morgan

JUNE 82

ISSN 0262–2572

RADIO & ELECTRONICS WORLD

AUSTRALIA	$1 85c
CANADA	$2 95c
EIRE	£1-04p
NEW ZEALAND	$2 20c

75p

ZX81 Keyboard and Eprom programmer
2 Channel Mains Timer
Selective Calling

ICOM's New IC4 Hand-Held
DR600 Airband Monitor
A DC controlled Audio Preamplifier

TA2080
COST EFFECTIVE LOGIC ANALYSIS AT £1950

FEATURES

- Full system information always shown in display.
- 8 bit data memory, 252 bytes deep
- 8 bit reference memory, 252 bytes deep
- 23 bit triggering (8 data bits, 15 trigger bits)
- Sampling rates DC to 20MHz; synchronous or asynchronous clocking
- 15ns glitch capture in latch mode
- Powerful compound trigger delay by event and/or clock
- Selectable trigger position; variable trigger filter
- Clock qualifier and arm facilities
- Timing display shows all 252 bytes of the 8 data channels in timing diagram format with x2, x4, x8 expansions available
- State display shows 24 sequential bytes in either binary plus ASCII or hex plus octal plus ASCII
- Automatic or manual compare between recording and reference memories for equality or inequality.
- All inputs high impedance with variable threshold

The TA2080 is a portable 20MHz, 8 channel logic analyser offering comprehensive triggering, recording and display capabilities at an affordable price.

The TA2080 is controlled by a Z80 microprocessor linked to an interactive keyboard. Full system status is shown at all times in the top lines of the 5-inch CRT and simplicity of operation is achieved by display prompting.

Recording memory depth is 252 bytes and a reference memory of equal size is provided which can be loaded directly from the recording memory or from the keyboard.

Data can be displayed either in timing diagram format, with cursor, window and expansion facilities, or in state format which has cursor, reference memory compare, and word search features.

A feature of the TA2080 is its extensive triggering capabilities. In addition to a 23 bit trigger recognition facility it features a powerful compound trigger delay by trigger event and/or clocks, a selectable trigger position, a variable trigger filter, and an arm input.

All 24 inputs, grouped in 2 pods of 12, are via custom hybrid circuits which have a wide input range, adjustable logic thresholds and a high impedance to minimise circuit loading.

Pod and connector design, like the main instrument itself, is both ergonomic and robust and should satisfy all normal interface requirements with the circuit under test.

thandar

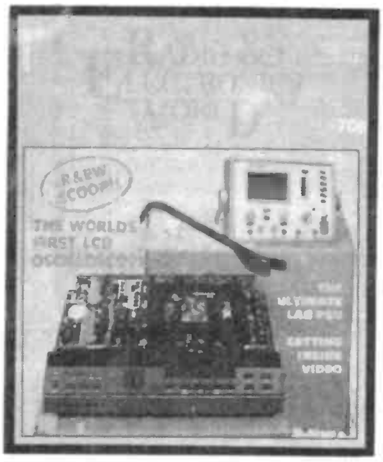
Thandar Electronics Ltd.,
Electronic Test & Measurement
London Road, St. Ives, Huntingdon, Cambs PE17 4HJ.
Tel: St. Ives (0480) 64646.

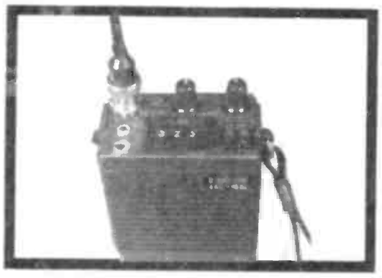
R&EW

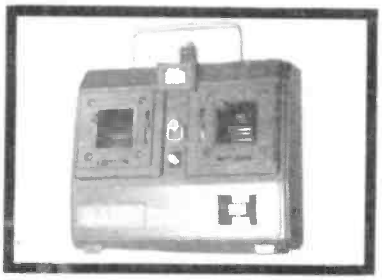
Contents

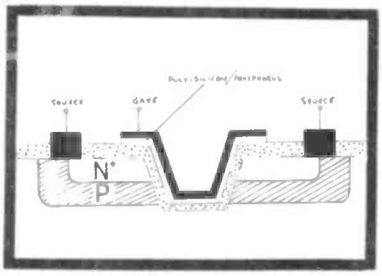
JUNE 1982

Volume 1 No. 9









We regret that as from this issue we have had to increase the price of R&EW to 75p. This makes a subscription even better value for money — see the order form on page 45.

