin 7 of IC_7 is used to reset pin 19 of IC_1 via pin 18 of IC_1, to prepare the u.a.r.t. for the next byte. IC_{5b} inverts the output from pin 6 of IC_7 and resets IC_4, which in turn enables IC_2 and disables IC_3.

To ensure that only one keyboard can produce a strobe input at any one time, the two strobe signals are fed into an exclusive OR gate, IC_{5c}, after being inverted by IC_{5a} and IC_{5b}. The output of IC_1 can be disabled by driving pin 4 of the i.c. high, but as the i.c. has limited driving capabilities, either the length of the connection

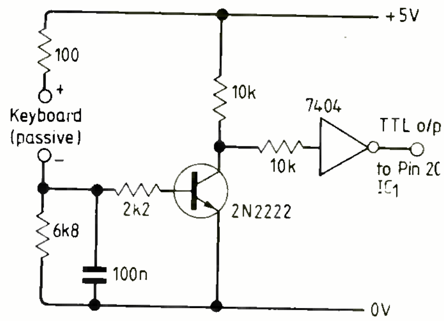


Fig. 2. Optional buffer circuit for 20mA loop input. This circuit replaces R_2, R_3, D_1 and TR_1 of Fig. 1.

between IC_1 and IC_2 will have to be kept small or buffers will have to be used.

The parallel input from the existing keyboard drives IC_3 in the same way that the remote keyboard drives IC_2, apart from the inclusion of R_5 in the strobe line which ensures that data from the u.a.r.t. is not blocked if the existing keyboard is unplugged.

Circuit options

The circuit of the interface is flexible, and can be adapted to suit individual circumstances. Firstly, the baud rate of the remote keyboard input can be compensated for by adjusting the value of C_1 of the clock section. R_6 should not be altered as it is only used to trim the oscillator, and is not effective over its full range. The circuit components shown are calculated for a clock frequency of 4800Hz and for a baud rate of 300. If high data rates are to be used, the pulse length from IC_7 may have to be reduced to less than the length of an incoming byte.

Figure 2 shows the circuit diagram required if a 20mA loop is to be used instead of RS232. This circuit replaces Tr_1, R_2, R_3 and D_1 of Fig. 1, and feeds pin 20 of IC_1 from pin 2 of the 25 pin 'D' socket. If 110-baud rate is to be used, the 0.1μF capacitor of Fig. 2 should be replaced by a capacitor of around 0.47μF.

Any monostable can be used for IC_7, but the values of the timing resistor and capacitor will have to be altered to give the required pulse length. There are also many alternatives to IC_2 and IC_3, which can be any 8-bit non-inverting buffers with tri-state outputs, or even a pair of 74LS125s.

Using the principles applied here, expansion to accommodate extra keyboards is simple. The original circuit was built on Vero-board, but the circuit layout is not critical so any bread-board system could be used. □

Table 1: Format options

Pin No (IC_1)	Pin name	'0' level	'1' level
34	control strobe (CS)		enter control bits
35	no parity (NP)	parity	parity ignored
36	number of stop bits (TSB)	1 stop bit	2 stop bits
37	No of bits/char. (NB2)	0 0	1 1
		=5 bits =6 bits	=7 bits =8 bits
38	No of bits/char. (NB1)	0 1	0 1
39	odd/even parity select (EPS)	odd parity	even parity

Sine oscillator

continued from page 70

usual practice, by setting carry to a 1 when in the subtract mode. In the add mode, carry is set to zero.

The sign extension logic shown in Fig. 2 extends the sign (1 or 0) for n bits each half step, as is usual practice when right shifting n places. For example

13 in binary is 00001101
13/8 is xxx00001

where xxx becomes 000 to result in 00000001 whereas

−13 in binary is 11110011
and −13/8 is xxx11110

where xxx becomes 111 to result in 11111110 which shows digital hardware gives

−13/8=−2

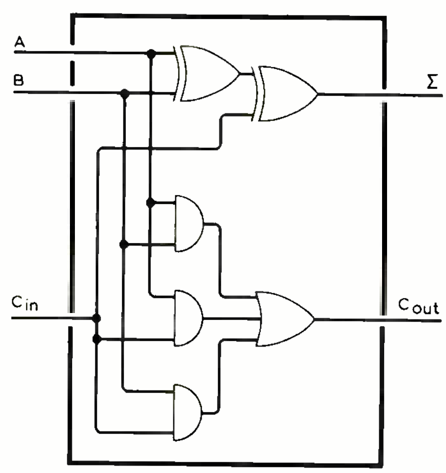


Fig. 4. Logic details of adder in Fig. 3.

A computer simulation of the device must reflect this form of truncation, which is to round off down to the smallest value.

Fig. 3 shows a logic diagram. The digital to analogue converter and the latch-stores to hold the digital value of sine is refreshed at each step. □

Correction

Wien-bridge oscillator – May, 1981

Mr Linsley Hood has pointed out two errors which appeared in this article. Firstly, Figures 4 and 5 should be interchanged and secondly, the inputs of the second 741 in the original Fig. 5 (now Fig. 4) should also be interchanged. We apologize for these mistakes.

Filter design with voltage-controlled voltage sources

Independent frequency, gain and damping for simplified variable filter design

by **Alan A. Thomas**

This filter design enables second-order, low- and high-pass functions to be realised with independently definable parameters. Such independence greatly simplifies design procedure, reduces the sensitivity to component tolerances and simplifies the design of continuously variable filters.

The basic configuration of the voltage-controlled voltage source circuit on which the proposed filter is based is shown in Fig. 1. An ideal v.c.v.s. circuit exhibits an infinite impedance at its input, and zero impedance at its output. In practice, if a modern operational amplifier is used, results closely approaching this ideal may be achieved.

The parameter H_o defines the gain of the filter within its pass band, and is equal to the gain of the v.c.v.s. circuit to which the complex pole network is connected. The v.c.v.s. gain constant, referred to as K, is defined as follows

$$K=\frac{V_o}{V_i}=H_o=1+(R_a/R_b) \qquad (1)$$

when $X_c \ll R_b$ at all frequencies of interest and the open loop gain of the amplifier is very large.

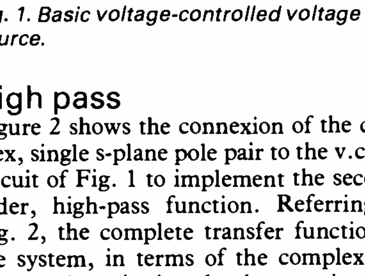


Fig. 1. Basic voltage-controlled voltage source.

High pass

Figure 2 shows the connexion of the complex, single s-plane pole pair to the v.c.v.s. circuit of Fig. 1 to implement the second-order, high-pass function. Referring to Fig. 2, the complete transfer function of the system, in terms of the complex frequency plane, is given by the equation:–

$$\frac{V_o}{V_i}(s)=\frac{Ks^2}{s^2+s[1/R_2C_1+1/R_2C_2+(1-K)/R_1C_1]+1/R_1R_2C_1C_2}$$

and the three filter parameters may be defined as follows:

$$\omega_o=\left(\frac{1}{R_1R_2C_1C_2}\right)^{1/2}$$

where ω_o is the natural undamped resonant frequency of the filter;

$$\alpha=\left(\frac{R_1C_1}{R_2C_2}\right)^{1/2}+\left(\frac{R_1C_2}{R_2C_1}\right)^{1/2}+\left(\frac{R_2C_2}{R_1C_1}\right)^{1/2}-K\left(\frac{R_2C_2}{R_1C_1}\right)^{1/2}$$

where α is the damping factor which determines the response of the filter; and

$$H_o=K.$$

Referring to the equations for damping factor and pass-band gain, they are both found to contain the identity K. These parameters are not, therefore, at present, independent. To make them so, it is proposed that the basic v.c.v.s. circuit of Fig. 1 is augmented such that independent K identities, designated $K\alpha$ and KH_o, may be generated for each parameter. This method, which is both simple and reasonably accurate, is shown in Fig. 3.

The circuit consists of two v.c.v.s. circuits of the basic form. The complex pole pair network is connected around the first v.c.v.s. circuit in the normal manner, but the filter output is taken via a second v.c.v.s., the input of which is connected to the inverting input of the first v.c.v.s. Referring to Fig. 3, The K identity for α may now be defined by R_a and R_b independently of the K identity for H_o, which is only dependent on R_c and R_d. This may be proved mathematically as follows:–

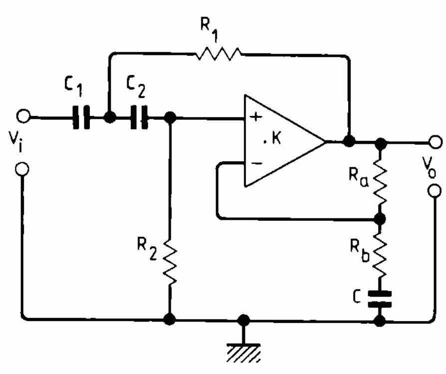


Fig. 2. Second-order, high-pass filter formed from v.c.v.s. of Fig. 1.

First, rearranging equation (1) for V_i.

$$V_i=\frac{V_o}{1+(R_a/R_b)} \qquad (2)$$

Now expressing the voltage appearing at the inverting input of the v.c.v.s. circuit of Fig. 1, designated V_{fb}, in terms of V_o, R_a and R_b, by proportion,

$$V_{fb}=V_o\left(\frac{R_b}{R_b+R_a}\right)$$

which may be re-written

$$V_{fb}=\frac{V_o}{1+(R_a/R_b)} \qquad (3)$$

Finding the gain from input to inverting input by dividing equation (3) by equation (2),

$$\frac{V_{fb}}{V_i}=\frac{\dfrac{V_o}{1+(R_a/R_b)}}{\dfrac{V_o}{1+(R_a/R_b)}}=1 \qquad (4)$$

Refer now to the augmented v.c.v.s. circuit of Fig. 3. From equation (1),

$$K_\alpha=1+(R_a/R_b) \qquad (5)$$

and from equation 1 and 4

$$KH_o=[1+(R_c/R_d)]1=1+(R_c/R_d) \qquad (6)$$

The filter parameters may now be redefined in terms of the new v.c.v.s. arrangment of Fig. 3.

$$\omega_o=\left(\frac{1}{R_1R_2C_1C_2}\right)^{1/2} \qquad (7)$$

$$\alpha=\left(\frac{R_1C_1}{R_2C_2}\right)^{1/2}+\left(\frac{R_1C_2}{R_2C_1}\right)^{1/2}+\left(\frac{R_2C_2}{R_1C_1}\right)^{1/2}-\left(1+\frac{R_a}{R_b}\right)\left(\frac{R_2C_2}{R_1C_1}\right)^{1/2} \qquad (8)$$

and $\quad H_o=1+(R_c/R_d) \qquad (9)$

By comparing equations (8) and (9) it is evident that they no longer contain any common identities and α and H_o are thus independent. Similarly, comparing equations (7) and (9) reveals no common identities and that ω_o and H_o are also independent. Comparing equations (7) and (8), however, several common identities are located, namely R_1, R_2, C_1 and C_2.

Closer inspection of equation (8) reveals that α is not dependent directly on the values of these components, but is dependent solely on their ratios. It follows, therefore, that if R_1, R_2 and/or C_1, C_2 are varied so that their ratios remain constant, ω_o may be varied independently of α.

One of the design requirements set for the filter was that each parameter could be continuously varied to facilitate tuning. In order to maintain a constant ratio between R_1, R_2 and/or C_1, C_2, either both R_1, R_2 and /or C_1, C_2 must be varied simultaneously by equal proportions. This requires some practical consideration. Firstly, ganged variable capacitors are not available in values suitable for low-frequency filters. Secondly, assuming that the resistors must be the variable elements, ganged potentiometers of the standard type are only available with tracks of equal value. The ratio R_1, R_2 must, therefore, be 1:1, for practical reasons.

Consider now the most suitable ratio for the fixed capacitors. It is obviously convenient if $C_1 = C_2$, since problems of locating suitable preferred values to obtain the desired ratio are eliminated; further, this also has the desirable effect of minimizing the temperature sensitivity of α.

Accepting that capacitors suffer worst from temperature drift, if C_1 and C_2 are of equal value and of similar construction, any change in value due to temperature, in theory at least, will be equal in both capacitors. Hence, their ratio remains constant, and since α is dependent on those components only through their ratio, α will remain constant with temperature.

In the proposed filter design, therefore, $R_1=R_2$ and $C_1=C_2$ and all parameters become independent, providing ω_o is varied by simultaneous and equal adjustment of R_1 and R_2.

The filter parameters in Fig. 3 may now be more simply defined.

From equation (7) and given that $R = R_1 = R_2$ and $C = C_1 = C_2$,

$$\omega=\frac{1}{RC} \tag{10}$$

From equation (8) and given $R_1=R_2$ and $C_1=C_2$,

$$\alpha=2-(R_a/R_b) \tag{11}$$

and, as in equation (9),

$$H_o=1+(R_c/R_d) \tag{12}$$

Low-pass

Figure 4. shows the connexion of the complex s-plane pole pair to the augmented v.c.v.s. circuit, adopted in Fig. 3, to implement the second-order low-pass function. If a similar analysis is carried out

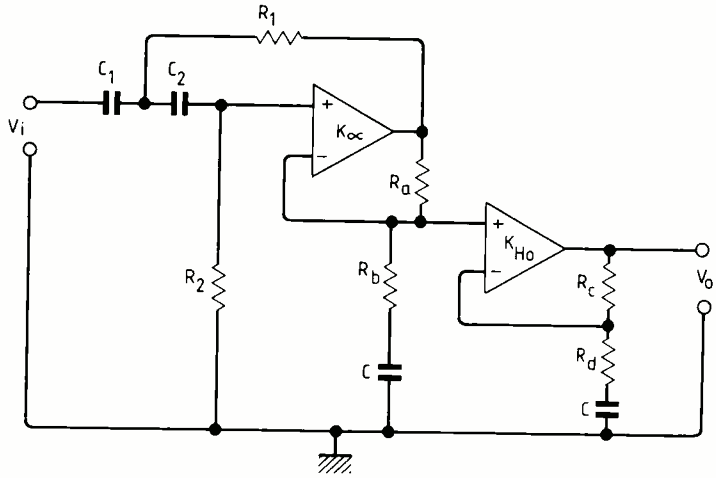


Fig. 3. Damping factor and pass-band gain made independent by use of two sources.

as in the case of the high-pass filter, it is found that, given that $R_1= R_2$ and $C_1 = C_2$, identical design equations, namely, equations (10) to (12), appear for the three filter parameters. A common set of simplified design equations may therefore be applied to both high-and-low-pass filters.

Common to both filters is the restriction that the damping factor cannot exceed 2, given that $R_1 = R_2$ and $C_1 = C_2$. This restriction occurs since the factor $K\alpha$ cannot be less than 1 in the proposed design. In practice, this restriction is of little importance since once α exceeds 2, the poles are no longer complex.

To aid design, Table 1 lists several damping factors required when implementing standard second-order responses. The ratio R_a: R_b is also included for convenience.

Finally, a practical example will be given. The circuit of Fig. 5 is intended as a rumble filter. In this design, the cut-off frequency designated f_o is continuously variable from less than 20Hz to greater than 160Hz using a standard, twin-ganged potentiometer. The response chosen is standard Butterworth, maximally flat, within a design accuracy of 0.2%, using preferred values of the E24 resistor range, and is independent of the chosen cut-off frequency. The pass-band gain, which is also totally independent, has been set to unity by effectively setting R_c to zero and R_d to ∞ By comparison, if the more common unity-gain, second-order, high-pass filter arrangement had been adopted, the response could not have been set to standard Butterworth while still maintaining a standard twin-ganged potentiometer, that is, equal value resistors, to set the chosen cut-off frequency – regardless of the ratio of the two capacitors C_1 and C_2.

