



ELECTRONICS

VOLUME 9 No. 1 JANUARY 1973

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Our February issue will be published on Friday, January 12, 1973

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14 + 14 watts r.m.s. 40Hz to 40kHz + 3dB. Total distortion at 10 watts at | kHz - 0 | 9

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For both systems we have chosen the famous Garrard SP25 Mk. III deck, with fitted magnetic cartridge, which comes complete with simulated teak plinth and tinted acrylic cover.

The exclusive Duo loudspeaker systems are incomparable for quality within their price range. Large speakers in extremely substantial cabinets. There's a choice of the Duo II's for the smaller room or the big Duo III's for real bass response.

SPEAKERS

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Duo Type III Size approx. 23 $\frac{1}{2}$ in. \times II $\frac{1}{2}$ in. \times 9 $\frac{1}{2}$ in. Drive unit 13 $\frac{1}{2}$ in. \times 8 $\frac{1}{2}$ in. with H.F. speaker. Max power 20 watts 8 ohms. Freq. range 20Hz to 20kHz. Teak veneer cabinet. £32 pair \pm £3 p & p.

SPECIFICATION RIOI

A watts per channel into 3 to 4 ohms (suitable 3-15 ohms). Total distortion # 10W # 1kHz0·19°, P.U.I. (for ceramic cartridges) ISOmV into 3 Meg. P.U.Z. (for magnetic cartridges) HSOmV into 3 Meg. P.U.Z. (for magnetic cartridges) HSO # 16 R.I.A. A. Rodio ISOmV into 20K. (Setsion 10 Rep. 10 Rep.

PRICES: SYSTEM I Viscount 11 R 101 amplifier 2 × Duo Type II speakers Garrard SP25 Mk. 111 with MAG, cartridge plinth and

£23.00 +£1.50 p&p

£59.00 Available complete for only £52 + £3-50 p & p

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UNISOUND MODULES ONLY 66-95 If you prefer, you can buy the three modules—pre-amplifier power supply/dual power amplifier, and control panel—by themselves for only 66-95. P. & P. 50p extra. No soldering, just simply screw together with screwdriver supplied. Their overall specification is the same as shown for the complete Unisound console, using the high efficient I.C. monolithic power chips to ensure very low distortion at all power levels, correct operation in all ambient temperatures, full power over the audio spectrum.



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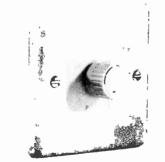
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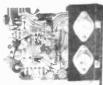
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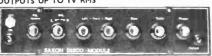


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(Chassis)		£31-00
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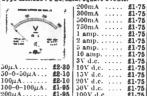
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MODEL TE-200 20,000 O.P.V. Mirror scale, overload protec-tion. 0/5/25/125/1,000V d.c. 0/10/50/250/1,000V a.c. 0/50μΑ/ a.c. 0/50µA/ 250mA. 0/60K/6 meg Ω. —29 +62dB. **£8.95**. P. & P. 15p.



| MODEL 500 30,000 O.P.V. with overload protection mirror scale 0/0-5/2-3/10/25/10/

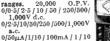


HT100R4 MULTI-METER Features a.c. current ranges, 100,000 O.P.V. Mirror Scale, Overload protection. 0/0.5/2.5/ 10 / 50 / 250 / 500 / 1,000V d.e.



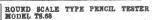
110/230/14/23/23/230MA/ 0 amp. d.c. 0 amp. a.c. 0/20K/200K/2MEG/20 MEG, -20 +62 dB. 212-50, P. & P. 25p.

870 WTR MULTIMETER Features a.c. current ranges. 20,000 O.P.V. 0/0.5/2.5/10/50/250/500/ 1,000V d.c.



amp. d.c. 0/100mA/1/10 amp. a.c. 0/5K/50K/500K/5MEG/50MEG. -20 +62dB. \$15, P. & P. 25p.

RUSSIAN 22 RANGE MULTINETER Model U437 10,000 O.P.V. A first class versatile in-instrument manufactured in U.S.S.R. to the highest standards. Ranges: 2-3/10/50/230/500/1,000V a.c. 2-5/10/50/230/500/1,000V a.c. 10/50/250/500/1,000V a.c.
current 100wA/1/10/
100mA/1A. Resistance
300 ohnus/3/30/300K/3m \(\Omega \).
Complete with batteries,
test leads, instructions and sturdy steel carrying case. OUR PRICE \$5.97, P. & P. 25p.





Completely portable, simple to use pocket sized tester.
Ranges 0/3/30/300V a.c. Ranges 0/3/30/300V a.c. and d.c. at 2,000 O.P.V. Resistance 0.20K ohms. ONLY £1.97, P. & P. 13p.

LT 601 MULTI-METER New style 20,000 O.P.V. pocket multimeter. 5/25/50/250 / 500 / 2,500V d.c. 10/50/100/500/1,000V a.c. 50µA/50A & AV/6 max/50A



1,000V a.c. $50\mu\text{A}/2$ 250A. 6K/6 meg ohms. -20 to +22 dB. **28.75**. Post 20p.



MODEL TH-12 20,000 O.P.V. Overload protection. Slide switch selector. 0/0-25/2-5/10/50/250/1,000V d.c. 0/10/50/250/1,000V a.c. d.c. 0/10/50/250/1,000 v 0/50μA/25/250mA d.c. 0/3K/ 30K/300K/3 meg. -20 to +50dB.

MODEL TE-300. Mirror scale, overload ion 0/0.6/3/15/60/300/ protection 1,200V 1,200V d.c. 0/6/30/120/600/ 1,200V a.c. 0/30/µA/6mA/ 60mA/300mA/600mA. 0/8K/ 80K/800K/8 meg. ohm —20 to 80K/800K/8 meg. ohm —20 +63 dB. **25.97**, P. & P. 15p.



1 Meg/10 -20 to +46dB . \$8.97, P. & P. 12p.

MODEL PL436 20k Ω/V d.c. 8k Ω/V a.c. Mirror scale. 0·6/3/12/30/120/600V d.c. 3/30/120/600V a.c. 50/600μA/60/ 600mA. 10/100K/



TMK MODEL TW-50K 46 ranges, mirror scale, 50K/Y d.c. 5K/Y a.c. Dc.: Volts 0-123, 0-25, 1-25, 2-5, 5, 10, 25, 50, 125, 2-0, 500, 1,000V. A.c. Dc.: Volts: 1-5, 30, 3, 1, 10, 25, 30, 125, 250, 300, 1,000V. Dc. Current: 52, 50µA, 2-5, 5, 250, 50 250, 500mA, 5, 10 amp. Resistance: 10K, 100K, 11 MEG Ω. Decibels: -20 to +81.5 dB. 48-50, P. & P. 17p. Decibels: -20 to 28.50, P. & P. 17p.

MODEL K228A
Taut band
suspension.
Overload pro-Polarity reversing switch.



30,000 01.17 0(0-5/2-5/15/ 50/250/500/1,000/2,500 V d.e. 0/15/50/150/ 500/1,000 V s.c. 0/50μA/5/50/150/500mA/ 5A d.e. 0/3K/300K/3meg. £8-95. Post 20p.



HIOKI MODEL 700X 100,000 O.P.V. Overload protection. Mirror scale. 0·3/0·6/1·2/1·5/3/6/12/30/60/

MODEL C-7080 EN



MODEL C-7080 EN Giant 6in mirror scale. 20,000 O.P.V. 0/0-25/1/2-5/10/50/250/ 1,000/5,000V d.c. 0/2-5/10 /50/250/1,000/5,000V a.c. 0/50µA/1/10/100/500mA/ 10 amp, d.c. 0/2K/200K/ 20 meg. -20 to +50dB. £13-95. Post 35p

0 0

U4812 MULTIMETER

104312 MULTIMETER

Extremely sturdy instrument for general electrical use. 687 O.P.V. 9/α·3/1-5/7·5/30/60/150/300/60/900V d.c. and 75mV. 9/α·3/1-5/7·5/30/60/150/300/600/900V d.c. and 75mV. 9/α·3/1-5/7·5/30/60/150/300/600/900V d.c. 9/300/μΑ/1-5/6/15/66 amp. d.c. 9/1-5/6/15/66 amp. d.c. 9/1-5/6/15/6/15/60/0MA/1-5/6/15/6 amp. d.c. 9/200 Ω/3k/30k Ω. Accuracy Knife edge pointer, mirror scale. Complete with sturdy metal carrying case, leads and instructions. 29-50 plus P. & P. 25p.

Selected TEST EQUIPMENT

FTG-401 TRANSISTOR TESTER Full capabilities for measuring A, B and 1CO. npn or pnp. Equally adaptable for checking diodes. Supplied complete with instructions, battery and leads. 27-50. Post 20p.



ModelS-100TR MULTIMETER/TRANSISTOR

Model8-100TR MULTIMETER/7 TESTER 100,000 O.P.V. mirror scale/overload protec-tion. 0/0-12/0-6/31/2/30/120/ 600V d.c. 0/6/30/120/600V a.c. 0/12/600_d./12/300m A/12 amp. d.c. 0/10 K/1 MEG/100 MEG. —20 to +50dlB. 0-01-2 MFD. Transistor tester neasures Alpha, beta and Ico. Complete with batteries, instructions and leads. £13-50. P. & P. 25p.



Checks trite a.c. beta in/out. Checks Icho. Checka ilodes in/out. Checka Set. Checka Set. etc. Beta III 10—300 lob. 02—30 lob. 02—30 lob. 02—30 lob. 217-50. Pout 25p.

MODEL 449A IN CIRCUIT TRANSIS-TOR TESTER

Checks true a.c. beta in/out. Checks Icbo.



TE-20D RF SIGNAL GENERATOR
Accurate wide range signal generator covering
120 kHz-500 MHz on 120 kHz-500 MHz on 6 bands, Directly calibrated Variable R.F. attenuator, audio output, Xtal socket for calibration. 220/240 v.s. Brand new with instructions. \$15. Cart, 37½p. Size 140mm × 215mm × 170mm.

MODEL L-55 FET

V.O.M.
Toput impedance V.O.m. Input impedance 10 meg ohus. 0/0-3/1-2/6/ 30/120/600V d.c. 0/3/12/ 60/120/600V a.c. 0/120µA /120mA d.c. 0/1K/100K/ 10 meg/100 meg ohms, £15-97. Post 25p.



CI-5 PULSE OSCILLO-SCOPE

Stope

free running 20-200,000mz m ... Calibrator pips. 220mm × 3 430mm, 115-230V a.c. operation. £39. Carr paid.

TO-8 PORTABLE OSCILLOSCOPE



3in tube, Y amp. Sensitivity
0-1V p-p/CM. Bandwidth
1-Seps-1-5MHz. Input
Imp. 2 meg Ω 20pf X amp.
sensitivity 0-9V. p-p/CM.
Bandwidth 1-Seps-8908 Hz.
Input imp. 2 meg Ω 20pf
Time base. 5 ranges 10cps300kHz. Synchronisation.
x 215mm x 335mm. Weight 154lb. 220/
240V a.c. Supplied brand new with handbook. 240-00. Carr. 50p.

RUSSIAN CI-16 DOUBLE BEAM OSCILLOSCOPE z Pass Band, Sep-

SUSHIAN UI-10 DOUBLE BEAR OSCILLOSCOPE

STATE Y I and Y2
amplifiers. Rectangular Jin × in C.R.T. Calibrated triggered sweep from 0-2µ/sec to 100 milli-sec per cm. Free running time base 30 Hz-1MHz. Bullt-int time base calibrator and amplitude calibrator. Supplied complete with all accessories and instruction manu 237. Carr. paid.





TRANSISTORISED L.C.R. A.C. MEASURING BRIDGE



A new portable bridge offering excellent range and accuracy at low cost. Ranges: R. $1\Omega-111$ meg Ω 6 Ranges $\pm 1\%$.

Transistorised

TE-16A Transistorised Signal Generator, 5 ran-ges 400kHz—30MHz. An

ges 400kHz—30MHz. An inexpensive instrument for the handyman. Operates on 9V battery. Wide easy to read scale.

| 143-11 | neg 0 | 144-11 | neg 0 | 145-11 | 148 | 148 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 158

MODEL TEIS GRID DIP

MODEL TE15 GRID DIP METER Transistorised. Operates as Grid Dip, Oscillator, Absorption Wave Meter and Oscillating Detector, Frequency range 440kHz-280MHz in 6 coils, 500µA meter. 9V battery opera-tion. Size 180mm × 80mm × 40mm. × 40mm. £12.50. Post 20p.



BELCO AF-5A SOLID STATE SINE SQUARE WAVE C.R. OSCILLATOR



Sine 18-200,000 Hz; 18-50 000 Ontr Hz. Output max. +10dB(10 K ohms) Operation internal batterles. Attrac-tive 2-tone case 73 in × 5 in × 2 in. Price £17-50. Carr. 17p.

MODEL MG-100 SINE SQUARE WAVE AUDIO

WAVE AUDIO
GENERATOR
Range 19-220,000
Hz. Sine Wave
19 — 100,000 Hz.
Square Wave. Output Sine or Square
wave 10V. P. to P. Size 180mm × 90mm ×

Operation 220/240V a.c. Post 37p.



MODEL AT201 DECADE ATTENUATOR Frequency rs 0-200kHz. range

Attenuator 0-111dB, 0-1dB step. Impedance 600

ohms. Max. input power 30dBm. Size 180mm × 90mm × 55mm. £12-50. Post 37p.

TE-65 VALVE VOLTMETER



ALVE VOLUMETER
28 ranges. D.c. volts
15-1,500V a.c. volts
15-1,500V a.c. volts
15-1,500V a.c. volts
15-1,500V a.c. operation. Complete with
probe and instructions.
217-50. P. & P. 30p.
Additional probes available: R.F. £2-12; H.V.
£2-50.

MODEL U4811 SUB-STANDARD
MULTI-RANGE VOLT AMMETER
Sensitivity 330 ohms/Volt
a.c. and d.c. Accuracy 0·3/6

165mm.
0/300/730/pt-1-3/3/7-3/15/380/
0/300/730/pt-10-3/11-3/3/7-3/15/3/80/

0/300/750µA(1-5/3/7-5/15/30)
-75/150/300/750mA(1-5/3/7-5/150)
-75/150/300/750mA(1-5/3/7-5/150)
-75/150/300/750V d.e. 0/
-75/150/300/750V d.e. 0/
-75/150/300/750V a.e.

Automatic cut out. Supplied complete with test leads, manual and test certificates. \$49. Post 50p.

G. W. SMITH & CO. (RADIO) LTD. Also see opposite page and next two pages

: (1)

TMR_RO RECEIVER



4 Bands covering 550kHz-30MHz. BFO. Built-in Speaker 220/240V a.c. Brand new with instructions. £15.75, Carr. 37p.



SOLID STATE COMMUNICATION UR-1A SOI RECEIVER

4 Bands covering 550kHz-30MHz. RET. 8 Meter. Variable BFO for SSB, Built-in Speaket, Bandspread, Sensitivity Control. 220/240V a.c. or 12V d.c. 12½m.4½in.x7in. Brand new with instructions. £25, Carr. 37p.

SKYWOOD CX203 COMMUNICATION



Solid state. Coverage on 5 bands 200-420 kHz and 0-65 to 30MHz. Illuminated slide rule dial. Bandapread. Aerial tuning. BFO, AVC, ANL, "S" meter. AM/CW/88B. Integrated appeaker and phone socket. Operation 220/240V a.c. or 12V d.c. Size 325 x 265 x 150 mm. Complete with instructions and circuit. \$288-50. Carr. 50p.

LAFAYETTE HA-600 SOLID STATE RECEIVER



General coverage



TRIO 9R59DS COMMUNI-CATION RECEIVER 4 band cove ing 550kHz

ing 530kHz con10, 15, 20 40 and 80 metres. 8 valve
plus 7 diode circuit. 4/8 ohm output and
phone jack, SSB-CW. ANL. Variable BFO.
8 meter. 8ep. bandspread dial. 1F frequency
456kHz. Audio output 1-5W. Variable RF
and AF gain controls 115/230V a.c. Size
7in X18nz. 10in with instruction manual.
449-50. Carr. paid.



EMI LOUDSPEAKERS

Model 350. 13in×8in with single tweeter/crossover, 20-20,000Hz. 15W RMS. Available 8 or 15 ohms. £7.25 each. 8 or 15 ohms. £7.25 each. P. & P. 37p. Model 450. 13in×8in with twin

tweeter/crossover. 55-13,000Hz. 8W RMS. Available 8 or 15 ohms. £3:62 each. P. & P. 25p.



Can be panel or bench mounted. Basic meter mea-sures IV d.c. but

sures 1V d.c. but can be used to measure a wide range of a.c. and d.c. volt, current and ohms with optional and d.c. volt, current and ohms with optional plug in cards. Specification: Accuracy: ± 0.2 , ± 1 digit. Resolution: ImV. Number of digits: 3 plus fourth overrange digit. Overrange: 100% (up to 1-999). Input impedance: 1000 Meg ohm. Measuring cycle. I per second. Adjustment: Automatic zeroding, full scale adjustment against an internal reference voltage. Overload: to 100V d.c. Input: Fully floating (3 poles). Input power: 110-230V a.c. 50/60 cycles. Overall size: 5\fin x2\film x8\film. AVAILABLE BRAND MEW AND FULLY GUARANTEED. 236-50, Carr. 50p.

SINCLAIR IC-12



£1.80 P. & P. 10p

SINCLAIR EQUIPMENT

Project 60 Package offers.



2×Z30 amplifier, stereo 60 pre-amp, PZ5 power supply. £15-95. Carr. 37p. Or with PZ6 power supply. £18-00. Carr. 37p. 2×Z50 amplifier, stereo 60 pre-amp, PZ8

2×Z50 amplifier, stereo 60 pre-amp, PZ8 power supply, £20-25, Carr. 37p.
Transformer for PZ8, £2-97 extra.
Add to any of the above £4-45 for active filter unit and £13-00 for pair of Q16 speakers.
All other Sinclair products in stock.
2000 amp. £21-95. Carr. 37p.; 3000 amp. £28-50. Carr. 37p.; Neoteric Amp. £43-95. Carr. 37p. 1C12, £1-80, P. & P. 10p.
NEW PROJECT 605—£20-97. Carr. 37p.

WHARFEDALE MID-RANGE HI-FI UNITS

used in As used in world famous system. 5in dia. Impedance 4/8 ohms. High flux ceramic magnet. 20W RMS. Brand new £1-50, Carr. 37p.



Hi-Fi 12in 20W twin cone full range speaker. 30-16,000Hz. 16,500 gauss. 8 ohm imped-ance. Brand new and hoxed. (List price £21-72). OUR PRICE £12.50 each. Cart. 50p.



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EA.41 REVERBERATION

Self contained, transistor Selfcontained, transistorised, battery operated.
Simply plug in microphone, guitar, etc., and output into your amplifier. Volume control, depth of reverberation control. B walnut cabinet. 7½in×3in×4½in.

Beautiful walnut cabinet. P. & P. 15p. 25-97



SPECIAL OFFER! ROTEL RH700 STEREO HEADPHONES

20-20,000Hz. 8-16 ohm. (List £9-95). OUR PRICE £6.75.



SPECIAL OFFER! STEREO

STEREO
SPEAKERS
Matched pair of stereo
bookshelf speakers. Deluze teak veneered finish.
Size: 14\in \times 19 \times \times XIMS.
16W peak. Complete
with DIN lead. £12-95.
Carr. 50p.

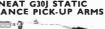


HA-10 STEREO HEADPHONE AMPLIFIER All silicon transistor amplifier oper-

ates from magnetic.

ceramic or tuner inputs with twin stereo headphone outputs and separate volume controls for each channel. Operates from 9V battery. Inputs 5MU/100MU. Output 50MW. £5-97, P. & P. 15p.

SPECIAL PURCHASE! NEAT G30J STATIC BALANCE PICK-UP ARMS



Identical specification to NEAT G30 arm but with two-tone chrome and black finish. Complete with head shell, pick-up rest and plug in phono leads. BRAND NEWplug in phono leads. FULLY GUARANTEED ONLY £8.95. P. & P. 25p.



ARF-300 AF/RF
BIGNAL GENERATOR
All transistorised, compact,
fully portable. AF sine wave
18 Hz to 220 KHz. AF
square wave 18 Hz to 100
KHz. Output sine/square
10v. P-P. RF 100 KHz to
200 MHz. Output 1v. maximum. Operation 220/244v
AC. Complete with instructions and leads. £29-95. Post
50p.

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SUPER MONEY SAVING OFFERS—BUY **NOW WHILE STOCKS LAST!** ALL BRAND NEW AND **FULLY GUARANTEED**



GENUINE BARGAIN!



KOSS SP.3XC STEREO HEADPHONES

Response 10-15,000Hz Impedance 4-6 ohms. Brand new: Boxed and fully g'teed (List £9-50). OUR PRICE £8.50. & P. 25p.

1021 STEREO LISTENING STATION



STATION
For balancing and gain selection of loudspeakers with additional facility or stere headphone switching. 2 gain controls, speaker on-off silde switch, stereo headphone sockets. 6in×4in×24in. 22·25. headphone P. & P. 15p.

MP7 MIXER PREAMPLIFIER



5 inicrophone in-puts each with individual gain midwidual mixing an individual mixing facilities. Battery operated. 9 lin x 5 in x 3 in. V 600 ohm. Phono nieg. 4mV 50K. 2 x 3 mV 600 ohm. Phono nieg. 4mV 50K. Phono ceramic 100mV 1 meg. Output 250mV 100K. 28-97. P. & P. 20p.

TE-1035 STEREO HEADPHONES

HEADPHONES
Low cost high performance stereo headphones.
Foam rubber ear cups.
Adjustable head-band.
8 ohn impedance. 25—
18,000Hz. With lead and stereo jack plug. ONLY £1.97, P. & P. 12p.

NEW GARRARD MODULES



Popular range of Garrard decks with Shure cartridge fitted in deluxe plinth with hinged lid.

Our Price £23.50 SP25 III Module/M75-6 AP76 Module/M75-6 AP96 Module/M75-6 Zero 1008 Module/M93E £33.80 £38.75 £52-60 Carr. 50p extra any item

HOSIDEN DH-08S DE-LUXE STEREO HEADPHONES



Features unique mech-anical 2 way units and anical 2 way units and fitted adjustable level, controls. 8 ohm impedance 20-20,000cps Complete with spring lead & storeo jack plug lead & stereo jack plug 27.97. P. & P. 12p.

DOLBY SYSTEM NOISE REDUCTION UNIT



£32.50 PRICE

Carr. 50n

HOSIDEN DHO-2S STEREO HEADPHONES



and excellent per-formance combined. Adjustable band band. 8 ohm impedance. 20-12,000 cps. Complete with lead and plug. ONLY £2:37. P. & P.

TAPE

TAPE
CASSETTES
Top
quality
Hi-Fi
Low Noise
in Library

cases. C60 3 for 75p. 10 for 22:35 C90 3 for £1:05 10 for £3:30 C120 3 for £1:35 10 for £4:20 Tape Head Cleaner 30p each. P. & P. 10p C60 extra

SE! LEAK SANDWICH SPEAKERS SPECIAL PURCHASE! MINI-



Brand new and fully guaranteed. 8W, 8 ohm. Teak finish. (Rec. list £59-50 pr.) OUR PRICE £39-50 pr.



TRANSISTORISED FM TUNEE

6 TRANSISTOR
HIGH QUALITY
TUNER, SIZE
ONLY SIXE
ONLY SIXE
ONLY LONG
LONG
LONG
Criminator. Ample

Double tuned dis-criminator. Ample output to feed most 88-108MHz. Ready built ready for use. Fan-tastic value for money. £6-87. P. & P. 12p. Stereo multiplex adaptors £4-97.

TE 1018 DE-LUXE MONO HIGH IMPE-DANCE HEADSET Sensitive, soft earpads, adjustable headband. Magnetic, impedance 2,600 ohms. £1-97. P. & P. 15p.



G. W. SMITH & CO. (RADIO) LTD. Also see previous pages and opposite page

FANTASTIC OFFER!



17+17W r.m.s. stereo amplifier with inputs for Magnetic and Crystal phono, Tuner, Tape, Aux and Tape Monitor. Outputs for two pairs of stereo speakers and tape. Stereo headphone socket, Full range of controls including loudness control, scratch filter, Full range of controls including lo etc. Size 13in × 9in × 3in. Unrepeatable offer—limited stocks!

List price £59.50 OUR PRICE

WHARFEDALE LINTON SYSTEM



Wharfedale Linton Amplifier, Linton Turntable, pair of Linton 2 speakers and all leads.

£105

TELETON CRIOT/RG42

SYSTEM

Leak Delta 30 stereo amplifier, Goldring GL75, plinth, cover and G800 cartridge. Pair of Leak 150 speakers and all leads. OUR £121.50

LEAK DELTA 30

SYSTEM

TELETON F2300 SYSTEM



Teleton AM/FM 4+4W stereo tuner amplifier, Garrard 2025 T/C, plinth and cover, stereo cartridge, pair of matching Teleton F2300 AM/FM. 7+7W stereo tuner amplifier, Garrard SP25 III or BSR MP60, plinth and cover, 9TAHCD cartridge, pair of Stereosound Deluxe speakers and all leads.

£59.95

Carr. and Ins. £1.50

AMSTRAD 8000 II SYSTEM

£35.50



Amstrad 8000 II 7+7W amplifier. Garrard 8P25 III or B8R MP50, plinth and cover, Goldring G800 cartridge, pair of Apollo speakers and all leads.

OUR PRICE

£48.25

Amplifier only, £14.50. Carr. 50p.

MW/LW CAR RADIO

speakers and all leads.

OUR PRICE



Fully transistorised, dual waveband. Size 6½in×42in×2in. 12V d.c. Neg. or pos. earth. Complete with fixing kit, speaker and leads.

£7.50

SUPER BARGAIN! 8-TRACK CAR STEREO TAPE PLAYER



selector. Complete with matched pair stereo speakers, connections and fittings.

ONLY

TELETON SAQ206B SYSTEM



Teleton SAQ206B 8+8W amplifier, Garrard 8P25 III or BSR MP60, plinth and cover, Goldring G800 cartridge, pair of Apollo speakers and all leads.

£55.95

Amplifier only, £22.95. Carr. 50p.

B.S.R. TD8S 8-TRACK STEREO TAPE PLAYER DECK

Integrated preamps (output 125mV) to feed into any stereo amplifier. Automatic and manual programme selector. 4 pole synchronous motor. 210/240V a.c.

OUR PRICE Carr. 37n

£16.25

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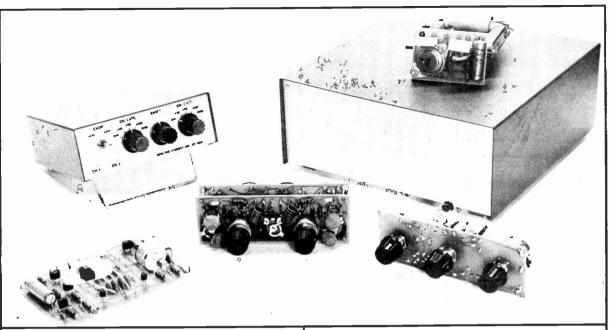
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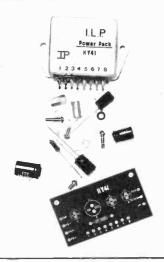
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THE HY41

The HY41 supersedes the popular HY40 introduced by ILP last year. This highly improved module achieves true High Fidelity with a dramatic reduction in distortion (typically 0.05% at 1KHz into 8 ohms!) and is electronically and mechanically compatible with the HY40.

With this important improvement the HY41 retains all of the quality characteristics found in the earlier version and P.C. board, Resistor, Capacitors, Hardware Mountings and comprehensive manual are included in the basic kit. No further components are required to construct a complete power amplifier of extremely high performance sufficiently versatile to provide power not merely for Hi-Fi but also for public address systems and industry.

The free manual gives a full circuit diagram of the HY41 and its various applications including a complete stereo amplifier.

Like its predecessor the HY41 is based on conventional and proven circuit techniques developed over recent years.

OUTPUT POWER: British Rating 40 WATTS PEAK, 20 watts

R.M.S. continuous. LOAD IMPEDANCE: 4-16 ohms. INPUT IMPEDANCE: 30K ohms at 1KHz.

VOLTAGE GAIN: 30db at 1KHz

TOTAL HARMONIC DISTORTION: less than 0.15% (typical 0.05%)

at 1KHz

FREQUENCY RESPONSE: 5Hz-50KHz + 1db.

SUPPLY VOLTAGE: + 22.5volts D.C. SUPPLY CURRENT: 0.8 amps maximum.

PRICE: inc. comprehensive manual, P.C. board, five extra components and P. & P.:-MONO: £4.90 STEREO: £9.80

UNIQUE HYBRID PRE-AMPLIFIER

The HY5 has rapidly established a position in the WORLD as the sole hybrid pre-amplifier to contain all feedback and equalization networks within an integrated pre-amplifier circuit.

Supplied with the HY5 are two stabilizing capacitors and by the addition of volume, treble and bass potentiometers it is ready for use.

Internally the HY5 provides equalization for almost every conceivable input, the desired function is achieved by use of a multi-way switch or by direct interconnection.

Two distinctive features of the HYS are its inbuilt stabilization circuit, allowing it to be run off any unregulated power supply from 16–25 Volts and a balance circuit which, when linked by a balance control to a second HYS, forms a complete stereo pre-amplifier

Specifically and critically designed to meet exacting Hi-Fi standards, the HY5 combines extremely low noise with a high overload capability. When used in conjunction with the HY41 and PSU45 forms a completely intergrated system.

Magnetic Pick-up (within ±1db RIAA curve)

2mV. 47K Ω Tape Replay (external components to suit head). 4mV. 47K Ω

Microphone (flat) 10mV, 47K Ω Ceramic Pick-up (equalized and compensatable) 20~2000mV, variable.

Tuner (flat) 250mV, 100K Ω Auxiliary 1 250mV, 47K Ω

Auxiliary 2 2-20mV. 100K Ω

OUTPUTS

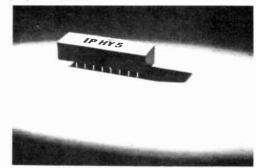
Main Pre-amp output 500mV. Direct tape output 120mV

ACTIVE TONE CONTROLS (Bexendall) Treble + 12db.
Bass + 12db.
INTERNAL STABILIZATION
Enables the HY5 to share an unregulated

supply with the Power Amplifier.
SUPPLY VOLTAGE

16-25 volts PRICE MONO: £3.60

STEREO: £7.20



SUPPLY CURRENT 6mA approx

OVERLOAD CAPABILITY

better than 26db on most sensitive input infinite on tuner and auxl.

OUTPUT NOISE VOLTAGE: 0.5mV.



POWER SUPPLY PSU45

The versatile P.S.U.45 is designed to supply your HY41's +HY5's in stereo or mono format.

Specification

Input: 200–240 Volts. Output: ± 22.5 Volts at 2 amps. Overall Dimensions: L. 7"; D. 3.8", H. 3.1"

PRICE: £4.50 inc. P. & P.

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Type IMP Mk. 2 Brand New and Boxed. These well known timers are already in world-wide use and are perfect for Industrial Electronic Timing, Research and for all machine control timing problems. Repetitive accuracy better than 0-5% of full scale setting. Two or more can be interconnected to give control of a series of processes, 230/250V. 50Hz, also available 60Hz. 15 minutes full scale, 15 sees, per division. Driven by self-starting sync. motor. Contact rating 5 amp at 250V a.c. Incorporates sclennif operated clutch

tact rating a sup at 250 V a.c. In-corporates solenoid operated clutch also lever actuated micro switches. Normal price probably in excess of £16. Complete with multi-pin con-nector as illustrated.

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2000mF 6V 25p; 25V 42p; 50V 5 2500mF 50V 62p; 3000mF 25V 4 5000mF 6V 25p; 12V 42p; 25V 7	57p. 17p; 50V 65p.	