NICADS : UK's LOWEST PRICES

AMBIT'S NEW CONCISE COMPONENT CATALOGUE IS OUT NOW

Available at your newsagent or direct, for 70p inc.

Ambit's new style catalogue continues to lead the market with low prices, new items, info, 3 £1 discount vouchers. In a recent supplier survey, we were one of only two suppliers listed in all categories!

There's a few examples of some super low prices.

78XX 1A	37p
BC237/8/9	8p
3SK51	54p
10MHz xtals	£2
8 Pole 10.7MHz xtal filters	£14.50
2GHz coax relay 150W	£10.95

All the "usual" stuff at rock bottom prices + Toko coils, crystal and ceramic filters, micro-metals toroids, Fairite ferrites, Alps switches, OKI LSI, Piezo sounders, RF, IF Modules + Kits etc.

RECHARGEABLE UP TO 400 TIMES PER CELL!

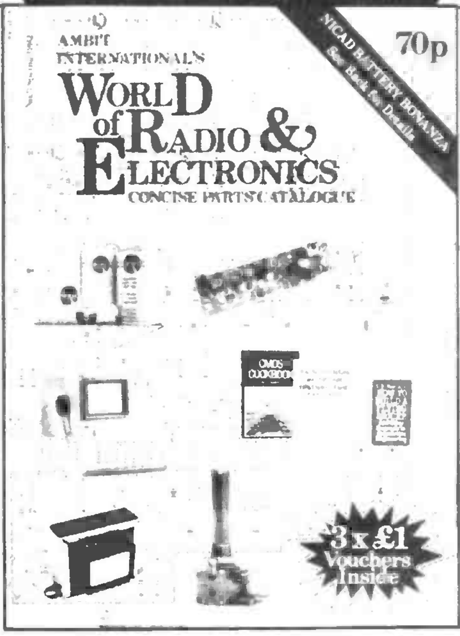
CAPACITY	TYPE	1-9	10-49
500 mAh	AA	80	74
2200 mAh	C	2.35	1.99
1200 mAh	D	2.14	2.06
4000 mAh	D	3.05	2.85
110 mAh	PP3	3.70	3.50

Price on the page

CMOS	
4000	0.11
4001	0.11
4002	0.12
4007	0.13
4008	0.50
4008AE	0.80
4009	0.25
4010	0.30
4011AE	0.24
4011	0.11
4013	0.25
4015	0.50
4016	0.22
4017	0.40
4019	0.38
4020	0.55
4021	0.55
4022	0.55
4023	0.15
4024	0.33
4025	0.15
4026	1.05
4027	0.26
4028	0.50
4029	0.55
4030	0.35
4035	0.67
4040	0.50
4042	0.50
4043	0.50
4043AE	0.93
4044	0.60
4046	0.60
4047	0.68
4049	0.24
4050	0.24
4051	0.55
4052	0.55
4053	0.55
4054	1.30
4055	1.30
4056	1.30
4059	5.75
4060	0.75
4063	1.15
4066	0.30
4067	4.30
4068	0.16
4069AE	0.14
4070	0.16
4071	0.16
4072	0.16
4073	0.16
4075	0.16
4076	0.55
4077	0.18
4078	0.18
4081	0.12
4082	0.18
4093	0.30
4099	0.80
4175	0.80
4502	0.60
4503	0.50
4506	0.70
4507	0.37
4508	1.50
4510	0.55
4511	0.45
4512	0.55