No attempt has been made in the example quoted above to optimise clipping levels. The maximum signal which the augmented v.c.v.s. filter circuits can handle before the onset of clipping is related to the values chosen for α and H_o. This signal level is limited either to V_p, which is the clipping level of the operational amplifier, or

$(V_p[R_b/R_a+R_b])\ (1+R_c/R_d)$

TABLE 1
Damping factors and ratios R_a/R_b for several second order responses

response	damping factor	R_a/R_b
Butterworth	1.414214	0.585786
Bessel	1.732051	0.267949
Chebyshev (ripple 0.5)	1.157781	0.842219
Chebyshev (ripple 1.0)	1.045456	0.954544
Chebyshev (ripple 2.0)	0.886015	1.11398
Chebyshev (ripple 3.0)	0.766464	1.23354

For the Chebyshev designs, the ripple quoted is the maximum peak to peak deviation within the pass band in dB.

Symbols

- f – frequency of interest.
- ϕ_f – degrees of lead or lag at frequency of interest.
- f_o – cut-off frequency of the filter.
- f_p – frequency of response peak.
- G_{fp} – gain at response peak.
- G_{fo} – gain at cut-off frequency.
- ω_o – natural undamped resonant frequency of the filer.
- H_o – band pass gain of the filter.
- α – damping factor applied to tailor response of the filter.

should this be $\leq V_p$

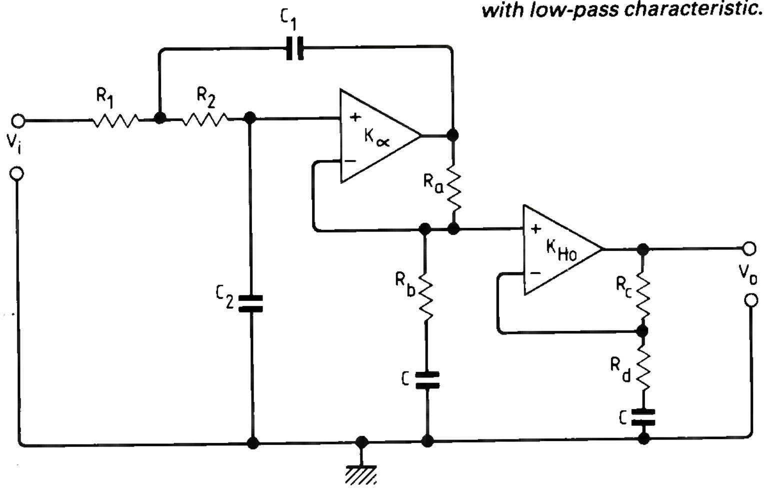
The thoretical absolute worst-case clipping level occurs when $\alpha= 0$ and $H_o=1$, giving V_p−9.5dB. A more practical example, however, would be when Butterworth response has been chosen. Here, $\alpha = 1.414$, and assuming H_o is at the worst-case value of unity, the clipping level will be V_p – 4dB.

As a useful general rule, should it be necessary to maintain the clipping level of the filters at a premium, the associated circuitry should allow H_o to be a minimum of $3-\alpha$. In most cases, however, there should be no need to take such precautions since filters of this nature are generally positioned at the input of an audio system where the signal levels encountered are naturally at a minimum.

Reference

1. Operational Amplifiers – Design and Application. Jerald G. Graeme (copyright Burr-Brown Corp.). McGraw-Hill.

Fig. 4. Similar circuit to that of Fig. 4, but with low-pass characteristic.



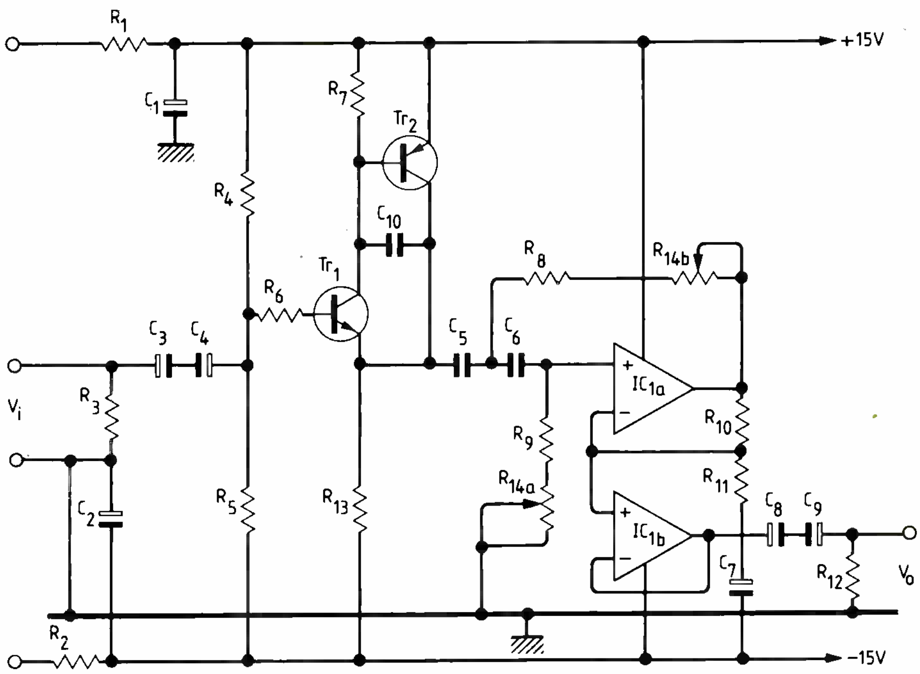


Fig. 5. Practical rumble filter, tunable from 20Hz to more than 160Hz.

Components

Rumble filter

Resistors

1.	75R	
2.	75R	
3.	100k	
4.	220k	
5.	220k	
6.	220R	
7.	3k	
8.	10k	2%
9.	10k	2%
10.	30k	2%
11.	51k	2%
12.	100k	
13.	3K3	
14a,b.	100k	5% ganged

All resistors 5% tolerance unless otherwise stated

Capacitors

1.	150μ	25V	electrolytic
2.	150μ	25V	electrolytic
3.	2.2μ	35V	tantalum
4.	2.2μ	35V	tantalum
5.	82n	5%	polystyrene
6.	82n	5%	polystyrene
7.	10μ	25V	tantalum
8.	22μ	16V	tantalum
9.	22μ	16V	tantalum
10.	27p	5%	polystyrene

Semiconductors

Tr_1	BC184LC
Tr_2	BC214LC
IC_1	LM1458 or similar

Appendix

The following equations may be of help when checking low and high pass filter arrangements.

Transfer characteristic – low-pass

$$\frac{V_o}{V_i}=H_o\left(\frac{1}{\left[\left(1-\left[\frac{2\pi f}{\omega_o}\right]^2\right)^2+\left(\frac{2\pi f\alpha}{\omega_o}\right)^2\right]^{1/2}}\right)$$

High-pass

$$\frac{V_o}{V_i}=H_o\left(\frac{\left(\frac{2\pi f}{\omega_o}\right)^2}{\left[\left(1-\left[\frac{2\pi f}{\omega_o}\right]^2\right)^2+\left(\frac{2\pi f\alpha}{\omega_o}\right)^2\right]^{1/2}}\right)$$

Phase response – low-pass

$$\phi_f=-\left(\arctan\left[\frac{1}{\alpha}\left(2\frac{2\pi f}{\omega_o}+[4-\alpha^2]^{1/2}\right)\right]+\arctan\left[\frac{1}{\alpha}\left(2\frac{2\pi f}{\omega_o}-[4-\alpha^2]^{1/2}\right)\right]\right)$$

High-pass

$$\phi_f=+180^\circ-\left(\arctan\left[\frac{1}{\alpha}\left(2\frac{2\pi f}{\omega_o}+[4-\alpha^2]^{1/2}\right)\right]+\arctan\left[\frac{1}{\alpha}\left(2\frac{2\pi f}{\omega_o}-[4-\alpha^2]^{1/2}\right)\right]\right)$$

Cut-off frequency – low-pass

$$f_o=\omega_o[\tfrac{1}{2}([\alpha^2-2)^2+4]^{1/2}-[\alpha^2-2])]^{1/2}$$

High-pass

$$f_o=\omega_o[\tfrac{1}{2}([\alpha^2-2)^2+4]^{1/2}-[\alpha^2-2])]^{-1/2}$$

Frequency of response peak (when α is less than 1.414) – low-pass

$$f_p=\omega_o(1-\alpha^2/2)^{1/2}$$

High-pass

$$f_p=\omega_o(1-\alpha^2/2)^{-1/2}$$

Gain at response peak (when α is less than 1.414) – low pass

$$G_{fp}=H_o[(\alpha^2/2)^2+(\alpha^2[1-\alpha^2/2])]^{-1/2}$$

High-pass

$$G_{fp}=H_o[(\alpha^2/2)^2+(\alpha^2[1-\alpha^2/2])]^{-1/2}$$

The gain at cut-off frequency for both high and low pass filters is: –

$$G_{fo}=2^{-1/2}.H_o$$

and finally, the gain at ω_o for both high and low pass filters is: –

$$G_{\omega o}=\alpha^{-1}.H_o.$$

NEW PRODUCTS

Digital transmission system

Twin wires or Post Office lines can be used to convey the condition of up to 240 parallel on/off type inputs in up to six channels using the Highland microprocessor-controlled multiplexer. The transmitter scans the inputs of each channel and converts the information to serial form for transmission to a remote receiver. Serial data is converted back to parallel form by the receiver. The parallel-data output is identical to the input data to the transmitter. These outputs can be used to drive l.e.d. displays, digital event recorders, alarm systems or remote control equipment. Surge and false signalling protection is provided and the system has built-in fault diagnosing circuitry. Highland Electronics Ltd, Highland House, 8 Old Steine, Brighton, E. Sussex BN1 1EJ.

WW301

Auto ranging d.v.m.

Voltage, current and resistance ranges of the latest digital multimeter from AVO are provided with auto-ranging facilities. The DA118 offers five functions, including direct current and voltage, alternating current and voltage, and resistance ranges, all fully protected against overload. Response time of the d.c. and resistance ranges is less than one second and the manually selected 20mV d.c. range gives a resolution of 10μV. Basic d.c. accuracy is 99.7%. The 31/2 digit l.c.d. indicates the unit of measurement and decimal point and provides range-hold, polarity, over-range and 'battery low' information. Either battery or mains power can be used for the instrument. Optional probes are available for r.f. and temperature measurements. Avo Ltd, Archcliffe Road, Dover, Kent CT17 9EN.

WW302

6-18GHz amplifiers

Gallium arsenide f.e.t. amplifiers covering the frequency range 6 to 18GHz are manufactured by Dexcel. This series, called DXA-061800, consists of five standard units with gains of 9, 18, 27, 36 or 45dB over the full bandwidth. All have a maximum noise figure of 8dB and minimum output power of 10dBm at 1dB gain compression, or 20dBm to special order. Both input and output v.s.w.r. are 2:1. A 36dB gain unit measures 2.67 × 1.35 × 0.5in. In addition to these basic amplifiers various options are offered. March Microwave Ltd, 112 South St, Braintree, Essex.
WW303

Typewriter/printer

A bi-directional printer which can also be used as a typewriter has been introduced to the market by Weyfringe Ltd. The Century KSR II can be used in microcomputer installations where hard copy is needed at the data input stage, or as an interactive second printer in any time sharing system. An integral ASCII keyboard with separate numeric keypad is used for data entry. Lower case type-face has descenders below the line. Up to sixteen characters, entered on the keyboard, can be stored in a first-in/-first-out memory, and to cope with high typing speeds, N-key rollover is suppled as standard.

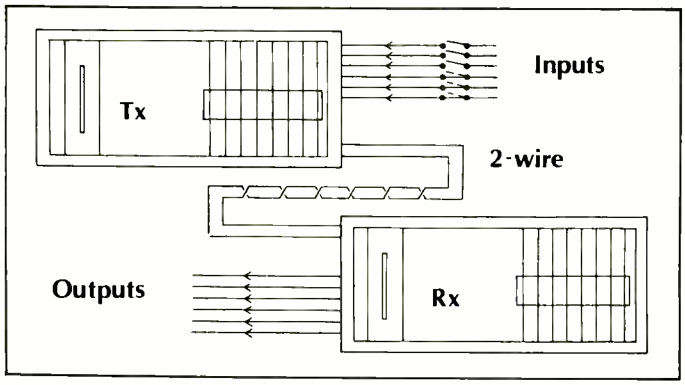
The KSR II can be linked to any computer with an RS232C, V24 or 20mA loop interface. The price is around £995. In the near future, a version of this printer which can produce four different type depths will also be available. Weyfringe Ltd, Longbeck Rd, Marske, Redcar, Cleveland TS11 6HQ.
WW 304

R.f. screening material

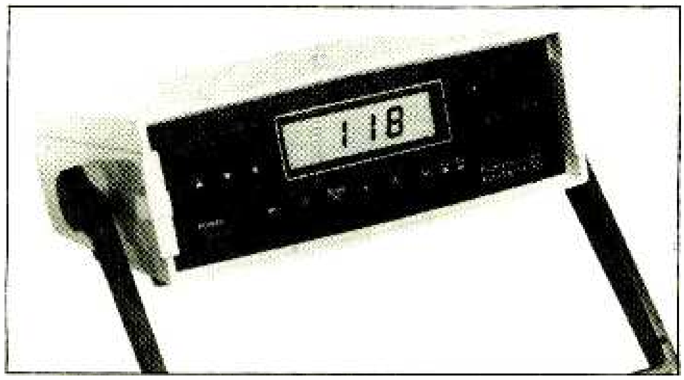
What might be a useful product for those concerned about r.f.i. emitted from microcomputers is available from RFI Shielding Ltd. Alumashield, as it is known, is a laminate comprising 40 micron thick aluminium foil and 1.5mm thick p.v.c. foam with a pressure sensitive adhesive backing. The shielding, after removal of a protective backing sheet, can be applied directly to the inner surfaces of plastic enclosures, etc. This material can also be supplied with copper or tinned copper as the shielding medium (Coppashield?), and with the p.v.c. foam replaced by silicone sponge elastomer in various thicknesses. RFI Shielding Ltd, Warner Drive, Springwood Indust. Est., Rayne Rd, Braintree, Essex CM7 7YW.
WW 305

Byte erasable e.e.p.r.o.m.

Any byte of the 16Kbit Intel 2816 e.e.p.r.o.m. (electrically erasable p.r.o.m.) can be erased and rewritten in 20ms. The standard version



WW301


WW302

WW303


WW304

of this 2K × 8-bit memory has a 'worst-case' access time of 250ns and two other versions are available with 200 and 350ns access times. At 125°C, data retention is predicted to be at least 20 years and refreshing is not required, regardless of frequency. Byte erase/write or chip erase require 10ms pulses of 21V. This 24-pin device is pin-compatible with the 2716, has a temperature range of 0 to 70°C and requires 495mW in the active state and 132mW in standby mode. Applications of this i.c. are in any process which requires regular updating of r.o.m., such as industrial control processes. Intel Corp. (UK) Ltd, Dorcan House, Eldene Drive, Swindon, Wilts SN3 3TU.