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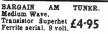
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Ref. VA	Weight	Size cm.		P & P
No. (Watts) Ib oz			£ p
07 20	1.11	7·0 × 6·0 × 6·5		161 30
100 60	3 8	8-9 × 8-0 × 7-7		2-39 36
61 100	3 8 5 12 9 8	10·2× 8·9× 8·3		2.62 52
30 200		$12.0 \times 10.3 \times 10.0$		4-39 52
62 250	12 4	9.5 × 12.7 × 11.4		5-80 67
55 350	15 0	14-0 × 10-8 × 12-4		7.77 82
63 500	27 0	17·1 × 11·4 × 15·9		11-20 *
92 1000	40 0	17.8 × 17.1 × 21.6		20-63 *
128 2000	63 0	24-1 × 21-6 × 15-2		34-10 *
	AUTO	SERIES (NOT	ISOLATED)	
Ref. VA	Weight		Auto Tabs	P & P
	ts) Ib oz			£ p
113 20		7:3 × 4:3 × 4:4	0-115-210-240	0.85 22
64 75			0-115-210-240	1-66 30
4 150			0-115-200-220-240	2.00 36
66 300		10.2 × 10.2 × 9.5		3-89 52
67 500		14·0 × 10·2 × 11·4		5.78 67
84 1000		11-4 × 14-0 × 14-0		10-49 82
	16 0			
93 1500		13.5 × 14.9 × 16.5		15-20 *
	28 9			

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Ref. Amps. Weight
No. 12V 24V 1b 02
111 0-5 0-25 12 7-6× 5-7× 4-4 0-12V at 0-25A ×2 0-85 22
213 1-0 0-5 1 0 83 3× 5-1× 5-1 0-12V at 0-5A ×2 1-01 22
71 2 1 1 0 7-0× 6-4× 5-7 0-12V at 1A× 2 1-33 22
18 4 2 2 4 8-3 × 70× 70 0-12V at 1A× 2 1-33 22
18 4 2 2 4 8-3 × 70× 70 0-12V at 1A× 2 1-33 22
18 6 3 3 12 10-2× 7-6× 8-6 0-12V at 2A× 2 1-86 36
17 6 6 3 3 12 10-2× 7-6× 8-6 0-12V at 3A× 2 2-24 42
18 6 8 7 8 12-1× 9-5× 10-2 0-12V at 5A× 2 2-94 52
17 16 8 7 8 12-1× 9-5× 10-2 0-12V at 6A× 2 2-94 52
115 20 10 11 13 12-1× 11-4× 10-2 0-12V at 16A× 2 1-65 45
18 7 30 15 16 12 13-33 ×12-1× 12-1 0-12V at 15A× 2 10-67 82
226 60 30 34 0 17-0× 14+5× 12-5 0-12V at 30A× 2 19-61 *

						RANGE	_	
Ref.	Amps.	Weigh	Size cm.		Secondar	y labs	Ρ.	& P
No.		Ib oz					4	Þ
112	0.5	1 4	8·3 × 3·7 ×	4.9	0-12-15-2	10-24-30V	1.01	22
79	Ī-Ŏ	2 0	7.0 × 6.4 ×	6.0		201	1.35	36
3	2.0	3 2	8.9 × 7.0 ×	7.6			2.01	36
20	3.0	4 6	10.2 × 8.9 ×	8-6			2.48	42
21	4.0	6 0	10-2 × 10-0 ×	8-6		11	2.94	52
51	5.0	6 8	12·1 × 10·0 ×	8.6		11	3.66	52
117	6.0	7 8	12·1 × 10·0 × 1	0.2		11	4.36	52
88	8.0	10 0	14·0 × 11·7 × 1		**	**	5.64	67
89	10.0	12 2	14:0 × 10:2 × 1	1.4	11	23	7-14	67
				50	VOLT	RANGE		
Ref.	Ambs	Weigh	Size cm			ary Tabs	P	& P

Ref. Amps, Weight.		Size cm.	Secondary Taps	P & P	
No.		Ib oz			£ p
102	0.5	1/11	7.0 × 7.0 × 5.7	0-19-25-33-40-50V	1:33 30
103	1.0	2 10	8.3 × 7.3 × 7.0	., .,	1.94 36
104	2.0	5 0	10.2 × 8.9 × 8.6	11 12	2-69 42
105	3.0	6 0	10-2 × 10-2 × 8-3	11 11	3.65 52
106	4.0	9 4	12-1 × 11-4 × 10-2	11	4-83 52
107	6.0	12 4	$12 \cdot 1 \times 11 \cdot 1 \times 13 \cdot 3$	11	7-14 67
118	8.0	18 9	13·3 × 13·3 × 12·1	71 11	9.32 97
119	10.0	19 12	16·5 × 11·4 × 15·9		11.68 97
1			64	VOLT RANGE	
Ref.	Amps.	Weight	Size cm.	Secondary Tabs	P & P
No.		lb oz			£ p
124 1	0.5	2 4	8·3 × 9·5 × 6·7	0-24-30-40-48-60V	1 35 36

No.	0.5	1b 2	0 Z 4	8·3 ×	9·5 ×	6.7	0-24-30-40	-48-60V	1.35	36
126	1.0	- 3	0	8·9 ×	7.6 ×	7.6	**		1.88	36
127	2.0	5	6	10·2 ×					2.94	
125	3.0	8	8	11.9 ×	9·5 ×	10.0	77		4.48	
123	4.0	10	6	- 11⋅4×	9.5 ×	11:4	a 11		5.78	67
120	6.0	16	12	13·3 ×	12-1 ×	12-1		**	8-37	82
122	10.0	23	2	16·5 ×	12.7 ×	16.5			13.85	
	1.1	5 A C		CID RA	TTEE	v ~	MARCER	TYPE	•	

	L.I	EAC	AC	ID BA	TTER	Y CH	HARGE	R TYPES		
Ref.	' Amps.	. W	eight	- Si	ze cm.				P	& P
No.		16	oz						£	Þ
45	1.5	- 1	9	7·0 ×	6.0 ×	6.0			1-34	30
5	4.0	3	11	10·2 ×	7.0 ×	8.3	Please	note, these	2.03	42
86	6.0	5	12	10.2 ×	8.9 ×	8.3	units o	do not in-	3.07	52
146	8.0	6	4	8-9 ×	10.2 ×	10.2	clude r	ectifiers	3.49	52
50	12.5	- 11	14	13·3 ×	10.8 ×	12-1			5.20	67
All	ratings	are	cont	inuous.	Standa	ard cor	nstructio	on: open wi	th sol	der

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100 + 6·5p	25+ 55p	25 + 55p				
500 + 6p	100 + 45p	100 + 50p				
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to 50 Resistors and a further 2p	for each
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10.W Wire wound	10p each
plus p. & p. 7p for up to 25 resistor	rs plus 1p
for each additional 25.	

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ohms	
7, 9, 10, 12, 14, 17-5, 20	@ 700mA 20p
22, 25, 28, 30, 33, 36	@ 700mA 25p
40, 47, 52, 56, 60, 63, 66	@ 300mA 20p
75, 87, 100, 120, 140, 160	@ 300mA 25p
180, 200, 220, 250, 270	@ 300mA 25p
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1ΚΩ	@ 100mA 20p
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OKΩ	100KΩ	1ΜΩ	
25KΩ	250K Ω	2ΜΩ	
og or lin	less switch	(& 1KΩ lin)	12p
og or lin	with switch		24p
lual less	switch		40p
lual with	switch 10K	, 100K & 1M	
og only			52p
OK log -	-10K antilog	less switch	40p
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250	2-5K 12	25K Ω	250K 12	2.5M (2
500	5K Ω	50K Ω	500K Ω	5M 12

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Ceramio		63V (C3)	33)
1-8pf	8·2pf	33pf	120pf
2 2pf	10pf	39pf	150pt
3-3pf	12pf	47pf	180pf
3-9pf	15pf	56pf	220pf
4-7pf	18pf	68pf	270pf
5-6pf	22pf	82pf	330pf
6-8pf	27pf	100pf	
all 5p. e	ach		

mylar film 1000pf 2p 2000pf 2p 5000pf 2p	01μF 02μF 04μF 05μF	100V 3p 3p 3p 3p 3p	-068μF -1μF -2μF	4p 4p 5p
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metallised	polyester	25	OV (C28	(0)
-01μF 3 p	-068μF	33p	47uF	8p
·015μF 3 p	1µF	4p	68µF	11p
·022μF 3p	15µF	4p	1μF	13p
033μF 3p	22µF	5p	1-5 uF	20p
-047μF 3p	·33µF	6 <u>1</u> p	2-2µF	24p

metallised	polyester		400V (C28	31)
-01μF 43p		6p	22µF	10p
-015μF 4½p		6р	·33µF	14p
·022μF 4 ½ p	·1μF	7р	-47μF	15p
033µF 5⅓p	-15μF	8р		

mixed	diele	ctric	60	0V	
01 μF	7p	047µF	7p	-22µF	16p
022µF	7p	068µF	8p	47µF	24p
-033µF	7р	-1μF	8p	1μF	33p
					-
mixed	diele		10	00V	
1000pf	diele:	ctric 6800pf	10 9p	00V -1μF	12p
					12p 22p
1000pf	6p	6800pf	9p	-1μF	

Ceran	nic				
12KV.	d.c.	8KV.d.	C.	HI-K 750	V.
10pf	9p	200pf	9р	1000pf	5p
15pf	9p	220pf	9p	1500pf	5p
22pf	9p	250pf	9p	2000pf	5p
68pf	9p	270pf	9p	3000pf	5p
82pf	9p	300pf	9p	5000pf	5p
100pt	9p	750V E	ISC	10,000pf	5p
120pf	9p	470pf	5p	feed-	
140pf	9p	1000pf	5p	through	
150pf	9p	5000pf	5p		
180pf	9p	10,000pf	5p	1000pf	5p

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AC127	15p	BC149	10p	BF272	53p	OC170	23 p	2N1893	30p		ra.
AC128	15p	BC157	12p	BFY50	24 p	OC171	30p	2N2926 8	11 10p		.50
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ACY20	20p	BD131	70 p	MJE340	67 p	ZT X302	20p	2N3704	18p		.00
AD140	40 p	BD132	70p	MPF192	40p	ZTX303	20p	2N3705	18p		.00
AD149	40 p	BQ131/2#	И.P.	MPF103	37p	ZTX304	25 p	2N3706	10p		.00 19p
AD161]			149p	MPF104	37p	ZTX341	20ρ	2N3707	15p		55p
A D162	50p	BF160	21 p	MPF105	40 p	ZT X500	15p	2N3708	12p		.99
AF114	18p	BF167	20p	MPF106	45 p	ZTX501	15p	2N3709	12p		.50
AF115	18p	BF173	20p	OC28	40 p	ZTX502	20 p	2N3710	12p		.50
A F116	18p	BF180	25 p	OC35	40 p	ZT X503	17p	2N3711	12p	EIL TER A	
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BC107	10p	BF185	25 p	OC71	11p	2N697	18p	2N3904	17p		(5p
BC108	10p	BF194	15p	OC72	17p	2N706	12p	2N3905	21 p	μΑ723C £1	.05
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2·2 3·3 4·7 6·8	=	_	Ξ			-	
3·3 4·7 6·8	_		_	_			
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					_	_	5р
10			-			6p	6р
	_	_		-	6p		6р
15		_	_	60		бр	6p
22	_	200	бр	_	6p		6р
33	_	бр		6p		6p	
47	6р		6p		6p	6p	6p
68		6p	_	бр	_	_	10p
100	6p	_	6p	_	6р	6p	12p
150		6p	_	6p	6p	10p	12p
220	6p		6р	6p	10p	12p	18p
330	6р	1000	6p	10p			21 p
470		бр	10p		12p	18p	40p
680		10p	-	12p	18p	21p	
1000	10p	_	12p	18p	21 p	40p	60p
1500		12p	18p	21p			-
2200		16p	21 p	40p	45₽#	55 p	93p
3300		21p			_		-
4700	21p			60p	75p	93p	

CAP	VOLTA	GE		
μF	16	25	40	64
500			33ρ	40 p
1250			50p	
1600			_	75p
2000	40p	50p		_
2500	<u>.</u>		75p	93p
3200	50p	-		-
4000		75p	93p	
6400	75p	93p		

We still have large stocks of Mullard C426 and C437 series capacitors and will continue to supply these upon request until stocks become exhausted

TV Electrolytics

	•••				
1; 2; 4; 8µF 450V	14p	32 µF	450V	20p	
16µF 450V	15p	50µF	350∀	20p	
8 + 8µF; 450 V.W	18p	$32 + 32 \mu F$;	350 V.W	25p	
8 16 µF, 450 V W	20p	32 + 32 µF;	450 V W	43p	
16 + 16 µF; 450 V.W	25p	50 - 50 HF;	350 V.W	35p	
16+100+100 +300+	F. 275	V.W	f	1.23	
32 + 100 + 125 + 200 _k	F: 275	V.W	f	1.23	
32 + 100 + 200 · 200	F: 300	V.W	f	1.23	
100 + 100 + 100 + 150	150 _F	F: 320 V.W		1.66	
100 + 100 + 200 + 300	JμF: 27	5 V.W.	f	1.23	
60 + 100 + 200 pF; 30	0 V.W.			93p	
100 + 200 µF; 275 V.V	٧.			75p	
100 + 200 + 200 µF; 3	00 V.W			£1	
100 + 400 µF; 275 V.V	V.		£	1.15	
200 µF: 275 V.W. 50	Dp 30	0 - 300 µF: 3	800 V.W. £	1.90	



For the benefit of those who have a scientific rather than a literary bent, may we explain! Omar Khayyam was a Persian Tent Maker who lived in the 11th Century. He was also a Poet, Philosopher and Astronomer. Thanks to the fine translation by Edward Fitzgerald, his best known work is the exquisite "Rubaiyat". It was first produced in England as a pamphlet and offered at sixpence. It didn't sell and was reduced to two-pence. As there are only three known copies left in existence you may imagine what they are worth today!

One of the best known verses runs as follows:

"Here with a loaf of Bread beneath the Bough, A Flask of Wine, a Book of Verse and Thou Beside me singing in the Wilderness And Wilderness is Paradise enow." We hope that throws some light on our cartoon. If you read the poem you are bound to come to the conclusion that O.K. liked his tipple—obviously a thoroughly "good type".

What's all this to do with Electronics? You may well ask !!!

Nothing really, but after all this is the Christmas Number, so we should be able to let our hair down. In any case we are sure you must already know that we produce an excellent Components Catalogue which will make interesting holiday reading for you, listing as it does some 6,785 items (over 1,750 illustrated) and costing only 75p including postage and packing (only 55p if you collect it). It also contains 10 vouchers (each worth 5p when used as directed). Are you convinced? No? Well you'd better go out and buy Omar's "Rubaiyat" instead!

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DOWN TO EARTH

The obvious sometimes obscures other parts of the picture. The main purpose of a constructional article is to give all information necessary to enable any suitably experienced constructor to produce for himself a correctly functioning replica of a proven prototype equipment.

Obvious and true; but this is far from all. In fulfilling its purpose a constructional article demonstrates in the most effective and objective manner possible how circuits can be applied in practice. Interesting and unusual applications of the technology are frequently first brought to the attention of the reader through a constructional design. The Biological Amplifier described in this month's issue is a good example of this, since it opens a door to an area of activity perhaps totally unfamiliar to many readers.

Purely theoretical articles are essential and they play their important part in explaining new concepts for circuit design and in suggesting lines for experimentation with new circuit devices. But when it comes to the nitty gritty business of determining precise facts, no amount of theorising can be as convincing, nor as reliable, as the detailed technical description of an actual model, with every component value stated and a performance already established, not merely calculated or predicted.

Amongst our readers there will be a sizeable number who confine their interest in electronics mainly to a study of circuitry and its uses in the abstract—and we suspect they include quite a few who have never held a hot soldering iron in their hand. We believe it would be a great error were they to skip the pages devoted to practical designs. The old saw that an ounce of practice is worth a pound of theory is very relevant even when considering general or non-constructing readers, simply because they do rely exclusively upon the printed word and diagram for knowledge.

Constructional articles help to infuse reality into a subject which, because of the impalpable nature of its workings, is all too liable to be elevated into rarefied regions—with the ready connivance of some of the technical intelligentsia, it has to be admitted. No matter whether we build a particular project or not, careful examination of the text and diagrams will usually teach us something; and certainly help us keep the whole of electronics in true perspective and our own feet firmly on the ground.—F.E.B.

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Editorial & Advertising Offices: Fleetway House, Farringdon St., London EC4A 4AD Phone: Editorial 01-634 4452 Advertisements 01-634 4202 A linear ohmmeter is an essential piece of equipment for carrying out accurate resistance measurements on thermistors, l.d.r.s, resistive transducers, motor field and armature windings, heating elements, etc. Such an instrument is also extremely useful for checking resistors and resistance combinations, or for batch selection from low tolerance components.

The instrument described in this article is ranged 0-5 Ω f.s.d. to 0-100k Ω f.s.d. in 10 ranges utilising a divide by two facility. These ranges will cover most applications from measuring low resistance motor armature windings to thermistors and transducer

tracks.

The circuit is extremely stable but built-in calibration is provided to compensate for drift as a result of battery deterioration or extreme environmental effects. Battery life is six months or more and the indication can be guaranteed to have an accuracy ± 1 per cent of full scale deflection.

PRINCIPLE OF OPERATION

The principle of operation is well established and is based on the simplified circuit diagram shown in

Fig. 1.

The resistance to be measured (R_x) is fed by a constant current generator (I_g) to give an input voltage V_i . This is then amplified and the output voltage V_o , proportional to the input resistance value R_x , is measured on a moving coil meter calibrated in ohms. The operational amplifier is connected in its non-inverting mode and has sufficient feedback to ensure good stability of operation, and satisfactory input and output impedance values.

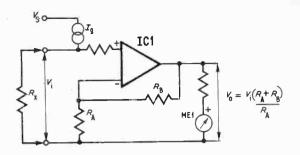
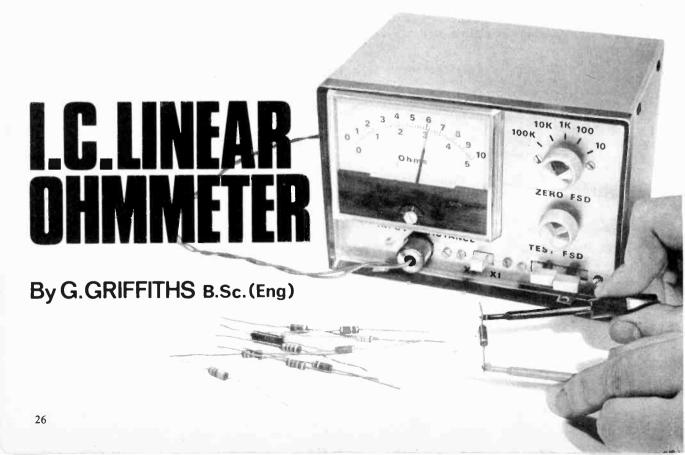


Fig. 1. Simplified circuit diagram of the ohmmeter

THE COMPLETE CIRCUIT

The circuit diagram of the ohmmeter is given in Fig. 2. The constant current generator TR1 is adjusted by VR1, VR2 or VR3 to give the required outputs which may be passed through the test resistance R_N or through the standard range resistors R1 to R5 by selection of switch S1a or S1b. A fine setting is achieved by adjustment of VR4 to give an accurate full scale meter deflection when the standard resistors (calibrated input) are selected. By scale calibration prior to test readings the accuracy of the system is dependent only on the standard range resistors and the meter.

The operational amplifier IC1 is connected to give the required closed loop gain by adjusting the resistor values at the range selection switches S2c and S2d.



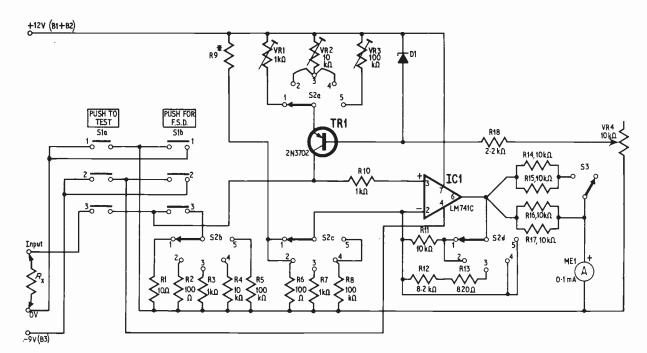


Fig. 2. Circuit diagram of the linear ohmmeter

The amplifier has a minimum input resistance of 25 megohms and 400 megohms in the unity gain condition so that input resistance ranges of up to 10 megohms may be measured without loss of accuracy. The output resistance is never greater than 10 ohms so a 1 milliamp meter movement may be used without loading the amplifier unduly. The use of such an indicator, used with appropriate series resistors, offers better accuracy and shock resistance as well as being cheaper than a more sensitive movement.

The divide by two switch S3 gives a full scale deflection of 2.5V when selected and so expands the range of the instrument. The operating conditions as referred to Fig. 1 are shown in Table 1.

COMPONENTS

Many of the resistors as shown in Fig. 2 are of high tolerance and stability. It is, of course, of para-

mount importance to have accurate standard range resistors, as the instrument read-out accuracy is dependent on these.

The current generator is constructed from three presets, a Zener diode and a transistor. The presets may be the Cermet type or the skeleton type, but any silicon *pnp* transistor and any 5-IV 400mW Zener will suffice.

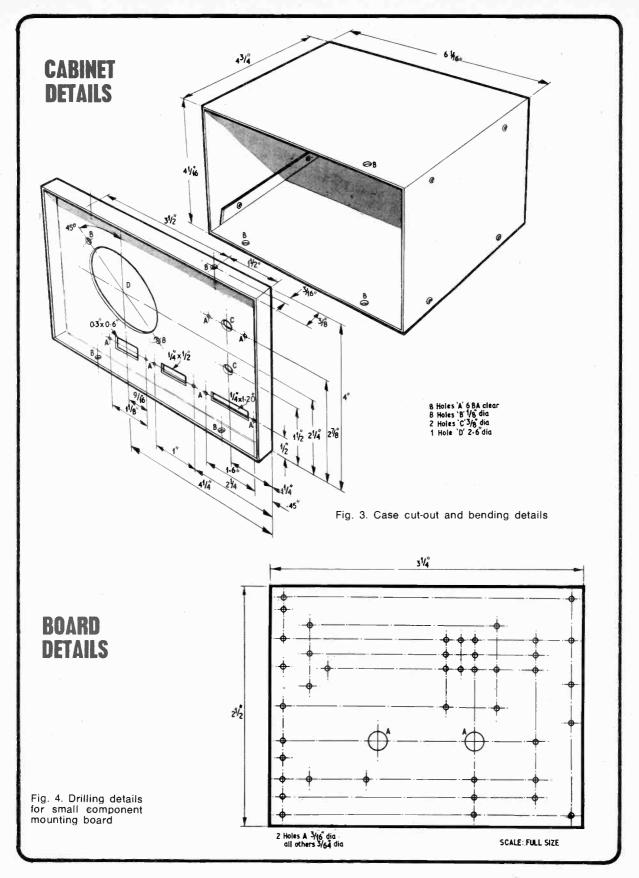
The amplifier used in this circuit is preferably the LM741C, but a "A709 may be used with appropriate frequency dependent feedback components. If the latter is used it may be necessary to decouple the supply rails to prevent parasitic oscillation.

The function/on-off switch S1 consists of two, unit assembled three-pole wavechange switches with three functions; f.s.d., test and off.

The range switch S2 is made up of four, single-pole 6-way wafers one way of each not being used. S3 is a single pole on/off slide switch.

Table 1: OPERATING CONDITIONS

Switch Position	Resistance Range	$V_i = [I_g R_X]$	Amplifier Gain == G	R_{Λ}	R_{B}	/ g	V o
1	10Ω	50mV	100	100 Ω	10k Ω	5mA	5 V
. 2	100Ω	50m V	100	100Ω	10kΩ	500μA	5V
3	1kΩ	500mV	10	1kΩ	9k Ω	500μA	5V
4	10k Ω	5 V	1	100kΩ	0	500µA	5V
5	100k Ω	5V	1	100k Ω	0	50μA	5V 🚤



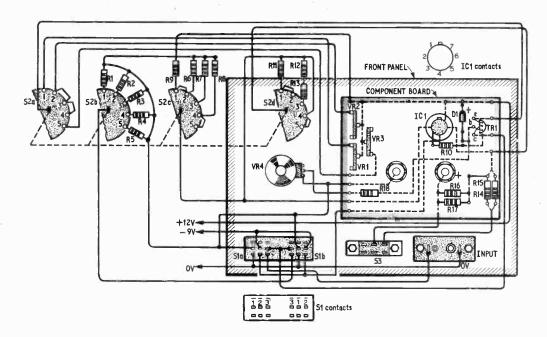


Fig. 5. Component assembly and wiring details. Wafer switch wiring is shown separate for clarity

COMPONENTS . . .

Resist	ors	
D4	400	40/

R1	1012 1%	K 10	1K12 5%
R2	100 Ω 1%	R11	10k Ω 2 %
R3	1kΩ 1%	R12	8·2k Ω 2%
R4	10kΩ 1%	R13	820 Ω 2%
R5	100kΩ 1%	R14	10kΩ 2%
R6	100 Ω 2 %	R15	10kΩ 2%
R7	1kΩ 2%	R16	10k Ω 2%
R8	100kΩ 5%	R17	10k Ω 2%
R9*	See text	R18	2·2kΩ 5%

D10 11.0 F0/

All 1 watt carbon resistors

Potentiometers

VR1 1k Ω vertical preset VR2 10k Ω vertical preset VR3 $100k\Omega$ vertical preset VR4 $10k\Omega$ carbon linear

Diode

D1 5·1V 400mW Zener diode

Transistors

TR1 2N3702

Integrated Circuit

ICT LM741C

Switches

S1 2-bank, 3-pole, 2-way wavechange switch

S2 Switch kit with four 1-pole, 6-way wafers

S3 Single pole on/off slide type

Meter

ME1 1mA moving coil meter 100mm × 80mm (SEW type)

Batteries

B1, B2 6 volt style PP1 (2 off) 9 volt style PP9 R3

Miscellaneous

Aluminium sheet 20 s.w.g. 6in × 4in and $15\frac{1}{2}$ in \times $13\frac{1}{2}$ in

OPERATION

To operate the instrument, S2 is first selected to give the required range (if known). The function switch S1b is then pushed to give full scale deflection on the meter which, if necessary, is adjusted by means of VR4.

The unknown resistance may be connected and the test function switch \$1a depressed. Should the ensuing reading be less than half full scale deflection the divide by two facility may be used to give better accuracy of reading.

PRACTICAL CONSIDERATIONS

In the design stage it was envisaged that leakage currents would not give a significant output reading with both inputs grounded, that is, in the zero input resistance condition. However on test it was found that some i.e.s gave up to 40 µA leakage under maximum gain conditions.

Under these circumstances it will be necessary to introduce a small offset voltage to the inverting input to give zero output deflection. This may be done by adding resistor R9 as shown in Fig. 2.

To calculate this resistance use the equation as follows, referring to Table 1 for the appropriate unknown values.

$$R_9 = \frac{12 R_A G}{V_0}$$

where R_A = appropriate value to setting (e.g. $R_{\Lambda} = 100 \text{ when } G = 100$

G = gain setting

 $V_0 = \text{indicated leakage output voltage } (0-5\text{V})$ f.s.d.)

Finally, for low resistance measurements, it must be remembered to take into account lead resistance. This was 0.18 ohms in the prototype unit.

continued on page 59



CAMBRIDGE TELESCOPE

Within a few days of operation after the official opening of the Cambridge five kilometres radio telescope at Lords Bridge, new maps were made available.

While the telescope was in construction radio astronomers in America had announced the discovery of radio waves emanating from the bright star Algol. This source has provided the Cambridge workers with the means of calibration much more accurate than hitherto. The radio coordinate system they use is now to be held to a figure better than 0.1 second of arc relative to Algol.

The position of Cygnus X-3 has now been measured to within 0.15 second of arc so that there is now a possibility of identifying the X-ray star with an optical object.

The future prospects for this new telescope are very exciting and with its versatility and resolution potential it will bring a great deal of data for analysis.

The resolving of two of the extragalactic objects 3C 86A and 3C 295 gives some idea of the telescope potential, for these two objects had not previously been properly resolved. The object 3C 295 is of particular interest because of its large red shift. The new maps show that this is in fact two units spaced some 4.5 seconds of arc apart.

Interest in galactic sources has greatly increased since the molecular lines and infra-red emission from dust clouds have been discovered. One of the new maps using a frequency of 5GHz has shown, in the contours of NGC 7538, an intense source in addition to the extended emission. This source is a galactic hydrogen cloud and the resolving of the main extended source and the intense source, will enable important deductions to be made.

PULSARS

The Jodrell Bank programme for the study of pulsars continues to extend the known catalogue. The total is now in excess of 100 pulsars that can be identified. The programme under the leadership of Prof. J. D. Davies added some 18 more to the list during September and October 1972.

Among the new finds was one pulsar that was within 0.6° of the centre of an extensive nebula known as IC 443. This nebula is a remnant of a supernova which came into being about 65,000 years ago. It is a powerful radio source by reason of the high energy electrons in strong magnetic fields which com-

pose the remnant.

A check on the rotational period of the pulsar showed that it was faster than average yet slowing. The period was 0.334 seconds. Over a period of seven weeks this slowed by 0.33 microseconds. This lengthening of the rotational period is characteristic and is due to the rotational energy of the pulsar being converted into high energy radiation. From the slowing down it is estimated that the pulsar is about 125,000 years old.

The distance from the solar system. based on the dispersion of the radio pulses, would appear to be something of the order of 5,000 light

years.

A clue to future methods of search for pulsars is given by the fact that the pulsar is some 50 light years from the point of the original explosion of the supernova. The fact that the pulsars can be thrown out with a large amount of momentum would suggest that search for pulsars should take place outside the supernova remnants as well as within the known area of activity.

OLD GALAXIES AND QUASARS

There has been an attack on the exponents of the theory that quasars and "new" galaxies can be formed from the exploding of "old" galaxies. There would appear to be some doubt as to whether galaxies are in fact interconnected or that quasars are connected to galaxies.

The 46 metre dish at the Algonquin radio observatory operating at wavelengths of 2.2 and 4.2cm was not able to detect any interaction. The fact that the radio spectra were normal and no unusual radio effects appeared suggests that there were no violent reactions to provide the birth of a new galaxy much less a quasar. It is also possible that the "bridges" thought to exist between some galaxies may in fact be optical illusions.

SOVIET PROBE VENUS-8

The results of the findings from the latest Soviet exploration of Venus indicates that there are similarities between the planet and earth.

The Soviet Academician Vinogradov, already familiar with the analysis of moon rocks, said that the material at the Venus landing site seems to be similar to terres-trial granites. The surface soil contained potassium to 4.0 per cent, uranium 0.0002 per cent, and thorium 0.00065 per cent. These measurements were made by the gamma ray techniques.

Although one spot cannot be taken as representing the whole surface it is likely that the surface has been formed from basic igneous rocks that have undergone meta-morphosis. The density of the soil at the landing area was about half that of the earth. The figure obtained for Venus was 1.5g per

cm³.

In the planet's atmosphere there were traces of ammonia (about 0.1 per cent) at the level of the cloud cover. The measurements were made at 33 and 44Km altitude. The apparatus used was a silica gel column saturated with a sensitive dve for indication. No details of the composition of the cloud cover is available, but measurements of density shows that there is a detectable difference between night and day and that there is evidence that the light from the sun does reach the surface.

MOON MAGNETISM

Explanations of the residual magnetic field trapped in the rocks brought back from the moon has been examined by various workers. At the moment there are a number of difficulties which prevent a satisfactory explanation to enable a model to be offered for the evolution of the interior of the moon.

To produce the conditions for a magnetic field to have come into being would require that the moon at one time revolved very much faster than earth. This however. would have resulted in its destruc-

tion.