4514	1.25
4515	1.25
4516	0.60
4518	0.35
4520	0.60
4521	1.30
4522	0.89
4527	0.80
4528	0.65
4529	0.70
4531	0.65
4532	0.80
4534	4.00
4536	2.50
4538	0.85
4539	0.80
4543	0.80
4549	3.50
4553	2.70
4554	1.20
4555	0.35
4556	0.40
4557	2.30
4558	0.80
4559	3.50
4560	2.50
4561	1.00
4562	2.50
4566	1.20
4568	1.45
4569	1.70
4572	0.22
4580	3.25
4581	1.40
4582	0.70
4583	0.80
4584	0.27
4585	0.45
4702	4.50
4703	4.48
4704	4.24
4705	4.24
4706	4.50
4720	4.00
4723	0.95
4724	0.95
4725	2.24
40014	0.54
40085	0.99
40098	0.54
40106	0.69
40160	1.05
40161	1.05
40162	1.05
40163	1.05
40174	1.05
40175	1.05
40192	1.08
40193	1.08
40194	1.08
40195	1.08

TTL	N
7400N	0.10
7401N	0.10
7402N	0.20
7403N	0.11
7404N	0.12
7405N	0.12
7406N	0.22
7407N	0.22
7408N	0.15
7409N	0.15
7410N	0.12
7411N	0.18
7412N	0.19
7413N	0.27
7414N	0.51
7416N	0.27
7417N	0.27
7420N	0.13
7421N	0.28
7423N	0.22
7425N	0.22
7426N	0.22
7427N	0.22
7430N	0.13
7432N	0.23
7437N	0.22
7438N	0.22
7440N	0.14
7441N	0.54
7442N	0.42
7443N	0.62
7444N	0.62
7445N	0.62
7446N	0.62
7447N	0.62
7448N	0.56
7450	0.14
7451N	0.14
7453N	0.14
7454N	0.14
7460N	0.14
7470N	0.28
7472N	0.27
7473N	0.28
7474N	0.28
7475N	0.35
7476N	0.30
7480N	0.26
7481N	0.20
7482N	0.75
7485N	0.35
7486N	0.24
7489N	1.05
7490N	0.30
7491N	0.55
7492N	0.35
7493N	0.35
7494N	0.70
7495N	0.60
7496N	0.45
7497N	1.40
74100	1.10
74104	0.62
74105	0.62
74107	0.26
74109N	0.35
74110N	0.54
74111N	0.68
74112N	1.70
74116N	1.98
74118N	0.85
74119N	1.20
74120N	0.95
74121N	0.34
74122N	0.34
74123N	0.40



Prices shown EXCLUDE VAT. Access/Barclaycard may be used with written or telephone orders, official MA details on application. E & EO.

POSTAGE and PACKING 50p per order

74125N	0.40
74126N	0.40
74128N	0.65
74132N	0.50
74136N	0.65
74141N	0.45
74142N	1.85
74143N	2.50
74144N	2.50
74145N	0.75
74147N	1.50
74148N	1.09
74150N	0.79
74151N	0.55
74153N	0.55
74154N	0.55
74155N	0.55
74156N	0.55
74157N	0.55
74159N	1.90
74160N	0.55
74161N	0.55
74162N	0.55
74163N	0.55
74164N	0.55
74165N	0.55
74166N	0.70
74167N	1.25
74170N	1.25
74173N	1.10
74174N	0.75
74175N	0.75
74176N	0.75
74177N	0.75
74178N	0.90
74179N	1.35
74180N	0.75
74181N	1.22
74182N	0.70
74184N	1.20
74185N	1.20
74188N	3.00
74190N	0.56
74191N	0.55
74192N	0.55
74193N	0.55
74194N	0.55
74195N	0.55
74196N	0.55
74197N	0.55
74198N	0.85
74199N	1.00
74221N	1.00
74246N	1.50
74247N	1.51
74248N	1.89
74249N	0.11
74251N	1.05
74265N	0.66
74273N	2.67
74278N	2.49
74279N	0.89
74283N	1.30
74284N	3.50
74285N	3.50
74290N	1.00
74293N	1.05
74297N	2.36
74298N	1.85
74365N	0.85
74366N	0.85
74367N	0.85
74368N	0.85
74390N	1.85
74393N	1.85
74490N	1.85

