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MAY 1976

30p

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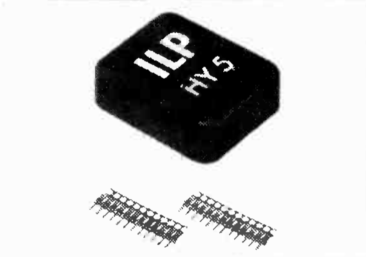
15—240 Watts!

HY5
Preamplifier

The HY5 is a mono hybrid amplifier ideally suited for all applications. All common input functions (mag Cartridge, tuner, etc) are catered for internally, the desired function is achieved either by a multi-way switch or direct connection to the appropriate pins. The internal volume and tone circuits merely require connecting to external potentiometers (not included). The HY5 is compatible with all I.L.P. power amplifiers and power supplies. To ease construction and mounting a P.C. connector is supplied with each pre-amplifier.
FEATURES: Complete pre-amplifier in single pack — Multi function equalization — Low noise — Low distortion — High overload — Two simply combined for stereo
APPLICATIONS: Hi-Fi — Mixers — Disco — Guitar and Organ — Public address
SPECIFICATIONS:
INPUTS. Magnetic Pick-up 3mV, Ceramic Pick-up 30mV, Tuner 100mV, Microphone 10mV, Auxiliary 3-100mV; input impedance 47kΩ at 1kHz.
OUTPUTS. Tape 100mV; Main output 500mV R.M.S.
ACTIVE TONE CONTROLS. Treble ± 12dB at 10kHz; Bass ± at 100Hz.
DISTORTION. 0.1% at 1kHz. Signal/Noise Ratio 68dB.
OVERLOAD. 38dB on Magnetic Pick-up. SUPPLY VOLTAGE ± 16-50V.
Price £4.75 + £1.19 VAT P&P free.



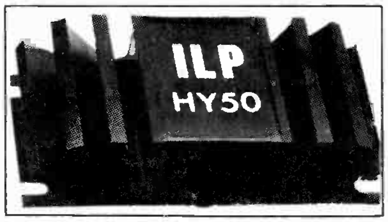
HY30
15 Watts into 8Ω

The HY30 is an exciting New kit from I.L.P. it features a virtually indestructible I.C. with short circuit and thermal protection. The kit consists of I.C., heatsink, P.C. board, 4 resistors, 6 capacitors, mounting kit, together with easy to follow construction and operating instructions. This amplifier is ideally suited to the beginner in audio who wishes to use the most up-to-date technology available.
FEATURES: Complete Kit — Low Distortion — Short, Open and Thermal Protection — Easy to Build
APPLICATIONS: Updating audio equipment — Guitar practice amplifier — Test amplifier — audio oscillator
SPECIFICATIONS
OUTPUT POWER 15W R.M.S. into 8Ω; DISTORTION 0.1% at 15W.
INPUT SENSITIVITY 500mV FREQUENCY RESPONSE 10Hz-16kHz —3dB
SUPPLY VOLTAGE ± 18V
Price £4.75 + £1.19 VAT P&P free.

Available June '76

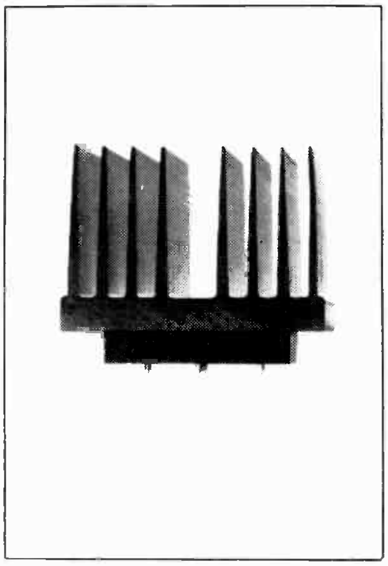
HY50
25 Watts into 8Ω

The HY50 leads I.L.P.'s total integration approach to power amplifier design. The amplifier features an integral heatsink together with the simplicity of no external components. During the past three years the amplifier has been refined to the extent that it must be one of the most reliable and robust High Fidelity modules in the World.
FEATURES: Low Distortion — Integral Heatsink — Only five connections — 7 Amp output transistors — No external components
APPLICATIONS: Medium Power Hi-Fi systems — Low power disco — Guitar amplifier
SPECIFICATIONS: INPUT SENSITIVITY 500mV
OUTPUT POWER 25W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0.04% at 25W at 1kHz
SIGNAL/NOISE RATIO 75dB FREQUENCY RESPONSE 10Hz-45kHz—3dB
SUPPLY VOLTAGE ± 25V SIZE 105.50.25mm
Price £6.20 + £1.55 VAT P&P free.



HY120
60 Watts into 8Ω

The HY120 is the baby of I.L.P.'s new high power range, designed to meet the most exacting requirements including load line and thermal protection this amplifier sets a new standard in modular design.
FEATURES: Very low distortion — Integral heatsink — Load line protection — Thermal protection — Five connections — No external components
APPLICATIONS: Hi-Fi — High quality disco — Public address — Monitor amplifier — Guitar and organ
SPECIFICATIONS
INPUT SENSITIVITY 500mV
OUTPUT POWER 60W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0.04% at 60W at 1kHz
SIGNAL/NOISE RATIO 90dB FREQUENCY RESPONSE 10Hz-45kHz —3dB SUPPLY VOLTAGE ± 35V
SIZE 114.50.85mm
Price £14.40 + £1.16 VAT P&P free.

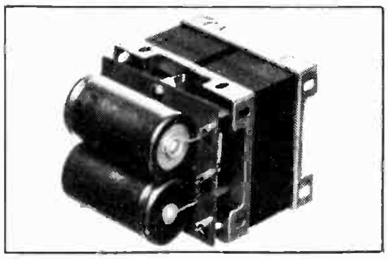


HY200
120 Watts into 8Ω

The HY200 now improved to give an output of 120 Watts has been designed to stand the most rugged conditions such as disco or group while still retaining true Hi-Fi performance.
FEATURES: Thermal shutdown — Very low distortion — Load line protection — Integral heatsink — No external components
APPLICATIONS: Hi-Fi — Disco — Monitor — Power slave — Industrial — Public Address
SPECIFICATIONS
INPUT SENSITIVITY 500mV
OUTPUT POWER 120W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0.05% at 100W at 1kHz
SIGNAL/NOISE RATIO 96 dB FREQUENCY RESPONSE 10Hz-45kHz — 3dB SUPPLY VOLTAGE ± 45V
SIZE 114.100.85mm
Price £21.20 + £1.70 VAT P&P free.

HY400
240 Watts into 4Ω

The HY400 is I.L.P.'s "Big Daddy" of the range producing 240W into 4Ω! It has been designed for high power disco or public address applications. If the amplifier is to be used at continuous high power levels a cooling fan is recommended. The amplifier includes all the qualities of the rest of the family to lead the market as a true high power hi-fidelity power module.
FEATURES: Thermal shutdown — Very low distortion — Load line protection — No external components
APPLICATIONS: Public address — Disco — Power slave — Industrial
SPECIFICATIONS
OUTPUT POWER 240W RMS into 4Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0.1% at 240W at 1kHz
SIGNAL/NOISE RATIO 94dB FREQUENCY RESPONSE 10Hz-45kHz — 3dB SUPPLY VOLTAGE ± 45V
INPUT SENSITIVITY 500mV SIZE 114x100x85mm
Price £29.25 + £2.34 VAT P&P free.



POWER SUPPLIES

PSU36 suitable for two HY30's **£4.75** plus £1.19 VAT. P/P free.
PSU50 suitable for two HY50's **£6.20** plus £1.55 VAT. P/P free.
PSU70 suitable for two HY120's **£12.50** plus £1.00 VAT. P/P free.
PSU90 suitable for one HY200 **£11.50** plus £0.92 VAT. P/P free.
PSU180 suitable for two HY200's or one HY400 **£21.00** plus £1.68 VAT. P/P free.

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electronics today international

MAY 1976 VOL 5. No. 5.

Features

Projects

Data Sheet

News

Information

Special Offer

COVER:- Viewdata in operation on a GPO receiver. Our thanks go to the Post Office for arranging this special photograph for ETI.
Many thanks also to Tektronix for providing the storage scope photos.

EDITORIAL AND ADVERTISEMENT OFFICE
36 Ebury Street
London SW1W OLW
Telephone: 01-730 8282

HALVOR W. MOORSHEAD
Editor

ROBERT C. EVANS
Advertisement Manager

LES BELL, G4CFM
RON HARRIS
Editorial Assistants

JEAN BELL
Production

INTERNATIONAL EDITIONS
COLLYN RIVERS
Editorial Director

AUSTRALIA
Modern Magazine Holdings Ltd
Ryrie House, 15 Boundary Street
Rushcutters Bay 2011
Sydney, Australia.

FRANCE
DENIS KACOB
Editor in chief
CHRISTIAN DARTEVILLE
Editor
Electronique Pour Vous International,
17 Rue de Buci
Paris, France.

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READER SERVICES See page 82 for details of all ETI Reader Services and other information

PROJECTS BOOK 3 page 56

BI-PAK SEMICONDUCTORS

COMPONENTS

CARBON RESISTOR PAKS

These Paks contain a range of Carbon Resistors, assorted into the following groups:—

R1	50 Mixed 100 ohms — 820 ohms ⅛th W	0.60
R2.	50 Mixed 1K ohms — 8.2K ohms ⅛th W	0.60
R3.	50 Mixed 10K ohms — 82K ohms ⅛th W	0.60
R4.	50 Mixed 100K ohms — 820K ohms ⅛th W	0.60
R5.	30 Mixed 100 ohms — 820 ohms ½ W	0.60
R6.	30 Mixed 1K ohms — 8.2K ohms ½ W	0.60
R7.	30 Mixed 10K ohms — 82K ohms ½ W	0.60
R8.	30 Mixed 100K ohms — 820K ohms ½ W	0.60

These are unbeatable prices.

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500 µF 50V Elect 0.09 each
01 µF 400V 0.03 each

REPANCO CHOKES & COILS

RF Chokes	CH1	2.5mH	0.27
	CH3	7.5mH	0.29
	CH5	1.5mH	0.26
	CH2	5.0mH	0.28
	CH4	10mH	0.31
COILS	DRX1 Crystal set		0.29
	DRR2 Dual range		0.42

CARBON POTENTIOMETERS

Log and Lin 4.7K, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M.

VC 1	Single Less Switch	0.20
VC 2	Single D.P. Switch	0.40
VC 3	Tandem Less Switch	0.60
VC 4	1K Lin Less Switch	0.20
VC 5	100K Log anti-Log	0.60

HORIZONTAL CARBON PRESETS

0.1 Watt 0.09 each
100, 220, 470, 1K, 2.2K, 4.7K, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M, 4.7M.

REPANCO TRANSFORMERS ★

240V. Primary. Secondary voltages available from selected tappings 4V, 7V, 8V, 10V, 40V, 50V and 25V-0-25V.

Type	Amps	Price	P&P
MT50/½	½	£3.00	0.45
MT50/1	1	£4.00	0.48
MT50/2	2	£5.00	0.60

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NORMAN ¼" Cores & Formers 0.07p
⅜" Cores & Formers 0.09p

SWITCHES

DP/DT Toggle 0.28p
SP/ST Toggle 0.22p

FUSES

20mm, 100mA, 200mA, 250mA, 500mA, 1A, 1.5A, 2A QUICK BLOW *0.05p each
Anti-surge 20mm only *0.8p each

VEROBOARDS★

VB 1
containing approx. 50sq. ins. various sizes all 0.1 matrix *0.60p
VB 2
containing approx. 50 sq. ins. various sizes all 0.15 matrix *0.60p

DECON-DALO 33PC Marker★

Etch resistant printed circuit marker pen. Full instructions supplied with each pen *0.92p

BATTERY HOLDERS★

Takes 6 H.P. 7's complete with terminal clip and lead *0.31p each

V.A.T.

ALL PRICES EXCLUDE V.A.T.

Please add 8% to all prices marked *. Remainder add 25%. Do NOT add V.A.T. to prices marked †.

INSTRUMENT CASES

(In 2 sections, Black Vinyl covered top and sides and bezel)

No.	Length	Width	Height	Price
BV1	8"	x 5¼"	x 2"	*£1.25
BV2	11"	x 6"	x 3"	*£1.62
BV3	6"	x 4¾"	x 1½"	*£0.92
BV4	9"	x 5¼"	x 2½"	*£1.39

ALUMINIUM BOXES

No.	Length	Width	Height	Price
BA1	5¼"	x 2¼"	x 1½"	*0.45
BA2	4"	x 4"	x 1½"	*0.45
BA3	4"	x 2¼"	x 1½"	*0.45
BA4	5¼"	x 4"	x 1½"	*0.54
BA5	4"	x 2½"	x 2"	*0.45
BA6	3"	x 2"	x 1"	*0.39
BA7	7"	x 5"	x 2½"	*0.79
BA8	8"	x 6"	x 3"	*£1.02
BA9	6"	x 4"	x 2"	*0.65

(Each complete with ½" deep lids & screws)
PLEASE ADD 20p POSTAGE AND PACKING FOR EACH BOX

COMPONENT PAKS

Pak No.	Qty	Description	Price
C1	200	Resistors mixed values approx. count by weight	.60
C2	150	Capacitors mixed values approx. count by weight	.60
C3	50	Precision Resistors mixed values	.60
C4	75	⅛th W Resistors mixed preferred values	.60
C5	5	Pieces assorted Ferrite Rods	.60
C6	2	Tuning Gangs. MW/LW VHF	.60
C7	1	Pak Wire 50 metres assorted colours	*.60
C8	10	Reed Switches	*.60
C9	3	Micro Switches	*.60
C10	15	Assorted Pots & Pre-Sets	.60
C11	5	Jack Sockets 3 x 3.5m, 2 x standard Switch Type	.60
C12	30	Paper Condensers preferred types mixed values	.60
C13	20	Electrolytics Trans. types	.60
C14	1	Pack assorted Hardware-Nuts/Bolts, Grommets etc.	*.60
C15	5	Mains Slide Switches, 2 Amp	.60
C16	20	Assorted Tag Strips Panels	.60
C17	10	Assorted Control Knobs	.60
C18	4	Rotary Wave Change Switches	.60
C19	2	Relays 6-24V Operating	*.60
C20		Sheets Copper Laminate. approx. 200 sq. ins.	*.60

Please add 20p post and packing on all component packs, plus a further 10p on pack nos. C1, C2, C19 & C20.

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CABLES

			Per Metre
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CP	2	Twin Common Screen	*0.11
CP	3	Stereo Screened	*0.12
CP	4	Four Core Common Screen	*0.21
CP	5	Four Core individually screened	*0.28
CP	6	Microphone Fully Braided Cable	*0.11
CP	7	Three Core Mains Cable	*0.11
CP	8	Twin Oval Mains Cable	*0.08
CP	9	Speaker Cable	*0.06
CP	10	Low Loss Co-Axial	*0.14

P&P

Postage and Packing add 25p unless otherwise shown. Add extra for airmail. Minimum order £1.00

ANTEX EQUIPMENT ★

SOLDERING IRONS

x25. 25 watt	*£2.45
Model G. 18 watt	*£2.70
CCN 240. 15 watt	*£2.90
SK2 Soldering Kit	*£3.90

BITS AND ELEMENTS★

Bit No.			
102	for model CN240	3/32"	*42p
104	for model CN240	3/16"	*42p
1100	for model CCN240	3/32"	*42p
1101	for model CCN240	3/8"	*42p
1102	for model CCN240	¼"	*42p
1020	for model G240	3/32"	*42p
1021	for model G240	1/8"	*42p
1022	for model G240	3/16"	*42p
50	for model X25	3/32"	*44p
51	for model X25	1/8"	*44p
52	for model X25	3/16"	*44p

ELEMENTS★

Model ECN	£1.10*
Model EG 240	£1.35*
Model ECCN 240	£1.55*
Model EX 25	£1.20*

SOLDERING IRON STAND

ST3 Suitable for all models	*£1.10
Antex heat shunt	*10p

PLUGS		PRICE
PS 1	D.I.N. 2 Pin (Speaker)	0.10
PS 2	D.I.N. 3 Pin	0.11
PS 3	D.I.N. 4 Pin	0.14
PS 4	D.I.N. 5 Pin 180°	0.15
PS 5	D.I.N. 5 Pin 240°	0.15
PS 6	D.I.N. 6 Pin	0.16
PS 7	D.I.N. 7 Pin	0.17
PS 8	Jack 2.5mm Screened	0.17
PS 9	Jack 3.5mm Plastic	0.11
PS 10	Jack 3.5mm Screened	0.17
PS 11	Jack ¼" Plastic	0.14
PS 12	Jack ¼" Screened	0.20
PS 13	Jack Stereo Screened	0.33
PS 14	Phono	0.09
PS 15	Car Aerial	0.14
PS 16	Co-Axial	0.14

INLINE SOCKETS		
PS 21	D.I.N. 2 Pin (Speaker)	0.13
PS 22	D.I.N. 3 Pin	0.19
PS 23	D.I.N. 5 Pin 180°	0.19
PS 24	D.I.N. 5 Pin 240°	0.19
PS 25	Jack 2.5mm Plastic	0.15
PS 26	Jack 3.5mm Plastic	0.15
PS 27	Jack ¼" Plastic	0.28
PS 28	Jack ¼" Screened	0.32
PS 29	Jack Stereo Plastic	0.28
PS 30	Jack Stereo Screened	0.35
PS 31	Phono Screened	0.17
PS 32	Car Aerial	0.20
PS 33	Co-Axial	0.20

SOCKETS		
PS 35	D.I.N. 2 Pin (Speaker)	0.07
PS 36	D.I.N. 3 Pin	0.09
PS 37	D.I.N. 5 Pin 180°	0.09
PS 38	D.I.N. 5 Pin 240°	0.10
PS 39	Jack 2.5mm Switched	0.11
PS 40	Jack 3.5mm Switched	0.11
PS 41	Jack ¼" Switched	0.19
PS 42	Jack Stereo Switched	0.28
PS 43	Phono Single	0.07
PS 44	Phono Double	0.09
PS 46	Co-Axial Surface	0.09
PS 47	Co-Axial Flush	0.19

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Containing 6 sheets of 6" x 4" single sided laminate, a generous supply of etchant powder, etching dish, etchant measure, tweezers, etch resistant marking pen, high quality pump drill with spare bits, cutting knife with spare blades, 6" metal ruler, plus full easy to follow instructions. *£7.80 per kit

Spare container of etchant for above, complete with instructions *70p

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2 x quality market pens, specifically designed for drawing fine etchant resistant circuits on copper laminate. Complete with full instructions *£1.53 per pair

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C60	*33p
C90	*44p
C120	*56p

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Containing a range of slider pots.

SP1	6	mixed values sliders	0.60
SP2	6	470R Lin. sliders	0.60
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SP4	6	22K Lin. sliders	0.60
SP5	6	47K Log. sliders	0.60
SP6	6	47K Lin. sliders	0.60

AUDIO LEADS

S221	5 pin DIN plug to 4 phono plugs length 1.5m	£1.08
S222	5 pin DIN plug to 5 pin DIN socket length 1.5m	.68p
S237	5 pin DIN plug to 5 pin DIN plug mirror image length 1.5m	£1.20
S238	2 pin DIN plug to 2 pin DIN socket length 5m	.68p
S268	5 pin DIN plug to 3 pin DIN plug 1 & 4 and 3 & 5 length 1.5m	£1.00
S270	2 pin DIN plug to 2 pin DIN socket length 10m	.80p
S271	5 pin DIN plug to 2 phone plugs connected to pins 3 & 5 length 1.5m	.70p
S275	5 pin DIN plug to 2 phono sockets connected to pins 3 & 5 length 23cm	.68p
S318	5 pin DIN socket to 2 phono plugs connected to pin 3 & 5 length 23cm	.68p
S404	Coiled stereo headphones extension cord extends to 7m	£1.40
S217	3 pin DIN plug to 3 pin DIN plug length 1.5m	.80p
S219	5 pin DIN plug to 5 pin DIN plug length 1.5m	.80p
S474	3.5mm Jack to 3.5mm Jack length 1.5m	.68p
S600	5 pin DIN plug to 3.5mm Jack connected to pins 3 & 5 length 1.5m	.80p
S700	5 pin DIN plug to 3.5 jack connected to pins 1 & 4 length 1.5m	.80p

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Offering the amateur a fantastic bargain PAK and an enormous saving — identification and data sheet in every pak. **ONLY £1.85 each**

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REF		PRICE
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'J'	Tape Head Cleaning Kit	72p
'P'	Hi-Fi Cleaner	*30p
Model 9	Wire Stripper	*£1.00
23	¼" Tape Editing Kit	*£1.80
24	⅛" Cassette Editing Kit	*£1.84
29A	Salvage Cassette	*44p
32A	Stylus Balance	£1.28
33	Splicing Tape	*38p
36A	Record & Stylus Cleaning Kit	*32p
41	8 Track Cartridge Head Carrier	88p
Model 42	Groov-Kleen	*£1.84
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43	Record Care Kit	*£2.76
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46	Spirit level	*72p
48	Record Dust-off	*26p
52A	Cassette Tray	*54p
53	Hi-Fi Stereo Test Cassette	*£2.40
56	Hi-Fi Hints & Tips Book	*48p
Model 60	Groov-Kleen	*£1.72
160/S	Replacement Brush Velvet Pad and Base Sticker for Model 60	*24p
62	Cassette Head Cleaner (Liquid)	48p
71	Record 'Dust Off' (Displays of ten)	*66p
71A	Record 'Dust Off' (Bubble Pack)	*70p
75	Indexa Record	*£1.50
76	Stylus Cleaner	*36p
78	Cassette Fast Hand Winder	*98p
83	Cassette Title & Container Labels (20 & 10)	*36p

UNTESTED LIN PAK

Manufacturers "Fall Outs" which include Functional and part Functional Units. These are classed as 'out-of-spec' from the maker's very rigid specifications, but are ideal for learning about I.C.'s and experimental work.

PAK NO.		CONTENTS			PRICE
ULIC709	=	10	x	709	0.60
ULIC710	=	7	x	710	0.60
ULIC741	=	7	x	741	0.60
ULIC747	=	5	x	747	0.60
ULIC748	=	7	x	748	0.60

G.P. SWITCHING TRANS ★

TO18 SIM. TO 2N706/8
BSY27/28/95A. All usable devices. No open and shorts. ALSO AVAILABLE IN PNP similar to 2N2906, BCY 70.
20 for 75p, 50 for £1.50, 100 for £2.50, 500 for £12, 1,000 for £20
When ordering please state NPN or PNP

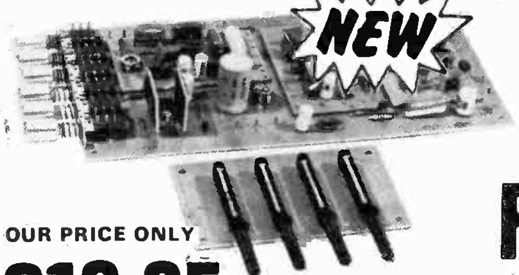
BI-PAK

PO BOX 6 WARE HERTS

BI-PAK

High quality modules for stereo, mono and other audio equipment.

NEW



PUSH-BUTTON

STEREO FM TUNER

OUR PRICE ONLY

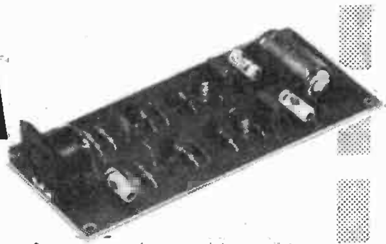
£19.95 **Fitted with Phase Lock-loop Decoder**

The 450 Tuner provides instant program selection at the touch of a button ensuring accurate tuning of 4 pre-selected stations, any of which may be altered as often as you choose, by simply changing the settings of the pre-set controls.
Used with your existing audio equipment or with the BI-KITS **STEREO 30** or the **MK60** Kit etc. Alternatively the **PS12** can be used if no suitable supply is available, together with the Transformer **T461**.
The S450 is supplied fully built, tested and aligned. The unit is easily installed using the simple instructions supplied.

★ FET Input Stage
★ VARI-CAP diode tuning
★ Switched AFC
★ Multi turn pre-sets
★ LED Stereo Indicator

Typical Specification:
Sensitivity 3μ volts
Stereo separation 30db
Supply required 20-30v at 90 Ma max.

MPA 30



Enjoy the quality of a magnetic cartridge with your existing ceramic equipment using the new M.P.A. 30, a high quality pre-amplifier enabling magnetic cartridges to be used where facilities exist for the use of ceramic cartridges only.
It is provided with a standard DIN input socket for ease of connection. Full instructions supplied.

£2.65

VAT ADD 25%

POSTAGE & PACKING

Postage & Packing add 25p unless otherwise shown. Add extra for airmail. Min. £1.00

STEREO PRE-AMPLIFIER

PA 100

OUR PRICE **£13.50**

A top quality stereo pre-amplifier and tone control unit. The six push-button selector switch provides a choice of inputs together with two really effective filters for high and low frequencies, plus tape output.

Frequency Response + 1dB 20Hz 20KHz. Sensitivity of inputs
1. Tape Input 100mV into 100K ohms
2. Radio Tuner 100mV into 100K ohms
3. Magnetic P.U. 3mV into 50K ohms

P.U. Input equalises to R1AA curve with 1dB from 20Hz to 20KHz.
Supply — 20-35V at 20mA.
Dimensions — 299mm x 89mm x 35mm

MK. 60 AUDIO KIT: Comprising 2 x AL60's. 1 x SPM80. 1 x BTM80. 1 x PA100. 1 front panel and knobs. 1 Kit of parts to include on/off switch, neon indicator, stereo headphone sockets plus instruction booklet. **COMPLETE PRICE £27.55.** plus 62p postage.

TEAK 60 AUDIO KIT: Comprising Teak veneered cabinet size 16¾"x11½"x3¾", other parts include aluminium chassis, heatsink and front panel bracket plus back panel and appropriate sockets etc. **KIT PRICE £9.20** plus 62p postage.

AL10-20-30

AUDIO AMPLIFIER MODULES

The AL10, AL20 and AL30 units are similar in their appearance and in their general specification. However, careful selection of the plastic power devices has resulted in a range of output powers from 3 to 10 watts R.M.S.
The versatility of their design makes them ideal for use in record players, tape recorders, stereo amplifiers and cassette and car-tridge tape players in the home.

SPECIFICATION:
- **Harmonic Distortion Po=3 watts f=1KHz 02.5%**
- **Load Impedance 8-16ohm** ● **Size: 75mm x 63mm x 25mm**
- **Frequency response ±3dB Po=2 watts 50Hz-25Hz**
- **Sensitivity for Rated O/P — Vs=25v. RL=8ohm f=1KHz 75mV.RMS**

AL10 3w R.M.S. **£2.30** **AL20** 5w R.M.S. **£2.65** **AL30** 10w R.M.S. **£2.95**

STEREO 30

COMPLETE AUDIO CHASSIS
7+7 WATTS R.M.S.

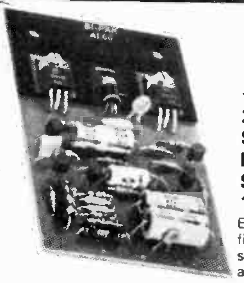
P & P 45p

£15.75

The Stereo 30 comprises a complete stereo pre-amplifier, power amplifiers and power supply. This, with only the addition of a transformer or overwind will produce a high quality audio unit suitable for use with a wide range of inputs i.e. high quality ceramic pick-up, stereo tuner, stereo tape deck etc. Simple to install, capable of producing really first class results, this unit is supplied with full instructions, black front panel knobs, main switch, fuse and fuse holder and universal mounting brackets enabling it to be installed in a record plinth, cabinets of your own construction or the cabinet available. Ideal for the beginner or the advanced constructor who requires Hi-Fi performance with a minimum of installation difficulty (can be installed in 30 mins).

TRANSFORMER £2.45 plus 62p p &p
TEAK CASE £3.65 plus 62p p & p.

AL 60



25 Watts (RMS)

★ Max Heat Sink temp 90C. ★ Frequency response 20Hz to 100KHz ★ Distortion better than 0.1 at 1KHz ★ Supply voltage 15-50v ★ Thermal Feedback ★ Latest Design Improvements ★ Load — 3,4,8, or 16 ohms ★ Signal to noise ratio 80db ★ Overall size 63mm. 105mm. 13mm.

Especially designed to a strict specification. Only the finest components have been used and the latest solid-state circuitry incorporated in this powerful little amplifier which should satisfy the most critical A.F. enthusiast.

£3.95

NEW

PA12

NEW PA12 Stereo Pre-Amplifier completely redesigned for use with AL10/20/30 Amplifier Modules. Features include on/off volume. Balance, Bass and Treble controls. Complete with tape output.

Frequency Response 20Hz-20KHz (—3dB). Bass and Treble range 12dB. Input Impedence 1 meg ohm. Input Sensitivity 300mV. Supply requirements 24V .5mA. Size 152mm x 84mm x 33mm.

£6.50

PS12

Power supply for **AL10/20/30, PA12, SA450** etc.

Input voltage 15-20v A.C. Output voltage 22-30v D.C.
Output current 800 mA Max. Size 60mm x 43mm x 26mm.
Transformer T538 £2.30

OUR PRICE £1.20

Stabilised Power Supply Type SPM80

SPM80 is especially designed to power 2 of the AL60 Amplifiers, up to 15 watts (R.M.S.) per channel simultaneously. With the addition of the Mains Transformer **BMT80,** the unit will provide outputs of up to 1.5A at 35V. Size: 63mm. 105mm. 30mm. Incorporating short circuit protection.
Transformer BMT80
£2.60 + 62p postage

£3.00

BI-PAK

P.O. BOX 6, WARE, HERTS.

COMPETITION WINNERS

The winners of our Heathkit competition receive their prizes from Mr. R. Smith of Heathkit (far right) and our editor Hal Moorshead (far left).

ROCKETING COSTS

At the time when Britain is wallowing in poverty, news of the two super-powers space budget does seem slightly insulting. In 1975 the USA spent approximately $5,000m (£2500m) their space programme. The USSR, of course, will not tell us capitialists how much they spent. However the American Astronautical Society estimates the Russians as spending roughly three times as much – £7500m! At this rate why do they need fuel? Burning money MUST be cheaper.

62LB OF LSI

Rockwell International produced more than two million "large-scale integrated" (LSI) semiconductors in January of this year. Although the confetti-sized "chips" contained the equivalent of 20 billion transistors, they weighed only 62 pounds.

The original cost of designing each ranged from nearly $100,000 to more than $250,000, and production prices can be less than $2 or more than $50 depending on quality and complexity.

At $2 each, two million chips are worth $40m. Since the most expensive is worth $50, the maximum value possible is $100m. Gold is presently at $2120 per pound. i.e. $131,440 for 62lb which all means that 62lb of LSI is worth its weight in gold – 760.8 times over. Anyone fancy an LSI ring?

A RUB OFF OF THE NEW BLOCK

A new method of cleaning PCBs prior to etching has appeared. The item is called a 'Polifix Abrasive Block', and is exactly that. Consisting of silicone rubber with very fire-grade abrasives, non-metallic, implanted, it works like a giant pencil rubber, and will remove grease, fingermarks etc. from the copper. After rubbing with this block the copper is then 'keyed' ready to accept etch resist.

Obviously it could be used to clean veroboard as well, and the makers claim it will clean ANY metallic plastic or painted surface.

From component suppliers in pack of 2 – £1.50.

SHRINKING FINANCES

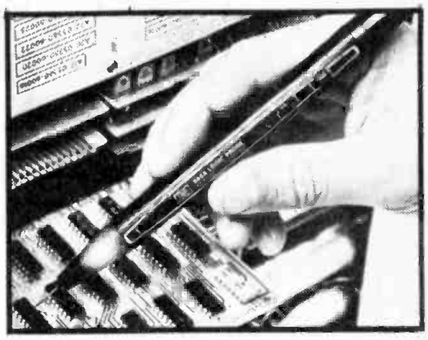
Barclays Bank are about to install new microfilm equipment to replace their present computer output system. The new machines will now produce up to 70% of the total output. So now you know who to blame if your balance looks smaller this year.

MULTI-FAMILY LOGIC PROBE

Designed to simplify and speed logic circuit testing the new 545A Logic Probe from Hewlett-Packard indicates digital states and pulses in both CMOS and TTL logic. An single lamp indicator displays high or low level or detects bad level and open circuit conditions. Operation is with a slide switch. CMOS logic threshold levels are variable and set automatically.

Featured in the Model 545A is a built-in pulse memory which will catch intermittent pulses. When a logic change occurs, the indicator lamp turns on and remains lighted until the memory is reset.

Pulse stretching is provided so the operator can see fast pulses as short as 10 nanoseconds with the blinking display. Pulse trains to a frequency of 80MHz are detected in TTL logic, and to 40MHz in CMOS logic.



The 545A is fully protected against voltage overload. UK price as yet unknown to us, but the probe sells in the US for £82.

Hewlett-Packard Limited, King Street Lane, Winnersh, Wokingham, Berkshire RG11 5AR.

CZECH ON CALCULATOR PRICES

A typical dour Czech day. The rain sleets across Prague.
Somewhere in the back streets well away from the patrols and the populace, Ivan scuttles into a dingy corner shop.

There, amid the Western papers and naughty mags, he spots the object of his desires.

Eyes alight he lifts the proscribed machine from the rack, and carries it reverently to the counter, behind which stands the owner.

"How much?" he stammers, hands shaking.

"Novus 650 comrade? To you, £172. Crossed the border this morning right under the army's noses." he looks around furtively, and leans across the counter, whispering.

"Interested in the REAL thing eh comrade? "Ivan nods. The man reaches below the counter and produces a battered show box. Ivan's eyes are wide by now, riveted to the lid as it lifts. Inside lies a full frontal scientific, a HP 45.

Ivan faints.

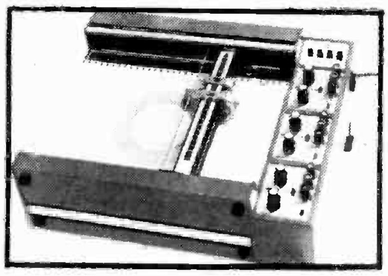
Now before you dismiss this as merely the alcoholic follies of the ETI staff, following a party, let us inform you dear reader, that whilst we may be guilty of slight embroidery, our flight of fancy is based on fact.

It seems our Eastern friends consider pocket calculators to be highly prized items, and will pay vast sums to acquire them. What would cost you or I £7, our Ivan would need £172 to own. For that HP 45 you could possibly get a weekend with Siberian Sue, belle of the Balkans.

The reason behind this black marketing and smuggling is that calculator ships are not produced behind the ferric curtain and the machines are banned from importers lists by the governments, to preserve foreign exchange as their value is so high.

I wonder how they count it?

PUT PEN (AND PEN) TO PAPER



The WX446 2-pen Recorder allows the recording of two variables in the Y axis against one variable in the X axis.

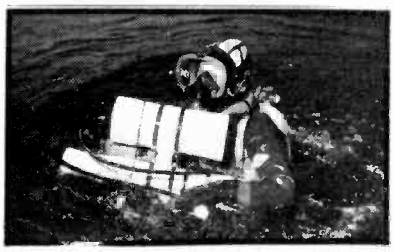
A choice of input amplifiers is available with switched ranges giving a maximum sensitivity of 50 microvolts/cm, 0.5mV/cm or 10mV/cm. The minimum output is 1 Megohm.

The recorder features electrostatic paper hold down; servo free switch, which allows the pen carriage to be moved manually when making notes on the chart; push to operate zero and vernier controls, and optional fibre or jewel-tip pens.

Enviromental Equipments Limited, Eastheath Avenue, Wokingham, Berkshire RG11 2PP.

TV TAKES A DIVE

Following a two-year study into working with television underwater, EMI Electronics Limited, of Feltham, Middlesex, has introduced a new, highly sensitive underwater television system that requires little artificial lighting.



Designated the MTV3-U, this system is some 2500 times more sensitive than a standard closed-circuit TV system and comprises a rugged cylindrical-shaped camera and a control console for remotely monitoring and controlling the camera's video output from the surface.

EMI Limited, 135 Blyth Road, Hayes, Middlesex UB3 1BP.

CORDLESS HEADPHONES

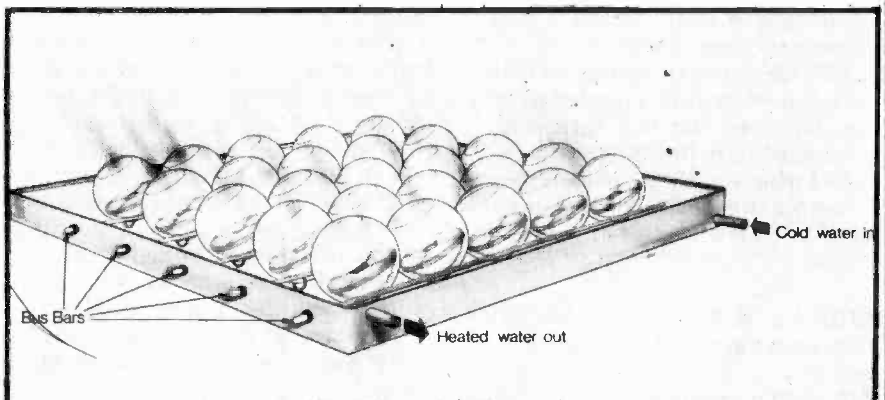
Those long trailing headphone cords may soon be a relic of the past. Sennheiser, Siemens and Beyer all have cordless systems either in production or under development.

Beyer's system is now available in the USA and that from Sennheiser should be on the market very soon.

In all these systems an infra-red transmitter is connected to the audio amplifier output and floods the listening area with harmless and invisible infra-red radiation.

The infra-red carrier is modulated by a frequency modulated carrier of about 90kHz. The frequency modulated signal is of course multiplexed to accomodate the two separate channels of a stereo system. The infra-red signal is received by small sensors mounted on the individual head sets. In fact this system is now available in Britain, but only for use from television receivers. The set in question is made by Normende and sells at £750. Further details from Vessco, Unit 4, Blackwater Way, Aldershot.

AN EYE FOR ENERGY



Array of solar energy spheres

Football-sized plastic eyeballs that move to keep looking at the sun and convert the light directly into electricity are being developed by a British research establishment. Standard Telecommunications Laboratories, are working on what researchers there refer to as "solar eyeballs' which automatically follw the movement of the sun by a new type of self-contained magnetic drive.

Each one of the eyes can give up to one volt, but greater output is possible by using several of the units. To allow them to move freely, the eyeballs are floated in a water tank, the sunlight shines through ball's lens and on to the solar cell. As the sun moves, light tends to wander off the solar cell, which is surrounded by four gas reservoirs rather like four large petals. When the sunlight touches any one of these the gas inside expands and moves a small magnet inside the eyeball. This reacts with an outside field and the unit is 'nudged', aligning it with the sun again.

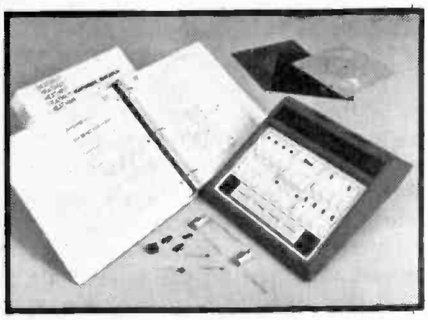
STL researchers emphasise that the device is still under development and cannot forecast when it could be offered for sale. However, it is tentatively predicted that for a peak output of one kilowatt cost would be about £350 to £500.

STC Labs, London Road, Harlow, Essex.

news digest

HEATHKIT ENTER THE EDUCATIONAL MARKET

We have news that Heathkit are about to enter the educational electronics market with a series of "individual Learning Programmes". These are designed as a series of separate progressive courses. The use who has a fairly good background knowledge could opt to start with a more advanced course.



The various 'programmes' available are designed to follow each other. As an example of cost the Fundamentals course — which includes three separate sections — will sell for about £90 including an experimenter/trainer — a type of super breadboard.

Other course so far announced include Digital Techniques which, incidentally is so up-to-date that it includes microprocessors.

ETI has not yet studied any of these courses as, at the time of writing they have not yet been officially announced, but Heathkit's approach to kits makes them an ideal initiator for such a scheme. We hope to report on one of these courses in the near future.

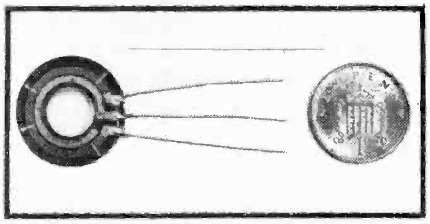
BUDDY CAN YOU SPARE AN MPU?

RCA have been without success in finding a second-source for their CDP 1800 microprocessor in the USA. Motorola and Intersil are believed to be amongst those hardening their hearts to RCA pleas for a supplier.

HONEYWELL PASSES ITS 'A' LEVELS

Honeywell computers have gained entrace to Aberdeen University, replacing an ICL 4/70, which has presumably been sent down. This is the first time that Honeywell have managed to sell to a British university, who have traditionally tended to buy from IBM or the British firm ICL. Aberdeen give their main reason for buying the Level 66 machine as being the advanced 'database' system it incorporates. This is a field with which the University has been closely involved.

POT OF LIGHT



This new device titled the MPC 1054 consists of a photoconductive cell manufactured in circular form with an effective stroke of 290 degrees and has a variable output resistance relative to the position of light falling upon the cell. It therefore acts as a conventional potentiometer but the output is completely isolated from the input so electrical noise or interference cannot be transferred from one part of the circuit to the other. Light passes through a slit 1mm wide to fall on the photoconductive cell and as this light moves around the cell area the resistance is varied relative to the position of the light.

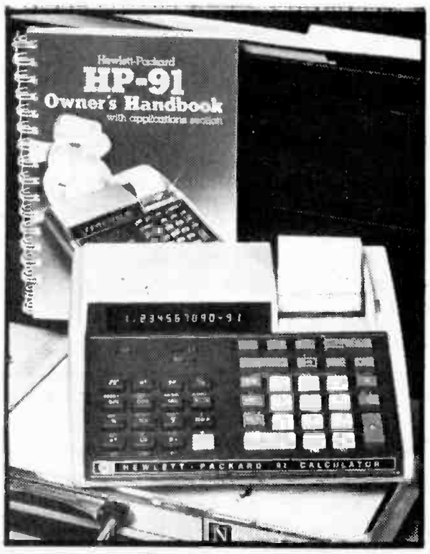
Photain Controls Limited, Unit 18, Hangar 3, The Aerodrome, Ford, Sussex.

PORTABLE PRINTING CALCULATOR

A printing calculator which fits easily into a briefcase has been introduced by Hewlett-Packard. Operated by rechargeable battery or mains the HP91 weighs less than two and half pounds including batteries. The HP91 is priced at £310 including VAT.

The calculator is a more powerful version of the widely-used HP45 pocket calculator with all the pre-programmed functions of the HP45.

Hewlett-Packard Limited, King Street Lane, Winnersh, Wokingham, Berks.



DOWN TO EARTH WARNING SYSTEM

A ground proximity warning system, which will alert pilots when they are dangerously near ground or water, will become mandatory for British public transport aircraft from 1st January 1977. A suitable system, designated AD 2610, will be produced by Marconi-Elliott.

The system gives a computer-generated audible command to "pull up" if the aircraft approaches the ground too quickly. It takes inputs of flap and undercarriage position, radio altitude, barometric rate of descent and ILS glide path deviation in making assessment. The system actually "speaks" the works "pull up . . pull up . . pull up" until the pilot recovers the situation safely. The design is considered to be the most advanced in the world and can be programmed to meet specific safety requirements.

STOPWATCH STOP PRESS

Marshalls have informed us that the price for the Stopwatch kit is £3.50 not £2.50 as shown in our last issue. We also heard from our readers that all is not well with the Novus 650. It has been modified. New models are not convertable. Yet do not despair, we have arranged with Novus to supply a large number of the older type to readers through us. If you intend to build the project your safest course is to order the calculator through us

However should you wish to purchase from a shop check the serial number before buying. Models earlier than 80000 are likely (but not guaranteed) to work.

A few readers are having trouble getting a Novus 650 to count at the required rate for this project. To cure this hang-up it is necessary to change the resolution to 1/50th sec,and make the device add '2' at each increment.
The modification needed is as follows;
Increase C5 to 0.1uf, R7 to 150k, and C8 to 0.015uf. Take the wire from pin 8 IC2 to pin 17 IC3, and connect it to pin 16 IC3 instead.

Bi-Pre-Pak Price Correction

Bi-Pre-Pak of Westcliff-on-Sea ask us to bring to your attention a wrongly quoted VAT rate from their "Super Spark MK.V", advertisment in this, and last, months ETI. The advertisement shows 25%, whereas the correct rate is only 8% making VAT 64p and 84p respectively and not £1.99 and £2.62 as readers might be led to believe.

FREE Brochure on New KITS

Whether professional, student, teacher or amateur, the field of electronics can open up a new world for you.

Please add 15p to cover postage plus 10" x 12" self-addressed envelope.