WW306

'Pocket' pattern generator

This battery operated tv pattern generator, from HRS Components Ltd, measures 160 × 72 × 40mm and weighs 355gm. Crosshatch, white synchronized raster and grey scale signals of the PG101 are selected by touch buttons exhibiting the required pattern, and the output is produced in the form of a modulated u.h.f. signal (channel 36) through a lead which plugs directly into the tv antenna socket. After about 15 minutes, the 5mA supply from a PP3 type dry cell is cut off automatically to save the battery if the unit is inadvertently left switched on. The generator is said to give a stable display suitable for bench or field servicing and the cost, including co-axial connecting lead, is £49 + v.a.t. HRS Electronic Components Ltd, Brasshouse Passage, Birmingham B1 2HR.

WW307

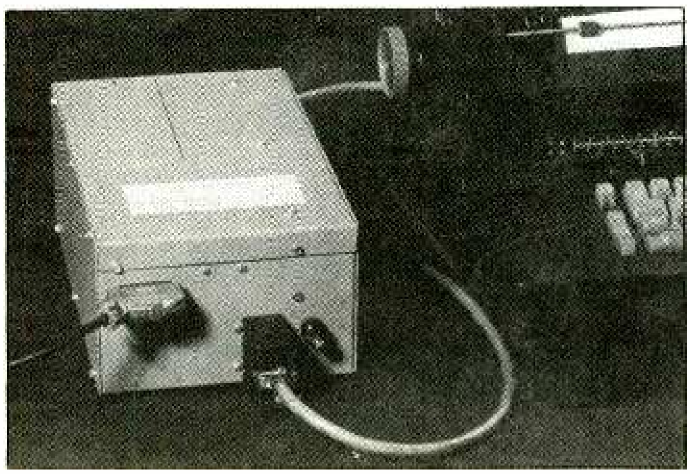
Golf-ball/computer interface

Standard golf-ball typewriters from IBM can be used to produce printouts from a computer using the USA manufactured Escon interface from Data Resources Ltd. The typewriter keyboard stays active when the interface is connected, so variable information such as names, addresses, etc., can be inserted in standard information sheets by using programmed pauses. An internal 6502 microprocessor controls the interface and protocol routines and baud rates from 75 to 19,200 are switch selectable. Printing speed is around 160 words/minute. Options are available to suit RS232C or 8-bit parallel interfaces and foreign and non-standard IBM golf-ball typewriters. A 512 character buffer is fitted to the RS232 version and a pre-programmed test routine is built-in. Prices start at around £415 exclusive of v.a.t. Data Resources Ltd, Caldare House, 144-146 High Road, Chadwell Heath, Essex RM6 6NT.

WW308

Variable isolating transformer

Continuously variable alternating voltages from 0 to 250V at 3A can be supplied by the Svenska Transduktor type 237 mains isolating transformer from Technical Selling Services. This toroidal transformer is cased, and provided with a voltmeter, ammeter and a 3A thermal circuit breaker. Although the unit is designed for 220V mains operation, the distributors say that it will work at 240V without detriment. With the output set to 220V, the change in voltage from no-load to full-load conditions is about 5%.

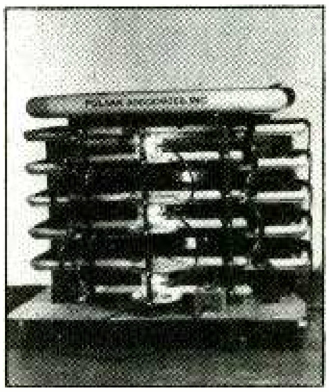


Primary/secondary insulation is tested to 4kV r.m.s. at 50Hz. The price is around £148.50. Technical Selling Services, Unit 5, Brunel Gate, West Portway Indust. Est., Andover, Hants SP10 3SL.

WW309

Lightning simulator

Two generator systems have been developed to simulate the effects of lightning. Model 790, from Pulsar Associates Inc., is a high-current generator, capable of delivering 200kV and 100,000 amperes in a ringing pulse, from 10kJ stored

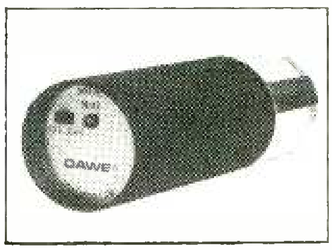


energy. Expansion to 20kJ with 150,000A peak current is possible. Model 890 produces a 1.4MV output which can produce a six feet long arc through air with a damped peak follow-through current of around 8,000A. The 890 is used to assess the effects of lightning on scaled down aerospace models. Singer Products Co. Inc., 875 Merrick Ave, Westbury, New York 11590.

WW310

Acoustic calibrator

Dawe instruments have introduced a simple means of calibrating sound level meters with 25mm microphones in the form of a cartridge, the 1411C, which provides an output of 90dB±1dB at 1kHz±5% and is powered from a



9V battery. Couplers are also available for microphones of 12 and 20mm diameter. Overall dimensions of the calibrator are 118 × 45mm diameter. Dawe Instruments Ltd, Concord Road, Western Ave., London W3 0SD.

WW311

Load cell

A centre point load cell, for weighing applications, is available from Sangamo. The D99 can measure loads up to 150mm off centre with <0.02% error when half the rated load is applied. These cells are available for ranges from 0-6kg to 0-25kg with an error of 1 in 3000 and a repeatability of 1 in 10,000, to OMIL specifications. Sangamo Transducers, North Bersted, Bognor Regis, W. Sussex.

WW312

Instrument cases

Lightweight 19in instrument cases, designated the E2000 series, are available from Optima Enclosures Ltd. These cases, constructed almost entirely from aluminium, are available in 2, 3, 4 and 5U heights and 430 and 522mm panel-to-panel depths, and have square-hole

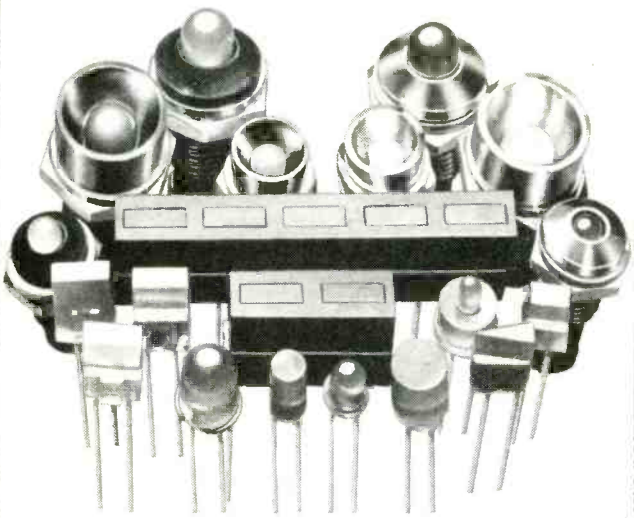
mounting brackets. Cases can be supplied in any single or two-colour variations from a range of 12 colours. Optima Enclosures Ltd, Macmerry, Tranent, East Lothian.

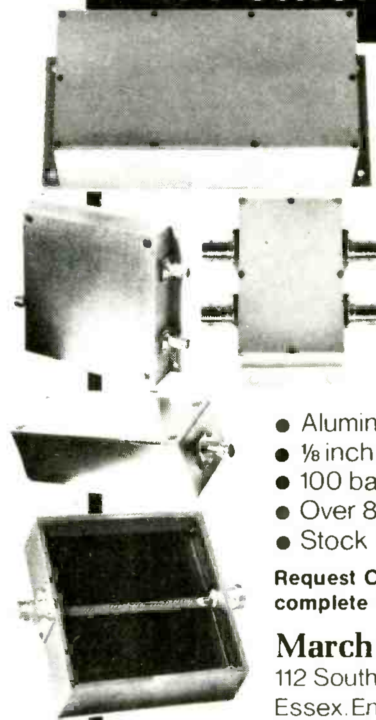
WW313

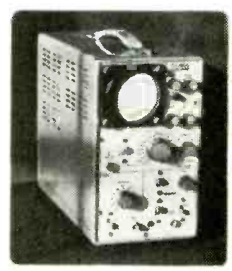
High-voltage resistors

Continuous voltages of up to 21kV can be withstood by resistors in the T40 series from Welwyn. Immersed in oil, the maximum continuous voltage is 50kV, which is also the maximum figure given for pulsed voltages in air. Values ranging from 100kΩ to 15GΩ are available with tolerances of 1, 2 or 5%, and with a temperature coefficient of ± 100p.p.m./°C. Resistors can be supplied with tighter tolerances, and temperature coefficients down to ±25p.p.m./°C. Matched sets, and low-inductance versions can also be supplied. These resistors are available with wire lead outs, or with threads or thread/wire combinations. Welwyn Electric Ltd, Bedlington, Northumberland NE22 7AA.

WW314







TRANSCENDENT 2000 single-board synthesizer

Complete Kit £168.50

Designed by consultant Tim Orr (formerly synthesizer designer for EMS Ltd.) and featured as a constructional article in ETI, this live performance synthesizer is a 3-octave instrument transposable 2 octaves up or down giving sweep control, a noise generator and an ADSR envelope shaper. There is also a slow oscillator, a new pitch detector, ADSR repeat, sampe and hold, and special circuitry with precision components to ensure tuning stability amongst its many features.

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 fibreglass 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 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 many times the price.

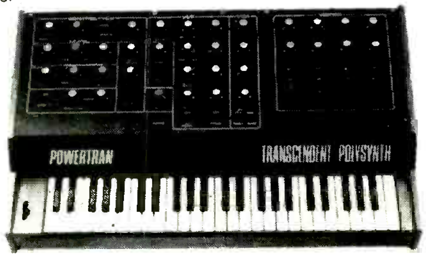
Comprehensive handbook fully describes construction and tells you how to set up your synthesizer with nothing more elaborate than a multi-meter and a pair of ears!

TRANSCENDENT POLYSYNTH

expandable polyphonic synthesizer

Complete Kit £320 (single voice)

Plug-in extra voices **£52** (or £48 – if ordered with kit)



By brilliant design work and the use of high technology components the Polysynth brings to the reach of the home constructor a machine whose versatility and range of sounds is matched only by ready-built equipment costing thousands of pounds. Designed by synthesizer expert Tim Orr and published in Electronics Today International, this latest addition to the famous Transcendent family is a 4-octave transposable over 7½ octaves) polyphonic synthesizer with internally up to 4 voices making it possible to play simultaneously up to 4 notes, whereas conventional synthesizers handle only one at a time.

The basic instrument is supplied with 1 voice and up to 3 more may be plugged in. A further 4 voices may be added by connecting to an expander unit, the metalwork and woodwork of which is designed for side-by-side matching with the main instrument. Each voice is a complete synthesizer in itself, with 2 VCOS, 2 ADSRS, a VCA and a VCF (requiring only control voltages and power supply, the voice boards are also very suitable for modular systems). One of these voices is automatically allocated to a key as it is operated. There are separate tuning controls for each VCO of each voice. All other controls are common to all the voices for ease of control and to ensure consistency between the voices.

Although using very advanced electronics the kit is mechanically very simple with mininal wiring, most of which is with ribbon cable connectors. All controls are PCB mounted and the voice boards fit with PCB mounted plugs and sockets. The kit includes fully finished metalwork, solid teak cabinet, professional quality components (resistors 2% metal oxide or metal film of 0.5% and 0.1%), nuts, bolts, etc.

TRANSCENDENT DPX MULTI-VOICE SYNTHESIZER Complete Kit £299

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

To add interest to the sounds and make them more natural there is a chorus/ensemble unit which is a complex phasing system using CCD (charge coupled device) analogue delay lines. The overall effect of this is similar to that of several acoustic instruments playing the same piece of music. The ensemble circuitry can be switched in with either strong or mild effects.

Although the DPX is an advanced design using a very large amount of circuitry, much of it very sophisticated, the kit is mechanically extremely simple with excellent access to all the circuit boards which interconnect with multiway connectors, just four of which are removed to separate the keyboard circuitry and the panel circuitry from the main circuitry in the cabinet.

The kit includes fully finished metalwork, solid teak cabinet, professional quality components (all resistors 2% metal oxide), nuts, bolts, even a 13A plug!

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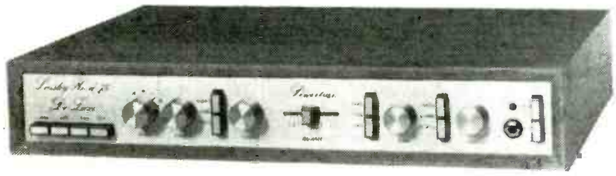


Complete Kit £85

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 while distortion is less than 0.01%.

T20 + 20 20W STEREO AMPLIFIER £33.10

This kit, based upon a design published in Practical Wireless, uses a single printed circuit board and offers at very low cost, ease of construction and all the normal facilities found on quality amplifiers. A 30 watt version of this kit (T30 + 30) is also available for **£38.40**+VAT. MATCHING TUNERS – See our FREE CATALOGUE!

MPA 200 100W. (rms into 8 ohms) MIXER/AMPLIFIER

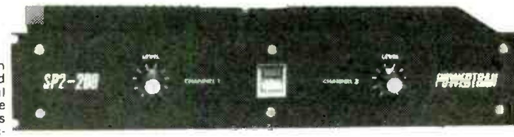
COMPLETE KIT £49.90

Featured as a constructional article in ETI, the MPA 200 is an exceptionally low priced – but professionally finished – general purpose high power amplifier. It features adaptable input mixer which accepts a wider range of sources such as microphone, guitar, etc. There are wide range tone controls and a master volume control. Mechanically the MPA 200 is simplicity itself with minimal wiring needed making construction very straightforward.

The kit includes fully finished metalwork, fibreglass PCBs, controls, wire, etc – complete down to the last nut and bolt.

SP2-200 2-CHANNEL 100W. AMPLIFER

COMPLETE KIT £64.90



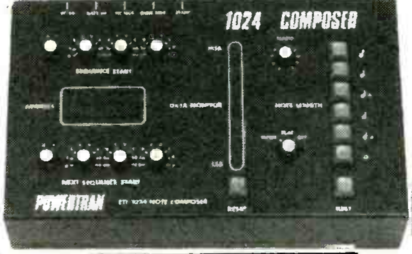
The power amplifier section of the MPA 200 has proved not only very economical but very rugged and reliable too. This new design uses two of these amplifier section powered by separate power supplies fed from a common toroidal transformer. Input sensitivity is 775mV. Even simultaneously driven, each channel delivers over 100W rms into 8 ohms. The kit includes fully finished metalwork, fibreglass PCBs, controls, wire, etc. – complete down to the last nut and bolt!

NEW KITS!

1024 COMPOSER

Complete Kit £89.50

Programmed from a synthesizer, our latest design to be featured in ELECTRONICS TODAY INTERNATIONAL, the 1024 COMPOSER controls the synth, with a sequence of up to 1024 notes or a large number of shorter sequences e.g. 64 of 16 notes all with programmable note length. In addition a rest or series of rests can be entered. It is mains powered but an automatically trickle charged Nickel-Cadmium battery supplying the memory, preserves the program after switch off. The kit includes fully finished metalwork, fibreglass PCB, controls, wire, etc. – Complete down to the last nut and bolt!