There are suggestions regarding the magnetic field which involve certain conditions having been fulfilled during the formation and or the acquisition of the moon. One such theory involves the simultaneous formation of the earth and the moon

At the present time every hypothesis put forward has faced one or other impossible condition and the field is therefore still wide open. Most of the ideas put forward have involved a liquid core, similar to that of the earth. It could be that this is not a prime requirement and that some other condition existed. The fact that there is no means by which the core of the moon can be examined in detail is the main difficulty.

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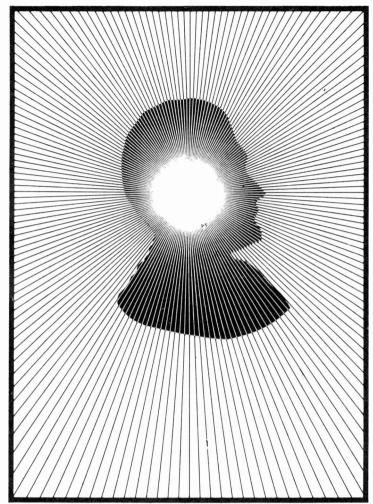
Shows major characteristics of the more important types of fixed capacitors used in amateur electronics.

Measuring 21in. x 15½in., this wall chart is a companion to previous identicharts specially prepared for quick reference in the workshop.

ELECTRONICS

FEBRUARY ISSUE ON SALE JANUARY 12

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Biological Amplifier

This experimental project can demonstrate how neuro systems and electronics can be made to interact and influence certain muscular functions.

By D. BOLLEN

LECTRICAL signals from the human body have been used for many years to diagnose certain illnesses and to monitor the condition of a patient during treatment. However, the possibility of using such signals for non-medical applications is a recent development.

The alphaphone, or electroencephalophone, is currently being used by mystics and others to achieve "instant" relaxation, by feeding back brain signals. A similar instrument can also serve as a lie detector monitoring the level of brain signals during interrogation.

Car drivers, athletes, and other people subject to stress, can learn to control their heart rate consciously with a cardiophone, which establishes an external feedback loop between heart and brain. The biological pre-amplifier described in this article was designed as a general purpose module for detecting very low frequency signals from electrodes placed on the skin. Also described are a selection of output stages for specific projects, which include the alphaphone, lie detector, and cardiophone.

SKIN SIGNALS

Brain and nerve cells are similar to logic circuits in that they operate by emitting pulses of electrical energy. Under certain conditions, a group of cells will "fire" together in synchronism, to give a combined output either in the form of a large amplitude pulse (heartbeat) or slow sinusoidal waveform (brain

rhythm). The nerve cells of a tensed muscle emit a

stream of random pulses.

As a rough guide to signal levels from a pair of electrodes damped with salt water and placed on the skin, the chest will yield a heartbeat bulse of, say, 500 microvolts peak, the forehead an eyeblink pulse of 200 microvolts peak, and the crown of the shead an alpha rhythm amplitude of around 50 microvolts r.m.s.

Other brain rhythms, with the exception of delta, tend to be of low amplitude, generally not more than 10 microvolts, and there is also a rapid, low voltage asynchronous activity when the subject is concentrat-

ing or excited.

The very approximate frequency range and psychological characteristics of some brain rhythms are as follows:

ALPHA Frequency 1-4Hz for infants, 4-7Hz for children and 8-12Hz for adults. This frequency can be modified by make of certain drugs. Alpha is normally present when of certain drugs. Alpha is closed, and signal is reduced or eliminated by seeing, sleep, unfamiliar sounds, anxiety, and mental concentration. A high level of alpha associated with deep meditation and pain immunity.

BETA Frequency 18-25Hz. Amplitude increased by anxiety and reduced during the initiation of movements and by muscular activity.

DELTA Frequency 2-3Hz. Strictly speaking, the name applies only to a type of rhythm associated with brain damage, but signals of similar frequency occur during sleep, accompanied by short bursts or "spindles" at around 14Hz.

THETA Frequency 4-71-Thought to be related to creative thinking and problem solving activities, and with disappointment and frustration in young people.

BIO-FEEDBACK

Experiments currently being conducted in the U.S.A. seem to indicate that bio-feedback techniques can be used to alleviate symptoms arising from stress (of which there are many), to reduce heartrate and blood pressure, as well as provide a short-cut to the benefits arising from meditative practices such as Yoga.

The two most convenient ways of feeding signals back to the brain is via the ears or eyes. Fig. 1a shows the aural feedback alphaphone, which picks up subsonic alpha waves from the brain, uses them to modulate an audio signal, and feeds the resulting

output to the ears. The direct link between ear and brain is the feedback path, and the brain itself appears to be capable of adjusting a signal phase to positive or negative. With the alphaphone, the user quickly learns to reinforce his alpha waves, or reduce them, at will.

In the second example of bio-feedback (Fig. 1b), the heartbeat pulse is made to flash a light and the eye feeds this light pulse back to the brain. In time, the subject finds it possible to reduce or increase his heartrate by several beats per minute.

Visual feedback can also be achieved by watching an oscilloscope display, or meter readout of a

biological signal.

GENERATOR MPLIFIER : Electrode Brain ALIDIO Feedback Earphone

Fig. 1a. Graphical illustration showing the aural feedback path

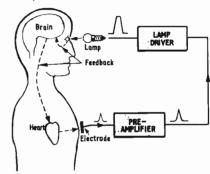


Fig. 1b. Graphical illustration showing the visual feedback path

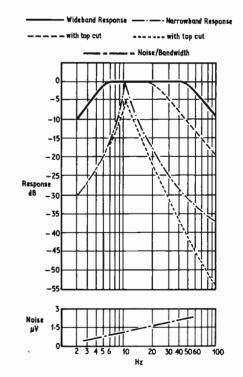


Fig. 2. Graphs of frequency response and noise of the biological pre-amplifier

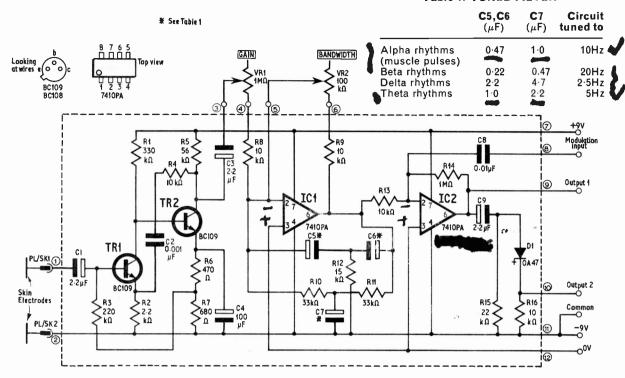


Fig. 3. Circuit of the biological pre-amplifier with component values of C5, C6 and C7 for different rhythms

CIRCUIT CONSIDERATIONS

Professional electroencephalographs (brain rhythm recorders) are carefully screened and operated under controlled conditions to achieve a typical noise-bandwidth performance of 2 microvolts at 0 to 75Hz. There is usually some provision for reducing bandwidth by means of switched filters to improve hum and noise rejection.

A noise performance only slightly inferior to that of a professional electroencephalograph is achieved with the biological pre-amplifier described here by sacrificing d.c. coupling. Flicker noise from transistors rises very steeply at sub-audio frequencies, and a considerable reduction in total noise can be obtained by giving the circuit a response roll-off below about 5Hz.

The pre-amplifier also incorporates a continuously variable bandwidth control which can be set to exclude mains interference in ordinary domestic environments and reduce amplifier noise.

Response and noise curves are shown in Fig. 2. At maximum bandwidth (-3dB at 4 and 60Hz) noise is less than 2.5μ V, while at minimum bandwidth this figure is reduced to less than 0.5μ V.

In its basic form, the pre-amplifier is tuned to 10Hz to give good resolution of alpha signals, but will also handle large amplitude beta, theta, and muscle pulses when set to wideband. However, the circuit can be modified quite easily for narrowband handling of beta, theta, delta, and low frequency alpha signals by altering the values of three capacitors.

All of the circuits given here are battery powered with outputs of less than 6 volts r.m.s., because it is potentially very dangerous to conduct electrode experiments with mains powered equipment. Even

so, a mere 6 volts applied to the scalp is sufficient to cause visual strobing effects, twitching of facial muscles, an unpleasant tingling under the electrodes, and a mild headache if prolonged.

As a general policy, therefore, it is inadvisable to touch any circuit wiring while wearing head electrodes, and the temptation to couple bio-amplifiers to, say, audio amplifiers or flashing light systems, should be strictly avoided.

PRE-AMPLIFIER CIRCUIT

The circuit of the biological pre-amplifier is shown in Fig. 3. Input transistor TR1 has a collector current of 50 µA for low noise working with typical skin electrode impedances of around 5 kilohms.

A proportion of TR2 emitter voltage is fed back to TR1 base via R3, to set the d.c. operating points of TR1 and TR2. C2 and R4 reduce the gain of the input stage above 100Hz to combat noise and instability. At 10Hz, the combined voltage gains of TR1 and TR2 is approximately 300.

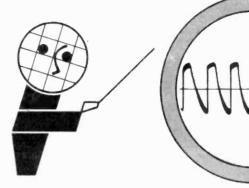
A resistance placed between the inverting input and output of an operational amplifier will determine its gain. In the circuit in Fig. 3, an operational amplifier (IC1) uses a twin-T filter between input and output (C5-C7, and R10-R12) to offer a near infinite impedance at the frequency to which it is tuned; a low impedance is presented at other frequencies. Hence, the gain of IC1 is very high at the centre frequency and the amplifier behaves like a high-Q tuned circuit.

The bandwidth of IC1 is controlled by a variable resistance VR2 placed in parallel with the twin-T filter. With VR1 at minimum and VR2 at maximum resistance, stage gain is eleven, and can be reduced

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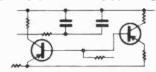
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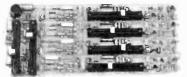
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\$3	1B/2C/o	100	10-20	,
84	2M/1B	2k	36	
85	4 M	50	6-12	
*86	(2M/1B/2C/o	1.3k	30	
Twin	1M/1C/o	630	15	
87	1M/1B/1C/o	2k	36	
Pl	1 M	175	28	30A
P0	2C/o	650	28	11A
P3	1 M	200	24	H.T. Tips
- P4	1 M		24	20A
Po	2M	350	15	2A
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P7	3M	500		5A
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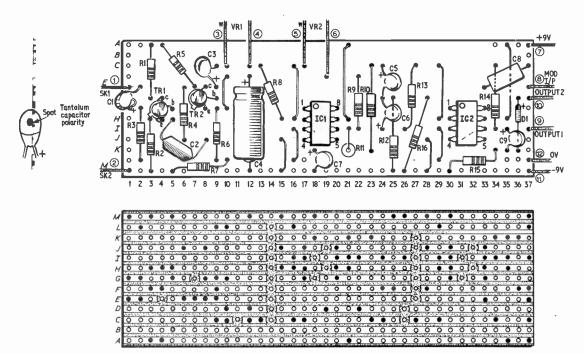
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ISKRA I/2W	10%	3M3-10M	E12	Ιp
MULLARD 1/3W	10%	1R-3R9	EI2	Ιp
MULLARD 1/5W	5%	4R7-1M	E24	Ιp
METAL FILM I W	5%	27R-IM	EI2	lip
WIREWOUND 2-5W	10%	R22-R33, R47	7 E12	9p
WIREWOUND 2-5W	5%	1R-270Ř	EI2	7p
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to less than unity when VR1 is at maximum resistance.

The values listed for C5-C7 in Table 1 with Fig. 3 will give centre frequencies to suit different brain rhythms, but a frequency of 10Hz will serve for general purpose use, including muscle activity.

Output stage IC2 is another operational amplifier set for a voltage gain of 100, making the total gain of the pre-amplifier 330,000. Capacitor C8 has a dual purpose role, firstly as a modulation input whereby the subsonic bio-frequencies can be rendered audible after demodulation by diode D1, and secondly to act as an additional top-cut filter when connected to output 1, depending on the type of output circuit used with the pre-amplifier.

As it is not practicable to use conventional decoupling techniques with very high gain low frequency circuits, owing to the large values of coupling capacitance required, the pre-amplifier is independently powered by two miniature 9 volt batteries, with output circuits separately powered to avoid interaction.

CONSTRUCTING THE PRE-AMPLIFIER

Pre-amplifier components can be assembled on a 3.7in by 1.3in piece of 0.1in matrix Veroboard, see Fig. 4. Having cut the circuit board to size, cut the copper strips where shown with a spot face cutter or sharp knife, then proceed to mount and solder components in position.

Take care not to let solder bridge the gaps between copper strips (a miniature soldering iron is essential here) and ensure that capacitor and diode polarities are correctly observed. To complete the panel, solder 3in lengths of 20 s.w.g. tinned copper wire as circuit board leads, in positions numbered 1 to 12 in Fig. 4.

For preliminary testing of the pre-amplifier module, join leads 3 and 4, and also leads 5 and 6. Spread out the remaining leads so that they do not touch, and connect leads 7, 12, and 11 to two 9 volt batteries. Polarity is shown in Fig. 3.

Fig. 4. Layout and wiring of the pre-amplifier board

COMPONENTS	
PRE-AMPLIFI	ER
$\begin{array}{lll} \textbf{Resistors} \\ & \text{R1} & 330 \text{k}\Omega \ \frac{1}{2} \ \text{watt metal oxide.} \\ & \text{R2} & 2.2 \text{k}\Omega \\ & \text{R3} & 220 \text{k}\Omega \\ & \text{R4} & 10 \text{k}\Omega \\ & \text{R5} & 5.6 \text{k}\Omega \\ & \text{R6} & 470 \Omega \\ & \text{R7} & 680 \Omega \\ & \text{R8} & 10 \text{k}\Omega \\ & \text{All} \pm 10\% \ \frac{1}{2} \text{W} \ \text{carbon except R1} \end{array}$	$ \begin{array}{lll} R9 & 10kΩ \\ R10 & 33kΩ \\ R11 & 33kΩ \\ R12 & 15kΩ \\ R13 & 10kΩ \\ R14 & 1MΩ \\ R15 & 22kΩ \\ R16 & 10kΩ \\ \end{array} $
Potentiometers VR1 1MΩ preset knob trimmer VR2 100kΩ preset knob trimme	г
Transistors TR1, TR2 BC109 (2 òff)	
Integrated circuits IC1, IC2 7410PA or equivalent	(2 off)
Diode D1 OA47 or 1B40	
Capacitors C1 2·2μF tantalum 35V C2 1,000pF polystyrene C3 2·2μF tantalum 35V C4 100μF elect. 6V C5, C6, C7 35V tantalum (see t C8 0·01μF polyester C9 2·2μF tantalum 35V	
Miscellaneous Veroboard 0·1in matrix, 3·7in × plugs and sockets.	1-3in. Two 2mm

Now, with a 20 kilohms-per-volt testmeter, measure the voltage relative to lead 11 of the following: TR1 case (1.9V), TR2 case (11V), IC1 pin 6 (9V), IC2 pin 6 (9V). A variation of about ± 0.5 V can be allowed on the above voltages.

Disconnect the batteries and place the preamplifier on one side for use with the projects to be described next.

ALPHAPHONE -

The purpose of the alphaphone is to apply biofeedback to the brain to increase the level of alpha rhythms and thus promote those "good feelings" which, for some people, are associated with alpha.

Commercial versions of the alphaphone retail in the U.S.A. for £100 or more, but the version shown in Fig. 5 can probably be built for under £10 if a

pair of headphones are already available.

It is important that the sound heard by the alphaphone user should not be harsh, otherwise this will tend to interfere with relaxation. Another important point is that the alpha signal may have to compete with a background of external, domestic sounds which tend to distract the user and "block" his alpha. Ordinary stereophones, with their soft ear cushions, are excellent for attenuating noise, and a pair may be to hand. Alternatively, cheap mono phones with good sound insulation can be purchased for use with the alphaphone.

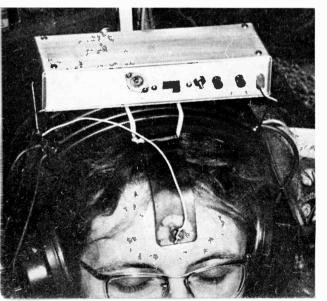
Referring back to the pre-amplifier circuit (Fig. 3) if white noise or an audio note is fed to the modulation input (lead 8) it will be mixed with the subsonic alpha signal at the input of IC2, and the intensity of this noise or note will vary in sympathy with the alpha signal after being passed through a

non-linear diode D1.

In preference to an audio note, which is tedious to listen to for long periods, the alphaphone circuit (Fig. 5) uses a simple white noise generator (D2, R17, R18) to supply a restful "chuff-chuff" sound in the headphones, rather like a distant steam locomotive.

An output taken from the pre-amplifier demodulator diode (lead 10) is taken by way of R19 and C10 to a standard type of pre-built audio amplifier. The low alpha frequency is removed by C10 to leave only the higher frequency white noise, which is then amplified and fed to the phones.

The alphaphone fitted to the headband



LISTENING AMPLIFIER

Almost any small 9V amplifier, of about 50mV sensitivity and ½ watt output into 8 ohms, will serve. The author used a Newmarket module PC7+. The value of R17 (Fig. 5) can be adjusted to raise or lower the sound output in the phones, and it may be necessary to reduce the value of C10 with audio amplifiers of high input impedance, to give the required alpha frequency rejection.

The output socket, SK3 in Fig. 5, is shown wired for mono and stereo phones, to drive mono earpieces in parallel, and stereo earpieces in parallel.

The alphaphone should be well screened to minimise interference and instability. A suggested layout, inside a metal box, is included in Fig. 5, and this will give an instrument small enough to fit in a large pocket, and light enough to be carried by a stereophone headband.

The pre-amplifier module can be supported on its stiff wire leads, with a rectangle of s.r.b.p. under the Veroboard copper strips to prevent contact with the

base of the metal box.

The PC7+ amplifier can be held in place with two screws, on stand off spacers. VR1 and VR2 may be glued to the front panel with a semi-flexible adhesive, which is easy to prise apart if one of the sub-miniature potentiometers needs to be replaced.

HEAD ELECTRODES

Electrodes held in place with sticky tape tend to pull at hair and leave adhesive behind on the skin, so the arrangement adopted here was to use spring loaded electrodes mounted on a shaped headband; see Fig. 6.

The electrode configuration shown, with one on the forehead and one on the crown of the head, is suitable for all brain rhythms except beta, and will pick up a good eyeblink pulse. A couple of layers of lint covering the electrode discs will retain the salt water conductive liquid for long periods without attention.

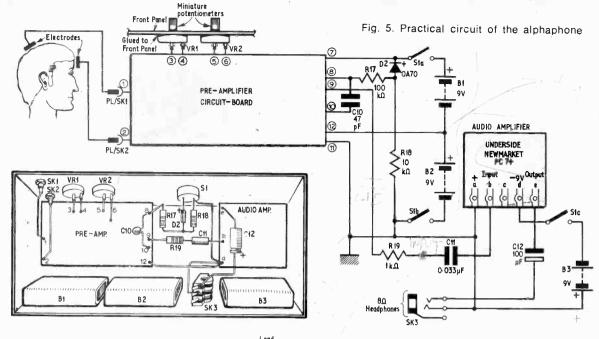
The electrode headband is a strip of η_0^3 in sheet Perspex measuring approximately 10in by $1\frac{1}{4}$ in and shaped in a steam jet or boiling water to be a loose fit on the top of the head. Holes are drilled at each end of the strip to take the spring loaded electrodes.

The eyeblink pulse is useful to test that equipment is in working order, but it may interfere with brain rhythm experiments, in which case the forehead electrode can be resited near the top of the head by drilling another hole in the Perspex strip. The complete electrode assembly is held in place on the head either with an elastic strap under the chin, or when mounted on a stereophone headband.

Electrode leads should preferably be of twisted or "side-by-side" insulated wire, as ordinary screened cable generates several microvolts of low frequency noise when bent or pulled. Even so, some amount of electrode lead noise is unavoidable if the alphaphone user moves his head around or touches the

leads with his hands.

When using the electrodes, the lint covering is first soaked in salt water, and good contact is made with the crown of the head by soaking the patch of intervening hair with salt water. Natural skin grease acts as an insulator and should be removed with hair shampoo or surgical spirit.



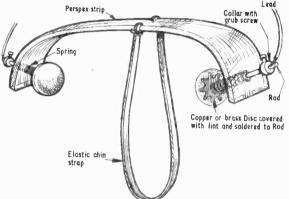


Fig 6. Construction of the head electrode assembly

USING THE ALPHAPHONE

When ready to use the alphaphone, insert the headphone jack in SK3, but leave the head electrodes disconnected from SK1 and SK2. Set VR1 to midresistance and VR2 to minimum resistance (wideband) and switch on. A low, steady hiss should just be audible in the headphones. If there is humming, or buzzing sounds, this will probably be mains interference, so try resiting the alphaphone away from house wiring.

Advance VR1 to the point where low frequency noise from the pre-amplifier is just audible. When a 4.7 kilohm resistor is inserted across SK1 and SK2, pre-amplifier noise should disappear.

Wet the electrodes and place them on the head, and connect to SK1 and SK2. A sharp sound should now be heard every time the eyes are blinked, and a crackling noise from jaw muscles when the teeth are clenched, against a background of random brain noise.

Relax with the eyes closed and listen for the "chuff chuff" alpha signal; initially this will tend to come and go in short bursts, but with practice the alpha can be maintained at a steady, high level.

COMPONENTS . . .

ADDITIONAL COMPONENTS FOR ALPHAPHONE

Resistors

R17 100kΩ

R18 $10k\Omega$

R19 $1k\Omega$

All $\pm 10\% \, \frac{1}{2} W$ carbon

Capacitors

C10 47pF polystyrene

C11 0.033µF polyester

C12 100µF elect. 12V

Diode

D2 OA70

Switch

S1A, B, C 3-pole, 2-way miniature wafer

Socket

SK3 3-pole jack

Batteries

B1, B2, B3 9 volt style PP3 (3 off)

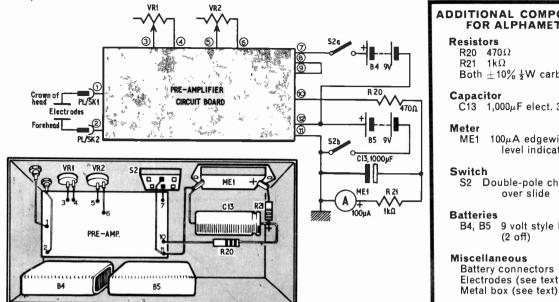
Audio amplifier

Newmarket PC7+ or similar (see text)

Miscellaneous

8 ohm mono or stereo headphones Electrodes (see text) Battery connectors Metal box (see text)

Fig. 7. Suggested wiring of the pre-amplifier for an alphameter



If mains interference is impossible to avoid, decrease gain (VR1) and reduce bandwidth (VR2) until a satisfactory signal is obtained. The tendency of the pre-amplifier to oscillate at 10Hz when VR2 is near minimum bandwidth can be checked by blinking the eyes. If there is appreciable ringing after an eyeblink (several cycles of 10Hz oscillation) increase bandwidth.

ALPHAMETER

The circuit in Fig. 7 can be variously employed as a relaxation meter, lie detector, and sleep threshold monitor, on the principle that alpha rhythm amplitude varies inversely with anxiety, and is reduced to zero by sleep.

Diode DI in the pre-amplifier module here acts as a meter rectifier, to feed ME1 in Fig. 7 via series resistors R20 and R21, while C13 provides a time constant of 2-3 seconds to smooth out signal fluctuations. C8 in the pre-amplifier module is linked to output 1 (leads 8 and 9) for additional top-cut (see Fig. 2) to reduce interference and unwanted brain noise. Low frequency roll off is also increased by the meter load placed on output capacitor C9 in the pre-amplifier circuit, to remove delta type sleep rhythms.

CONSTRUCTING AND USING THE ALPHAMETER

If ME1 is a miniature edgewise meter, small enough to mount on the front panel, the alphameter can be housed in a metal box of the same dimensions as that used for the alphaphone. A suggested layout is shown in Fig. 7, with ME1 and C13 taking up the space previously occupied by the packaged amplifier.

To use the alphameter as a relaxation meter, set VR1 to maximum gain and VR2 to wideband. Place the electrode assembly on the head, after wet-

COMPONENTS . . .

ADDITIONAL COMPONENTS FOR ALPHAMETER R20 470Ω R21 1k Ω Both ±10% ½W carbon C13 1,000µF elect. 3V 100μA edgewise type level indicator S2 Double-pole changeover slide B4. B5 9 volt style PP3 (2 off) Miscellaneous Battery connectors Electrodes (see text)

ting with salt water, and switch on. When the subject's eyes are open, a reading of about 5% of full scale should be obtained, assuming that there is little or no mains interference.

Now ask the subject to close his eyes and relax, whereupon the meter reading should rise to about half full scale, indicating a state of moderate relaxation. A gentle tap on a door will cause the meter reading to fall back towards zero, by alerting the subject out of his relaxed state, and the same applies if the subject is asked to do mental arithmetic.

It is interesting to note the increase of meter reading when the subject's eyes are open and be becomes excited, caused by a rise in "brain noise" and theta.

LIE DETECTION

A similar technique to the above is employed for lie detection, with the virtue that the instrument cannot be misused against the will of the person being because nervousness or interrogated obliterates the alpha signal, and renders the lie detector inoperative.

With the subject relaxed and showing a consistently high meter reading, interrogate with a series of simple, undemanding questions, with a short pause allowed between question and answer. If a significant question is suddenly interposed, which calls for a devious answer, the meter reading will fall dramatically towards zero, despite the apparent outward calm of the subject.

To use the alphameter as a sleep threshold detector, the subject is asked to compose himself for sleep, and when the eyes are closed alpha rhythms will initially be generated, causing the meter to read. Just before sleep, the alphameter reading will start to become erratic, and will fall to near zero at the onset of unconsciousness.

Part 2 will describe a brain rhythm frequency meter and cardiophone.

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1N200 1N645	0.25	A8Y29 A8Y36	0-80 0-25	BYZ15	1.00	OAZ241 OAZ242	0.22	ZTX 107	0.15
1N725A	0.20	A8Y50	0.17	BYZ16	0.62	OAZ244	0.22	ZTX108	0.12
1N914	0.07	A8Y51 A8Y53	0.40	BYZ88C3	V3	OAZ246	0.28	ZTX300	0.12
1N4007 1B113	0.20	ASY 55	0.20	CHI	0·15 0·65	OAZ290 OC16	0-88 0-50	ZTX304	0-25
18130	0.18	ASY62	0.25	CR81/05	0.25	OC16T	0-88		0.16
18131 18202	0·18 0·28	A8Y86 A8Z21	0-88 0-42	CR81/40 C84B	0.45 2.50	OC19	0.87	ZTX503 ZTX531	0-17 0-25
2G371	0.22	A8Z23	0.75	CSIOB	3.18	OC20 OC22	0.85	ZIAOUI	0.20
2G381	0.25	AUY10	0.98	DD000	0.15	OC23	0-60	INTEGRA	
2G414 2G417	0-80 0-22	AU101 BC107	1.50 0.10	DD003 DD006	0-15 0-18	OC24	0.60	CIRCUIT	
2N404	0.20	BC108	0.10	DD007	0-40	OC25	0-87 0-25	7400 7401	0-20 0-20
2N697 2N698	0-15 0-40	BC109 BC113	0-10 0-15	GD3	0-88 0-88	OC28	0.80	7402	0.20
2N706	0.10	BC115	0.20	(1D4	0.05	OC29	0.60	7403	0.20
2N706A	0.12	BC116	0.25	GD5	0.88	OC30	0.40	7404 7405	0-20 0-20
2N708 2N709	0-15 0-63	BC116A BC118	0.80 0.25	GD8 GD12	0-25	OC35	0.50	740G	0.30
2N1091	0.88	BC121	0.20	GET102	0-80	OC36	0.60	7407 7408	0-30 0-20
2N1131 2N1132	0·25 0·25	BC122 BC125	0-20 0-68	GET103 GET113	0.22 0.20	OC41	0.25	7409	0-45
2N1302	0.18	BC126	0.65	GET114	0.15	OC42 OC43	0.80 0.40	7410	0.20
2N 1303	0.18	BC140	0-55	GET115 GET116	0.45	OC44	0.17	7411 7412	0-23 0-42
2N 1304 2N 1305	0-22 0-22	BC147 BC148	0·15 0·13	GET116 GET120	0-50 0-25	OC44M OC45	0·17 0·12	7413	0.30
2N1306	0.25	BC149	0.15	GET872 GET875	0.30	OC45 OC45M OC46	0.18	7416	0.30
2N1307	0.25	BC157 BC158	0.15	GET875	0.25	OC46	0.27	7417 7420	0.30
2N1308 2N2147	0.25 0.75	BC158	0·12 0·63	GET881	0-87 0-25	OC57 OC58	0.60 0.60	7422	0-48
2N2148	0.60	BC169	0.13	GET881 GET882 GET885	0.25	OC59	0.65	7423 7425	0-48 0-48
2N2160 2N2218	0.60	BCY31	0.85	GET885	0.25	OC66	0.50	7427	0.42
2N2219	0.20	BCY32	0.55	GEX44 GEX45/1	0.10	OC70 OC71	0·12 0·12	742H	0.50
2N2369A 2N2444	0.15	BCY33	0.25	GEX941	0.15	OC72	0.20	7430 7432	0-20 0-42
2N2444 2N2613	1.99 0.28	BCY34 BCY38 BCY39	0-40	GJ3M GJ4M	0.25	OC73	0-30 0-30	7433	0.70
2N2646	0.45	BCY39	1.00	GJ5M	0.25	0C74 0C75	0.25	7437 7438	0-65 0-65
2N2904 2N2904A	0-20 0-25	BCY40	0-50 0-25	GJ7M HG1005	0-87 0-50	OC76 OC77 OC78	0-25	7440	0.80
2N2906	0.20	BCY70	0.15	H8100A	0.90	OC78	0.40 0.20	7441 VX	0.75
2N2907	0.23 0.23	BCY40 BCY42 BCY70 BCY71 BCZ10	0.20	MAT100	0.25	OC79	0-22	7442 7450	0-75 0-20
2N2924 2N2925	0.23	BCZ10	0.35	MAT101 MAT120	0.30 0.25	OC81 OC81D	0-20 0-20	7451	0.20
2N2926	0.10	BD121	0.65	MAT121	0.80	OC81M	0.20	7453	0-20
2N3054 2N3055	0-50 0-75	BD123 BD124	0-80 0-75	MJE520 MJE2955	0.87 1.27	OC81DM	0.18	7454 , 7460	0.20 0.20
2N3702	0.10	BDY11	1.62	MJE3055	0.87	OC81Z OC82	0.40 0.25	1 7470	0.80
2N3705	0.10	BF115	0.25	NKT128 NKT129	0.35	OC821) OC83	0.20	7472	0.80 0-40
2N3706 2N3707	0.23 0.12	BF117 BF167	0.50 0.25	NKT129 NKT211	0.80 0.25	OC83 OC84	0.25 0.25	7473 7474	0.40
2N3709	0.10	BF173	0.25	NKT213 NKT214	0.25	OCTES	0.88	7475	0.55
2N3710 2N3711	0-10 0-10	BF181 BF184	0.85 0.20	NKT214 NKT216	0-15 0-87	OC122	0.60	7476 7480	0-45 0-80
2N3819	0.85	RF185	0.20	NKT217	0.35	OC123 OC139	0-65 0-25	7482	0-87
2N5027	0.58	BF194	0.17	NKT218	1.13	OC140	0.85	7483 7484	1.00 0.90
2N5088 2B301	0-33 0-50	BF195 BF196	0-15 0-15	NKT219 NKT222	0-88 0-20	OC141 OC169	0-60 0-20		0.45
28304	0.75	BF196 BF197	0.15	NKT222 NKT224 NKT251	0.22	OC170	0.25	7490	0-75
28501 28703	0-37 0-62	BF861 BF898	0.28 0.28	NKT251 NKT271	0.24 0.25	OC171	0-80 0-40	7491AN 7492	1.00 0.75
AA129	0.20	BFX12	0.20	NKT272	0.25	OC200 OC201 OC202	0-70	7493	0.75
AAZ12	0.30	BFX13	0.25	NKT273	0.15	OC202	0-80	7494	0.80
AAZ13 AC107	0·12 0·87	BFX29 BFX30	0.25 0.25	NKT274 NKT275	0.20 0.25	OC203	0-40 0-40	7495 7496	0-80 1-00
AC126	0.20	BFX35	0.98	NKT277	0.20	OC204 OC205	0.75	7497	6.25
AC127 AC128	0-25 0-20	BFX63 BFX84	0.50 0.25	NKT278 NKT301	0-25 0-40	OC206 OC207 OC460 OC470	0.90	74100 74107	2-50 0-50
AC187	0.25	BFX85	0.30	NKT304	0.75	OC460	0.20	74110	0-80
AC188	0.25	BFX86 BFX87	0.25	NKT403	0.75	OC470	0.80	74111	1-45
ACY17 ACY18	0.30 0.25	I BFX88	0-25 0-20	NKT404 NKT678	0.55 0.80	OCP71 ORP12	0-97 0-50	74118 74119	1-00 1-90
ACY19	0.25	BFY10 BFY11	1.00	NKT713	0.25	ORP60	0-40	74121	0-60
ACY20 ACY21	0.20 0.20	BFY11 BFY17	1.25 0.25	NKT773 NKT777	0-25 0-38	ORP61 819T	0-42	74122 74123	1.85 2.70
ACY22 ACY27	0-10	BYF18 BFY19	0.25	078B	0.88	SAC40	0.25	74141	1.00
ACY27	0.25	BFY19 BFY24	0.25	OA5	0.20	SFT308	0.88	74145	1.50
ACY28 ACY39	0·17 0·50	BFY44	0.45 1.00	OA6 OA47	0·12 0·10	ST722 ST7231	0.88 0.68	74150 74151	3.35 1.10
ACY39 ACY40	0.15	BFY50	0.22	OA70	0·10 0·10	8X68	0.20	74154	2-00
ACY41 ACY44	0-15 0-25	BFY51	0-20 0-22	OA71 OA73	0-10 0-10	SX631	0.80	74155	1.55
AD140	0.50	BFY52 BFY53	0.17	OA74	0.10	8X635 8X640	0-40	74156 74157	1.80
AD149	0.80	BFY64	0.42	OA79	0·10 0·08	8X641	0.55	74170	4.10
AD161 AD162	0-87 0-87	BFY90 BSX27	0-65 0-50		0.12	8X642 8X644	0-60 0-75	74174 ⁻ 74175	2.00 1.35
AF106	0.80	B8X60	0.98	OA86	0.15	8X645	U-70	74170	1.60
AF114 AF115	0.25 0.25	B8X76 B8Y26	0·15 0·18	OA90 OA91	0.08 0.07	V15/30P V30/201P	0-50 0-75	74190	1-95 1-95
AF116	0.25	BSY27	0.17	OA95	0.07	V30/201P V60/201	0.50	74191 74192	2.00
AF117	0.25	BSY51	0.50 0.12	OA200 OA202	0.07	V60/201P	0.75	74193	2.00
AF118 AF119	0-62 0-20	BSY95A BSY95	0.12	OA210	0·10 0·25	XA101 XA102	0·10 0·18	74194 74195	2.50 1.85
AF124	0.25	BT102/50	0 R	OA211	0.30	XA151	0.15	74196	1.50
AF125 AF126	0·20 0·17	BT Y42	0.75 0.92	OAZ200 OAZ201	0.55 0.50	XA152	0-18	74197	1.50
AF127	0.17	BT Y79/10	00 R	OAZ202	0.42	X A 161	0.25	74198 74199	4-60 4-60
AF139 AF178	0.80 0.55	BTY79/40	0.75	OAZ203 OAZ204	0.42	XA162 XB101	0-25		
AF179	0-65		1.25	OAZ205	0.42	X B102	0.10	Plug in se	
AF180 AF181	0.52	BY100 BY126	0-15 0-15	OAZ206 OAZ207	0.42	X B103	0.25	low pro 14 pin Dl	
AF186	0.40	BY127	0.17	OAZ208	0.32	XB113	0.12		0.15
AFY19	1.18	BY127 BY182	0.85	OAZ209	0.82	XB121	0-48	16 pin D	L
AFZ11	0-60	BY213	0.25	OAZ210	0-9%	ZR24	0.48	1	0-17

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BAROMETERS 'N' THINGS

My younger daughter came to me some months ago indignant that her sister ought to be able to know (instinctively) that the weather was going to be awful, particularly as Nanny always reckoned she could tell!