BARCLAYCARD | Buy it with Access

CROFTON don't just sell kits, we offer you a technical back up service to ensure your success

The following is a selection of some of the more popular kits -

★ Mullard CCTV Camera
★ P.E. CCTV Camera
★ The 'Mistral' Digital Clock
Kit **£12.50** incl. VAT + p.&p. 50p
Built **£18.00** + p.&p. 50p
★ Electronic Ignition
★ Sound Operated Flash
★ P.W. Tele-Tennis Game
★ U.H.F. Modulator
★ Bench Power Supply
★ Wobbulator
★ All ETI Top Projects
★ Many of the Elektor Projects

NOTE: P.C.B's for most published projects available to order

CROFTON ELECTRONICS LTD

Dept. C, 35 Grosvenor Road, Twickenham, Middx. 01-891 1923

ETI PCB's

TITLE	PROJECT NO.	ISSUE	BOARD NO.	TOTAL INCL.
Int. Stereo Amp. 25 watts/chan.	Int. 25	Oct. 1975	Int. 25	£4.21
Dual Power Supply	105	Apr. 1972	014	£1.48
Wide Range Voltmeter	107	Top Project No. 1	022	£1.09
I.C. Power Supply	111	Jan. 1973	111	£1.43
Thermocouple Meter	113	Dec. 1973	113	£1.57
Dual Beam Adaptor	114	Oct. 1974	114	£1.00
Impedance Meter	116	June 1975	116	£1.01
Digital Voltmeter	117	Oct. 1975	117A	68p
			117B	68p
Simple Freq. counter	118	Nov. 1975	118	68p
The Revealer	213	Top Project No. 1	213	68p
Brake Light Warning	303	Oct. 1972	007	68p
Automatic Car Theft Alarm	305	Aug. 1972	019	99p
International Battery Charger	309	Nov. 1973	309	98p
Electronic Ignition CDI/Tacho	312	May 1975	312	£1.72
Auto Amp	314	May 1975	314	75p
ET Four Input Mixer	401	Top Project No. 2	005A	67p
Super Stereo	410	Top Project No. 2	025	£1.51
100W Guitar Amp	413	Feb. 1973	413	£1.73
Master Mixer	414	Top Project No. 1	414A	£1.14
			414B	£1.52
			414C	£1.52
Stage Mixer	414	July 1975	414D	£1.89
			414E	£1.78
Mixer Pre-Amp	419	Dec. 1973	419	91p
International 420 Four Channel Amp	420	Apr. 1974	420A	76p
			420B	£1.11
			420C	£1.21
			420D	£1.21
Discrete SQ Decoder	420E	June 1974	420E	£1.69
Int. 422 Stereo Amp 50 watts/Chan.	422	Aug. 1974	422	£2.97
Plus Two Add on Decoder Amp	423	Nov. 1974	423	91p
Stereo Rumble Filter	426	Jan. 1975	426	76p
Simple Stereo Amp	429	Mar. 1975	429	76p
Line Amp	430	July 1975	430	76p
Photographic Timer	512	Aug. 1972	023	76p

TITLE	PROJECT NO.	ISSUE	BOARD NO.	TOTAL INCL.
Tape Slide Synchroniser	513	Top Project No. 2	026	
Digitial Stop Watch	520	Jan. 1974	520A	£2.05
			520B	50p
Electronic One Arm Bandit	529	Sept. 1975	529A	£2.32
			529B	£2.32
Temp. Controller	530	Mar. 1975	530	85p
Photo Timer	532	Sept. 1975	532	87p
Digital Display	533	Oct. 1975	533A	68p
			533B	68p
Radar Intruder Alarm	702	June 1975		£1.13
Light Dimmer		Apr. 1975	702	68p
Intruder Alarm		Sept. 1973		94p
Digital Alarm Clock	Tim-Ironic		5017	£1.24
Utiliboard		Nov. 1975	AA/BB	£1.68

At the time of goint to press we have stocks of all the above boards. Allow 7/10 days for delivery by post. Boards also available for other published designs at 6p a sq. inch + VAT and P&P. Large stocks of components also available.

The above mentioned are a few of the more popular boards — for prices of any boards not mentioned phone or write, sending 15p. Prices include VAT and P.&P.

CROFTON ELECTRONICS LTD.

Dept. C, 35 Grosvenor Road, Twickenham, Middx. 01-891 1923

Sparkrite mk2

Capacitive discharge electronic ignition

VOTED BEST OF 8 SYSTEMS TESTED BY 'POPULAR MOTORING' MAGAZINE

* Smoother running
* Instant all-weather starting
* Continual peak performance
* Longer coil/battery/plug life
* Improved acceleration/top speeds
* Up to 20% better fuel consumption

Sparkrite Mk. 2 is a high performance, high quality capacitive discharge, electronic ignition system in kit form. Tried, tested, proven, reliable and complete. It can be assembled in two or three hours and fitted in 15/30 mins.

Because of the superb design of the Sparkrite circuit it completely eliminates problems of the contact breaker. There is no misfire due to contact breaker bounce which is eliminated electronically by a pulse suppression circuit which prevents the unit firing if the points bounce open at high R.P.M. Contact breaker burn is eliminated by reducing the current to about 1/50th of the norm. It will perform equally well with new, old, or even badly pitted points and is not dependent upon the dwell time of the contact breakers for recharging the system. Sparkrite incorporates a short circuit protected inverter which eliminates the problems of SCR lock on and, therefore, eliminates the possibility of blowing the transistors or the SCR. (Most capacitive discharge ignitions are not completely foolproof in this respect). All kits fit vehicles with coil/distributor ignition up to 8 cylinders.

THE KIT COMPRISES EVERYTHING NEEDED

Ready drilled pressed steel case coated in matt black epoxy resin, ready drilled base and heat-sink, top quality 5 year guaranteed transformer and components, cables, coil connectors, printed circuit board, nuts, bolts, silicon grease, full instructions to make the kit negative or positive earth, and 10 page installation instructions.

OPTIONAL EXTRAS

Electronic/conventional ignition switch.

Gives instant changeover from "Sparkrite" ignition to conventional ignition for performance comparisons, static timing etc., and will also switch the ignition off completely as a security device, includes: switch connectors, mounting bracket and instructions. Cables excluded. Also available RPM limiting control for dashboard mounting (fitted in case on ready built unit).

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VIEWDATA

Trials are currently being conducted by the British Post Office linking your TV set via the existing telephone lines to a central computer. In a few years from now you may be able to summon up information from literally millions of 'pages' for display on your TV. Angus Robertson reports.

EVEN TODAY you can use your telephone other than for speaking to someone else: you can have a bedtime story (01-246 8000) or find out about skiing conditions in Scotland (031-246 8041) but this is mundane compared to Viewdata service that is being planned.

Virtually everyone has a TV set, most people have access to the telephone and viewdata is a marriage of the two: a new type of information service.

In many ways Viewdata is not unlike Teletext; relatively simple digital codes instruct a character generator in, or adjacent to, the user's TV to provide the display. However, Viewdata, unlike Teletext, has the potential for two way communication and will allow the user to enter data into the system as well as receive it.

Only information requested by the customer is transmitted to the Viewdata receiver unlike Teletext where the entire programme content is being transmitted continually, and the receiver 'catches' a page as it is broadcast. The maximum capacity of broadcast Teletext as included in field blanking at present, is 800 pages per TV channel and this gives a worse case access time of about three minutes for a particular page. Increasing page capacity would increase this access time and the service would thus deteriorate. However, with Viewdata, data base size is only limited by the cost of the computers and disc storage involved; ultimately many millions of pages could be available with an access time of only a couple of seconds.

How a Viewdata receiver might be used. In the current experiment 200 pages are available. This prototype design — one of many — incorporates the 'phone with the receiver probably useful in commerce. Domestic installations are unlikely to incorporate the two as only a simple wire need be run from the phone's junction box to the TV.

Information suppliers

At this stage, the marketing phase of Viewdata has just begun but over the next two to three years the Post Office hope to finalise the service available to subscribers. The PO does *not* intend to supply information for the Viewdata network — it will just provide the hardware for information storage and the means for subscribers to gain access to this data base. The idea is for information to be supplied by commercial and other organisations who will either have terminals for inserting information into the data base or have their own computers connected, via a date link, to the Viewdata computers and data base.

Possible services

Information available should include news, entertainment, holidays, education, professional information, telephone directories, classified advertising, shopping hints, a calculation service, and reference material. It will be possible, for instance, for restaurants to advertise the daily menu and eventually for a subscriber to reserve a table and order the meal over the Viewdata system. Similar reservation systems could operate for hotels and theatres. It will also be possible to send messages to other Viewdata subscribers.

Although an alphanumeric keypad will be available, enabling subscribers to compose messages, those with only a numeric keypad should be able to use pre-written messages such as "Please meet me at the station at ——", the time being inserted using the numeric keypad. The user number of the called subscriber is also inserted, the message stored in the system; it may prove possible to arrange for a light to be operated on the call subscriber's receiver. When this is noticed and the Viewdata centre called, the stored message is received.

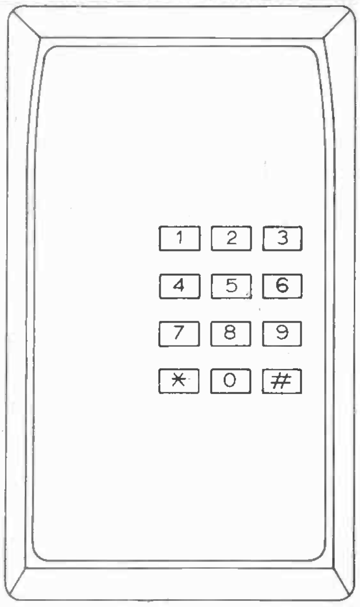
Classified advertising also has considerable possibilities. Using the special editing facilities authorised information suppliers could undertake to have an advert written and inserted into the Viewdata data base where it could be classified by subject (Ford Cortinas, 1974 registered). Potential customers would select the particular heading of interest, see the advertisement and could then reply either using the telephone or Viewdata. When the sale is completed, the advertiser would remove the advert from the data base so as not to be bothered by other would be purchasers. This ability to convey decisions might eventually become available, but is not considered likely in the first stages.

Another interesting interactive service would be games, either with another subscriber or with the computer. A game similar to *Mastermind* has been demonstrated where the player has to guess a four digit number with help from the computer. Chess might be another possibility. Unfortunately, games and such interactive services make considerable demands on computer processor time, moreso than simple information retrieval, and the availability of these services depends upon the cost of computer time being considerably reduced and on their not adversely affecting normal retrieval operations.

Operation

The following system will be employed to obtain information from the Viewdata system. Using the telephone dial (or keypad) the Viewdata centre is called — an automatic dialer might even be provided. A characteristic high pitched tone is received when the computer answers and a button is pressed which connects the Viewdata receiver to the telephone line. The subscriber is greeted by the computer and a subscriber identification number requested — later this might be signalled automatically like a telex answerback. Upon proper identification being received (for charging purposes etc), the Viewdata index is displayed, listing ten different categories of information.

Using the numerals on the keypad (fig. 1), the digit appropriate to the selection is pressed. A further index will be displayed and selection takes place until the desired page is located. In theory, six index selections would accommodate up to a million pages. To go back one page *0 is keyed, while the start again *♯. Each page is individually numbered and may be directly selected using *(page number)♯. The system is so designed that each step is explained with instructions on how to proceed displayed on each page. If an uncertain subscriber gets lost, simply keying *♯ enables the start to be reached from where a full explanation may be found.



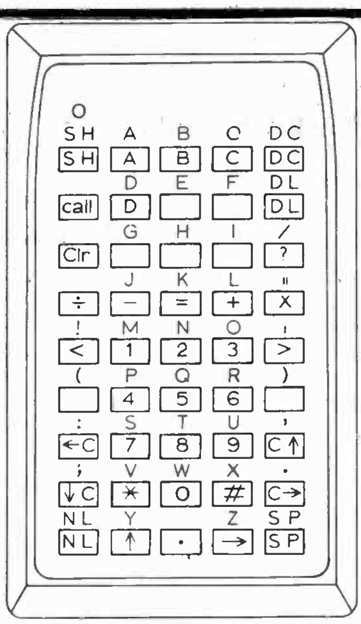
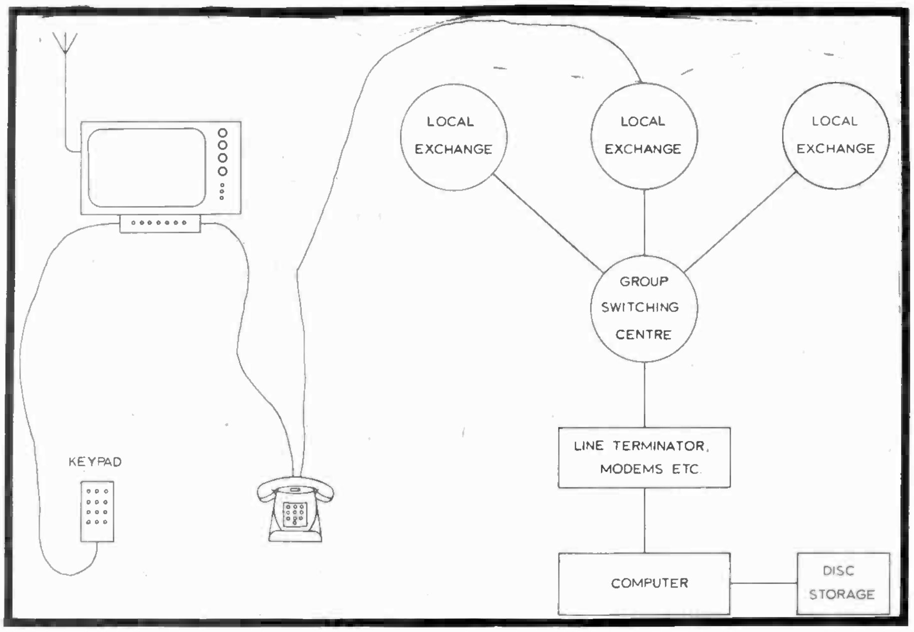


Fig. 1. (above) A simple numeric keyboard will be used to select the pages. Fig. 2. (right) Viewdata subscribers may wish to have the facility to input information. This would first be displayed on the local screen for editing before being fed into the central data bank.

SH	**Shift. Activates functions engraved on case.**
DC	**Delete character**
Call	**Automatic call set-up**
DL	**Delete line**
Clr	**Clear. Automatic call cleardown**
←C	**Cursor shift and direction**
NL	**New line**
SP	**Space**
*****	**Star**
#	**Square**

The GEC computers (rights) which are planned for use with Viewdata.

Fig. 3. (below) The connections of the telephone and TV to the central data store.



VIEWDATA

The 12 keys on the numerical keypad provide all the facilities required for Viewdata operation. However, to compose complex messages, perform calculations and such activities, an alphanumeric keypad, Fig. 2, could be supplied (this layout is still provisional). This new approach to keypad design is necessary since the standard *qwerty* typewriter layout is the wrong format for a hand held keypad. It is also considered simpler to operate for those unfamiliar with a typewriter. A keyboard layout similar to that of the typewriter would be available for business environments. The same data code used for display is used by the keypad for transmission to the computer. Keypad characters are returned by the computer to the receiver so that it does not need to display characters directly. Of course, no direct connection between keypad and decoder is necessary — either ultrasonics or infra red could be used.

Two further possibilities exist to complement the reciever. A cassette recorder could be used to store Viewdata information for later viewing. This would also enable a large amount of information to be 'dumped' by the decoder, this taking only a maximum of eight seconds for each page while connected to the computer instead of the time required to read each page while on the line to the computer. Since both telephone and Viewdata charges may be charged on a duration basis, this could offer substantial savings in cost for the subscriber. Additionally information could be printed out as hard copy for permanent storage.

Viewdata system

Figure 3 shows how the Viewdata system is engineered. Either a Viewdata only or Viewdata/Teletext decoder may be used. Although initially these are extra units which might be hardwired into the TV receivers (or monitors), it should be possible to buy or rent self contained sets from normal retail companies eventually. The PO will only be supplying the telephone instrument and a line access unit, which will interface and isolate the telephone line from the receivers.

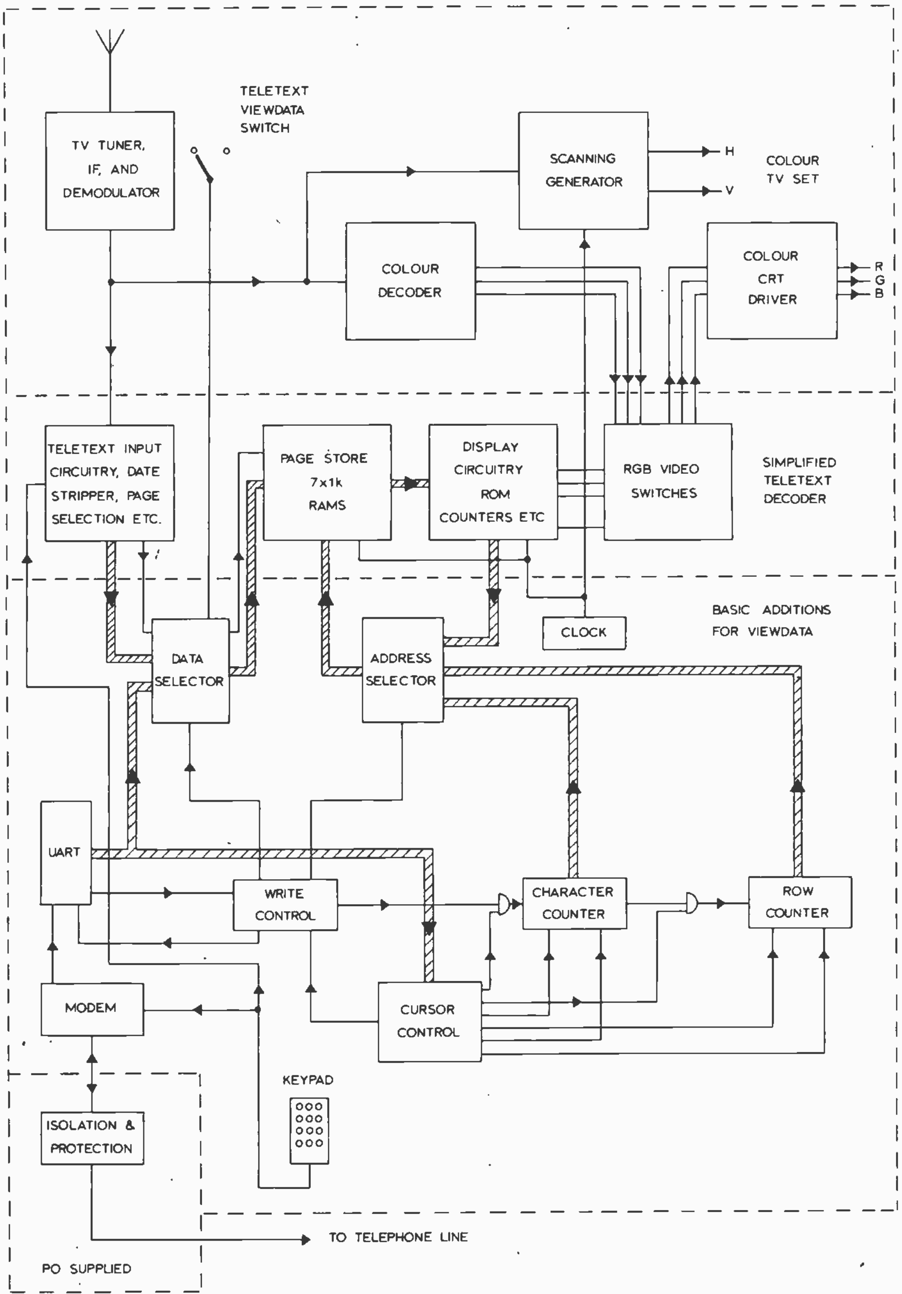
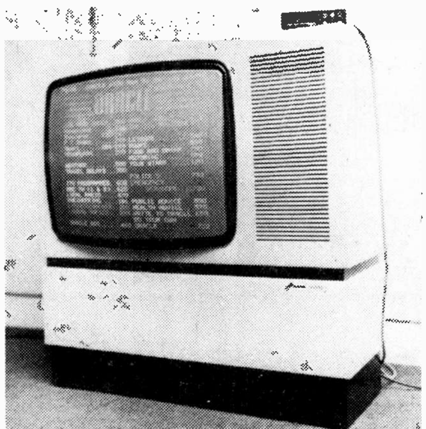


Fig. 4. (above) Block diagram of the circuitry necessary to receive Viewdata.



A Rank prototype receiver displaying Teletext. It is proposed to add Viewdata facilities as little additional circuitry is necessary. The Post Office hope that Teletext receivers will incorporate the Viewdata facility when the former become available.

Naturally the PO has no desire to receive any of the lethal voltages, using the TV sets down their lines and are going to take steps to protect themselves!

During the present pilot trial data is sent down the phone line using the Datel 600 system. In this, the digital information from the computer is frequency shift modulated using a 1,200 baud (bits per second) circuit between computer and subscriber and a much slower circuit of 75 baud for the keypad computer circuit. A modem (MODulator DEModulator) is used at either end of the telephone circuit to effet this frequency shift modulation and demodulation. It is possible that the send speed may be increased to 2,400 baud at some later date.

The page format for Viewdata is identical to Teletext with 24 rows of 40 characters on each page with seven colours and full graphics facilities. Storage and display circuitry is common between Teletext and Viewdata decoders, see Fig. 4. The TV set is shown at the tdp, a simplified Teletext decoder in the centre with the basic additions required for Viewdata at the bottom. Serial digital data is accepted by the UART (Universal Asynchronous Receiver/ Transmitter, a standard IC) which detects any errors in transmission (parity) and converts the data to parallel format for further manipulation.

The data selector allows this information to be stored while the cursor control keeps tabs on the characters and rows received. This information is fed, via the address selector, to the page store RAM which supplies characters to the display circuitry where alphanumerics and graphics are generated. Since the receiver may be operated while broadcast signals are not being transmitted, a clock with dividers is used to synchronise the line and field scanning generators. Unlike Teletext systems, TV synchronising information is not transmitted by Viewdata.

Decoded video is intercepted in the receiver before the CRT drivers and either Teletext or Viewdata electronically substituted. This means that colour characters may be displayed without using an expensive colour encoder but does mean that the Teletext/Viewdata decoder must be wired into the set. It would however be possible to display monochrome pictures using an RF modulator and plugging into the aerial socket but this would degrade the quality and increase the cost.

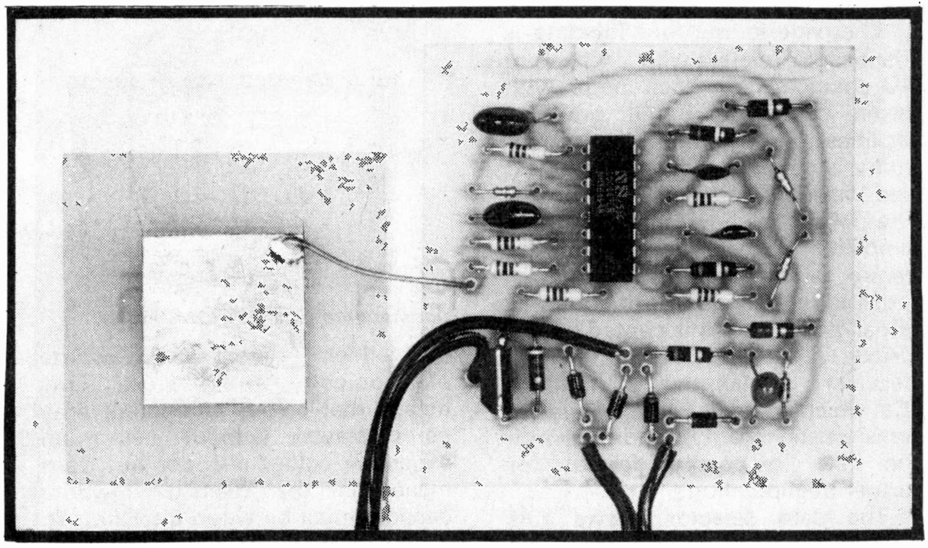
Another prototype Viewdata receiver.

Although the basic character format of Viewdata is identical to Teletext, changes have been made in the use of control characters (carriage return, line feed etc), to provide compatibility with CCITT ISO-7 characters for line transmission. Since this does not provide for the necessary control bits for transmitting colour and graphics, an escape sequence is used which acts like a shift key on a typewriter and changes the meaning of following characters.

The Viewdata centre is presently located at the Post Office Research Centre but eventually, depending upon demand, computers will be installed adjacent to many at the computer centre group switching centres, see Fig. 3. Line termination consists of automatic answering and a modem. This currently twin interfaces to the GEC 4080 computers which have a present disc storage of 5 Mbytes (about 5,000 pages) but another 70 Mbytes are planned to be added later this year. When a page is selected, this is transferred at high speed into a core memory in the computer from where it is read out at slow speed to the Viewdata subscriber. Future systems will use a line card with a page of memory and dedicated hardware to remove pressure from the compter core storage.

A pilot trial is currently taking place in which manufacturers of terminal hardware and potential information suppliers are working with the PO in developing the system. A market trial is due to start in September 1977 with a sample of 500 members of the public connected to the system and if this trial is succesful, the full Viewdata service will open in the latter half of 1978.

eti project 539



New 240V design offers toggle action and complete safety.

TOUCH SWITCH

TOUCH switches are fascinating devices and have been in use for many years in lift controls. The circuit used in lifts usually consists of a high-frequency oscillator which has a touch plate connected to the tuned circuit. When the plate is touched the additional capacitance introduced either detunes the oscillator thus changing the frequency, or couples the oscillation into the detector and switching circuitry. This approach, whilst effective, is very expensive and thus touch switches of this type are not widely used.

Most of the touch switches published in electronics magazines to date have required the sensing element actually to be touched — usually via a series resistor of about one megohm or higher. Such circuits rely on body resistance to activate the switch, and are therefore not safe for use in controlling devices operated on 240 Vac.

In the touch switch described in this project, it was specified that the action of the switch should be touch-on touch-off, and that no actual contact with the circuit be made (for safety reasons). These constraints led us to use a capacitive circuit. The touch plate is in effect a capacitor. When this plate is touched, the input of the first stage is capacitively referenced to earth, however as the supply rails to the control circuit are floating at rectified 240 Vac the 50 Hz waveform effectively appears at the input of the control circuit and initiates the switch action. The actual contact plate is a piece of single-sided printed-circuit board arranged so that the *non-copper side* is touched — the copper on the other side is connected to the control circuit. Thus a full 1.6 mm of insulation is always between the user and the circuitry at mains potential.

CONSTRUCTION

A touch switch may be constructed (and used) in many different ways. It may be mounted within the base of a lamp; fitted onto a conventional switch-plate to control overhead lights; or mounted in a piece of electronic equipment. It is however unlikely that the switch would be used as a separate unit and for that reason housing details have not been provided.

As stated above the touch plate is constructed from a piece of printed-circuit board as detailed in the drawing. The touch-plate need not be exactly as shown but can be any convenient shape or size. However make sure that the copper surface of the plate cannot touch any of the external metal surfaces and that it cannot be touched by the fingers. If the unit is to built into a lamp that has a plastic base a piece of aluminium foil may be glued to the *inner* surface of the base to act as the pickup plate.

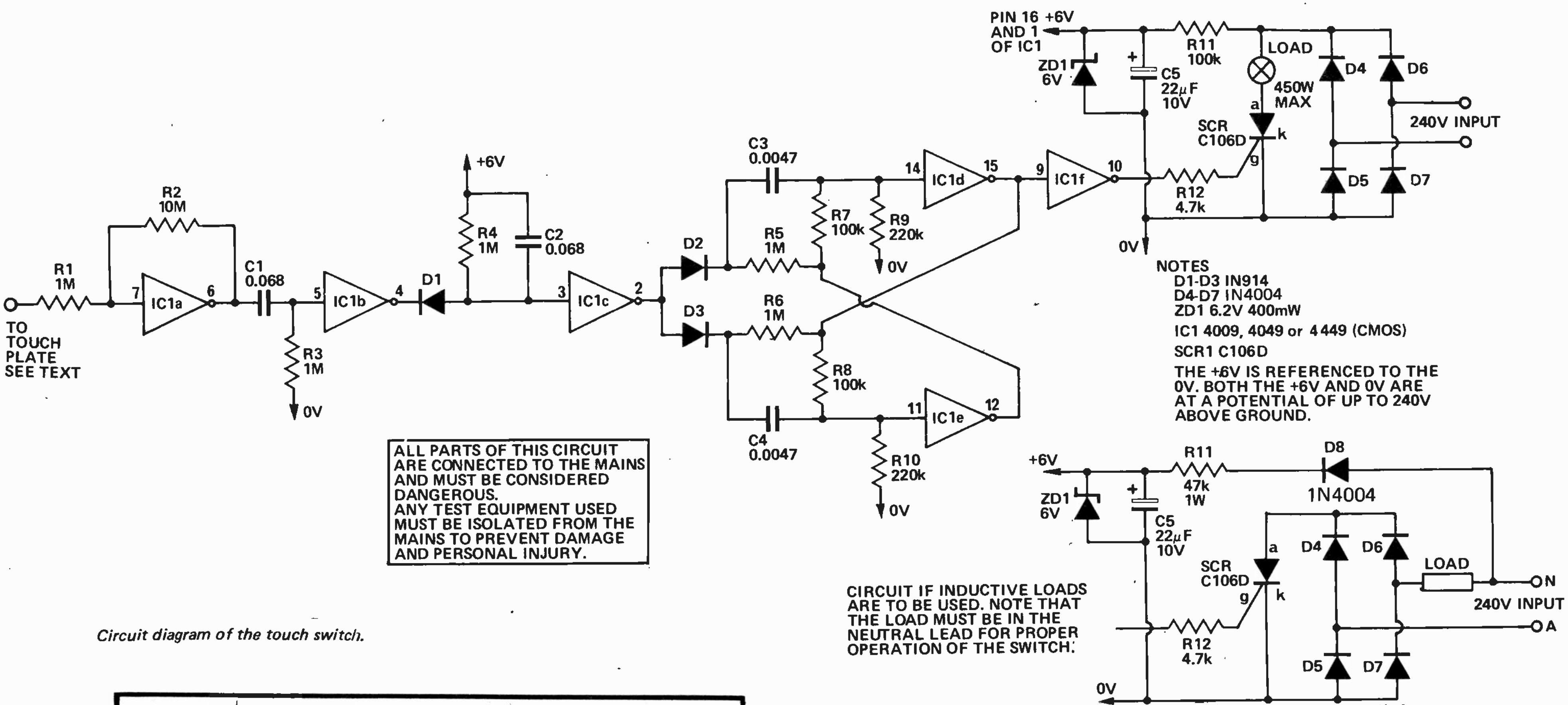
If the plate is too large or the lead connecting it to the circuit too long, stray capacitance to ground may be sufficient to prevent the switcn operating. If the lead is more than about 50 mm long shielded cable should be used (shield connected to '0' volts not to ground). If a large plate is used the gain of the first stage should be reduced by changing the value of R2. (Try 3.3 M first and if this is not effective try 1 M).

The circuit given in the main circuit diagram supplies the load with pulsating dc and is therefore suitable to drive resistive loads (such as light bulbs) only. If an inducive load must be supplied the slightly more complex alternative circuit (shown in the insert) must be used. In this circuit the load must be inserted in the neutral lead if the switch is to operate correctly. Thus it is essential to ensure that the active and neutral are connected correctly. To make the changes required for inductive loads it is necessary to instal a link between D4/D6 and the anode of the SCR. The resistor R11 is removed from the board and D8 and the new R11 are glued to the board with epoxy cement.

SPECIFICATION

Mode of Operation	touch-on, touch-off
Triggering Mode	capacitance
Power	450 VA resistive
	450 VA inductive*

*alternative circuit for load.



NOTES
D1-D3 IN914
D4-D7 IN4004
ZD1 6.2V 400mW
IC1 4009, 4049 or 4449 (CMOS)
SCR1 C106D
THE +6V IS REFERENCED TO THE 0V. BOTH THE +6V AND 0V ARE AT A POTENTIAL OF UP TO 240V ABOVE GROUND.

ALL PARTS OF THIS CIRCUIT ARE CONNECTED TO THE MAINS AND MUST BE CONSIDERED DANGEROUS.
ANY TEST EQUIPMENT USED MUST BE ISOLATED FROM THE MAINS TO PREVENT DAMAGE AND PERSONAL INJURY.

CIRCUIT IF INDUCTIVE LOADS ARE TO BE USED. NOTE THAT THE LOAD MUST BE IN THE NEUTRAL LEAD FOR PROPER OPERATION OF THE SWITCH.

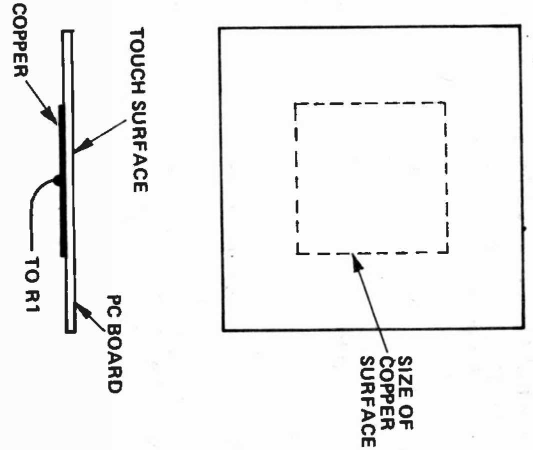
Circuit diagram of the touch switch.

PARTS LIST – ETI 539

R1,3,4,5,6	Resistor	1M	5%	½W
R2	"	10M	"	"
R7,8,11	"	100k	"	"
R9,10	"	220k	"	"
R12	"	4.7k	"	"
C1,2	Capacitor	0.068μF Polyester		
C3,4	"	0.0047μF Polyester		
C5	"	22μF 10V electro		
D1-D3	Diode	1N914 or similar		
D4-D7	"	EM404 or similar		
ZD1	Zener Diode	6.2V 400mW		
SCR	C106D			
PCB	ETI 539			

Case to suit

For inductive loads change R11 to 47k 1W add D8 — 1N4004



We constructed our touch plate from a 50 mm square piece of printed-circuit board. The board was etched to leave a 25 mm square section of copper in the centre. See text if different sized plate or long connecting lead is to be used.

HOW IT WORKS

POWER SUPPLY

The 240 Vac is rectified by diodes D4 to D7. The output of the diode bridge is then reduced, smoothed and regulated to 6 volts dc by R11, ZD1 and C5. The load is connected after the rectifier and has power switched to it via the silicon-controlled rectifier, SCR. Note particularly that the load is supplied with pulsating dc and therefore the type of load used with this circuit must be resistive, for example, an incandescent lamp. For inductive loads such as transformers etc, the load circuit must be modified as shown in the small diagram.

DETECTOR

The detector is formed by one section of a CMOS hex inverter, IC1a, in which the gain is set by the ratio of R2/R1. The touch plate is connected to the input of the detector and touching it effectively adds a capacitor to ground. However the '0' volt line (due to the diodes D4 to D7) when referenced to ground is effectively 50 Hz 240 volt rectified. The touch plate capacitance introduced therefore couples this waveform into the input of the detector and over-drives the amplifier so that the output is a 50 Hz squarewave. If the plate is not touched the capacitance is very much lower and hence the output of the amplifier is very much lower in level. The sensitivity may be altered by changing the value of R2 (lower value gives less sensitivity).

LEVEL SHIFTER

The output of IC1a is centred about 3 volts, and C1, R3 and IC1b are used to provide level shift such that the output of IC1b is normally high at +6 volts until the plate is touched. When the plate is touched the output of IC1b oscillates between +6V and 0 V at a 50 Hz rate. The hex-inverter IC has diodes internally which connect each input to ground. Thus these diodes prevent the inputs from being driven below –0.6 volts.

PULSE STRETCHER

The 50 Hz output from IC1b is not in a convenient form and must be converted into a signal which is only high and stays high whilst the plate is touched. This is performed by a pulse stretcher and inverter consisting of IC1c together with R4 and C2. The output of IC1c is normally low and goes high and stays high whilst ever the plate is touched.

FLIP FLOP

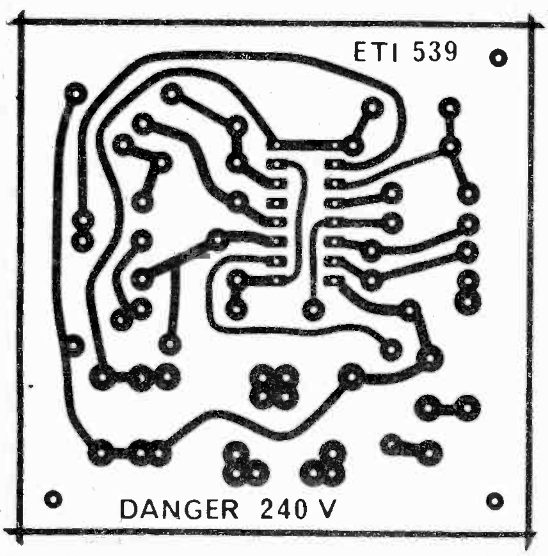
To meet our mode of operation requirement the circuit needs to be held on after the finger is removed from the plate and only switched off when the plate is touched a second time. Thus a toggle action is required and this is obtained by incorporating a flip flop formed by IC1d and IC1e. Cross coupling of gates normally provides an RS flip flop which may take up any state if both inputs are taken high together. For this reason the capacitors, resistors and diodes at the inputs to the flip flop are used to provide steering logic to ensure that correct toggle action is obtained.

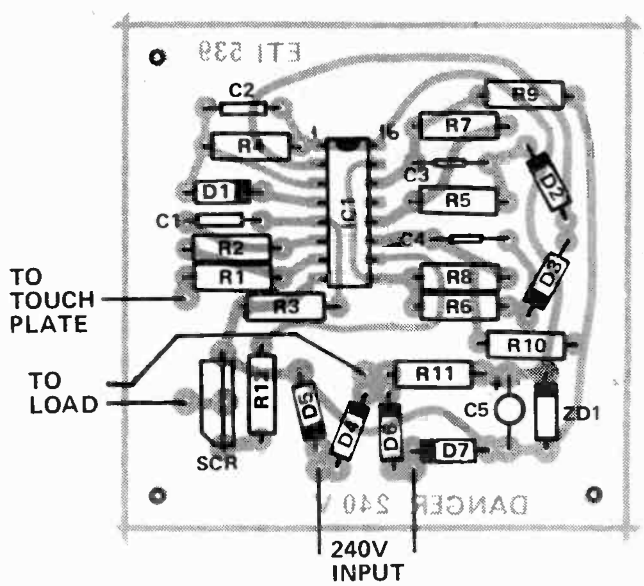
BUFFER

To prevent loading the flip flop, and because a spare section of the hex inverter is available, a buffer amplifier is inserted between the flip flop and the SCR. The SCR used is a C106D which is a sensitive gate type. This particular SCR will operate reliably with the 1 mA gate current provided. The SCR specified will be used – don't try substitutes.

TOUCH SWITCH

Printed-circuit board layout for the touch switch. Full size 68 mm by 68 mm.





How the components are positioned on the board.

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MM5378 Car clock, crystal controlled, LED	6.73
MM5379 Car clock, crystal controlled. Gas discharge	6.73
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MK50397 UP/DOWN Counter—MMSS.99	14.50
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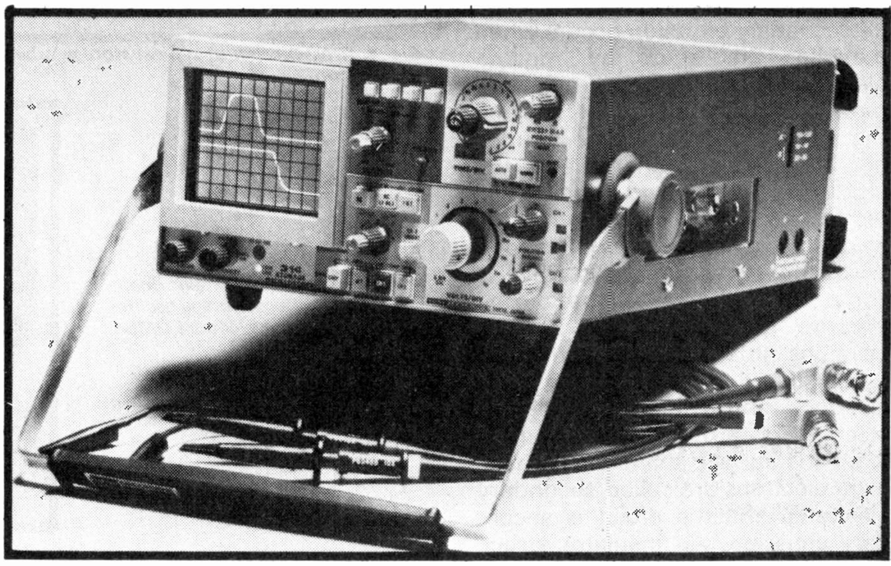
FROZEN SIGNALS

Storage oscilloscopes let engineers 'see' into circuits more clearly. In this article, Ian Sinclair explains how they work and what they do.

IN A SMALL electronics laboratory, an engineer is watching an oscilloscope intently. The oscilloscope is displaying the mains waveform, and he is watching it for intermittent pulses which have been the cause of faulty triggering of thyristors in a power pack. After 30 minutes, his attention is slacking; it is unlikely that he will gain anything from the morning's work. In another laboratory a few miles away, the same problem is being solved. The engineer is working on a power pack, glancing at the oscilloscope only occasionally, for the intermittent spike on the waveform, when it occurs, will remain displayed for several minutes, bright enough to be photographed with a simple camera.

In the air traffic control room of a small airfield, the ATC officer is watching the radar pattern. Two planes show as dots glowing brightly when the revolving trace comes round then fading rapidly. The room is dimly lit so that the after-trace can be seen at all; it is difficult to remember which is the most recent part of the trace. On a busier airfield, the ATC officer works in normal lighting watching a screen when the traces remain at high brightness, fading with time so that the brightest part of the trace is the most recent. Moving echos stand out well from these from fixed objects, and the whole of the traces can be erased by the press of a button.

In each of these cases, the improvement is due to the substitution of a storage tube for a normal cathode ray tube. This is a tube similar in style to the conventional cathode ray tube but which offers the advantages of trace (or picture) storage, a persistence which can be controlled, the ability to erase a stored trace rapidly, very high screen brightness and complete choice of phosphor colour. These characteristics are due not to the phosphor of the tube but to its



Tektronix Model 314 storage oscilloscope with a bandwidth of 10MHz.

electronic construction, and its working depends on three important physical principles: capacitor charging, coplanar grid control, and secondary emission.

PHYSICAL PRINCIPLES:

Capacitors consist of non-conducting materials sandwiched between conductors. When electronic charge (electrons) is taken from one conductor and placed on the other the capacitor is said to be charged and a voltage can be measured between the conductors. The capacitance of the arrangement is the ratio Q/V, where Q is the amount of charge and V the voltage. When the charge is allowed to flow back or is otherwise neutralised the

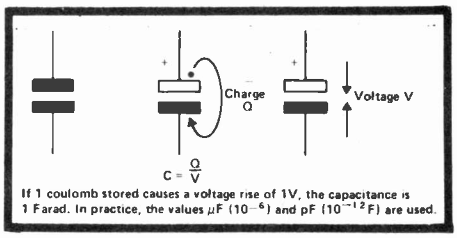


Fig. 1. Capacitor charging.

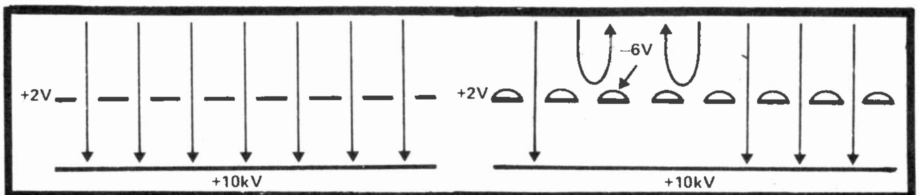


Fig. 2. Coplanar grid effect.

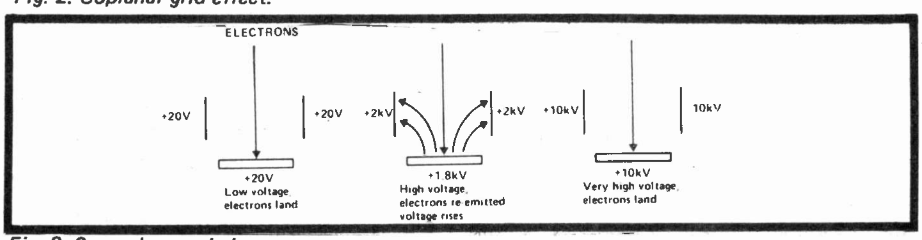


Fig. 3. Secondary emission.

capacitor is discharged and there is no longer a voltage between the conductors. Capacitor charging is vital to the storage tube, as it is the method of storing the signal information.

Coplanar grid effect is a method of controlling an electron stream by changing the voltage on a metal mesh. When the mesh is at a voltage slightly positive to the cathode of an electron gun, electrons pass freely through the holes of the mesh. A small negative voltage is enough to prevent this flow of electrons even if there is a positive voltage electrode on the other side of the mesh.

Secondary emission occurs when materials are stuck by moving electrons. If the electrons are moving slowly they either stick to the surface they strike or bounce off. If the surface is an insulator, the electrons which land on it will reduce its voltage until no more electrons can land. This will happen when the voltage at the surface is about the cathode voltage of the electron gun. At faster speeds, electrons hit the surface with such energy that they can dislodge other electrons, and if there is a positive electrode nearby, more electrons leave the surface than hit it. These extra electrons are called secondary electrons, and the effect is secondary emission. An insulator struck by fast moving electrons loses more electrons in this way than it gains, and so rises in voltage (as it is losing negative charge, equivalent to gaining positive charge) until the voltage is about the same as that of the positive electrode near it. It cannot rise further as this would cause electrons to land (they could go nowhere else) and so cause a fall in voltage.