74LSN	
74LS00N	0.10
74LS01N	0.10
74LS02N	0.11
74LS03N	0.11
74LS04N	0.14
74LS05N	0.13
74LS08N	0.12
74LS09N	0.12
74LS10N	0.12
74LS11N	0.12
74LS12N	0.12
74LS13N	0.20
74LS14N	0.30
74LS15N	0.12
74LS20N	0.12
74LS21N	0.12
74LS22N	0.12
74LS26N	0.14
74LS27N	0.12
74LS28N	0.15
74LS30N	0.12
74LS32N	0.12
74LS33N	0.15
74LS37N	0.15
74LS38N	0.14
74LS40N	0.13
74LS42N	0.30
74LS47N	0.35
74LS48N	0.45
74LS49N	0.55
74LS51N	0.13
74LS54N	0.14
74LS55N	0.14
74LS73N	0.21
74LS74N	0.16
74LS75N	0.22
74LS76N	0.20
74LS78N	0.19
74LS83N	0.40
74LS85N	0.60
74LS86N	0.14
74LS90N	0.32
74LS91N	0.28
74LS92N	0.31
74LS93N	0.31
74LS95N	0.40
74LS96N	1.20
74LS107N	0.25
74LS109N	0.20
74LS112N	0.20
74SL113N	0.20
74LS114N	0.19
74LS122N	0.35
74LS123N	0.35
74LS124N	1.80
74LS125N	0.24
74LS126N	0.24
74LS132N	0.42
74LS133N	0.24
74LS136N	0.20
74LS138N	0.30
74LS139N	0.30
74LS145N	1.20
74LS151N	0.30
74LS153N	0.27
74LS154N	0.99
74LS155N	0.35
74LS156N	0.37
74LS157N	0.30
74LS158N	0.30
74LS160N	0.37
74LS161N	0.37
74LS162N	0.37
74LS163N	0.37
74LS164N	0.40
74LS165N	0.60
74LS166N	0.80
74LS168N	0.70
74LS169N	0.85
74LS170N	0.90
74LS173N	0.60
74LS174N	0.40
74LS175N	0.40
74LS181N	1.05
74LS183N	1.75
74LS189N	1.28
74LS190N	0.45
74LS191N	0.45
74LS192N	0.45
74LS193N	0.42
74LS194N	0.35
74LS196N	0.55
74LS197N	0.60
74LS200N	3.40
74LS202N	3.45
74LS221N	0.50
74LS240N	0.80
74LS241N	0.80
74LS242N	0.70
74LS243N	0.70
74LS244N	0.60
74LS245N	0.80
74LS247N	1.35
74LS248N	1.35
74LS249N	1.35
74LS251N	0.35
74LS253N	0.35
74LS257N	0.40
74LS258N	0.37
74LS259N	0.60
74LS260N	0.50
74LS266N	0.22
74LS273N	0.70
74LS275N	3.20
74LS279N	0.35
74LS280N	2.50
74LS283N	0.42
74LS290N	0.50
74LS293N	0.40
74LS295N	1.50
74LS298N	0.76
74LS365N	0.32
74LS366N	0.34
74LS367N	0.32
74LS368N	0.35
74LS373N	0.70
74LS374N	0.70
74LS375N	0.40
74LS377N	0.85
74LS378N	0.65
74LS379N	0.60
74LS384N	2.50
74LS385N	2.05
74LS386N	0.29
74LS390N	0.68
74LS393N	0.61
74LS395N	2.10
74LS396N	1.99
74LS398N	2.75
74LS399N	2.30
74LS445N	1.40
74LS447N	1.95
74LS490N	1.10
74LS668N	1.05
74LS669N	1.05
74LS670N	1.70