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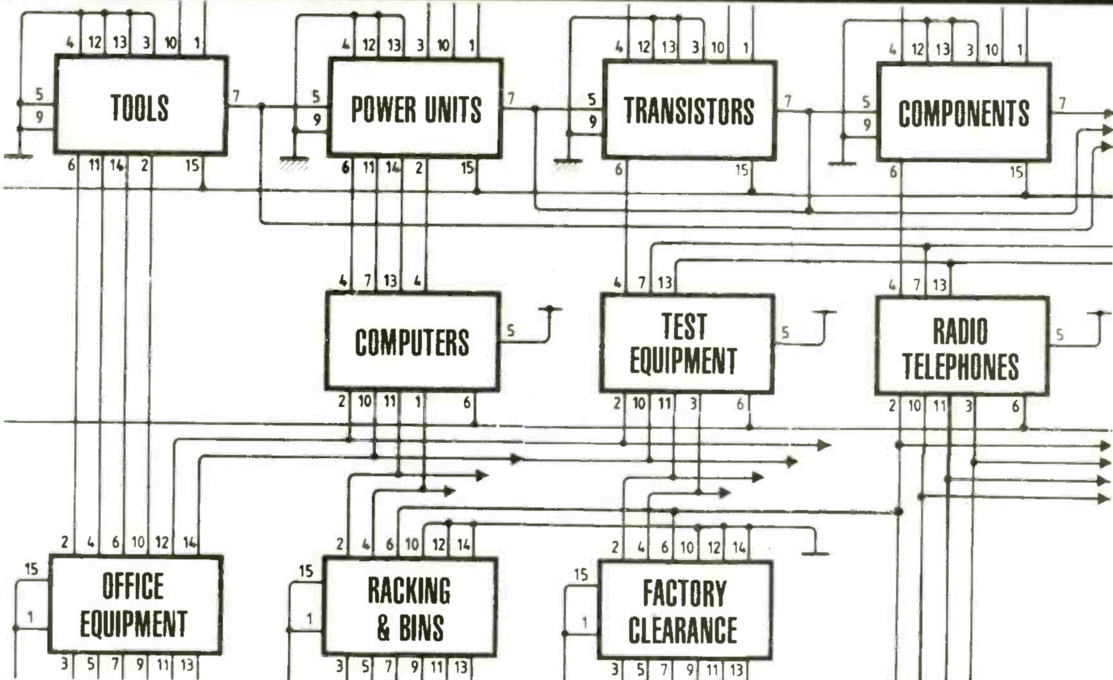

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	5-7-8-10-13-15-17-20-25-30-40-50v OR 25-0-25v OR 20-0-20v CAN BE OBTAINED FROM THE ABOVE RANGE			
11	12-15-20-25-30v	10	**£18.50**	£1 75
12	12-15-20-25-30v	5	**£10.50**	£1 50
13	12-15-20-25-30v	2	**£6.25**	£1 25
	3-4-5-6-8-9-10-12-15-18-20-24-30v OR 12-0-12v OR 15-0-15v CAN BE OBTAINED FROM THE ABOVE RANGE			
14	12-24v	12v 60A. 24v 30A	**£39.50**	£3 50
15	12-24v	12v 30A. 24v 15A	**£19.50**	£2.00
16	12-24v	12v 20A. 24v 10A	**£15.25**	£2 00
17	12-24v	12v 10A. 24v 5A	**£8.75**	£1 50
18	12-24v	12v 4A. 24v 2A	**£4.25**	£1 25

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HARDWARE DESCRIPTION (COMPONENTS)

- 30 ICs include: 2K Static Ram Buffer, 2K ROM, PIA with Scratchpad RAM (INS8154), MPU (INS8060), Cursor RAM (2102), Character PROM, LS-TTL and CMOS gates, dividers, counters multiplexers, monostables, registers, flip-flops and buffers.
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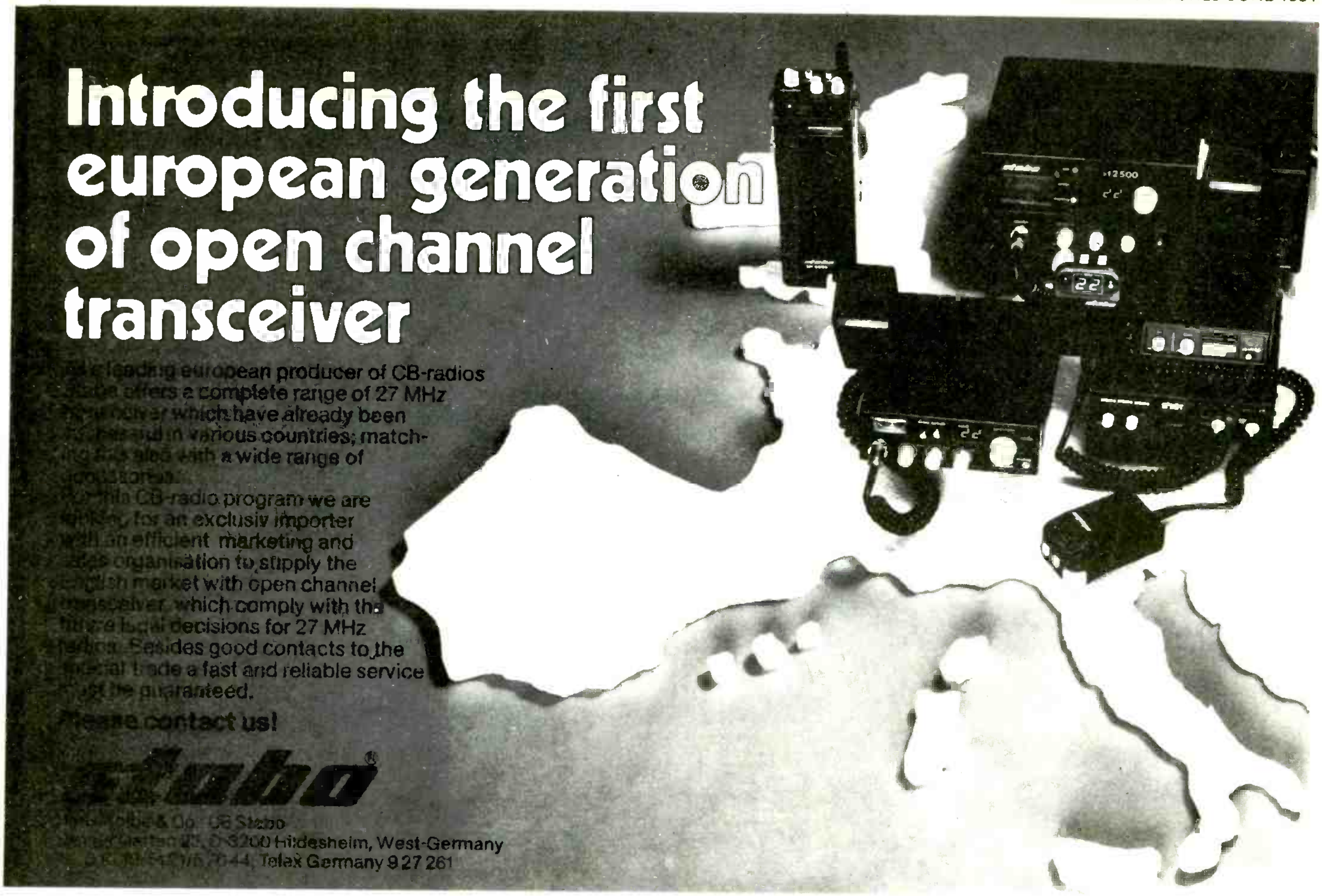
SOFTWARE DESCRIPTION (KEYBOARD FUNCTIONS)

● HEXADECIMAL ENTRY — DATA is written to SCREEN ADDRESS indicated by CURSOR HIGHLIGHT and the cursor is automatically incremented ● CURSOR FUNCTIONS — UP DOWN LEFT RIGHT PAGE — The CURSOR KEYS control movement of the cursor highlight DATA is displayed as a pair of HEX DIGITS which show CODE CONTENTS of each ADDRESS LOCATION ADDRESSES are MAPPED in X-Y fashion on the screen of a TV receiver or MONITOR Any of 16 PAGES may be viewed each containing 512 BYTES plus STATUS information PAGE changes automatically as the cursor crosses the page BOUNDARY ● ALTERNATE CURSOR — The FIX key stores the current cursor position for later reference providing a LABEL in ADDRESSING SPACE Thereafter SOFTY calculates and displays the HEXADECIMAL DIFFERENCE between cursors (showing correct value of RELATIVE JUMP For example) ● SWAP function exchanges the stored cursor with the current cursor (which complements the HEX difference as displayed on-screen) ● MATCHBYTE function will highlight and count all locations containing any REQUESTED BYTE This instruction may be repeated to find specific sections of code ● CLEAR operates in either FORWARD or BACKWARD modes to clear RAM BUFFER as requested Cleared memory is all-high rather than all-low An unprogrammed EPROM contains all FF bytes ● INSERT looks forward in memory to find THREE UNUSED BYTES in succession (FF FF FF) and shifts intervening code rightwards to permit extra instruction to be inserted ● DELETE removes the instruction at the cursor location and shifts code leftwards from first three unused bytes ● SERIAL and PARALLEL INPUT and OUTPUT ROUTINES are available to fill the RAM BUFFER from an external device such as a COMPUTER running an ASSEMBLER PROGRAM or a PUNCHED-TAPE READER BUFFER CONTENTS may also be transmitted to a TAPE-PUNCH or PRINTER These routines convert between HEX and ASCII it is easy to interface SOFTY with RS232 and CENTRONICS compatible devices (and with other BUS STRUCTURES by writing specific software and assigning a keyfunction) ● TRANSWIFT is a FAST SERIAL DATA TRANSFER system which can be used with ANY MICRO via a single bit of I/O It is used for EASY SERIAL INTERFACES and for direct connection with a TAPE RECORDER to store OBJECT CODE on tape (EPROM or BUFFER contents) ● EX-RAM function permits extension of RAM BUFFER to 4K BYTES by using a BYTE-WIDE RAM in the ZIF SOCKET There is provision for connection of SOFTY'S WRITE STROBE to the socket and BUFFER CONTENTS may be transferred using this function ● INTERNAL MICRO functions — SOFTY'S own INS8060 will run PROGRAMS in SCRATCHPAD RAM BUFFER or EPROM ● COPYFIRM copies back FIRMWARE into the RAM BUFFER Thus it is possible to modify SOFTY and reprogram it for CUSTOM APPLICATIONS write APPLICATION-ORIENTED KEYFUNCTIONS etc ● RUN function will transfer control to the device in the ZIF SOCKET Programs for particular applications may be committed to EPROM for use when required (2K bytes permits quite powerful applications — a disassembler perhaps?) ● GOSUB will perform the program in SCRATCHPAD — in effect this provides USER-PROGRAMMABLE KEYFUNCTIONS ● EXECUTE will action the program in RAM BUFFER before your very eyes as it were permitting insertion of BREAKPOINTS which cause the processor to stop without LOSS OF STATUS and print contents of INTERNAL REGISTERS SUBROUTINE POINTER etc in the STATUS LINE ● BLOCK FUNCTIONS are available to handle code in blocks ● DEFINE permits definition of the block using the CURSOR KEYS (The CURSOR HIGHLIGHT expands to enclose the BLOCK) ● MOVE allows the block to be SHIFTED around in memory by use of the CURSOR KEYS Intervening code is not erased it moves to the other side of the block This is a relocation function ● STORE will take the block into SCRATCHPAD memory where it can be called as a SUBROUTINE to provide an extra key-function re-inserted into code later as a MACRO — or just provide a means to put the block back elsewhere without relocating other code ● REPLACE writes the stored block into memory from the current cursor address and transfers the cursor to the end of it ● EPROM-HANDLING FUNCTIONS — SOFTY'S CHIEF PURPOSE is the HANDLING of OBJECT CODE and PROGRAMMING of EPROMS ● PRETEST checks that the program will go into the EPROM This is not merely a test for erasure (it CAN be if memory is cleared first) each location is examined in turn and compared with the code it will receive Those locations which cannot be programmed (BITS which must be HIGH are already LOW) are HIGHLIGHTED and COUNTED One useful application of this function is the employment of defective EPROMS which have a bit or two stuck low This happens Perhaps even more useful is the possibility of modifying an EPROM because the changes are in the right direction — one can be lucky! ● COMPARE checks each location in EPROM with the corresponding byte in RAM BUFFER and counts and highlights differences This function is also called automatically after a programming operation It is useful for testing suspect ROMS and EPROMS SOFTY MAKES A USEFUL PRODUCTION ROM CHECKER ● COPY transfers the EPROM contents into RAM BUFFER ● BURN transfers the RAM BUFFER contents into EPROM by applying a 50 millisecond PROGRAM PULSE to each location in turn whilst holding PROGRAM ENABLE at +25 volts LOCATIONS WHICH DO NOT REQUIRE PROGRAMMING ARE SKIPPED so a short program under development will burn much more quickly than a full EPROM



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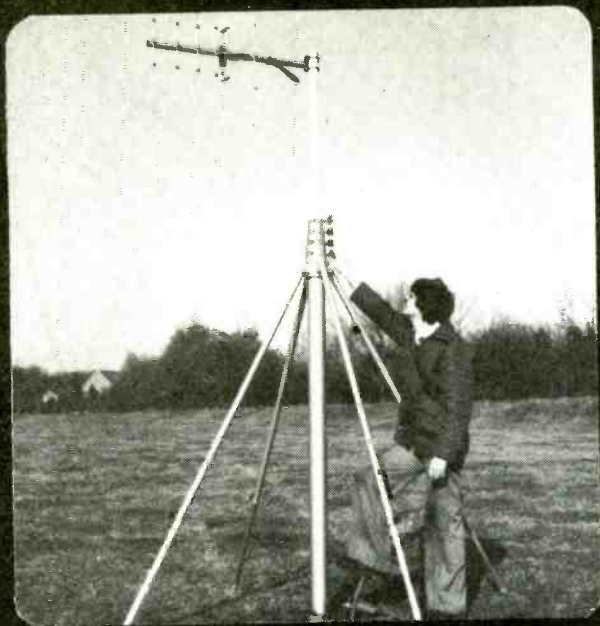

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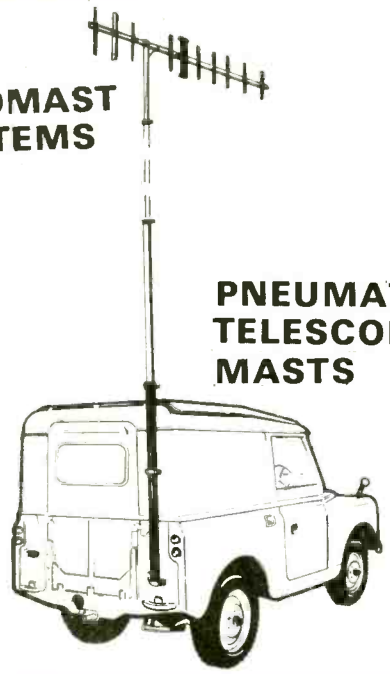

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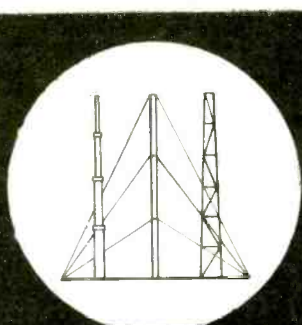