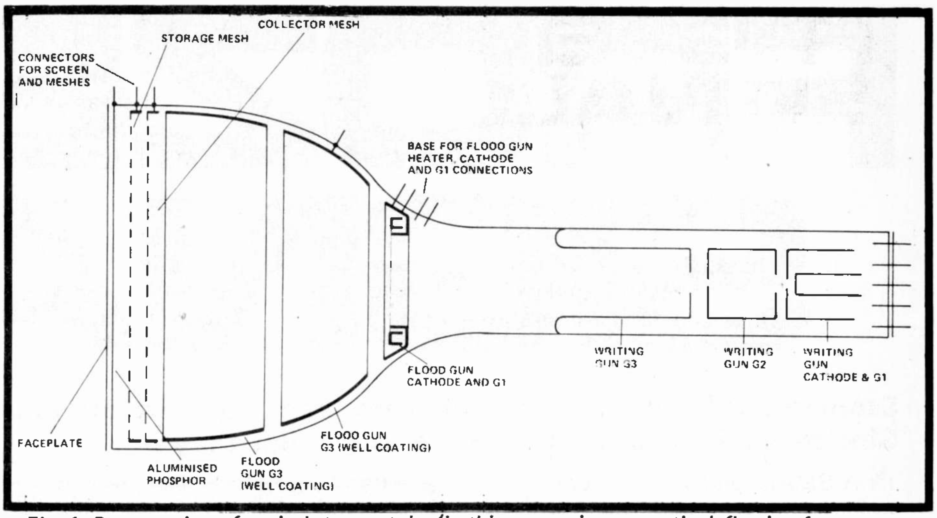
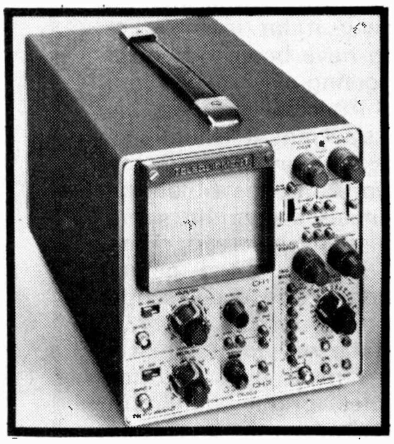


Fig. 4. Cross-section of typical storage tube (in this case, using magnetic deflection for writing gun.



Telequipment dual-trace storage oscilloscope, Model DM64.

THE STORAGE TUBE

Fig. 4 shows the cross-section of a type of storage tube, showing how the electrodes are arranged. The screen has placed about 1cm away from it and parallel to it a fine wire mesh (about 500 meshes per inch in each direction) called the storage mesh. On the side remote from the screen, this wire is coated with an insulator with good secondary emission characteristics. The screen is a conventional aluminised phosphor screen as might be found on any other CRT. About 3mm from the storage mesh is another mesh, the collector, made of coarser wire angled to minimise the moire patterns which appear when two meshes are nearly in line.

The flood gun is an electron gun which is neither focused nor deflected. Instead the electrons are spread out to form a parallel beam about the diameter of the storage mesh and uniform in density. The effect of the flood gun is, as its name suggests, to flood the screen with electrons so that the screen is uniformly bright. The brightness level of the screen depends on the rate at which electrons reach it, and this can be controlled by altering the voltage on the storage mesh, whose normal voltage is slightly more positive than the cathode of the flood gun. The voltage on the metal mesh is not the only one affecting electrons, however, as the surface of the insulator deposited on the mesh may be at a different potential. Because of coplanar grid effect, the potential of the insulator may take over control of the electron stream from the potential of the metal mesh.

INSULATOR POTENTIAL

We cannot change the potential of the insulator surface directly, but we can make use of the fact that the metal mesh will act as one plate of a capacitor and an electron beam hitting the insulator can act as another. Loss of electrons by secondary emission then completes the picture of possible action at the insulator surface.

The charging and discharging of the insulator surface by flood gun electrons enables us to cut off the electron beam without permanently changing any of the supply voltages. Imagine a positive going pulse applied to the metal storage mesh; raising its potential by about 10V for a short time. By normal capacitor action the potential of the surface of the insulator will rise also by about 10V, and, in the absence of any other effect, would continue to follow exactly the potential variations of the metal mesh. There is another effect, however, the stream of electrons from the flood gun. Electrons, approaching a surface which is about ten volts positive will land on the surface, and the negative charge of the electrons will steadily reduce the potential of the insulator surface until electrons can land no longer usually when the surface is at or slightly below flood gun cathode potential.

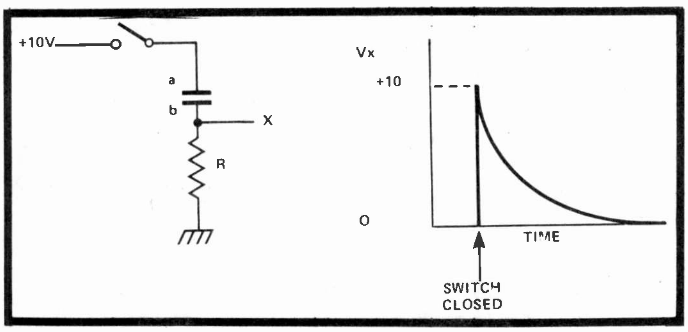
All of this takes place rapidly if there is a good supply of electrons from the flood gun, so that the potential of the surface of the insulator can be reduced rapidly to

FROZEN SIGNALS

cathode potential level while the metal part of the mesh is still held at +10V. Once the insulator surface has reached flood gun cathode potential electrons will no longer land on it, but will reflect. The collector mesh held at +200V, will then collect such reflected electrons and the potential of the insulator surface remains stabilised at about cathode potential.

When the potential of the metal mesh is lowered again from +10 to zero, the insulator will obediently also drop in voltage by 10V, ending up at —10V. This is similar to the previous change, except that now there are no electrons, to land on the insulator, since it is too negative to allow electrons to approach.

Fig. 5 (below). Equivalent circuit, showing what happens when a 10V potential is applied to the circuit.



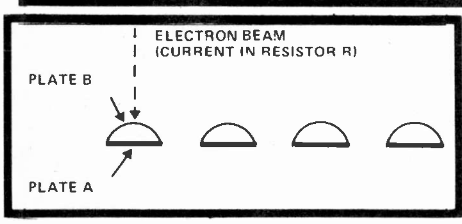
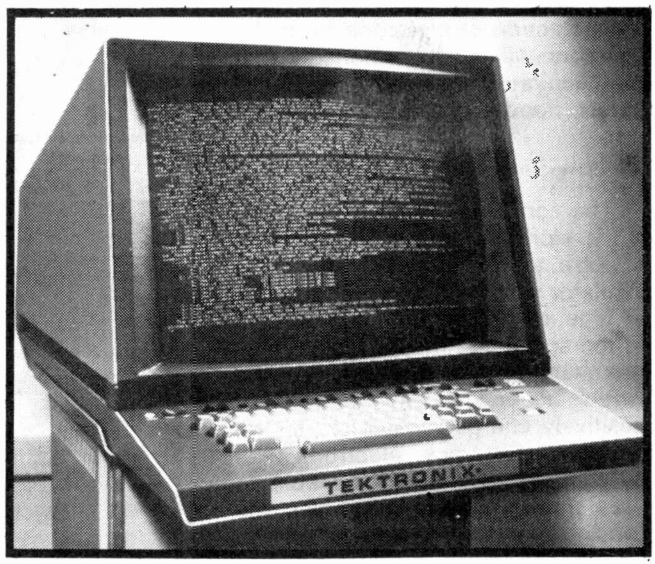


Fig. 6 (left) Action of insulator on mesh, shows similarity to equivalent circuit.



Tektronix computer terminal, fitted with a 19" storage CRT.

POSITIVE CHARGING

There are, in fact, only two ways in which the potential of the insulator surface can rise again with only the flood gun on. One is by leakage; if the resistance of the insulator is not very high, the stored charge maintaining the surface at —10V will steadily leak away through the resistance so enabling the potential of the surface to rise again. We can choose to use insulating materials whose insulation resistance is so high that the change of voltage by leakage is negligible, even for times of several months.

The other way in which the potential of the insulator surface can rise is by the landing of positive ions. These are particles very much heavier than electrons and carrying positive charge, and they are formed when atoms of a gas are struck by electrons. The energy of the electrons splits up the gas atoms into positive ions and more electrons; if left alone these will recombine, giving out their energy in the form of light, a process used in neon lamps. In tubes such as the storage tube, despite the high vacuum, there are still large numbers of particles which will be split up by electrons to form positive ions, and the positive ions obeying the usual laws of electrostatics will be attracted to any negative potentials. In the storage tube, ions formed on the gun side of the collector mesh are not likely to cause any trouble, since they will be repelled from the storage mesh, but there will still be a few ions formed in the space between the storage mesh and the collector mesh.

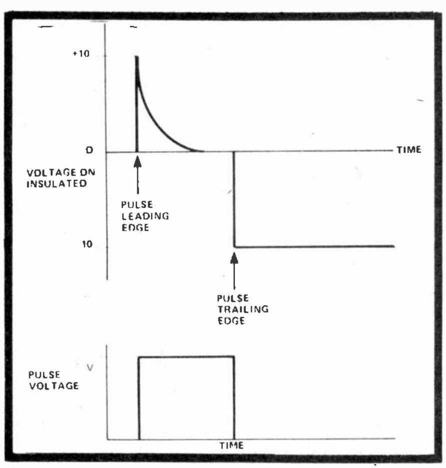


Fig. 7. Complete effect of single pulse on insulator.

When the potential on the insulator surface is negative and the flood beam is creating ions the ions will land on the insulator, raising the potential until it once again reaches flood gun cathode potential. It is unlikely to go much higher as there are more than enough electrons around to land on any positive surface and neutralise the effect of ions. The effect on the action of the mesh is that the steadily rising potential on the insulator will allow an increasing number of electrons to pass through the spaces in the mesh, so that the screen, which would be completely dark when the potential on the insulator was —10V would brighten up as the ions landed, ending up at full brilliance.

To summarise, a brief positive-going pulse on the metal mesh causes the insulator surface to end up negative (about as far *below* cathode potential as the pulse peak was *above* it), so cutting off the electron beam to the screen. Over a longer time as ions land on the insulator, the screen will brighten up and gradually attain full brilliance. The brightening up process takes about ten minutes, but can be delayed indefinitely if the flood gun is switched off (as for example by biassing the collector mesh negatively) when the display does not have to be viewed.

WRITING

So far, we have considered only the action of the flood gun which enables us to see how the insulator surface can be changed in potential without any direct connection being made. The action of the writing gun gives us another method of changing the insulator potential. The writing gun is a conventional CRT type of electron gun which is focussed and deflected; the deflection method may be electrostatic or magnetic, the focus is usually electrostatic. The gun is arranged so that the beam focusses on the insulator surface, and the cathode of the writing gun is about 2·5kV more negative than the cathode of the flood gun. This potential difference ensures that electrons from the writing gun which hit the insulator cause secondary emission of more electrons. The emitted secondary electrons then land on the collector mesh leaving the insulator surface more positive. The greatest potential which the insulator can reach during this process is that of the collector; if the writing beam is scanning across the insulator the action of electrons from the flood gun will in practice ensure that the insulator potential will not exceed flood gun cathode potential.

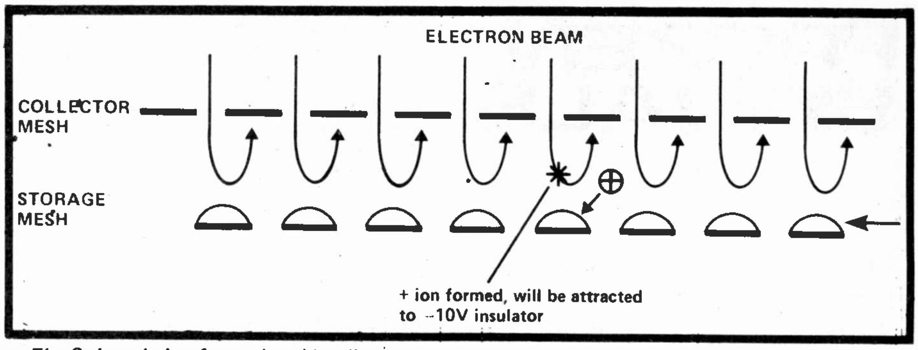


Fig. 8. Ions being formed and landing.

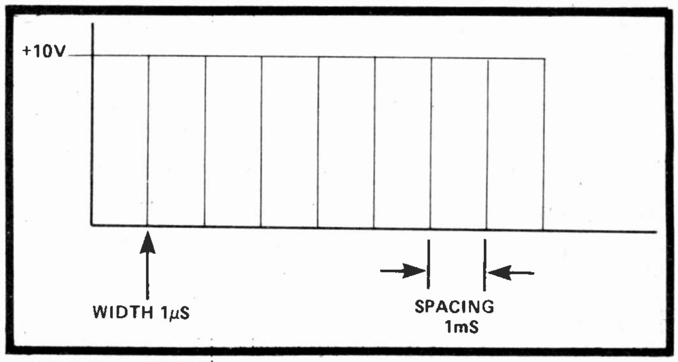


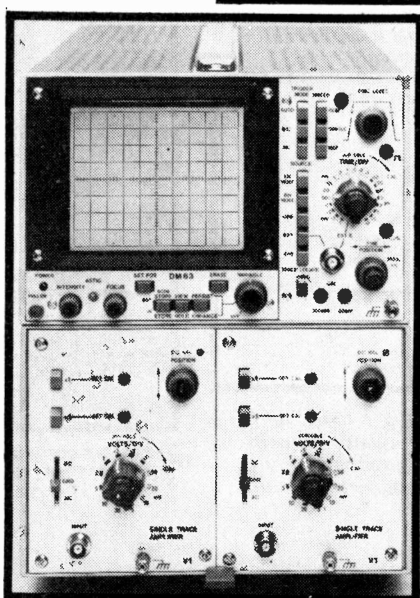
Fig. 9. Continuous erase pulses.

ACTION:

The complete action of the tube is therefore as follows. By applying a pulse to the storage mesh, the insulator surface is given a negative voltage, cutting off the electron flow to the screen. With the insulator in this state a trace scanned by the writing-beam will leave a track of positively charged insulator. In the region of this track, electrons will, by coplanar grid effect, be able to pass through the mesh holes, so causing the trace to appear on the screen. The trace will be stored, and will not decrease in brilliance; what limits its useful life is the decreasing contrast as the rest of the screen gradually brightens up around it. The brilliance of the trace depends on the phosphor efficiency and the screen voltage (typically 10kV) used and can be high enough for the tube to be usable in direct sunlight. The storage period can be extended if the flood beam is turned off while the tube is not being viewed.

ERASING:

Any trace or picture "written" with the writing gun can be erased. Total erase can be carried out by the same process as was used to clear the screen ready for writing, by applying a single positive pulse of about +10V amplitude and time exceeding 100ms. It is also possible to carry out a continuous erase, using repetitive pulses applied to the storage mesh. The pulses used must be of lesser width, a few μs for example, and often of smaller



Telequipment dual-beam storage oscilloscope, Model DM63.

amplitude. Their effect is to erase continually, so that the trace fades out with the screen never reaching full brilliance. this is in many ways a more satisfactory display as the background brilliance of the unwritten part of the screen can be kept steady and fairly low. The unwritten portion can never be completely dark, as each pulse peak momentarily raises the screen to full brilliance, but the effect of the pulse train is simply of a faint glow on the whole screen, with newly written traces very bright, and older traces steadily fading into the background. This type of display is of particular use for radar, as moving targets show up as trails whose head is bright fading towards the tail. Stationery echoes are of uniform brightness, enabling the operator to distinguish them instantly from the moving targets.

Selective erase is also possible on a more elaborate tube. If a third electron gun, similar to the writing gun, in every way but operated at a much more negative cathode potential of about 10kV relative to flood gun cathode, is added it can be used to bombard selected areas of the insulator surface with high energy electrons. At such high energies, the electrons, penetrate more deeply into the material and are retained so that the potential of the insulator is made more negative. Where such a beam is scanned, therefore, the insulator will be driven negative again sufficient to cut off the flood beam if necessary, and so giving the ability to erase selected portions of a picture or trace.

APPLICATIONS:

The use of this type of storage tube in an oscilloscope greatly extends the range of use of the oscilloscope, for very low speed timebases and for transients. Conventionally, low timebase speeds are handled by pen-and-chart recorders, but these cannot respond to the high speed of a sudden transient. CRT's operating at low timebase speeds do not have a long enough persistance trace to enable the complete trace to be easily seen. The storage tube, with its ability to leave a bright trace at the lowest timebase speeds and also to record short pulses which arrive during the

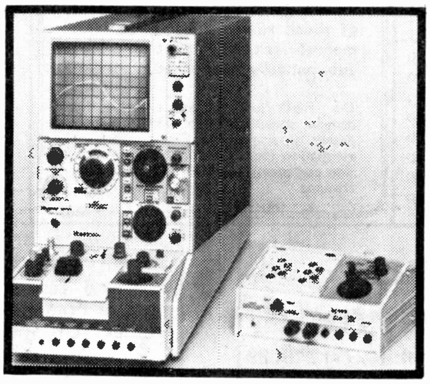
FROZEN SIGNALS

slow timebase covers the whole range of needs. At the other end of the scale, transients (pulses arriving at random) can be displayed on a fast timebase if the transient is used to trigger the timebase and the display delayed until the timebase has started. In this way, transients can be caught examined and photographed; a process difficult to achieve by other methods.

CONSTRUCTION:

The writing gun follows conventional oscilloscope or television cathode ray tube techniques, and is located in the narrow bore section of the tube in the usual way. The flood gun can be made in a variety of shapes, the most favoured method being annular, with a ring-shaped cathode G_1 and G_2 structure surrounding the end of the writing gun tube. In this way, the writing gun can be located at the centre of the tube and still permit the flood gun to operate as if it too were at the centre. The electrode controlling the callimation of the flood gun that is the degree of the spread of the beam, is usually a carbon coating over the large diameter portion of the tube.

The two meshes are the critical portions. The storage mesh is of nickel, a metal which possesses adequate strength and which can be electroformed in a relatively stress-free state. The mesh is usually 400-700 mesh per inch in fineness and is stretched on a nickel-alloy frame. The insulator chosen is generally magnesium fluoride, which combines good insulating and dielectric properties with high secondary emission and which is also comparatively easy to deposit on nickel by evaporation.



Tektronix type 577 curve tracer with storage CRT.

The collector mesh can be coarser in pattern and woven; stainless steel is suitable here, since this material is readily available in the form of woven mesh.

The screen is a completely conventional high-brilliance phospher deposited and aluminised in the usual way. Since the storage properties of the tube do not depend on the phosphor, any type and colour can be used.

CONCLUSIONS:

Storage tubes have enabled us to study a much wider range of effects, particularly in biological waveforms and in the study of transients, than was previously possible, and have also considerably extended the ease of use of radar systems. Some of the early storage tube oscilloscopes, such as the "Remscope", are now appearing on the second-hand market, so making the unique characteristics of these devices more accessible to laboratories which could not previously afford the expenditure. It seems very likely that there are other applications which will now open out for storage tubes and storage oscilloscopes.

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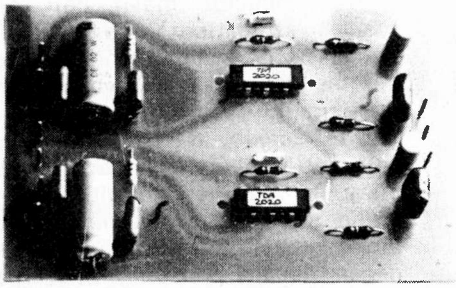

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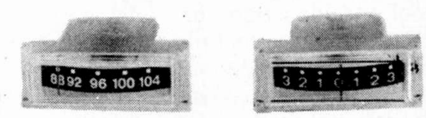

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25uF/25V	14p
47uF/25V	15p
100uF/25V	18p
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Accurate crystal-controlled markers for tuning and aligning communications receivers.

A LIMITATION of most low priced communications receivers and conventional radios is that tuning accuracy cannot be guaranteed. This means that when waiting for a short-wave station to come on the air we may well miss the beginning of the transmission because we have been tuned to the wrong frequency. The traditional method of overcoming this problem has been to use a marker generator or crystal calibrator. Such instruments generate a series of accurately known and harmonically related signals which are tuned by the receiver in order to determine the accuracy of the dial. The marker generator may also be used to perform the periodic calibration and alignment required by most sensitive receivers.

Although it is possible to build a generator which could be set to any desired precise frequency this approach is uneconomical. The more practical method is to have an oscillator running at an accurately known frequency and to generate harmonics of this frequency. For example a basic frequency of 1 MHz would have harmonics at 2 MHz, 3 MHz, 4 MHz . . . . and so on.

The marker generator must supply a stable and accurate signal without the necessity of elaborate initial setting up. This requirement leads to the obvious need for a quartz crystal as the basic frequency-determining element.

A slice of quartz crystal has the property that when a voltage is applied to either side of the crystal, the crystal will be mechanically strained and conversely, when mechanical strain is applied a voltage appears across the crystal. The crystal has a natural frequency of resonance and it is thus equivalent to a tuned circuit with a very high 'Q'.

The cheapest available crystals operate at 4 MHz and to obtain the frequency intervals that we require we used CMOS ICs to divide down from the higher frequency. To ensure maximum operating speed the CMOS ICs need to be operated from a 10 volt supply. Some exceptional devices will work on six volts but the level of higher harmonics is then reduced somewhat.

To cover as much of the dial as we can in an effective manner the harmonics should be spaced reasonably close together and should extend to 30 MHz. Ideally a harmonic should fall within the pass-band of a receiver no matter what frequency is tuned. We therefore selected a minimum spacing of 10 kHz as being the most practical. Unfortunately the inaccuracies of many receivers can, in the high bands, exceed 200 kHz thus several harmonics may be within the pass-band at any one time making it impossible for the operator to determine to which harmonic he is tuning. To overcome this problem the marker generator is switchable to provide harmonics spaced at intervals of 4 MHz, 2 MHz, 1 MHz, 100 kHz and 10 kHz.

To produce the series of harmonics required it is necessary to generate a series of very narrow pulses at a repetition rate equal to the spacing required. That is, 10,000 narrow pulses per second will produce the harmonic series 10 kHz, 20 kHz, 30 kHz up through 29 990 kHz and 30 000 kHz.

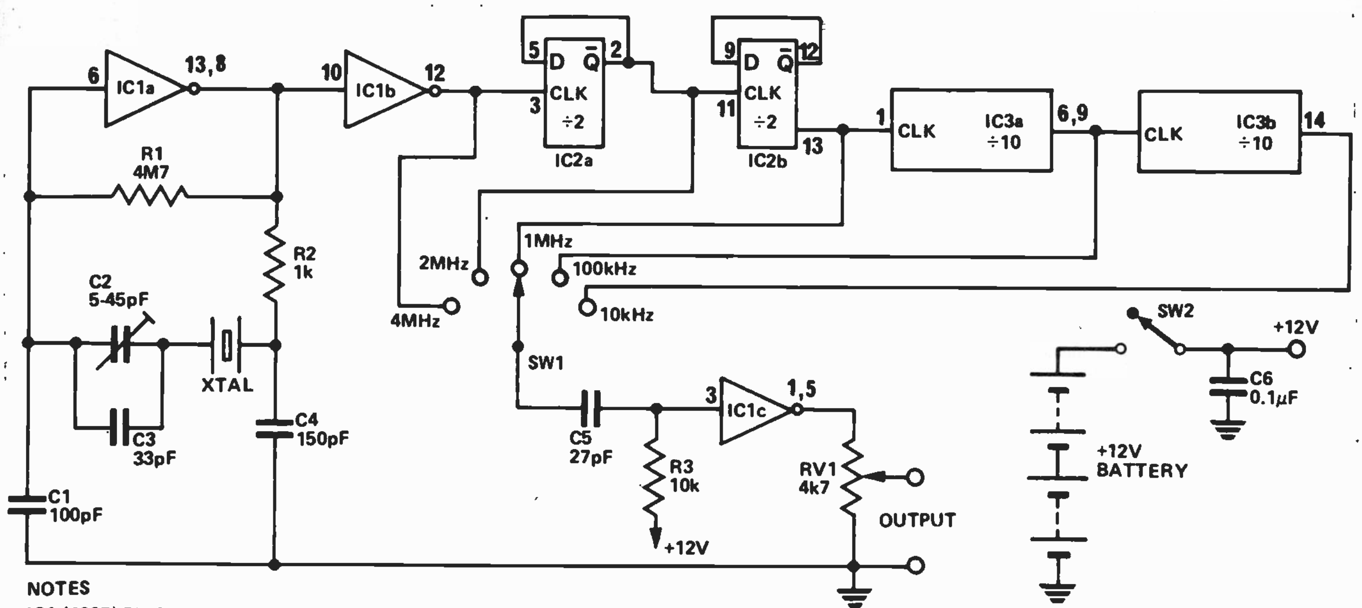
CONSTRUCTION

We mounted our unit in a commercially available aluminium box having dimensions of 150 mm wide by 75 mm high and 100 mm deep. The printed-circuit board is mounted on the rear panel of the box but spaced

SPECIFICATION

Harmonic Spacing	Five switchable outputs 4 MHz, 2 MHz, 1 MHz, 100 kHz and 10 kHz.
Harmonic Range	useable to 30 MHz
Accuracy	dependent on calibration.

MARKER GENERATOR



NOTES
IC1 (4007) PINS 7,4 AND 9 ARE GROUND
IC2 (4013) PINS 6,4,8,10 AND 7 ARE GROUND
IC3 (4518) PINS 8,7 AND 15 ARE GROUND

IC1 PINS 14, 2 AND 11 ARE +12V
IC2 PIN 14, IS +12V
IC3 PINS 2,10 AND 16 ARE +12V

Circuit diagram of marker generator.

HOW IT WORKS – ETI 706.

The marker generator is a constant-frequency oscillator driving into a CMOS divider chain. Switchable outputs from the divider chain are selected to drive a pulse generator.

The oscillator is IC1a in which R1 biases the IC into linear operation. The crystal determines the basic frequency of operation at 4 MHz in conjunction with C1, 2, 3 and 4 which appear to the crystal as one parallel capacitor. The capacitor C2 is used to tune the oscillator exactly to frequency as explained in the text. The resistor R2 adds extra phase shift but also reduces the gain. Thus if the oscillator is slow in starting reducing R2 may help. The output of the oscillator is buffered from the rest of the circuit by IC1/b.

IC2 is a CMOS dual type D flip flop that divides the 4 MHz by four to provide an output of 1 MHz, the 2 MHz also being brought out.

A further dual division by 10 is provided by IC3 which therefore provides outputs of 100 kHz and 10 kHz.

The required output is selected by SW1 and applied to C5 and R3 which differentiate the squarewave output of the divider. The waveform is then amplified and squared by IC1/c to provide an output train of narrow pulses, the amplitude of which may be varied by means of RV1.

from it by four 19 mm long machine screws. Also mounted on the rear panel are the two output terminals. The two switches and the potentiometer are mounted on the front panel whilst the battery holders are clamped to the bottom of the box by means of a clamp made from a scrap piece of aluminium.

With the exception of the ICs, mount all components and fit all links to the printed-circuit board. After checking that all are correct, mount the ICs, double checking their orientation before soldering. Fit all flying leads to the board allowing about 150 mm of free length.

Drill the box with all the required holes and fit all the components such as the switches, the potentiometer and the output sockets. Fit the printed-circuit board to the rear panel with C2 to the top of the box and route the leads to their respective points as detailed in the component overlay. Note that one of the screws through the wafer of SW1 has an earth lug underneath it which is used as the common earth point.

Fit the batteries and connect them up but do not switch on until a final wiring check has been carried out. Ten minutes of your time at this stage could save you the cost of a new set of ICs.

USING THE GENERATOR

Say for example, that we wish to tune a signal that we know to be on 13 250 kHz. First select 4 MHz on the marker generator and connect its output to the aerial socket of the receiver. Tune the receiver to the marker which will be found at 12 MHz (third harmonic of 4 MHz). Once located confirm that it is indeed coming from the marker generator by switching it on and off. Now switch to the 1 MHz markers and tune the receiver upwards to locate the 13th harmonic at 13 MHz. Now select 100 kHz markers and tune upwards through two markers to locate 13.2 MHz. Finally select the 10 kHz

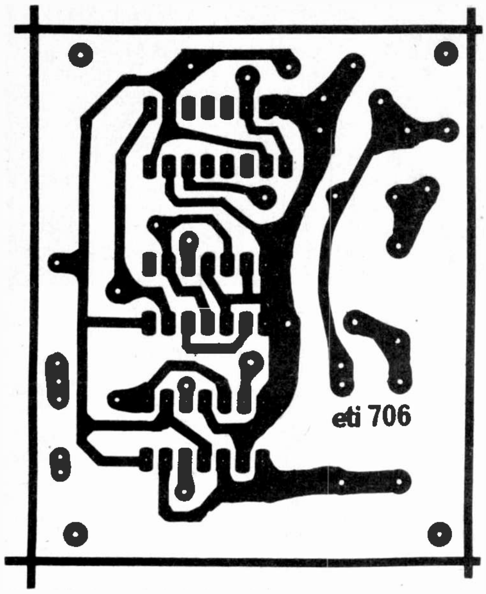
PARTS LIST – ETI

R1	Resistor	4M7	¼W	5%
R2	"	1k	"	"
R3	"	10k	"	"
RV1	Potentiometer	4k7	lin	
C1	Capacitor	100pF	Ceramic	
C2	"	5-45pF.	Beehive Trimmer	
C3	"	33pF	Ceramic	
C4	"	150pF	Ceramic	
C5	"	27pF	Ceramic	
C6	"	0.1μF	Ceramic	
IC1	Integrated Circuit	4007	(CMOS)	
IC2	" "	4013	(CMOS)	
IC3	" "	4518	(CMOS)	

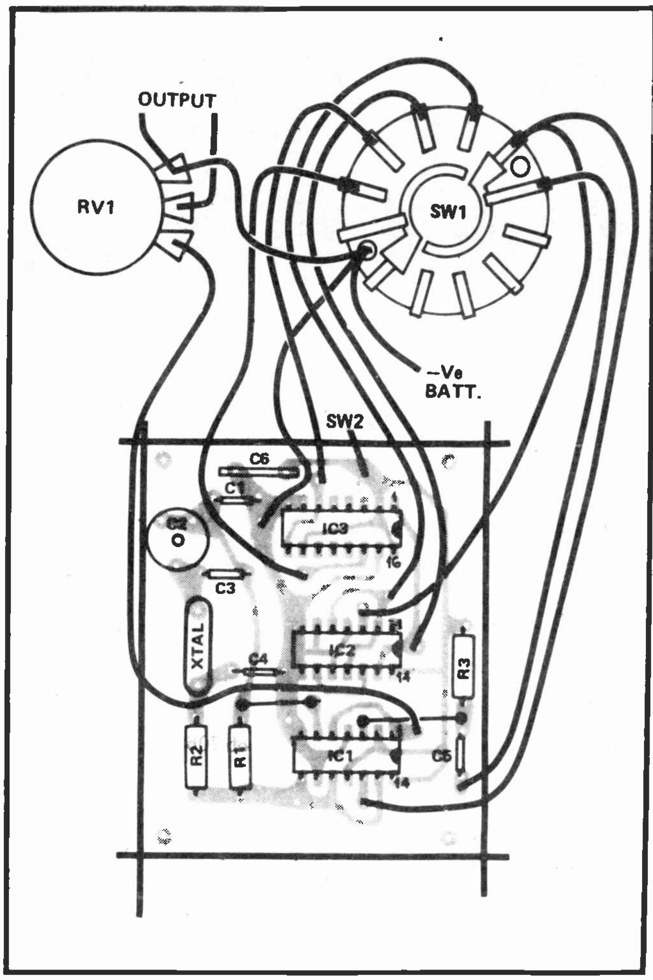
XTAL one 4.0000 MHz quartz crystal 30pF load

SW1 Rotary Switch 1 pole 5 position
SW2 Toggle Switch SPST
One pair of Terminals
PC Board ETI 706
Aluminium Box 150mm, 75mm, 100mm.

Two knobs
Eight AA size batteries
Two 4xAA size Battery Holders
Nuts and Bolts.



Printed-circuit layout. Full size 70 x 58mm.



Internal view of the completed marker generator. Note that the board is mounted with the crystal and C2 towards the top of the box.

markers and tune up through a further five markers to locate 13 250 kHz. Note that if this tuning procedure is carefully carried out it is quite simple to locate any position on the dial with great accuracy.

THE CRYSTAL.

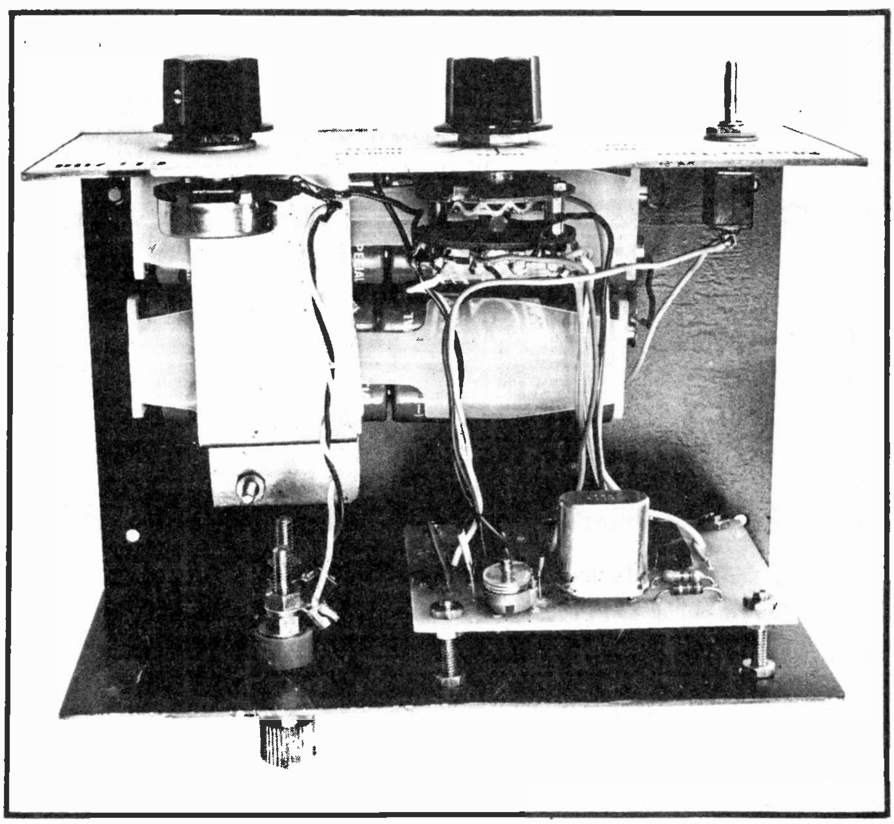
Crystals are supplied to work within specified tolerances. The tighter the tolerances the more expensive the crystal. However the crystal oscillator may be placed exactly on frequency (within small limits) by varying the amount of capacitance in parallel with it.

When purchasing a crystal you must tell the manufacturer what capacitance it will be working with and he will grind your crystal to be within the specified limits when it is used with that particular capacitance. This marker generator has been designed to work with crystals that are ground for 30 pF capacitance.

CALIBRATION

The marker will be sufficiently accurate for most people with C2 set to half value. For those who want greater accuracy the generator must be calibrated against a signal of known accuracy.

The generator may be aligned against one of these frequencies by the zero-beating technique. First tune in the signal and then connect the generator. A whistle will now be heard and C2 should be tuned to the point where the beat frequency has dropped so low that it cannot be heard. The generator is now spot on frequency and it should be noted that this calibration is independent of the generator. ●



Internal view of the generator. Note the crystal in the right foreground.

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2N456	0.80	2N3390	0.45	2N5295	0.48	AF115	0.35	BC207	0.27	BF160	0.23	LM309K	1.88	OC35	1.16
2N456A	0.85	2N3391	0.28	2N5296	0.48	AF116	0.35	BC208	0.11	BF163	0.32	LM5TI	1.50	OC42	0.50
2N457A	1.20	2N3391A	0.29	2N5298	0.50	AF117	0.35	BC212K	0.16	BF166	0.40	LM380	0.98	OC45	0.32
2N490	4.00	2N3392	0.15	2N5457	0.29	AF118	0.35	BC212L	0.16	BF167	0.25	LM381	2.07	OC71	0.17
2N491	4.38	2N3393	0.15	2N5458	0.26	AF124	0.30	BC214L	0.18	BF173	0.27	LM702C	0.75	OC72	0.25
2N492	5.00	2N3394	0.15	2N5459	0.29	AF125	0.30	BC237	0.16	BF177	0.29	LM709T099	0.48	OC81	0.25
2N493	5.20	2N3402	0.18	2N5492	0.58	AF126	0.28	BC238	0.15	BF178	0.35	8DIL	0.38	OC83	0.24
2N696	0.22	2N3403	0.19	2N5494	0.58	AF127	0.28	BC239	0.15	BF179	0.43	14DIL	0.40	ORP12	0.55
2N697	0.16	2N3414	0.20	2N5496	0.61	AF139	0.65	BC251	0.25	BF180	0.35	LM710	0.47	R53	1.80
2N698	0.82	2N3415	0.24	2N6027	0.45	AF186	0.46	BC253	0.25	BF181	0.36	LM3900	0.61	SL414A	1.80
2N699	0.59	2N3416	0.21	2N5777	0.45	AF200	0.65	BC257	0.15	BF182	0.35	LM723C	0.66	SL610C	1.70
2N706	0.14	2N3417	0.29	3N128	0.73	AF239	0.65	BC258	0.16	BF183	0.55	LM741T099	0.40	SL611C	1.70
2N706A	0.16	2N3440	0.59	3N139	1.42	AF240	0.90	BC259	0.17	BF184	0.30	8DIL	0.40	SL612C	1.70
2N708	0.17	2N3441	0.97	3N140	1.00	AF279	0.70	BC261	0.25	BF185	0.30	14DIL	0.38	SL620C	2.60
2N709	0.42	2N3442	1.40	3N141	0.81	AF280	0.79	BC262	0.25	BF194	0.12	LM747	1.00	SL621C	2.60
2N711	0.50	2N3638	0.15	3N200	2.49	AL102	1.00	BC263	0.25	BF195	0.12	LM7488DIL	0.44	SL623	4.59
2N718	0.23	2N3638A	0.15	40361	0.40	AL103	1.00	BC300	0.38	BF196	0.13	LM7805	1.88	SL640C	3.10
2N718A	0.28	2N3639	0.27	40362	0.45	BC107	0.14	BC301	0.34	BF197	0.15	14DIL	0.73	SL641C	3.10
2N720	0.57	2N3641	0.17	40363	0.88	BC108	0.14	BC303	0.54	BF198	0.18	LM7805	2.50	SN76003N	2.92
2N914	0.22	2N3702	0.11	40389	0.46	BC109	0.14	BC307	0.17	BF200	0.40	LM7812	1.99	SN76013N	1.95
2N916	0.28	2N3703	0.12	40394	0.56	BC113	0.15	BC308A	0.15	BF225J	0.23	LM7815	1.99	SN76023N	1.60
2N918	0.32	2N3704	0.15	40395	0.65	BC115	0.17	BC309C	0.20	BF244	0.21	LM7824	1.99	SN76033N	2.92
2N929	0.25	2N3705	0.15	40406	0.44	BC116	0.17	BC317	0.12	BF245	0.45	MC1303	1.50	ST2	0.20
2N930	0.26	2N3706	0.15	40407	0.35	BC116A	0.18	BC318	0.12	BF246	0.58	MC1310	2.50	TAA300	1.84
2N1302	0.19	2N3707	0.18	40408	0.35	BC117	0.21	BC337	0.20	BF247	0.65	MC13300P	0.90	TAA263	1.20
2N1303	0.19	2N3708	0.14	40409	0.52	BC118	0.14	BC338	0.20	BF254	0.19	MC1351P	0.80	TAA350	1.96
2N1304	0.26	2N3709	0.15	40410	0.52	BC119	0.29	BCY30	0.80	BF255	0.19	MC1352P	0.80	TAA550	0.32
2N1305	0.24	2N3710	0.15	40411	2.25	BC121	0.35	BCY31	0.85	BF257	0.47	MC1466	3.50	TAA611C	2.18
2N1306	0.31	2N3711	0.15	40594	0.74	BC125	0.16	BCY32	1.15	BF258	0.53	MC1469	2.75	TAA621	2.03
2N1307	0.30	2N3712	1.20	40595	0.84	BC126	0.23	BCY33	0.85	BF259	0.55	ME0402	0.20	TAA661B	1.03
2N1308	0.47	2N3713	1.20	40601	0.67	BC132	0.30	BCY34	0.79	BFR39	0.24	ME0404	0.13	TBA641B	2.25
2N1309	0.47	2N3714	1.38	40602	0.61	BC134	0.13	BCY38	1.00	BFR79	0.24	ME0412	0.18	TBA651	1.69
2N1671	1.54	2N3715	1.50	40603	0.58	BC135	0.13	BCY39	1.50	BFS21A	2.30	ME4102	0.11	TBA810	0.98
2N1671A	1.67	2N3716	1.80	40604	0.56	BC136	0.17	BCY40	0.97	BFS28	1.04	ME4104	0.11	TBA820	0.80
2N1671B	1.85	2N3771	2.20	40636	1.10	BC137	0.17	BCY42	0.28	BFS61	0.27	MJ480	0.95	TBA920	1.79
2N1711	0.27	2N3772	1.80	40669	1.00	BC140	0.68	BCY58	0.30	BFS98	0.25	MJ481	1.20	TIL209	0.30
2N1907	0.60	2N3773	2.65	40673	0.73	BC141	0.68	BCY59	0.32	BFX29	0.30	MJ490	1.05	TIP29A	0.49
2N2102	0.60	2N3779	3.15	AC126	0.20	BC142	0.23	BCY70	0.17	BFX30	0.34	MJ491	1.45	TIP30A	0.58
2N2147	0.78	2N3790	2.40	AC127	0.40	BC143	0.25	BCY71	0.22	BFX84	0.30	MJ2955	1.00	TIP31A	0.62
2N2148	0.94	2N3791	2.35	AC128	0.35	BC147	0.14	BCY72	0.15	BFX85	0.35	MJE340	0.48	TIP32A	0.74
2N2160	0.90	2N3792	2.60	AC151V	0.27	BC148	0.09	BD115	0.75	BFX87	0.28	MJE370	0.65	TIP33A	1.01
2N2218A	0.47	2N3794	0.10	AC152V	0.49	BC149	0.15	BD116	0.75	BFX88	0.30	MJE371	0.75	TIP34A	1.51
2N2219	0.42	2N3810	0.37	AC153	0.35	BC153	0.18	BD121	1.00	BFX89	0.90	MJE520	0.60	TIP35A	2.90
2N2219A	0.52	2N3820	0.29	AC153K	0.40	BC154	0.18	BD123	0.82	BFY50	0.23	MJE521	0.70	TIP36A	3.70
2N2220	0.25	2N3823	1.58	AC154	0.25	BC157	0.16	BD124	0.67	BFY51	0.23	MJE2955	1.20	TIP41A	0.79
2N2221	0.18	2N3904	0.19	AC176	0.41	BC158	0.16	BD131	0.40	BFY52	0.21	MJE3055	0.75	TIP42A	0.90
2N2221A	0.21	2N3906	0.19	AC176K	0.40	BC160	0.78	BD132	0.50	BFY53	0.18	MP8111	0.32	TIP29c	0.80
2N2222	0.20	2N4036	0.67	AC187K	0.35	BC167B	0.15	BD135	0.21	BFY90	0.75	MP8112	0.40	TIP30c	0.85
2N2222A	0.25	2N4037	0.42	AC188K	0.40	BC168B	0.15	BD136	0.22	BRY39	0.38	MP8113	0.47	TIP31c	1.00
2N2368	0.17	2N4058	0.18	ACY18	0.24	BC168C	0.15	BD137	0.24	BSX20	0.28	MPF102	0.30	TIP32c	1.25
2N2369A	0.22	2N4059	0.15	ACY19	0.27	BC169B	0.15	BD138	0.26	BSX21	0.30	MPSA05	0.25	TIP33c	1.45
2N2369	0.22	2N4060	0.15	ACY20	0.22	BC169C	0.15	BD139	0.71	BU104	2.00	MPSA06	0.31	TIP34c	2.60
2N2646	0.55	2N4061	0.15	ACY21	0.26	BC170	0.15	BD140	0.87	BU105	2.25	MPSA12	0.35	TIP41c	1.40
2N2647	0.98	2N4062	0.15	ACY28	0.20	BC171	0.16	BD529	0.80	C106D	0.65	MPSA55	0.25	TIP42c	1.60
2N2904	0.40	2N4126	0.21	ACY30	0.58	BC172	0.12	BD530	0.80	CA3180A	0.85	MPSA56	0.31	TIP49	0.70
2N2904A	0.45	2N4289	0.34	AD142	0.57	BC177	0.19	BFR39	0.24	CA3020A	1.80	MPSU05	0.65	TIP53	0.53
2N2905	0.47	2N4919	0.95	AD143	0.68	BC178	0.18	BFR79	0.24	CA3028A	0.79	MPSU06	0.58	TIP2955	0.98
2N2905A	0.50	2N4920	1.10	AD149V	0.74	BC179	0.21	BDY20	1.05	CA3035	1.37	MPSU55	0.63	TIP3055	0.50
2N2906	0.33	2N4921	0.83	AD150	0.63	BC182	0.12	BF115	0.29	CA3052	1.62	MPSU56	0.80	TIS43	0.28
2N2906A	0.42	2N4922	0.83	AD162	0.69	BC182L	0.12	BF117	0.55	CA3046	0.70	NE555V	0.70	ZTX300	0.13
2N2907	0.22	2N4923	1.00	AD161	0.64	BC183	0.12	BF121	0.35	CA3048	2.11	NE556	1.30	ZTX301	0.13
2N2907A	0.24	2N5190	0.92	AD162	0.69	BC183L	0.12	BF123	0.35	CA3089E	1.96	NE560	4.48	ZTX302	0.20
2N2924	0.20	2N5191	0.96	AF106	0.40	BC184	0.13	BF125	0.35	CA3090Q	4.23	NE561	4.48	ZTX500	0.15
2N2926	0.20	2N5192	1.24	AF109R	0.40	BC184L	0.13	BF152	0.20	LM301A	0.48	NE565A	4.48	ZTX501	0.13
2N3053	0.25	2N5195	1.46	AF114	0.35	BC186	0.25	BF153	0.25	LM308	1.17	OC23	1.35	ZTX502	0.18
2N3054	0.60	2N5245	0.29			BC187	0.27	BF154	0.16			OC28	1.48	ZTX530	0.23
2N3055	0.75	2N5294	0.48					BF159	0.27						

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CD4010	.52	CD4025	.19	CD4050	.45
CD4011	.18	CD4027	.43	CD4510	1.25
CD4012	.18	CD4028	.83	CD4511	1.94
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CD4014	.89	CD4030	.52	CD4518	1.87
CD4015	.89	CD4031	1.98	CD4520	1.87
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SN7401	0.16	SN7411	0.20	SN7437	0.28	SN7453	0.16	SN7482	0.65	SN74100	1.10	SN74154	1.20	SN74180	1.10
SN7401AN	0.29	SN7412	0.22	SN7438	0.28	SN7454	0.16	SN7483	0.82	SN741D7	0.30	SN74155	0.78	SN74181	1.95
SN7402	0.16	SN7413	0.28	SN7440	0.16	SN7460	0.16	SN7484	0.95	SN74118	0.85	SN74157	0.76	SN74190	1.86
SN7403	0.16	SN7416	0.28	SN7441AN	0.68	SN7470	0.29	SN7485	1.00	SN74119	1.75	SN74160	0.88	SN74191	1.86
SN7404	0.19	SN7417	0.28	SN7442	0.65	SN7472	0.21	SN7486	0.29	SN74121	0.32	SN74161	0.88	SN74192	1.15
SN7405	0.19	SN742D	0.16	SN7445	0.78	SN7473	0.31	SN7490	0.42	SN74122	0.42	SN74162	0.88	SN74193	1.15
SN7406	0.36	SN7423	0.23	SN7446	0.84	SN7474	0.31	SN7491	0.75	SN74123	0.65	SN74163	0.88	SN74196	1.60
SN7407	0.36	SN7425	0.23	SN7447	0.80	SN7475	0.45	SN7492	0.45	SN74141	0.75	SN74164	1.60	SN74197	1.58
SN7408	0.19	SN7427	0.23	SN7448	0.90	SN7476	0.30	SN7493	0.45	SN74145	0.72	SN74165	1.60	SN74198	1.80
SN7409	0.18	SN7430	0.15	SN7450	0.16	SN7480	0.42	SN7494	0.75	SN74150	1.20	SN74167	3.30	SN74199	1.80

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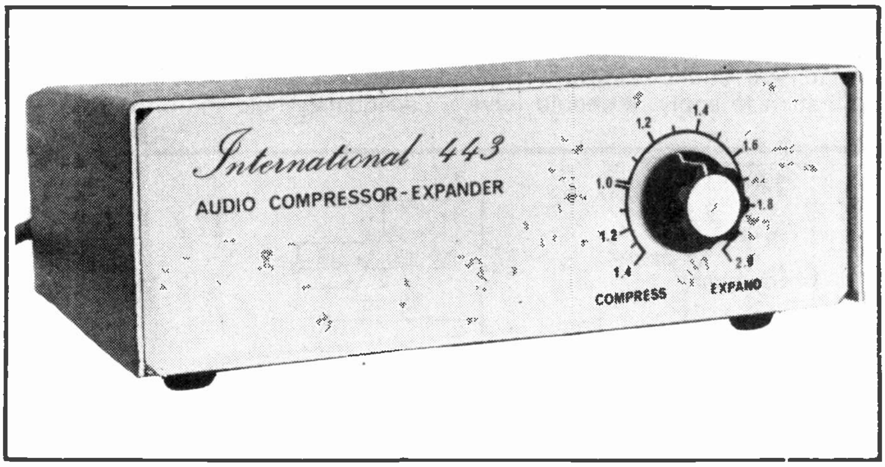
AUDIO EXPANDER-COMPRESSOR

Increase dynamic range of tape recordings or reduce record surface noise with this versatile unit.