My answer was that her sister probably didn't suffer with rheumatics and that I fancied many people might have this ability, certainly it was no stranger to me. But, I wondered, had anyone bothered to see if there was any correlation between aches and pains, and low (whatever that may mean) barometric pressure.

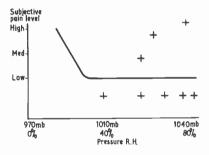


Fig. 1. Curve shows response vs pain level. Crosses indicate RH.

A relatively diligent search reveals that a high proportion of individuals from almost all ages maintain that they are able to indicate with fair accuracy when the weather is going to take a turn for the worse. However, not content with this (and feeling that relative humidity, RH, might play a hand in it too) I determined over the next few months to plot a graph (Fig. 1) of pressure and RH versus the subjective level of "ouch", averaged for several people.

It is a particularly interesting fact that although relative humidity doesn't seem to influence things very much, discomfort is definitely related to low pressure, that is pressures much below 1006 millibars (see Fig. 1). Sure, temperature effects have

not been mentioned, but at the time of preparing the graph (during Summer) no great temperature excursions were recorded.

Don't ask me what causes the effect, but there may be some connection with the fact that bone is piezoelectric. This, however, is a subject to which we must return in a later column.

Perhaps in future times, homes will be pressurised so that no one will be able to predict weather conditions. but then they probably won't care either. In the meantime we must either tolerate bouts of "the screws" or go on frequent diving holidays to avoid "weather forecasts"!

POSITION FIX

Some of the most elegant concepts in engineering are delightfully simple in actuality. No exception to this is an (old, British Rail?) idea recently tested as a feasibility exercise by the U.S. Department of Transportation, New Jersey, to reduce the high costs incurred by existing highway aid systems.

Dear old Britain resorts to motorway telephones spread at intervals of about a third of a mile from one another; but let's face it, this just wouldn't do if our country was even half the size of the United States. The way they have beaten the problem, and simultaneously raised the number of call-points per mile too, has been to adopt the scheme shown simply in Fig. 2.

Initial tests were performed along an 8 mile stretch of "freeway" cables being buried either side of the road. Each cable, which carried two wires, was broken by a currentmonitoring position at four miles, and these stretches were interrupted at intervals of about 200ft by paralleled push-button switches. At a distance farthest from the monitoring point the cables were terminated in a 100 ohm resistor.

Prior to testing, the line-current (with no buttons pressed) was nulled out. Subsequent operation of any switch thus resulted in a current value corresponding to its position. Hence, a switch near to the monitoring point gave a higher current indication than one operated farther down the cable.

Clearly the whole exercise is based upon a bit of economic thinking, I just hope that when this system is installed on the large scale no more than one button gets pressed at a time!

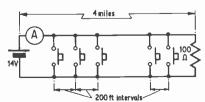


Fig. 2.

ELECTROPHONIC HEARING

What it's called now, I really couldn't say, but back in 1953 a paper bearing the title "Electrophonic Hearing", and written by Gordon Flottorp of the Psycho-acoustics laboratories at Harvard University, made pretty compelling reading. The effect he discussed, electrophony, was first observed in the early nineteenth century by Volta and They found that the sensation of hearing could be evoked by passing low currents through the head. Of course, only d.c. was available at that time, although a.c. effects, more recently investigated. show better promise.

Flottorp reported that in later experiments an "indifferent" electrode was usually connected to the fore-arm while the second electrode could have sites as varied in location as the roof of the mouth or the nape of the neck. Sometimes the tests have been performed using dampened electrodes, while at other times the results have been blessed with greater success when dry ones were employed; actually, under certain conditions, good results were achieved with a moving electrode too.



Quite wide frequency ranges have been obtained; e.g., 200Hz to 17kHz. although the intensity does not appear to have been very large. This was typically little more than a whisper at about 30dB above the threshold of hearing, but, significantly, a discernible signal.

Considerable difficulty has been experienced in all attempts to establish an exact mechanism for electrophonics, since, when passing current directly through the head, the number of possible paths must be very high. It is, therefore, likely that both the 8th cortical (auditory) nerve and the (sensory) organ of Corti are stimulated simultaneously. Indeed, there is a distinct possibility that the skin itself could take the role of a transducer, the sound it produces being sensed as "direct" hearing!

The voltages employed in these experiments have been kept within the range 1 to 5 volts at currents no greater than 30mA. Although at higher levels of V and I things are certain to become a little bit excruciating, it does rather look as if the effect ought to be re-examined as a possible aid to the deaf, always assuming that the neural function is intact in the first place.

PIANO

Part 5

By A. J. Boothman B.Sc.



THE final part of the series describes the complete mechanical construction of the piano, together with details on tuning and a number of points concerning the use of the instrument.

KEYBOARD

Since the commencement of this series of articles F-F keyboards have become available, but as a number of constructors will have purchased C-C Keyboards we now give modification details as promised in the first part of the series.

MORELLI-A KEYBOARD MODIFICATION

To modify the Morelli-A keyboard to F-F it was necessary to remove the lower C-E section from the main assembly. The wire which acts as a spindle for all the keys was withdrawn from the bottom end by first hammering a nail, whose point was positioned on the end of the spindle, at the top end of the compass. The spindle was then pulled out from the bottom end with a pair of pliers. Prior to this all springs had been released from their bottom clips in order to ease the pressure on the spindle.

Fig. 5.1. The Swedish keyboard with the section C-E separated

In this state all the keys are loose and should be placed on a clean flat surface in the order in which they are removed from the frame. With all keys removed the frame can be cut at the appropriate point with a hacksaw. On completion the keys are replaced in position with the lower C-E section now positioned at the top end.

The wire spindle is replaced from the bottom end, and the final top key (which was originally a C) is now put back to act as the top F. This key will require to be made captive since it is free to move up the rod, and for the prototype a brass collet was obtained from a model shop, and clamped on to the end of the rod using the grub screws tapped into the collet.

The frame should now be very carefully stored prior to mounting on the subframe, since the only mechanical linkage between the two parts of the keyboard is the spindle which could easily be accidentally bent.

The author has not attempted to modify the Morelli-B keyboard, but it should be possible to follow a similar procedure to that outlined above.

KIMBER-ALLEN SWEDISH KEYBOARD MODIFICATION

The Kimber-Allen keyboard is considerably different in construction to the two previously mentioned models, but as in their cases it is not possible to simply rearrange the keys, since the spacing of the fulcrum slots varies over an octave, and it is therefore necessary to cut the frame in order to remove the bottom C-E section and to fix it to the upper end (see photograph).

The first task is to remove some of the keys from the frame by first removing the springs at the rear of the board, which then frees the metal levers which are slotted into the keys. It is then necessary to remove the actuator pegs from the keys by pulling away from the keys. The actuators are a nylon plastic with push fit pegs into two holes in the key. The keys can then be removed.

In order to reduce the risk of damaging any keys, a fairly large area should be cleared—from C to B-flat at the lower end, and B to F at the top end—having first noted the position of E and F keys at the bottom. It would be wise to pencil the key letters on to the alloy frame opposite the relevant actuator holes.

The cut when made will be immediately to the left (viewing the keyboard from the front) of the hole corresponding to note E. This then leaves about half an inch of frame protruding beyond the bottom F key when the assembly is complete, which makes for easy mounting to the wooden sub-frame. For the same reason the line should be drawn to run close to the edge of the hole to leave the maximum amount possible on the piece being cut off, since this part acts as the mounting for the upper end of the keyboard when complete.

Three cuts are necessary, the first being to remove the unpunched section from the bottom end. A line should be drawn to the left of the first (C) hole and a sawcut made keeping the hacksaw vertical. Care should be taken not to damage the fulcrum slot, and to protect the fulcrum knife edge to the left of the slot. The second cut is made in the position described above—i.e. alongside the bottom E hole. Again the saw should be kept as vertical as possible. The third cut is made at the top end of the keyboard and removes the section containing half an actuator hole.

This is necessary in order to finish with the correct spacing between keys. The cut should be made $\frac{1}{8}$ in to the right of the last complete actuator hole, but it is important that the slot in the plastic spacer at the front of the frame is preserved by leaving some plastic protruding beyond the keyboard ($\frac{1}{4}$ in). When the new section is fitted its plastic can be cut back slightly in order to accommodate the protruding piece. The slot in the plastic is important in that it acts as the front key locator, preventing lateral movement.

The C-C board has two spare actuator holes at the top end which will now take C and D, having swapped the bottom C key with the previous top C key. The new section will accommodate E flat, E and F (the old top C key), with one surplus actuator hole at the top.

JOINING PLATES

Three steel plates should now be cut and drilled as shown in Fig. 5.2, and mounted as follows:

- a. Plate with four holes not countersunk—inside front edge.
- Plate with four holes countersunk—inside rear edge.
- c. Plate with two holes countersunk—outside rear top. This plate should be mounted as far back as possible so as not to interfere with the keyswitch assembly.

Holes should be drilled in the keyboard frame to line up with the metal plates, with the transferred section of frame positioned such that the distance between the two adjacent edges of the actuator holes is 1 in.

If all sawcuts have been made in a square manner there should be a gap between the two sections, however it is unlikely that such a degree of squareness can be achieved with a handsaw, and it may be necessary to make slight adjustments with a file.

The four holes on the front edge of the frame should be countersunk and the screws inserted from the front. The rear edge screws should be inserted from underneath the frame, and the top screws from the top, using the countersink in the plates. When all screws have been tightened the D, E-flat, and E

keys should be tried on the frame in order to check that they do not catch each other, thus requiring further adjustment of the joint.

All keys can then be replaced and the actuators pressed back into position.

SUB-FRAME FOR MORELLI-A KEYBOARD

The construction of the Morelli-A keyboard subframe, which carries the keyboard, key switch contacts, and terminal strips, is shown in Fig. 5.3.

Assembly of the sub-frame is best carried out using the large baseboard on which to screw down the unit thus ensuring a fully square frame during the process. Particular attention should be paid to this point when fixing the end cheeks which should be both glued and screwed. Using parts obtained from the materials list given the following procedure should be followed.

- 1. Take the large baseplate and mark out the position for front and rear 2in × 1in battens, and the end cheeks as shown in Fig. 5.3.
- 2. Cut the front and rear battens, the end cheeks, the terminal strip mount and the lin × ½in hardwood strip as shown in Fig. 5.3.
- Screw both battens to the baseboard, and glue and screw the end cheeks to the battens.
- 4. After the glue has been allowed to set remove the frame from the baseboard and fix the lin × ½in hardwood strip and the terminal strip mount.
- 5. The front of the keyboard frame is fixed to the lin × ½in strip with nuts and bolts, whilst woodscrews are used on the rear batten fixing. Holes should be drilled in the metal framework to accommodate the fixings.

Should it later be found that the downward travel of the white keys is restricted by the front $2in \times 1in$ batten, metal washers should be inserted between the keyboard frame and the $1in \times 1in$ hardwood strip in order to raise the front of the keyboard. This results in a very slight keyboard tilt which gives a comfortable playing position. Checks on the freedom of the key travel should only be made when the sub-frame is screwed down to the baseboard as the procedure given automatically results in some movement of the hardwood strip as the outer sub-frame is screwed home.

It is recommended that wherever possible the keyboard and sub-frame assembly should be kept on the baseboard whilst the project continues in order to avoid the possibility of mechanical distortion of the assembly, which still depends largely on the base for its mechanical rigidity.

KIMBER-ALLEN KEYBOARD SUB-FRAME

Fig. 5.4 shows the construction of the sub-frame for the Kimber-Allen keyboard. Again the simplest procedure is to lay out the battens on the main baseboard and glue and screw the four pieces together. The keyboard is fixed to the sub-frame at the ends using long screws passing through $\frac{7}{4}$ in packing pieces. The latter prevent too much stress being applied to the alloy frame when inserting the screws. For additional strength screws can be inserted into the front and rear legs into their respective battens.

Holes of approximately in diameter should be drilled at an angle as shown to take the wires from

the keyswitch to the terminal strips on the rear of the assembly. The terminal strips are cut into groups of six, one for each main p.c.b., and depending on the thickness used for the interconnecting wire either one or two holes per strip will be necessary.

The $2in \times 1in$ planed front bar and side plates are separate from the sub-frame and form part of the main frame which is described in more detail later. Again it is recommended that the keyboard sub-frame assembly should be stored on the baseboard to avoid mechanical distortion occurring.

THE KEYSWITCH ASSEMBLY

2 Carrying handles 4 Cupboard catches 4 24in leas Covering Material

The keyswitch assembly consists of a printed circuit board which anchors gold plated springy wires, and carries the touch sensitivity resistors, and seven rod supports which carry two gold plated rods. Fig. 5.5 shows the arrangement of the various components of the assembly.

Before assembling the parts together, the p.c.b. should be placed on the underside of the keyboard, and used as a template for drilling the 1/8 in holes required to take the self-tapping screws which fix the switch assembly to the frame.

The front edge of the switch assembly should be placed approximately in from the keyboard actuators, and should be centralised over its length with respect to the actuators. In the case of the Morelli keyboards the p.c.b. pads will roughly line up with the actuators, whilst in the case of the Kimber-Allen keyboard, which is longer, the overall length of the keyswitch is less than the total span of the actuators.

When the gold plated wires are attached they will be bent to fan out towards the extreme ends of the keyswitch, thus resting on the centre of each

MATERIAL AND COMPONENTS FOR KEYBOARD SUB-FRANES AND MAIN CABINET ASSEMBLY

SUB-FRAME

	MORELLI-A	KIMBER ALLEN
Front Batten	$34\frac{3}{4}$ in $\times 1\frac{7}{8}$ in $\times \frac{7}{8}$ in	35 in $\times \frac{7}{8}$ in $\times \frac{7}{8}$ in
Rear Batten	$34\frac{3}{4}$ in $\times 1\frac{7}{8}$ in $\times \frac{7}{8}$ in	35 in $\times 1\frac{7}{8}$ in $\times \frac{7}{8}$ in
End Cheek (2)	$6\frac{7}{8}$ in $\times 2\frac{3}{4}$ in $\times \frac{3}{4}$ in Block	$3\frac{1}{8}$ in $\times \frac{7}{8}$ in $\times \frac{7}{8}$ in
Packing Piece (2)	<u> </u>	$3\frac{1}{2}$ in $\times \frac{7}{8}$ in $\times \frac{7}{8}$ in
Mounting Strip	$34\frac{3}{4}$ in $\times 1$ in $\times \frac{1}{2}$ in	
Terminal Mount	$31\frac{1}{2}$ in $\times \frac{7}{8}$ in $\times \frac{7}{8}$ in	
Terminal Strips—6 contact	12 off	12 off
Terminal Strips—2 contact	2 off	2 off

MAIN CABINET

Baseboard	$42in \times 20\frac{1}{2}in \times \frac{1}{2}in$	Chipboard
Side Pieces (2)	$20\frac{1}{2}$ in \times $6\frac{3}{4}$ in \times $\frac{3}{4}$ in	Blockboard
Front Bar	$40\frac{1}{2}$ in \times $1\frac{7}{8}$ in \times $\frac{7}{8}$ in	
Rear Panel	$42 \text{in} \times 7\frac{1}{2} \text{in} \times \frac{3}{8} \text{in}$	Plywood
Rear Panel strip	$40\frac{1}{2}$ in $\times \frac{1}{2}$ in $\times \frac{1}{2}$ in	
Top Panel standard version	$40\frac{1}{2}$ in \times $13\frac{1}{4}$ in \times $\frac{1}{8}$ in	
Top Panel Strip	$40\frac{1}{2}$ in $\times \frac{3}{8}$ in $\times \frac{3}{8}$ in	•
Mains Panel (3)	$5\frac{1}{2}$ in \times 2in $\times \frac{1}{8}$ in	
Mains Panel Cover	$2\frac{1}{8}$ in \times 2in $\times \frac{1}{8}$ in	•
Speaker Panel Support (2)	$2\frac{1}{2}$ in $\times \frac{7}{8}$ in $\times \frac{7}{8}$ in	
Switch Panel (2)	$X \times Y \times \frac{1}{6}$ in	
Panel Support (2)	$2in \times \frac{1}{2}in \times \frac{1}{2}in$	•
Speaker Panel	$40\frac{1}{2}$ in \times $3\frac{1}{2}$ in \times $\frac{1}{4}$ in	
Panel Stiffners (2)	14 in $\times \frac{7}{8}$ in $\times \frac{7}{8}$ in	•
Main Amplifier Support	$2\frac{1}{2}$ in \times $\frac{7}{8}$ in \times $\frac{7}{8}$ in	
Lid Panel	$40\frac{1}{4}$ in \times $6\frac{1}{2}$ in \times $\frac{1}{4}$ in	Plywood
Lid Panel	$40\frac{1}{4}$ in \times 8in \times $\frac{1}{8}$ in	•
Music Support Panel	$39\frac{1}{2}$ in \times 7in \times kin	,
Lid End Pieces	$6\frac{1}{4}$ in \times $3\frac{1}{2}$ in \times $\frac{1}{4}$ in	
36in Piano hinge	-4 22.11 / 4.11	,

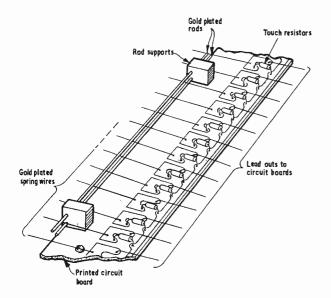
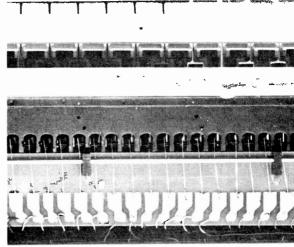


Fig. 5.5. Keyswitch assembly is screwed to the underside of the keyboard so that the actuators press against the spring wires

MAKING IT UP

When the holes have been drilled, and the p.c.b. removed from the frame, the keyswitch is assembled as follows:

- 1. Slide the seven rod supports on to one rod, using the hole nearest the face marked with a "B".
- 2. Insert the second rod through the remaining rod holes, and space the supports roughly opposite the holes which have been countersunk from the non-copper side of the p.c.b.
- 3. Fix the rod supports to the copper side of the p.c.b., using the countersunk screws, nuts and locking washers, with the support face marked "B" closest to the p.c.b.
- 4. Solder resistors to the pads provided, one on the common positive rail, and the other on the land which also carries the gold plated spring wire. The remaining land is used to anchor the output leads.
- 5. Solder wire links between the bottom rod and the negative printed track, and the top rod and positive printed track.
- 6. Cut the gold plated wire into 61 lengths of 1\frac{1}{4}in, and tin approximately \frac{1}{4}in of one end of each wire. Some wire will be left over to provide longer lengths where necessary.
- 7. Pass each wire between the two rods and solder the tinned end to a main pad. About ½in should be left to hang over the front edge of the p.c.b. The wire should be pressed flat to the p.c.b. close to the main pad using a match stick, and the soldering iron applied to the wire and land for as short a time as possible.



View of the key contacts at the underside of the keyboard

MATING WITH THE KEYBOARDS

The assembly can now be fixed to the underside of the keyboard using the self-tapping screws, and a first attempt made to line up each gold wire with the centre of its corresponding actuator.

Some wires will require resoldering to the pads in a different position in order to avoid obstacles such as the rod supports. In certain cases a considerable amount of bending will be required, and it may be necessary to use some of the spare wire to give longer lengths in these instances. The apparently complicated dog leg shapes are perfectly satisfactory in operation.

The final process is to adjust the bend of each wire to ensure that it seats satisfactorily against each rod in turn, whilst gently resting on the actuator in the non-depressed state. As a further precaution to avoid the wires springing off the actuators, small slots can be filed in the centre of each actuator to prevent the wires sliding.

WIRING THE SUB-FRAME

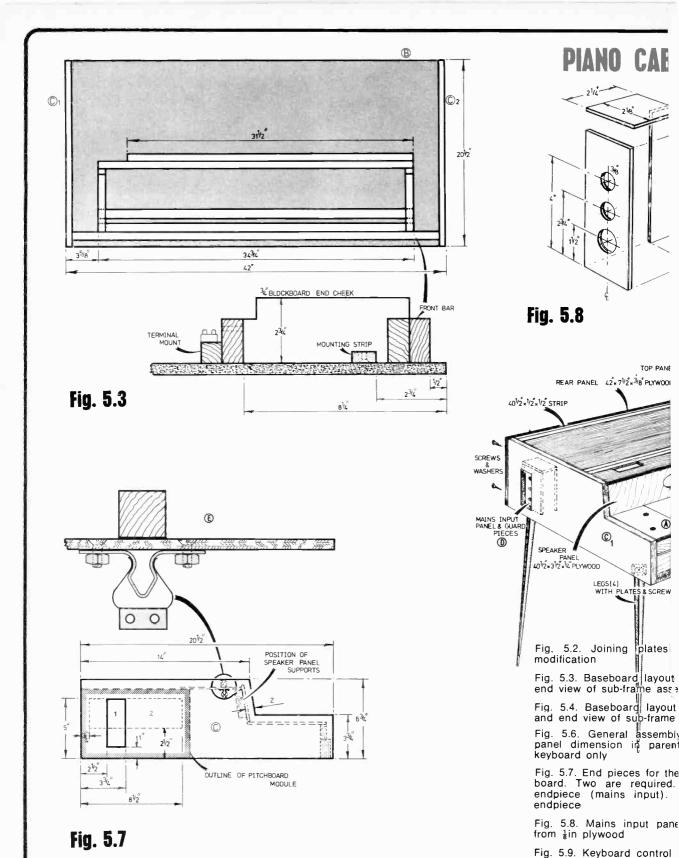
To complete the keyboard sub-frame assembly wires must be taken from each switch pad to the corresponding terminal strip at the back of the assembly. The pads are labelled with the note corcerned and as suggested earlier one or two holes have been drilled against each terminal strip which carries all octaves of a particular note.

A single link is also required between the sixth contact on each of the terminal strips, as this acts as the common sustain connection. Wires are also taken from the positive and negative pads on the keyswitch p.c.b. to a two contact terminal strip mounted on the left hand (power supply) end of the keyboard sub-frame.

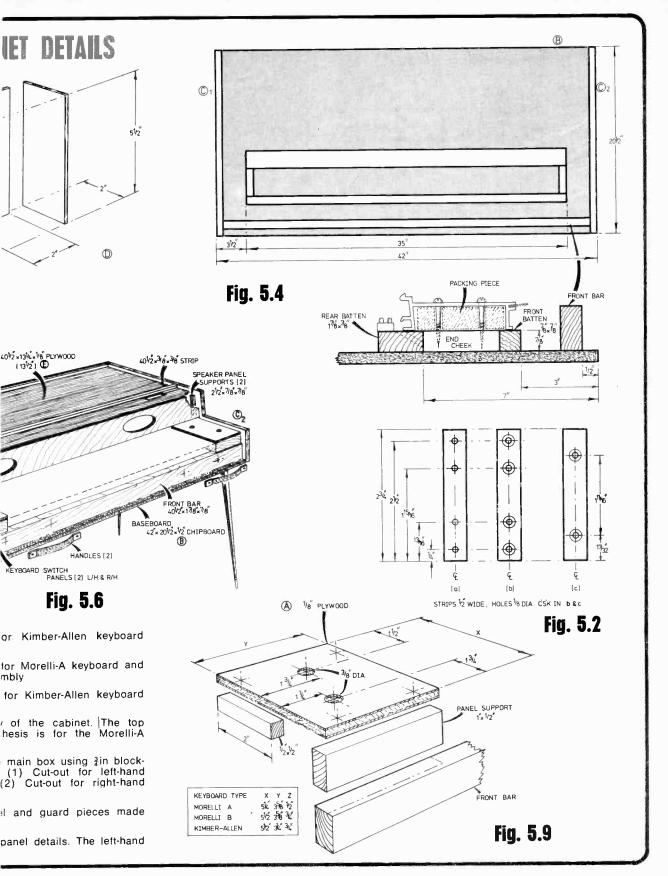
CABINET ASSEMBLY

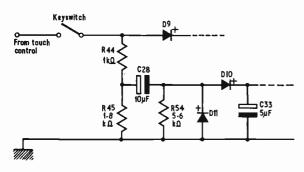
The general layout of the cabinet is shown in Figs, 5.2 to 5.9.

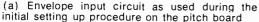
The cabinet construction has been kept deliberately simple, whilst achieving some aesthetic quality.

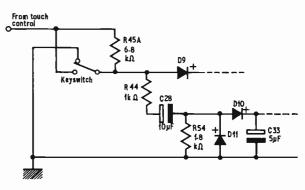


panel is shown









(b) Modified envelope input circuit to give touch sensitivity. R45A is mounted on the keyswitch assembly as shown in Fig. 5.5

Fig. 5.10. Circuit changes to give individual key touch sensitivity

The two end pieces are permanently fixed to the baseboard, joined by the front bar. All other parts are detachable in order to give easy access to the various sub units.

Two end pieces should be cut from $\frac{3}{4}$ in block board, each one requiring a different cut out as shown in Fig. 5.7. The position of the speaker panel supports is also indicated in this diagram. The two pieces should be glued and screwed to the chipboard base, with the front bar positioned $\frac{1}{2}$ in from the front edge of the base board.

The mains input panel should be cut and drilled from $\frac{1}{8}$ in plywood as shown in Fig. 5.8. The other three pieces shown form a box which covers the back of the mains switch, etc. to avoid the danger of electric shock.

The speaker panel was covered earlier, and is a removable unit which seats on the supports shown.

The rear panel has a $\frac{1}{2}$ in $\times \frac{1}{2}$ in strip glued along its top edge which acts as a retainer for the top panel. The rear panel is screwed to the end pieces and is easily removable.

The top panel is retained in position by the strip attached to the rear panel, and by spring clips positioned at the front, with the female part screwed to the end pieces. The clips used were of the common cupboard door type and are shown in Fig. 5.7. The slots cut in the top panel allow heat to be released from the power supply and main amplifier, whilst the $\frac{1}{2}$ in $\times \frac{1}{2}$ in strip acts as location for the lid when used in the music stand position.

Dimension W is dependent on the keyboard used, and if the constructor uses the Morelli-A keyboard he may like to add a ¼in strip on the sloping edges of the end pieces in order to retain the same styling as achieved when the other keyboards are used.

CONTROL SWITCH PANELS

Fig. 5.9 shows details of the construction of the keyboard level switch panels. Dimensions X and Y depend on which keyboard is used, and dimension Z from Fig. 5.7 is also given in the table. The $2\text{in} \times \frac{1}{2}\text{in} \times \frac{1}{2}$ in support strips should be glued to the side pieces. Using the dimensions given it should be possible to line up the front edge of the keys, when fitted on the keyboard sub-frame assembly, with the front edge of the keyboard switch panels.

COVERING THE CABINET

The choice of finish to use on the cabinet greatly depends on finances. To give maximum wear and a smart appearance a heavy grade of black p.v.c. sheeting was used on the prototype, with speaker fabric covering the whole of the speaker panel. Other alternatives could be a Contact/Fablon type material, or paint.

TOUCH SENSITIVITY

Individual touch sensitivity is achieved on each key by the use of a keyswitch assembly which is effectively 61 single pole changeover switches. The two contacts are actually busbars, common to all switches, one at ground and the other at the attack potential. See Fig. 5.10.

Referring to Fig. 5.10b the keyswitch is normally in the grounded busbar position. When a key is depressed the switch leaves the grounded busbar, thus allowing C28 to charge via R45A, the bottom end of which had previously been shorted to ground. The attack level passed on to C33 is determined by the attack voltage from the touch control, reduced by the voltage across C28.