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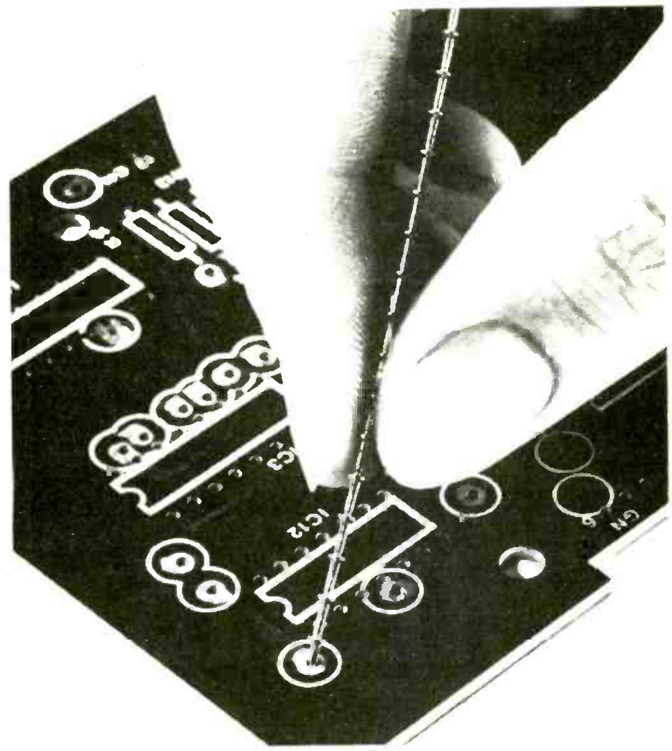

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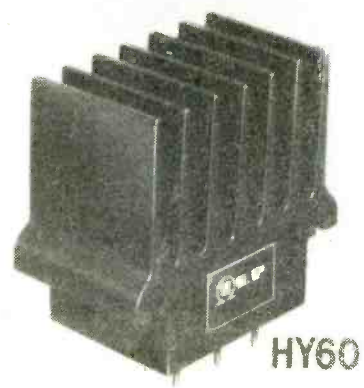
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Model	Output Power RMS	Distortion Typical at 1KHz	Slew Rate	Rise Time	Signal/Noise Ratio DIN AUDIO	Price & VAT
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HY120	60W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£17.48 + £2.62
HY200	120W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£21.21 + £3.18
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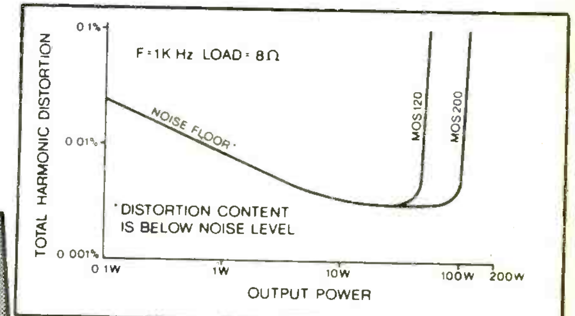

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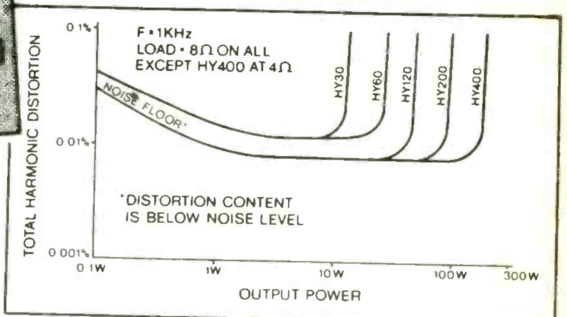
Input impedance both models 100KΩ Frequency response both models 15Hz-100KHz – 3dB



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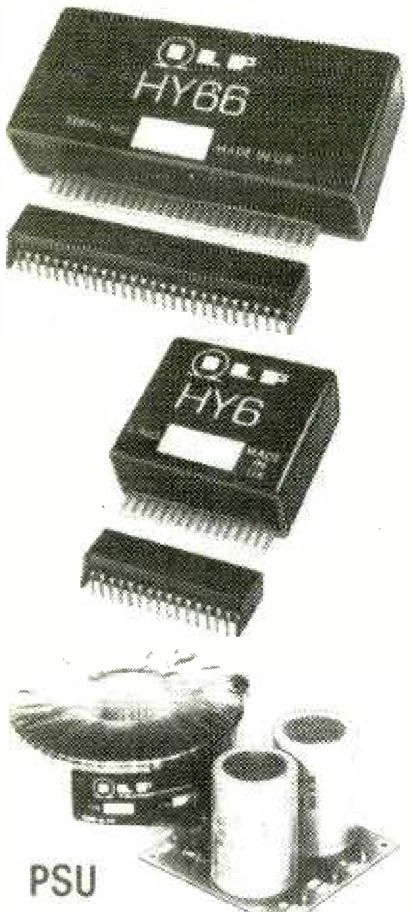

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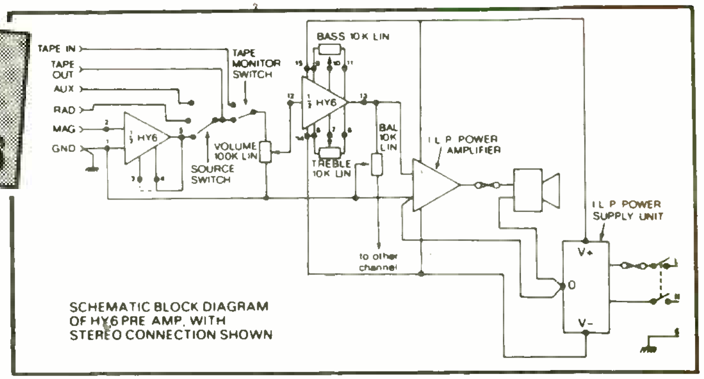

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- **NEEDS ONLY UNREGULATED POWER SUPPLY ±15 to ±60v**

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IN A RANGE OF 11 MODELS USING LATEST TOROIDAL TRANSFORMERS

Of the eleven power supply units which comprise our current range, nine have toroidal transformers made in our own factory. Thus these I.L.P power supply units are space-saving, more efficient and their better overall design helps enormously when assembly building. All models in the range are compatible with all I.L.P amps and pre-amps with types to match whatever I.L.P power amps you choose.

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- *THE FOLLOWING WILL ALSO DRIVE I.L.P PRE-AMPS*

PSU36 for use with 1 or 2 HY30's — **£8.10** + £1.22 VAT
- *ALL THE FOLLOWING USE TOROIDAL TRANSFORMERS*

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PSU60 for use with 1 HY120	**£13.04** + £1.96 VAT
PSU65 for use with 1 MOS120	**£13.32** + £2.00 VAT
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PSU75 for use with 1 or 2 **MOS120**	**£16.20** + £2.43 VAT
PSU90 for use with 1 HY200	**£16.20** + £2.43 VAT
PSU95 for use with 1 **MOS200**	**£16.32** + £2.45 VAT
PSU180 for use with 1 HY400 or 2 HY200	**£21.34** + £3.20 VAT
PSU185 for use with 1 or 2 **MOS200**	**£21.46** + £3.22 VAT

We want to know

We have always maintained good working relations with our customers, and therein lies a large measure of the company's success and growth. Now that we are running our most exciting programme yet, we would like to have your comments about our current products and any others you would like to see coming from I.L.P. Send us your letter (with your age, job, etc., if you don't mind) to: Customer Liaison, I.L.P. Electronics Ltd., FREEPOST, Roper Close, Canterbury, CT2 7EP (no stamp required).

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WW – 028 FOR FURTHER DETAILS

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FARNELL A15: 210/240V IP. Dual Op. 12-17v per rail at 100mA. Remote sensing, current limit protection. (164 x 130 x 38mm), with manual. **£12.**

FARNELL 7/3SC: 120/240V IP. Adjustable current limit. Remote sensing. (188 x 96 x 93mm). Two versions available: 15V at 2A or 30V at 1A. **£15 ea.**

COUTANT OA2: Op. amp, psu, 120/240V IP. Dual Op. 12-15v at 100mA. (138 x 80 x 45mm). **£12 ea.** or **2 for £22.**

BRANDENBURG Photomultiplier PSU. 19in. rack mounting. Metered, current limit protection.
374,374R 300V-1KV at 5mA.
375 500V-1K5V at 6mA.
376 660V-1K6V at 10mA.
Model 374R has reversible polarity op. All others have negative polarity op.
All models **£40.**
Some photo multiplier tubes available.

COUTANT ESM3: 105/115/220/240V IP. Four separate ops: 5V at 3A stabilised with current limit, overvoltage crowbar protection and remote sensing.
±12 to ±15V at 500mA stabilised.
12 or 24V unstabilised. (125 x 80 x 275mm). **£30.**

19" VEROCASES: For mounting Vero 19in. Subrack Units, 4μ or 6μ size. **£15 ea.**

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Over 2 million now in stock, mostly ITT. Many high-voltage types, e.g.:
210p 8KV, 1n 1KV, 2n2 2KV, 10n 2KV.
220p 1KV, 1n5 3KV, 4n7 1K5V.
Please send for our ceramic capacitor lists.

MYLAR FILM: Very large of the following values.
In 100V, 3n3 100V, 4n7 50/100V, 47n 50V, 100n 50V, 220n 50V.
Please send for our capacitor list for quantities.

MULLARD METAL FOIL CAPACITORS: Axial preformed.
220p 63V, 1n5 160V, 2n2 160V, 3n9 160V, 5n6 100V, 12n 63V, 27n 63V.

CASSETTE DECKS: With stereo heads, mechanically complete, but with no electronics. Smart black modern finish. **£5.00**

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Very large stock holding. Mostly ITT EN1212, EN1235 types.
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Very large stocks, PT10, PT15 enclosed types. Please send for our preset list. Most values 100R-5M

5-PIN DIN SOCKET
With DPDT switch. PCB, MTG. Large qty. in stock **10p**

75R BNC-BNC MALE READY-MADE LEADS
(UR70) **£1.00 ea.**

LARGE PANEL METERS
140-0-140μA (107x145mm) **£5.00**
0-1 mA (115x95mm) **£5.00**

HEAVY DUTY KEYSWITCHES
2P 12A 600V AC **£1.50**
8P 10A 380V AC **£3.00**
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49mm ☐ Fascia.

CINCH BARRIER STRIP
15A 530V AC. 6w, 8w, 10w, 12w, 18w stocked. Large quantities. **3p** per way.

ROTARY POTS
Good range stocked. Please phone your requirements. Large stocks of the following:
100K LIN + push switch **30p**
22K LOG + switch **30p**
2K2 LIN **30p**

SLIDE SWITCHES
PCB Mounting:
DPDT min. **20p**
4PCO min. **25p**
4PCO min. Long knob **30p**

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15MHz, 8 BIT

By Micro Consultants Ltd. 50Ω cable drive op. Linearity 0.25%, max. 0.125% typ. Settling time: 2V step 70nS typ. 2MV step 50nS colour television transmission standard. Diff. gain 0.5% diff. phase shift 0.5° types rad 802 and MC2208/8. Unused. Ex-maker's pack.

SPECIAL OFFER PRICE: £20

TRANSFORMERS:

5-0-5V 400mA	£1.25
6-0-6V 100mA	£1.25
8-0-8V 400mA	£1.25
9-0-9V 3A	£3.00
11V 2A, 22V1A	£2.00
12V 130mA	80p
12V 1A5	£1.25
0-12, 0-12 96VA	£8.00
15V 100mA	£1.00
17V 300mA	£1.50
20-0-20 400mA	£1.80
22-0-22 50mA	£1.00
24V 100mA	£1.00
24V 250mA	£1.50
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0-2-4-6-8-10 5A	£6.00

RESISTORS: Over 2 million in stock at last count.

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METAL OXIDE/FILM: Most values in E24 range, ¼-2W 5, 2 or 1%. A few values in 0.1% tolerance available.

WIRE WOUND: ORI-100K 3-200W. A selection of mains droppers available. Good selection of metal clad high power types.

SLIDER POTS BY EGEN. 60mm travel plastic. The following values only.
220K R.LOG DG **£1.00**
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2M2 R.LOG **60p**

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Most popular TV values stocked in depth.

FND 500, 7 segment LED display. **£1 ea**

SPECIAL OFFER: Filmet SC65 1MΩ 0.1% metal film resistors **20p ea.**

CERMET PRESETS 15p ea.

MINATURE AB16 POTS
PCB mounting 16mmø
100K LOG DG
220K LOG DG
100K LIN SG

10A 250V AC ILLUMINATED ROCKER SWITCH
Red, DP ST 26x30mm rect. Snap-in type **75p**

16A 250V AC ILLUMINATED ROCKER SWITCH
(Amber). 14x30mm rectangular snap-in type. SPST **30p**

ALUMINIUM BOXES:

AB7 134x64x38mm	70p
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AB9 102x57x38mm	70p
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AB11 102x64x51mm	85p
AB12 76x51x25mm	70p
AB13 152x102x51mm	£1.00
AB14 178x127x51mm	£1.20
AB15 203x152x76mm	£1.55
AB16 254x179x76mm	£1.75
AB17 254x114x76mm	£1.45
AB18 305x127x76mm	£1.75
AB19 305x203x76mm	£2.40

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RB1 152x114x64mm	£1.45
RB2 203x127x76mm	£1.70
RB3 229x127x89mm	£1.80
RB4 279x152x102mm	£2.40
RB5 279x190x114mm	£2.70

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75x50x25mm	65p
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01-800 Rectangular Snap-in Series.
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2PCO Momentary **£1.50**
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Lenses available in red or white only.

MINIATURE PUSH-BUTTON SWITCHES
PTM **20p,** PTB **25p,** PT M/B **40p.**

HEAVY DUTY ROTARY SWITCHES
9P3W 25A 500V AC **£3.00**
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WIREWOUND POTS
10R-100K by A.B., Colvern, etc. 1½W **40p,** 3W **60p,** 5W **80p.**

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10R-500K 10/20 turn. 1¼in. or ¾in. rectangular **60p ea.**

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Many types available, e.g.:
4x2PCO **40p**
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40x30x23mm deep. White/red scale on black background. Brand new. **60p ea.**

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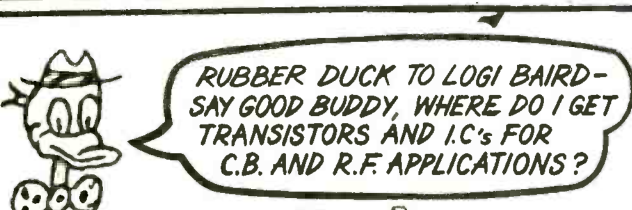

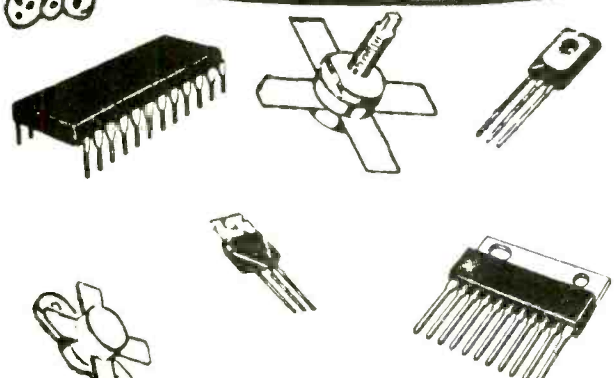

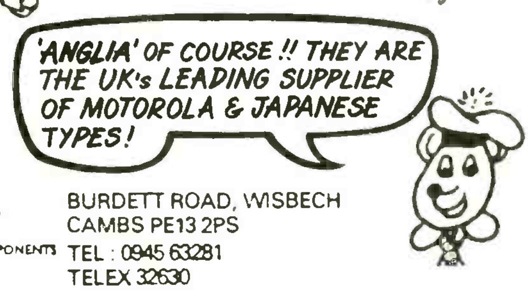

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TRANSFORMERS
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Pri 0-120, 0-100-120V (120, 220, 240V) Sec 60, 55-0-55 60 twice, to give 55, 60, 110, 115, 120, 125, 175, 180, 220, 225, 230, 235, 240.