MANY OF US have tapes in either the reel to reel format or on cassettes which leave a lot to be desired in terms of signal to noise ratio. It is not that we necessarily made a bad job of the recording in the first place, but rather the limitations of our equipment and tape were generally just a little bit too much compared with what is available today. And because the signal to noise ratio is so poor, many of these tapes (and quite a few records as well) tend to lie on the shelf because of their audible inadequacies. Apart from this it is by no means unknown for commercially pre-recorded tapes and records to be below an acceptable standard.

Many people arbitrarily think that this problem is what the Dolby system is intended to resolve. But this is not so. The Dolby system helps *maintain* the original signal to noise ratio when recording from one medium to another but it has very little to offer when faced by *existing* inadequacies.

DYNAMIC RANGE

Another problem that plagues many of us is the poor dynamic range of our tape recorders or of the pre-recorded material that we buy. For example, the majority of cassette recorders are hard pressed to offer even a 55 dB dynamic range. Many of them offer little more than 40 dB. As if this were not bad enough, few records have a dynamic range exceeding 50-55 dB and even this is soon degraded to 40-45 dB after a dozen or so playings in a dusty environment.

THE SOLUTION

Audio volume expansion is the simplest and most effective way of increasing the apparent signal to noise ratio of a worn or noisy recording. There is also no more effective way of preserving the full dynamic range of a sound than by recording with volume compression, and replaying with equal volume expansion. However, for these applications, the compression and expansion must be done in a precise and reproducible manner; which is by no means as simple as it first appears.

The Compressor-Expander described here is relatively inexpensive to build, yet its performance is quite adequate for all practical purposes. It is sufficiently versatile to interface with most existing audio equipment, at nominal signal levels from about 25 millivolts to 1 volt.

CONSTRUCTION

Due to the relative complexity of the circuit a double-sided printed-circuit board has been used to simplify the construction, and we strongly recommend that this board be used. A single-sided board would be much larger and would require a great number of wire links.

Begin construction by assembling the components to the board in accordance with the component overlay Fig. 2. Take particular care with the orientation of components as marked on the overlay. When soldering component leads to the top of the printed-circuit board use a soldering iron which has a small tip and use a small gauge of solder (1 mm recommended). Take care not to bridge solder between the IC pads. It is easy to miss soldering connections on the component side of the board and these should be double checked.

Take care to insert the electrolytics with the polarity as marked on the overlay and even more care with the orientation of the diodes. A reversed diode can result in the destruction of one or more of the dual transistors.

The resistors in the signal side of the circuit and those in the current-sink circuit should be 2% or better. Alternatively they may be selected from 5% values. In selecting values an ordinary multimeter (operated at about the centre of the range) suffices. The resistors in question are all values between R37 and R65.

For best results the two 12 volt zeners should also be matched but in practice any slight discrepancy may be compensated by using the normal stereo-balance control.

A value of 1 microfarad for C5 allows compression or expansion to follow the signal amplitude so rapidly that the ear is unlikely to detect the attack or release, which is virtually complete in about 20 milliseconds. However, with this value, low frequency signal components (50 Hz or lower) will not be averaged out in obtaining the gain control voltage, and severe intermodulation and 3rd harmonic distortion will result. At the other extreme, a value of 4.7 microfarads for C5 will prevent this distortion right down to the lower audible limit, but the attack and release time

AUDIO EXPANDER-COMPRESSOR

(about 100 milliseconds) is so long that the effects can be audible, although not necessarily unpleasant. A value of C5 equal to 4.7 microfarads will be found quite acceptable by most people.

Potentiometer R_{24} is used to match the signal levels of the compressor-expander with those of the associated equipment. Potentiometer R_{34} should be a wire-wound type; and for the front-panel calibration to apply, it should have an effective electrical rotation of 280°, and the midpoint of rotation should be set opposite the 1.0 index line.

Capacitor C5 should be chosen in accordance with the particular compromise that suits the user of the unit. Alternatively a switch may be used to select different values.

The box used in our prototype measured 200 × 125 × 63 mm and, although a little cramped did adequately hold the unit. The next larger box available was thought to be too big. The printed-circuit board is mounted at the rear of the box to allow room for the front panel potentiometer to be mounted. The board is mounted on 6 mm spacers and the transformer is then mounted directly onto the rear panel together with the phono input and output sockets.

POWER SUPPLY

The output of the transformer is rectified by a full-wave bridge to provide ±22 volts, as set by the Zener diodes. The voltages obtained from the MC1468L regulator are the ±15V required for correct operation of the compressor-ex-

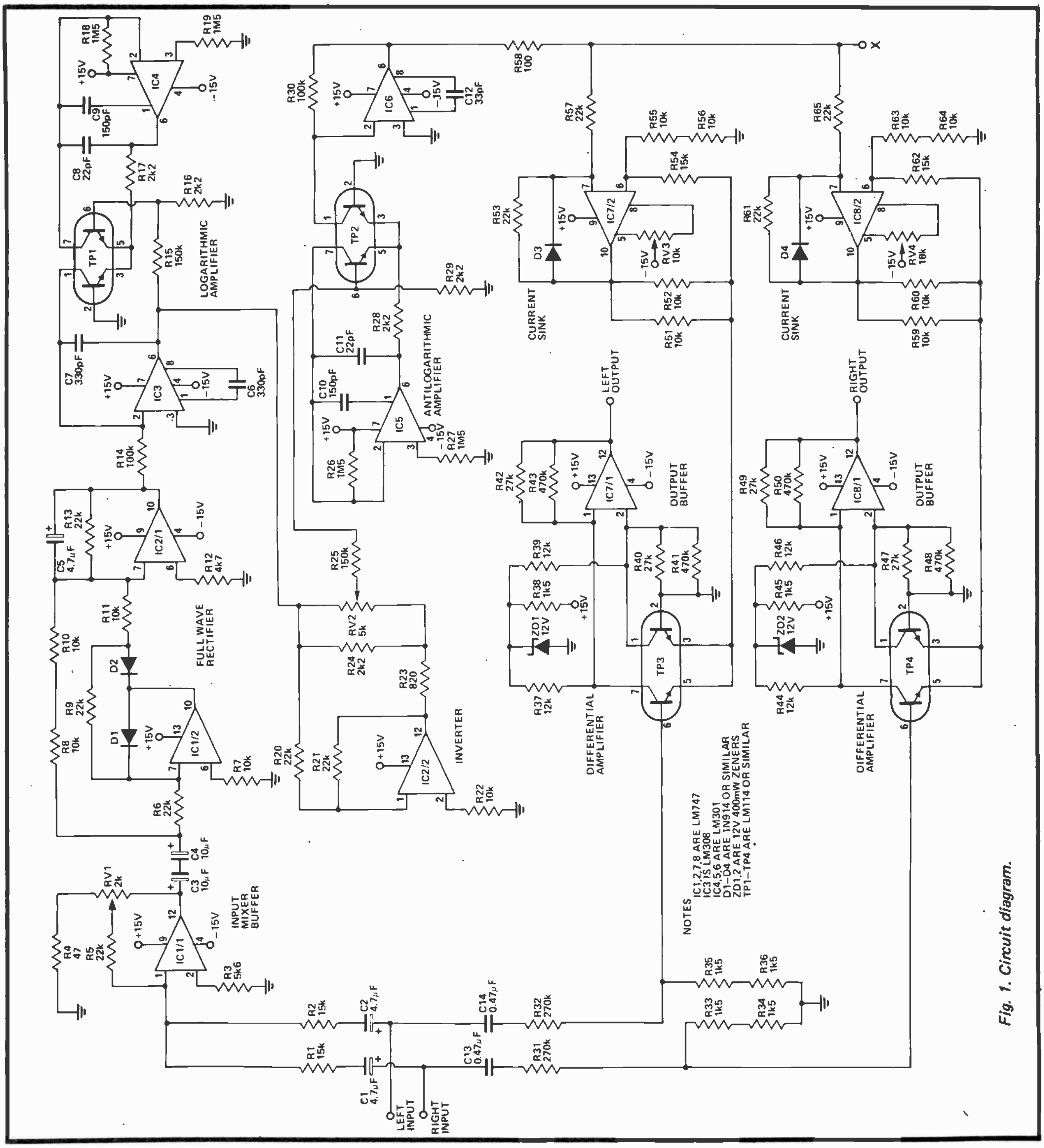
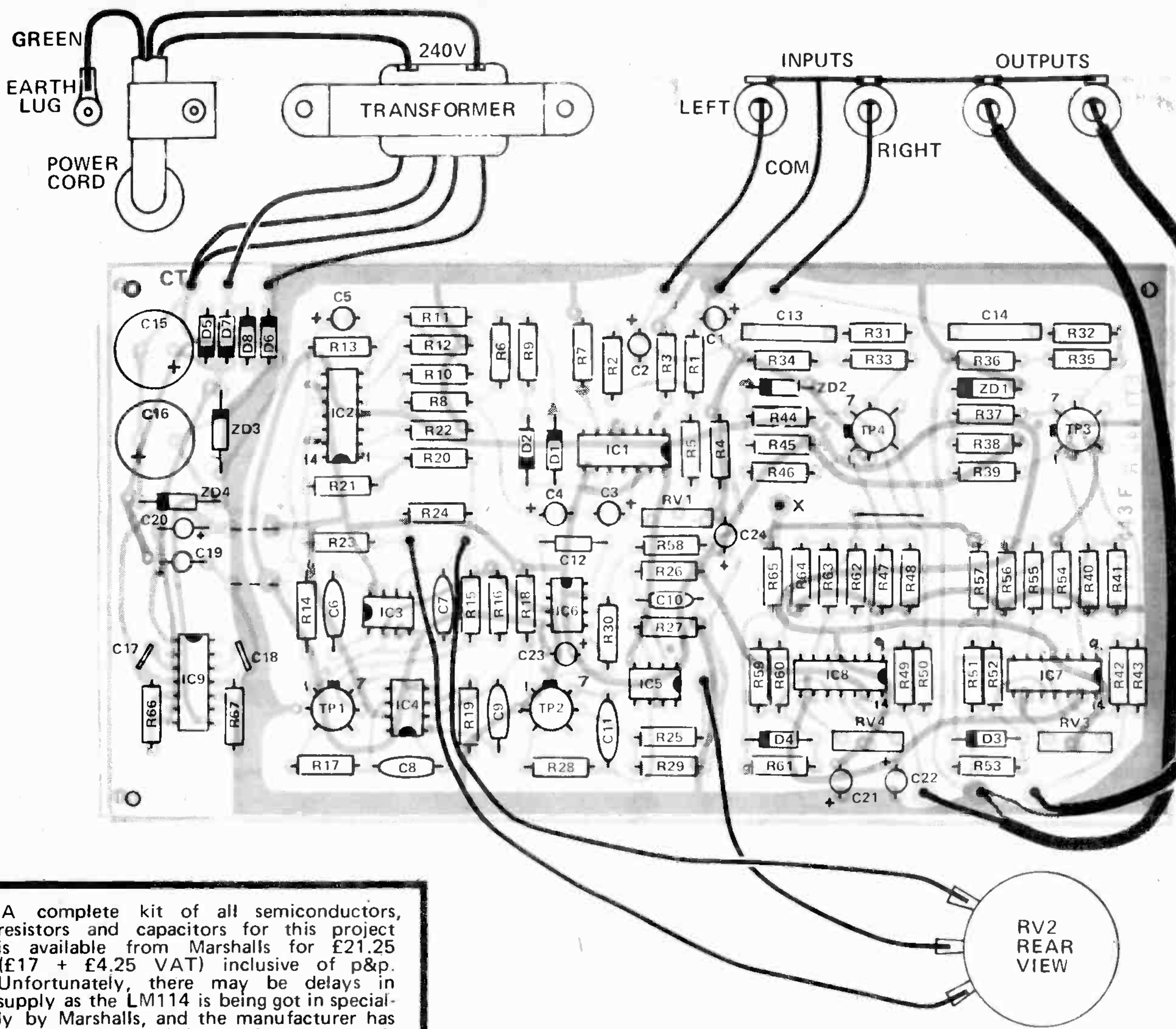


Fig. 1. Circuit diagram.



A complete kit of all semiconductors, resistors and capacitors for this project is available from Marshalls for £21.25 (£17 + £4.25 VAT) inclusive of p&p. Unfortunately, there may be delays in supply as the LM114 is being got in specially by Marshalls, and the manufacturer has quoted a long delivery time — there's another component shortage on the way!

Fig. 2. Component overlay (not full size)

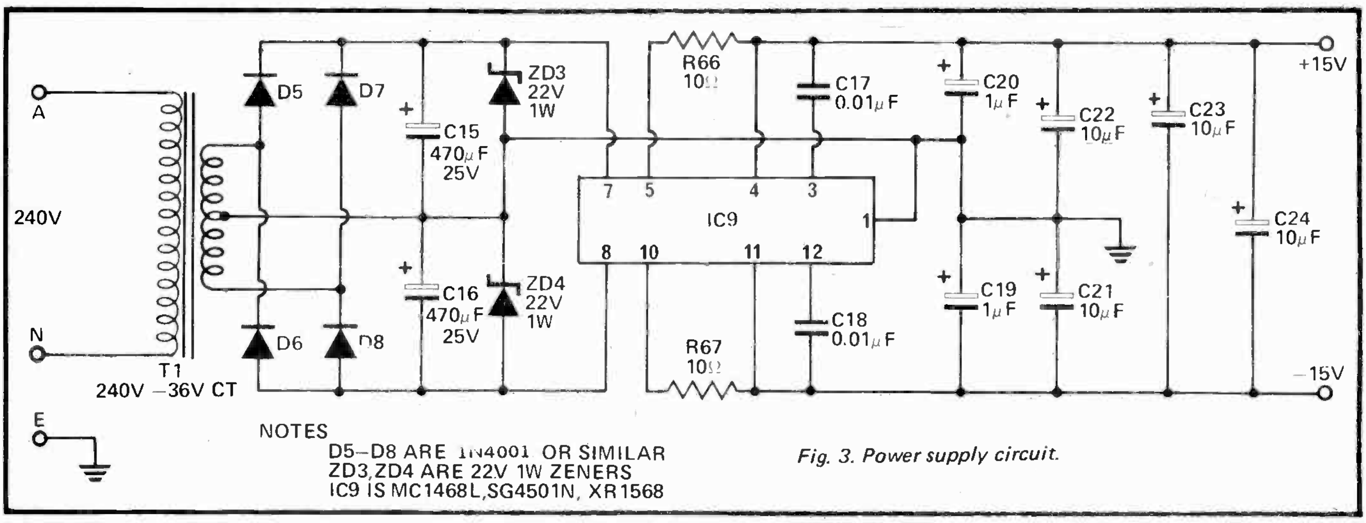


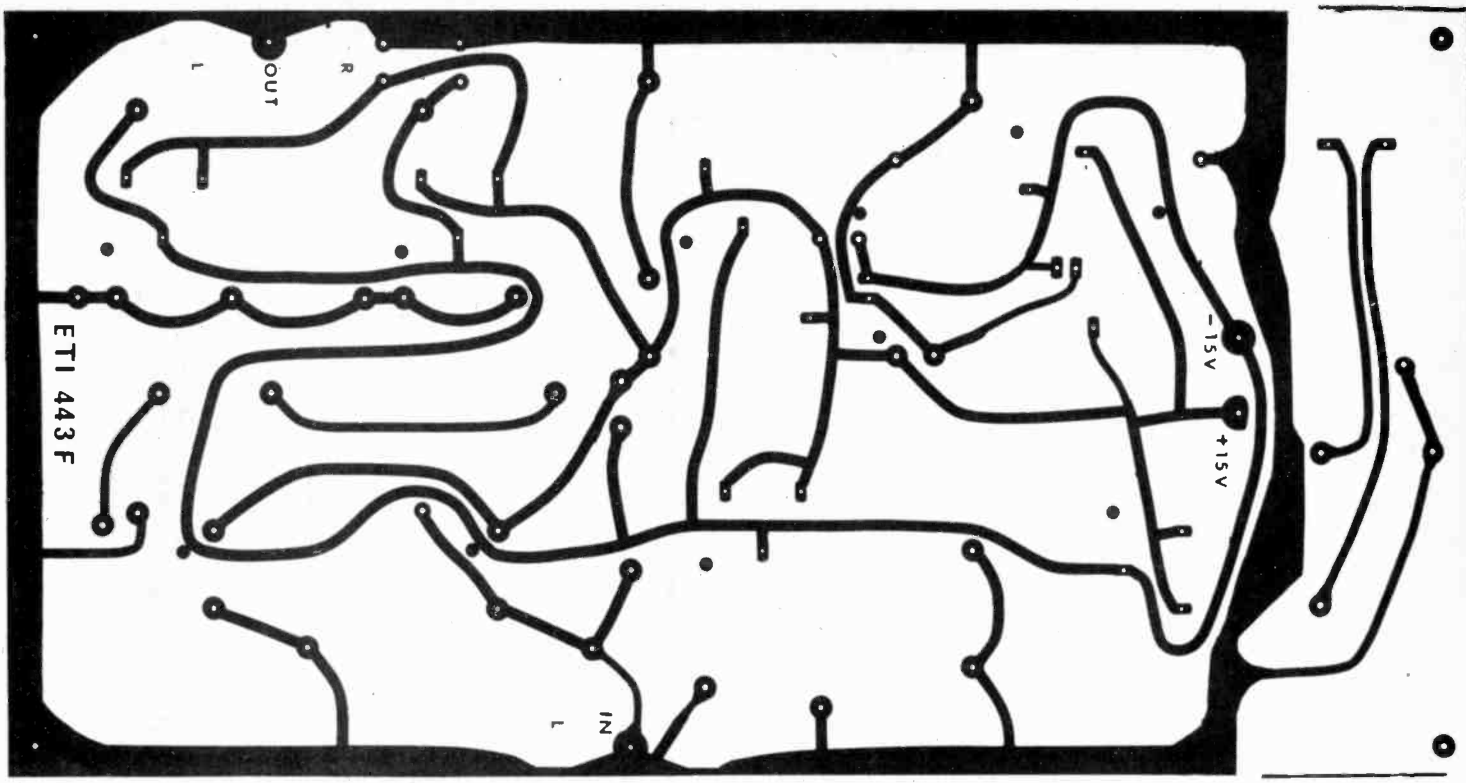
Fig. 3. Power supply circuit.

pander.

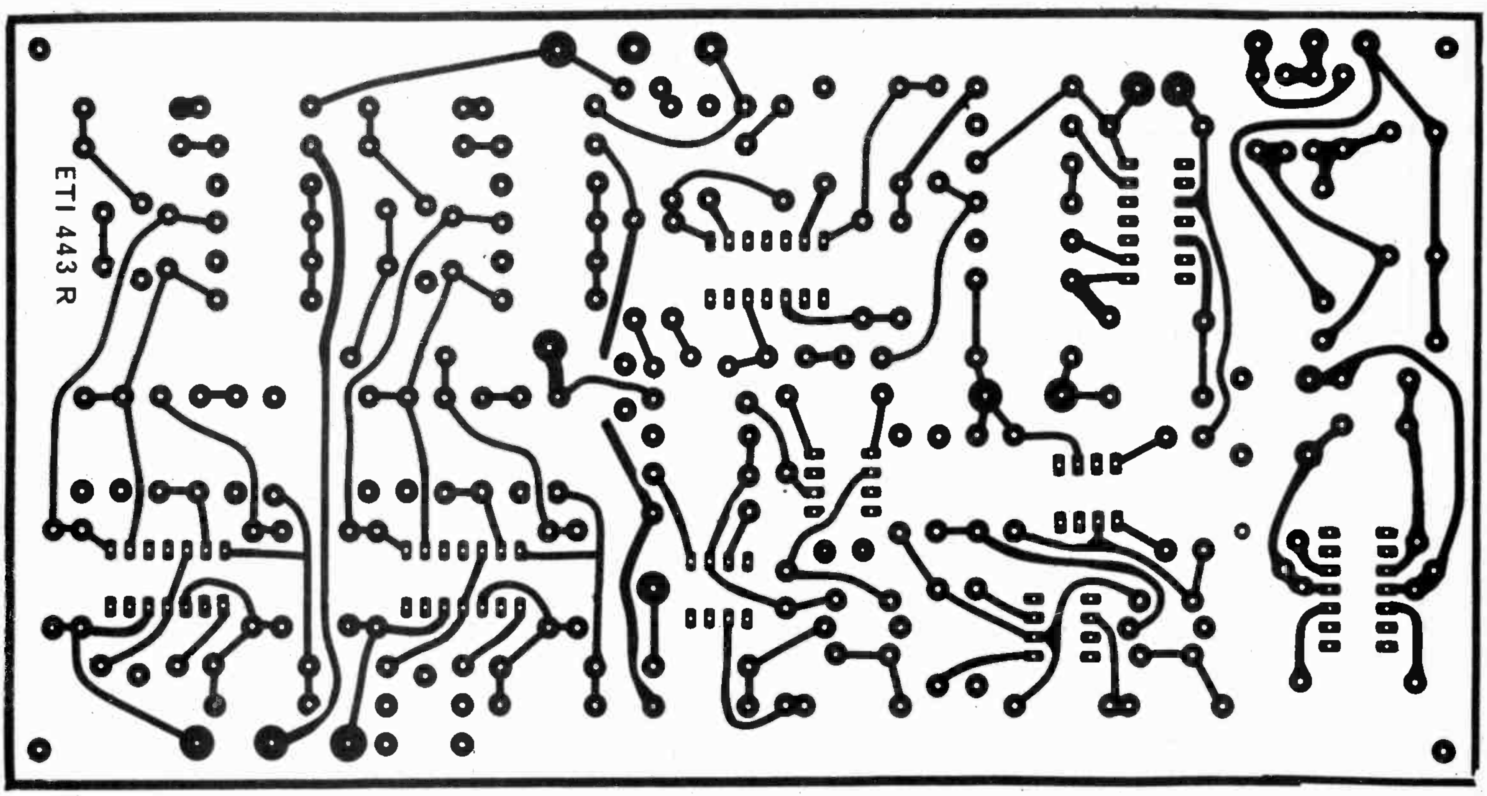
SETTING UP

With the power supply connected (check for correct polarity), apply a strong (about 1 volt) audio signal to both stereo inputs, while the point marked 'X' is shorted to ground. Monitor the left channel output with a high sensitivity meter (or amplifier) and adjust RV3 to the point where the output JUST disappears. Repeat with the right channel and RV4. This procedure balances out the input offset voltage of the current sinks, and ensures that the audio gain will be controlled correctly at the low end. Remove the input signal and the short circuit.

RV1 is set by the following



Double-sided PCB pattern (full size).



procedure:

(1) Connect the compressor-expander to its associated equipment, and supply an input of moderate level (e.g. music of average loudness). RV1 should be fully clockwise when viewed from the input edge of the board.

(2) Turn the compress-expand control to full compression, and adjust RV1 to bring the output up to its original level (loudness).

(3) Turn the compress-expand control towards the expansion end, and note any obvious change in output level.

(4) If a decrease in level occurs, turn RV1 slightly anticlockwise; if an increase occurs, turn RV1 slightly clockwise.

(5) Repeat steps (3) and (4) until the level remains reasonably constant over the whole range of compression and expansion. Note that this adjustment is subjective, and it does not need to be done with any great accuracy.

If RV1 cannot be adjusted as described, it means that the signal level is outside the optimum range of the compressor-expander. Somewhat higher signal levels can be accommodated by increasing the value of R1 and R2, whilst for lower signal levels, R4 should be decreased. If correct adjustment of

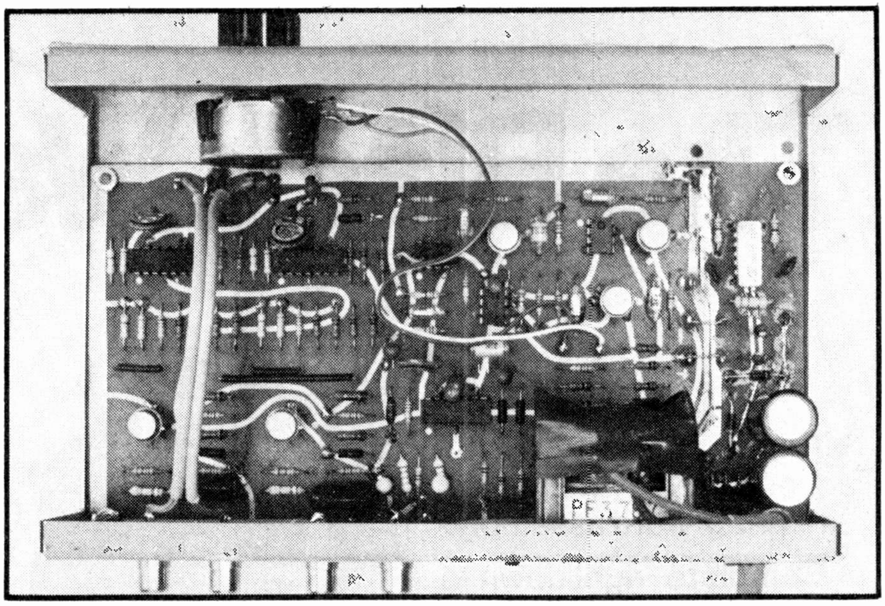
AUDIO EXPANDER-COMPRESSOR

RV1 is obtained well towards the anticlockwise end, then an improved signal-to-noise ratio results if R34 and R36 are increased to 18K, and the stereo outputs are each attenuated by a 470 ohm/3.9K divider. However, this modification is not essential.

With no input signal applied adjust RV2 such that the voltage at its wiper is zero volts. Now fit the knob such that the pointer lines up with the 1.0 calibration. Now check that the potentiometer travel approximately matches the scale. If not reverse the two outside leads to it.

HOW TO USE

The use of a compressor-expander need not be confined to those situations where such a device is really needed. Practically all tapes and many records become more listenable with a small amount of expansion.. On the other hand, background music is far less obtrusive if the volume is compressed to some extend. The key to listening pleasure lies in the handling of the compress-expand control. Don't move it far from the 1.0 position unless there is some definite reason.



Interior of the unit.

One final word of warning — this device is quite capable of outputting a signal of 10 volts. It would be wise to ensure that your amplifier is capable of accepting this voltage without damage.

HOW IT WORKS

The heart of an audio compressor-expander is invariably a voltage controlled amplifier; that is, an amplifier whose gain is set by means of an applied voltage. This voltage itself must be derived from the amplitude of the audio input signal, averaged over some preset period, and modified to give the required compression or expansion characteristics. In the circuit of Fig. 1, each portion of the circuit is identified according to its function. These portions, in turn, are grouped into three main sections; an AC to DC converter, a power function generator, and a stereo analogue multiplier.

The two channels of stereo input are mixed in buffer amplifier IC1/1, and the gain of this stage is set so that an output of about 1 volt is given by a signal which corresponds to moderate loudness. Amplifers IC1/2, and IC2/1 are used to obtain precision full-wave rectification of the mixed input, and the resulting positive DC voltage is stored in capacitor C5. The choice of value for C5 is important, and it will be discussed in detail later on.

Amplifiers IC3 and IC4 together with the transistor pair TP/1 constitute a logarithmic amplifier. With the components shown, the behaviour of this amplifier is described by the equation:

$$E_{out} = -4.15 \log E_{in}$$

The inverse of E_{out} is obtained from amplifier IC2/2 and by connecting the compression-expansion control potentiometer as shown between the input and output of this stage, any voltage between E_{out} and $-0.3E_{out}$ can be obtained. IC5, IC6 and TP_2 are combined as an antilogarithmic or exponential amplifier which is the exact inverse of the logarithmic amplifer, so that the effect of all these operations on the input signal is to give to a positive DC output voltage, equal in magnitude to the input voltage raised to the power k, where k can have any value from —0.3 to 1.

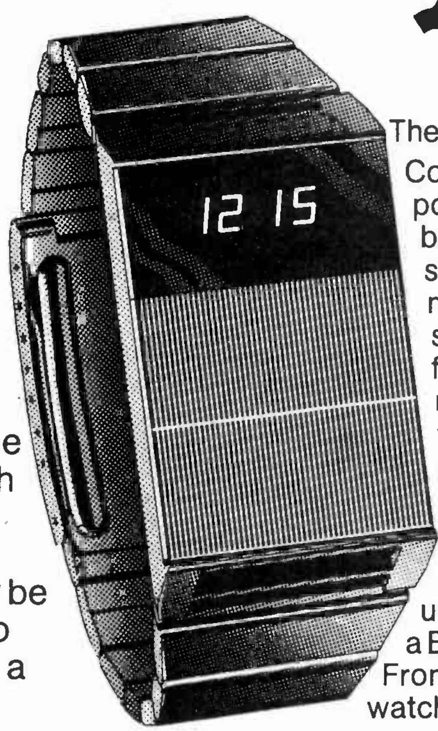
In the analog multiplier sections, this voltage (E_{in}) is converted to current by amplifiers IC7/2 and IC8/2 thus setting the effective gain of the differential amplifiers TP_3 and TP_4. These are directly coupled into the output buffers IC7 and IC8/1 so that the stereo signals reaching the outputs have been amplified by a factor which depends on the average amplitude of the signals, and the compression-expansion control setting. The actual voltage gain can vary from 0.0004 to 14, which represents a power gain range of 97dB.

PARTS LIST — ETI443

R1, R2	15k
R3	5k6
R4	47R
R5, R6, R9, R13, R20, R21	22k
R7, R8, R10, R11, R22	10k
R12	4k7
R14, R30	100k
R15, R25	150k
R16, R17, R24, R28, R29	2k2
R18, R19, R26, R27	IM5
R23	820R
R31, R32	270k
R33, R34, R35, R36	1k5
R66, R67	10R
All ½W, 5%	
R37, R39, R44, R46	12k
R38, R45	1k5
R40, R42, R47, R49	27k
R41, R43, R48, R50	470k
R51, R52, R55, R56, R59, R60, R63, R64	10k
R53, R57, R61, R65	22k
R54, R62	15k
R58	1k
All ½W, 2% (may be selected from 5% resistors)	
RV1	2k trimmer
RV2	5k wirewound pot
RV3, RV4	10k trimmer
C1, C2, C5	4.7µF 25V tantalum
C3, C4	10µF 25V tantalum
C6, C7	330pF
C8, C11	22pF
C9, C10	150pF
C12	33pF
C13, C14	0.47µF polyester
C15, C16	470µF 25V electrolytic
C17, C18	0.01µF polyester
C19, C20	1µF 25V tantalum
C21, C22, C23, C24	10µF 35V tantalum
TP1, TP2, TP3, TP4	LM114 Dual transistor or equivalent
IC1, IC2, IC7, IC8	LM747
IC3	LM308
IC4, IC5, IC6	LM301
IC9	MC1468L or equivalent
D1, D2, D3, D4	1N914
D5, D6, D7, D8	1N4001
ZD1, ZD2	12V, 400mW
ZD3, ZD4	22V, 1W
T1	240V/36V CT transformer
PCB ETI 443	

4 Phono sockets 4 6mm spacers
chassis and cover 200x63x125mm approx
nuts, bolts and assorted hardware

The Black Watch kit £14.95!



★ **Practical**–easily built by anyone in an evening's straightforward assembly.

★ **Complete**–right down to strap and batteries.

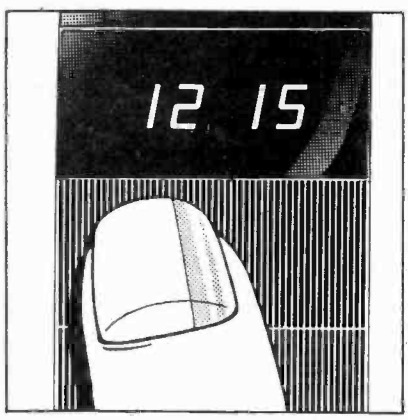
★ **Guaranteed.** A correctly-assembled watch is guaranteed for a year. It works as soon as you put the batteries in. On a built watch we guarantee an accuracy within a second a day–but building it yourself you may be able to adjust the trimmer to achieve an accuracy within a second a week.

The Black Watch by Sinclair is unique. Controlled by a quartz crystal, and powered by two hearing aid batteries, it uses bright red LEDs to show hours and minutes, and minutes and seconds. And it's styled in the cool prestige Sinclair fashion: no knobs, no buttons, no flash.

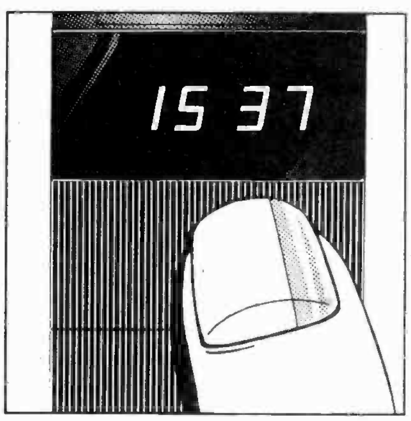
The Black Watch kit is unique, too. It's rational – Sinclair have reduced the separate components to just four–and it's simple: anybody who can use a soldering iron can assemble a Black Watch without difficulty. From opening the kit to wearing the watch is a couple of hours' work.

Touch and tell

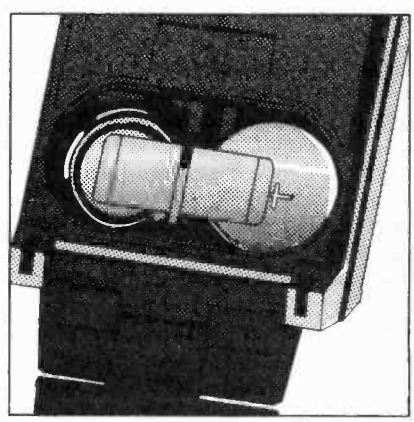
Press here for hours and minutes...



here for minutes and seconds.



Batteries easily replaced at home.



The specialist features of the Black Watch

Smooth, chunky, matt-black case, with black strap. (Black stainless-steel bracelet available as extra–see order form.)

Large, bright, red display–easily read at night. Touch-and-see case–no unprofessional buttons.

Runs on two hearing-aid batteries (supplied). Easily re-set using special button–no expensive jeweller's service.

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6 C90 DINDY SUPER CASSETTES

Plus stand

£2.99

Offer closes 31st May

ETI have made arrangements with Dindy for an offer on C90 cassettes. We have inspected and tested these and were impressed with the good value. The Dindy cassettes are designed to combine performance and reliability into a unit which offers unbeatable value.

The Dindy philosophy is that fine attention to detail is necessary in order to produce a cassette that meets all the demands of today's audio anthusiast. That is why Dindy cassettes feature:

- A five year replacement parts guarantee.
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- Extended frequency response.
- Improved magnetic stability.
- High quality screw type cassette casing.
- Separate roller pins.
- Flanged plastic rollers.
- Siliconised shims.
- Two point hub fixing.

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Please find enclosed my cheque/P.O. for £2.99 payable to Electronics Today International. IMPORTANT: Please write your name and address on the back of your cheque and P.O's.

This coupon will be used to dispatch your cassettes. The offer is strictly limited to one pack per coupon. Orders will be dispatched as soon as possible but please allow 21 days for delivery. We regret the offer is only open to UK readers.

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JUNE ISSUE **ON SALE MAY 7th** **30p**

TECH-TIPS SPECIAL

Tech-Tips is one of the most popular features in ETI and twice before we have produced bumper versions of this; we have another planned for the June issue – 6–8 pages crammed with ideas for the experimenter. Virtually all Tech-Tips are submitted by ETI readers and are of course paid for if they are used: payment varies depending on the quality but averages £6. Tech-Tips 'fans' may like to know that we are planning a 'special' feature many of the 300 plus ideas that have been produced in the past.

Garden Watering

A simple project which measures the dryness of the soil and which can be connected to an automatic watering system.

AUXETOPHONE

The first real gramophone, and hi-fi of its day, it began the march to modern music reproduction in the home. One intriguing feature is an amplified violin – dated 1903!

SELECTING CLOCK CHIPS

MOS clock chips are being released onto the home constructor market at an alarming rate and it is becoming possible to be up to the minute. However ETI has taken a hand and produced a sweeping survey. If you're about to spring into building a clock, take the time to read this first. We gathered up information on over 45 chips, sorted it out and present it next month. The format allows quick reference for the man of the minute, or a detailed specification for those with an hour or so on their hands.

WAA-WAA PROJECT

Usually waa-waa circuits are simple, cheap and not very dramatic. Ours is cheap, sophisticated and extremely effective. It includes facility for single or 'auto-run' operation. We have dispensed with the expensive pedal normally found, and have substituted two easily obtained foot switches, which are much cheaper. The unit can act as a treble booster if required, and the speed of the 'auto-run' is fully variable. Total cost we estimate to be well under £10! (including case).

LASER COMMUNICATIONS

The old saying that the laser was a discovery searching for a use is no longer true and today intensive research is being undertaken in several countries. More exciting is the use of optical fibres which can contain the laser beam with its enormous information carrying capacity.

Britain is well up with the leaders and the feature in next month's ETI has been written by Professor Gambling of the University of Southampton where much of the research is being conducted.

ETI READER OFFER
VIDEOSPORT
TV GAMES UNIT

ETI and Henry's Radio have got together to bring you an exceptionally good offer on the built Videosport Mk2 TV games unit. When we got the sample at ETI it disrupted the office for hours – there was such a queue to have a go.

The Video is absolutely complete and plugs into the aerial socket on your own TV (it is mains operated). There are three games: Tennis, Football and Hole-in-the-Wall (can be multiple or solo game). Players can move both horizontally and vertically. Recommended price is over £40; Henry's recently reduced the price to £29.50 but ETI readers only next month can get it for £22.50 all inclusive.

DATA SHEET

Devices planned for next months Data sheet include the AF100 universal active filter, LM3909 1.3 volt IC flasher, oscillator, trigger or alarm SN16880N logarithmic level detector/indicator and FX209 MOS delta-modulator.

Make sure of your copy

Do you find it difficult to buy ETI? You needn't, almost all newsagents will be happy to reserve a copy for you if you ask but get him to keep it under the counter – if he puts it on display it may be sold before you call for it!

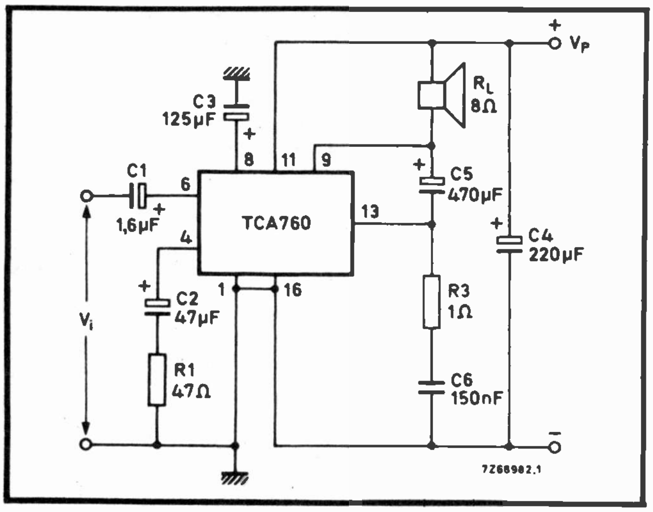
ELECTRONICS–IT'S EASY

Sales of Electronics–It's Easy Volume 1 are going well but newer readers will still find a gap between the finish of this and the current series. This will shortly be corrected as Volume 2 is nearly ready and will bring the reader right up to date.

ETI DATA SHEET SPECIAL

Mullard TCA760 1W

The TCA760 is a monolithic integrated audio amplifier for applications in battery and mains-fed equipment. Due to special internal circuitry (stabilization, temperature correction, high a.c. feedback of 20dB) the cross-over distortion is negligible over the entire supply voltage range (5 to 14V). Presetting the bias is not required, it is internally adjusted.



Supply voltage V_{11-16}	6	6	9	V
Load resistance R_L	4	8	8	Ω
A.F. output power	0,45	0,35	0,9	W 1)
at onset of clipping	0,42	0,33	0,8	W 2)
Sensitivity				
for P_o = 50 mW V_i	1,4	2,0	2,0	mV
for d_{tot} = 10% V_i	4,8	7,0	10	mV
T_{amb} (maximum)	70	95	60	°C
Supply current for full output power	185	125	190	mA
Quiescent current I_{tot}	10,0	10,0	10,0	mA
Value of R1	47	47	47	Ω
R2	100	100	100	Ω
R3	1	1	1	Ω
C1	1,6	1,6	1,6	µF
C2	47	47	47	µF
C3	125	125	125	µF
C4	470	220	220	µF
C5	1000	470	470	µF
C6	150	150	150	nF
C7	47	47	47	µF
Input impedance $\|Z_i\|$	15	15	15	kΩ

SGS TBA820 2W

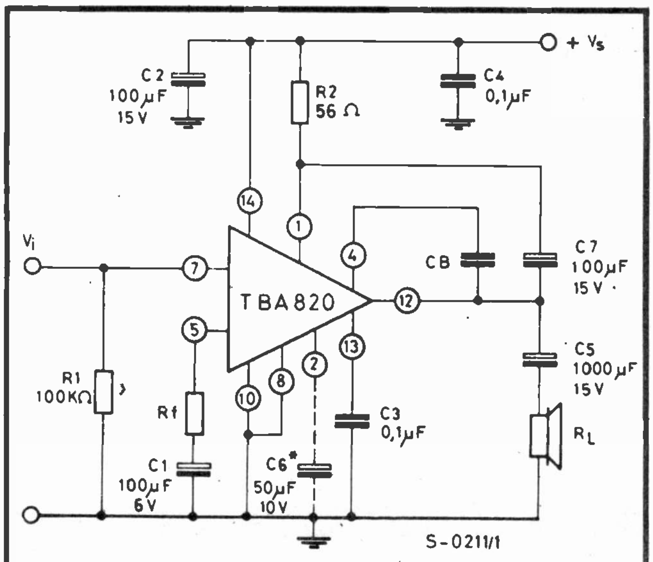
The TBA820 is intended for use as low frequency class B amplifier with wide range of supply voltage: 3 to 16V. Main features are: minimum working voltage of 3V, low quiescent current, low number of external components, good ripple rejection, no cross-over distortion, mounting compatibility with TAA611.