RAM	
2102	1.70
2112	3.40
2114/2	1.49
4027	5.78
4116/2	1.59
4116/3	1.49
4864P	12.50
6116P-3	9.00
6116P-4	11.25
8264	12.50

74CXX	
74C00	0.35
74C02	0.35
74C04	0.35
74C08	0.35
74C10	0.35
74C14	0.75
74C20	0.35
74C30	0.35
74C32	0.35
74C42	1.05
74C48	1.50
74C73	0.75
74C74	0.75
74C76	1.05
74C83	1.05
74C85	1.25
74C86	0.60
74C89	2.10
74C90	1.05
74C93	1.05
74C95	1.25
74C107	0.60
74C151	2.10
74C154	3.05
74C157	2.10
74C160	1.05
74C161	1.05
74C162	1.05
74C163	1.05
74C164	1.05
74C165	1.10
74C173	1.05
74C174	1.05
74C175	1.05
74C192	1.08
74C193	1.08
74C195	1.08
74C200	6.50
74C221	1.55
74C901	0.55
74C903	0.55
74C904	0.55
74C905	6.50
74C906	0.55
74C907	0.55
74C908	1.10
74C909	2.10
74C910	5.00
74C914	1.10
74C918	1.30
74C925	6.00
74C926	6.00
74C927	6.00

Processors

8080 Series	
8080AFC/2	7.30
8212	2.30
8214	3.50
8216	1.95
8224	3.50
8251	6.21
8255	5.40

Z80 Series	
Z80A	3.75
Z80ADRT	7.50
Z80APIO	3.50
Z80ASIO/1	11.00
Z80ASIO/2	11.00
Z80ASIO/9	9.95
Z80CTC	4.00
Z80ACTC	4.50
Z8001	65.00

PROM	
2708	2.00
2716	3.00
2532	OA
2732	4.00

AMBIT international

TELEPHONE (STD 0277) 230909 TELEX 995194 AMBIT G POSTCODE CM14 4SG

200 North Service Road, Brentwood, Essex

West London Retail Shop at 102. CHURCHFIELD ROAD, ACTON. W3 6DH Tel: 01-992-7748

G4JDT
HARVEY

EAST LONDON HAM STORE

G8NKV
DAVE

H. LEXTON LIMITED

191 FRANCIS ROAD LEYTON E.10
TEL 01-558 0854 TELEX 8953609 LEXTON G

RADIO & ELECTRONIC ENGINEERS — ENGINEERS ALWAYS AVAILABLE ON THE PREMISES

MAIN (UK) SERVICE CONTRACTOR TO HITACHI SALES (UK) LTD

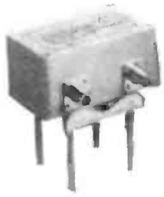
DRESSLER AMPLIFIERS

EXCLUSIVE TO US

D to A.T.V.		TBA
D70c 70cm		£499.00
D200C	*150FM 300W SSB	£300.00
D200	*300FM 600W SSB	£499.00
D200S	*500FM 1kW	£600.00

These are high power 240V linears using 4C x 150 or 4C x 250 or 4C x 350 Eimac Tubes NOT using the grounded Grid system.
Fully protected, no thermal damage to PA finals possible.

GASFET MASTHEAD PREAMPS



VV70GAAS	£75.00
VV2GAAS	£40.00
VV200GAS	£69.00
VV200GAS	£75.00

Powered by the linear or with separate ST200
.9dB signal to noise
.2dB insertion loss
3SK97 GASFET

ICOM
HF TRANSCEIVERS

IC730 200W	£586.00
IC2KL 500W linear	£839.00
IC2KLPS Power Supply	£211.00
IC AT100 100W auto A.T.U.	£249.00
IC AT500 500W auto A.T.U.	£299.00

ICOM
ACCESSORIES

BP5 IIV Pack	£30.15
BP4 Empty case for 6XAA	£5.80
BP3 STO Pack	£15.50
BP2 6V Pack	£22.00
DC1 12V adaptor	£8.40
WM9 Mic speaker	£12.00
CP1 Mobile Charging load	£3.20
LC1/2/3 cases	£3.50
BC30 base charger	£39.00
MMLI 10W Booster	49.00