The attack voltage is applied when the second busbar is reached, and the voltage across C28 increases as the time taken to traverse between the two busbars increases. The attack level passed on to C33 is therefore reduced as the time to traverse increases, and is therefore proportional to the average speed of key travel after it is depressed.

This is not of course exactly the same mode of touch sensitivity as on a conventional piano, where the final speed of key travel is the important parameter, but this system does give a degree of realism. The range of touch is considerably less than on a string instrument, but both classical and pop pianists have demonstrated a noticeable level of expression in their playing of the second prototype, relying solely on the keyboard touch sensitivity without access to the soft pedal.

In order to bring the touch sensitivity into operation the value of R54 is altered and R45 removed from the pitch board. R45A is mounted on the keyswitch assembly as described earlier.

Some constructors may find it interesting to experiment with the values of R44, R45A and R54 in order to vary the dynamic range of the touch sensitivity.

TREMOLO PRESET DEPTH

With all units interconnected the preset tremolo depth control (VR6 in Fig. 2.5) can be set. With VR2 in the maximum position and the tremolo on, adjustment of VR6 will produce zero tremolo effect at one extreme, and reduce the signal output to zero at the other extreme. A position can be found where maximum tremolo swing is obtained.

TUNING

Tuning can only be carried out by someone with the so called 'musical ear', so if you do not have one you will need to involve a friend or professional tuner.

Commence with A (the first above middle C) using a tuning fork A440. Strike the tuning fork against the cabinet, and use the top panel as a sound board. The pitch board test jig is used to hold the board under alignment, first using the capacitor values suggested in the table, and then small value changes made until A can be achieved with the inductor setting approximately in mid position.

The 'A' board is then put into the pitch module frame and a second board put in the test jig. The author preferred to tune the F board next by comparison with the 'A' and thus listening to a major third interval. Again the values given for 'F' in Table I (last month) are tried first with modifications

as necessary.

When the 'F' board seems satisfactory it is inserted into the module, and the 'C' board put into the test jig. The major chord F-A-C is easy to recognise and adjustments to both 'C' and 'F' (now in the module) can be made to give a satisfactory sound. 'A' should not be adjusted, but can be checked a number of times against the tuning fork in order to satisfy the constructor that he has tuned it correctly.

Using 'C' as the base, 'E' can now be tuned (major third) followed by 'G' in the major chord C-E-G.

Using 'G' as the base, 'B' can be tuned (major third) followed by 'D' in the major chord G-B-D, thus completing the white notes.

Two approaches are now possible to tune Eflat. Some would find evaluation of the F7 chord F-A-C-Eflat to be relatively easy, whilst others may prefer to use the major third B to Dsharp (Eflat)—that is using B as the root.

Bflat can be tuned from the major chord Eflat-

G-Bflat.

A choice exists again to tune Aflat, either using the Bflat seventh chord Bflat-D-F-Aflat or the major third E-Gsharp (Aflat). The full major chord E-Gsharp-B can be used to make judgement easier.

Fsharp can be tuned using the major third interval D-Fsharp, with A completing the major chord.

Csharp can be tuned using the A major chord

A-Csharp-E.

The cycle may need repeating a number of times, and other chords will probably produce some out of tune effects which small adjustments in tuning will bring into line. Tuning the piano should not be any more difficult than tuning a guitar, but it will take longer, and requires patience.

FINAL ASSESSMENT

The piano can now be played, and an evaluation made by the constructor of the properties of his instrument. Probably the most important observation will be an assessment of the relative outputs from each note on the keyboard using a constant playing action. If the constructor is dissatisfied he can adjust individual notes or complete pitch boards for increased or reduced output by variation of the resistors quoted in an earlier part of the series.

USING THE PIANO

Whilst the accent in the early part of the series was on constructing an instrument to use in the home, the electronic piano has very great potential for use in modern groups or bands, particularly since the pitch of pianos normally present in private rooms in hotels is often very flat, which can-cause very great difficulties for wind instrumentalists in the same band.

The piano can be connected directly to a public address or guitar amplifier thus offering the pianist power capabilities much higher than he has known before. In this connection it is important that very heavy duty speakers are always used when high amplification is involved.

The author uses an amplifier rated at 25 watts r.m.s. driving a speaker with a nominal rating of 50 watts (Fane POP-50). This has withstood a considerable amount of hard work with the piano and

three microphones on the same system.

Rating of loudspeakers in this application can be very misleading, since music power is the important factor, and a 25 watt r.m.s. amplifier is capable of driving 50 watts of music power thus requiring a suitably rated loudspeaker.

PLAYING THE PIANO

To close some comments are now made on the technique of playing the piano.

The normal switch setting when using the touch sensitive system is maximum attack. The other attack positions can be used to give a less percussive

characteristic for variety.

It is vitally important that the use of the keyboard level control is fully understood. Five positions are offered, but position one must only be used for single note solos, since the power output in this position is the same as a five note chord in position two.

Considerable distortion will occur if this is

ignored.

With position two selected, the volume control should be set to give the maximum required listening level. Selection of level for any particular passage is then controlled by the keyboard switch and the foot pedal. The volume control is not varied during a performance.

The natural tendency when trying to achieve greater attack on a piano is to hit the keys harder, up to a stage where great physical effort is involved. This tendency should be resisted on the electronic piano where as mentioned earlier the attack function

is different.

It will be found after practice that the touch can be very light, leading in some cases to an easier playing technique, whilst retaining a range of expression.

Note: There are a number of resistor value corrections in Fig. 3.1. These are: R84 should be 100 $k\Omega$, R85-R88, 56 $k\Omega$ (4 off) and R110, 270 Ω . Also, in Fig. 3.4, TR16 collector, base and emitter are labelled in reverse.

CEEFAX A PROPOSED NEW BROADCASTING SERVICE

MAGINE sitting down in front of your television set, and at the touch of a switch seeing the latest news, up to the minute stockmarket prices or a list of the day's television programmes with a summary of each. Just a pipedream? Not any more, for the BBC has developed a system which can allow you to do just that, and demonstrations should be underway as early as the middle of 1973.

THE CEEFAX SYSTEM

The system is known as Ceefax and the form that it will take is shown in the photograph. Fig. 1 shows how the Ceefax system fits into the existing television transmission network. At the transmitting end it will mean incorporating a terminal into the broadcasting system so that the pages to be sent out are mixed with the normal picture signals. This will probably mean using the frame synchronisation pulses on which are superimposed the digital signals.

At the receiving end the user will have to purchase a storage and display unit which will probably have a storage capacity of up to 30 pages. The general block diagram of the terminal is shown in Fig. 2.

The user will type out whichever of the 30 pages he requires and it will immediately appear on the screen, in a teleprinter type format, either on a blank background or superimposed on the normal television picture.

COST TO THE CONSUMER

The cost of the additional electronics to the domestic user will undoubtedly decrease as technology develops but it is estimated that in quantity production the cost will be approximately the same as a monochrome set or a tape recorder.

Any of the pages stored in the receiving unit can be updated in a matter of seconds, and some pages could be updated every few seconds to present information in book form or perhaps to provide subtitles for television programmes in foreign languages when we enter the Common Market.

INFORMATION AVAILABLE

Examples of the information which can be transmitted using the Ceefax system are limitless but some of the more obvious are: specialised weather

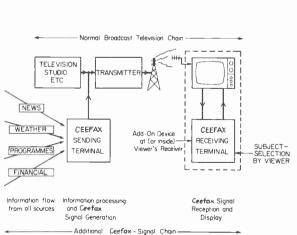


Fig. 1. The Ceefax programme material is injected into the normal television transmission in digital form

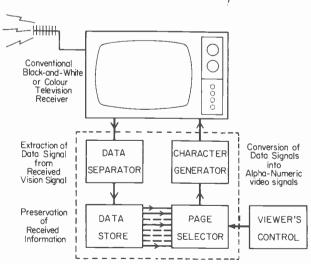


Fig. 2. The domestic receiver uses an add-on decoder and store ready for selected display on the screen

forecasts; a list of the day's television programmes with summaries; specialised programme news for the coming week; facts and figures relevant to current affairs programmes; public notices; up to the minute news (with the option of a flash service whereby important events are flashed onto the screen over the normal programmes), commercial news such as stockmarket prices; sports information; and entertainment in the form of recipes or crossword puzzles.

In the future it is hoped to co-ordinate Ceefax with the Post Office so that pages of information can be received over the normal telephone lines. This will bring the television set into the realms of the computer terminal and no doubt eventually personal facts stored in a computer, such as bank statements, will be at the fingertips of the user through the Ceefax system.

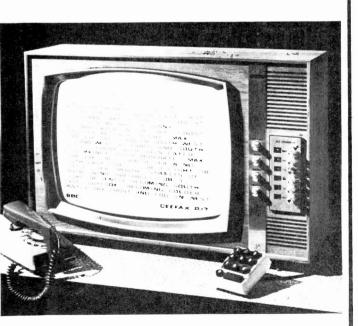
OTHER POSSIBILITIES

There is also no reason why educational institutions should not use one of the available channels for passing information on to the students, in reply to queries made over the phone. The telephone system could also be useful for receiving telegrams and telex messages, there being no need for the recipient to be present when the message is sent.

Although the Ceefax system seems at first like a simple development it is one of those advances, like the introduction of the telephone system, which could have a profound effect upon all our lives as it brings centres of information within easy reach of everyone. It could easily mean the end of newspapers as we know them today for they would be unable to provide such an immediate source of news and would probably only serve to give deeper insight into the news.

The first trials will probably use equipment manufactured by the BBC, but industry will have the opportunity of producing Ceefax units for a public

service operation.



Practical Electronics January 1973

NEWfrom Goodmans for constructors

Din 20 Kit

20 watt, high fidelity loudspeaker kit contains all parts necessary to complete the system, except timber and other material for the cabinet itself, with detailed,

illustrated instructions.

Specification: 20 Watts DIN,
4 ohms impedance, 8 ins bass unit, dome HF radiator, crossover frequency 4,000 Hz.

Goodmans

Goodmans

Axent 100



Dome HF Radiator with integral crossover.
Capable of high frequency sound reproduction with negligible distortion in systems rated up to 30 Watts DIN, this 'state of the art' drive unit has an integral crossover which cuts frequencies below 3kHz at a rate of 12dB/Octave.

Audiom 100

12 inch high fidelity bass loudspeaker.
For use as a bass unit in two-way systems, the sensitivity and high frequency roll-off of the Audiom 100 has been tailored to match the Axent 100.



Goodmans Sound reasoning.

THORN A member of the Thorn Grou

Please send Free leaflets on Constructors Equipment

Name.......

Address

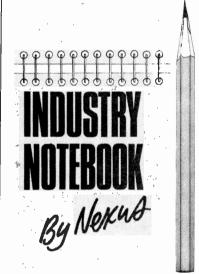
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Goodmans Loudspeakers Ltd., Downley Road, Havant, Hampshire PO9 2NL PF1

NEW BOSS AT MULLARD

Look out for the name Akerman. You'll hear a lot about him and a lot from him starting on January 1, 1973. For that's the date that Jack Akerman takes up his new role as managing director of Mullard Ltd. in succession to Dr. F. E. Jones who leaves to join the Board of Philips Industries Ltd.

Akerman is no newcomer to Mullard-he joined the company in 1936-but it is only in recent years that he has become prominent. Five years ago he moved into the higher echelons through his appointment to the Board of Associated Semiconductor Manufacturers Ltd., an associated company of Mullard. In 1969 he became head of Mullard's consumer electronics division and a year later, in 1970, he became commercial director and a member of the Mullard Board.



Dr. F. E. Jones came to wide public notice through the celebrated "Brain Drain" report which came out during the Wilson administration. But he was well known in the electronics industry long before that both as a brilliant engineer and businessman—a rare combination. He joined Mullard from the Royal Aircraft Establishment, Farnborough, where he was deputy director. After six years as technical director he became MD in 1962 so he has had a full ten years of the top job during which major expansion has been almost a routine.

Jack Akerman comes to the top job at an interesting time. Business is on the upturn and it is not only the consumer component side of Mullard business that is now doing well after the recession. Professional components are also booming and delivery times are lengthening.

LED PRICE BATTLE

Last month I mentioned the bright outlook for optoelectronic devices. Since then I have met Mike Meltzer, in London for a few days representing Monsanto interests in light-emitting diodes and associated devices.

Monsanto announced price cuts of typically 30 per cent but in a few cases up to more than 40 per cent on standard product lines. Not to be outdone, Sperry announced in the U.S.A. cuts of up to 40 per cent on some of their devices and Litronix, another US company, has also joined in the price battle.

How far prices will tumble is anybody's guess but most companies in the LED business now believe that the time is ripe to go for a huge volume market. Monsanto's Meltzer told me that if pocket calculators fall again in price next year, as they are likely to do, then that one single market could generate a demand for 100 million digits a year.

A real enthusiast on his subject, Meltzer spoke of the untold millions of digits which will be needed for as yet untapped markets like cars and the telephone industry. One of Meltzer's forecasts is that by 1980 the LED industry will be as large as the whole semiconductor industry today. Nice work for the survivors after the price war has taken its toll.

NEW FIELDS

Ever anxious to tap new markets, the industry is queuing up to get orders from oil companies. These new rigs scattered round the North Sea are becoming big business. Not so much a drilling platform, more a small town by the sound of things, and there are now over 40 of them all needing not only high grade communications systems but also beacons and other devices for bringing in helicopters as well as surface vessels.

One company, Marconi Marine is doing well supplying complete packaged radio stations including radio officers. Other companies tend to supply individual pieces of equipment.

THE VALVE IS NOT DEAD

Biggest ouptut in the U.K. of any single component group is still in the field of domestic receiving valves and tubes which are running at a rate of £60 million per year. Industrial valves and tubes are worth another £25 million per year. Despite the advent of solid state, valve and tube manufacturers are still doing excellent business.

If you think there is nothing new in the pipeline I suggest you

remember the initials CFA and FWI of which you may hear more in the next few years. CFA stand for Crossed Field Amplifier and FWI stands for Fast-Wave Interaction. CFA and FWI valves are reported under development at English Electric Valve Company.

The CFA combines the advantages of the magnetron and the travelling wave tube and could open up a new range of advanced radar systems. The FWI could open the way to much higher microwave power.

PRODUCTION SHOW BREAKS RECORDS

The fifth Internepcon Show at Brighton again broke all records. It concentrates almost entirely on packaging and production techniques for the electronics industry and is supported by a full-scale conference. This year it attracted over 14,500 visitors including a large number from overseas, some 1,000 of these having registered on the first day.

The Nepcon shows are popular world wide and are money spinners for the organiser as well as the exhibitors who seem so well pleased with results that they come back every year for more despite rising costs.

January sees the second Internepcon held in Tokyo. Ten British companies will be exhibiting. Then next June, the organisers will be launching the first European edition in Brussels which will be called Internepcon Europe 73. British companies Sixtv are expected to be there as one of the national groups. This will be followed in October by the usual show in Brighton for which many of this year's exhibitors have already booked space.

EXPANSION TARGET

Semicomps Ltd., the component distributors recently acquired by Simms Motor Division of Joseph Lucas, is embarking on a five-year plan to expand its business to £8 million a year turnover. Managing director Bill Richardson, founder of Semicomps, is confident that the new financial backing he now enjoys will ensure he attains his objective.

The big turnover will be achieved by setting up extra companies to give complete U.K. coverage. The parent company, based in the South East, already has a subsidiary in the North and another in Ireland. More will be set up and each will be expected to contribute £750,000 to £1 million turnover to the group total. First two areas to see new Semicomps companies will be the Midlands and Central Southern England.

IUST PUBLISHED '73 AUDIO-TRONICS

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BY A.FOORD

Schmitt Trigger

In many applications it is necessary to drive TTL circuits from a non-TTL input. How this may be achieved will depend on the input signal, but one possible arrangement is shown in Fig. 4.1. This is suitable for many input waveforms and there is no danger of the logic level for the integrated circuit being exceeded.

When the transistor is turned on its collector is pulled down to the logical 0 level for the gate, producing a 1 at the output. This circuit can be used where the rise and fall times of the input are faster than 1/4s. Unfortunately when high speed gates are driven directly by input signals which have a slow rise or fall time it is possible for oscillations to occur while the input signal passes through the linear region of the input/output characteristic.

The gate acts as a linear amplifier with a high gain, and various feed back paths exist which contribute to instability and consequent false outputs.

One solution for slow rise time inputs is to use a Schmitt trigger. The basic Schmitt trigger has a positive feedback arrangement which introduces hysteresis to the input/output characteristic, and its snap action prevents oscillation.

SCHMITT TRIGGER USING GATES

A Schmitt trigger can be constructed by using gates as in Fig. 4.2, but this circuit is not temperature stable, needs to be driven from a low impedance source, and requires discrete components.

THE SN7413

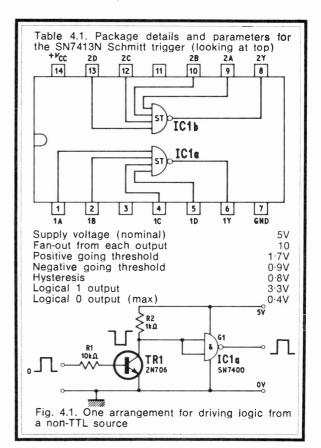
The SN7413 consists of two identical Schmitt trigger circuits, similar to the usual transistor arrangement. Each functions as a four input NAND gate with different input threshold levels for positive and negative going signals. This hysteresis is typically 800mV. The SN7413 is fully compatible with the other TTL circuits in the range.

Propagation delay from input to output is typically 16ns. The package details and parameters are shown in Table 4.1. It has built-in temperature compensation to maintain high stability of the threshold levels



HYSTERISIS Having a different switching threshold for increasing and decreasing signals.

INTERFACE A circuit or "black box" which joins dissimilar systems.



and can be triggered from the slowest of input waveforms and still give a jitter-free.output.

PULSE SHAPER

The SN7413 can be used as a pulse shaper interface between slow waveforms and fast TTL circuits as shown in Fig. 4.3a and b.

SINE TO SQUARE WAVE CONVERSION

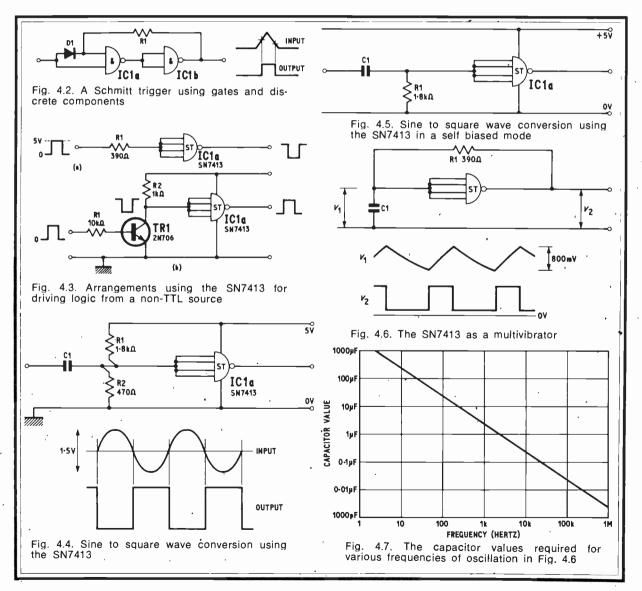
This is perhaps one of the simplest applications of the Schmitt trigger, and is shown in Fig. 4.4. The input of the circuit is biased midway between the upper and lower threshold points by R1 and R2 which gives a 50 per cent output duty cycle for sinusoidal inputs. The circuit can also be operated in a self biased mode, Fig. 4.5. These circuits can be used up to 5MHz or more.

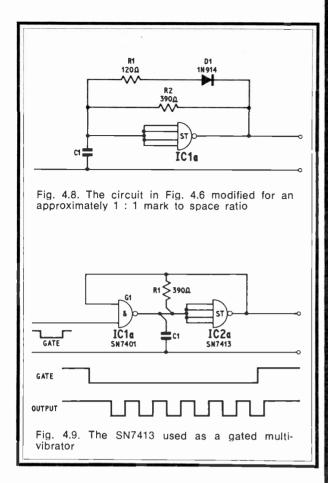
Although the input impedance is not high these circuits can usually be driven directly from an oscillator; care should be taken that the input logic levels are not exceeded.

R-C MULTIVIBRATOR

The circuit of Fig. 4.6 can be used over a wide frequency range for experimental work with TTL circuits, and makes a reliable oscillator from 1Hz to 1MHz by selection of the capacitor value: Suppose that initially the capacitor is discharged and the output is at logical 1. The capacitor then charges towards V_{cc} through resistor R1 until the upper threshold voltage is reached. The output then changes to a logical 0 and the capacitor discharges through RI to the lower threshold voltage, and the cycle repeats.

The duty cycle is 2: 1 rather than 1: 1 because the internal 4 kilohms resistor on the base of the input multi-emitter transistor acts as a current source. The capacitor required for a given frequency is best found empirically, typical values are shown in Fig. 4.7. This circuit only has a fan-out of two and should be buffered by the other Schmitt trigger in the package or by a SN7400 if a larger fan-out





The circuit can be modified for an approximate 1: 1 mark to space ratio as in Fig. 4.8, but the best way to obtain an exact 1: 1 mark to space ratio is to generate twice the required frequency and divide by two.

GATED OSCILLATOR

The basic multivibrator can be gated by adding an SN7401 open collector NAND gate, Fig. 4.9. The feedback path from the output of the SN7413 to me input of the SN7401 prevents the gate signal from acting until the output of SN7413 is at a logical 1, so that the oscillator will always produce a complete number of cycles.

When the oscillator is released the capacitor has to charge up from ground to the upper threshold level of the Schmitt trigger, so that there is a delay between the negative going edge of the start pulse and the beginning of the output pulse train. This delay is very approximately 0.7 of the total period of oscillation.

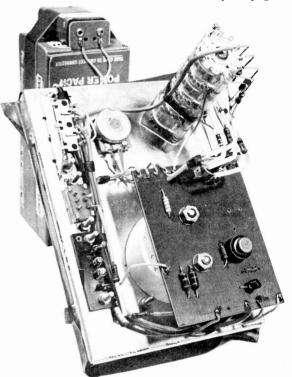
CONCLUSION

This article has shown several applications of the SN7413 Schmitt trigger, but it is especially useful as a straightforward wide range oscillator for future experiments.

Next month: Operational amplifiers with power stages

I.C. LINEAR OHMMETER

continued from page 29



Underside of ohmmeter control panel. Note the strapped battery pack assembly

CONSTRUCTION

The case is made from 22 s.w.g. aluminium and cut out as shown in Fig. 3. The front panel is cut out and drilled from 20 s.w.g. aluminium sheet.

A piece of paxolin, $2\frac{1}{2}$ in by $3\frac{1}{2}$ in is drilled according to Fig. 4. Wiring pins should be added to the board's extremities as seen in Fig. 5 and components assembled and inter-wired according to the dotted lines.

All control panel components should now be mounted, which includes the wafer switch assembly S2.

The component board is bolted onto the meter terminals and connections from these to the appropriate board pins made. Final wiring should be carried out according to Fig. 5.

To make up the power supplies a battery pack consisting of one 9V and two 6V batteries are strapped together (see photograph) and housed in the case.

SETTING UP

The resistance settings of VR1, VR2 and VR3 to give the required current generator outputs are approximately 900Ω , $9k\Omega$ and $90k\Omega$ respectively. These may be roughly set before switching on. Fine adjustment may then be carried out with the instrument on, to give full scale deflection.

The output should, of course, be perfectly linear but this may be checked by testing with some high accuracy resistors.

PATENTS BEVIEW...

LIFE TESTING

The not particularly cheerful but daily more pressing question of a definite test for life applicable to medical transplant techniques is raised by E. Roy John of New York in BP 1257 114. Obviously the need for a definitive "absence of life" test is crucial in transplant surgery. If removal of the transplant organ is delayed unnecessarily, the organ will be useless. If the organ is removed too early, the doctor will be acting immorally and illegally.

The original test for life was the existence of breath and heartbeat, but this is clearly outdated. Attempts are being made to use electroencephalograph and electrocardiograph readouts for sensing brain and heart activity respectively. But amplifier noise can be mistaken for brain activity—or more important, it may be mistakenly assumed that what is in fact brain activity, is simply amplifier noise.

The most recent technique is to stimulate the brain and detect response; but to avoid false results, due to areas of the brain being damaged, three of the major sensory systems have to be tested. All this can become very time consuming and time is of the essence in transplant surgery.

The patent suggests using digital and analogue systems for evaluating the *EEG* and *ECG* readouts after visual, auditory and somatic stimuli. To this end a graphic recorder is used which has at least three recording channels. An *EEG* has its input electrode connected to the patient and its output con-

nected to the first of these channels. An ECG has its input electrode connected to the patient and its output connected to the second of the channels.

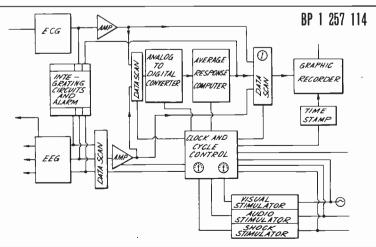
Finally, a data averaging device has its input connected to the outputs of both the *EEG* and *ECG* and its output connected to the third channel of the graphic recorder.

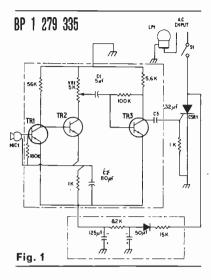
By using data averaging techniques a response signal can be separated from noise even though visual inspection of the "raw" readouts from the EEG and ECG will show no signs of response to stimulus. Brain response to a flashing light may, for instance, be indistinguishable when viewed on oscilloscope but will revealed by an average response computer. So by applying this average response data to the graphic recorder in addition to the raw" readouts from the EEG and ECG, the doctor will be in a far better position to make a positive decision without delay.

SOUND RESPONSIVE CIRCUIT

ARRANGING for electric lights to be illuminated in response to the presence of sound above a selected threshold level can be useful in many areas. The sounding of telephone or doorbells can be detected (e.g., when the user is deaf or has hi-fi headphones on); and burglar alarm systems can be devised which rely on noise detection.

In BP 1 279 335 Novar Electronics Corporation of Ohio, USA, also suggest that audio actuated





light can help the deaf learn to speak.

Their proposed basic circuitry is fairly simple and is shown in Fig. 1 above. An a.c. source is connected to the input terminals. The anode and cathode terminals of CSR1, being in series with the lamp and the power supply thus operate as a switch to block or pass current to the lamp.

The microphone picks up sounds, converts them into an audio output which is amplified and impressed on the gate electrode of CSR1.

In one possible circuit the first stage amplifier transistor TR1 is coupled to TR2 with its load resistor being the track of the 5k control VR1. The wiper of VR1 is coupled via a 5μ F capacitor C1 to a third amplifier transistor TR3, the latter being coupled to the thyristor gate via the 32μ F capacitor.

In the absence of sound at the microphone no trigger signal is present at CSR1 gate and the lamp LP1 stays off. But any signal from the microphone is amplified and if the peaks at gate are greater than the gate firing voltage, the lamp will be illuminated during that part of each half cycle of the a.c. source in which the anode and cathode terminals of the CSR are forward biassed.

The potentiometer VR1 of course, controls sensitivity, and thus can effectively decide between either continual illumination or flickering during speech as well as basic sensitivity to telephone bells.

THE subject of this month's article is the clock generator board which has the function of generating a range of timing pulses for use throughout the arithmetic operations. A single capacitor is used to control the speed at which the whole system operates and this fact means that by running the system at slow speed, faults become relatively easy to trace.

CLOCK BOARD

The circuit and logic of the clock pulse generating board is more interesting than, say, the shift register boards because of the diversity of the logic operations performed. The tasks which this circuit is called upon to carry out are listed below:

- (a) Generate batches of ten clock pulses for the A. Z, and AD boards when instructed to do so by the programme. During addition or subtraction a single batch is required whereas during multiplication or division batches are produced continuously until detection logic decides that the arithmetic operation has been completed.
- (b) Generate a single batch of n (or 10-n) clock pulses when instructed to do so at the beginning of the MULTIPLICATION programme and the end of the DIVISION programme respectively to clock the A, Z, and AD boards. These clock pulses are used for decimal point positioning purposes, where n is less than ten and is determined by the setting of the decimal point thumbwheel.
- (c) Provide an ungated clock pulse output to operate the programme counter and the ENTRY register normalisation system.
- (d) Generate a single output pulse for every batch of ten clock pulses produced so that the number of batches can be counted during the MULTIPLICATION and DIVISION programmes. This pulse to be generated during the batch generation time, to offset propagation delay problems.
- (e) Generate a single output pulse at the *end* of each batch of clock pulses for use with the OVERFLOW detection logic.
- (f) Generate an output to restart the programme sequence at the end of the series of additions or subtractions carried out during multiplication and division.
- (g) Provide an isolated buffering circuit for the large load represented by the A board PRESET input. (This buffer is not connected with any of the other clock circuits.)

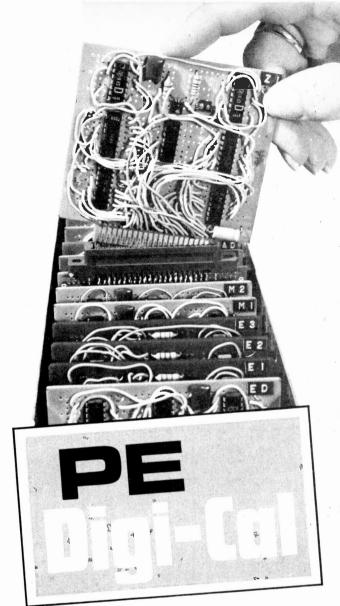
BASIC CIRCUIT

The heart of the CLOCK board is the circuit which produces a batch of ten pulses on demand, all other requirements being met by modification of this basic logic arrangement, which is shown in Fig. 7.1.

The "clock" shown in Fig. 7.1 is simply a square wave oscillator, and this is used to trigger a four-stage, decade counter via a single gate.

The counter will register each of the clock pulses until the tenth one sets the decade counter back to the 0000 state.

This event is detected by the output of the D counter stage falling, and is used to clock a D type flip-flop which has its data input (D) connected to a level "1" gate output (STOP CLOCK signal). When



By R.W.COLES PART 7 CLOCK GENERATOR BOARD

the counter clocks the flip-flop in this way the STOP *CLOCK input causes the flip-flop Q output to go to a "1" level and its \overline{Q} output to go to a "0" level.

The "0" level output from the \(\overline{Q}\) side of the flipflop is connected back to the gate in series with the clock input to the counter, and has the effect of preventing any further pulses from getting through to the trigger input.

If at some future time another batch of ten pulses is required, the flip-flop can be reset via its CLEAR input, whereupon the sequence is repeated.

Practical Electronics January 1973

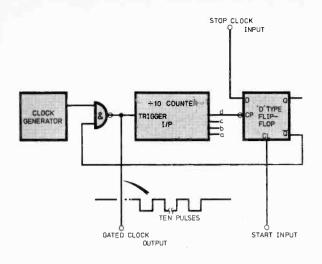


Fig. 7.1. This diagram shows the heart of the clock generator board

If more than one batch of ten pulses is required the STOP CLOCK input can be left in the "0" state so that when the flip-flop is clocked at the end of ten pulses, its \overline{Q} output remains in the "1" state.

When sufficient batches have been produced the STOP CLOCK input can be taken to the "1" condition so that at the end of the next batch the clock is shut off.

Note that with this system no matter how long the clock is allowed to run before being stopped the total number of clock pulses produced will always be divisible by ten, and this is obviously essential for the correct operation of Digi-Cal.

If a smaller number of clock pulses were produced during any batch, the answer produced would be in error by one or more powers of ten.