Output power:

P_o = 2 W at 12 V - 8Ω • P_o = 1.6 W at 9 V - 4Ω •

Input sensitivity	P_o = 1.2 W V_s = 9 V R_L = 8 Ω f = 1 kHz R_f = 33 Ω R_f = 120 Ω	 16 60	 mV mV
Input resistance		5	MΩ
Frequency response (-3 dB)	V_s = 9 V R_L = 8 Ω R_f = 120 Ω C_B = 680 pF C_B = 220 pF	 25 to 7k 25 to 20k	 Hz Hz
Distortion	P_o = 500 mW V_s = 9 V R_L = 8 Ω f = 1 kHz R_f = 33 Ω R_f = 120 Ω	 0.8 0.4	 % %

SGS ATES, Planar House, Walton Street, Aylesbury.



Capacitor C6 must be used when high ripple rejection is required.

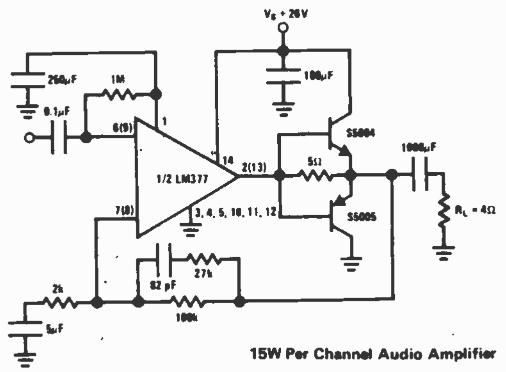
AUDIO AMPLIFIER ICs

NATIONAL LM377 DUAL 2W

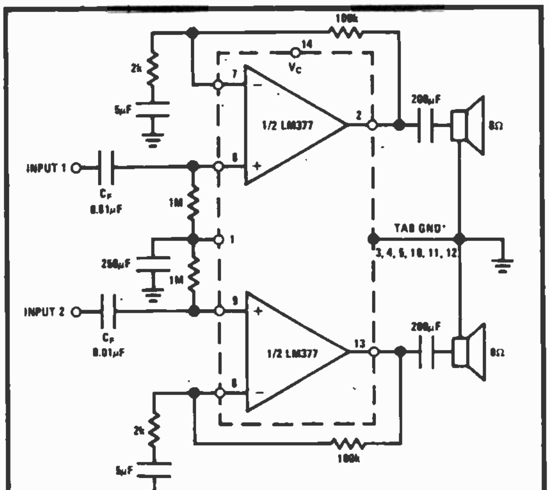
The LM377 is a monolithic dual power amplifier which offers high quality performance for stereo phonographs, tape players, recorders, and AM-FM stereo receivers, etc. The LM377 will deliver 2W/channel into 8 or 16Ω loads. The amplifier is designed to operate with a minimum of external components and contains an internal bias regulator to bias each amplifier. Device overload protection consists of both internal current limit and thermal shutdown.

PARAMETER	CONDITIONS	TYP	
Total Supply Current	P_{OUT} = 0W P_{OUT} = 1.5W/Channel	15 430	mA mA
DC Output Level		10	V
Supply Voltage			V
Output Power	T.H.D. = < 5%	2.5	W
T.H.D.	P_{OUT} = 0.05W/Channel, f = 1 kHz P_{OUT} = 1W/Channel, f = 1 kHz P_{OUT} = 2W/Channel, f = 1 kHz	0.25 0.07 0.10	% % %
Offset Voltage		15	mV
Input Bias Current		100	nA
Input Impedance			MΩ
Open Loop Gain	R_S = 0Ω	90	dB
Output Swing		V_S–6	$V_{P\text{-}P}$
Channel Separation	C_F = 250μF, f = 1 kHz	70	dB

National Semiconductors Ltd, Larkfield Estate, Greenock, Scotland.
Typical advertised price: £2.71



15W Per Channel Audio Amplifier

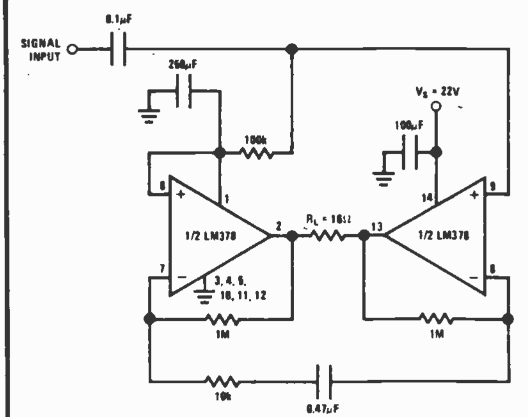


Simple Stereo Amplifier

NATIONAL LM378 DUAL 4W

The LM378 will deliver 4W channel into 8 or 16Ω loads. The amplifier is designed to operate with a minimum of external components and contains an internal bias regulator to bias each amplifier. Device overload protection consists of both internal current limit and thermal shutdown. The LM378 is basically very similar to the LM377, and the above table applies to both I.C.s, with the obvious exception of the output power. The 15W amp and the stereo amplifier are realisable with either chip.

National Semiconductors Ltd, Larkfield Estate, Greenock, Scotland.



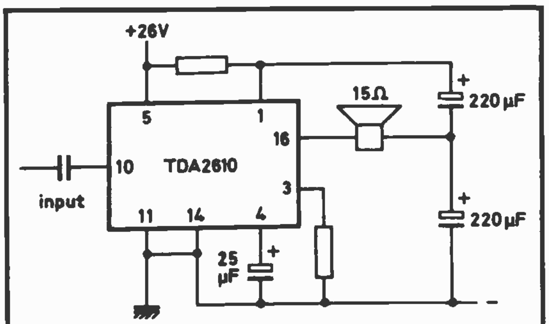
8W Bridge Amplifier

MULLARD TDA2610 4W

The output circuit is a class-B arrangement and can deliver an output power 4W. A current stabilizing circuit is incorporated to obtain a constant current drain. When this mode is used an output power of 4W is available.

QUICK REFERENCE DATA

Supply voltage range		5 to 14	V
Total quiescent current		5 to 15,7	mA
Supply voltage (peak value)	max.	14	V
Output power at d_{tot} = 10% at V_P = 9 V; R_L = 8 Ω	typ.	1,1	W
Total distortion before clipping	typ.	0,7	%
Input impedance	typ.	15	kΩ
Sensitivity for d_{tot} = 10%	typ.	10	mV



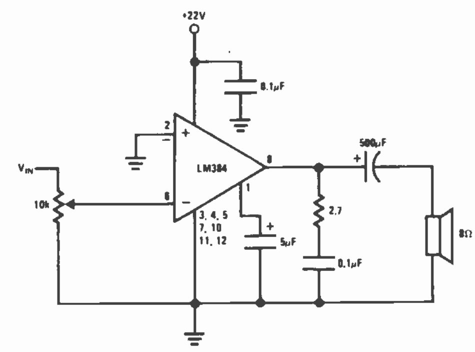
Mullard Ltd, Mullard House, Torrington Place, London SW1

NATIONAL LM384 5W

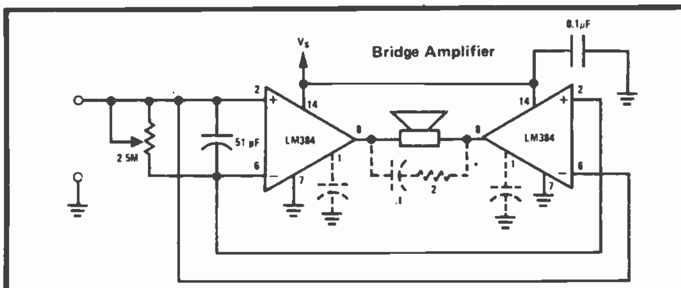
In order to hold system cost to a minimum, gain is internally fixed at 34 dB. A unique input stage allows inputs to be ground referenced. The output is automatically self-centering to one half the supply voltage.

PARAMETER	CONDITIONS	TYP	UNITS
Input Resistance (Z_{IN})		150	kΩ
Bias Current (I_{BIAS})	Inputs Floating	100	nA
Gain (A_V)		50	V/V
Output Power (P_{OUT})	THD = 10%, R_L = 8Ω	5.5	W
Quiescent Supply Current (I_Q)		8.5	mA
Quiescent Output Voltage ($V_{OUT\ Q}$)		11	V
Bandwidth (BW)	P_{OUT} = 2W, R_L = 8Ω	450	kHz
Supply Voltage (V^+)			V
Short Circuit Current (I_{SC})		1.3	A
Total Harmonic Distortion (THD)	P_{OUT} = 4W, R_L = 8Ω	0.25	%

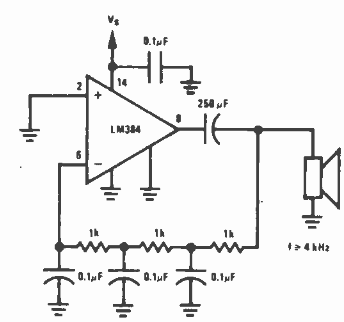
Typical 5W Amplifier



Bridge Amplifier



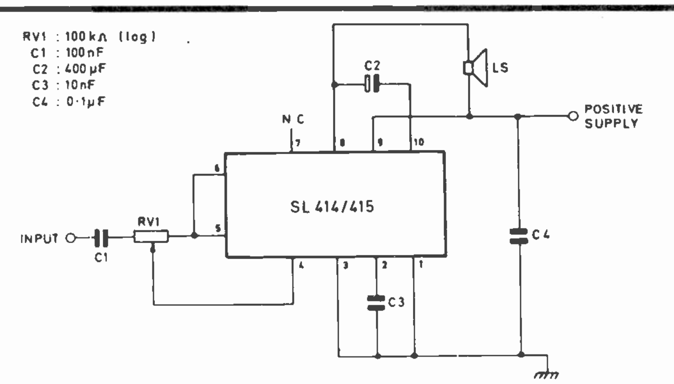
Phase Shift Oscillator



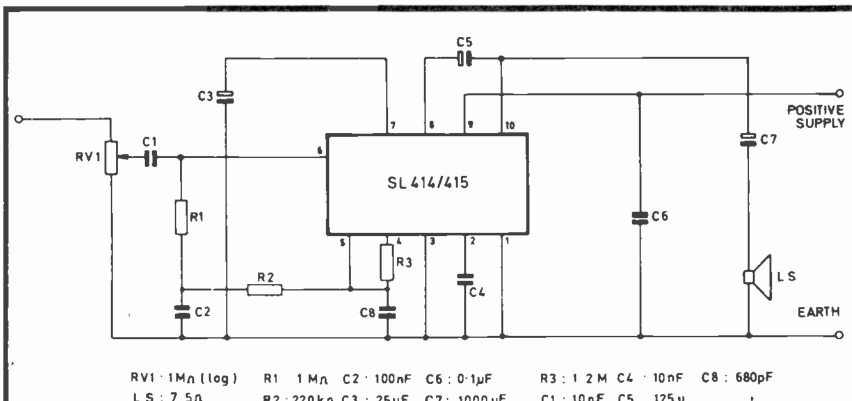
PLESSEY SL414A/SL415A 3W/5W

The SL415A and SL414A are robust high gain audio power amplifiers each with a separate pre-amplifier. The circuits have guaranteed power outputs of 5W and 3W respectively.
Typical advertised price: SL414 £1.80, SL415 £2.75.

Supply voltage		
SL414A	18	V
SL415A	24	V
Power into 15Ω load		
SL414A	2.2	W
SL415A	3.8	W
Pre amp. voltage gain	24	dB
Main amp. voltage gain	26	dB
Main amp. o/p impedance	0.2	Ω
Distortion		
Pre amp.	0.1	%
Main amp.	0.3	%
Noise level	−75	dB
Ripple rejection	30	dB
Input impedance		
Pre amp	20	MΩ
Main amp	100	MΩ



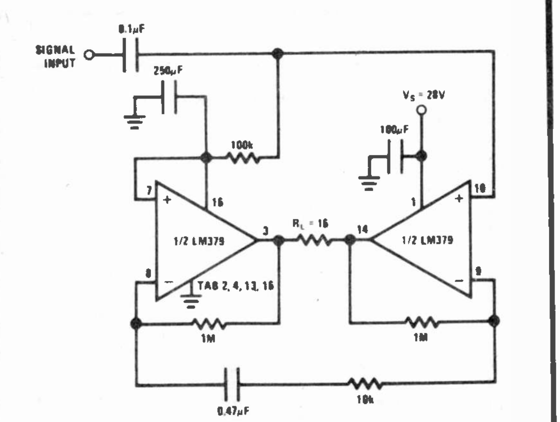
Minimum component circuit



NATIONAL LM379 DUAL 6W

The LM379 will deliver 7W/channel to an 8Ω load. The amplifier is designed to operate with a minimum of external components and contains an internal bias regulator to bias each amplifier. Device overload protection consists of both internal current limit and thermal shutdown. The LM379 may be used to advantage in any of the circuits given earlier for either the LM377 or the LM378 amplifier ICs. The circuit below delivers 14W r.m.s. into a 16Ω load.

National Semiconductors Ltd, Larkfield Estate, Greenock, Scotland.

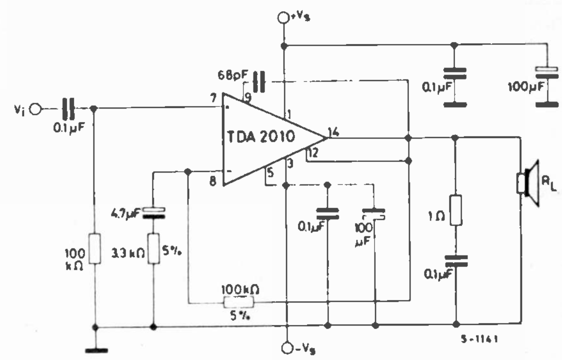


14W Bridge Amplifier

PARAMETER	CONDITIONS	TYP	
Total Supply Current	P_{OUT} = 0W P_{OUT} = 1.5W/Channel	15 430	mA mA
DC Output Level		14	V
Supply Voltage		10	V
Output Power	T.H.D. = 5% T.H.D. = 10%	6 7	W W.
T.H.D.	P_{OUT} = 1W/Channel, f = 1 kHz P_{OUT} = 4W/Channel, f = 1 kHz	0.07 0.2	% %
Offset Voltage		15	mV
Input Bias Current		100	nA
Input Impedance			MΩ
Open Loop Gain	R_S = 0Ω	90	dB
Channel Separation	C_F = 250μF, f = 1 kHz	70	dB
Ripple Rejection	f = 120 Hz, C_F = 250μF	70	dB
Current Limit		1.5	A
Slew Rate		1.4	V/μs
Equivalent Input Noise Voltage	R_S = 600Ω, 100 Hz – 10 kHz	3	μVrms

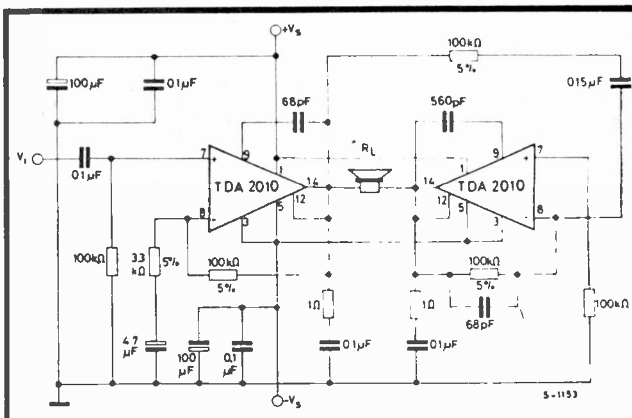
SGS TDA 2010 12W

The TDA 2010 is a monolithic integrated operational amplifier in a 14-lead quad in-line plastic package, intended for use as a low frequency class B power amplifier. Typically it provides 12 W output power (d = 1%) at ±14 V/4Ω; at V_S = ±14 V the guaranteed output power is 10 W on a 4Ω load and 8 W on a 8Ω load (DIN norm 45500). The TDA 2010 provides high output current (up to 3.5 A) and has very low harmonic and cross-over distortion. Further, the device incorporates an original (and patented) short circuit protection system, comprising an arrangement for automatically limiting the dissipated power so as to keep the working point of the output transistors within their safe operating area. A conventional thermal shut-down system is also included. The TDA 2010 is pin to pin equivalent to TDA 2020.



Typical amplifier with split power supply

	Parameter	Min.	Typ.	Max.	Unit
R_i	Input resistance (pin 7)		5		MΩ
V_s	Supply voltage	± 5		± 18	V
P_o	Output power		12		W
V_i	Input sensitivity		220 250		mV mV
B	Frequency response(-3 dB)		10 to 160,000		Hz
d	Distortion		0.1		%
	* Thermal shut-down case temperature		120		°C

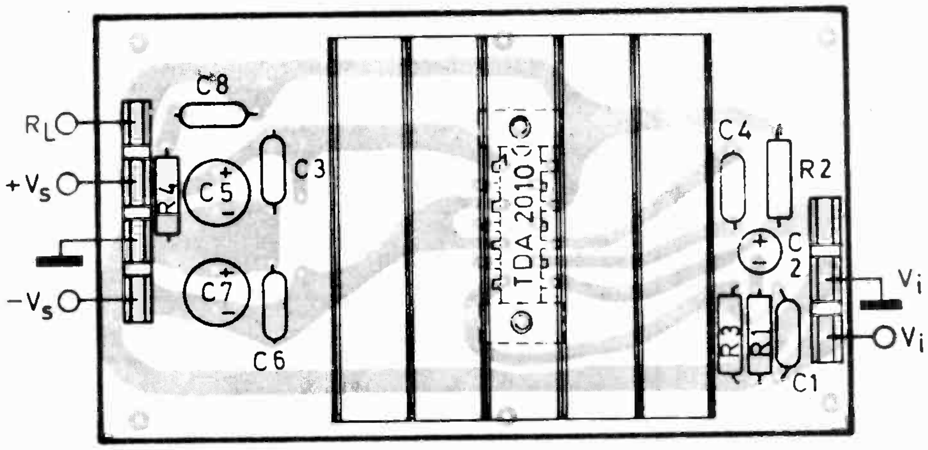


20 W bridge amplifier configuration
V_s = ± 13V, R_L = 8 Ω, d ⩽ 1%)

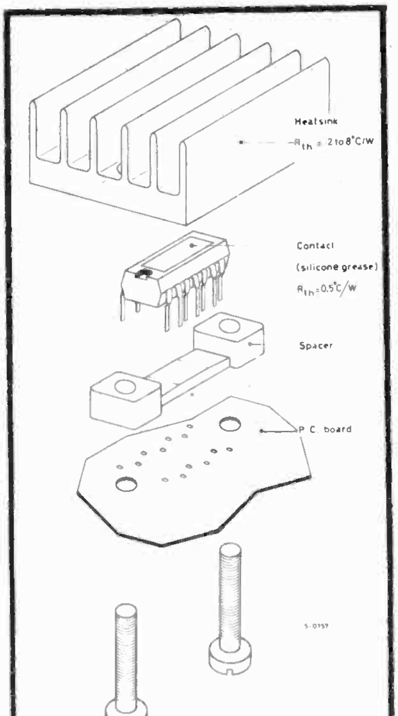
SGS TDA 2020 20W

The TDA 2020 is a monolithic integrated operational amplifier in a 14-lead quad in-line plastic package, intended for use as a low frequency class B power amplifier. Typically it provides 20 W output power (d = 1%) at ± 18 V/4Ω; the guaranteed output power at ± 17 V/4Ω is 15W (DIN norm 45500). Being a pin-pin replacement for the 2010, all circuits given here, for either device, can apply to both. The PCB layout similarly is applicable to both circuits.

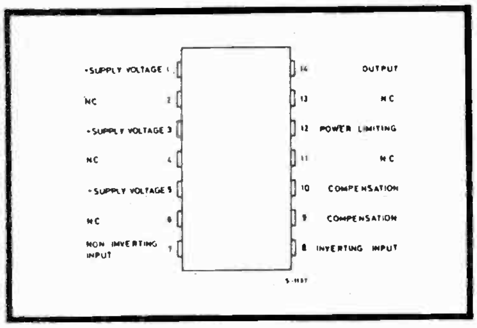
Heatsink guidelines are to be observed. Pin 5 is electrically connected to the copper slug on both devices and should be connected to most negative point.



Printed circuit board layout — TDA 2010/20 with split supply rails

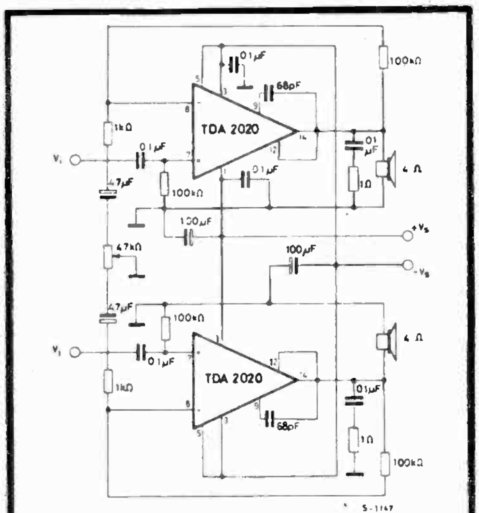


Mounting system
TDA 2020
TDA 2010

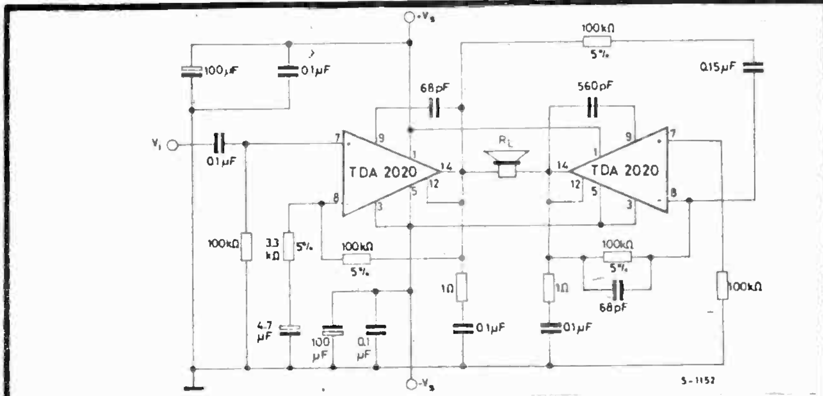


	Parameter	Test conditions	Min.	Typ.	Max.	Unit
P_o	Output power	d = 1% G_v = 30 dB $T_{case} \leqslant 70$ °C f = 40 to 15,000 Hz				
		V_s = ± 17V R_L = 4 Ω	15	18.5		W
		V_s = ± 18V R_L = 4 Ω		20		W
		V_s = ± 18V R_L = 8 Ω		16.5		W
		d = 10% G_v = 30 dB $T_{case} \leqslant 70$ °C f = 1 kHz				
		V_s = ± 17V R_L = 4 Ω		24		W
		V_s = ± 18V R_L = 8 Ω		20		W
V_i	Input sensitivity	G_v = 30 dB f = 1 kHz P_o = 15W				
		V_s = ± 17V R_L = 4 Ω		260		mV
		V_s = ± 18V R_L = 8 Ω		380		mV

SGS ATES, Planar House, Walton Street, Aylesbury.
Typical advertised price: TDA 2010 £3, TDA 2020 £3.75.



stereo amplifier with split power supply



bridge amplifier configuration with split power supply (R_L = 8 Ω d ⩽ 1%; 30 W @ V_s = ± 17V)

For a more detailed description of the TDA 2020 and related performance refer to SGS-ATES Application Note n. 130.

ILP HY200 100W

The HY200 is a 100 Watt amplifier of hybrid construction with an integral heatsink. Internally the HY200 features open and short circuit protection with the added feature of thermal shutdown when the heatsink rises above a predetermined temperature, with these features the HY200 can be installed into any equipment with the confidence that it is virtually indestructible under any operating conditions. The low distortion and high signal to noise ratio together with wide band width makes the HY200 an amplifier of true hi-fi performance and these factors coupled with its robustness make it suitable for hi-fi, group, disco, PA, etc:

SPECIFICATION

Output power 100 watts into 8Ω

Input sensitivity 500mV R.M.S.

Input impedance 100KΩ

Signal/noise ratio 96 db at 100 watts

Power bandwidth 10Hz — 45KHz ± 3db

Distortion 0.05% typical

Weight 1 kilo (2.2lb)

NOTES OF OPERATION

No input capacitor is required due to an internal capacitor of 250 volt working.

Output is directly coupled to loudspeaker via a *quick blow* fuse of 3 amps.

The amplifier can only be used on a split line power supply, ie: 45-0-45 VDC.

The thermal shutdown operates at approximately 70°C and will turn the amplifier on again when the heatsink has cooled by 10°C. Under operating conditions the temperature of the heatsink should be between 30-60°C depending upon the type of signal and output power used.

It is recommended that the HY200 is counted with the fins vertical and unrestricted airflow around them.

No circuits are given here for the HY200, but the device is so simple to connect, that we did not feel this would be a drawback. Only five connections are provided to the IC, Input, Output, Earth and two supply rails. These are colour coded, and ILP provide data with each HY200. So you didn't really need any circuits, now did you?

POWER SUPPLY REQUIREMENTS

MAXIMUM SUPPLY VOLTAGE: 50-0-50 VDC
RECOMMENDED SUPPLY: 45-0-45 VDC
SUPPLY CURRENT: 2ADC

ILP ELECTRONICS LTD
Crossland House, Nackington, Cant., Kent
Price:— £10.56 +VAT.

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MEMORIES ARE MADE OF THIS

WE HAVE ALREADY SEEN in *Microfile 1 (March 1976)* that the key concept of the microprocessor is that its operation is controlled by a sequence of bit patterns held in memory, in an identical manner to the operation of the full-scale digital computer. Micro systems almost always incorporate two types of semiconductor (MOS or bipolar) memory.

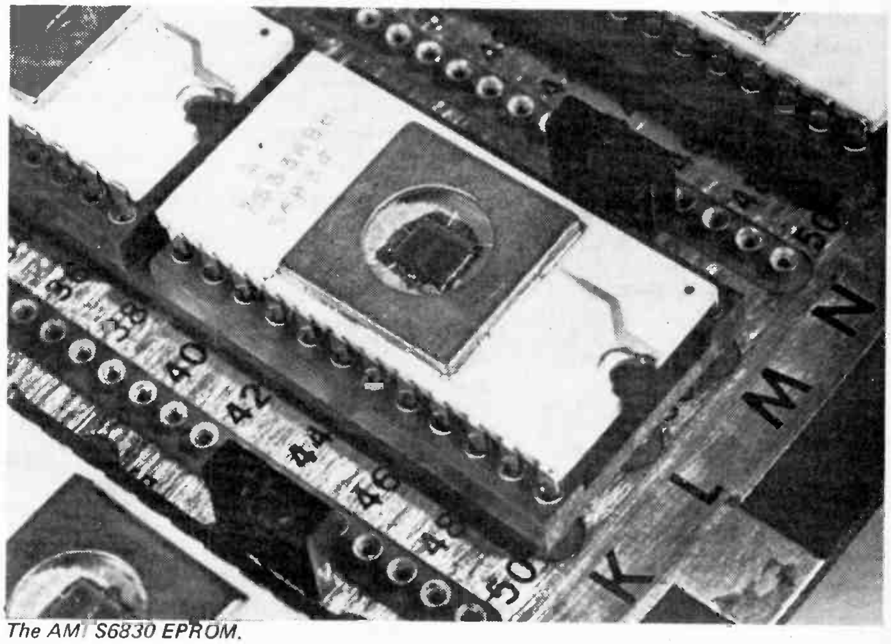
For programs which are permanently resident in the system and must not be erased when power is lost (e.g. traffic light control programs, microcomputer load/monitor programs) the program is held in *Read Only Memory (ROM)* which is preprogrammed before the system goes into operation and is then only changed in exceptional circumstances (such as the discovery of a program fault or *bug*). For the storage of intermediate results, and programs which are not permanently resident in the system, *Random Access Memory (RAM)* is used which can be both read from, and written into, by the processor.

ROM

Read Only Memory chips are available in several types and are made by many manufacturers. The main type used by manufacturers of equipment using microprocessorsin high volume runs is *Mask Programmed* ROM, which is programmed during manufacture by the specification of a metallization mask pattern worked out by computer from a punched paper tape or deck of punched cards. This is the cheapest form of ROM in large quantities, but of course is unalterable once made and no company would ever go to ROM without thoroughly testing their programs for bugs. Mask-programmed ROM is uneconomic in small quantities and impossible for one-offs. Typical devices are the Motorola MCM6830, Intel 8308, and AMD Am2961.

PROM

Programmable Read Only Memory is used in small-volume systems and for development work. These PROMs (often called fusible-link PROMs) are programmed simply by blowing small links made either of nichrome or polysilicon. This is done by selecting the address of the bit to be programmed in the normal manner, and applying a short, (on the order of a few hundred microseconds) high current pulse at the output pin. Once programmed, the chip can be plugged into the system and, hopefully, the program will run. AMD's Am2971 is typical of the genre.



The AM S6830 EPROM.

EPROM

The Erasable PROM can be 'wiped clean' by lifting the cover from a transparent quartz window on the top of the chip and exposing it to an ultra-violet source for around ten minutes. The EPROM can then be reprogrammed by a similar method to a fusible-link PROM. The device in fact operates by trapping charge in a floating gate avalanche injection MOSFET. This device is extremely useful in prototyping systems but it is a bit pricey for production use. AMI's S6830, which was mentioned last month is a good choice of EPROM for micro systems, or alternatively Intel's 2708, 2704 and 8702 are in fairly common usage.

EAROM

Electrically Alterable ROM can be repeatedly erased and reprogrammed electrically, considerably more quickly than EPROM, e.g. erasure takes only 100 mS. Some EAROMs (e.g. NCR1105) are erasable by row, so that complete erasure and reprogramming is not necessary.

GENERAL ORGANIZATION

Most of the devices mentioned above are byte-wise organised, i.e. when a specific address on the chip is selected, the processor puts 'read' out on the control bus and VMA goes high, then 8 bits in parallel are output onto the data bus. Note on figure 1 that the output to the data bus goes via a set of three-state output buffers. Three-state logic (Tri-state logic is a National

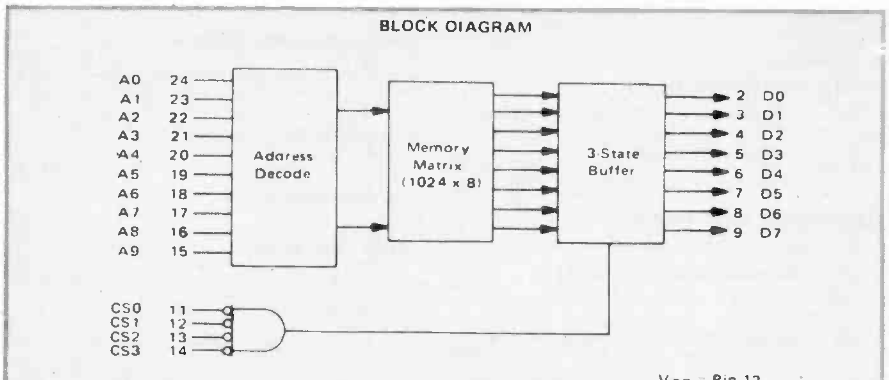


Fig. 1. Internal arrangement of the MCM6830 ROM.

trademark) was explained in ETI in October 1972, and we made reference to it last month when discussing the Halt, DBE and TSC control signals of the MPU. As far as memory is concerned, if the chip select inputs of the ROM (or RAM) chips are not enabled, the output buffers stay in the high-impedance mode and isolate the chip from the bus. Thus, as many chips as required can be wire-ORed onto the data bus, and they are only in a low impedance (0 or1) state when selected.

RAM

There are two types of RAM: static and dynamic. If data is stored in a static RAM, provided power is kept on the device and all other signals are kept constant, the data will be maintained. However, a dynamic RAM uses the parasitic capacitance of MOSFET gates with a storage cell to store the data. Therefore, due to junction leakage currents, this is only possible for a short time and so the data has to be refreshed once every 1mS, typically. This is done by cycling through the low-order address lines (A_0 – A4).

Static RAM is, in general slower in operation, and is smaller. Once again, byte wise organised memories are most suitable for ease of use in MPU systems, and these can only be found in static types. The Motorola M6800 family includes a 128 byte static RAM, MCM6810, which is easy to use in a 6800 system. As in the case of ROM, three-state buffers are provided on the chip, but in the case of RAM they are bi-directional. Note that some chips do not have three-state buffers (e.g. AMD Am2970, Am2950) and so are more difficult to design into bus-oriented systems.

Dynamic memories offer higher density storage, at the penalty of increased circuits complexity. 4k (4096 bit) dynamic RAMs are now the industry standard and are commonly available in 22 pin and now 16 pin DIL packages. However, additional memory refresh circuitry must be provided so that one would regard a card of around 8k bytes of dynamic RAM as a convenient 'building block' for memory systems, with static RAM being used for smaller memory boards, which can be simply extended when required. Dynamic RAM is of course organised as 4k x 1 bit rather than byte oriented, hence one should use 8 x 4k chips to make a 4k byte memory system.

ADDRESSING MEMORY

Most 8 bit microprocessors, including the M6800 which we have used as an example, have a 16 bit address bus. Consequently they can address up to

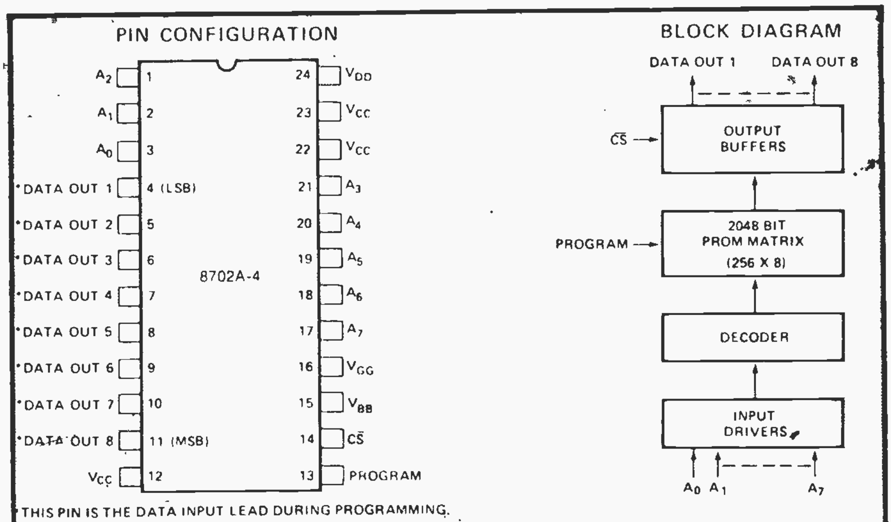


Fig. 2. Pinout and block diagram of Intel's 8702A-4 EPROM.

65k of memory directly over the 16 lines of the address bus. However, as some of you will have noticed, the MCM6830 ROM has only 10 address inputs, and the MCM6810 RAM has only 6. This is where the chip select inputs come in handy. Using them one can position a chip anywhere in memory, for example starting at address 2048 or at 0 simply by connecting the CS and $\overline{CS}$ (NOT CS) inputs to the address bus lines that are left over. Only when all the CS inputs are at 1 and the $\overline{CS}$ inputs at 0 will the chip be enabled. One can, for example, arrange that the CS inputs of a 6830 ROM be connected to bits 14 and 15 of the address bus, while the CS inputs of 1 6810 RAM are connected to bits 14 and 15. This means that the ROM starts at address 49152 i.e. C000 HEX, while the RAM starts from zero and goes up to address 127 or 007F HEX.

In addition, one should note that Q2 of the system clock should be applied to CS so that the chip is only enabled during Q2 of the clock cycle. It is also good practice to connect VMA to a CS input. Of course, if one runs out of CS inputs one can always AND signals before applying them to a a CS, or alternatively NAND them and then apply that signal to $\overline{CS}$.

Bringing together then our knowledge of the bus configuration of an M6800 system we end up, (Fig. 4) with a minimum system consisting of the MPU, 1 ROM, 1 RAM, 1 PIA (peripheral Interface Adaptor), and 1 ACIA (Asynchronous Communication Interface Adaptor. The last two units are the I/O devices of the 6800 series, but no special instructions exist to handle data input/output. Instead, the devices sit on the buses and are written into and read from exactly as if they were memory locations. Hence the connections from the PIA and ACIA to the are CS and CS inputs, RS (Register Select) to address one of the internal registers on the chip and E (Enable) inputs which are normally connected to Q2 of the system clock, and the I/O chips look to the processor like memory.

THE PIA

The Peripheral Interface Adaptor (MC6820 is the parallel I/O device of the 6800 microcomputer system, and gives 16 independent lines which can be used to control lamps, relays or used for parallel interface with other units. There are two almost identical halves to the PIA which each have 8 input/output lines, each of which is independently programmable as an input or output as well as two control lines in each half of the devices. Internally, the device has

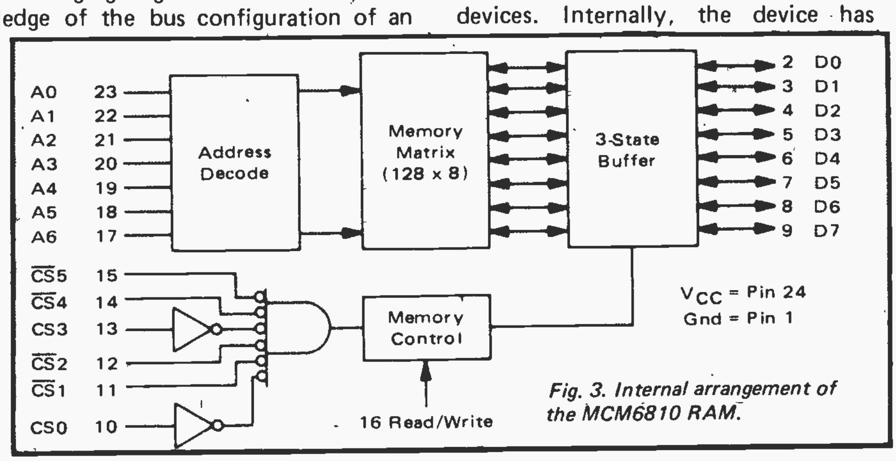


Fig. 3. Internal arrangement of the MCM6810 RAM.

microfile

served registers. If we consider section A of the PIA, Data Direction Register A (DDRA) controls the direction of data through each corresponding peripheral data line. If a particular bit of DDRA is set at '1', the corresponding line will be an output, if set at '0', it will be an input.

The Control Register A (CRA) is pretty complex in organization and so we won't go into it in depth here. It controls the operation of the control lines CA1 and CA2, as well as monitoring interrupts. Output Register A, when addressed, latches the information on the MPU data bus, and puts it on the peripheral data lines.

The PIA, as can be seen, is an extremely versatile device for parallel I/O. For serial I/O, the MC6850 Asynchronous Communications Interface Adaptor provides an even more impressive list of functions, including Parity, Overrun and Framing Error detection. Full details of both these devices can be found in the Motorola M6800 Systems Reference and Data Sheets book which many readers will already have.

Most microprocessor systems have their own I/O devices. For example Intel's 8080 has the 8255 Programmable Peripheral Interface and the 8251 Programmable Communication Interface.

We shall return to I/O devices in greater detail later.

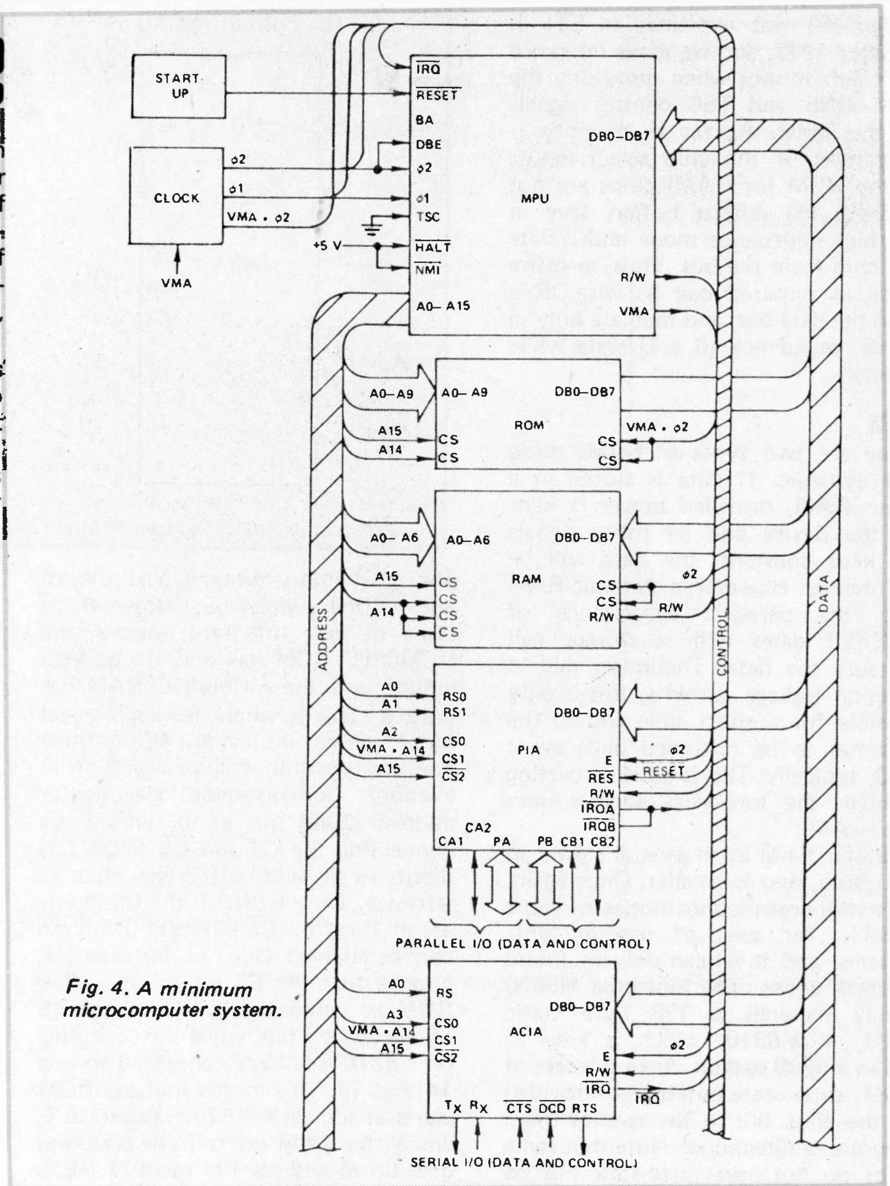


Fig. 4. A minimum microcomputer system.

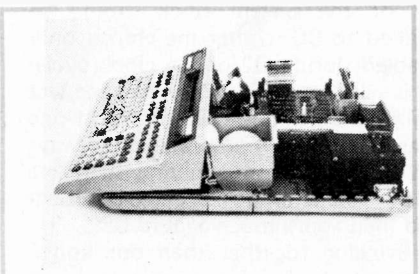
NEWS

Intel are holding a 'Microcomputer Fair' at the Hilton Hotel, Park Lane on May 4th. There will be 4 simultaneous seminars and an exhibition of components and equipment. Over 20 papers will be read, some introductory and some on more advanced topics for experienced engineers. The fee of £15 covers entry, literature, morning coffee, a 3 course lunch at the Hilton, and afternoon tea. Intel have emphasized that numbers will be limited and all bookings will be dealt with in strict rotation.

Intel Corporation (UK) Ltd, Broadfield House, 4 Between Towns Road, Cowley, Oxford OX4 3NB.

MICRO-BASED EQUIPMENT

Several new products have been introduced this month which use microprocessors, including a new desktop calculator from Hewlett-Packard. The 9825 embodies special features for use in engineering and science as an integral part of a test/measurement system using the HP Interface Bus, or simply as a powerful stand-alone calculator. Important abilities of the



calculator include: vectored two-level priority interrupt, which gives a secondary benefit in the form of a 'live' keyboard which can be used while the calculator is running another program; direct memory access with input speeds up to 400,000 16-bit words per second; high-performance bi-directional tape drive; multi-dimensional arrays; automatic memory dump and load; internal calculation range of $\pm10^{\pm511}$ and optional plug-in ROMs.

The microprocessor at the heart of this machine is of HP design and manufacture and is a hybrid 3-chip processor consisting of a 16-bit parallel binary processor chip, an I/O chip, and an extended math chip which gives floating point and hardware multiply capability. The 16 X 16 bit binary multiply time of 6µS is an indication of the speed of this processor. It's yours for only £3,955 plus VAT.