Ref.	VA (Watts)	£	P&P
07★	20	**4.84**	1.20
149	60	**7.37**	1.20
150	100	**8.38**	1.44
151	200	**12.28**	1.72
152	250	**14.61**	2.04
153	350	**18.07**	2.12
154	500	**22.52**	2.20
155	750	**32.03**	OA
156	1000	**40.92**	OA
157	1500	**56.52**	OA
158	2000	**67.99**	OA
159	3000	**95.33**	OA

★115 or 240v sec only. State volts required. Pri. 0.220-240V.

12 or 24-VOLT

Separate 12V windings Pri 220-240V

Ref.	12v Amps	24v	£	P&P
111	0.5	0.25	**2.42**	.95
213	1.0	0.5	**2.90**	1.00
71	2.0	1.0	**3.86**	1.00
18	4.0	2.0	**4.46**	1.20
85	5.0	2.5	**6.16**	1.20
70	6.0	3.0	**6.99**	1.20
108	8.0	4.0	**8.16**	1.44
72	10.0	5.0	**8.93**	1.60
116	12.0	6.0	**9.89**	1.60
17	16.0	8.0	**11.79**	1.72
115	20.0	10.0	**15.87**	1.84
187	30.0	15.0	**19.72**	2.04
226	60.0	30.0	**40.41**	OA

50 VOLT RANGE (Split Sec)

Pri 220-240V. Voltages available 5, 7, 8, 10, 13, 15, 17, 20, 25, 30, 33, 40 or 20V-0-20V and 25V-0-25V.

Ref.	Amps 50v	25v	£	P&P
102	.5	1	**3.75**	1.20
103	1	2	**4.57**	1.20
104	2	4	**7.88**	1.44
105	3	6	**9.42**	1.60
106	4	8	**12.82**	1.72
107	6	12	**16.37**	1.84
118	8	16	**22.29**	2.20
119	10	20	**27.48**	OA
109	12	24	**32.89**	OA

30 VOLT RANGE (Split Sec)

Pri 220-240V. Voltages available 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24, 30V or 12V-0-12V and 15V-0-15V

Ref.	Amps 30v	15v	£	P&P
112	5	1	**2.90**	1.00
79	1	2	**3.93**	1.00
3	2	4	**6.35**	1.20
20	3	6	**7.39**	1.44
21	4	8	**8.79**	1.60
51	5	10	**10.86**	1.60
117	6	12	**12.29**	1.72
88	8	16	**16.45**	1.96
89	10	20	**18.98**	1.84
90	12	24	**21.09**	OA
91	15	30	**24.18**	OA
92	20	40	**32.40**	OA

60 VOLT RANGE

Pri 220-240V (Split Sec.)
Voltages available 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60V or 24V-0-24V and 30V-0-30V

Ref.	Amps 60v	30v	£	P&P
124	5	1	**4.27**	1.20
126	1	2	**6.50**	1.20
127	2	4	**8.36**	1.60
125	3	6	**12.10**	1.72
123	4	8	**13.77**	1.96
40	5	10	**17.42**	1.84
120	6	12	**19.87**	2.04
121	8	16	**27.92**	OA
122	10	20	**32.51**	OA
189	12	24	**37.47**	OA

SCREENED MINIATURES Pri 240V

Ref.	mA	Volts	£	P&P
238	200	3-0-3	**2.83**	50
212	1A, 1A	0-6, 0-6	**3.14**	1.00
13	100	9-0-9	**2.35**	.50
235	330, 330	0-9, 0-9	**2.19**	.60
207	500, 500	0-8-9, 0-8-9	**3.05**	.95
208	1A, 1A	0-8-9, 0-8-9	**3.88**	1.20
236	200, 200	0-15, 0-15	**2.19**	.60
239	50MA	12-0-12	**2.88**	.50
214	300, 300	0-20, 2-20	**3.08**	1.00
221	700 (DC)	20-12-0-12-20	**3.75**	1.00
206	1A, 1A	0-15-20, 0-15-20	**5.09**	1.20
203	500, 500	0-15-27, 0-15-27	**4.39**	1.20
204	1A, 1A	0-15-27, 0-15-27	**6.64**	1.20

HIGH VOLTAGE

MAINS ISOLATING
Pri 200/220 or 400/440
Sec 100/120 or 200/240

VA	Ref.	£	P&P
60	243	**7.37**	1.20
250	246	**4.61**	2.04
350	247	**18.07**	2.04
500	248	**22.52**	OA
1000	250	**45.94**	OA

AUTO TRANSFORMERS

Voltages available 105, 115, 190, 200, 210, 220, 230, 240. Voltages for step up or step down.

Ref.	VA (Watts)	TAPS	£	P&P
113	15	0-115-210-240V	**2.17**	1.00
64	80	0-115-210-240V	**4.41**	1.20
4	150	0-115-200-220-240V	**5.89**	1.20
67	500		**12.09**	1.84
84	1000		**20.64**	2.20
93	1500		**25.61**	OA
95	2000		**38.31**	OA
73	3000		**65.13**	OA
80s	4000	0-10-115-200-220-240	**84.55**	OA
57s	5000		**98.45**	OA

˙0, 115, 220, 240 Step Up or Step Down

CASED AUTOS

240V cable input USA 115V Flat pin outlets

VA	P&P	Ref.	
20	**£6.55**	95	56W
75	**£8.50**	1.20	64W
150	**£11.00**	1.44	4W
200	**£12.02**	1.44	65W
250	**£13.38**	1.44	69W
500	**£20.13**	2.04	67W
1000	**£30.67**	2.20	84W
2000	**£54.97**	OA	95W

* NEW * CONSTANT VOLTAGE TRANSFORMERS ± 1%

For 'clean' mains to computers, peripherals. No spikes, transients + constant voltage to ± 1%.

250VA	**£95.00**
500VA	**£127.00**
1KVA	**£147.00**
	+ carriage
2KVA	**£229.00** + VAT

NOW: Agents for Galatrek C.V.Ts

MINIATURE TRANSFORMER

015V CT (7.5-0-7.5V

Ref	Amp	Price	P&P
171	500MA	**2.30**	52
172	1A	**3.26**	90
173	2A	**3.95**	90
174	3A	**4.13**	99
175	4A	**6.30**	1.10

BE7 0-110-120 220 240V Sec 20V 1 Amp £1.80. P&P 32p + VAT

SPLIT BOBBIN TRANSFORMER
Pri. 0-115; x2 (70010). Sec. 0-12-15-20-24-30. To give 3, 4, 5, 6, 8, 10, 12, 15, 18, 20, 24, 30, 2 Amps, **£4.65** P&P £1.10 + VAT.

End of line offers – **M679** 120V-2; 36V 1 6A **£3** pp 78p + VAT.

OTHER PRODUCTS

AVO TEST METERS

Latest Model 8 Mk. 5	£116.40
71 Electronics	£45.80
73 TV Service	£63.90
MM5 MINOR	£40.50
DA211 LCD Digital	£57.00
DA212 LCD Digital	£74.00
DA116 LCD Digital	£121.70
Megger 70143 500v	£97.20
Megger Battery	£65.30

Avo Cases and Accessories
P&P £1.32. VAT 15%

TOOLS

Mains Neon test screwdrivers	61p	20p
Long-nosed pliers	£2.17	35p
6 precision screwdriver set	£2.17	75p

ANTEX SOLDERING IRONS 15W and 25W **£4.58**
Stand for above £1.75. P&P 53p. VAT 15%

PANEL METERS

43mm × 43mm		82mm × 78mm	
0-50μa	£6.20	0-50μA	£6.70
0-500μ1A	£6.70	0-500μA	£6.70
0-1mA	£6.70	0-1mA	£6.70
0-30V	£6.70	0-30V	£6.70

VU Panel Ind 48 x 45mm 250μA FDS £2.60
Carriage 76p VAT 15%

BRIDGE RECTIFIERS

200v	2A	**45p**
400v	1A	**25p**
400v	2A	**55p**
100v	25A+	**£2.10**
200v	4A	**65p**
400v	4A	**85p**
400v	6A	**£1.40**
500v	12A	**£2.85**

P&P 20p. VAT 15%

TELEPHONES – Latest model 746, brand new, boxed, 2 tone grey **£11.50**, Ivory **£12.50**, PP £1.20 + VAT.

METAL OXIDE RESISTORS £1/10

Special Offer TR4 5% (in 100s only). Use instead of carbon film.
47Ω - 390Ω - 470Ω - 510Ω - 560Ω - 820Ω - 1K - 1K2 - 1K6 - 1K8 - 2K - 2K4 - 3K - 16K - 20K - 22K - 24K - 47K - 82K - 100K - 110K - 120K - 130K - 180K - 220K - 270K - 300K Electrosil. P&P30p - VAT

Send 20p for catalogue.
Prices correct at 20/3/81

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WW – 063 FOR FURTHER DETAILS

LINSLEY HOOD CASSETTE RECORDER 2

Our new improved performance model of the Linsley Hood Cassette Recorder incorporates our VFL 910 vertical front mechanism and circuit modifications to increase dynamic range. Board layouts have been altered and improved but retain the outstandingly successful mother-and-daughter arrangement used on our Linsley-Hood Cassette Recorder 1.
This latest version has the following extra features. Ultra low wow-and-flutter of .09% — easily meets DIN Hi-Fi spec. Deck controls latch in rewind modes and do not have to be held. Full Auto-stop on all modes. Tape counter with memory rewind. Oil damped cassette door. Latching record button for level setting. Dual concentric input level controls. Phone output. Microphone input facility if required. Record interlock prevents rerecording on valued cassettes. Frequency generating feedback servo drive motor with built-in speed control for thermal stability. All these desirable and useful features added to the excellent design of the Linsley-Hood circuits and the quality of the components used makes this new kit comparable with built-up units of much higher cost than the modest, **£94.90** + V.A.T. we ask for the complete kit.

LINSLEY-HOOD CASSETTE RECORDER 1

We are the Designer Approved suppliers of kits for this excellent design. The Author's reputation tells all you need to know about the circuitry and Hart expertise and experience guarantees the engineering design of the kit. Advanced features include: High-quality separate VU meters with excellent ballistics. Controls, switches and sockets mounted on PCB to eliminate difficult wiring. Proper moulded escutcheon for cassette aperture improves appearance and removes the need for the cassette transport to be set back behind a narrow finger trapping slot. Easy to use, robust Lenco mechanism. Switched bias and equalisation for different tape formulations. All wiring is terminated with plugs and sockets for easy assembly and test. Sophisticated modular PCB system gives a spacious, easily-built and tested layout. All these features added to the high-quality metalwork make this a most satisfying kit to build. Also included at no extra cost is our new HS15 Sendust Alloy record/play head, available separately at **£7.60** plus V.A.T. but REPRINTS of the 3 articles describing this design **45p**. No V.A.T.
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These latest designs from the drawing board of John Linsley-Hood, engineered to the very highest standard, represent the very best that is available on the kit market today. The delicacy and transparency of the tone quality enable these amplifiers to outperform, on a side-by-side comparison, the bulk of amplifiers in the commercial market-place and even exceed the high standard set by his earlier 75-watt design.
Three versions are offered, a 30-watt with Darlington output transistors, and a 35- and 45-watt, both with Mosfet output devices. All are of identical outside appearance which is designed to match and stack with our Linsley-Hood cassette recorder 2.
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30-watt Darlington amplifier, fully integrated with tone controls and magnetic pick-up facility. Total cost of all parts is **£81.12**. Special offer price for complete kits **£72**.
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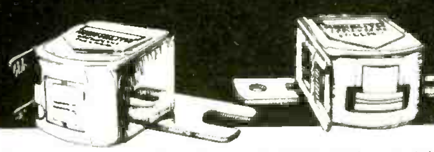

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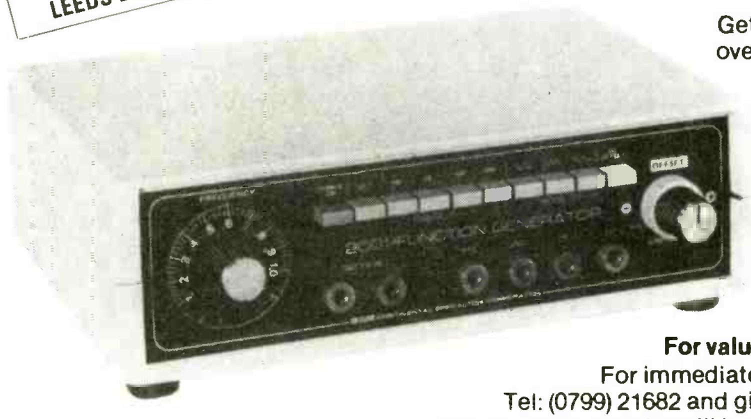

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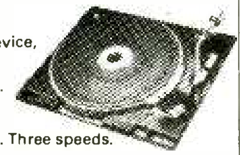

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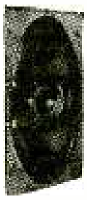

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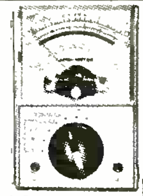

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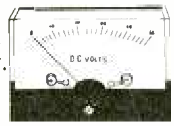

50μa 100μa 500μa,
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25 volt, 50 volt, VU Meter.
Facia 2⅜ x 1¾ x 1½in.
Fixing hole 1½in. dia.
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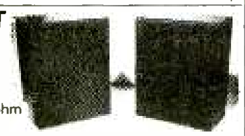

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MODEL	INCHES	OHMS	WATTS	TYPE	PRICE
MAJOR	12	4-8-16	30	HI-FI	£12
DELUXE MK II	12	8-16	15	HI-FI	£12
SUPERB	12	8-16	30	HI-FI	£20
AUDITORIUM	12	8-16	45	HI-FI	£20
AUDITORIUM	15	8-16	80	HI-FI	£34
GROUP 45	12	4-8-16	45	PA	£12
GROUP 75	12	4-8-16	75	PA	£20
GROUP 100	12	8-16	100	PA	£20
GROUP 100	15	8-16	100	PA	£28
DISCO 100	12	8-16	100	DISCO	£20
DISCO 100	15	8-16	100	DISCO	£28

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£69 Post £2
Ideal for Halls/PA systems, Discos and Groups. Two inputs. Mixer, Volume Controls, Master Bass, Treble and Gain.
Special offer
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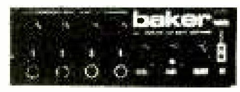