FULL CIRCUIT

The full clock circuit is shown in Fig. 7.2 and as can be seen a considerable amount of extra gating has been added to modify the basic circuit to enable it to perform all the tasks listed earlier. To make

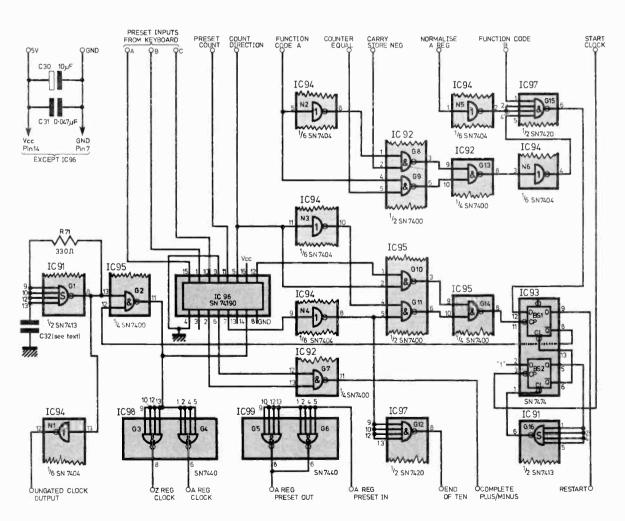


Fig. 7.2. The full circuit diagram of the clock generator board

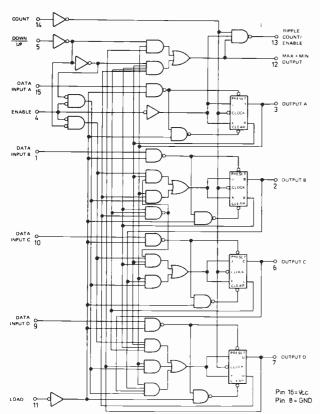


Fig. 7.3. The internal logic of the SN74190 reversible counter with pin numbers of the D.I.L. package

the circuit easier to follow, the gates have not been rigidly constrained within a square box as they have been in previous circuits. That kind of approach can make the whole thing look more complicated than it really is where a lot of gating logic is employed.

UP/DOWN COUNTER

The decade counter used on this board is not the ubiquitous SN7490 as may be expected, because although this type of counter would perform satisfactorily in the basic circuit already discussed, it could not be modified to allow it to carry out task (b).

The counter chosen is in fact the SN74190 which incorporates several extra facilities including the ability to count down as well as up, and the provision of parallel data inputs which allow the starting count to be preset to any b.c.d. number from zero to nine.

The logic diagram of this counter is shown in Fig. 7.3 and a glance at this will serve to confirm that being able to buy one of these in a 16 pin package saves a lot of time and money over having to construct such a circuit from separate gates and flip-flops!

Note that apart from the usual clock input and data outputs, there are parallel data inputs and a wide variety of control inputs and outputs whose functions are listed as follows.

DOWN/UP Decides count direction (i.e. 0 to 0 or 9 to 0)

ENABLE Allows counting to take place (not required in Digi-Cal)

LOAD Presets the counter to the condition on the DATA INPUTS

MAX/MIN Goes to a logic "1" if the counter contains 9 and is count-

ing UP, or 0 and is counting DOWN

RIPPLE COUNT Output used for cascading SN74190 (not required in Digi-

CLOCK OSCILLATOR

The clock oscillator is very simple and takes advantage of the useful properties of the SN7413 dual, four input, Schmitt trigger gate. The gates in this package have regenerative feedback applied so that they can be operated from slowly changing d.c. inputs without any spurious oscillations being produced as can sometimes occur with the standard TTL gate circuit.

The hysteresis embodied in the input characteristic of the SN7413 makes it ideal for use as a free-running multivibrator for use between 1Hz and 30MHz.

The only components required to form such a multivibrator, in addition to one of the gates in an SN7413 package, are a 330 ohm resistor and a capacitor of suitable value to set the frequency to the required range.

When Digi-Cal is completed the clock frequency will be left set to one value, but during the testing phase it is handy to be able to alter the frequency to a much lower value so that things happen more slowly.

To assist constructors in the choice of capacitor for low frequency operation, Fig. 7.4 shows a graph for reading frequency against capacitor value.

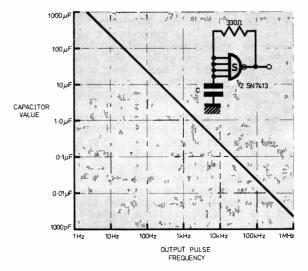


Fig. 7.4. This graph shows the relationship between the clock frequency and the value of the timing capacitor

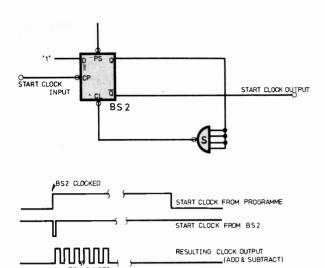


Fig. 7.5. Detail of Fig. 7.2 showing the flip-flop and Schmitt gate used to generate a narrow pulse

COUNTER OPERATION

Using the output of the counter to clock the D-type latch flip-flop is complicated in the full circuit by the need to use different clock stimuli depending on the count direction. This is taken care of by gates G10, G11, G14 and inverters N3, N4 which, depending on the state of the UP/DOWN control line select either the D output or the MAX/MIN output of the counter to feed the SN7474 clock input.

The operation of the counter when generating batches of ten clock pulses is the same as that of the basic circuit, but some extra logic is necessary to start the sequence.

The START CLOCK command arrives as a long pulse from the programme circuits, and because of its length it cannot be used directly to clear BS1. If it was used for this purpose it would start the clock generation satisfactorily, but the ten clock pulses are generated so quickly that when the time came to stop the clock the START CLOCK would still be present and another batch would begin.

To overcome this problem the necessarily long START CLOCK pulse is used to trigger a monostable circuit in the shape of BS2 and G16, which gives a very narrow output pulse which is ideal for clearing BS1.

The use of a flip-flop and a gate as a monostable seems a little strange and to make the operation of this arrangement a little clearer it has been redrawn as Fig. 7.5. The circuit relies upon the normally troublesome "propagation delays" associated with all gates and flip-flops, to allow its operation.

When the rising edge of the START CLOCK pulse arrives it triggers the flip-flop and causes the open circuit or "1" condition to be clocked through from the D input to the Q output. The rising Q output is then used to operate the flip-flop CLEAR input via the SN7413 gate which acts as an inverter and a delay element.

When the flip-flop is cleared the circuit returns to its starting condition, ready to be retriggered in the future. The output pulse width (which could be taken from either the Q or the \overline{Q} output) is dependent on the delay in the gate and the delay between a CLEAR input and a corresponding output (this varies from device to device), but gives a pulse of about 30 to 40 ns in practice.

STOP CLOCK INPUTS

The logic decision whether or not to allow the STOP CLOCK input to BS1 to go to a "1" level is a function of five board inputs, and depends on the arithmetic operation in progress.

The logic producing the STOP CLOCK signal comprises gates G8, G9, G13, G15, and inverters N2, N5, N6. The FUNCTION CODE B input (which is a "0" level during ADDITION and SUBTRACTION) and the NORMALISE A REGISTER input (which is a "0" level during the MULTIPLICATION and DIVISION decimal point positioning period) have a direct effect and stop the clock at the end of one batch of pulses.

The COUNTER EQUAL input (which is the basic STOP signal during MULTIPLICATION) and the CARRY STORE NEGATIVE input (which is the basic STOP signal during DIVISION) are allowed to stop the clock when sufficient batches of ten pulses have been produced, and are selected according to the programme used, by the FUNCTION CODE A input. This input is a '0" level for MULTIPLY and a "1" level for DIVIDE.

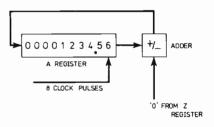


Fig. 7.6. This diagram shows the basic A register and adder sections to illustrate how virtual left shifts are managed

NORMALISATION

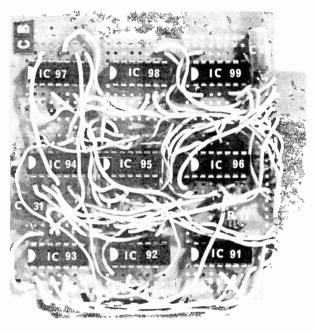
The arithmetic section of Digi-Cal does not take account of decimal fractions directly, and treats all numbers as integers. Thus, 2.5 times 2.0 is treated as 25 times 20, giving an answer of 500 which, when displayed, appears as 50.0, instead of 5.0 as required.

The answer reached in this way obviously needs correction, and this is achieved by shifting it to the right by the number of decimal places selected on the thumbwheel. This part of the programme sequence is called NORMALISATION, and is achieved in a different way during DIVISION.

Division of 2.5 by 0.5 leads to an initial answer of 0.5, which suggests a left shift of one place is required, but in practice it is necessary to left shift not the ANSWER, but the DIVIDEND, before the arithmetic process starts. In this way, 2.5 divided by 0.5 becomes 25.0 divided by 0.5, which gives the correct answer of 5.0 without correction.

Left and right shifts such as those described above obviously require a batch of less than ten clock pulses, and this is where the PRESET inputs of the SN74190 are used to advantage. Before looking at

CLOCK GENERATOR BOARD



Z CLOCK SWITCH & C CODE PRESET CNT CARRY STORE NEG FUNCTION B GND END OF TEN A REG PRESET (UN)
A REG PRESET (IN)
A REG PRESET (IN)
A REG PRESET (IN)
A REG CLOCK
ADD/SUB COMPLETE
RESTART
UNGATED CLOCK
START CLOCK 39 40 41 42 43 44

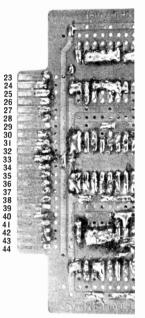


Fig. 7.7. Layout of the components on the clock generator board and function of the edge contacts. Also shown is the wiring details of the edge connector (below left)

0

Z1/21, Z2/21 2 3 4 5 6 7 8 9 10 112 13 14 15 16 17 18 19 20 1 22 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 40 41 42 43 Ç B SW. CODE (fr kbd) B (fr kbd)
P'SET CNT (fr prog)
CNT DIR'N (fr prog)
FUNC CODE A (fr kbd)
AD/36
MI/I7
FUNC CODE B (fr kbd) +5V TO 0'FLOW LOGIC not used not used NORM A REG (fr prog) A1/43, A2/43 P'SET A REG (fr prog) A1/40, A2/40 M1/22 RESTART (to kbd)
UNGATED CLK (to prog)
START CLK (fr prog)

0 CB

COMPONENTS . . .

CLOCK GENERATOR BOARD

Resistors

R71 330 $\Omega \downarrow W \pm 10\%$ carbon

Capacitors

C30 10µF 15V elect. C31 0.047µF

C32 see text

Integrated Circuits IC91 SN7413 IC92 SN7400 1C93 SN7474 IC94 SN7404 IC95 SN7400 IC96 SN74190 **IC97** SN7420 IC98, IC99 SN7440 (2 off)

Printed Circuit Board

Type DL109/22 (Shirehall)

the generation of these shortened batches, it is necessary to look at just how the normally right-shifting a register is made to shift left.

VIRTUAL LEFT SHIFTS

The way in which left shifts are achieved is best studied with the aid of Fig. 7.6 which shows the basic Digi-Cal A REGISTER and ADDER.

The requirement is to shift the number 1234.56 two places to the left, because DIVISION is in progress and the thumbwheel is set to two.

To turn the A REGISTER into a bi-directional type at the hardware level would require considerable numbers of extra gates, not to mention the preclusion of the use of SN7496 devices, and for this reason any such move is undesirable.

Fortunately by employing what amounts to a programming "dodge" it is possible to turn a hardware right shift into a virtual left shift, and this is achieved by clocking the register with 10 minus n pulses.

By applying only eight pulses to the register in Fig. 7.6, and by leaving the output of the ADDER unmodified by the z REGISTER input, the A data recirculates until it ends up as 123456.00.

This system relies on the fact that there are at least n zeros to the left of the number to be shifted, and provides one reason why the A and Z registers are ten digits long.

GENERATING LESS THAN TEN CLOCK PULSES

To generate the *n* pulses needed during the MULTIPLICATION NORMALISATION the counter PRESET COUNT input is taken to a "0" level which loads the true thumbwheel code into the SN74190, e.g. DCBA equals 0011 for a setting of three.

Next, the COUNT DIRECTION input is taken to a "I" level to set the count direction to DOWN, and the START CLOCK input initiates the sequence.

The counter will then count 2, 1, 0, whereupon the MAX/MIN output of the SN74190 will go to "1" clocking BS1 and stopping the clock via G2, only three pulses having been produced in all.

To generate the 10 minus n pulses required during DIVISION NORMALISATION the counter is loaded with the same code as before but in this case the count direction is set to UP, and the sequence for the example of three is, 4, 5, 6, 7, 8, 9, 0, producing a total of seven pulses. The D output of the counter is used to trigger BS1 in this case, not the MAX/MIN output.

BOARD OUTPUTS

There are several outputs from the CLOCK board, some of which (such as the A and Z register buffered clock lines), are self-explanatory. Gate G7 is used to detect counts six and seven to give a negative-going edge after clock seven to trigger the counter boards used during MULTIPLICATION and DIVISION. A trigger for this purpose is produced early in the sequence to allow the COUNTER boards and COMPARATOR to register an equality during MULTIPLICATION and still have time to stop the clock at the end of its run.

This output is called PLUS/MINUS COMPLETE. Gate G12 is used to buffer the pulse produced after each

batch of ten clock pulses to give the END OF TEN output required by the error detection, or OVERFLOW logic.

The RESTART output is taken from the Q output of BS1 and is used to restart the programme during MULTIPLICATION OF DIVISION when the series of additions or subtractions have been completed.

The A register PRESET buffer gates are included on this board for convenience, and have no logic connection with it. They are parallel connected to provide the high drive capability required by the PRESET function of the SN7496.

CONSTRUCTION

This circuit is built on a DL109/22 card, which has a 22-way edge contact on the printed side of the board. The component layout and edge contact wiring is shown in Fig. 7.7.

Wiring-up follows the same pattern as was outlined for previous boards.

The value of the capacitor used to set the clock frequency is about 3,000pF for the completed Digi-Cal (three 001µF capacitors in series were used in the prototype) but during testing procedure it is often convenient to use a very slow clock to enable the exact operation of the programme for instance to be traced using only the display and perhaps a voltmeter as indication.

The prototype has been tested with values as high as 1,000 µF and still operated correctly, if rather slowly! For this reason it is better not to wire in a capacitor permanently at this stage since a suitable component can be connected when required.

Next month: The Adder Board

POINTS ARISING

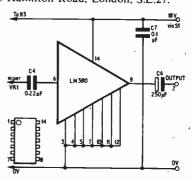
I.C. INTERCOM (October 1972)

It has been brought to our notice that the PA234 i.c. is no longer available. A suitable alternative (not substitute) is the LM380, a 2W amplifier with its gain preset at 50. It requires fewer external components than the PA234 (R4, R5, R6, and C5 are not necessary) as shown below.

not necessary) as shown below.

Minor alterations to the Veroboard layout are required. Pins 3, 4, 5, 10, 11 and 12 must be connected to a heatsink for 2W. It is recommended that a piece of copper be soldered to these pins under the panel if the i.c. is to be used at high power for any length of time. (This i.c. will drive an 8 ohm speaker.)

The LM380 is available (£1.45) from D.T.V. Group Ltd., 126 Hamilton Road, London, S.E.27.



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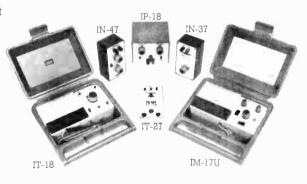
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RE WE so immersed in the technicalities of hi fi equipment that we are sometimes guilty of spurning the real purpose of that equipment?

This poignant remark heard at this year's Audio Fair at Olympia is perhaps more significant in its implications than in the statement itself. It was a further cause for ponderance on tasting some of the lectures held simultaneously with the exhibition. These were enthusiastically attended and the presentation by the speakers was generally of a high standard. But one must hold some sympathies with the lay public who in some cases found the technical content some justification for not staying to the end.

On further analysis one can conclude that those keenly interested in hi fi equipment are extremely knowledgeable on the technical aspects. So much so that this is largely responsible for the cool reactions so far to quadraphonic reproduction in this country.

There has so far been a continuous air of "wait and see how it goes," while the Japanese persistently try to convince the British public that their systems are "proof of the pudding." If one was to assess quadraphonic sound on what one hears at Olympia then there can be little surprise at disillusionment, with comments like . . . "But who wants to sit in the middle of the orchestra."

SIMULATED AMBIENCE

To sell quadraphonic sound, not only does the cost have to be fully justified, but also the ultimate accommodation in the home has to be compatible with normal domestic requirements. With necessary furnishings to blend with, both acoustically and visually, successful four-channel ambience is largely dependent on room dimensions and acoustic properties. A pseudo mock-up in a crowded stereotype

cubicle does not give a fair indication to the listener of what quadraphonic ambience should be like in a domestic setting and all too often these demonstrations were valueless. As one exhibitor put it: The speaker system is only as good as the room that loads it. The addition of ten or twenty listeners in the room adds further influence.

Only a trickling of British companies are offering four-channel facilities, usually in the form of a matrix decoder fed from two-channel equipment. The merits of this method lie only in the convenience of adaptability from existing equipment to suit "quadraphonic" recordings. The major drawback is some loss of channel separation. True quadraphonic ambience is only really authentic when derived from totally independent channels. The CD-4 discrete recorded four-channel system is the recommended version that uses this method.

Those offering quadraphonic equipment at the Audio Fair include the following (the code letters indicate equipment origin): J—Japan, WG—West Germany, UK—United Kingdom, USA—United States of America, DM—Denmark.

BRITISH FOUR-CHANNEL EQUIPMENT

Goodmans Module 90 tuner amplifier (UK)—an impressive piece of equipment with excellent styling. This unit receives m.w. and f.m. bands by preset or variable tuning and contains a 45+45 watt r.m.s. amplifier with less than 0·1 per cent total harmonic distortion.

The model shown in our photograph is the white finish version and has elegant push-button arrays, twin level meters and slider controls. The "4D ambiophonic capability" will require two additional speaker units, while the main circuitry incorporates many of the features of the slightly

more expensive Models One-Ten and Module 80 (f.m.). Four f.m. band presetting controls are provided at the bottom right-hand end which are selected by four push-buttons above them. Two power output meters are also fitted.

Compared with some units this represents good

value at £121 (white finish).

FOREIGN QUAD

Grundig (WG) have an integrated tuner/amplifier complete for four-channel sound and including all the necessary decoder and amplifier circuitry ready for connection to four speakers. This is called the "Studio 2000b," has all the features expected of its kind, but is priced at £238·60, which includes a Dual 1216 transcription auto-changer fitted with a Shure M75 MBD magnetic cartridge.

The tuner has seven v.h.f. pre-selectors, each with its own tuning scale and short, medium and long wave reception. This might be classed as budget equipment of superior quality although the dis-

tortion figures ought to be better.

An alternative version without the transcription unit and of lower output (12.5W r.m.s.) is the Grundig RTV 800, and the RTV 900 at 25W r.m.s. per channel is similar in appearance. Similar push buttons are used as in the Goodmans unit and slider controls are also preferred. The photograph shows the RTV 800 with the individual tuning scales to the left of the main scale.

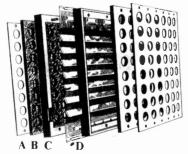
All three of these models are large, at least 22in long, the Model 2000b being larger. The RTV 800 is priced at £135.80 and the RTV 900

at £177.25.

Other ranges of quadraphonic equipment shown were from National Panasonic (J), JVC Nivico (J), Pioneer (J), Sansui (J), Sanyo (J), Siemens (WG), Sony (J), most of whom have demonstrated this technique before in some form. Golding Skandia (J) also had cartridge players quoted as "simulated quadphonic" at various prices.



Marantz Model 19 stereo receiver



A Steel Plate B Rubber Magnet
C Inert Plastic Frame D Unique Diaphragm

The layers of the isodynamic headphone structure by Rank Wharfedale. Note the printed circuit style diaphragm at D

ISODYNAMIC HYBRID

In taking an overall view of the equipment on show it is evident that manufacturers are coming close to the ultimate performance versus cost factor and innovations such as have been regular occurrences in the past are now very thin on the ground.

Probably one of the most significant commercial developments though shown this year is the Isodynamic Stereo Headphone made by Rank Wharfedale. High quality stereo headphones have so far been somewhat heavy for long term listening, but this one weighs only 13 ounces (375 grammes). It is a semi-hybrid whereby the whole diaphragm is driven evenly and freely as in the electrostatic principle, but is influenced by an anisotropic ceramic/synthetic rubberised sheet magnetised perpendicular to the diaphragm.

The diaphragm is a polymide film with flexible printed circuit style metallic grid. The electromagnetic influences caused by the sound signal passing through this grid, in conjunction with the magnetised rubber, make the diaphragm move.

Subjective measurements on these phones show no violent variation in spectral response and the frequency response using a standard "artificial ear" shows -3dB points at 40Hz and 15kHz. The price is competitive at £19.95.

RAPID DEVELOPMENT

With the expansion of stereo broadcasting to Radio 2 (from early November) and the likelihood of commercial sound broadcasting to come, one would have expected to see a strong emphasis on advanced tuner developments using integrated circuits. There were surprisingly few; the general trend seems to be to integrate the complete tuner with the amplifier in one case. Very few separate tuners were evident.

However, Lecson Audio (a promising newcomer) have in less than 12 months produced some superb high quality equipment in revolutionary new styling. The tuner TF1 is a self-powered unit with preset v.h.f. tuning and variable tuning controls for stereo or mono broadcasts.

The controls take the form of sliding bars matching the case styling. The performance is specified as 1.5µV sensitivity for 30dB quieting; a.m. rejection 42dB; signal-to-noise ratio better than 60dB; audio frequency response ± 1dB 20Hz to 14.5kHz.

LOW DISTORTION

The matching control unit pre-amplifier, also selfpowered with slide controls and electronic switching, is a two-channel stereo unit with two four-channel configurations for a supplementary matrix decoding surround-sound unit, to be made available. The performance is claimed to be so impressive that the sceptics will probably need convincing.

There are the usual input facilities to be expected with signal-to-noise ratios of 70dB (magnetic pick-ups) and 80dB for others. Outputs supply 500mV into 1kΩ loads for pick-up and radio; 100mV for tape; 2W into 8 ohms for headphone use. Distortion is quoted as typically less than 0.02 per cent; frequency response + 0.5dB 10Hz to 25kHz.

The power amplifiers AP1 and AP2 boast distortion figures of less than 0.005% at 1kHz at 35W, less than 0.02% at 50W and better than 0.05%

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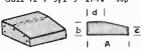
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3-3µF	63V	6p	68µF	16V	6 p
4.7µF	63V	6р	100μF	107	6 p
8µF	40 V	7 p	220µF	16V	7 p
10µF	25V	6p	330µF	16V	116
10µF	64V	7 p	470µF	107	116
I 6µF	40V	7 p	1,000µF	16V	19p
33µF	16V	6р	1,500µF	16V	23 p

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Jack. 2 mm unscreened
Jack. 3 mm unscreened
Jack. 3 mm unscreened
Jack. 3 mm unscreened
Jack. 4 in screened
Jack. 4 in screened
Jack, 4 in screened
Jack, 4 pin screened
Jack, 4 pin screened
Jack, 4 pin screened
Jack, 4 pin screened
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Co-axial
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D.I.N. 3 pin, 180°
D.I.N. 5 pin, 180°
D.I.N. 5 pin, 240°
Jack, 3 mm
Jack, 4 in screened
Jack, tereo, screened
Phono, plated metal