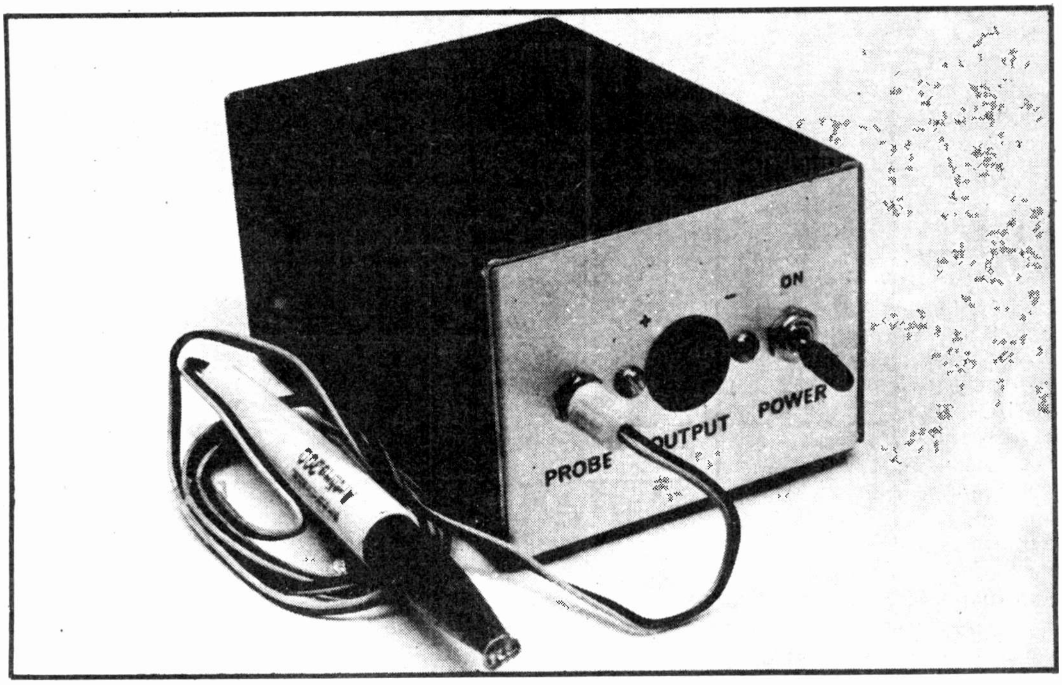
Hewlett-Packard Ltd., King Street Lane, Winnersh, Wokingham, Berks, RG11 5AR.

Fluke International have introduced a new microprocessor-controlled data logger with the ability to scan 60 channels in the mainframe and up to 1000 with extender options. The Summa II 2240A is fully programmable in range, function, skip, alarm limits, date/time, interval and fixed data, all from the front panel. Complete programs can be listed from memory — the program storage has a data retention of a minimum of five years.

Fluke International Corporation, Garnett Close, Watford, WD2 4TT.

eti project 130

TEMPERATURE METER



Converter connects to any analogue or digital meter.

OUR original design concept for this unit was as a complete instrument based on our ETI 533 digital display (October 1975 and Top Projects No.3) sensor — this generating a temperature-proportional voltage which in turn is supplied to a voltage-to-frequency converter. We planned to use a timebase to generate the necessary strobe and reset pulses. However the cost and complexity of this arrangement was such that we decided against it.

What finally emerged was a simple temperature-to-voltage converter which can be used in front of *any* analogue or digital meter. The converter provides an output of 10 mV/degree which can be either Celcius or Farenheit depending on calibration. If a dedicated digital readout is required we suggest our ETI 118 digital voltmeter (October 1975 and Top Projects No. 3).

CONSTRUCTION

Whilst a printed-circuit board is by no means essential, using one certainly makes construction easier and improves the appearance. The potentiometers as shown in our prototype are single turn presets which are quite adequate if an analogue meter is to be used for the readout. However if a digital meter is to be used the extra accuracy of the readout would warrant ten-turn presets being used for RV1 and RV2, as setting accuracy is considerably improved.

The converter quite readily fits into a small aluminium case. Two nine volt batteries are used to power the unit and battery drain is low enough to ensure a life of many months.

A 3.5 mm jack is used to connect the sensor to the unit and the output to the meter is provided via an inexpensive two-pin speaker socket.

The probe is constructed by mounting the sensor-diode into the tip of a ball-point pen casing, or similar. The method may best be understood by reference to the drawing.

CALIBRATION

To calibrate the instrument, two accurately known temperatures are required. One may be water or oil at room temperature (ice water should not be used as there the temperature may vary several degrees between different points in the solution). The high temperature is best obtained by heating oil or water and allowing it to stabilise at around 80°C. A second smaller heat conductive container filled with water is then immersed in the larger container. This simple procedure prevents errors due to circulating currents in the larger volume of water. An accurate mercury-in-glass thermometer should be used to measure temperatures during the calibration procedure as detailed below.

SPECIFICATION

RANGE	0 to 100°C
	32 to 212°F
OUTPUT	10 mV/degree
ACCURACY	± 1°
RESPONSE TIME	3 seconds

TEMPERATURE METER

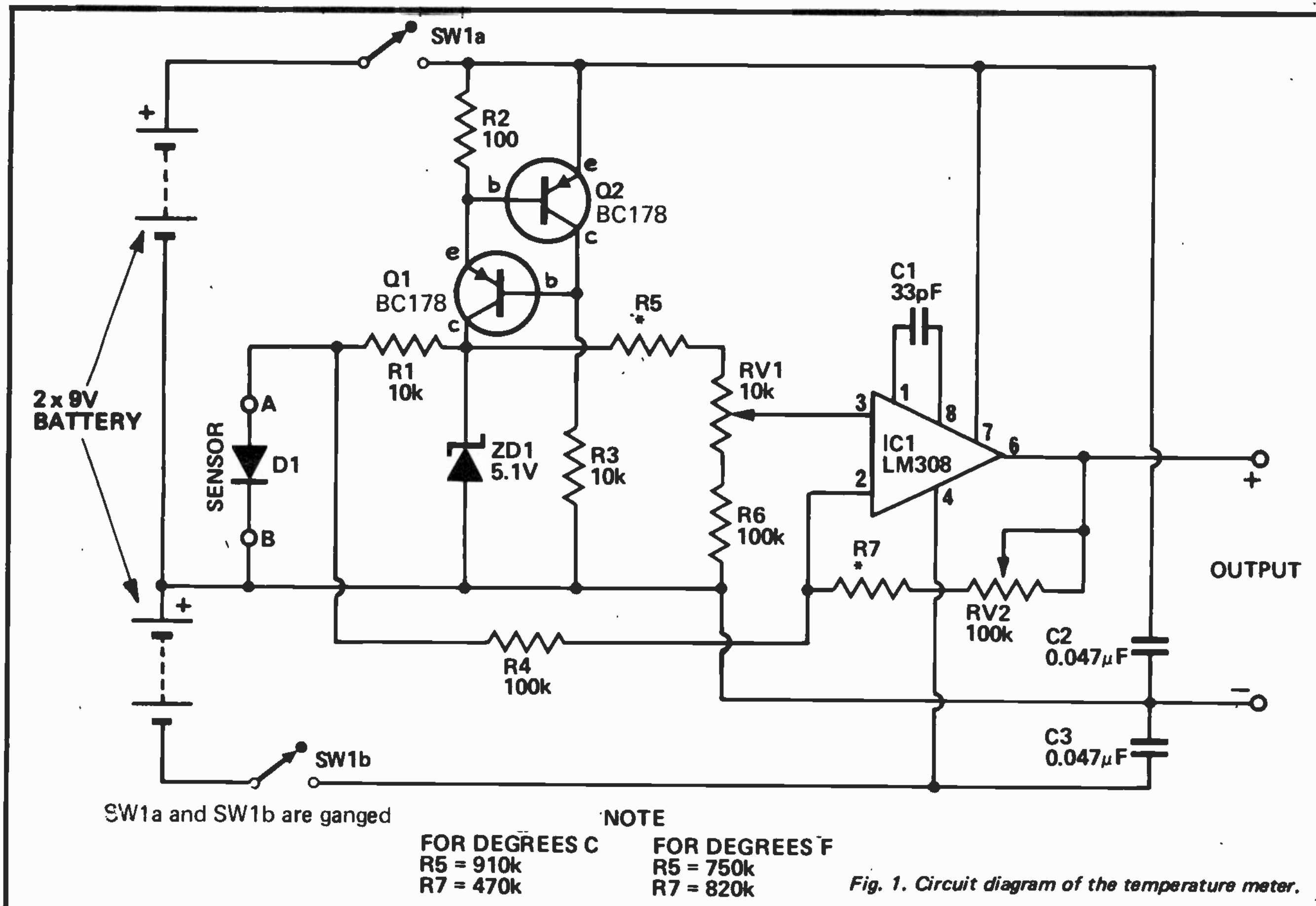


Fig. 1. Circuit diagram of the temperature meter.

1. Place the sensor and thermometer into the cool solution, allow a little time for stabilisation, and then measure the voltage from the converter and the temperature. Record these two readings.

2. Place the sensor and thermometer into the hot solution and measure the voltage and temperature as before. The voltage change between the first and second readings should be equal to the temperature change times 10 millivolts.

3. If the voltage versus temperature is not as specified in step 2 adjust RV2 and repeat steps 1 and 2 until it is. Note that varying RV2 changes the voltage at both the hot and the cold positions. It is the correct slope, or rate of change that we are after at the moment.

4. When the correct rate of change has been set as above place the sensor and thermometer into the cool solution and adjust RV1 to obtain a reading of 10 mV per degree. That is if the solution is at 25°C adjust RV1 to obtain a reading of 0.25 V.

Due to the spread of diode characteristics from one device to another the necessarily small adjustment range of RV1 and RV2 may not allow all diodes to be calibrated with the resistor values specified. If this is found to be the case it may be necessary to change the value of R5, R6 or R7.

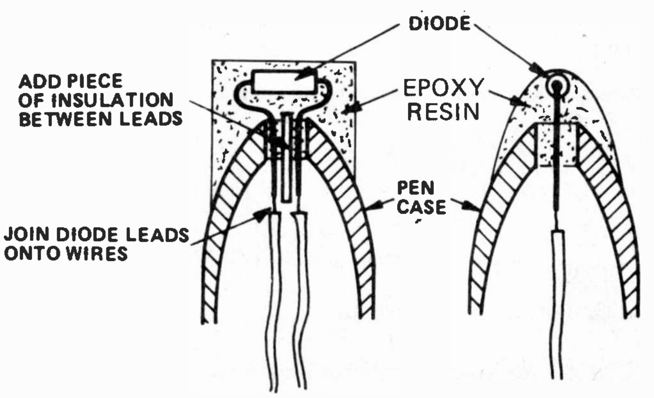


Fig. 2. This diagram shows how the sensor is mounted into a ball-point pen casing or similar.

PARTS LIST

R1,3	Resistor	10k ½W 5%
R2	"	100 ½W 5%
R4,6	"	100k ½W 5%
R5,7	"	See Fig. 1 and test.
RV1	Potentiometer	10k * trim type
RV2	"	100k * " "

*for digital readout a multiturn trim potentiometer is recommended.

C1	Capacitor	33pF ceramic
C2,3	"	0.047µF polyester
D1	Diode	1N914
ZD2	Zener Diode	5.1V, 400mW
Q1,2	Transistor	BC558, BC178
IC1	Integrated Circuit	LM308

Metal box
Two 9V batteries (PP3 etc)
Two pole toggle switch
PC board ETI 130
3.5mm plug and socket
Two pin plug and socket for output

HOW IT WORKS – ETI 130.

A forward biased diode has a temperature coefficient of about –2 mV/°C. That is the normal voltage across a silicon diode of nominally 0.6 volts will decrease by two millivolts for every degree C increase in temperature. This change with temperature is sufficiently linear over the range of 0 to 100°C to use it as a temperature sensor.

What the ETI 130 circuit does is to amplify this voltage and to provide offset compensation for the normal 0.6 volt drop across the diode.

Transistors Q1 and Q2 provide a constant-current source of about 5 mA into the zener diode ZD1 such that a very stable five volt reference is obtained which is independent of the battery supply voltage. (V supply greater than 6 V.) The forward bias current through the sensor diode is about 0.5 mA as provided by R1. This current is low enough to prevent errors due to self heating of the sensor diode.

The voltage across the sensor diode is amplified by IC1 (a very high input-impedance operational amplifier) whose gain is fixed at the ratio of (R7 + RV2)/R4. The necessary offset is provided by RV1 which is adjusted to cancel the normal 0.6 volt drop across the diode. By selecting the correct values for R5 and R7 as shown on the circuit diagram the indication of temperature in degrees C or F may be obtained.

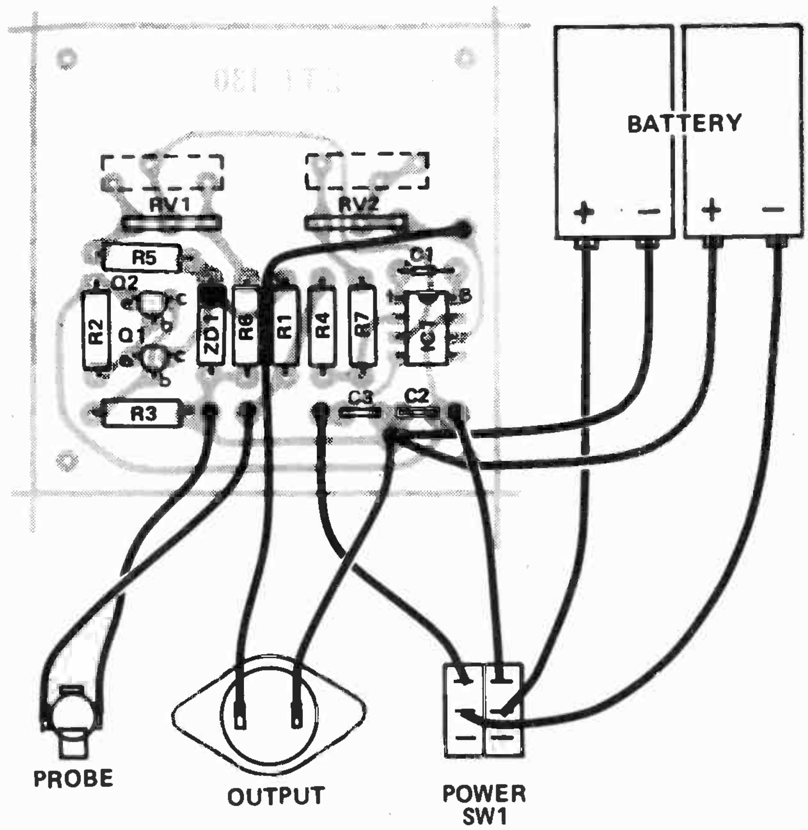


Fig. 3. Component overlay and interconnection diagram.

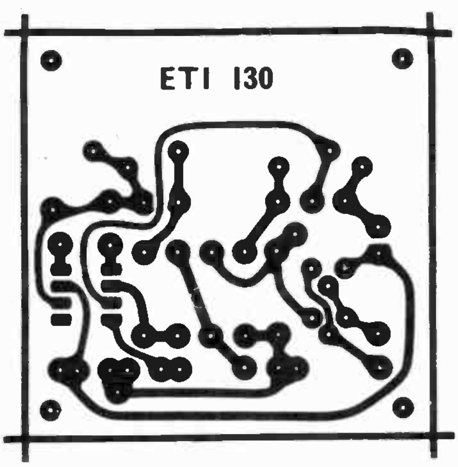
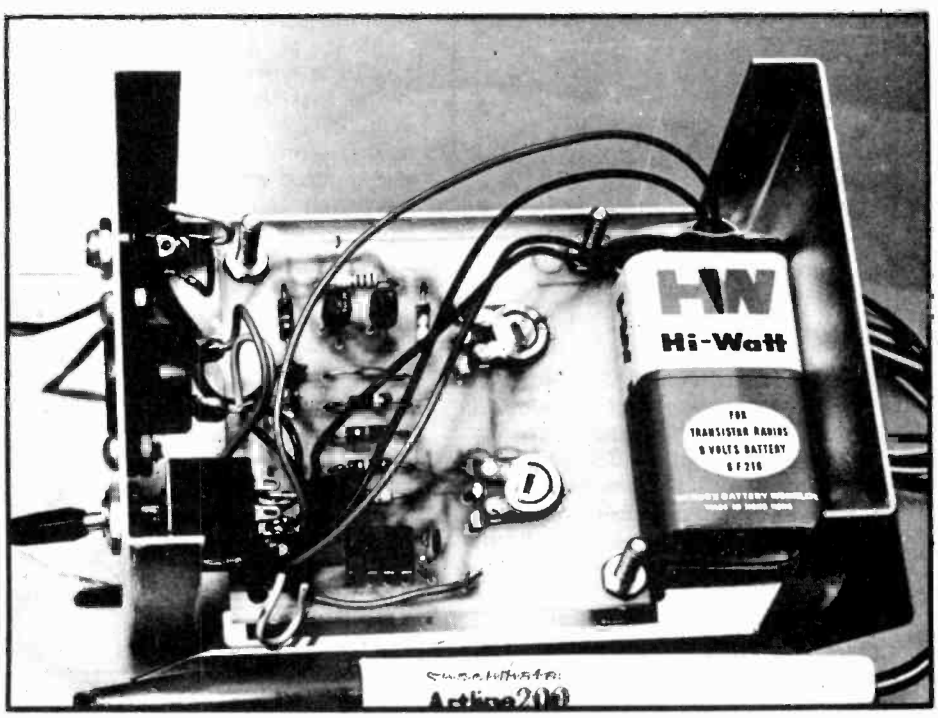


Fig. 4. Printed circuit pattern. Full size 63 x 63 mm.



Internal view of the completed temperature converter. Note also the probe at front.

A SUBJECT CLOSE TO OUR HEARTS

NUCLEAR PACEMAKERS

ELECTRICAL IMPULSES are at the heart of us all. More specifically two masses of nerves — an upper one on the heart muscle called the sinoatrial, and a lower known as the atrio-ventricular — set up impulses which causes the muscular contraction. When the electrical conduction between them is impaired the heart beat is slowed down and, in extreme cases the patient may die. During the last few years artifical pacemakers have been developed to provide the electrical impulses needed and thus drive the heart at a normal rate. (Up to 250 μW at about 5V are needed). The present units employ mercury cells with a life of about two years, and replacement involves an operation.

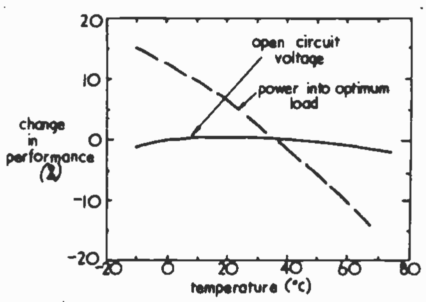


Fig. 1. Graph of pacemaker battery performance against temperature.

It would be better to reduce the number of these replacements by increasing the life of the unit.

ATOMIC FUEL

Dr J. Myatt at the AERE Harwell laboratories has in fact developed power sources for this purpose fuelled by plutonium 238, using its thermal energy and converting it to electric power by a thermoelectric module with a life expected to be of the order of ten years or more.

For safety the fuel has two stages of hermetic sealing. Elaborate care has been taken to ensure shock immunity.

Since the battery produces only about 0.25V while the pacer circuit needs 5V, a DC/DC converter is used to amplify the voltage, using Zener diodes to stabilise output voltage at either 5.5V or 6.7V.

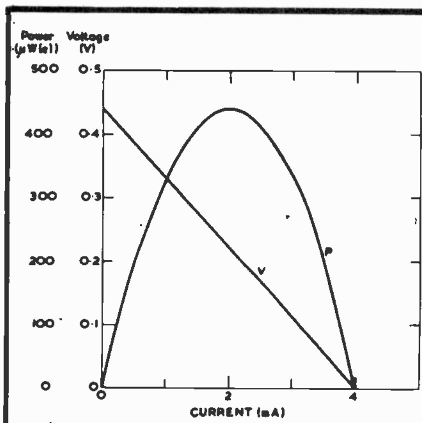


Fig. 2. Battery output characteristics at 37°C.

RISKS INVOLVED

This approach to powering the battery needs a very critical examination of the risks involved for both the patient and the public.

Most of the emission from Pu238 is alpha particles, absorbed in the first few thousandths of an inch of the capsule. However, neutrons and gamma radiation are also emitted and must be kept at a low level. Using the isotope at a high level of purity helps with this, but there are practical limits to the gamma shielding possible.

The organs most sensitive to radiation are the eyes, gonads, and bone-marrow, all of which are a good distance from the source centre and should therefore receive only a very low dose. Whether this dose is acceptable will depend on the views of the health authorities. Since the intensity follows the inverse square law, radiation danger to the public is considered negligible, even for the patient's spouse. The battery is able to withstand shock, accidental mechanical damage, and even cremation! ●

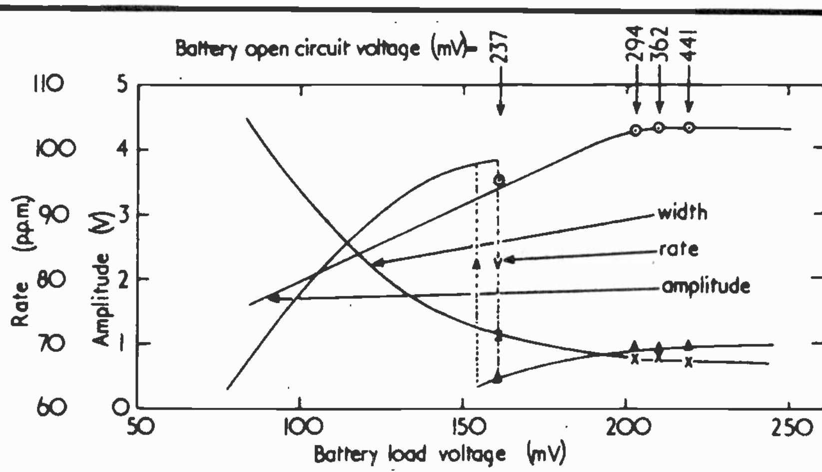
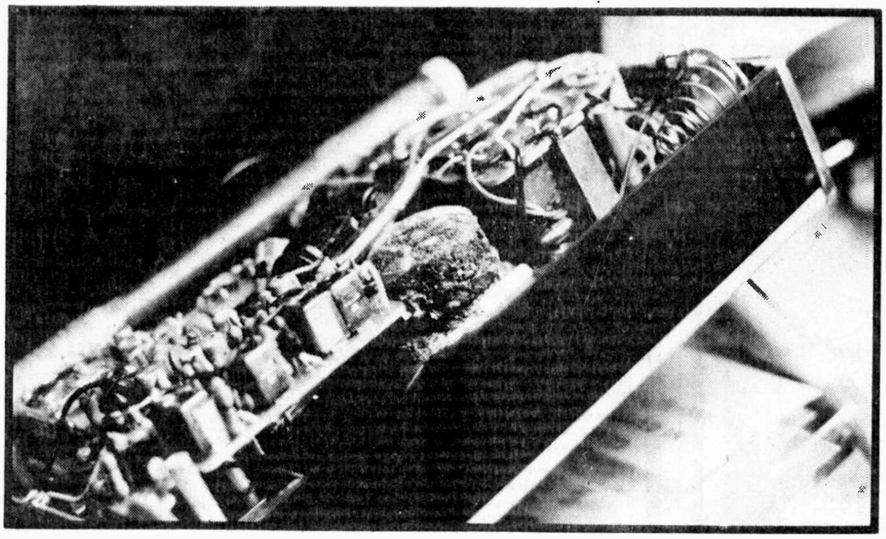


Fig. 3. Heart pacemaker performance v Battery load voltage.



ASSAULT BY BATTERY

MOST PEOPLE are aware of what happens when they leave exhausted batteries in a hand-torch: the chemical content of the cells eats its way through the casing and starts to attack the body of the torch itself.

If left for a prolonged period, the damage and corrosion becomes so extensive that it is impossible to which consequently has to be scrapped.

The situation becomes much worse and considerably more expensive when battery corrosion affects electronic equipment. Transistorised tape recorders and radios are the most common victims, having been set aside and forgotten for a while, during which time corrosion can cause considerable damage.

The owner of apparatus so damaged is usually caught out completely, and quickly takes it to a servicing organisation in the hope that things can be rectified easily. Unfortunately, the devastation caused by corrosion can be so severe that some equipment has to be written off. This certainly applies to small transistor radios, where the economics of repair would be out of proportion to the value of the apparatus.

In the case of more expensive equipment, a rigorous approach can save it on many occasions.

The battery compartment will have suffered most; if it is a separate item it should be replaced in its entirety. Fortunately this compartment often serves to contain the bulk of the corrosion, and provided the caustic fluid has not escaped into the remainder of the equipment, there is a good chance that the repair will be 100 per cent effective.

If fluid has penetrated into the remainder of the equipment the situation will inevitably be much more serious. Printed panels, switches, coils and transformers are particularly vulnerable, and a preliminary examination should be carried out to see to what extent these components have been affected. Note that the fluid can penetrate underneath larger components and seep through, causing damage at a later date. It is essential that all traces of corrosive material be removed, even if to do so involves the removal of components from a printed panel.

If a panel has been badly saturated, but not extensively eaten away by corrosive fluid, it is best to remove all inductive components and switches, then wash it off thoroughly in fairly hot water. A small toothbrush is useful for scrubbing, and a hair-dryer can be used for drying off afterwards. Healthy components will survive this treatment unscathed; sick looking ones may well be damaged and should be replaced.

Switches affected should always be replaced, and this also applies to RF and IF coils, ferrite rod windings and transformers, all of which may cause trouble at a later date even though they may appear to have survived superficially.

Repairs such as these usually take up a large amount of time, and often some expensive components, so the economics of any one repair should be assessed early on, so that work is not commenced precipitately on a job which will ultimately be uneconomic.

Fortunately, assessment is not too difficult when one bears in mind the foregoing points. It is relatively easy for an experienced engineer to say that possibly three hours work will be required, plus a switch bank, battery box, several IF transformers and a loudspeaker. A quick mental totting-up will yield a figure which can then be compared with the value of the repaired apparatus.

Do remember though that this sort of repair can never be guaranteed. It is possible for 'green spot' corrosion to occur in coils after a period of time, even if they appear to have escaped initial damage, and a customer should be made aware of this.

Spares availability plays a major part in the success or otherwise of a repair. This is true to the extent that a relatively cheap transistor radio of obscure origin, may need to be written off if there is any possibility of damage beyond the area of the battery compartment.

Standard battery compartments, of Japanese origin, are now easily available and can be used as standard replacements.

Portable tape recorders, when affected by battery corrosion, can present further problems in addition to those mentioned above. The mechanical side of the machine can be adversely affected, and in particular castings can be eaten away. The effects on ball-races, flywheels, and motors (let alone rubber drive belts!) must be seen to be believed. In any event, a complete stripping down operation is often the only sure approach, a process which is obviously time-consuming and expensive.

If ever the point should be made that prevention is better than cure, it applies in the case of damage by battery corrosion. Whenever equipment is being put away for a period, the batteries should be removed as a precaution. If it is obvious that the batteries are flat, they should be removed *straight away*. Do not wait until you have purchased new ones; you could slip up and break your leg on the way home, and by the time you are discharged from hospital, your pocket calculator could be a write-off!

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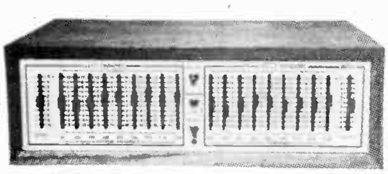
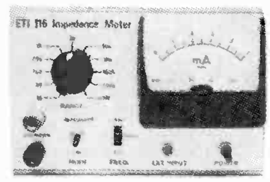
TOP PROJECTS No.3

WHICH INCLUDES . . .

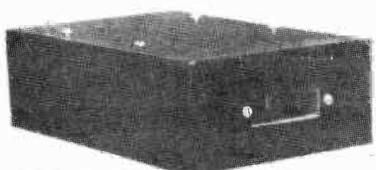


GRAPHIC EQUALISER

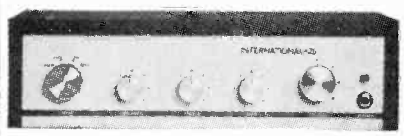


IMPEDANCE METER

BIKE SPEEDO



RADAR INTRUDER ALARM



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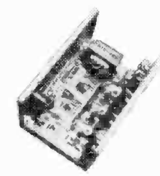

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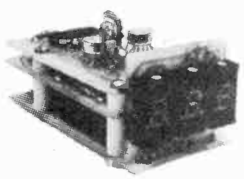

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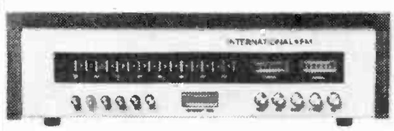
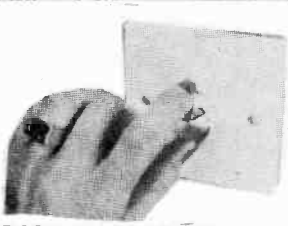


STEREO FM TUNER

LINE AMPLIFIER



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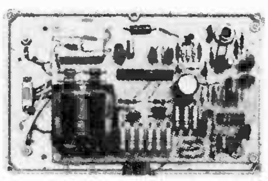

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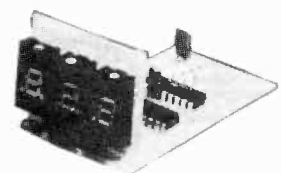

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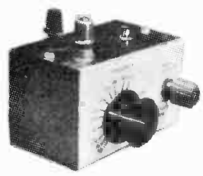

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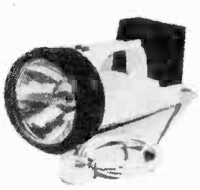

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[CMOS]

We will continue our discussion of CMOS this month by considering several diverse topics briefly including shift registers, memories and the phase locked loop.

SHIFT REGISTERS

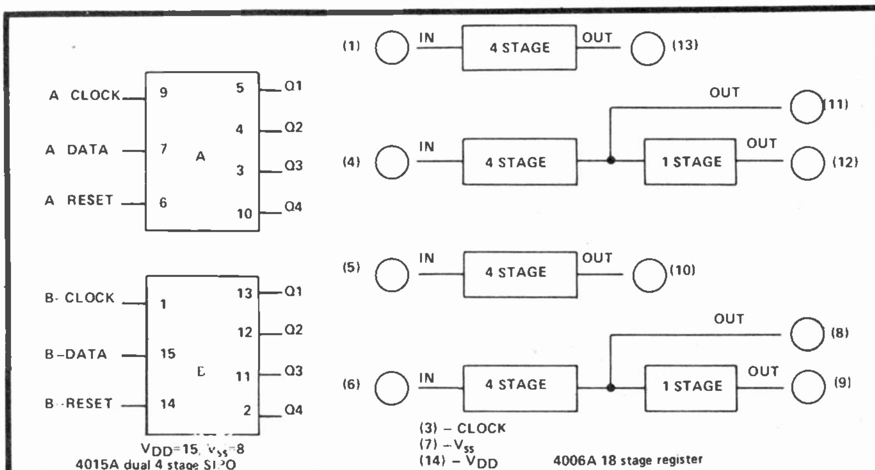
WE HAVE already seen how flip-flops may be cascaded to form shift registers and, as you might guess, these are available already connected in a single IC. As usual we will start with some pin-out diagrams.

Referring to fig. 1 we start with the 4015A, a dual four stage serial input parallel output (SIPO) version. The two parts "A" and "B" are independent and each consists of four D-type flip-flops with outputs Q1-Q4 and data is transferred from each one to the next and from the data inputs to the first on the rising edge of the clock pulse. A high input to the reset clears all the outputs to zero.

The 4006A is an 18 stage device with the registers so arranged that 4, 5, 8, 9, 10, 12, 13, 14, 16, 17 and 18 stage registers may be produced. These are serial in-serial out (SISO) devices. It should be noted that the clock input is common to all the stage so that although two separate five stage registers could be produced they would have to share the same clock.

Finally in fig. 1 we have the 4014A and 4021A which are both eight bit registers with the same pin connections. The 4014A works as follows: On the rising edge of the clock pulse, the data is all shifted down and a new datum accepted from the serial input if the parallel/serial input is low. If instead it is high, no shift occurs and instead each stage of the register adopts the state present at the parallel inputs. The 4021A is similar in almost all respects except that when the Parallel/serial is taken high the stages are jammed asynchronously (i.e. it does not wait for the clock transition like the 4014A). We mentioned earlier that the 4042A quad D latch is often used for temporary storage but for many applications a shift register is superior, giving options of serial or parallel operation. As far as eight bit data manipulation is concerned, the ultimate shift register must surely be the 4034A whose pinout is given in fig. 2. It is described as a bi-directional bus register because the two data lines "A" and "B" are interchangeable in that if the A/B input is high the A lines are inputs and the B lines are outputs, whereas when A/B is held low the reverse applies. When the parallel/serial input is high then data is accepted from the parallel inputs (on the positive clock transition when Asynch / synch is low, asynchronously otherwise) whereas when parallel/serial is low data is accepted from the serial input and shifting is performed on the positive clock transition. The only other feature is the A-enable input which enables the A lines when it is high thus allowing several registers to feed a common bus. Designers of large digital processing systems will find many applications of this device.

Applications of shift registers in data storage and conversion are not really very interesting out of context and so we will look briefly at counters. The connection of shift registers (under the guise of a sequence of flip-flops), to form Johnson counters, has already been



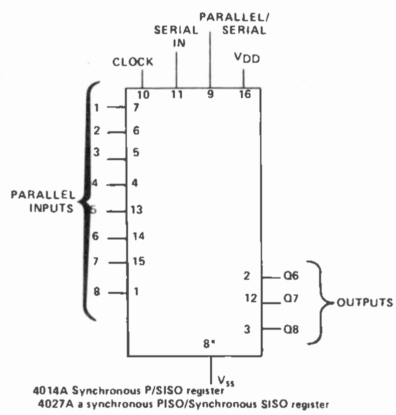


Fig. 1. Pinouts of four small shift registers.

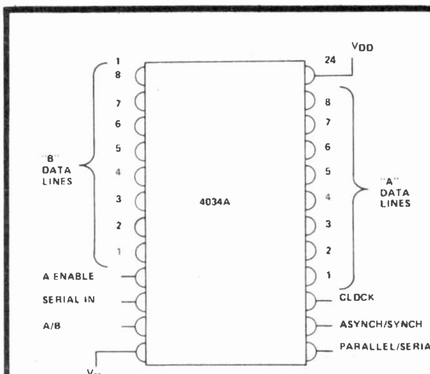
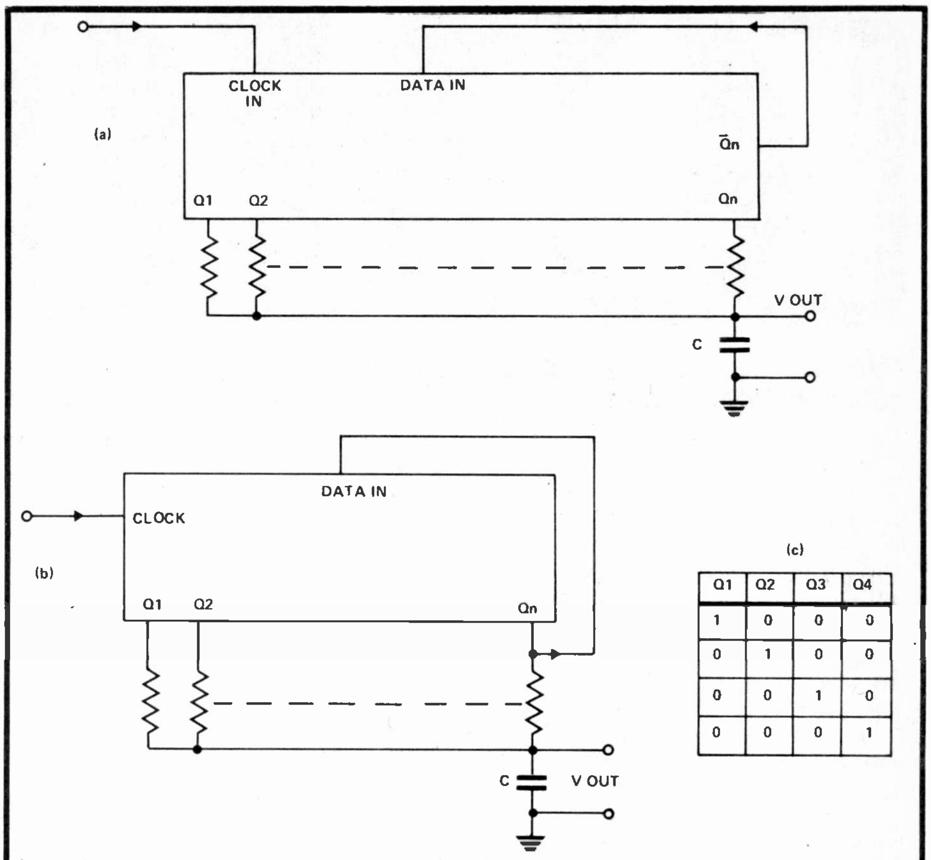


Fig. 2. The 4034A bidirectional bus register.

considered but it is worth noting that in the same way as we produced digital to analogue converters from counters we can also produce waveform synthesisers from Johnson counters (see fig. 3(a)). The calculation of the required value of each register is rather tedious because each is on for half a complete cycle. Nevertheless, an eight stage register gives sixteen separate values out but not all of these are independent. On occasions this method is superior to the single bit approach. The circuit in fig. 3(b) is not complete because the single bit must be inserted to start with. If the application will tolerate switches in the starting sequence it is a trivial design exercise but if complete auto-starting is required it becomes quite interesting.

These small registers we have been considering are by no means the top end of the range. Fig. 4 gives the pinouts for some high capacity registers. The 4031A is a single sixty-four stage shift register, the only addition being a Q̄ output and mode and recirculation connections. When the mode control is low the recirculation input is inoperative and data accepted from the data input. When mode is high, however, data is accepted from the recirculation input instead. Thus if the Q output is connected to the recirculation input a register is formed with a control input which will either recirculate its contents continually or accept new data, depending on the control signal. You might well wonder why the recirculation input is not internally connected to the Q output. This is not done because it would generally reduce the versatility of the device and, more particularly, would prevent the formation of multi-chip recirculating registers like the one shown in fig. 5(a). The 4013A is positive edge triggered and it has also got a delayed clock output which, as the name implies is a replica of the clock signal delayed by several hundred nano-seconds so that the cascading method shown in fig. 5(b) may be used. The addition of the flip-flop if recirculation is required should be noted as without it this method will not work. The cascading method in Fig 5(a) must be used for highest speed operation although it requires higher clock drive.

Having said so much about the 4031A there is less to say about the next three devices. The 4517 is dual sixty-four bit register, the two devices being distinguished in the pin diagram by the suffices "A" and "B". During normal operation the device is positively edge triggered, data is entered at the data pin and outputs are available at Q16, Q32, Q48 and Q64. This is with the write enable low. When it is high however data is entered at the data, Q16, Q32 and Q48 pins (the Q16 pin acting as a data input to stage 17 etc) thus allowing complete filling of the device in sixteen clock periods.



Q1	Q2	Q3	Q4
1	0	0	0
0	1	0	0
0	0	1	0
0	0	0	1

Fig. 3. (a) Johnson type waveform synthesis (b) principle of the single bit circulation register (c) counting sequence for (b) when it is correctly set up.

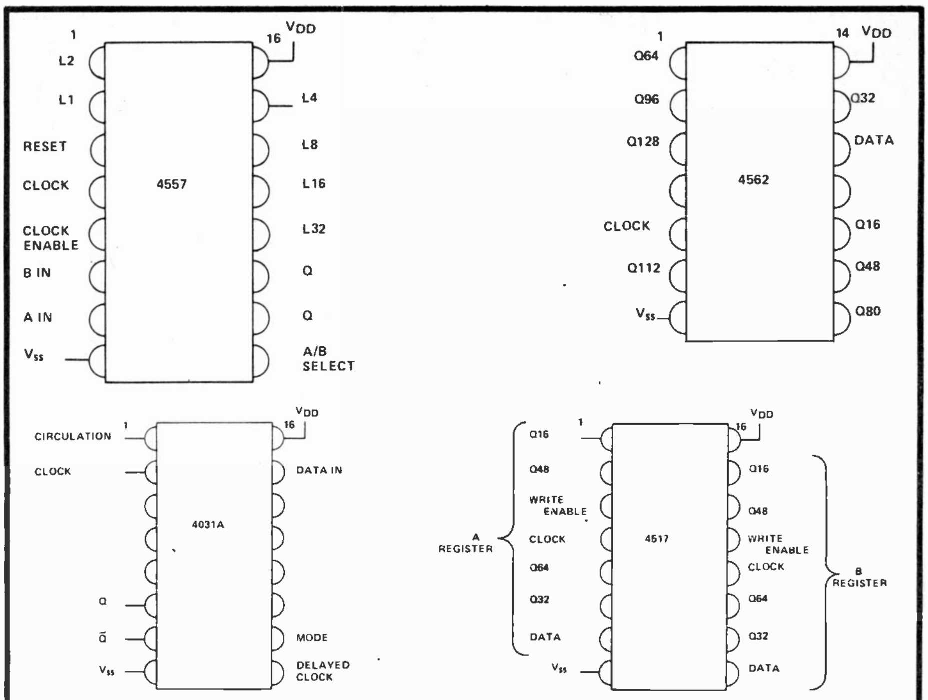


Fig. 4. Some larger shift registers.

The 4562 is a straight forward one hundred and twenty eight stage positive edge triggered device with no additions except outputs every sixteen stages throughout. The 4557 is an altogether more interesting device. Basically, the length of the shift register between the A and B inputs and the $\bar{Q}$ and $\bar{Q}$ outputs is equal to the sum of the L inputs which are high plus one. Thus if L32 and L4 are the only ones held high the shift register will be of length 32+4+1 = 37. The reset input clears all stages to zero when it is taken high. The A/B select input is used to decide whether the A or B inputs will be used as the data source, when it is low B is used, when it is high A is chosen instead. It should be clear from our previous discussion how a recirculating register could be formed. As for the clocking, when the clock enable is low the device behaves as a conventional positive edge triggered register, but if negative edge operation is required this can be achieved by holding the clock at logical one when a falling edge at the enable input will operate the device. Using this device as a Johnson counter would lead to an interesting binary programmable symmetric frequency divider. Before we leave the subject of shift registers we will point out that all those we have considered are static devices which means that they maintain their state even if they are not clocked for some time. A two hundred stage dynamic shift register is available but there is not really time to describe it here. Its type number is 4062A.

MEMORIES

Of course, a shift register can be used as a memory. The disadvantage is that it is a serial access device which means that a lot of unwanted information must often be passed by while the piece we require is arriving. Random access memories (RAMS) avoid this problem because access is by a set of address lines, the signal on which determines which bit of the memory is to be written to or read from. We intend here just to give brief details of one available device (see fig. 6). The 4061A two hundred and fifty six bit static RAM has been chosen as our example because it is simple enough for a brief description of its features to be given easily. AO to A7 are the eight binary address lines necessary to specify any one bit and these should only be changed while the chip enable input is high. Only when the chip enable has returned to zero can read and write operations be performed, reading when "read/write" is low, writing otherwise. The buffering of the outputs is such that the data in line may be tied to either data out or data out if desired. It should also be noted that the V_{SS} and V_{DD} pins are unconventionally positioned so that the devices are compatible with other MOS memories. Of course, there are a few other pieces of timing protocol to be observed. For example, the chip enable signal should not go low too soon after an address change but we will not go into these here as anyone who uses this device in a system will doubtless be obtaining data sheets for other devices anyway.

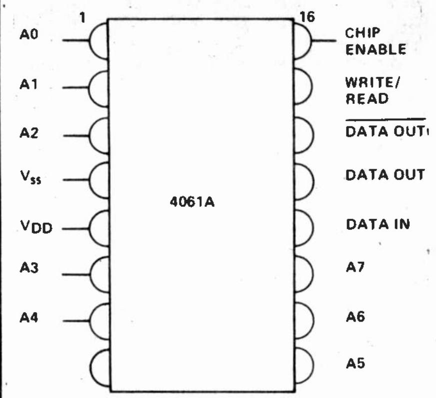


Fig. 6. The 4061A static 256 bit random access memory (RAM).

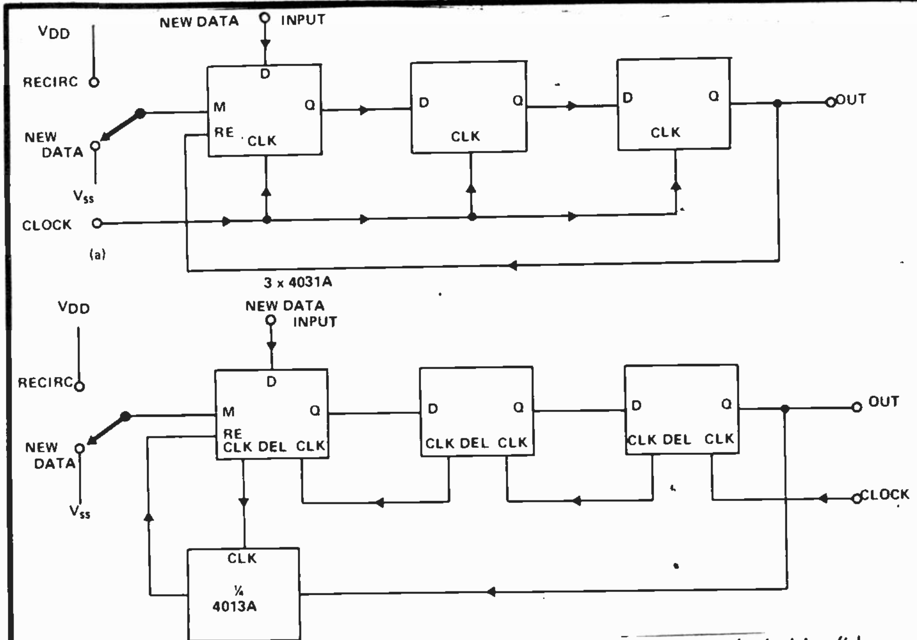
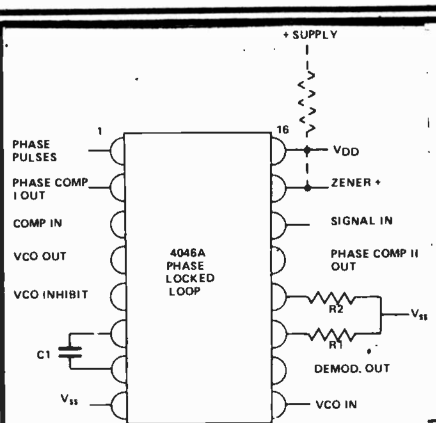


Fig. 5. 192 stage shift register using 3 4031A. (a) version requiring higher clock drive (b) version using delayed clock.