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GOODMANS	TWEETER	3½in	25	8	£4.00
AUDAX	TWEETER	3¾in	60	8	£10.50
SEAS	MID-RANGE	4in	50	8	£7.50
SEAS	MID-RANGE	5in	80	8	£10.50
SEAS	MID-RANGE	4½in	100	8	£12.50
GOODMANS	FULL-RANGE	5½in	15	8	£6.50
GOODMANS	FULL-RANGE	8in	30	8	£9.50
GOODMANS	AUDIOM 8p	8in	15	15	£8.50
SEAS	WOOFER	8in	30	8	£14.00
CELESTION	DISCO	10in	20	8/16	£11.50
CELESTION	DISCO	10in	60	8/16	£21.50
RIGONDA	GENERAL	10in	15	8	£6.50
GOODMANS	AUDIOM PG	12in	60	8	£20.00
GOODMANS	PP12	12in	75	8/15	£24.50
GOODMANS	AUDIOM P	12in	50	8/15	£20.00
GOODMANS	GR12	12in	90	8/15	£27.50

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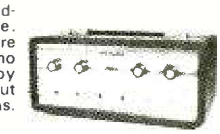

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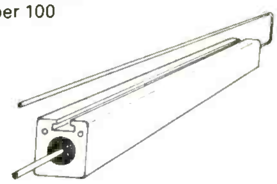

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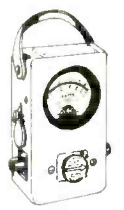

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50 watts	50H	50A	50B	50C	50D	50E
100 watts	100H	100A	100B	100C	100D	100E
250 watts	250H	250A	250B	250C	250D	250E
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	1X011	9+9	1.66	
	1X012	12+12	1.25	
	1X013	15+15	1.00	
	1X014	18+18	0.83	
	1X015	22+22	0.68	
	1X016	25+25	0.60	
	1X017	30+30	0.50	
50VA 80x35mm 0.9 Kg	2X010	6+6	4.16	**£4.93** + £1.10 P/P + 0.90p VAT
	2X011	9+9	2.77	
	2X012	12+12	2.08	
	2X013	15+15	1.66	
	2X014	18+18	1.38	
	2X015	22+22	1.13	
	2X016	25+25	1.00	
	2X017	30+30	0.83	
	2X028	110	0.45	
	2X029	220	0.22	
	2X030	240	0.20	
80VA 90x30mm 1 Kg	3X010	6+6	6.64	**£5.47** + £1.43 P/P + £1.04 VAT
	3X011	9+9	4.44	
	3X012	12+12	3.33	
	3X013	15+15	2.66	
	3X014	18+18	2.22	
	3X015	22+22	1.81	
	3X016	25+25	1.60	
	3X017	30+30	1.33	
	3X028	110	0.72	
	3X029	220	0.36	
	3X030	240	0.33	
120VA 90x40mm 1.2 Kg	4X010	6+6	10.00	**£6.38** + £1.43 P/P + £1.17 VAT
	4X011	9+9	6.66	
	4X012	12+12	5.00	
	4X013	15+15	4.00	
	4X014	18+18	3.33	
	4X015	22+22	2.72	
	4X016	25+25	2.40	
	4X017	30+30	2.00	
	4X028	110	1.09	
	4X029	220	0.54	
	4X030	240	0.50	

TYPE	SERIES No	SECONDARY RMS Volts	Current	PRICE
160VA 110x40mm 1.8 Kg	5X012	12+12	6.66	**£8.44** + £1.43 P/P + £1.48 VAT
	5X013	15+15	5.33	
	5X014	18+18	4.44	
	5X015	22+22	3.63	
	5X016	25+25	3.20	
	5X017	30+30	2.66	
	5X018	35+35	2.28	
	5X028	110	1.45	
	5X029	220	0.72	
	5X030	240	0.56	
225VA 110x45mm 2.2 Kg	6X014	18+18	6.25	**£10.06** + £1.73 P/P + £1.77 VAT
	6X015	22+22	5.11	
	6X016	25+25	4.50	
	6X017	30+30	3.75	
	6X018	35+35	3.21	
	6X026	40+40	2.81	
	6X028	110	2.04	
	6X029	220	1.02	
	6X030	240	0.93	
300VA 110x50mm 2.6 Kg	7X016	25+25	6.00	**£11.66** + £1.73 P/P + £2.01 VAT
	7X017	30+30	5.00	
	7X018	35+35	4.28	
	7X026	40+40	3.75	
	7X025	45+45	3.33	
	7X028	110	2.72	
	7X029	220	1.36	
	7X030	240	1.25	
500VA 140x60mm 4 Kg	8X017	30+30	8.33	**£15.53** + £2.05 P/P + £2.64
	8X018	35+35	7.14	
	8X026	40+40	6.25	
	8X025	45+45	5.55	
	8X033	50+50	5.00	
	8X028	110	4.54	
	8X029	220	2.27	
	8X030	240	2.08	

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For 240V Primary (U.K.) insert 2 in place of "X" in type number.
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	P2402	4.5+4.5	0.33	
	P2403	6+6	0.25	
	P2404	7.5+7.5	0.20	
	P2405	9+9	0.17	
	P2406	12+12	0.12	
	P2407	15+15	0.10	
	P2409	20+20	0.07	
6VA	P3401	3+3	1.00	**£1.91** + £30p P/P + 33p VAT
	P3402	4.5+4.5	0.67	
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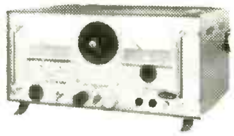

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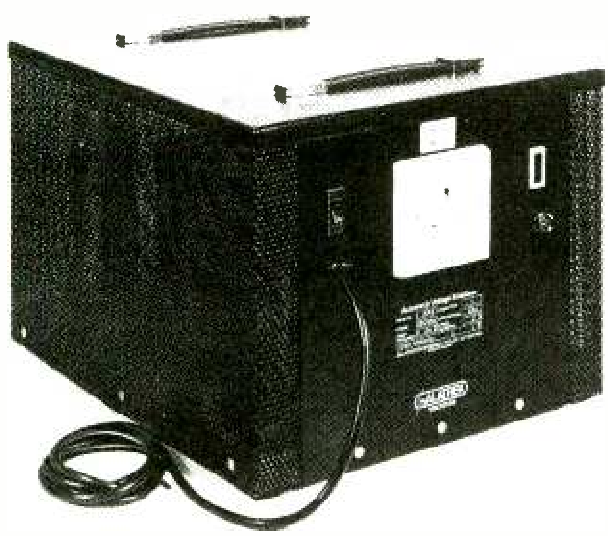

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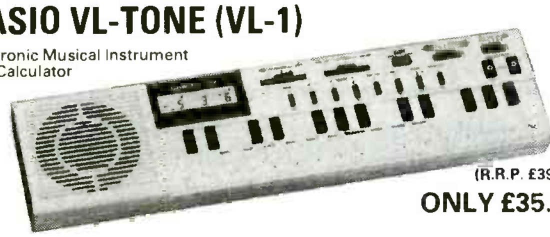

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Thanks to Casio's V.L.S.I. advanced technology you can compose and play music with one finger. Simply enter the notes of a melody into the memory (maximum 100 notes). Recall the notes in sequence with the **One Key Play** button, varying tempo and duration of each keystroke to create a melody.

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VL-1 29-note synthesiser records and plays back MANUAL or ONE KEY playing. The octave shift expands the range to almost 5 octaves.

Preset sounds: Piano, Violin, Flute, Guitar, Fantasy and ADSR.

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Dimensions: 30 × 300 × 75mm (1⅛ × 11¾ × 3in.). **Weight**: 438g.; 15.4oz.

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TEMPUS Dept. WW, Beaumont Centre, 164-167 East Road Cambridge CB1 1DB. Tel: 0223 312866

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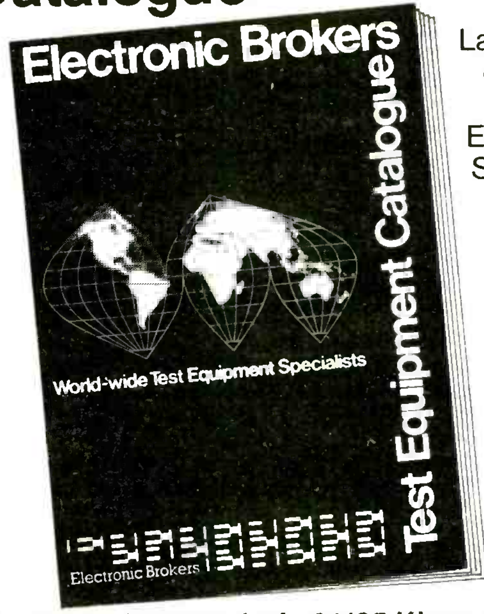
New Test Equipment Catalogue



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Electronic Brokers Ltd., 61/65 Kings Cross Road, London WC1X 9LN.
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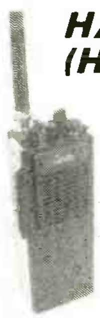
WW – 083 FOR FURTHER DETAILS

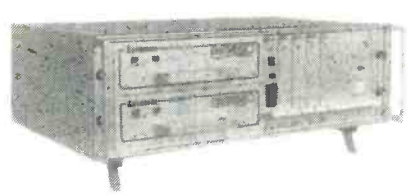
FM RADIOTELEPHONES for 66-68, 156-175 and 400-470 MHz

FM9000-HIGH POWER HAND PORTABLE (High Band Only)



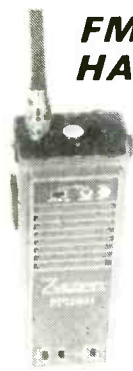
5 watts output with low power switch. 6 channels. High sensitivity receiver. Mobile mount/charger. External remote mic/speaker and desk or wall mount chargers available.

FM2500 REPEATER OR DUPLEX BASE STATION



25 watts output. Tone mute/talk through fitted as standard. Repeater has 8 or 16 channel capability. Auto mains failure standby. Modular construction. All solid state control.

FM26 – MOBILE/ HAND PORTABLE



2 watts output with lower power switch. Rugged construction. Vehicle mount converts unit to mobile with external antenna. Remote mic/speaker for mobile and body worn use. Used extensively by the Emergency Services.

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We are the sole UK representatives of Communication Specialists. Their tone products are probably the most advanced available today. Crystal control, DIP switch programming and small size make their application simple.

All our equipment is approved to MPT 1301, and can be fitted with selective call and tone mute products.

Illustrated leaflets are available on request. Agents throughout the UK.

Suppliers to many Local Authorities, Emergency Services and the Post Office.

FM2512 – MOBILE UNIT

25 watts output. 12 channels selected by front panel switch. Easy to install and operate. Mic contains separate speaker module to aid copy under adverse ambient noise conditions.

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47 Pentrich Road Ripley Derby DE5 3DS Tel: (0773) 44281 Tlx: 377466

WW – 082 FOR FURTHER DETAILS

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Advertisements accepted up to 12 noon Monday, June 1, for July issue, subject to space being available.

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BOX NUMBERS: £1 extra. (Replies should be addressed to the Box Number in the advertisement, c/o Quadrant House, The Quadrant, Sutton, Surrey SM2 4AS.)
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ELECTRONIC COMPUTER AND MANAGEMENT APPOINTMENTS LIMITED
148-150 High St., Barkway, Royston, Herts SG8 8EG.

(1118)

PIONEER®
require a

TECHNICAL TRAINER

with a difference. £8,500 negotiable

To assist with expansion and the further development of our staff and the training of dealer's engineers, we now need a Technical Trainer to organise, prepare and implement training programmes.

This will include preparing training material, eg circuit descriptions, practical repair and calibration techniques, etc., with audio visual aids, the training of our Engineers in developing their skills in the repairing and maintenance of high technology products and planning training programmes as necessary for new products.

You must be an experienced engineer with sound knowledge of video and digital techniques related to video products and have proven experience in a training environment. Knowledge of microprocessors will be an advantage.

For this position we offer outstanding career prospects to a person who has the ambition and ability to succeed in this highly competitive and exciting industry.

For more information, candidates, male or female, please write to or telephone:

Mr. Peter Forster, Personnel Manager
Pioneer High Fidelity (GB) Limited
Pioneer House, The Ridgeway
Iver, Bucks SL0 9JL
Telephone: 0753 652222

(1084)

Broadcast Engineer

Test and Service

Seltech Equipment Limited is a leading supplier of broadcast equipment and its increasing share of the market requires further expansion.

The position offered will involve testing and servicing a full range of broadcast products including switching, pulse generation, time code, clock and audio systems, utilizing the latest technology. The successful applicant will probably be qualified to HNC level but broadcast related experience is of prime importance.

The position is based in the company's modern premises at Bourne End, Bucks. Limited travel will be required.

Salary and conditions will be in keeping with the position offered.

In the first instance apply to: D. Craddock, Sales Director
SELTECH EQUIPMENT LIMITED
Rose Industrial Estate,
Cores End Road,
Bourne End,
Bucks. SL8 5AT
Tel: Bourne End (06285) 29131

SELTECH

(1089)

INNER LONDON EDUCATION AUTHORITY

LEARNING MATERIALS SERVICE
TELEVISION CENTRE, THACKERAY ROAD, LONDON SW8 3TB

The Television Centre produces a range of educational programmes in the form of video cassettes, sound cassettes and 16mm film for distribution within London and nationally. It has a colour television studio, colour mobile unit and film unit all equipped to professional Broadcasting standards.

MAINTENANCE ENGINEER (ST3)

(£8304-£8916)

The maintenance section has four members and is responsible for all the equipment at the studio centre, both vision and sound.

Applicants must have relevant technical qualifications (a knowledge of digital techniques would be an advantage), and should have good experience in the field, though consideration would be given to experience in allied fields. Limited "on the job" training is available, and the Authority will pay for attendance at specialised manufacturers' courses where these are considered necessary.

Further information and application forms available from the Education Officer (EO/Estab 1c), Room 365, County Hall, London, S.E.1. Telephone 01-633 7456/7546.

Closing date: 14 days from appearance of advertisement.

MOBILE SECTION ENGINEER (ST3)

The mobile section operates colour broadcast standard television facilities including a three camera (link 120) mobile control room and battery portable equipment (Sony BVP, BVU). The main function of the section is to make observational classroom recordings for use in teacher education both in London and nationally. All members of the crew share rigging duties and driving of vehicles. A current driving licence is highly desirable and training will be provided leading to an H.G.V. test.

The engineer will join a team of three engineers who are jointly responsible for the operation and maintenance of the section's equipment. This involves lighting, vision control, microphone rigging, sound mixing and V.T. operation. Experience in one of the fields is essential; however as training in others will be given, it is important that candidates have appropriate academic qualifications and a thorough knowledge of current broadcast engineering practices. Candidates must also possess good health and normal colour vision.

Hours of work will be in accordance with the requirements of the service (the normal working week being 35 hours).

Further details available from the mobile video recording section, telephone 01-622 9966.

Salary within the scale £8304-£8916 (plus an irregular hours allowance of £156 per annum).

Closing date: June 26, 1981.

Application forms for both posts from the Education Officer (EO/ESTAB 1c), Room 365, The County Hall, London, S.E.1. Telephone 01-633 7456/7546.

(1110)

Sony Broadcast Ltd

The continued expansion of one of the world's leaders in professional broadcast television equipment has created an immediate opening for the following:

Technical Author

Applications are invited for this new and challenging position which responds to the Technical Training Manager. First class working conditions and facilities will be offered to the successful candidate, who will after a suitable familiarisation period be responsible for the following:

- Compilation of product training manuals.
- Preparation of circuit descriptions.
- Edit relevant articles observed in the periodical press. Also assist with editing technical papers presented by Sony staff.

Candidates should be self motivated, able to express complex technical ideas accurately and concisely and possess a knowledge of modern broadcast technologies/techniques. Specific product training will be provided.

If you like the thought of enjoying the success of world leadership then write in strict confidence to Barry White, Company Personnel Manager, now! And please don't forget a CV.