TRIO/KENWOOD

TS930S	POA
TS830S HF Transceiver	£680.00
TS130S HF Transceiver	£530.00
TR8400 UHF mobile	£320.00
TR9500 UHF Multimode	£440.00
TR7800 VHF mobile	£268.00
TR7850 HP FM 2m	£295.00
TR7730 2m FM	£230.00
TR9000	£370.00

Many Trio/Kenwood accessories available

YAESU

SPECIAL OFFERS

FT1	£1295.00
FT902 DM	POA
FT101Z	POA
FT101ZDFM	POA
FT101ZDAM	POA
FT707 200W PEP	POA
FP707 PSU	POA
FC707 ATU	POA
FV707 DM VFO	POA

FT707 + FP707 + FC707
SPECIAL PRICE POA

FT277ZD Soco all extras inc	POA
FT7670X	POA
FT902DM Sommerkamp	POA
FC902 ATU	POA
FV901 DM VFO	POA
SP901 speaker	POA
YO901P Scope	POA
FTV901 Transvertor	POA
FT208 VHF	POA
FT708 UHF	POA
FT290 Multimode	POA

ALL ACCESSORIES AVAILABLE

MICROWAVE MODULES

MMA 144V 2m Preamp	£34.90
MML 144/25 RF AMP	£59.00
MML 144/40	£77.00
MML 144/100S New with Preamp	£129.95
MMT 432/144 2-70 Transverter	£184.00
MMT 28/144 10m Transverter	£99.00
MM 81 Morse Talker	£115.00

MM 4000 RTTY
SEE IT WORKING AT OUR SHOP
£299.00 inc. keyboard
Full range stocked

STANDARD

CPB 58	£79.50
CPB 78	£67.50
C78 70cm Portable	£219.00
C58 2mtr. Port ssb/FM	£239.00
CMB8 Mounting tray	£19.95
CL8 Carry case	£6.95
Battery charger	7.95
Set Nicads	11.00

ROTATORS ETC

DIAWA	
DR7600X	£135.00
DR7600R	144.00
DR7500R	£105.00
KENPRO	
KR250	£44.00
KR400	£90.00
HAM IV	£189.00
CHANNEL MASTER 9502	£50.00
CN620 1.8–150MHz Pwr/swr	£52.00
CN2002 2.5kW PEP auto ATU	£190.00

DATONG

PCI G/C converter HF on 2mtr	£120.75
VLF very low frequency converter	£25.30
FL1 frequency agile audio filter	£67.85
FL2 multimode audio filter	£89.70
ASP/B auto RF speech processor (Trio)	£79.35
ASP/A auto RF speech processor (Yaesu)	£79.35
D75 manually controlled RF Sp/Processor	£56.35
RFC/M RF speech clipper module	£26.45
D70 Morse tutor	£49.45
AD270 indoor active antenna	£37.95
AD370 outdoor active antenna	£51.75
MPU1 PSU for above	£6.90

CUSHCRAFT ANTENNA

HF. A3 20/15/10 3 ele beam 8bD £170.00
AV3 20.15.10 Trapped vertical £39.95
AV5 10.15.20.40.80. Trapped vertical £84.95
214B 14 ele boomer 05.2dB £59.95
ARX 2B Ring Ranger 6dB vertical £32.00
CS100 Speaker £13.50
A144.44 ele Yagi £18.25
A144.77 ele Yagi £23.00
A144.11 11 ele Yagi £29.95
ARX2K Conversion Kit RINGO MkI to Ringo MkII £14.18
144–10T x YAGI £38.95
144–20T x YAGI £55.00
147–20T
144 - 146 x YAGI £55.00

RECEIVERS ALL ON SPECIAL OFFER –

R600	Trio/Kenwood
R1000	Trio/Kenwood
FRG7	Yaesu
FRG7700	Yaesu
FRG7700	Memory
FRT7700	Tuner
FRV7700	A/B/C/D/E Convertors