THE 4046A PHASE LOCKED LOOP

The possibilities of combining linear and digital circuitry on the same chip has made the fabrication of the 4046A phase locked loop possible in CMOS. As usual we will discuss this device with reference to its pin diagram which is given in fig. 7.

A zener diode of 5.2V is provided at pin 15 for supply regulation if required although the circuit will operate at any value of V_{DD} between five and fifteen volts. The chip contains two phase comparators with outputs at pins 2 and 13. The first of these is an exclusive — OR network which requires a 1:1 mark space ratio at the input to work effectively, will lock onto harmonics of the input frequency but makes up for a lot by having good noise rejection and it also leaves the



$$f = K\left[\frac{\dfrac{VCO_{IN} - 1{\cdot}65}{R1}}{(C1 + 32)} + \frac{\dfrac{C_{DD} - 1{\cdot}35}{R2}}{(V_{DD} + 1{\cdot}6)}\right]$$

$K = 0{\cdot}95$, $V_{DD} = 5, 10V$

$K = 1{\cdot}08$, $V_{DD} = 15V$

f is in MHz, R1, R2 in MΩ (≥ 5kΩ)

Cin pF (≥50pF)

$1{\cdot}65 \leqslant VCO_{IN} \leqslant V_{DD}$ Ω $1{\cdot}35V$

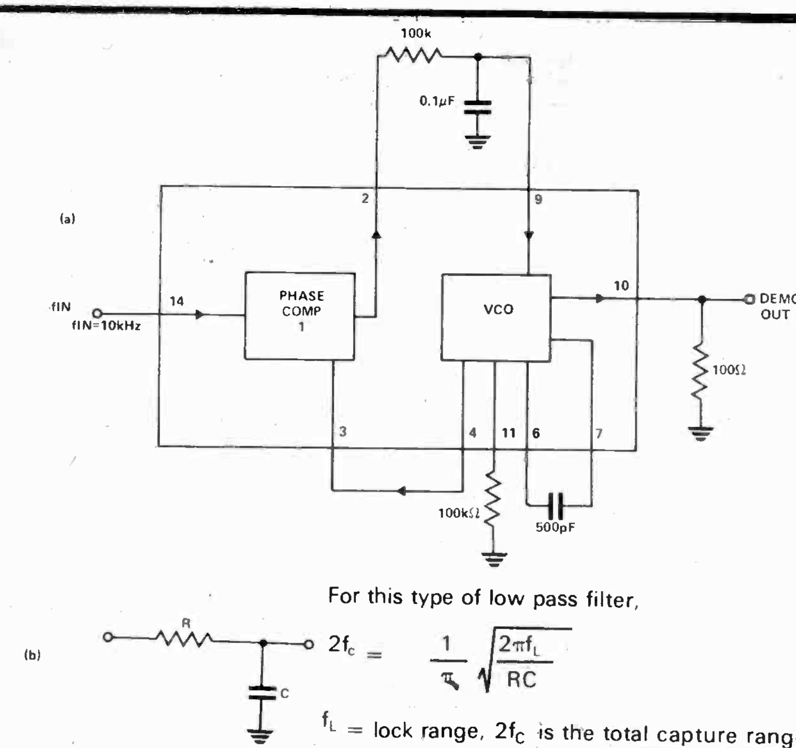
Fig. 7. The 4046A pinout and formula for determining frequency.

CMOS

voltage controlled oscillator running in mid-range with no input connected. In contrast to this, phase comparator 2 can handle pulses and leaves the oscillator running at minimum frequency. The output from one of these phase comparators is generally connected via a low pass filter to the input of the V.C.O. In passing we will mention that when the first phase comparator is used, the capture range (that is the range of frequencies that will pull the loop into lock) can be made less than the lock range (the range over which the loop will follow an already locked input) by using an appropriate low pass filter. In the case of comparator 2 however, the lock and capture ranges are identical.

The frequency of the V.C.O. for given R1, R2 and C1 is given in fig. 7. The highest frequency attainable is over 1MHZ but the supply voltage may need to be a full fifteen volts to achieve this with the cheapest plastic encapsulated devices. For experimenting purposes this description of the oscillator is probably sufficient but if it is required to design for specific frequency ranges, the R.C.A. data sheet on the device gives graphs which are easier to use than the somewhat cumbersome formula. Basically the smaller R2 is, the smaller the range the VCO may be swept over. If pin 12 is left open, the frequency can be swept from a negligible value to a megahertz or over.

If the signal in is within CMOS logic levels ("0"$\leqslant$30%V_{DD}, "1"$\geqslant$70%V_{DD}) then it may be directly coupled to the signal input but if capacitive coupling is used signals at least as low as 1.5V p-p will be accepted. The inhibit input saves power by disenabling the VCO when it is taken high and the "DEMOD OUT" terminal provides a buffered copy of the "VCO IN" signal for use as an output in demodulation set-ups. If this is used a resistor of 10kΩ — 1MΩ should be connected between it and V_{SS}. Perhaps we can save time by giving one or two examples of the use of the 4046A rather than talking about it further. Fig. 8 shows an F.M. demodulator designed to operate with a centre frequency of 10kHz. It uses phase comparator 1 for good noise rejection and the formula for the capture range shows that the values used give ±400Hz. As R2 is infinite the circuit will track over a very wide range and the linearity obtainable is very high.



For this type of low pass filter,

$$2f_c = \frac{1}{\pi}\sqrt{\frac{2\pi f_L}{RC}}$$

f_L = lock range, $2f_C$ is the total capture range

This formula is only applicable to phase comparator I

Fig. 8. (a) An FM demodulator for 10kHz. (b) Design of low pass filters for phase comparator I.

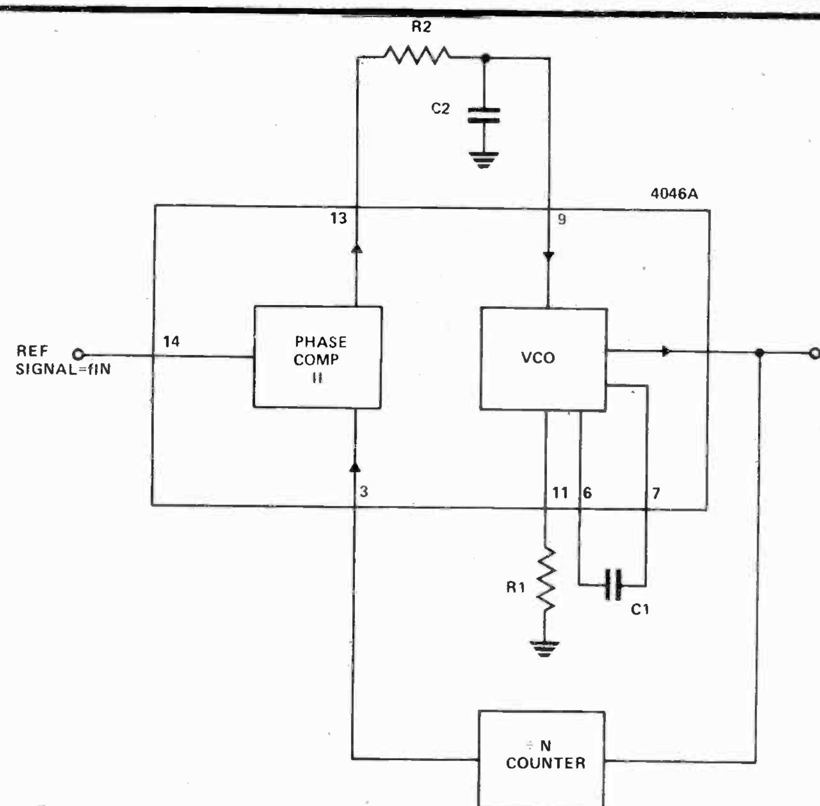


Fig. 9. Basic PLL frequency synthesiser.

Fig. 9 shows the outline design of a frequency synthesiser. The second phase comparator is used because it will deal with non symmetric output from the divider and will not lock onto harmonics. The V.C.O. is set with the pin 12 resistor infinite for maximum range. Three to nine hundred and ninety nine kilohertz in one kilohertz steps can easily be achieved. The low pass filter should be optimised for minimum settling times. The divide by N counter has been shown as a block as these have been discussed at length previously.

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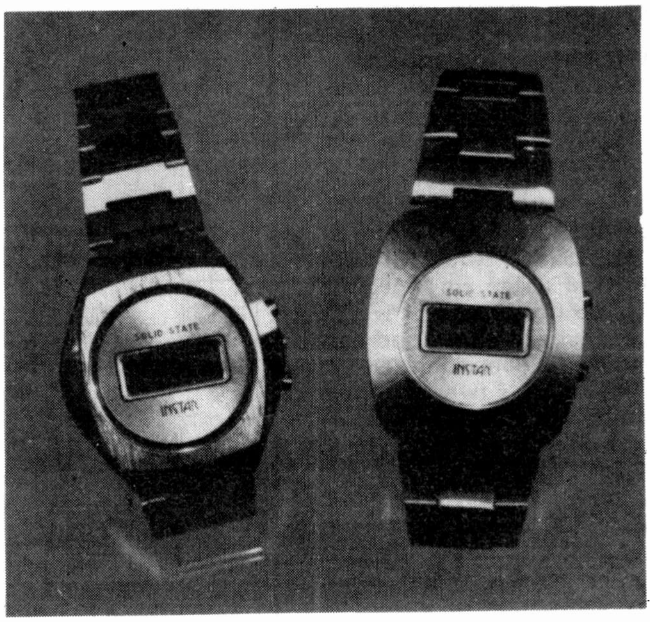

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REFLEX ACTION

An electronic duel to see who's quickest to the trigger

REFLEX ACTION IS a simple electronic game sufficiently competitive to keep two children amused for several hours (it will probably find usage amongst the adults of the household as well!) The device is both cheap and easily constructed, consisting as it does of four LED's two switches, and the necessary amount (small!) of circuitry.

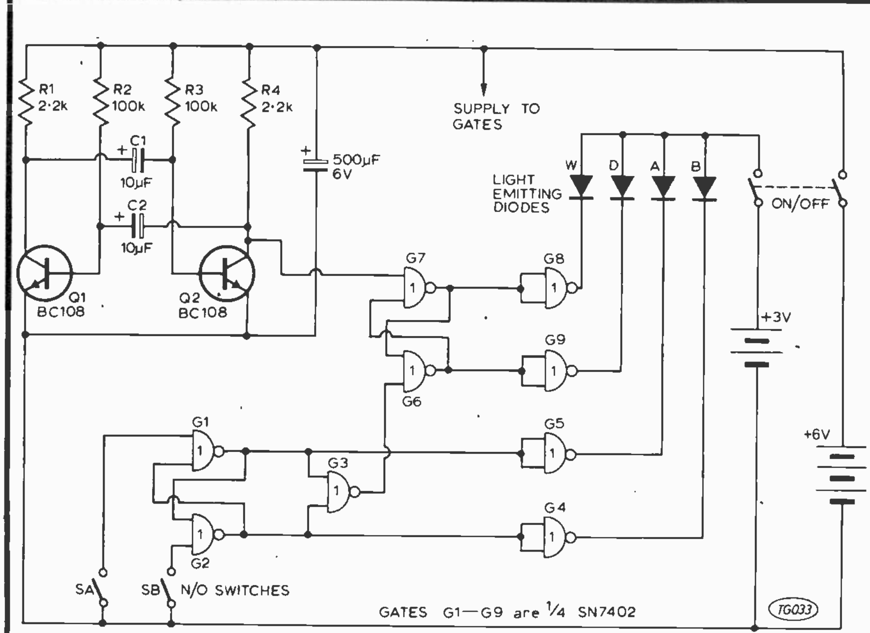


Fig. 1. Complete circuit of the game

RULES OF THE GAME

Battle is joined by both contestants attempting to beat the other in operating thier switch when the 'win' lamp comes on. The circuit will then indicate the winner by lighting that persons LED. Both lamps can never be on at the same time, and will only remain lit as long as the switches are held closed. If a player tries to anticipate by pressing his switch before the 'win' lamp the 'disqualified' signal will operate, and the opposition is awarded a point.

THE WORKS

The circuit is shown in Fig.1, and consists of a multivibrator,and nine two input TTL NOR gates (7402's). The contest switches feed a latch circuit, the inputs of which are normally high. Pressing either switch causes that input to go low, taking the output high.The other switch now has no effect. Hence if both buttons are operated apparently simultaneously, the latch will set on the first switch closing, and ignore the second.

This same circuitry runs the 'disqualify' LED. In this case the latch inputs are the clock multivibrator,(which also lights the win lamp in the first place) and the NOR gate G3.This gate gives a low output when either contest switch is depressed. A 500uf capacitor decouples the supply,and the LED's are run from a separate 3V battery, to avoid poor regulation interferring with the operation of the logic or clock.

CONSTRUCTION

A veroboard layout is given in Fig.2, although this is not critical and may be altered if the whim should take you. Note that on our layout, some of the tracks beneath the IC's have been used to make interconnections.The prototype used spring metal making onto bolt heads for the contest switches, but micro-switches would be better, though not to your pocket!

A double pole switch is essential for the power supply, as two batteries are employed. If you intend to power the device via a transformer, the supply voltage should be changed to 5V, and must be stabilised. This is because TTL packs run from an absolute maximum of 7V, which must not be exceeded.

COMPLICATIONS

If the game as it stands is too simple for you, there are some interesting refinements to the basic circuit which should not be too difficult to add

For example, any number of switches can be added in parallel with Sa and Sb, making this a team game. In this case it is the fastest member of each team who scores the point. You can argue amongst yourselves as to it was!

To prevent the addition of phantom points, counters can be arranged to keep score automatically. Loaded from the players LED's, each one would count up by one every time that LED came on. A NAND gate, with one input inverted, and fed from the contest switches and the disqualifying lamp, would add one to the appropriate score when ever a player jumped the gun.

This modification could also be done using the spare gates in the fourth 7402. We'll leave the details to our readers ingenuity!

A circuit of this nature lends itself easily to additions, and no doubt you can think of many more, but don't forget to try playing the game whilst you're trying!

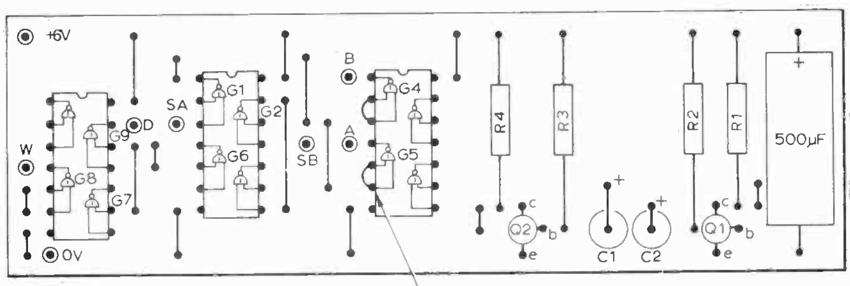


Fig 1 Circuit diagram of the game

PARTS LIST

R1,4	2k2	¼w	5%
R2,3	100k	¼w	5%
C1,2	10uf	9V	electrolytic
C3	500uf	9V	electrolytic
IC1-3,	SN7402N		
LED's	TIL 209 or similar		
Sa,Sb	push to make		

Double pole battery switch
Case to suit
6V battery
3V battery

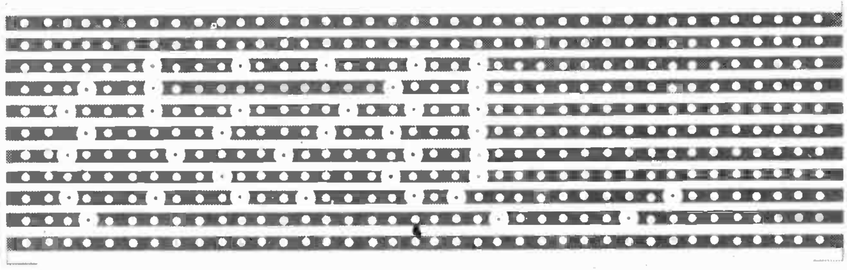


Fig 2 Veroboard layout

ELECTRONICS —it's easy! PART 27

Integrated circuit forms of logic functions.

NOW that we have a basic understanding of switching circuits and the algebra used to mathematically describe logical operations we can look at the modern methods used in solid-state circuitry to produce the various logic functions in integrated circuit packages.

LOGIC FAMILIES
DIODE LOGIC – DL:

Previously it was explained how a single diode could be used as a switch by altering the bias or the input signal level. If more than one diode feeds the

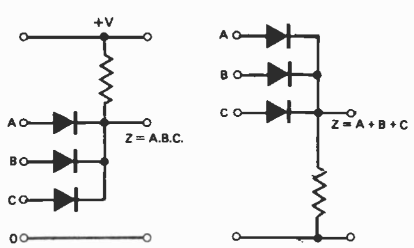


Fig. 1. The implementation of AND and OR gates using diode logic.

bias node the circuit becomes a gate. Three input AND and OR gates are shown in Fig. 1. The circuits are the same; the different class of gate arising because of different bias conditions in each case. Fig. 13 of the previous part showed the use of diode logic.

Diode logic is the simplest form of solid-state logic, it is not available in integrated form but is often used in discrete designs to obtain logic functions at high, or unusual (compared to standard IC logic) voltage levels.

RESISTOR-TRANSISTOR LOGIC – RTL:

Logic gating operations can also be obtained using transistors acting as switches in various ways. Fig. 2. shows a typical RTL NOR gate for which Z = $\overline{A + B + C}$. Base current appearing at A, B or C will cause the respective transistor to switch to the ON state taking the output to ground which is a '0' in a positive logic system.

This family was the first to be used in the now more usual integrated-circuit form based on the planar manufacturing technique (one in which a mask is used to selectively diffuse impurities into a pure substrate in order to produce and separate active device junctions).

RTL is based on a supply of 3.6 V. Propogation delay is 12 nS for a medium power gate and 40 nS for a low power gate. It is a reasonably economic family to use but needs more space than the alternatives developed since. This form of logic was very much in vogue in the early 1960s but, although still manufactured by some companies for replacement purposes, is an obsolete type not used in new design.

DIODE-TRANSISTOR LOGIC – DTL:

This was the next family developed. The devices of the family use resistors, diodes and transistors. Initially DTL logic was constructed with discrete components. These designs were then integrated as shown in Fig. 3. Later devices used transistor input logic instead of diodes, thus reducing the input current requirement and allowing higher fanouts. Typical noise immunity (for a 5 V supply level – the standard used) is around 1 V. The delay time for a pulse signal to travel through, that is, the propagation delay between input change causing output change, is around 30 ns. Output is > 3.5 volts for a '1' and < 0.4 volts for a '0'.

It has a generally lower speed and lower noise immunity than other families. The advantages of DTL are the reasonably high fanout of 10 and the ease of interfacing or coupling a stage to the TTL family to be considered next.

A similar family is HTL (high threshold logic) which uses 15 V supply lines and zener diodes. This is useful in situations where high noise levels occur because this logic is more immune to noise effects than is DTL.

TRANSISTOR-TRANSISTOR LOGIC – TTL:

This is the most popular logic family in current use. It has higher speed and driving capability than DTL. The propagation delay is around 12 ns which is quite fast enough for the majority of computing applications.

A typical TTL gate circuit for Z = $\overline{A.B.C.}$ is shown in Fig. 4. Note how the diode input gate has been replaced with a multi-emitter transistor. This multi-emitter technique reduces the input capacitance thus speeding up the switching time, as well as simplifying manufacture. In TTL the supply is +5 V, the output switching between around > 2.4 for a 1 to < 0.40 for 0 (in positive logic). Fig. 5. shows a TTL signal switching state with time.

For all of its popularity TTL is not ideal, especially for the fastest circuit operation or where the lowest power consumption is required. Another difficulty with TTL is that switching transients occur (see Fig. 5) at the transitions. It is also not particularly suitable for large-scale integration by virtue of the relatively large amount of space and power required by each gate function.

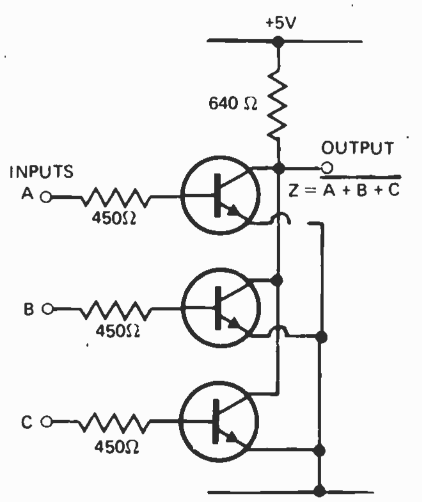


Fig. 2. Typical RTL circuit of a NOR gate: any logical '1' input will give a logical '0' output.

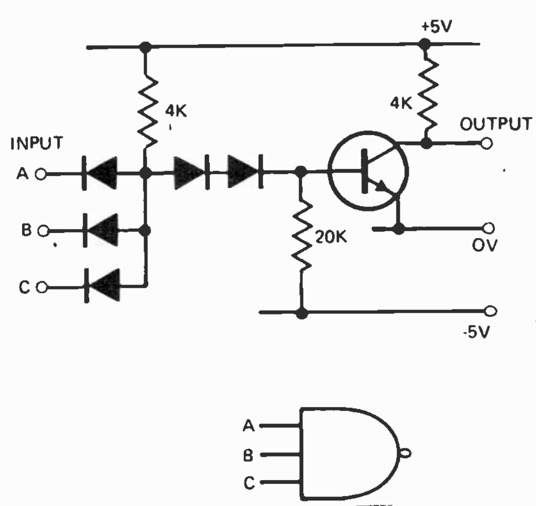


Fig. 3. An early integrated circuit design for a NAND gate in diode-transistor logic – DTL.

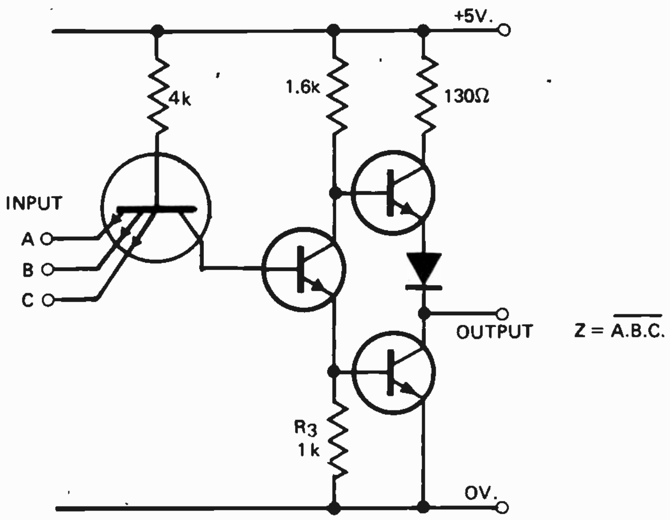


Fig.4 Typical output signal from TTL, note the transient ringing at each transition.

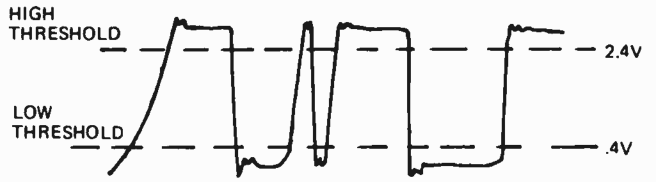


Fig.5 In the TTL (transistor-transistor logic) form of NAND gate a multi-emitter transistor replaces the diodes of DTL.

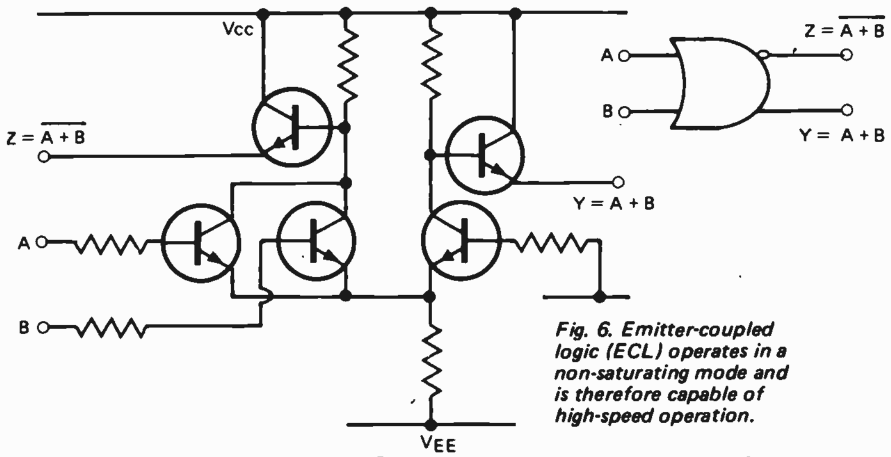


Fig. 6. Emitter-coupled logic (ECL) operates in a non-saturating mode and is therefore capable of high-speed operation.

EMITTER-COUPLED LOGIC – ECL:

A typical ECL stage is shown in Fig. 6. As this operates in the linear mode, that is, without allowing the active devices to go into saturation, it gives high-speed 2-3 ns switching times. It, however, needs a moderate power requirement, is not particularly noise immune and needs an extra power supply line. Supply voltages used for ECL vary but when typical supply rails of 0 V and −5.2 volts are used the output is −1 volt for the '1' state and −1.6 volts for the '0' state.

Each of the above logic families is based on the use of the transistor semiconductor junctions – the so-called bi-polar technique. Around 1970 ECL emerged as a possible future contender to TTL and at the same time another quite different kind of semiconductor active device became freely available – the field effect transistor FET. A variation of this is the insulated-gate field-effect transistor IGFET. Fig. 7 lists the symbols of the basic FET structures used in logic. This technique is manufactured using metal-oxide-semiconducting materials; abbreviated to MOS. Hence, the MOSFET is a metal-oxide-semiconductor field-effect-transistor. They can be made in the two complementary ways, P or N, of which the first is most conventional giving the PMOS technique. With improvements in technology the NMOS technique is also being used for very complex circuit blocks.

The attraction to manufacturers and users of MOSFET devices is that the packing density of the active devices is the highest of all types – much better than TTL. It is, however, not as fast as TTL but adequate for a large part of the consumer market. FETs have extremely high input impedance, 1.0 TΩ (1 000 000 M Ω) is common.

THE CMOS FAMILY

IC device designers went a step further in the early 70's to produce yet another family – the complementary metal oxide semiconductor logic – CMOS. This combines both the P and N, MOS technique in a complementary manner to produce a more ideal switching action than PMOS – Fig. 8 illustrates the difference between the two. Fig. 9 is the schematic of a CMOS two-input

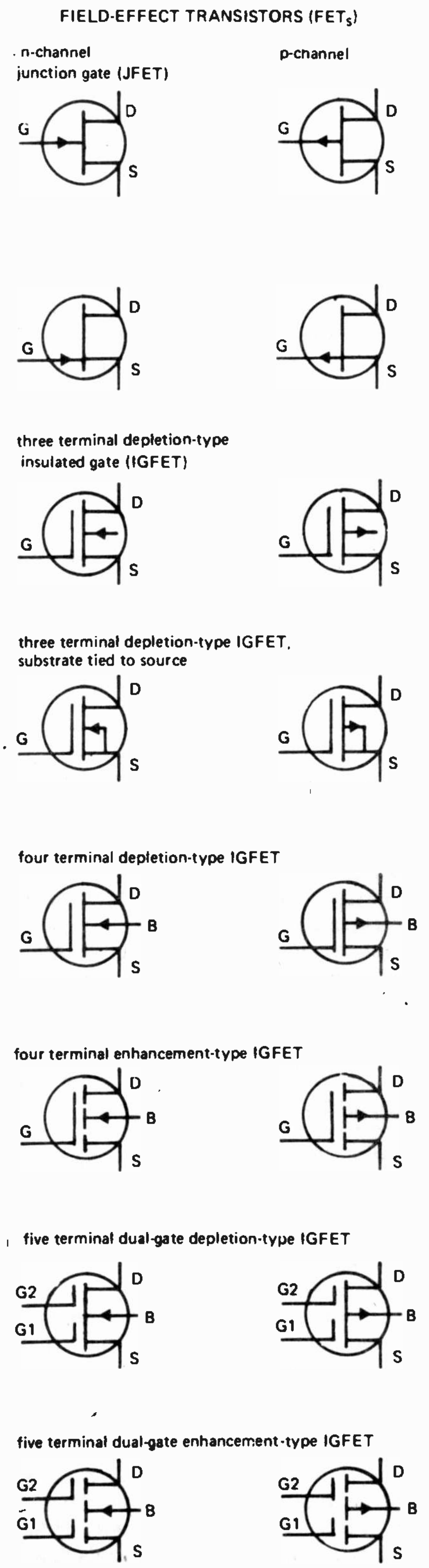


Fig. 7. The symbols used for the various types of FET device.

ELECTRONICS -it's easy!

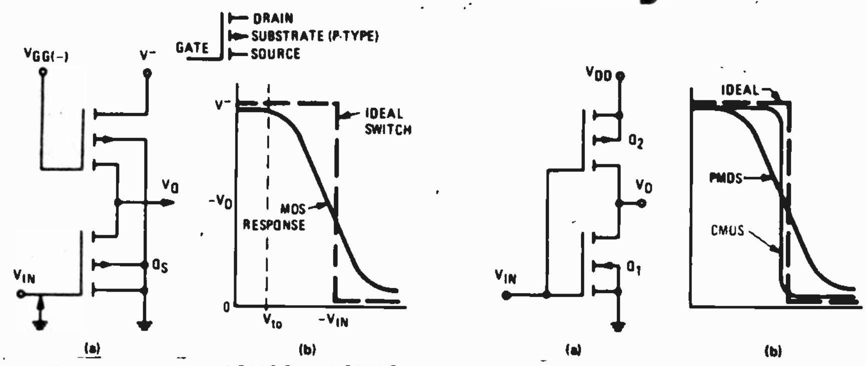
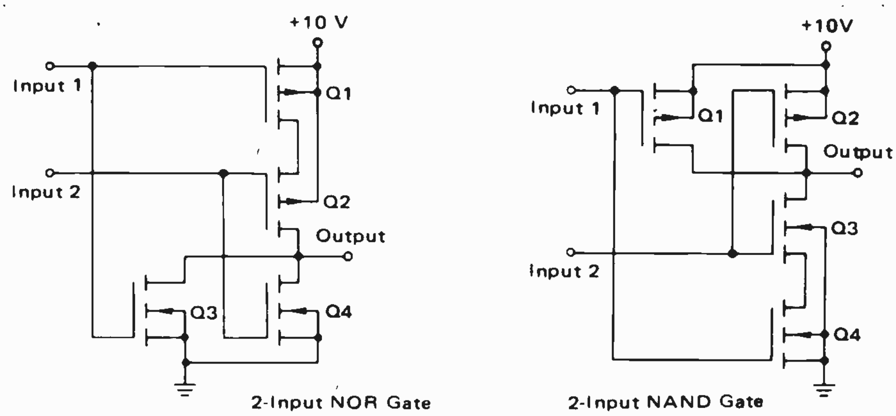


Fig. 8. A comparison of PMOS and CMOS inverters.



"0" = 0 V	"1" = +10 V	
Input 1	Input 2	Output
0	0	1
0	1	0
1	0	0
1	1	0

"0" = 0 V	"1" = +10 V	
Input 1	Input 2	Output
0	0	1
0	1	1
1	0	1
1	1	0

Fig. 9 (a). A CMOS 2-input NOR gate.
(b). A CMOS 2-input NAND gate.

NOR gate. One of the most significant advantages of CMOS is its low power dissipation. Because of the extremely high off-resistance of MOS transistors, and because only one transistor of the series-inverter CMOS pair is ever on at the one time, the dc current drain of a CMOS inverter is in the low nano-ampere range as compared to 0.2 milliamps for a low-power TTL inverter. At the system level a CMOS system typically requires one-twentieth to one-thirtieth the power required by an equivalent TTL system. In fact torch batteries are adequate to run quite complex CMOS devices.

Because of the complementary configuration CMOS has high common-mode noise immunity (such as power supply variations). It will operate with supplies from 3 V to 16 V and needs only a single positive supply. In addition the high packing density has allowed the building of low cost large-scale-integrated (LSI) packages. Interfacing to conventional transistor logic is easy because it has a low output impedance. It generates low noise because of nicely conditioned rise and fall times. The fan-out factor of 50 is the highest of all logic because of the extremely high input impedance. Its speed is better than PMOS but not quite up to that of TTL — propagation delays being from 12 to 60 nanoseconds depending upon supply voltage used.

We have merely glossed over these various kinds of device because we are mainly concerned here with digital systems in general. To design systems requires little in-depth understanding of the manufacturing method used for the actual logic element. The logic IC is merely a black-box with certain input-output characteristics as stated on a data sheet.

Why do new families keep emerging? The facts are that there is still a cost saving to be had and the market is huge. The estimated value of the total market for IC devices in 1975 ran to around £200 000 000. CMOS offered new horizons in cost savings in manufacture. As a bonus from the power requirements of CMOS systems, the so-often neglected power supply cost drops remarkably.

We have all experienced the remarkable increase in the use of active devices in the last decade or so. A transistor radio now costs £1 to make commercially — and there the semiconductors are but a small part of the cost. (Just one common thermionic valve costs more than this today!) A calculator using hundreds of devices can be bought for £5. Minicomputers and microprocessors are rocketing down in price — tens of thousands of elements for a few hundred pounds. It might be argued that reducing the price will soon reduce the makers' total income but as prices fall, applications for digital circuitry widen at an even faster rate, thereby keeping up an expanding demand.

THE DUAL-IN-LINE PACKAGE

The most commonly used form of IC logic package in small batch production is the dual-in-line (DIL) arrangement with 8, 14 or 16 pins. Large-scale integration LSI used by specialist manufacturers will vary in number of connection, but systems based on these require very large volume sales to make a large special system economic. Thus LSI chips are largely restricted to computers or very high volume runs such as calculators and digital clocks.

The number of connections decides the available combination of functions or inputs and outputs. Assuming a need for two power-supply terminations, of which one is the common for all functions, a 14 pin device will have 12 pins available to produce various combinations of input. Fig. 10 shows the main units that are marketed. Available are the sextuple inverter (6 inverters with one input and one output each); the quad 2 input NAND (four two-input NAND gates); the quad two-input NOR, triple three-input NAND, dual four-input NAND, single eight-input NAND plus other more special combinations such as a more powerful dual four-input NAND buffer and others to be discussed below. Each gate function is a quite separate entity on the substrate; when schematic circuits are drawn the individual gates can appear anywhere on the system schematic.

As well as gates there are several other basic digital-system building blocks. These are the flip-flop, (more correctly called the bistable), the monostable, the astable and the Schmidtt trigger. Let us look at each in turn.

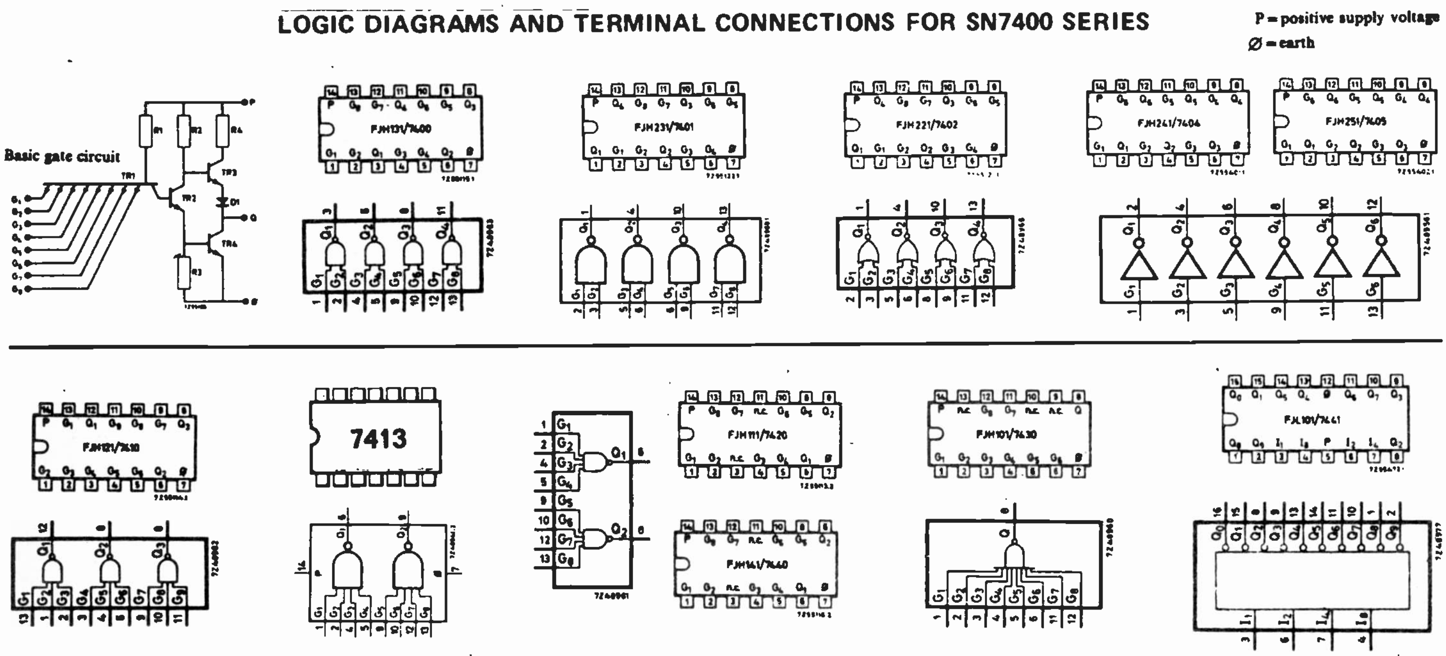


Fig. 10. The basic logic gates of the TTL family.

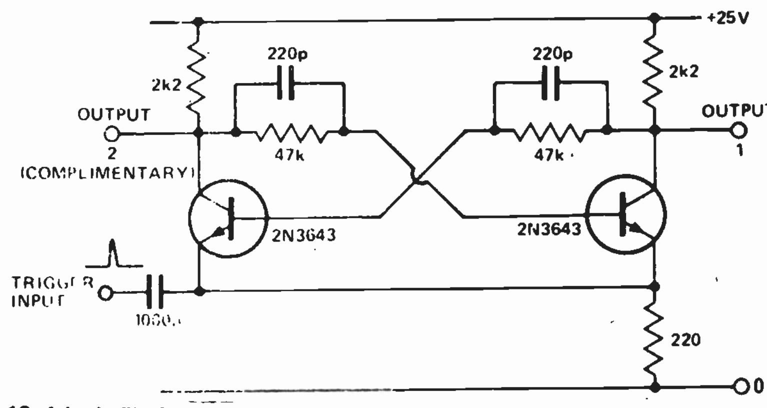


Fig. 13. A basic flip-flop built with discrete components.

THE FLIP-FLOP

Gates are used to perform logical arithmetic, such as, allow event A to occur when B or C have operated. Digital systems can be greatly enhanced by the addition of blocks that remember and count the digital numbers. It is quite possible to use the gates we have discussed to form counting stages but it is more economical to build specific circuitry that will count pulses and/or store values in a binary form. The basic block of modern counting technique is the flip-flop — FF or bistable — one of the multivibrator family.

The most elementary flip-flop circuit is repeated from Part 20 as Fig.11. It consists of two-transistors and several resistors which are dc coupled in such a way that each stage provides a signal which controls the state of the other. In essence the characteristic behaviour is that one stage will be held ON when the other is OFF, or vice versa. To reverse the situation a pulse or change in input signal level (which can be applied to either the base, emitter or the collector) will cause the system to toggle over to the other state. Because of the heavy degree of positive feedback provided, the circuit does not dwell in the in-between state. State change is very rapid — nanoseconds in well designed IC flip-flops.

A decade ago flip-flops were built from two, or in the faster toggling circuits, four transistors. Considerable effort was expended to provide a fast, reliable flip-flop action. Today a typical IC equivalent, see Fig.12 uses many active elements for less cost than two discrete transistors. As discrete designs play no real part today we will only give the characteristics of the flip-flop, not its design details.

Flip-flops provide a counting action because each pulse at its input causes the system to switch over one state — the output, therefore, switches state at each *second* input pulse providing a divide by two action. The output is a switched level which can then be used to pulse a following stage dividing by two again and so through cascaded flip-flops.

The most commonly used flip-flop symbol is given in Fig.13. Outputs are denoted by the symbol Q. A flip-flop has two outputs, one of which is the inverted value of the other, that is, Q and Q̄. The pulsing input is denoted T for trigger. As well as these connections we need a set and reset input denoted S,R. (Although often only R is provided). These enable the flip-flop to be set up on demand with the output Q set to either 0 or 1 state as is needed. This is essential firstly because a flip-flop can come up in any state when the power is energised, and secondly because it may be necessary to set counterstages to a given binary number.

Some flip-flops provided in IC form also may contain three-input AND gates that feed the set and reset inputs. These are known as the J and K inputs giving the name J-K flip-flop. The JK flip-flop overcomes an ambiguous output state, when both inputs are high, that occurs with the RS flip-flop. We will see, when counting systems are discussed, why the reset ability is vital in many counters. Fig. 16 gives the schematics of some of the available flip-flop ICs.

THE MONOSTABLE

If one of the bias resistors of the bi-stable circuit is replaced by a capacitor, as shown in Fig.14, the circuit provides a different action from the normal flip-flop. When triggered the circuit changes state, but only stays toggled in the changed state for a time decided by the product of the values of the capacitor and its "charging" resistor R. (T = 0.7RC) Hence a pulse input will cause the output to change state and remain there for a chosen time interval before it triggers back to the original state.

The monostable, also called a one-shot or single-shot provides, as we

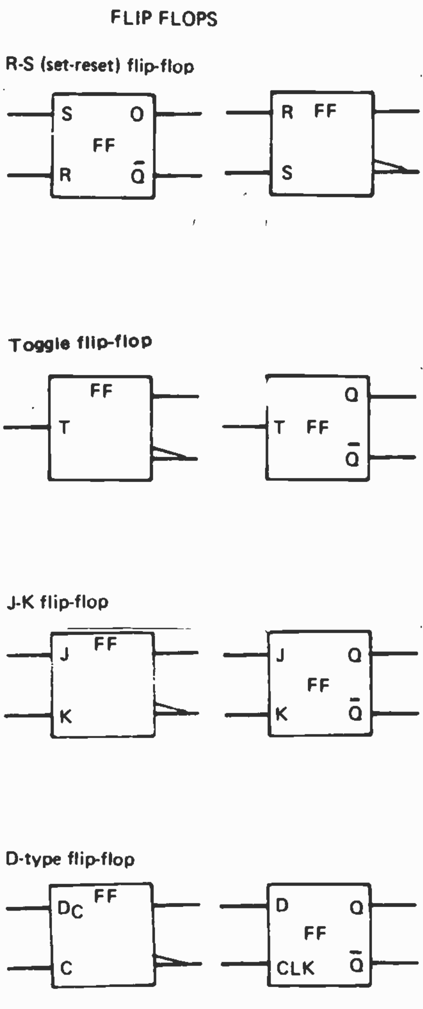


Fig. 12

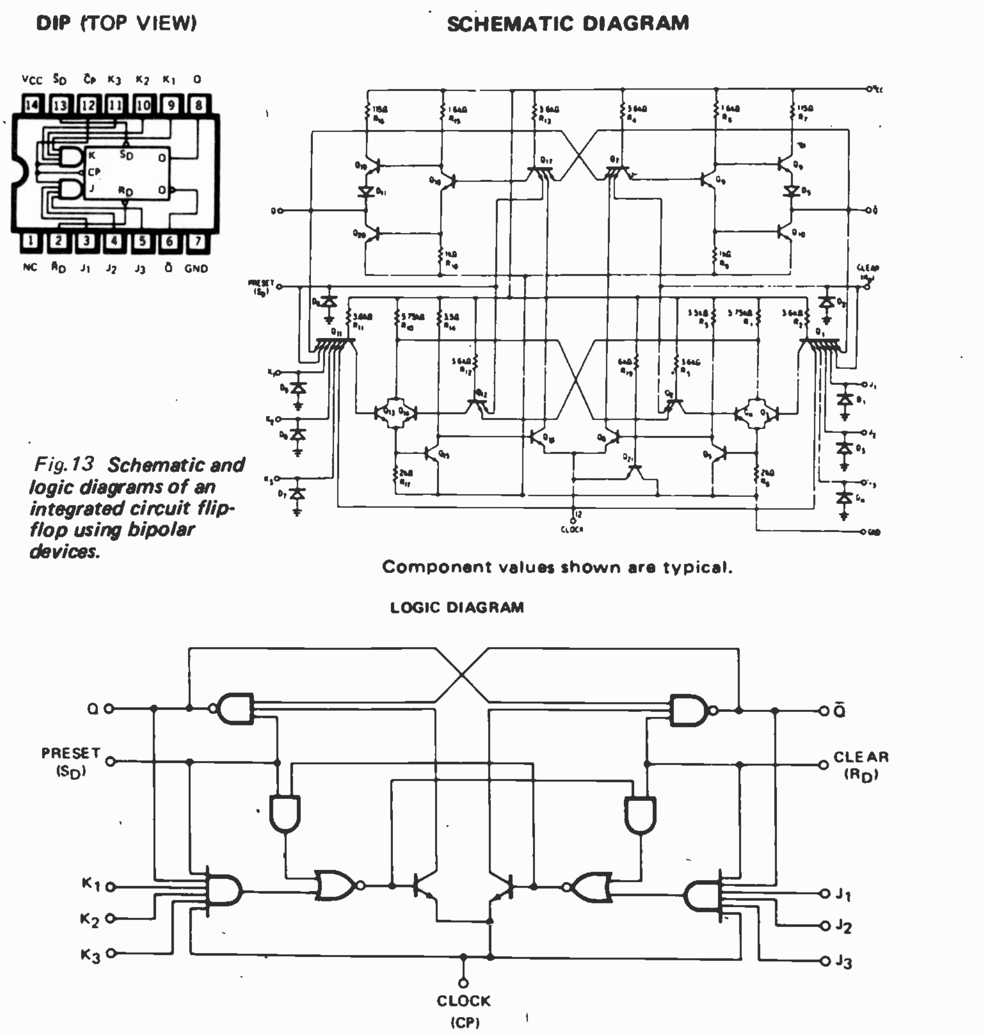


Fig. 13 Schematic and logic diagrams of an integrated circuit flip-flop using bipolar devices.

saw in Part 20, an output pulse having a designed length and height which remains the same irrespective of the input pulse shape. It, therefore, finds application as a pulse reshaper. As the duration is fixed it can also be used to generate a pulse that is delayed from the triggering pulse by the length of the monostable pulse. Monostables are available in IC form, and can provide pulses of duration from 20 ns upwards to minutes or more by appropriate choice of values.