SONY. Broadcast

Sony Broadcast Ltd.
City Wall House
Basing View, Basingstoke
Hampshire RG21 2LA
Telephone (0256) 55011

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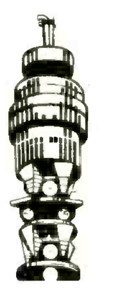

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Design, Dev. and Test to £10,000
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For further information, contact: (1115)

Charles Airey Associates

4 Hammersmith Grove, London W6 0NA. Tel: 01-741 4011

SERVICE TECHNICIAN

SOUNDCRAFT
ELECTRONICS LIMITED

We are looking for an experienced person to take responsibility for our Servicing and Spares operation.

Key requirements are:

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★ Experience of Professional Audio Equipment.
★ Ability to liaise efficiently with our international customers and dealers.

Salary Circa £6,000 p.a.

Write or telephone for an application form:
Mick Newman, Soundcraft Electronics
5-8 Great Sutton Street, London, EC1
01-251 0581

(1109)

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THE ILR STATION TO SERVE BRISTOL AND AVON

(Due on air in Autumn 1981) requires

BROADCAST ENGINEERS

preferably with radio experience. Salaries negotiable.

Write with C.V. to: The Chief Engineer,
Radio West, Bush House,
72 Prince Street, Bristol BS1 4NU.

RADIO WEST

Kiribati

Technical Officer (Marine Electronics)

Up to £8,021 plus allowances

Candidates must possess the City and Guilds Telecommunications Technicians Certifcate or an equivalent diploma in marine electronics. In addition, at least two years' experience on installation and maintenance of radio, radar and electronic navigation equipment and land-based MF, HF and VHF communications of up to 1KW output would be an advantage.

The successful applicant will be responsible to the Senior Technical Officer for the installation, maintenance and repair of ship stations on locally registered vessels. The appointee will advise ship owners on spares' requirements and holdings and supervise local officers.

Shipborne installations comprise JRC (JAPAN) and DECCA radars with navigation equipment mainly of "Kelvin Hughes" and "Omega" origin.

The salary includes a substantial tax-free allowance paid under Britain's overseas aid programme.

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(1080)

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ELECTRONICS ENGINEER/PROGRAMMER

Working as a member of a small team, the Electronics Engineer/Programmer will be required to programme microprocessor systems and to design and develop electronic circuits primarily based on digital techniques. The successful applicant will need to be self-motivated, have some electronic/design experience and be qualified to H.N.C. or equivalent.

Applications should be made by completion of an application form which is obtainable, together with a copy of the job specification, from

Mrs. T. I. Breed – Personnel Officer
THOMAS MERCER LIMITED
Eywood Road, St. Albans, Herts, AL1 2ND
Telephone: St. Albans 55313

(1121)

YORKSHIRE REGIONAL HEALTH AUTHORITY

Regional Medical Physics Service

ELECTRONICS TECHNICIAN GRADE IV – GRIMSBY

Required to undertake maintenance on a wide range of medical equipment and to assist with the development of new instruments. The post is based at the Grimsby Maternity Hospital, Second Avenue, Grimsby.

Candidates should possess an appropriate degree, HNC, ONC or other relevant qualifications and experience. Further details may be obtained from the Principal Physicist (Grimsby) Mr. J.M.M. Stirling, Tel: (0472) 74111.

Salary – Grade IV £4404 – £5790 p.a. The starting point will depend on qualifications and experience.

Application forms and job description obtainable from and to be returned to: District Personnel Officer, Grimsby Health District, Queen Street, Grimsby, Tel: (0472) 53771. Closing date: 10th June, 1981.

Grimsby Health Services

Humberside Area Health Authority

(1106)

Radio Development Engineer

ZIMBABWE **Circa £12,000**

Our client seeks the services of a radio development engineer having minimum 5 years' experience in the development of FM/AM radios, hi-fis and tape recorders. Emphasis is on practical experience. Theoretical qualifications are not of prime importance, but will influence salary offered.

This position is with a leading radio manufacturing company in very pleasant Bulawayo.

Telephone or write: Tony Bridges, 01-995 5151. Morgan-Bryant & Bridges, Personnel Services, Power Road, London W4 5PT.

(1083)

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QUALITY CONTROL TECHNICIAN

We manufacture and market audio reduction equipment which is used by major recording companies, recording studios, the film industry and broadcasting authorities throughout the world.

The Quality Control technician will be responsible to the Quality Assurance Manager for monitoring product quality in all areas of manufacturing. He, or she, will also carry out reliability trials and investigations.

The successful applicant will have experience in the service or manufacture of audio equipment.

Salary is negotiable.

Write or telephone:
Kevin Cross, Dolby Laboratories Inc.
346 Clapham Road, London SW9 9AP
or telephone: 01-720 1111.

(1120)

ELECTRONIC TEST TECHNICIANS
(up to £6,000 p.a.)
ELECTRONIC INSPECTORS
(up to £100 p.w.)

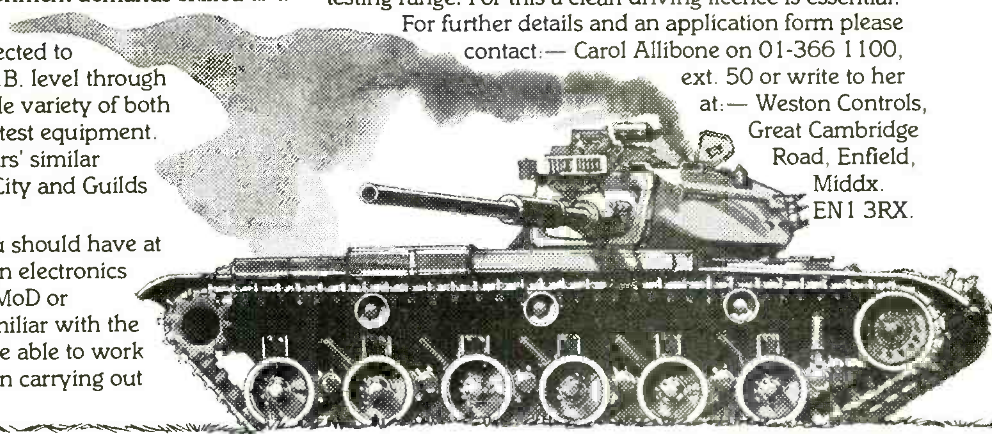
Exciting opportunities exist to help test and inspect our Simfire range of laser-based microprocessor controlled simulators which are used in the training of tank crews and other military personnel. The need for high reliability in the product's varied operating environment demands skilled and experienced staff.

In our Test area, you will be expected to test and diagnose faults from P.C.B. level through to system integration using a wide variety of both commercial and special purpose test equipment. You should have at least two years' similar experience and have a relevant City and Guilds examination (or equivalent).

For our Quality Control area, you should have at least three years' experience as an electronics inspector preferably holding an MoD or similar stamp. You should be familiar with the use of standard test meters and be able to work with the minimum of supervision carrying out detailed inspection on any of our products or systems.

Although based mostly within the factory, you will as part of a closely knit team, in both areas, become regularly involved in final testing of the equipment at our nearby outdoor testing range. For this a clean driving licence is essential.

For further details and an application form please contact:— Carol Allibone on 01-366 1100, ext. 50 or write to her at:— Weston Controls, Great Cambridge Road, Enfield, Middx. EN1 3RX.



WESTON
Schlumberger

Cancer Research Campaign

ELECTRONICS TECHNICIAN

If you have confidence, take pride in your designs and would like to work in a modern laboratory, then we should like to hear from you.

Experience in design, although desirable, is not essential, but you will be expected to be familiar with state-of-the-art analogue and digital techniques in the frequency range DC-1GHz. Preferred qualifications are degree or equivalent.

You will join a small team working on such diverse problems as fibre-optics telemetry and nanosecond spectrophotometry. Much of the work is in conjunction with a unique dual-polarity 4-million volt Van de Graaff accelerator. Starting salary about £6,000, dependent on experience and qualifications, on an incremental scale (currently under review).

Application forms and further information from the Deputy Director (5V).
CRC Gray Laboratory
Mount Vernon Hospital
Northwood, Middx. HA6 2RN. Northwood 28611

(1090)

AIR RECORDING STUDIOS

require a

MAINTENANCE ENGINEER

to work in their West End studios, with a possible tour of duty in the Caribbean. Applicants should be conversant with the latest analogue and digital recording technique and qualified to H.N.C. standard. Salary according to experience with regular reviews and bonus.

For interview please call:
DAVE HARRIES or MALCOLM ATKIN
on 01-637 2758

(1126)

AIR TRAFFIC ENGINEER GRADE 2

Applications are invited from persons aged 25 years or over who hold a minimum of ONC (Eng.), City and Guilds Telecommunications Technician (Course 270/271), up to and including T3, TEC Certificate Diploma in Telecommunications or equivalent technical qualifications, for the post of Air Traffic Engineer Grade 2, at Ronaldsway Airport on the staff of the Isle of Man Airports Board. Candidates should have a sound knowledge of electronics and be experienced in the maintenance of Airport Communications, Radar, Nav. Aids, CCTV or data processing systems.

The post is permanent and pensionable on a non-contributory basis (save for a contribution of 1½% towards family benefits) and has a salary scale of £6,252-£7,170 per annum. The post involves shift work, including some Saturday and Sunday working for which an additional allowance is payable. Arrangement exist for the transfer of certain pension rights, a removal expenses grant of 60% is payable and the standard rate of income tax in the Island is 20%. The duties of the post include the installation, maintenance, repair and calibration of electronic equipment and systems concerned with Air Traffic Control and Operations at Ronaldsway Airport. Further details can be obtained from the Airport Director (Tel. 0624-823311).

Applications stating full name, address, date of birth, qualifications and experience, together with the names and addresses of two referees, should be submitted to the **Secretary, Civil Service Commission, Central Government Offices, Douglas,** within fourteen days of the date of this advertisement.

(1103)

ISLE OF MAN
CIVIL SERVICE

Appointments

DATA COMMUNICATIONS
TECHNICAL SUPPORT ENGINEER

c. £8,000 **Oxfordshire**

In the field of Data Communications our client has secured an International reputation for expertise in the design of Network Management Systems.

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For further information and an application form write/phone:

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Tesel Services Limited is an expanding British high technology company providing wireline logging services to the international oil industry.

We require Electronics Technicians responsible for the maintenance and repair of a wide range of measuring, processing and data recording equipment. They should also have some mechanical and general workshop ability. Applicants should have ONC, HNC, or relevant Service qualifications.

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marking your envelope Reference WW301 (1087)

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Basic responsibilities will include operating, maintaining and modifying all equipment to current broadcast specifications, advising and assisting on programme production and contact with all sections of the trade to provide advice on audio visual equipment.

The position is directly responsible to our Engineering Manager who supervises a staff of nine people.

It is envisaged that the successful applicant will have sound experience of audio visual technical work covering TV and other equipment as found in a similar department or TV studio, plus several years' practical experience of electronic engineering theory and practice to H.N.C./degree standard.

Salary will be in the range of £5,342-£7,776 according to age and experience, and a car will be provided. A contributory pension scheme is in operation.

Please write or telephone for an application form, quoting reference DITV/1, to the

Personnel Manager, Distributive Industry Training Board
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(1104)

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METROPOLITAN POLICE

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Vacancies for Telecommunications Technical Officers Grades II and III exist in the Operations (Technical) Support Group of the Chief Engineer's Department.

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Closing date for return of application forms is 3rd June 1981.

(1108)

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(1082)

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(8994)

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Salary will be in a range rising to £8,647 (salaries will be reviewed in July). Generous relocation expenses will be paid where appropriate.

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Applicants (male or female) should write or telephone for an application form quoting reference WW/BTS to Glynis Powell, Personnel Officer, IBA, Crawley Court, Winchester, Hampshire, SO21 2QA. Telephone 822270.

(1101)

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(1028)

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to test primarily the custom-built products, mainly intercommunication systems, along with the standard product range. Some experience in the testing of audio and digital circuits and in the design of test jigs is desirable.

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(1130)

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Air Traffic Engineers Grade 2 are involved in the installation and maintenance of radio, radar, air navigational and landing aids, and data processing systems. Staff are employed at some Civil Airports, Air Traffic Control Centres and Radar Stations and other locations throughout the UK but at present most of the vacancies are likely to be in the South of England with a few vacancies elsewhere in the UK.

Qualifications and Experience

You should be at least 20 years of age and have obtained either the O.N.C. (Eng.) with an electronic bias or C. & G. Telecommunications Technician T3 Certificates or other similar technical qualifications.

Skilled working experience in radio, radar or data processing is essential.

Salary

Salaries are on an incremental scale £5,683-£8,783. Posts in the London area attract an additional allowance (Inner London £1,082 – Outer London £452). Grade 1 posts (maximum salary £10,610) are normally filled by promotion from Grade 2.

For full details and an application form complete and send the coupon to: CAA, Personnel (Tels), Room T 1206, CAA House, 45-59 Kingsway, London, WC2B 6TE.

Name...

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CAA

Civil Aviation Authority

(1125)

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Department of Medical Physics & Bio Engineering

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Applicants should hold a minimum qualification of ONC, but preference will be given to those holding HNC/HND or equivalent. All applicants should have at least 2 years' relevant experience as a Technician III.

Further information available from the Principal Physicist, Cardiff Royal Infirmary, Newport Road, Cardiff. Tel: (0222) 492233, Ext. 659.

Application forms and job descriptions available from: Mrs. D. V. Eaton, Assistant Unit Administrator, Cardiff Royal Infirmary, Newport Road, Cardiff. Tel: (0222) 492233, Ext. 407.

Closing date: 20th June, 1981. (1123)

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For application form with job description please write to the Deputy Secretary, Institute of Psychiatry, De Crespigny Park, Denmark Hill, London SE5 8AF or telephone 703 5411, Ext. 214, quoting reference MJC/WW. (1107)

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For application forms and job description contact Personnel Manager, Miss J. A. Jenks, Brompton Hospital, Fulham Road, London, SW3. Tel. 01-352 8121 ext. 4357.

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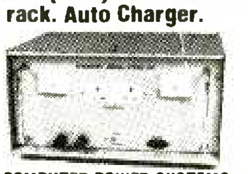

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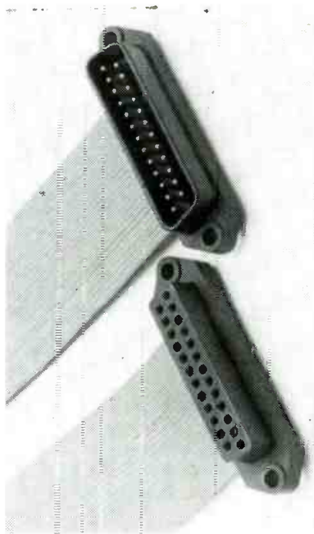

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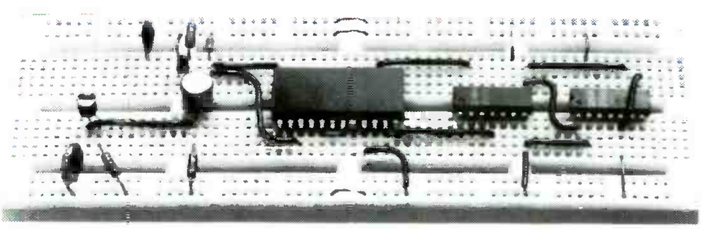

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