SOCKETS

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Co-axial, surface
Co-axial, flush
D.I.N. 2 pin (speaker)
D.I.N. 3 pin
D.I.N. 5 pin, 180°
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Jack, 4 jin unswitched
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3-3 pf 500V 5/M 7 pr 0-0033 pf 500V Poly. 6p 10pf 125V P.S. 5p 0-0034 pf 500V 5/M 13p 100Pf 125V P.S. 5p 0-0034 pf 500V 5/M 13p 10pf 125V P.S. 5p 0-0047 pf 500V 5/M 13p 125V P.S. 5p 0-0047 pf 500V 5/M 20pf 125V P.S. 5p 0-0047 pf 500V 5/M 20pf 125V P.S. 5p 0-0047 pf 500V 5/M 20pf 125V P.S. 5p 0-0047 pf 1.000V MDC 6p 125V P.S. 5p 0-0047 pf 1.000V MDC 6p 125V P.S. 5p 0-005 pf 100V MDC 6p 125V P.S. 5p 0-005 pf 100V MDC 6p 125V P.S. 5p 0-005 pf 100V MDC 6p 125V P.S. 5p 0-005 pf 125V P.S. 101 pr 125V P.S. 5p 0-0068 pf 500V 5/M 30p 33pf 500V 5/M 71p 0-0082 pf 125V P.S. 101 pr 125V P.S. 5p 0-01 pf 125V P.S. 101 pr 125V P.S. 5p 0-01 pf 125V P.S. 101 pr 125V P.S. 101 pr 125V P.S. 5p 0-01 pf 125V P.S. 101 pr 12	2-2 pF	500V	S/M	71p			P.S.	6p
Spf 500V S/M 71p 0.0033µF 1.000V MDC 6p 10pF 500V S/M 71p 0.0047µF 12sV P.S. 9p 15pF 500V S/M 71p 0.0047µF 12sV P.S. 9p 15pF 500V S/M 71p 0.0047µF 500V S/M 20p 15pF 500V S/M 71p 0.0047µF 500V S/M 20p 12pF 500V S/M 71p 0.0047µF 500V S/M 20p 22pF 12sV P.S. 5p 0.005µF 100V Mplar 3p 22pF 500V S/M 71p 0.006µF 500V S/M 3p 33pF 500V S/M 71p 0.006µF 500V S/M 30p 33pF 500V S/M 71p 0.008µF 500V S/M 30p 33pF 500V S/M 71p 0.008µF 500V S/M 30p 47pF 500V S/M 71p 0.01µF 12sV P.S. 101p 50pF 500V S/M 71p 0.01µF 160V M.F. 3p 68pF 500V S/M 71p 0.01µF 500V S/M 30p 0.01µF 500V S/M 50p 0.01µF 500V S/M 50p 0.01µF 500V S/M 50p			S/M	7 i p	0.0033µF	500V	Poly.	6р
10pF 500V 5/M 7ip 0.0047µF 125V P.S. 9p 15pF 500V Cer. 4p 0.0047µF 500V 5/M 20p 18pF 500V Cer. 4p 0.0047µF 500V 5/M 20p 18pF 500V 5/M 7ip 0.0047µF 1.000V MDC 4p 22pF 125V P.S. 5p 0.005µF 100V Mylar 3p 22pF 500V 5/M 7ip 0.006µF 500V 5/M 31pF 500V 5/M 7ip 0.006µF 500V 5/M 31pF 500V 5/M 7ip 0.006µF 500V 5/M 31pF 500V 5/M 7ip 0.006µF 500V 5/M 30p 33pF 500V 5/M 7ip 0.008µF 500V 5/M 30p 47pF 500V 5/M 7ip 0.008µF 500V 5/M 30p 47pF 500V 5/M 7ip 0.00µF 125V P.S. 10ip 50pF 500V 5/M 7ip 0.01µF 125V P.S. 10ip 50pF 500V 5/M 7ip 0.01µF 500V 6/P 50pF 500V 5/M 7ip 0.022µF 100V 6/P 50pF 500V 5/M 5/P			S/M	7 i p	0.0033µF		MDC	6р
SpF 125V P.S. Sp 0.0047µF 500V SpM 20p 18pF 500V SpM 71p 0.0047µF 1.000V MDC 6p 122V P.S. Sp 0.005µF 100V MDC 6p 22pF 500V SpM 71p 0.005µF 500V Cer. Sp 22pF 500V SpM 71p 0.005µF 500V Cer. Sp 23pF 500V SpM 71p 0.005µF 500V SpM 30p 23pF 500V SpM 71p 0.006µF 500V SpM 30p 33pF 500V SpM 71p 0.006µF 500V SpM 30p 33pF 500V SpM 71p 0.008µF 125V P.S. 101p 33pF 500V SpM 71p 0.008µF 125V P.S. 101p 30pF 500V SpM 71p 0.008µF 125V P.S. 101p 500V SpM 30p 30pF 500V SpM 71p 0.008µF 125V P.S. 101p 50pF 500V SpM 71p 0.008µF 125V P.S. 101p 50pF 500V SpM 71p 0.01µF 125V P.S. 101p 50pF 500V SpM 71p 0.01µF 125V P.S. 101p 50pF 500V SpM 71p 0.01µF 500V SpM 500V SpM 71p 0.01µF 500V SpM 500V SpM 71p 0.01µF 500V SpM							S/M	15p
Spf S00V Cer. 4p 0.0047µF 500V S/M 20p 18pF 500V S/M 71p 0.0047µF 500V MDC 6p 22pF 500V S/M 71p 0.005µF 500V S/M 71p 0.005µF 500V S/M 31pF 500V S/M 71p 0.006µF 500V S/M 31pF 500V S/M 71p 0.006µF 500V S/M 31pF 500V S/M 71p 0.006µF 500V S/M 30pF 500V S/M 71p 0.008µF 500V S/M 30pF 500V S/M 71p 0.008µF 500V S/M 30p 47pF 500V S/M 71p 0.008µF 500V S/M 30p 500V S/M 71p 0.01µF 125V P.S. 101p 50pF 500V S/M 71p 0.01µF 160V 90lV 4p 50pF 500V S/M 71p 0.01µF 500V S/M 30p 1200pF 500V S/M 71p 0.01µF 500V S/M 30p 1200pF 500V S/M 71p 0.01µF 500V S/M 30p 1200pF 500V S/M 71p 0.01µF 600V MDC 7p 1200pF 500V S/M 71p 0.01µF 600V MDC 7p 1200pF 500V S/M 71p 0.02µF 100V Mylar 3p 120pF 500V S/M 7p 0.02µF 100V MDC 10p 120pF 500V S/M 8p 0.047µF 1.000V MDC 10p 120pF 500V S/M 8p 0.047µF 1.000V MDC 10p 120pF 500V S/M 8p 0.047µF 1.000V MDC 10p 100pF 500V S/M 8p 0.047µF 1.000V MDC 10p 10p 120pF 500V S/M 8p 0.047µF 1.000V MDC 10p				7 ½ P	0.0047µF		P.S.	ΑÞ
The content of the			P.S.	3p				
22pF 500V S/M 71p				4P				
22pF 500V S/M 71p 0-005µF 500V Cer. 5p 27pF 500V Cer. 4p 0-006µF 500V S/M 30p 33pF 500V S/M 71p 0-008µF 500V S/M 30p 33pF 500V S/M 71p 0-008µF 500V S/M 30p 33pF 500V S/M 71p 0-008µF 125V P.S. 101p 39pF 500V S/M 71p 0-008µF 125V P.S. 101p 39pF 500V S/M 71p 0-008µF 125V P.S. 101p 50pV S/M 30p 33pF 500V S/M 71p 0-008µF 125V P.S. 101p 50pV S/M 30p 33pF 500V S/M 71p 0-001µF 125V P.S. 101p 50pF 500V S/M 71p 0-01µF 125V P.S. 101p 50pF 500V S/M 71p 0-01µF 125V P.S. 101p 50pF 500V S/M 71p 0-01µF 125V P.S. 101p 50pV S/M 71p 0-01µF 500V S/M 71p 0-02µF 100V Mylar 3p 150pF 500V S/M 71p 0-02µF 100V Mylar 3p 150pF 500V S/M 71p 0-02µF 100V Mylar 3p 120pF 500V S/M 8p 0-047µF 120V MPC 10p 10p 120pF 500V S/M 8p 0-047µF 120V MPC 10p 10p 120pF 500V S/M 8p 0-047µF 120V MPC 10p 10p 120p 120	22.5E		D C			1,000 \$		
25pF 500V S/M 7ip 0.0068µF 125V P.S. 10ip 33pF 125V P.S. 5p 0.0068µF 500V S/M 30p 33pF 500V S/M 7ip 0.0082µF 500V S/M 30p 47pF 500V Cer. 4p 0.01µF 125V P.S. 10ip 50pF 500V S/M 7ip 0.01µF 125V P.S. 10ip 50pF 500V S/M 7ip 0.01µF 125V P.S. 10ip 50pF 500V S/M 7ip 0.01µF 500V Cer. 3p 68pF 500V S/M 7ip 0.01µF 500V Cer. 3p 75pF 500V S/M 7ip 0.01µF 500V Cer. 3p 100pF 500V S/M 7ip 0.01µF 500V Cer. 3p 100pF 500V S/M 7ip 0.01µF 500V S/M 30p 120pF 500V S/M 7ip 0.01µF 500V MDC 7p 100pF 500V S/M 7ip 0.01µF 600V MDC 7p 120pF 500V S/M 7ip 0.02µF 100V Mylar 3p 120pF 500V S/M 7ip 0.02µF 100V Mylar 3p 120pF 500V S/M 7ip 0.02µF 100V Mylar 3p 120pF 500V S/M 7ip 0.02µF 100V MDC 10p 120pF 500V S/M 8p 0.04µF 120V NF. 4p 120V NF. 4p	22 pF		S/M	71p				
27pF 500V Cer. 4p 0.0068µF 500V S/M 30p 33pF 500V S/M 71p 0.0082µF 125V P.S. 101p 33pF 500V S/M 71p 0.0082µF 125V P.S. 101p 500V S/M 30p 47pF 125V P.S. 5p 0.01µF 125V P.S. 101p 500V S/M 30p 47pF 125V P.S. 5p 0.01µF 125V P.S. 101p 500V S/M 30p 500V S/M 71p 0.01µF 125V P.S. 101p 50pK 500V S/M 71p 0.01µF 125V P.S. 101p 50pK 50pK 50pK 50pK 71p 0.01µF 125V P.S. 101p 50pK 68pF 125V P.S. 5p 0.01µF 500V S/M 71p 0.01µF 500V S/M 70p 0.01µF 1.000V P.D. 70pK						125V	P.S.	10 ip
33pF 500V 5/M 71p 0.0082\(\mu F \) 500V 5/M 30p 47pF 125V P.S. 5p 0.0082\(\mu F \) 500V 5/M 30p 47pF 125V P.S. 5p 0.01\(\mu F \) 125V P.S. 101p 500V 5/M 30p 50pF 500V 5/M 71p 0.01\(\mu F \) 125V P.S. 101p 50pF 500V 5/M 71p 0.01\(\mu F \) 125V P.S. 101p 50pF 500V 5/M 71p 0.01\(\mu F \) 125V P.S. 101p 68pF 125V P.S. 5p 0.01\(\mu F \) 50V 5/M 71p 0.01\(\mu F \) 60V 70V 7	27pF	500V	Čer.	4p		500V	S/M	
39pF 500V 5/M 7ip 0-0082μF 500V 5/M 30p 47pF 500V Cer. 4p 0-01μF 12SV P.S. 10ip 50pF 500V 5/M 7ip 0-01μF 500V 68pF 500V 5/M 7ip 0-01μF 500V 67p 68pF 500V 5/M 7ip 0-01μF 500V 67p 68pF 500V 5/M 7ip 0-01μF 600V MDC 7p 100pF 500V 5/M 7ip 0-01μF 600V MDC 7p 120pF 500V 5/M 7ip 0-02μF 100V Mylar 3p 150pF 500V 5/M 7ip 0-02μF 100V Mylar 3p 150pF 500V 5/M 7ip 0-02μF 100V Mplar 3p 150pF 500V 5/M 7ip 0-02μF 100V MDC 7ip 100V 1	33pF			5p		500V	Poly.	
47pF 125V P.S. 5p 0·01 μF 18V Disc 4p 47pF 500F 500V S/M 7ip 0·01 μF 125V P.S. 10jp 50pF 500V S/M 7ip 0·01 μF 160V Poly 4p 68pF 125V P.S. 5p 0·01 μF 250V M.F. 1p 68pF 125V P.S. 5p 0·01 μF 500V Poly 3p 82pF 500V S/M 7ip 0·01 μF 500V S/M 3p 100pF 500V S/M 7ip 0·01 μF 100V PolV 3p 100pF 500V S/M 7ip 0·01 μF 100V PolV 3p 10pF 500V S/M 7ip 0·01 μF 400V PolV 3p 10pF 500V S/M 7ip 0·02 μF 400V Poly 3p 10pF 500V S/M	33pF			71p	0.0082µF	125V		10 P
47pF 500V Cer. 4p 0-01 F 125V P.S. 10 p 50pF 500V S/M 7 p 0-01 F 160V Poly. 4p 56pF 500V S/M 7 p 0-01 F 160V Poly. 4p 56pF 500V S/M 7 p 0-01 F 250V M.F. 3p 68pF 500V S/M 7 p 0-01 F 500V Cer. 5p 75pF 500V S/M 7 p 0-01 F 500V Cer. 5p 75pF 500V S/M 7 p 0-01 F 500V S/M 30p 100pF 500V S/M 7 p 0-01 F 500V MDC 7p 100pF 500V S/M 7 p 0-01 F 600V MDC 7p 100pF 500V S/M 7 p 0-01 F 600V MDC 7p 100pF 500V S/M 7 p 0-01 F 600V MDC 7p 100pF 500V S/M 7 p 0-01 F 600V MDC 7p 100pF 500V S/M 7 p 0-01 F 600V MDC 3p 120pF 500V S/M 7 p 0-02 F 600V Mylar 3p 150pF 500V S/M 7 p 0-02 F 600V MPlar 3p 150pF 500V S/M 7 p 0-02 F 600V MDC 7 p 150pF 500V S/M 7 p 0-02 F 600V MDC 7 p 150pF 500V S/M 7 p 0-02 F 600V MDC 7 p 150pF 500V S/M 7 p 0-02 F 600V MDC 7 p 150pF 500V S/M 7 p 0-02 F 600V MDC 7 p 150pF 500V S/M 7 p 0-02 F 600V MDC 7 p 150pF 500V S/M 7 p 0-02 F 600V MDC 7 p 150pF 500V S/M 8p 0-047 F 120V MF. 4p 250pF 500V S/M 8p 0-047 F 120V MF. 4p 400V Poly. 3p 30pF 500V S/M 8p 0-047 F 600V MDC 8p 600PF 500V S/M 8p 0-047 F 600V MDC 8p 600PF 500V S/M 8p 0-047 F 600V MDC 8p 600PF 500V S/M 8p 0-14 F 600V MDC 8p 600PF 500V S/M 8p 0-14 F 600V MDC 8p 600PF 500V S/M 8p 0-14 F 600V MDC 8p 600PF 500V S/M 8p 0-14 F 600V MDC 8p 600PF 500V S/M 8p 0-14 F 600V MDC 8p 600PF 500V S/M 8p 0-14 F 600V MDC		500V	S/M	7jp				30p
Sope	4/PE			3P				
Sept				710				
68pF 125V P.S. 5p 0-01µF 500V Cer. 3p 75pF 500V S/M 71pD 0-01µF 500V S/M 30p 82pF 500V S/M 71pD 0-01µF 500V S/M 30p 82pF 500V S/M 71pD 0-01µF 500V S/M 30p 100pF 500V S/M 71pD 0-01µF 600V MDC 7p 100pF 500V S/M 71pD 0-01µF 1,000V MDC 7p 100pF 500V S/M 71pD 0-01µF 1600V MDC 7p 100pF 500V S/M 71pD 0-01µF 1600V MDC 7p 100pF 500V S/M 71pD 0-01µF 160V Mylar 3p 150pF 500V S/M 71pD 0-02µF 100V Mylar 3p 150pF 500V S/M 71pD 0-02µF 100V M.F. 3p 150pF 500V S/M 71pD 0-02µF 160V M.F. 3p 150pF 500V S/M 71pD 0-02µF 600V MDC 71pD 200pF 500V S/M 71pD 0-02µF 100V MDC 71pD 125V P.S. 5p 0-033µF 400V Poly. 4p 220pF 500V S/M 8p 0-047µF 12V Disc 6p 270pF 500V S/M 8p 0-047µF 12V Disc 6p 130pF 500V S/M 8p 0-047µF 12V Disc 6p 130pF 500V S/M 8p 0-047µF 12V Disc 6p 1470pF 750V S/M 8p 0-047µF 100V MDC 8p 390pF 500V S/M 8p 0-047µF 100V MDC 8p 560pF 500V S/M 8p 0-047µF 100V MDC 8p 560pF 500V S/M 8p 0-047µF 100V MDC 8p 560pF 500V S/M 8p 0-047µF 100V MDC 10p 680pF 500V S/M 8p 0-1µF 250V M.F. 4p 560pF 500V S/M 8p 0-1µF 250V M.F. 4p 680pF 500V S/M 8p 0-1µF 250V M.F. 4p 680pF 500V S/M 8p 0-1µF 250V M.F. 3p 6001µF 125V P.S. 5p 0-1µF 250V M.F. 3p 6001µF 125V P.S. 6p 0-1µF 100V MDC 10p 680pF 500V S/M 8p 0-1µF 250V M.F. 3p 6001µF 500V S/M 8p 0-1µF 250			S/M		0.01/rE		M.F.	30
68pF 500V S/M 7ip 0-01µF 500V Cer. 3p 82pF 500V S/M 7ip 0-01µF 500V S/M 30p 82pF 500V S/M 7ip 0-01µF 600V MDC 7p 100pF 123V P.S. 3p 0-01µF 1,000V MDC 9p 100pF 500V S/M 7ip 0-01µF 1,000V MDC 9p 100pF 500V S/M 7ip 0-015µF 160V Poly. 3p 120pF 500V S/M 7ip 0-02µF 100V Mylar 3p 150pF 500V S/M 7ip 0-022µF 100V Mylar 3p 150pF 500V S/M 7ip 0-022µF 250V M.F. 3p 150pF 500V S/M 7ip 0-022µF 100V MDC 7ip 120vF 500V S/M 7ip 0-022µF 100V MDC 10p 120vF 125V P.S. 3p 0-033µF 250V M.F. 4p 250pF 500V S/M 8p 0-047µF 125V M.F. 4p 125V	68pF		P.S.	5p				3p
T5pF S00V S/M Tip O-01 F S00V S/M 30p			S/M	71p				, 5p
100pF 125V P.S. 5p 0-01 1,000V MDC 9p 100pF 500V Sym 71p 0-01 5uf 160V Poly. 3p 100pF 500V Cer. 5p 0-01 5uf 160V Poly. 3p 120pF 500V Sym 71p 0-02 uf 180V Poly. 3p 150pF 125V P.S. 5p 0-02 uf 180V Poly. 3p 150pF 500V Sym 71p 0-022 uf 180V Poly. 3p 150pF 500V Sym 71p 0-022 uf 160V MPC 7p 200pF 500V Sym 71p 0-022 uf 100V MDC 7p 200pF 500V Sym 71p 0-022 uf 1000V MDC 7p 200pF 500V Sym 71p 0-022 uf 1000V MDC 7p 220pF 125V P.S. 5p 0-033 uf 250V M.F. 4p 220pF 500V Sym 8p 0-047 uf 12V Disc 6p 270pF 500V Sym 8p 0-047 uf 12V Disc 4p 270pF 500V Sym 8p 0-047 uf 160V Poly. 3p 330pF 125V P.S. 5p 0-047 uf 160V Poly. 3p 330pF 125V P.S. 5p 0-047 uf 160V Poly. 4p 330pF 500V Sym 8p 0-047 uf 160V Poly. 4p 390pF 500V Sym 8p 0-047 uf 160V Poly. 4p 390pF 500V Sym 8p 0-047 uf 160V Poly. 4p 390pF 500V Sym 8p 0-047 uf 160V Poly. 4p 30V Poly. 4	75pF		S/M	7 1 P				30p
100pF 500V 5/M 7jp 0.015µF 160V Poly. 3p 120pF 500V 5/M 7jp 0.02µF 100V Mylar 3p 120pF 500V 5/M 7jp 0.02µF 100V Mylar 3p 150pF 500V 5/M 7jp 0.022µF 250V M.F. 3p 150pF 500V 5/M 7jp 0.022µF 250V M.F. 3p 180pF 500V 5/M 7jp 0.022µF 400V Poly. 3p 180pF 500V 5/M 7jp 0.022µF 400V Poly. 3p 180pF 500V 5/M 7jp 0.022µF 1.000V MDC 7jp 0.022µF 1.000V MDC 7jp 0.022µF 1.000V MDC 7jp 0.022µF 1.000V MDC 10p 0.022µF 1.000V MDC 10p 0.022µF 1.000V MDC 10p 0.022µF 1.000V MDC 10p 0.022µF 1.000V MPC 10p 0.000V MPC 1			S/M				MDC	7p
120pF 500V 5/M 71p 0-02µF 100V Mylar 3p 150pF 500V 5/M 71p 0-022µF 250V M.F. 3p 150pF 500V 5/M 71p 0-022µF 250V M.F. 3p 180pF 500V 5/M 71p 0-022µF 400V Poly 3p 180pF 500V 5/M 71p 0-022µF 600V MDC 71p			P.S.	_5p		1,0000		Ϋ́P
120pF 500V 5/M 71p 0-02µF 100V Mylar 3p 150pF 500V 5/M 71p 0-022µF 250V M.F. 3p 150pF 500V 5/M 71p 0-022µF 250V M.F. 3p 180pF 500V 5/M 71p 0-022µF 400V Poly 3p 180pF 500V 5/M 71p 0-022µF 600V MDC 71p			5/M	/ip		4007		30
ISODF 125V P.S. 5p 0-022µF 18V Disc 5p 150pF 500V Sim 7ip 0-022µF 250V M.F. 3p 150pF 500V Sim 7ip 0-022µF 400V Poly, 3p 180pF 500V Sim 7ip 0-022µF 600V MDC 7ip 200pF 500V Sim 7ip 0-022µF 1,000V MDC 7ip 220pF 125V P.S. 5p 0-033µF 250V M.F. 4p 220pF 500V Cer. 5p 0-033µF 250V M.F. 4p 270pF 500V Sim 8p 0-047µF 12V Disc 6p 270pF 500V Sim 8p 0-047µF 12V Disc 6p 270pF 500V Sim 8p 0-047µF 160V Poly, 3p 330pF 125V P.S. 5p 0-047µF 160V Poly, 4p 330pF 500V Sim 8p 0-047µF 400V Poly, 4p 330pF 500V Sim 8p 0-047µF 400V Poly, 4p 390pF 500V Sim 8p 0-047µF 1,000V MDC 8p 470pF 750V Disc 5p 0-1µF 250V M.F. 4p 500pF 500V Sim 8p 0-1µF 400V Poly, 5p 560pF 500V Sim 8p 0-1µF 400V Poly, 5p 560pF 500V Sim 8p 0-1µF 400V Poly, 5p 560pF 500V Sim 8p 0-1µF 400V Poly, 5p 680pF 500V Sim 8p 0-1µF 400V Poly, 5p 680pF 500V Sim 8p 0-1µF 600V MDC 10p 680pF 500V Sim 8p 0-1µF 600V MPC 10p 6001µF 500V Sim 600V 22µF 250V M.F. 5p 0-001µF 500V Sim 600V MPC 150V MPC 150V MPC 150V MPC 150V 1			Cer.	71n	0.01345	100 V		10
1506F 500V 5/M 7½p 0-022µF 250V M.F. 3p 1809F 500V 5/M 7½p 0-022µF 600V MDC 7½p 1809F 500V 5/M 7½p 0-022µF 600V MDC 7½p 1909C 7½p 1909C 125V P.S. 5p 0-033µF 250V M.F. 4p 220pF 500V 5/M 8p 0-047µF 12V Disc 6p 270pF 500V 5/M 8p 0-047µF 12V Disc 6p 330pF 500V 5/M 8p 0-047µF 12V Disc 5p 0-047µF 1000V MDC 8p 300F 12V P.S. 5p 0-1µF 30V Disc 6p 0-047µF 12V Disc 5p 0-1µF 30V Disc 3p 3v 3v 3v				' Į P	0.0224F			
180pF 500V Cer. 5p 0.022µF 400V Poly. 3p 180pF 500V S/M 71p 0.022µF 600V MDC 71p 200pF 500V S/M 71p 0.022µF 1.000V MDC 71p 220pF 500V S/M 71p 0.022µF 1.000V MDC 71p 220pF 500V Cer. 5p 0.033µF 400V Poly. 4p 270pF 500V Cer. 5p 0.047µF 12V Disc 6p 270pF 500V Cer. 5p 0.047µF 12V Disc 6p 270pF 500V S/M 8p 0.047µF 12V Poly. 3p 330pF 500V S/M 8p 0.047µF 160V MDC 8p 390pF 500V S/M 8p 0.047µF 400V Poly. 4p 330pF 500V S/M 8p 0.047µF 1.000V MDC 8p 470pF 12SV P.S. 5p 0.1µF 400V Poly. 4p 390pF 500V S/M 8p 0.047µF 1.000V MDC 10p 470pF 750V Disc 5p 0.1µF 250V M.F. 4p 500pF 500V S/M 8p 0.1µF 400V Poly. 5p 560pF 500V S/M 8p 0.1µF 400V Poly. 5p 560pF 500V S/M 8p 0.1µF 400V Poly. 5p 560pF 500V S/M 8p 0.1µF 400V Poly. 5p 680pF 500V S/M 8p 0.1µF 600V MDC 10p 680pF 500V S/M 8p 0.12µF 160V MDC 10p 680pF 500V S/M 8p 0.12µF 160V Poly. 6p 0.001µF 100V Mylar 3p 0.22µF 250V M.F. 5p 0.001µF 500V Cer. 5p 0.47µF 250V M.F. 5p 0.001µF 500V Cer. 5p 0.47µF 250V M.F. 8p 0.001µF 500V S/M 10p 0.33µF 500V S/M 10p 0.33µF 500V S/M 10p			S/M	7 to	0.022µF			3 _D
180pF 500V 5/M 71p				5p	0-022µF	400V	Poly.	30
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330pF 500V S/M 8p 0.047μF 600V MDC 8p 390pF 500V S/M 8p 0.047μF 1,000V MDC 10p 470pF 125V P.S. 5p 0.1μF 30V Disc 6p 470pF 750V Disc 5p 0.1μF 250V M.F. 4p 500pF 500V S/M 8p 0.1μF 400V Poly. 5p 560pF 500V S/M 8p 0.1μF 400V Poly. 5p 680pF 500V S/M 8p 0.1μF 600V MDC 10p 680pF 500V S/M 8p 0.1μF 1,000V MDC 14p 1,000V MF. 5p 1,000V MDC 15p 1,000V 1	330pF							4p
390							MDC	8p
470 F 750 V Disc 5p 0-1 μF 250 V M.F. 4p 500 F 500 V S/M 8p 0-1 μF 400 V Poly. 5p 560 F 500 V S/M 8p 0-1 μF 600 V MDC 10p 680 pF 125 V P/S. 6p 0-1 μF 1,000 V MDC 14p 680 pF 500 V S/M 8p 0-1 μF 1,000 V MDC 14p 680 pF 500 V S/M 8p 0-1 μF 1,000 V MDC 14p 1,000 V MDC 14p 160 V Poly. 6p 0-20 μF 1,000 V M.F. 5p 0-20 μF 1,000 V M.F. 6p 0-20 μF 1,000 V M.F. 1,000 V M					0.047µF			
S00pF S00V S/M Sp 0-1 μF 400V Poly. Sp S60pF S00V S/M Sp 0-1 μF 600V MDC 10p 680pF 125V P.S. 6p 0-1 μF 1.000V MDC 10p 680pF 500V S/M Sp 0-1 5μF 250V M.F. Sp 820pF S00V S/M Sp 0-1 5μF 250V M.F. Sp 0-001 μF 100V Mylar 3p 0-22 μF 250V M.F. Sp 0-001 μF 100V Mylar 3p 0-22 μF 250V M.F. Sp 0-001 μF 100V S/M 10p 0-33 μF 1.000V MDC 15p 0-001 μF 1.000V MJC 15p 1.000V MJC 1.000V M					0·1μF			бp
SeopF Soov S/M Sp O-IµF Goov MDC IOp					0·1μF			4 p
680pF 125V P.S. 6p 0-1 μF 1,000V MDC 14p 680pF 500V S/M 8p 0-15 μF 250V M.F. 5p 820pF 500V S/M 8p 0-15 μF 250V M.F. 5p 0-10 μF 100V Mylar 3p 0-12 μF 160V Poly. 6p 0-001 μF 100V Mylar 3p 0-22 μF 250V M.F. 5p 0-001 μF 500V S/M 10p 0-33 μF 250V M.F. 3p 0-20 μF 1,000V MDC 15 0-001 μF 500V Cer. 5p 0-47 μF 250V M.F. 8p 0-001 μF 1,000V MDC 6p 0-47 μF 400V Poly. 3p 0-47 μF 400V Foil 15 p 0-001 5 μF 500V S/M 10p 1-0 μF 250V M.F. 13p 0-001 5 μF 500V S/M 10p 1-0 μF 250V M.F. 13p 0-001 5 μF 500V S/M 10p Note: 3p 0-001 μF 500V Mylar 3p 0-001 μF 500V Mylar 3p 0-002 μF 500V Mylar 3p M.F. = myllar min. foil.				8p				
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$ \begin{array}{cccccccccccccccccccccccccccccccccccc$				8n		250V		5p
0-001 fr 100V Mylar 3p 0-22 fr 250V M.F. 5p 0001 fr 125V P.S. 6p 0-22 fr 400V Foil 10p 0-001 fr 400V Foil 3p 0-22 fr 1,000V MDC 15p 0-001 fr 500V Cer. 5p 0-47 fr 250V M.F. 8p 0-001 fr 1,000V MDC 6p 0-47 fr 400V Foil 15p 0-001 fr 500V Cer. 5p 0-47 fr 1,000V MDC 25p 0-001 fr 500V Cer. 5p 0-47 fr 1,000V MDC 25p 0-001 fr 500V Cer. 5p 0-47 fr 1,000V MDC 25p 0-001 fr 500V Cer. 5p 0-002 fr 500V Cer. 5p MDC—a.c. rating = 300V M.F. = 300V M								6p
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0-001 μF 500V S/M 10p 0-33 μF 250V M.F. 8p 0-001 μF 500V Cer. 5p 0-47 μF 250V M.F. 8p 0-001 μF 1,000V MDC 6p 0-47 μF 400V Foil 15p 0-015 μF 500V S/M 10p 1-0 μF 250V M.F. 15p 0-015 μF 500V Cer. 5p 0-0015 μF 500V Cer. 5p 0-002 μF 500V Mylar 3p 0-002 μF 500V Cer. 5p 0-002 μF 500V Mylar 3p MJC—a.c. rating = 300V M.F. #Myllard min. foil.		125V	P.S.		0-22µF			10p
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0.001 μF 1,000 V MDC 6ρ 0.47 μF 400 V Foil 15ρ 0.001 μF 400 V Foly 3ρ 0.47 μF 1,000 V MDC 25ρ 0.001 μF 500 V S/M 10ρ 1.0 μF 250 V M.F. 15ρ 0.001 μF 500 V Cer. 3ρ 0.001 μF 500 V S/M 10ρ Note: 0.002 μF 500 V Mylar 3ρ 0.002 μF 500 V Cer. 5ρ MDC—a.c. rating = 300 V.002 μF 500 V S/M 10ρ M.F.= Myllard min. foil.			S/M					
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0-0015μF 500V S/M 10p 10μF 250V M.F. 15p 0-0015μF 500V Cer. 5p 0-0018μF 500V S/M 10p Note: 0-002μF 500V Mylar 3p S/M silver mica 1% tol. 0-002μF 500V Cer. 5p P.S. = polystyrene 2½% tol. 0-0022μF 500V S/M 10p Note: 0-0022μF 500V S/M 10p Note: 0-0022μF 125V P.S. 6p MDC—a.c. rating = 300V. M.F.= Myllard min. foil.		400						25p
0-0015µF 500V Cer. 5p 0-0018µF 500V S/M 10p 0-002µF 500V S/M 10p 0-002µF 500V Cer. 5p 0-0022µF 500V Cer. 5p 0-0022µF 125V P.S. 6p 0-0022µF 500V S/M 10p M.F.=Mullard min. foil.	0.001544			100				15p
0.0018µF 500V S/M 10p Note: 0.002µF 100V Mylar 3p 0.002µF 500V Cer. 5p 0.0022µF 500V S/M 10p 0.0022µF 125V P.S. 6p MDC—a.c. rating = 300V. 0.0022µF 500V S/M 10p M.F.=Mullard min. foil.	0.0015µF			5p	. 0,2.	2001	,	
0-002μF 100V Mylar Jp S/M =silver mica 1% tol. 0-002μF 500V Cer. 5p P.S. = polystyrene 2½% tol. 0-0022μF 125V P.S. 6p MDC—a.c. rating = 300V. 0-0022μF 500V S/M 10p M.F.= mullard min. foil.	0.0018µF		S/M	IOp	Note:			
0·0022μF 125V P.S. 6p MDC—a.c. rating = 300V. 0·0022μF 500V S/M 10p M.F. = Mullard min. foil.	0.002µF		Mylar	3р	S/M = si	Iver mica	1% to	ıl.
0-0022μF 125V P.5. δp MDC—a.c. rating = 300V. 0-0022μF 500V S/M 10p M.F.= mullard min. foil. 0-0022μF 1,000V MDC δp Cer. = ceramic.			Cer.	5p	P.S. = p	olystyren	e 21%	tol.
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MAIL ORDERS: Some items have a post and packing charge shown against them. Where p. & p. is not shown the charge is 12p for any selection. When both classes of goods are ordered the charge is 12p plus any p. & p. charges shown. (Overseas extra.) Telephone 01-692 4412.



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at all other frequencies and power levels. Transient distortion effects are claimed to be non-existent, while noise is quoted at less than 90dB below 35W.

The two models AP1 (50W per channel) and AP2 (minimum 70W per channel) are housed in decorative cylindrical cases. Prices match performance: The tuner is £70, AC1 control unit £95, AP1 £75, AP2 £90, and the excellent horn loudspeaker introduced earlier this year £89. Distribution is through appointed dealer only network.

The new AR1214 a.m./f.m. stereo receiver from Heath (Gloucester) Ltd. has an integral 15W + 15W r.m.s. power amplifier and, as in the case of the P.E. Gemini Tuner, uses two integrated circuits, two ceramic filters, a phase locked multiplex demodulator, and a pre-assembled ready aligned f.m. tuning head to provide 2µV sensitivity. The kit price is £69.80.

PRICED PERFORMANCE

Prices of equipment generally at the Fair were high when compared with the forerunners; some may be justified, others perhaps taking advantage of a booming market. It is a strange fact that the high quality goods attract some very high prices.

It is now not unusual to find a single unit costing more than £100 and some tuner/amplifiers combined at more than £200. One even goes as high as £775 and, when £125 is donated to Government funds in the form of purchase tax, the buyer will be asked to find £880—almost the price of a reasonably comfortable family car.

This particular model is the Marantz Model 19 f.m. stereo receiver. The Marantz demonstrator went to great pains to illustrate that all their amplifiers gave an identical sound (and so it seemed to be at Olympia); the reason for the variation in prices

was said to be in the facilities offered. Comparing this Model 19 with their a.m./f.m. stereo receiver Model 2215 at £186, an immediate difference is apparent: the 2215 has an f.m. sensitivity of 4.5mV against 1.8mV, stereo separation at 30dB against 45dB, t.h.d. and intermodulation distortion at 0.5% against 0.15%.

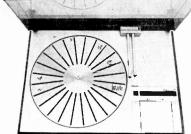
There are others, but do they really add up to nearly £600 worth of extra materials or technical expertise? They also seem to believe that users will frequently need to check amplifier performances on the built-in oscilloscope in the Model 19. Surely this should not be necessary at this price. This American company builds its equipment in Belgium and distributes in the UK through Pyser-Britex (Swift) Ltd., of Edenbridge, Kent.

By comparison with some British units the cost/ performance factor of these units and the new Model 1030 and 1060 amplifiers is generally on the high side.

SERVO TRANSCRIPTION

One would not have thought that there was much more room for development on the transcription unit, but B & O attracted considerable attention with their Model 4000, mainly due to the electronically controlled tangential arm.

Disc cutting heads traverse the disc in a straight line along the radius by using the "lathe screw" principle of motion. The 4000 pick-up does likewise, but instead of having only one arm, it has two, one carrying a photocell which senses the presence, size, and specified playing speed of the disc.



Model 4000 tangential arm transcription unit with servo control by Bang & Olufsen



In conjunction with a servo motor the pick-up lathe screw is driven in synchronism with the rotation of the disc, so avoiding drag friction and skating problems. Preset controls on a panel are set to feed basic data to enable correct operation to be carried out. Any error in setting up will inhibit operation.

Provided specially for this pick-up arm, the new SP15 cartridge has a sealed-in stylus which is factory fitted and tested as being the perfect match for the arm supplied. The price for the complete transcription unit is £179.50 (teak), £180.50 (rosewood), and replacement cartridges SP15 are £36.08.

IN BRIEF

Following the success of the DM1 Monitor loudspeaker system by B & W Electronics at £37.39, they have now introduced the DM4 which has greater power handling capacity and extended bass response down to 30Hz. This model sells at £49.66.

BSR have produced an eight-track stereo tape cartridge player, the TD8-3V at £27-99.

New plinth systems have been designed and produced by SME, the Model 2000, which is available in component form to suit various Thorens transcription units and SME pick-ups. Prices vary, but for a complete plinth with Perspex cover you can expect to pay in the region of £50.

Garrard (part of the Plessey organisation) have also produced plinths with Perspex lids. These "modules" are supplied complete with the transcription units for which they are made, prices ranging from £23.49 for the SP25 Mk 3 (less cartridge) to £59.07 for the Z100S (less cartridge), including purchase tax.

Philips introduced their N2510 high quality stereo cassette deck recorder for chromium dioxide tape. It has twin meters, and sleek slider and push button controls.

The well-known Philips dynamic noise limiter circuit is included in the Philips N2506 and the equivalent Pye model 9145 stereo cassette recorders costing £65.

Other less expensive items of equipment were on show, but it seems that, like most things, new products are an accepted method of attracting higher prices, but that is another subject-not for this page.



TRANSISTOR AUDIO AND RADIO CIRCUITS Published by Mullard 283 pages, 8½in × 5¾in. Price £1·80

THE GREAT popularity of the first edition of this excellent book published in 1969 has led Mullard to update and augment the information, and present it in a second edition. The appeal of the first edition must be attributed to the wealth of useful and really practical circuits presented. All the circuits are of proven design and the performance figures quoted are taken from the prototypes rather than merely theoretical calculations.

In addition to the established designs for 10W and 25W amplifiers there are three new circuits for 15W, 35W, and 50W amplifiers together with a preamplifier

for these circuits.

Other additions to the first edition are a radio receiver, and amplifiers using integrated circuits. There is also a new chapter on loudspeakers, which discusses choosing a suitable speaker and design features of enclosures for high quality systems.

Other sections describe tape recorders with a design for a 4W machine, a circuit for a high quality f.m. tuner, and a chapter on a.f. amplifiers for car radios. Full details of all components are given as well as suppliers for the more difficult to obtain devices. No constructional details are given although where special care needs to be taken, as in the case of stereo amplifiers, this is more than adequately discussed.

Though not designed for the beginner this is a book from which everyone can learn, and a price that anyone can afford makes this an excellent,

practical, reference work.

S.R.L.

HI FI YEAR BOOK—1973 Edited by C. Sproxton Published by IPC Electrical-Electronic Year Book Ltd. 464 pages, 83 in × 6in. Price £1.50

FURTHER 88 pages on top of last year's volume, packed with many more items of equipment and accessories for the audiophile. For those new to this regular work, the Hi Fi Year Book catalogues technical specifications and photographs of a wide range of domestic and studio hi fi equipment, following four introductory articles on the state of the art. The articles this year include an insight into specifications jargon, a selection of pre-recorded cassette tapes, an up to date look into quadraphony—its techniques and purpose, and a survey of loud-speaker development.

Included in the classified directory are added quadraphonic equipment, tape transport machines, decks, and players, tables on tape playing times and v.h.f. transmitters. The standard of production is well maintained, although equipment news released after September 1972 may not be included (for some of these refer to our Audio Fair report

in this issue).