THE ASTABLE

If both feedback paths use capacitive coupling the circuit becomes self-toggling with the stages alternating in state without being externally driven. We considered this circuit in Part 20 when discussing signal generation. The astable is important in digital systems for it provides the square wave signal that increments the digital system along pulse by pulse. It acts as the 'clock' regulating a digital system's sequential operations.

Astables are not usually produced directly in IC form, for the same action is obtainable with other elements, for instance, with the next element to be considered, the Schmitt trigger. Fig. 15a shows a clock source based on a Schmidtt trigger IC. Fig.15 shows one based on two NAND gates.

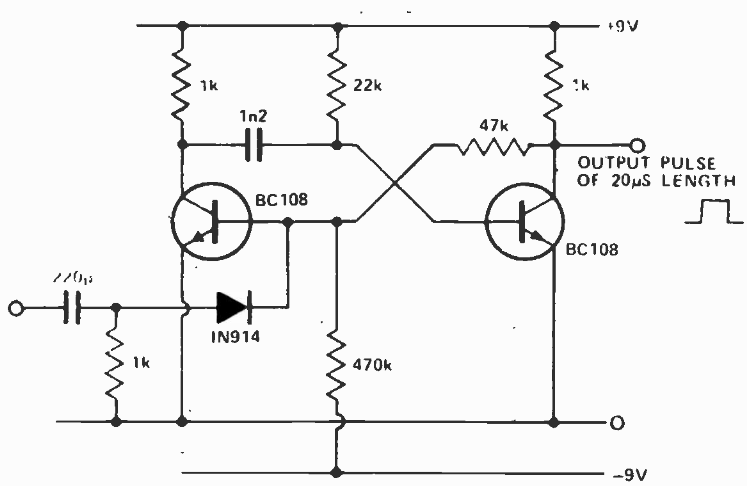


Fig. 14 A basic monostable constructed with discrete components.

THE SCHMITT TRIGGER

This unit, also introduced in Part 20 toggles over from one state to the other at a certain input voltage level. It remains in the opposite state until the voltage falls below the threshold level. The Schmitt trigger is used to produce digital signals from analogue signals providing the two necessary binary levels at the output which indicates whether the analogue signal is above or below the threshold and, which are compatible with the rest of the digital system.

The Schmitt function is available in

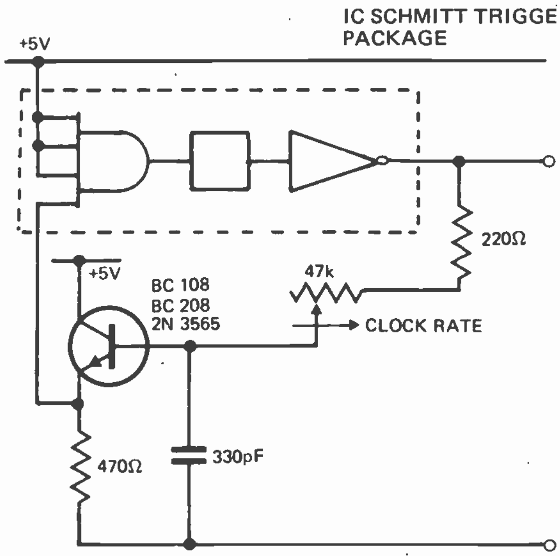
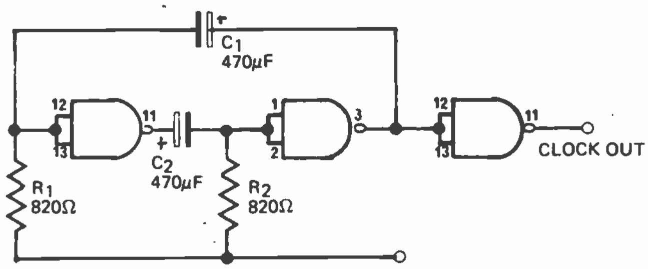


Fig. 15a LEFT: A Schmitt trigger combined with a transistor provides an astable multivibrator action.
Fig.15b BELOW: Astable action may also be produced with two NAND gates.



IC form as a dual-in-line pack. It has a four input AND gate feeding the actual trigger circuit and is buffered with an inverter. The Schmitt trigger is readily identified in Fig.15. Its preferred symbol is given in Fig.16.

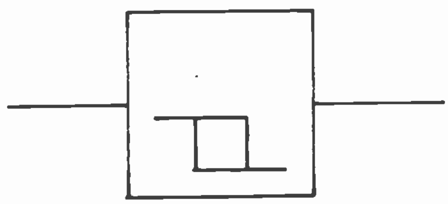


Fig. 16 Standard Schmitt trigger symbol.

YOUR LIBRARY

There are a bewildering number of digital ICs and to identify them correctly it is wise to have a good range of manufacturers' catalogues and application notes.

ELECTRONICS TOMORROW

by John Miller-Kirkpatrick

IT HAPPENED with audio amplifiers, and now with digital clocks — the modular revolution — or how to build a digital clock the very easy way. For some time various digital clock kits have been on the market, some have come and gone whereas others have developed into more complex units. Right from the days of the TTL clock unit it has been a race for retailers to keep up with technology. I think that the first digital clock kit using LSI circuits was based on the Timtronic which was an article in ETI some three years ago, this kit was reasonably simple to build but cost of components added up to over £30.

FIRST ATTEMPTS

One of the first successful complete clock kits using LSI must have been from Pulse Electronics. This used the famed MM5314 chip with drivers and displays, all presented with transformer, etc, in a pleasant perspex case. Although I have never seen the kit version the finished clock that I saw about a year ago looked quite attractive, and I have heard that the kit is relatively easy to build. It was quite a bargain at about £16 when it first appeared. At about the same time as the Pulse clock kit came onto the market General Instruments announced their CPD-1 clock, available as a module or as a fully built clock. (Many of you might recognise this as the ETI Pulsar although it went out under various disguises).

This clock module was beset with many problems in its early days as the chip was of the new NMOS type and was very prone to static problems. GI had not fully tested the clock in anything other than a laboratory environment and although the electronics may have been good the unit suffered from components physically moving during transit with the result that the clocks failed to work. All of these problems were eventually solved late last year, some 14 months after I had seen the first prototype.

The thing that the Pulse kit and the CPD-1 clock did do was to set the prices for this type of product at about the £15 area. This has the advantage from the customer's point of view that prices are now settling at a level which was not far from what must be the eventual digital clock price of £9.95. Thus unlike calculators and digital watches the cost of buying or building a clock now is not much different than the expected price this time next year.

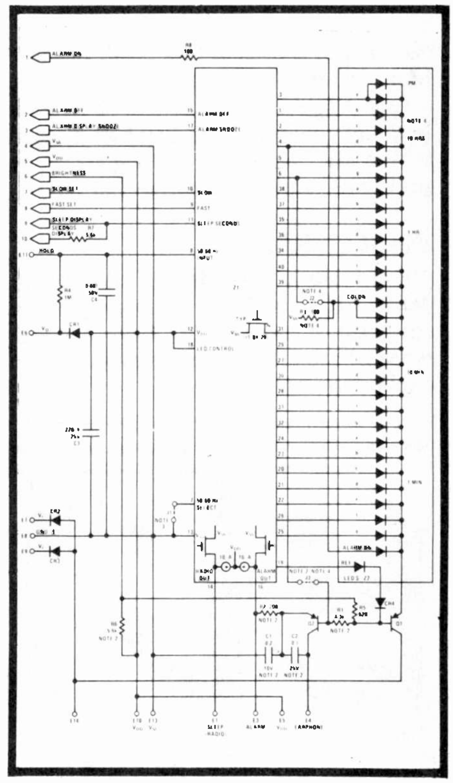
This was confirmed late last year by the introduction of the Mistral clock kit from Imtech at £12.50. Simple to build with simple functions — 12/24 hour readout, 50Hz input and easy setting. This has now been followed by the Mistral 2 which is a complete clock, with functions similar to the Pulsar, but with the Futaba 5-LT-01 display which is green whereas the Pulsar has an orange display. The Mistral 2 has been dropped down stairs and even subjected to the GPO test — throwing it across a room — it still seems to work!

Another clock, out just before Christmas from Carmen (the Hair Curler people), is in a slim vertical case, again with the Futaba display, but this time with optional filters to alter the colour. A very attractive clock but too highly priced at a RRP of £30. However, this points to the idea that we might see digital clocks from other similar names that you might not normally associate with clocks. (Smiths, Timex, Westclocks, etc have not yet appeared on a digital clock at all).

THE REASON FOR ALL THIS HISTORY

Now most of the regular Electronics Tomorrow readers may well have guessed that the above is in fact a lead in to yet another new product. This time from National Semiconductors, who recently announced the MA1001 clock module, although it has been mentioned before it is only now that we can bring you all of the thrilling details. But first to whet your appetite, the one off price — £8 and that means that you can now build a clock for less than £10.

The MA1000 series starts with the MA1001 combining a monolithic MOS LSI integrated clock circuit, four digit 0.5" LED display, power supply and other discrete components on a single printed circuit board to form a complete



electronic clock 'movement'. The user need only add a transformer and switches to construct a pretested digital clock for applications in clock-radios, alarm or instrument panel clocks. Timekeeping can be from 50 or 60 Hz inputs and 12 or 24 hour display formats may be chosen. Direct (non-multiplexed) LED drive eliminates RF interference.

FEATURES

Features include alarm on indicator, PM indicator, flashing colon, Sleep and Snooze timers and a variable brightness control. Alarm clock options include a switched output and/or a transistor oscillator circuit for use with low cost earphone audio transducers. Power failure is indicated by flashing the entire display on and off at a 1Hz rate — this is reset by using either of the fast or slow setting controls. The outputs for controlling clock radios are —

Sleep: a positive current source controlled by the sleep timer (max 59 minutes). This output can be used to switch on an NPN power transistor for controlling a radio or other appliance. Alarm: a positive current source controlled by the alarm enable and comparator circuit, this output can be used to drive radios or appliances in a similar manner to the sleep output. The alarm output is disabled for a period of 10 minutes by the snooze button. Alarm Tone: some versions of the module use the Alarm output to enable an oscillator which is capable of driving a small earphone type transducer.

VERSIONS AND STANDARDS

The MA1001 is just becoming available in this country but do check that the suffix indicates the module you want, as some of the options are interchangeable (eg 60Hz conversion to 50Hz is a simple link but 12/24 hour option is not).

The various models presently available are —

MA1001B switched alarm output, 50Hz, 12 hour.
MA1001D switched alarm output, 50HZ, 24 hour.
MA1001F Tone alarm output, 50Hz, 12 hour.
MA1001H Tone alarm output, 50Hz, 24 hour.

The standard for the UK will be either the F or H versions as these have both the switched and tone alarm outputs. The oscillator can be built onto the PCB if the B or D versions are the only ones available and all of the 60 Hz versions can be easily altered to 50Hz. I would personally be very interested to hear from readers whether they prefer 12 or 24 hour readout and any other points of preference on the subject of clocks.

MPUs, CPUs, Teletext, Viewdata, Uncle Tom Cobley and all....

What if we had a Teletext and/or Viewdata installed in most households already, what about a small microprocessor unit possibly connected to the same unit? Apart from the usual household chores you could program the MPU to do it could record Open University programs from Teletext, enable you to swap software via Viewdata, you could communicate with computers and other microprocessors all over the world, you could even possibly design your own cartoons or news items for CEEFAX and transmit them to the BBC via Viewdata. Now that information is available on all these three I would like to hear from any readers who have built and used any of them, what comments have you got to make on Teletext or MPUs, what do you think of Viewdata, what problems have you had? Whether you are a manufacturer or user of MPUs or Teletext or even if you are just interested in them what are the average consumer applications going to be in a few years' time — make some predictions and let's see how right you are in a couple of years.

REFERENCES

1. MH9 — Bywood Electronics, 68 Ebberns Rd, Hemel Hempstead, HP3 9QRC.
2. Pulse Electronics, 202 Skefford Rd, Clifton, Shefford, Beds.
3. CPD-1, G.1.C.P.D., Berk House, Basing View, Basingstoke, Hants.
4. Mistral — Imtech Products Ltd, Imp House, Ashford Rd, Ashford, Middx.
5. MA1001 — Bywood or National Semiconductors (UK) Ltd, 19 Goldington Rd, Bedford.

tech-tips

CAR BATTERY WATCHDOG

In winter, motorist are apt to emerge from work to face the inconvenience and perhaps expense of a totally flat battery due to having left their head-lights switched on when parking.

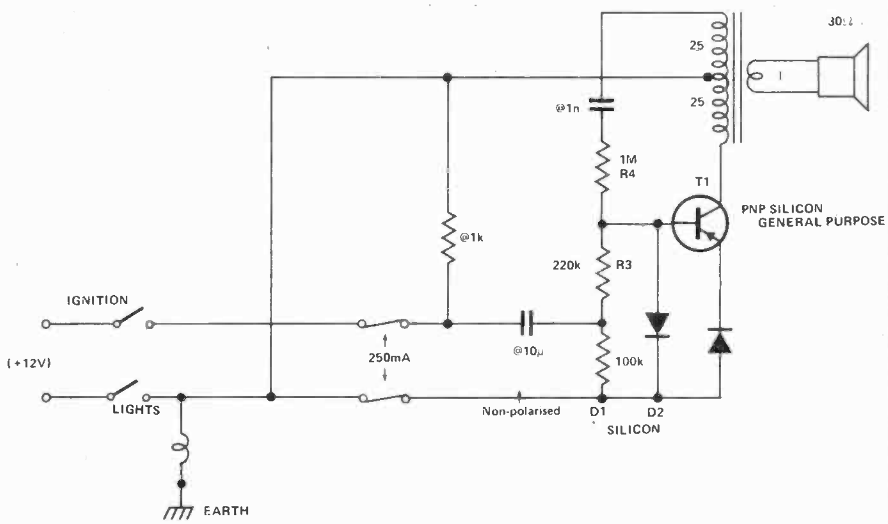
This circuit provides an audible warning if the ignition is switched off with the lights left on, in the form of a few seonds of output of varying pitch. No switches are required and standby current is very small.

The audio oscillator is normally biased off, but when the ignition switch is opened it is temporarily biased on the charging action of R1, R2, C1.

D1 in conjunction with R3, prevents damage to T1 due to spikes on the ignition line, etc. The fuses are an optional precaution against short circuits across ignition or lighting supplies.

The oscillator circuit will no doubt depend, as will the transduçer, on the contents of the experimenter's junk box. Basic requirements are that it should not be self-sustaining when the ignition switching transient in the base circuit has died away. The ratio R3/R4 was of course chosen to achieve this in the circuit shown, assisted by D2.

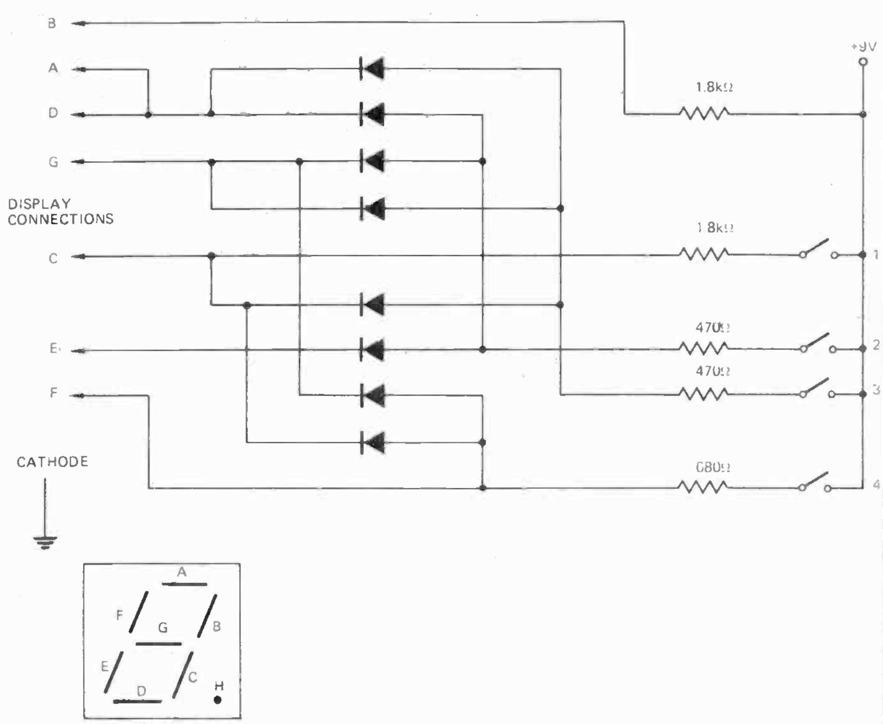
For negative earth operation T1 would of course be NPN and D1 and D2 would be reversed.



STATION INDICATOR FOR FM TUNERS

Modern FM equipment using varicap tuners generally have four stations pre-tuned and selected by push buttons in addition to a continuously variable control. Most users of such tuners would presumably have the pre-set pushbuttons set to BBC Radios 1,2,3,4. It is, then, quite a simple matter to utilise the unused switch positions which, more often than not, exist in the pushbuttons to set up a display of 1,2,3 pr 4 on a 7 segment LED using blocking diodes and limiting resistors as shown in the diagram. Any general purpose diode capable of carrying 5mA is suitable. A suitable display would be the inexpensive MAN3M which is quite large enough for such an application.

Some users may have a local radio station pre-tuned, this can be indicated with the character "L" using the F,E and D segments of the display. Other alpha characters that can be formed with a 7 segment display are A C E F H L O P S U Y b d g h.



THE 'MISTRAL' 1 DIGITAL CLOCK

★ COMPLETE KIT ★

- Pleasant green display · 12/24 Hour readout
- Silent Synchronous Accuracy · Fully electronic
- Pulsating colon · Push-button setting
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★ Fully Built, Tested and Guaranteed ★

WITH SLEEP-OVER FEATURE

- Soft Green Display
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- 10 Minute Repetition
- Alarm Set Indicator
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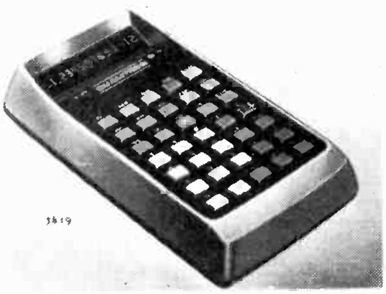
Henry's Radio, 231 Tottenham Ct. Rd., London W1; Henry's Radio, 404 Edgware Rd., London W2; Crofton Electronics Ltd., 124 Colne Rd., Twickenham, Middx.; Imtech Products Ltd., Imp House, Ashford Rd., Ashford, Middx.; Bywood Electronics, 68 Ebberns Rd., Hemel Hempstead, Herts.

1419 — ADVANCED



SPECIFICATION
- 14 digit LED display
- 10-digit mantissa with sign and 2-digit exponent with sign for data entry or results $(10^{-99} \sim 10^{99})$
- Automatic selection of correct notation for result display (scientific or floating point)
- Dome keyboard for excellent response and preventing double entry input

BASIC FUNCTION (+ — × ÷) AND MEMORY
- Algebraic mode operation
- Constant operations
- Repeat operations
- Chain operations
- Change sign operation
- Display and Y-register exchangeable
- One accumulating memory
- Display and memory exchangeable

SPECIAL FUNCTION
- Trigonometric functions (sin, cos tan)
- Inverse trigonometric functions ($\sin^{-1}$, $\cos^{-1}$, $\tan^{-1}$)
- Hyperbolic functions (sinh, cosh, tanh)
- Inverse-hyperbolic functions ($\sinh^{-1}$, $\cosh^{-1}$, $\tanh^{-1}$)
- Radian or degree selectable
- π constant
- Logarithms (ln, log)
- Anti-logarithms (e^x, 10^x)
- Power function (y^x)
- Reciprocal (1/x)
- Square root ($\sqrt{x}$)

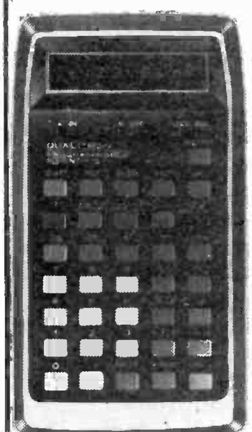
PRICE £25.89
P&P 75p + VAT £2.13

1420 — SENIOR

- 14-digit LED display
- 10 digit mantissa with sign and 2-digit exponent with sign for data entry or results $(10^{-99} \sim 10^{99})$
- Automatic selection of correct notation for result display (scientific or floating point)
- Dome keyboard for excellent response and preventing double entry input
- Algebraic mode operation
- Chain operations
- Change sign operation
- Three memories
- Display and memory exchangeable
- Trigonometric functions (sin cos, tan)
- Inverse-trigonometric functions ($\sin^{-1}$ $\cos^{-1}$ $\tan^{-1}$)
- Radian or degree selectable
- π constant
- Logarithms (ln, log)
- Anti-logarithms (e^x 10^x)
- Combinatorial functions ($n!$, $\binom{n}{k}$ $(n)_k$)
- Normal distribution function (Pr(x))
- Gamma function (Γ (x))
- Group operations (Σ± 0, X, |X|)
- Group controls (K↑ K↓, Σ↑ Σ↓ CL_{GRP})
- Power function (y^x)
- Reciprocal (1/x)
- Square root ($\sqrt{x}$)
- Square (x^2)
- Sum of squares (Σx^2)
- Summation (ΣX)
- Item count (n)
- Mean value (X)
- Mixed chain operations with parentheses approach (up to two levels)

PRICE £55.63
P&P 75p + VAT £4.51

1421 — PROGRAMMABLE



BESIDES HAVING THE CAPABILITY OF A SCIENTIFIC CALCULATOR
- 9-digit LED display
- 8 digits capacity for data entry or results $(10^{-8} \sim 10^{8})$
- Full floating point
- Automatic display blanking
- Three-register operational stack
- Change sign operation
- Reverse polish notation
- Display and Y-register exchangeable
- One accumulating memory (Memory store, Memory recall, M + x, M — x and M + X^2)
- Trigonometric functions (sin, cos, tan)
- Inverse-trigonometric functions ($\sin^{-1}$ $\cos^{-1}$ $\tan^{-1}$)
- Radians and degrees exchangeable
- π constant
- Logarithms (ln, log)
- Anti-logarithms (e^x)
- Power function (y^x)
- Reciprocal (1/x)
- Square root ($\sqrt{x}$)
- Square (X^2)

IT CAN LOAD ANY 102 STEPS PROGRAM TO HELP YOU SOLVE THE REPEATED ENORMOUS COMPLEX PROBLEMS

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tech-tips

SOUND OPERATED FLASH

The circuit shown enables near instantaneous synchronisation between sound and flash. The latching facility has been incorporated so that the flash is not retriggered.

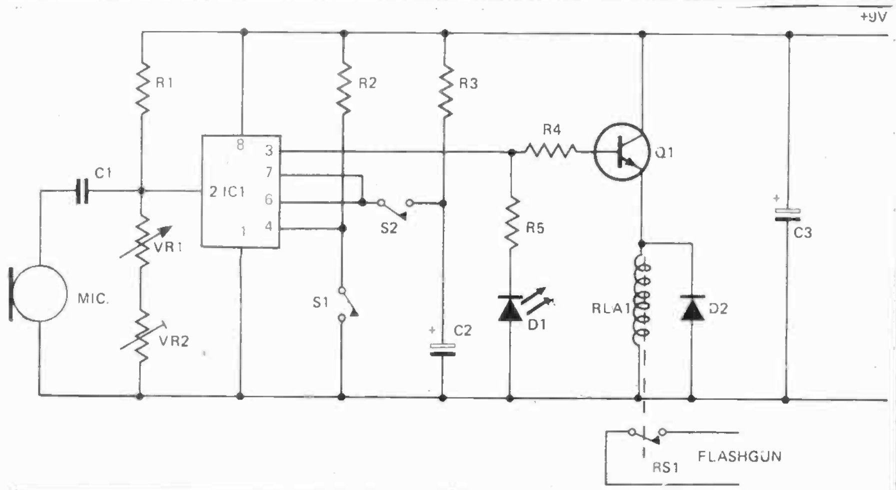
Resetting is by S1. With S2 closed, resetting occurs after a time after a time determined by 1.1xC2xR3. This approximately equals five seconds as shown.

D1 indicates triggering and is used when setting the sensitivity:- set VR1 to zero and increase VR2 until D1 just fails to light. A sharp snap of the fingers causes it to light. S2, R3 and C2 maybe omitted if not required.

The output from IC1 via R4 and Q1 activates the read relay, used for its simplicity and speed of action. The relay itself is connected across the flash sync leads.

The unit maybe battery powered e.g. PP3, as it consumes a mere 15mA or so.

The circuit has been built as the result of many modifications to other circuits. I find it an interesting toy and in its simplicity, should cost less than £2.



COMPONENTS *(see text)

Resistors			**Capacitors**	
R1	330kΩ		C1	10nF
R2	22kΩ		C2	4.7μF, 10V*
R3	1MΩ	* all ¼W, 10%	C3	100μF, 10V
R4	4k7Ω		**MISC.**	
R5	560Ω		mic	crystal mike insert
Potentiometers			S1	push to make switch
VR1	50kΩ	lin	S2	spst switch
VR2	250kΩ	preset	RLA1	reed relay coil
Semiconductors			RS1	normally open reed switch
IC1	NE555			
Q1	BC108			
D1	TIL209 LED			
D2	1N914			

OP AMP CHECKER

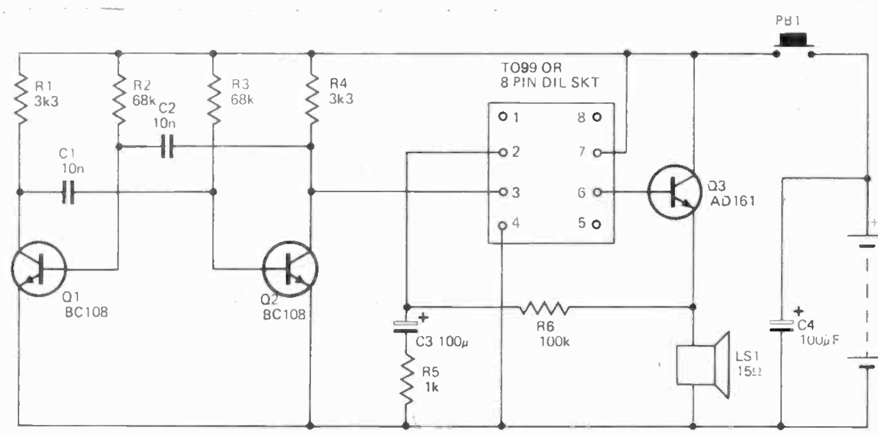
This circuit allows a quick and accurate GO/NO GO test to be made on 741 op-amps.

A1kHz square wave is generated by the astable multivibrator Q1 and Q2 and the associated components R1–R4 and C1–2. This is fed into pin pin 3 of a standard 8 pin DIL or TO99 IC socket.

Assuming a working IC has been inserted this signal will enter it's non-inverting input and appear amplified at the output, pin 6.

Q3, an inexpensive germanium power transistor is connected as a class A output stage whose load is a 15Ω speaker.

R5 and R6 form the feedback loop to the inverting input whilst C3



isolates this pin from ground.

The battery employed should be a large type and periodic checking of its voltage must be made since a 741 will not work below 6V.

On pushing the test button a good IC will produce a loud note from the speaker. A faulty one will produce little or no output and should be discarded.

IDENTIFYING SURPLUS IC's

In checking unmarked surplus IC's, a clue can be gained as to the identity of the IC if the ground pin can be located first. In epoxy encapsulated IC's, the truncated part of the lead frame can be seen at both ends, perhaps partially covered by moulding flash. This is generally connected to the substrate. In TTL and most linear IC's, this is the most negative pin (ground). In PMOS (clock and calculator chips) this is Vss, the most positive pin. An ohmmeter can find which pin is connected to the substrate by touching one probe to the frame and the other to each pin in turn.

Another clue to whether the IC is linear or digital is the fact that most digital IC's have diode protection against reverse bias at inputs. Knowing the ground pin, this can be checked rapidly.

tech-tips

Tech-Tips is an ideas forum and is not aimed at the beginner. We regret we cannot answer queries on these items.

ETI is prepared to consider circuits or ideas submitted by readers for this page. All items used will be paid for. Drawings should be as clear as possible and the text should preferably be typed. Circuits must not be subject to copyright. Items for consideration should be sent to ETI TECH-TIPS Electronics Today International, 36 Ebury Street, London SW1W 0LW.

STABILISED BENCH POWER SUPPLY

The heart of this voltage stabiliser is a 741 op amp which is used as a non-inverting amplifier

A novel feature is that the input reference voltage ZD1 is contained within the feedback loop of the amplifier. This produces an extremely stable output which can be varied merely by altering the values of R4 and R2.

An economical, high performance supply can be built using this circuit and the accompanying table.

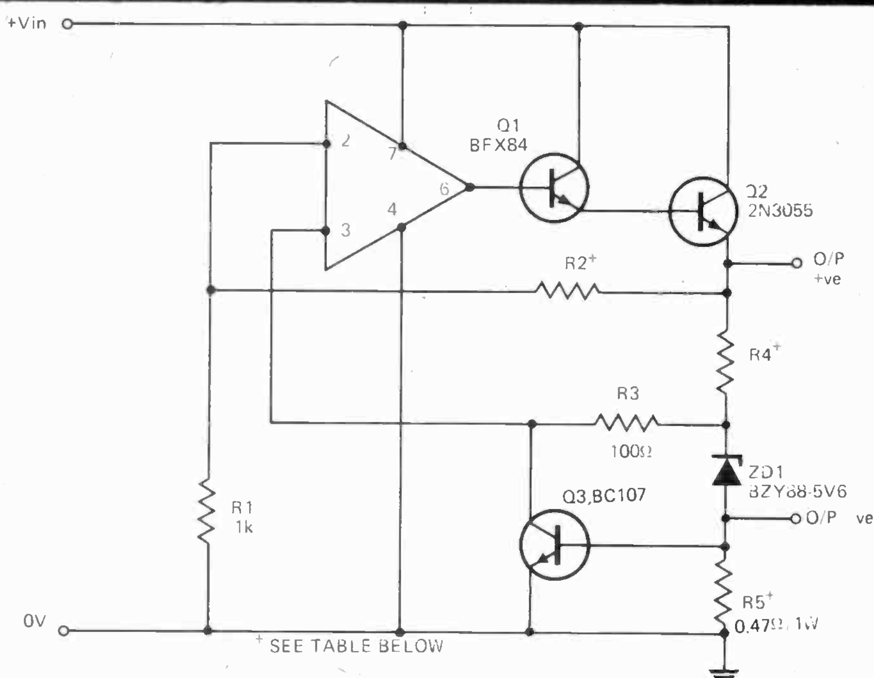
Briefly the supply works as follows. The reference voltage across ZD1 is directly coupled into the non-inverting input (pin 3) of the IC. After amplification the output from the IC is coupled into the power Darlington consisting of Q1 and Q2 connected in the emitter follower mode. This ensures that a low output impedance, less than 1Ω, is presented to the load.

R4 provides current for the zener diode from the stabilised output thus placing the reference voltage in the feedback loop. Overload protection is provided by Q3 and R5. When current exceeds a level determined by R5, Q3 turns hard on earthing pin 3 of the IC. This has the effect of turning it hard off.

The output voltage is defined by the ratio of R2 to R1. For simplicity R1 is kept constant and the value of R2, R4 and R5 can be obtained from the table to suit various output voltages and current limits.

Construction is not critical and as long as the usual precautions of keeping the output away from the input is observed no trouble should be experienced.

A point to watch however, is to fit Q2 to an adequate heatsink since it may be called upon to dissipate several watts.

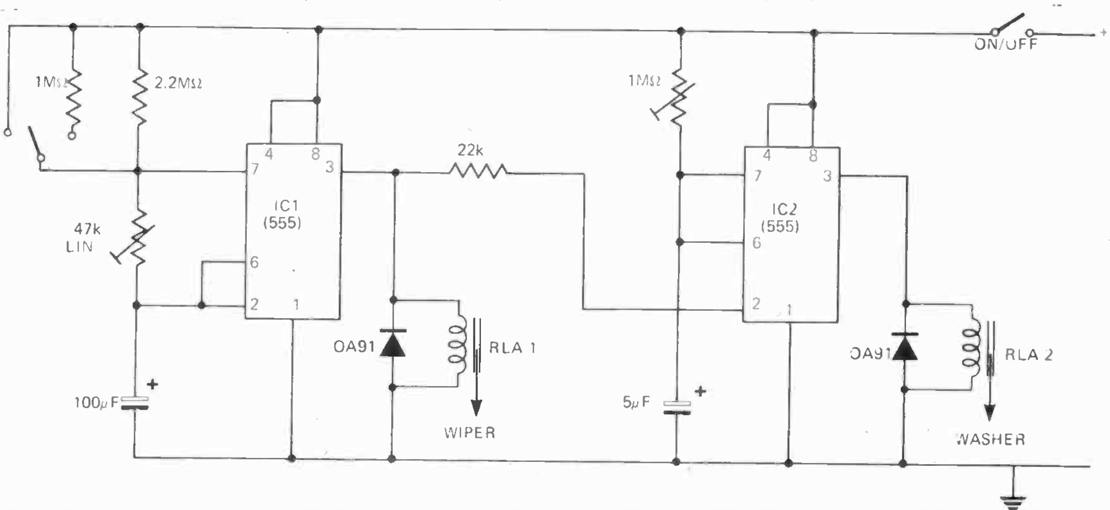


Vout	R2	R4	VIN
6V	68Ω	82Ω	
7.5V	330Ω	390Ω	12V
9V	620Ω	680Ω	DC
12V	1k2	1k2	20V
15V		1k8	DC
18V	2k2	2k2	30V
24V	3k3	3k9	DC

I LIMIT	R5
1.1A	0.47Ω
650mA	1Ω
325mA	2.2Ω
100mA	6.8Ω

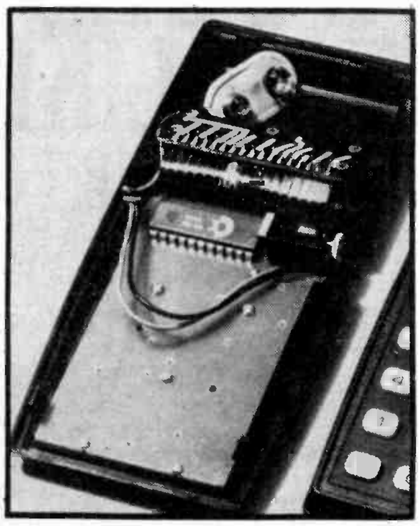
AUTOMATION FOR REAR WIPERS

Many estate cars are now fitted with rear washer/wiper sets without any sort of sutomation. This circuit provides an end-of-cycle stop, a delay of 1 minute, 4 minutes, or continuous operation, and, from RLA2, a measured squirt of water at the start of each cycle. The circuit has been slightly modified to use a standard auto 3-way toggle, on which the first pole has no connection. One of the many published spike suppression suppression circuits should be used to protect the IC's. The circuit uses no more switches than manual control and requires less concentration from the driver.



Continued from page 8

CHIP SHORTAGE



A new slant on the potato shortage from CBM. This is their new calculator IC, which contains ALL the circuiting for an 8-digit machine with memory including the digit drivers. This makes the case look somewhat deserted on the inside!

SURROUND SOUND OF CONCORDE

British Airways has fitted a distinctly different headphone 'stereo' entertainment to its supercraft. This is based on a 'dummy head' recording system which simulates a sound field much more accurately than conventional stereo. This was specially recorded for B. A. by Emison, and includes sone Concorde propaganda of course, by Michael Bentine Esq. The only trouble is that the stethoscope headphones in use do not have channels marked on them, and correct orientation is vital to the creation of a binaural field. So many people will completely miss the point of the whole show. Next time you're in Concorde take note.

BOXING CLEVER

Wembley Stadium have ordered the worlds biggest computerised box office accounting system. It will be used for events held in the Empire Pool, in the theatre of the newly-built Conference Centre and selected events in the main Wembly Stadium and the Squash Centre.

The system is based on a 64 kilbyte GEC 2050 computer. Two 4.8 + 4.8Mbyte fixed/exchangeable cartridge disc units for database storage and a thermal printer are included in the configuration. The value of the order is in excess of £100,000.

WANNA BUY A DIRTY CRYSTAL?

It seems that as demand for digital watches increases to ever greater heights, the supply for crystals are failing to keep pace. This has gotten to such a state that a black market is now thriving!

Companies are believed to be 'double ordering' to ensure their supplies thus worsening the situation still further. The black marketing, especially on low-grade quartz (what else?), is freely admitted by suppliers. However nobody knows exactly who is selling what to whom and when. Perhaps the CIA are in need of a crystal division.

NEW SPEAKER IN THE HOUSE

Ever been to Luton? A few of us brave men of the press gathered our courage about us to do so recently at the invitation of Acoustic Research, much as it seems that Luton is the last place to launch a new range of loudspeakers.

The whims of manufacturers wax strange indeed at times.

Acoustic Research are an offshoot of the American giant, although they have been left to themselves in developing this new range. Their latest brood is designated "Advanced Development Division", and is based on the AR 10π and AR 11 speakers.

The major innovation incorporated in these speakers is a magnetic fluid, employed as a filler in the gap between coil and magnet assembly. Claimed advantages are greatly increased heat dissipation, and a self-centering effect generated on the coil.
A very high local magnetic field is generated around the coil by the technique, which is said to improve linearity of the motor system. Because of the fluid, the inner suspension, or spider, can be dispensed with, without imparing the cone behaviour under drive. The new midrange unit used in some of the ADD speakers takes advantage of this.

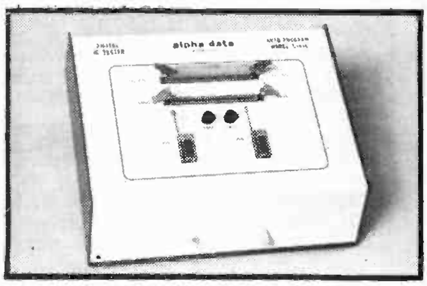
ADD price list		PRICE inc VAT
AR-10π	per pair	432.50
AR-11	" "	302.50
AR-12	" "	270.00
AR-14	" "	210.00
AR-16	" "	132.50
AR-7X	" "	81.25

Due to the increased heat dissipation the new models show an improved power handling capability over their ancestors. They also deliver a better transient response and the smaller models offer very good value for money.

With Hi-Fi 76 now looming ever larger on the horizon, why did not AR release the range there where it could be judged directly against its peers? Another nail in the exhibition worlds coffin.

AUTO IC TESTER

The Alpha C1416 can test up to 500 devices per hour and is desgined to test virtually all types of digital CMOS, TTL and DTL circuits. Insertion of a standard IC into the comparison socket accomplishes internal self programming, thus obviating the usual need for manual programming by skilled technicians.



Plug in cards provide +5V power and ground to the appropriate device pins. The remaining pins are driven HI or LO from individual test circuits incorporating specially designed current limiters. Should the driver be applied to a device "output" the output state will be unaffected because of the current limiter.

In a 14 pin IC 12 drivers are connected to the 12 logic lines of the device and 12^{12} logic states are successively applied to both the comparison device and the unit under test. Test time required is approximately 1 second, and green and red lights indicate pass or fail for the IC. Details from Telonic Altair U.K. 2 Castle Hill Terrace, Maidenhead, Berks SL6 4JR.

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0.25μF	33	16	67p
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2.0μF	50.8	25.4	£1.44

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6.8μF	£1.96	£1.38	£1.13
10μF	£2.40	£1.95	£1.64
15μF	£3.22	£2.79	£2.24
22μF	£4.28	£3.68	£3.08

*TANTALUM BEAD CAPACITORS — Values available: 0.1, 0.22, 0.47, 1.0, 2.2, 4.8, 6.1μF at 15V/25V or 35V; 10μF at 16V/20V or 25V; 22.0μF at 6V or 16V; 33.0μF at 6V or 10V; 47.0μF at 3V or 6V; 100.0μF at 3V. ALL at 10p each, 10 for 95p, 50 for £4.

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AF178	30p	BD131/132	39p	*2N2926Y	11p
AF239	38p	BF115/167	22p	2N3054	65p
BC107/8/9	9p	BF173	24p	2N3055	50p
*BC114	12p	BF178	26p	2N3702/3704	11p
*BC147/8/9	10p	BF184	22p		
*BC153/154	12p	*BF194/195*	12p	*TIP30A	52p
*BC157/8/9	12p	*BF196/197*	12p	TIP31A	55p
BC177	18p	BF200	27p	TIP32A	64p
*BC182/183L	11p	*BF262/263*	60p	TIP3055	55p
*BC183/183L	11p	BFY50/51/52	20p	*MPU131	49p
*BC184/184L	12p	BFX84/86/88	20p	NE555	61p
*BC212/212L	14p	BFX85	26p	741C	32p
*BC213/213L	11p	BR101	41p	ZN414	£1.15
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BC169C	12p
BC177/8/9	17p
BC182/3/4/L	11p
BC186/7	30p
BC212/3/4L	12p
BCY70/71/72	13p
BF194/5	12p
BF196/7	14p
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We cannot solve the problems faced by individual readers building our projects unless they are concerning interpretation of our articles. When we know of any error we print a correction as soon as possible at the end of News Digest. Any useful addenda to a project will be similarly dealt with. We cannot advise readers on modifications to our projects.

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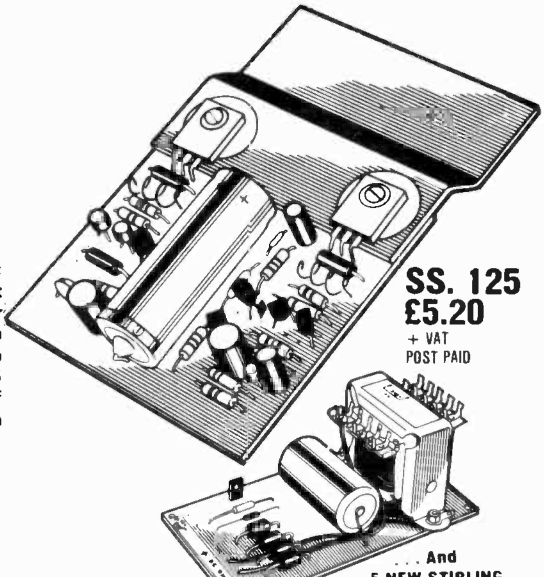

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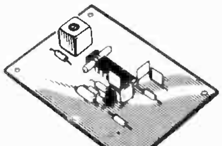

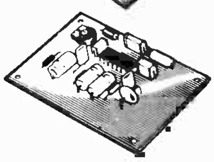

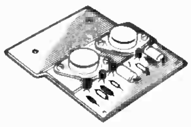

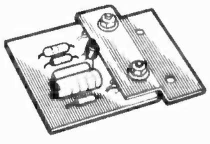

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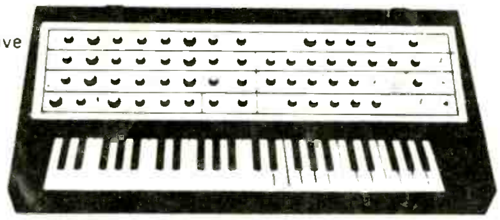

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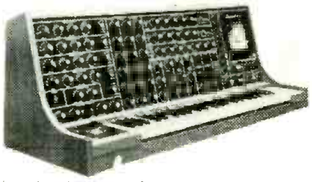

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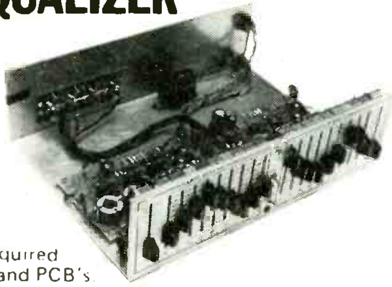

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