POA
PHONE
HOT LINE
01-556 1415

TC2001 inc. M/Adaptor £148.00
SEARCH II £55.00

ICOM PORTABLES

IC2E FM 2m	£159.00
IC202 SSB	£169.00
IC402 70cm	£242.00
IC4E FM 70cm	£199.00

All accessories available — see below

ICOM MULTIMODES

IC251 2m	£495.00
IC451 70cm	
IC290 2m	£366.00

ICOM FM MOBILES

IC24G	£165.00
IC25E	£259.00

ICOM 720A G/C

IC720A 200W	£883.00
PS15 Power Supply	£99.00
PS20P/S with speaker	£130.00
IC730 See panel, below left	

ALL ACCESSORIES AVAILABLE – PLUGS SKTS CO-AX 2MTR COLINEAR £31.50, 70CM COLINEAR £31.50

Access

PRICES INCLUDE VAT AT THE PRESENT RATE OF 15%
OPEN MON–FRIDAY 9:00–5.30. SATURDAY 10:00–3:00. INSTANT HP FACILITY AVAILABLE
EASY ACCESS M2–M11–M1 NORTH CIRCULAR ROAD–EASY PARKING

BARCLAYCARD
VISA

167 for further details

Editorial Offices
117a High Street, Brentwood,
Essex CM14 4SG

Editorial (0277) 213819
Managing Editor
William Poel
Assistant Editor
Gary Evans
Communications Editor
Graham Leighton
Computing Editor
Jonathan C Burchell
Projects Editor
Roger Ray
Editorial Secretary
Kim Mitchell

Production (0277) 213819
Production Editor
Jack Burrows
Art/Production Manager
Patrick Haylock
Art Editor
Sally Bennett
Layout
Helen White
Martin Sheehan

Advertising 01-531 7621
Advertisement Manager
Bob Kennedy
Hillcroft House, 16 The Avenue,
Highams Park, London E4 9LD

Subscription 01-868 4854
Subscription Manager
Owen Rundle
45 Yeading Avenue, Rayners Lane,
Harrow, Middx HA2 9RL

Printers
LSG Printers, Lincoln

Photosetting by
Delafield Reprographic Service
481 Ongar Road,
Brentwood, Essex CM15 9JG

Distributors 01-274 8611
SM Distribution Ltd

Overseas Agents 071-144988
Holland Electronics
Postbus 377, 2300 A J LEIDEN

INFORMATION

Classified: 01-868 4854

Back Issues: 95p each inclusive of postage from Subscription Dept, or send reply paid card with cheque or PO.

Technical Enquiries: SAE to editorial office.
Telephone enquiries 2.00-5.30pm
THURSDAYS ONLY (0277) 213819.

Publishers Broadercasting Limited

Comment

FOLLOWING ON FROM last month's mention of the additional staff we have acquired to cope with the side effects of *R&EW*, it has been suggested that we might use **R&EW** as a medium for recruitment advertisements. But in view of the reaction we received to our own advertisement for additional staff, we are wondering if perhaps we might 'boldly go' where no magazine has hitherto gone, and suggest that persons seeking employment (or a change thereof) might like to submit brief details of themselves for inclusion in a recruitment section.

We are aware that there are many keen and eager persons (the sort that read **R&EW**) seeking a more interesting position, but without the necessary contacts to make the necessary moves. So, if you feel you would like to offer your enthusiasm and drive for the benefit of the sort of enterprising employer who might read **R&EW**, then send us an SAE for a 'For Hire' form, and leave the rest to us. We will obviously keep this service in strict confidence, and will only publish details of persons in a strictly standard format: Age, Area, Qualifications, Experience, Salary Requirements, 'ideal' job requirements. Potential employers will be advised to job seekers via our reader response system, and we would ask all job seekers to respond courteously in reply. There's no danger of your current employer being told that you're playing the market!