BEGINNERS GUIDE TO TELEVISION

By Gordon J. King Published by Newnes-Butterworths 211 pages, 5in×7§in. Price £1·60.

OMESTIC television receivers have for long had a special kind of fascinating appeal to electronics followers, probably due to the various "tricks" in achieving a satisfactory performance with some pruned down economic circuitry. Since transistors have to a substantial extent replaced valve circuits. I was surprised to find little more than a page devoted to this aspect, but then the majority of this book is concerned with general principles rather than detailed circuit theory. In the examples of valve circuits described, only the basic timebase and pulse circuits are explained, the remainder of the excellent diagrams are mainly illustrative of methods of system operation. The photographs are also of excellent quality, although one or two would probably rate as superfluous.

It is an interesting fact that the 32-page chapter on colour television forms a useful introduction to the colour techniques used, but in the U.K. and Europe the N.T.S.C. system is really only of academic interest. If this system is worth inclusion then, for comparative discussion, so too is SECAM. PAL is the main domestic system, and is briefly described, including delay line techniques; greater detail would have enhanced the value of this

book to the service engineer.

Whilst being somewhat critical of contents selection, one must compensate by complimenting the down to earth writing style and presentation of this popular author. This book is still to be recommended on this account if it suits your requirements, but beginners beware—you do need some prior knowledge of general radio and electronics theory for some parts.

M.A.C.

READER'S DIGEST REPAIR MANUAL Published by The Reader's Digest Association 704 pages, 7½in × 10½in. Price £6:30

THOUGH the price of this book may be somewhat discouraging, the amount of information contained within its pages is really enormous, covering everything from jewellery to caravans. All practical details are explained with the aid of a multitude cf clear, "comic-strip" type drawings and the section on renovating and restoring contains some excellent colour photographs.

To elucidate further on the contents, the main areas covered are: house repairs and decoration; renovating and restoring; repairs around the home and in the garden; electrical equipment; in the garage: and a reference section giving miscellaneous

information and advice.

The section on electrical repairs assumes no technical knowledge and thus only deals with "mechanical" work. The chapter on cars contains some useful information on fitting suppressors to improve radio reception.

This book is not only for the do-it-yourself man but also includes lots of information that women would find very useful, not to mention the children.

S.R.L.

THIS IS THE FIRST PAGE OF THE GREAT BI-PA

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ACY17	0 - 25		0·10 0·10	BC213L BC214L	0·11 0·14	BF154 BF155	0 45	BSY+0 BSY41	0·28 0·28	OC205 OC309	0.85	2N1131 2N1132	0 · 20 0 · 22						
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ACY20 ACY21	0.20		0·15 0·15	BC226 BCY30	0·35 0·24	BF157 BF158	0.55	BSY95A Bul05	0·12 2·00	P397 OCP71	0 - 42	2N1303 2N1304	0·14 0·17	AA119 AA120	0.08	BY133	0.21	OA10	0.35
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ACY27 ACY28	0·18 0·19		0·10 0·30	BCY32 BCY33	0·80 0·22	BF160 BF162	0 · 40 0 · 40	C400 C407	0·30 0·25	ORP60	0.40	2N1306	0.21	AAY30	0.09		0.42	OA79	0.07
ACY29	0.35	BC120	0.80	BCY34	0.25	BF163	0.40	C424	0.20	ORP61 ST140	0 · 40 0 · 12	2N1307 2N1308	0 · 21 0 · 23	AAZ13 BA100	0·10 0·10	BYZ10 BYZ11	0.35	OA81 OA85	0·07 0·09
ACY30 ACY31	0·28 0·28		0.12	BCY70	0.14	BF164	0.40	C425	0.50	ST141	0.17	2N1309	0.23	BA116	0.21	BYZ12	0.30	OA90	0.08
ACT34	0.21		0·18 0·12	BCY71 BCY72	0·18 0·14	BF165 BF167	0.40	C426 C428	0.35	T1843 UT46	0·30 0·27	2N1613 2N1711	0·20 0·20	BA126 BA148	0·22 0·14	BYZ13 BYZ16	0.25	OA91 OA95	0.06
ACY35	0·21 0·28		0 18	BCZ10	0.20	BF173	0.22	C441	0.30	2G301	0.09	2N1889	0.32	BA154	0.12	BYZ17	0.35	OA200	0.06
ACY36 ACY40	0.17		0·12 0·15	BCZ11 BCZ12	0·25 0·25	BF176 BF177	0·35 0·35	C442 C444	0.30	2G302 2G303	0·19 0·19	2N1890 2N1893	0 45	BA155 BA156	0·14 0·13	BYZ18 BYZ19	0.35	OA202 SD10	0.07
ACY41	0.18		0.15	BD121	0.60	BF178	0.30	C450	0.22	2G304	0.24	2N2147	0.72	BY100	0.15	CG62		SD19	0.05
ACY44 AD130	0 · 35 0 · 38		0 · 40 0 · 80	BD123 BD124	0.65	BF179 BF180	0.30	MAT100 MAT101	0·19 0·20	2G306 2G308	0 40	2N2148 2N2160	0 - 57	BY101 BY105	0·12 0·17	(Eg) OA9	0 · 05	IN34 1N34A	0.07
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SN7420	0-43 0-15	0.40	0:38	SN74119	£1:35	£1 · 25	£1 10
SN7422	0.50	0·14 0·40	0-12	SN74121	0.40	0 37	0.34
SN7423	0.50	141	0.45	SN74122 SN74123	£1 -40 £2 -80	£1:30 £2:70	£1 · 10 £2 · 40
SN7425	0.50	0.48	0-45	SN74141	9.47	9 44	0:53
SN7427	0.45	0.42	9.40	SN74145	£1:50	61.46	£1:30
SN7428	0.70	0.45	- 44	SN74150	£3 e0	£2-70	£2:50
SN 7430	0:15	0 14	0-12	SN74151	£1 00	0.95	0.70
SN7432	0.45	0.42	0.40	SN74153	£1 · 20	£1 10	0.95
SN7433	0.80	0.75	9.70	SN74154	£1 -80	£1 70	£1 40
SN7437	0 64	0.62	0.40	SN74155	£1 40	£1:30	£1 28
SN7438	0.84	0.42	0.60	SN74156	£1:40	£1:30	£1-20
SN7440	0.15	0.14	0-12	SN74157	£1.90	£1:80	£1:70
SN 744 I	8-6 7	9-64	0 58	SN74160	£1 80	£1:70	£1 40
SN7442	0-67	0.64	0.50	SN74161	£1 80	£1 -70	£1 40
SN7443	£1:30	£1 -25	£1 -20	SN74162	£4 0 0	£3·75	£3-50
SN7444 SN7445	£1:30	£1 -25	£1 20	SN74163 SN74164	£4-00	£3·75	£3:50
SN7446	£1 86 8 97	£1:77	£1:75 0:88	SN74165	£2 20 £2 25	£2:15 £2:20	£2:10 £2:15
SN7447	£1 00	0.97	0.95	SN74166	£3:50	£3-25	£3 00
SN744R	11.00	0.97	95	SN74174	£2:30	£2·20	£2·10
SN7450	0:15	0 14	0-12	SN74175	£1 60	£1 50	£1-40
SN7451	0.15	0:14	0 12	SN74176	£2:50	£2 -40	£2 · 30
SN7453	0.15	0:14	0.12	SN74177	£2:50	£2 40	£2 :30
SN7454	0.15	0:14	0-12	SN74180	£2 00	£1 60	£1 40
SN7460	0.15	0:14	0:12	SN74181	£5 ·50	£5 e0	£4-75
SN7470	0 - 29	1 24	0-24	SN74182	£2 00	£1-00	E1 60
SN7472	0.29		8-24	SN74184	£3 50	£3 · 25	£3 00
SN7473	0.37	0.35	0.32	SN74190	£1 9 5	£1 90	£1:65
SN7474	0.37	0 35	0-32	SN74191	£1.90	£1 85	£1 60
SN7475	0.45	0.43	0-42	SN74192	£1 95	£1 90	£1:45
SN7476	9.40	0 .39	0:36	SN74193	£2 00	£1 80	£1 75
SN7480 SN7481	9-67	0-64	0.58	SN74194 SN74195	. £2:70	£2 40	£2 :50
SN7481 SN7482	£1:20 0:87	£1-15	£1 10	SN 74195 SN 74196	E2 00 E1 00	£1 76	E1 80
SN7483	£1:10	0 86 £1 05	0-85 0-95	SN74196 SN74197	£1 00	£1-70	El 40
SN7484	£1 40	8 95	195	SN74198	£5 50	25 00	£4-50
SN7485	£3 44	£J-50	£3.40	SN74199	£5 50	£5 00	£4 -50
SN7486	0:32	0:31	0.30				

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Type No. BP201C — S1 201C BP701C — S1.701C BP702C — S1.701C BP702C — S1.702C BP702—72702 BP709—72709 BP710—72710 BP741—72741 BP741—72741 — A703C TAA263—TAA263—TAA263—TAA293—	1-24 68p 68p 68p 53p 36p 36p 44p 45p 75p 28p 70p	Price 25-99 58p 58p 50p 45p 34p 42p 43p 60p 26p 75p	45p 45p 45p 46p 36p 36p 46p 50p 24p 55p 76p
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S.G.S. EA1000 243	170p	158p	150p

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BP933			13p	12p	He
BP935			13p	12p	Hp
BP936			13p	12p	Hp
BP944			13p	12p	11p
BP945			25p	24p	22p
R P946			12p	llp	10p
BP948			25p	24p	22p
8 P951			65p	60p	55p
BP962			12p	Hp	10p
BP9093			40p	38p	35p
BP9094			40p	38p	35p
B P9097			40p	30p	35p
R P9099			40p	36p	.35p
Devices	mak	he	mixed	io avalifa	

quantity price. Larger quantity prices on application. (DTI 930 Series only).

NUMERICAL INDICATOR TUBES

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MODEL	CD66	GR116	3015F Minitron	
Anode voltage (Vdc)	170min	175min	5	
Cathode Current (mA)	2.3	14	8	All indicato
Numerical Height (mm)	16	13	9	point. All sic
Tube Height (mm)	47	32	22	data for a
Tube Diameter (mm)	19	13	12 wide	on request.
I.C. Driver Rec.	BP41 or 141	BP41 or 141	BP47	
PRICE BACH	#1-70	#1-55	\$1.90	

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Three switched stereo inputs, and rumble and scratch filters are features of the PA100, which also has a STEREO/MONO switch, volume, balance and continuously variable has and trails control.

bass and treble controls.



SPECIFICATION.

Frequency Response Harmonic Distortion

Inputs: 1. Tape Head
2. Radio, Tuner
3. Magnetic P.U.

better than 0.1% 1.25 mV into 50 K Ω 35 mV into 50 K Ω 1.5 mV into 50 K Ω All input voltages are for an output of 250mV. Tape and P.U. inputs equalised to RIAA curve within \pm 1dB. from 20Hz to 20KHz.

Bass Control
Treble Control
Filters: Rumble (High Pass)
Scratch (Low Pass)
Signal/Noise Ratio

Input overload

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20Hz - 20KHz ± 1dB

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load dimmer.
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Mid and Lowfrequency audio input
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fitted to fascia for manual flashing
of lamp load. Neon load indicator
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fitted.
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unit with slider fader controls for audio trigger level and background load dimmer. An attractive unit with independent control of High, Mid and Low frequency audio trigger levels. Slider fader background or dimmer controls on each channel, D.J. Pulse-Flash push buttons on each channel together with neon load indicators.

load indicators.

Constructed on glassfibre printed circuit material with attractive black anodised fascia panel. Input and load connections at rear so unit is ideally suited for mounting into disco-console.

Maximum Load 1-5kW per channel at 250V 50Hz.

R.F.I. filters incorporated.

R.F.I. filters incorporated. Price: £38-50 each post free U.K.

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intensity on the loudness of the audio source.

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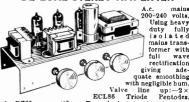
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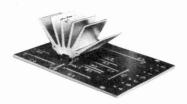
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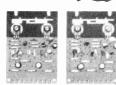
Z.30 & Z.50 power amplifiers

Built, tested and guaranteed with circuits and instructions manual. 2.30 £4.48 7.50 £5 48

The Z.30 and Z.50 are of advanced design using silicon epitaxial planar transistors to provide unsurpassed standards of performance. Total harmonic distortion is an incredibly low 0.02% at 15w (8 Ω) and all lower outputs. Whether you use Z.30 or Z.50 amplifiers in your Project 60 system will depend on personal preference, but they are the same size and are intended for use principally with other units in the Project 60 range. Their performance and design are such, however, that Z.50s and Z.30 may be used in a far wider range of applications.

SPECIFICATIONS (Z.50 units are interchangeable with Z.30s in all applications). — Power Outputs: Z.30 15 watts R.M.S. into 8 ohms using 35 volts: 20 watts R.M.S. into 3 ohms using 30 volts. Z.50 40 watts R.M.S. into 3 ohms using 50 volts. Traquency response: 30 to 300.000Hz \pm 1dB. Distortion: 0.02% into 8 ohms. Signal to noise ratio: better

than 70dB unweighted. Input sensitivity: 250mV into 100 Kohms (for 15w into 8 Ω). For speakers from 3 to 15 ohms impedance. Size: 14 x 80 x 57mm



Project 60 Stereo F.M. Tuner

The phase lock loop principle was used for receiving signals from space craft because of its vastly improved signal to noise ratio. Now, Sinclair have applied the principle to an F.M. tuner with fantastically good results. Other advanced features include varicap diode tuning, printed circuit coils, an I.C. in the specially designed stero decoder and switchable squelch circuit for silent tuning between stations. In terms of high fidelity this tuner has a lower level of distortion than any other tuner we know. Stereo broadcasts are received automatically, a panel indicator lighting up as the stereo signal is tuned in. This tuner can also be used to advantage with most other high fidelity systems.

SPECIFICATIONS—Number of transistors: 16 plus 20 in I.C. Tuning range: 87.5 to 108MHz. Sensitivity: 7µV for lock-in over full deviation. Squelch level: Typically 20µV. Signal to noise ratio: >65dB. Audio frequency response: 10Hz = 15KHz (±1dB). Total harmonic distortion: 0.15% for 30% modulation. Stereo decoder operating level: 2µV. Cross talk: 40dB. Output voltage: 2 x 150mV R.M.S. maximum Operating voltage: 25–30VDC. Indicators: Stereo on: tuning. Size: 93 x 40 x 207mm.

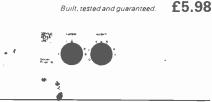


Built and tested. Post free

£25

A.F.U. High & Low Pass Filter Unit

For use between Stereo 60 unit and two Z.30s or Z.50s. The unit is very easily mounted and is unique in that the cut-off frequencies are continuously variable. As attenuation in the rejected band is rapid (12dB/octave), there is less loss of the wanted signal than has previously been possible. Amplitude and phase distortion are negligible. The A.F.U. is suitable for use with any other amplifier system. There are two filter sections – rumble (high pass) and scratch (low pass). H.F. cut-off (—3dB) variable from 28KHz to 5KHz. L.F. cut-off (—3dB) variable from 25Hz to 100Hz. Distortion at 1KHz (35V. supply) 0.02% at rated output. Operating voltage from 15 to 35V. Current 3mA. Size:



Power Supply Units

Designed specifically for use with the Project 60 system of your choice. Use PZ.5 for normal Z.30 assemblies and PZ.6 or PZ.8 where a stabilised supply is essential

PZ.6 35 volts stabilised PZ.8 45 volts stabilised (less mains transformer) £7.98

PZ.8 mains transformer





Typical Project 60 applications

System '	The Units to use	together with	Units cost
Simple battery record player	Z.30	Crystal P.U., 12V battery volume control, etc.	£4.48
Mains powered record player	Z.30, PZ.5	Crystal or ceramic P.U. volume control, etc.	£9.45
12W. RMS continuous sine wave stereo amp. for average needs	2 x Z.30s, Stereo 60; PZ.5	Crystal, ceramic or mag P.U., F.M. Tuner, etc.	£23.90
25W. RMS continuous sine wave stereo amp. using low efficiency (high performance) speakers	2 x Z.30s, Stereo 60; PZ.6	High quality ceramic or magnetic P.U., F.M. Tuner, Tape Deck, etc.	£26.90
80W. (3 ohms) RMS continuous sine wave de luxe stereo amplifier. (60W. RMS into 8 ohms)	2 x Z.50s, Stereo 60; PZ.8, mains transformer	As above	£34.88
Indoor P.A.	Z.50, PZ.8, mains transformer	Mic., guitar, speakers, etc., controls	£19.43

F.M. Stereo Tuner (£25) & A.F.U. (£5.98) may be added as required.

If, within 3 months of purchasing any product direct from Sinclair Radionics Ltd., you are dissatisfied with it, you money will be refunded at once. Many Sinclair appointed Stockists also offer this same guarantee in co-operation with Sinclair Radionics Ltd.

Sinciar radionics cto.

Each Project 60 module is tested before leaving our factory and is guaranteed to work perfectly. Should any defect arise in normal use, we will service it at once and without any charge to you, if it is returned within two years from the date of purchase. Outside this period of guarantee a small chail (typically £1.00) will be made. No charge is made postage by surface mail. Air Mail is charged at cost.

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Power			Values	Price	•
watts	Tolerance	Range	available	1-99	100+
+	5%	4-7Ω-2-2MΩ	E24	1p	0.8p
- 4	10%	3-3MΩ-10MΩ	E12	Ιp	0.8p
1	2%	10Ω-ΙΜΩ	E24	3·5p	3р
Í	10%	10-3.90	E12	l p	0.8p
Į.	5%	4-7Ω-IMΩ	E12	Ιp	0.8p
4	10%	1Ω-10Ω	E12	6p	5-5p
					-4

Quantity price applies for any selection. Ignore fractions on total order

DEVELOPMENT PACK

0.5 watt 5% iskra resistors 5 off each value 4.7 Ω to IM Ω . E12 pack 325 resistors £2.40, E24 pack 650 resistors £4.70.

Carbon track $5k\Omega$ to $2M\Omega$, log or linear (log $\frac{1}{2}W$, lin $\frac{1}{2}W$). Single, 12p. Dual gang (stereo), 40p. Single D.P. switch 24p.

SKELETON PRESET POTENTIOMETERS

Linear: 100, 250, 5000 and decades to 5M0. Horizontal or vertical P.C. mounting (0-1 matrix). Sub-miniature 0-1W, 5p each. Miniature 0-25W, 6p each.

300-miniatore	0 1 VV. 3p	Cacii.	· milacur	C 0 23	v, op cac			
TRANSISTO	RS							
TRANSISTC ACION CONTROL OF CONTRO	AFI 25 AFI 26 AFI 27 AFI 39 AFI 80 AFI 80 AFI 80 BC 107 BC 108 BC 107 BC 147 BC 148 BC 149 BC 157 BC 158	20p 20p 20p 32p 32p 40p 40p 9p 9p 13p 13p 14p	BD132 BD133 BF115 BF173 BF177 BF179 BF180 BF181 BF194 BF195 BF197 BF200 BFY50 BFY51	75p 75p 25p 20p 28p 32p 32p 32p 15p 15p 15p 15p 20p 20p	OC28 OC35 OC42 OC44 OC45 OC70 OC71 OC81 OC82D 2N2904 2N2926 2N2926	R 9p O 9p Y 9p /	2N3702 2N3703 2N3704 2N3705 2N3707 2N3707 2N3709 2N3710 2N3711 2N4062 40360 40361 40361 40408	13p 12p 13p 12p 11p 11p 11p 11p 11p 12p 35p 35p 40p 40p
AFII7 20p AFII7 38p	BC159 BC187	14p 22p	BFY52 BUI05	20p 225p	2N3054		ZTX302 ZTX500	15p
AFI24 22p	BD131	75p	OC26	45p	2N3055	60p	ZTX502	20p

ZENER DIODES 400mW 5% 3.3V to 30V, 15p.

LINEAR I.C.'s (D.I.L.) 709 40p 741, 45p 710 45p 748, 45p DIL Socket 14 and 16 pin. 16p

DIODE	1000000			2 - 250 - 210
RECTIF BY127		IA	12p	SIGNAL OA85
BZVIO	800V	6A	25p	OA90 OA91
BZY13 IN4001	200∨ 50∨	6A IA	20p 7p	OA202
IN4004 IN4007	400V 1000V	IA	12p	IN4148 BA114

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86mm × 9mm × 16mm, length of track 59mm.
SINGLE 10K, 25K, 100K log, or fin. 40p.
DUAL GANG, 10K + 10K etc. log, or fin. 60p.
KNOB FOR ABOVE 12p.
FRONT PANEL 65p.
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MYLAR FILM CAPACITORS 100V 0·001μF, 0·002μF, 0·005μF, 0/01μF, 0·02μF, 21μρ. 0·04μF, 0·05μF, 0·068μF, 0·1μF, 31μρ.

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OLID TANTA	LUM BEAD	CAPACIT	ORS			120
	₄F 35V		35∨ 🐷	22µF	167	
0.22	∡F 35V	4·7µF	35V	33µF	107	
0.47	ιF 35V 👰	6 BuF	25V	47µF	6-3V	
ب(0 ∙ 1	iF 35V ●	IOμF	25V	100µF	3 V	

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	2½ × 3½ 2½ × 5 3½ × 5 7 × 2½ 7 × 5 (plain) 7 × 3½ (plain) 7 × 2½ (plain) 2½ × 3½ (plain) 2½ × 5 (plain)	0·I 22p 24p 24p 27p 75p 100p	0-15 16p 24p 24p 27p 571p 78p 82p 60p 42p 11p	Standard screened 18p 2.5mm insulated Standard insulated 12p 3.5mm insulated 8p 5tero screened 35p 3.5mm screened 13p 5tero screened 35p 3.5mm screened 13p 5tero socket 18p 2.5mm socket 8p 5tero socket 18p 3.5mm socket 8p 0.1.N. PLUGS AND SOCKETS 2 pin, 3 pin, 5 pin 180°, 5 pin 240°, 6 pin Plug 12p. Socket 8p, 4 way screened cable, 15p/metre.
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controls. Built-in pre-amp. Tape speed 33 ips (9.5 cms). Frequency response: playback 30-10,000 Hz; recording/playback 30-8,000 Hz. Line output: fully variable 0-500mV. The RP-1000ST incorporates all the features you'd expect on a top quality Cartridge Tape Deck Size 16" wide, 4" high, 9" deep. Cabinet in walnut, Including connecting leads As reviewed in

REALISTIC 30 WAYT STERED AMPLIFIER MODEL SA-500

February 1972 A superb hir if amplifier with all the fea-tures, you've ever wanted — for under £46-00. Saving over £10.00 on the normal retail value. Up-to-the-minute slider controls for bass and treble. Separate volume and balance controls. Headphone, socket on front panel. Push-button £35.20 input controls — magnetic phono (high/low) tuner, aux, mono, monitor Loudness push-button control for perfect sound at low output levels. Left and right push-button on/off switches for speakers. Noise filtering and tape monitoring facilities. Two auxiliary AC outlets. Frequency response 20-20,000 Hz \pm 1 db at full power. 15 watts rms per channel. Walnut cabinet with satin aluminium trims. Inputs phono 2 5mV and 5mV RIAA; tuner/aux 250mV. Hunand noise: phono - 50db; tuner/aux - 65db. How's that for a specification! Size 14½ wide, 3½ high, 10½ deep



OLSON RA-310 AM/FM/MPX STEREOTUNER

This ROC Tuner is especially designed to match the Oison AM-395 Stereo Amplifier. In price and value, as well as it's good looking design! But of course it's also

ideal for use with any other amplifier. The RA-310 costs £10:00 less than the normal retail value, and yet it is a highly sophisticated unit, incorporating the latest solid state techniques. Operation is drift free for sup 50 00 reme station-holding capability. You can connect this Tuner to a stereo amplifier, to a tape deck or a tape recorder. And of course it covers all the stations in the AM and FM bands. FM: 87-108 MHz; AM: 525-1605 kHz.

FM Sensitivites: FM, $3\mu V$; AM, $250\mu V$. Stereo separation 30dB at 1kHz, image rejection 60dB. Size: $11\frac{n}{16}$ wide, 4 high, $7\frac{1}{2}$ deep.



REALISTIC SA-100B 6-WATT RESTREED AMPLIFIER

Here's fabulous, exciting value in miniature! This high quality stereo amplifier measures only 9" wide \times 3" high × 5%" deep. And yet it has separate ganged volume, balance and tone controls. Plus speaker in/out, mono/stereo, phono,

tuner and power on/off slide switches. The ends are oiled walnut, with matching manualled metal top. The front panel is satin aluminium and walnut-brown ename! Frequency response is 50 to 10,000 Hz \pm 3d8, Output 3 watts r.m.s. per channel into 8 ohms. Inputs are 100mV for both phone and tuner

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24.10

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OLSON AM-395
40-WATT STEREO
AMPLIFIER
An ideal unit for your new

stereo separate system. It is more than £10.00 below the normal retail price! Making the AM-395 one of Britain's best hi-fi

buys. It takes in signals from magnetic or ceramic pick-ups, tuners (see Olson RA-310) and tape decks, And it's got outputs for taping and for heedphones. There are separate base and treble controls, separate Left and Right channel volume controls. And a loughess switch for boosting the bess and

trable notes when istaning at low output levels. Frequency response: 20-20,000 Hz ± 368. Dutput; 20 wetts .m.s. per channel into 8 ohme, inputs: magnetic phono 3 omV RIAA, crystal phono 100mV; tape 160mV; tuner 150mV. Size 11½ "wide, 4"high, 7½" deap. The specification reads well – sounds even batter!



SOLIO STATE STEREO AMPLIFIER The A-3000 looks as good as it sounds! Giving you a big performance this superb audio amplifier has a full range of facilities on the front and rear panels. On the front all the controls you're ever likely to need plus a headphone socket. On the rear -

signal inputs, speaker outputs and a line fuse for circuit protection. Specifications: 18 watts rms per channel into 8 ohms. Fraquency response 20-35,000 Hz (± 2db) Inputs Magnetic, Ceremic, Tuner, Tape, Aux. Tape Play. Size: 345mm × 300mm × 130mm

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These will do justice to your amplifier - and to your pocket. At only £17-80 a pair, they are real value-formoney. Each cabinet is heavily lagged and teak finished. They handle 16 watts rms (8 watts rms each). Each loudspeaker contains a large dual cone base unit, plus a separate tweeter. Frequency range: 40 to 19,000 Hz. Size 14in, high, 9in, wide, 61/4in, deep

Here's mervellous value for someone just starting to set them-selves up in audio! At only £10-50, you get a fine amplifier in a scratch resistant metal cabinat, with a smart brushed eluminium front panel. It incorporates separate tone and volume controls for each channel. Inputs are provided for turntable (caremic cartridge), tunes and tape deck or recorder. Frequency response: 70-20,000 Hz ± 3d8, Output: 2 wetts r.m.s. per channel into 8 obms. Inputs: phono 80mV; tuner/aux 80mV, Size 8" wide, 2§" high,

0 25-WATT 3-WAY CRYSIER LIVING AUDIO SPEAKER CE-56

This high quality speak er has its own built-in 3-way sound response switch. giving you the ideal frequency response for hi-li, netural or mood music listening. Its beautiful, heavy, oiled welnut cabinet

incorporates two separate speaker units on 8" woofer, and a 5 mid-range with 2" concentric tweeter. Power handling capacity: 25 wetts r.m.s into 8 ohms. Overall frequency res — ponse: 35-20,000 Hz. Cebinet size: 10\frac{1}{2}^+ \times 7\frac{1}{4}^+ \times 8\frac{2}{4}^-. Exectly right for matching the most modern decor

£39-95 each.



PALACE AM/FM/MPX STEREO TUNER AMPLIFIER SSA-18 This is one of the lowest priced stero tuner emplifiers on the harket. It covers the full renge of both AM and FM broadcest frequencies. And when you're switched to FM, an indicator lights up when a stereo signal is received – that's the time to switch to 'Stereo'! The SSA-18 has all the facilities you'd expact to find on tuners costing twice as much — separate vol-tip, bass, trable, balance and tuning controls. Selector switch for tape, phono, AM, FM, stereo. Jack socket on front penal for starec headphones. Frequency range: FM 88-108 MHz. AM 535-1605 kHz. Frequency response: 50-10,000 Hz. ± 3d8, Power output: 4 watts total music power into two 8 ohm sceakers. Size: 15" wide, 42" high, 8" deep,

ROC 7-WATT STEREO AMPLIFIE CHASSIS SK-317 This exclusive R D C Stereo Chassisis completely self-contained, and t costs £2 25 less than the normal re-tail value! The SK-317 is a really compact until measuring only 5; "wide, 1§" high and 6% deep. It contains its own mains

power supply, and has a ganged volume control and separate trable controls for each channel. Specification: fraquency response 40-17 000 Hz \pm 3dB; output 3-5 walts music power per channel into 8 ohms, input, phono, 600mV; signal-to-noise ratio better than 45d8



OLSON AM-372 18-WATT STEREO AMPLIFIER R Here's a really good amplifier at a really down-to-earth price naarly C7 less than the normal retail value! Just look at what the AM-372 will do for you – reproduce signels from ceramic or crystel cartridges, AM and FM tuners, and tape recorders. And it gives you outputs for two sets of speakers, headphones and tape recorders. Frequency response is 30 to 20,000 Hz ± 3d8. Output 8 watts r.m.s. per channel music power into 8 ohm speakers. Phono input 200mV. Tuner input 200mV. Size: 12½" wide, 3½" high, 7½" deep.

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2 pin Din Speaker Plug/socket		10p	**
3 pin Din Line Socket		18p	1.7
3.5mm Jack Plug Screened	573	10p	
Standard Jack Plug		10p	11
Screened Standard Jack Plugs	N.	15p	**
Stereo Jack Plug		18p	**
Screened Stereo Jack Plug		18p	100
Phono Plugs: Red or Black 8p each.			
1			

pp on above items 31p.

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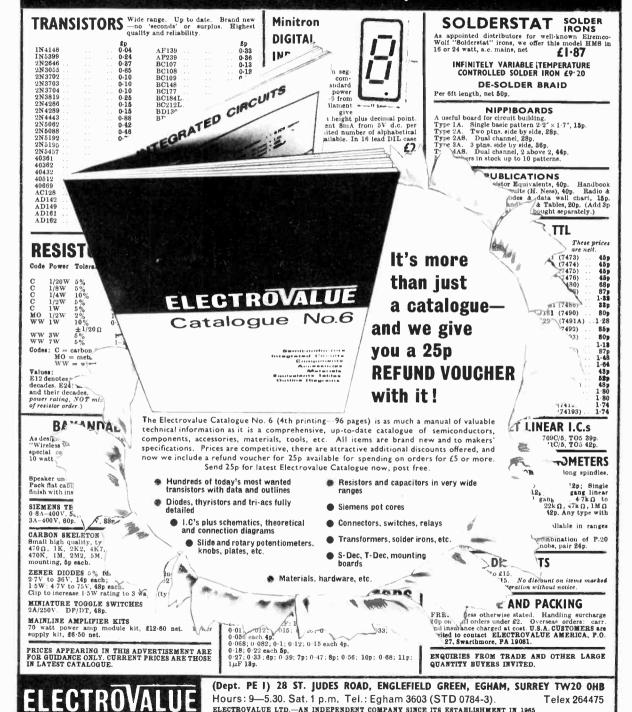
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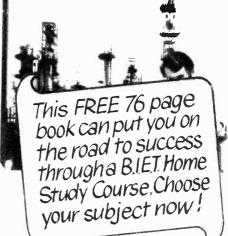
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Operate at 40kc/s up to 100 yds. Ideal remote switching and signalling. Complete with data and circuits.
PRICE PER PAIR £5-90, Post 10p.

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4 TRACK MONO
or 2 TRACK STEREO

17" High Impedance
18" Med-Low Imp.
Erase Heads for above
18 Track mono
19 Track mono
High
Impedance
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