Get it together

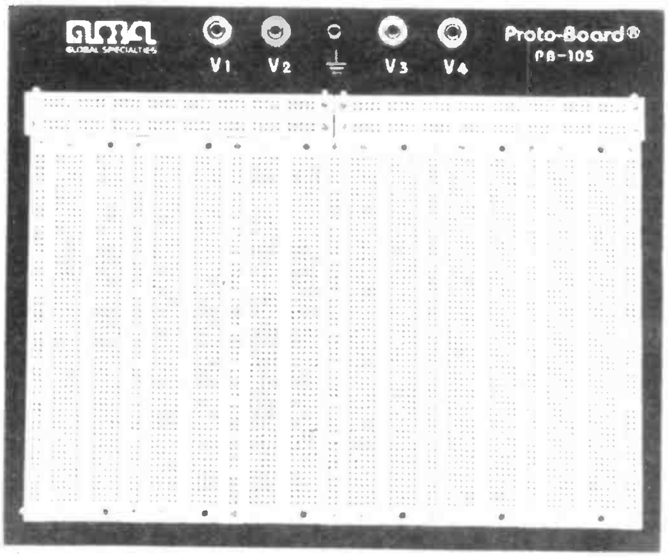
R&EW binders are at last available — but judging by the rate at which they are disappearing at exhibitions and over the 'counter', we are going to need to re-order soon. One warning though, it may be difficult to get 12 issues inside, and we may be obliged to add to our list of innovations by producing a metric volume of 10 issues.

Recovery time

The last issue of **R&EW** fell victim to the dreaded Singapore 'flu'. As followers of this magazine will already know, we operate to a very tight schedule, and the loss of more than half the staff for half the month of February inevitably confounded our attempts to produce all the proposed features. In an attempt to recoup the lost 'lead' on production, we have been forced to drop back to 96 pages for the next few issues. We hope to enter the autumn period with enough material in hand to combat the ravages of the next epidemic season.

Columbia for a copy

Following the problems of the latest space shuttle flight, we are placing NASA on the **R&EW** mailing list to ensure that they have access to the best ideas in communications technology. A pair of IC4 s might be handy next time.



Bread and Board

New from GSC, the 'Superboard' PB-105 is a large-area solderless breadboard which is ideally suited to microprocessor-based projects and other applications involving large numbers of integrated circuit packages. Measuring 9.2 x 11.4 inches (234 x 290mm) the PB-105 can carry up to 48 14-pin dual-inline packages, and also incorporates five binding posts and 18 distribution buses to meet the most exacting circuit requirements.

The PB-105 is based on standard GSC sockets and bus strips, featuring the company's high-quality contacts with an initial resistance of less than 0.5Mohms. The breadboard provides a total capacity of 912 terminals and 4500 tie points, while the five-way binding posts include four red floating connection points and a black one grounded to the base plate.

The PB-105 is ideally suited to use with Size 22AWG wire, and can be used with component leads from 0.01 to 0.033 inch (0.25 to 0.84mm) in diameter.

Price of the PB-105 'Superboard' is £71 (or £83.95 including VAT, postage and packing).

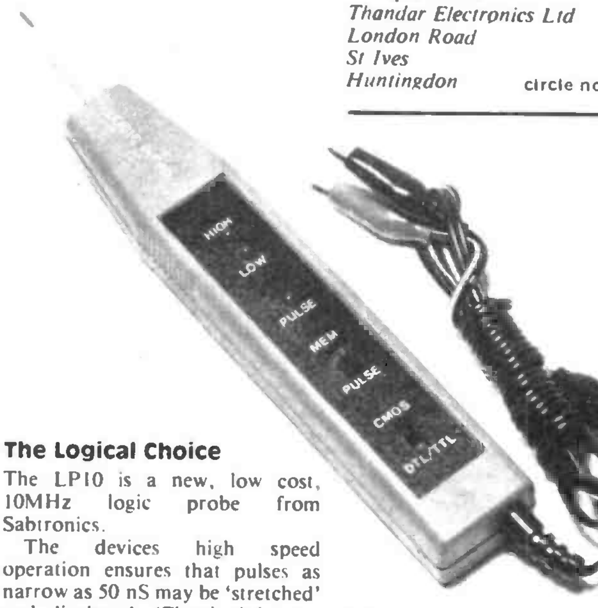
Further information from
Global *Specialities Corporation*
Shire Hill Industrial Estate,
Saffron Walden
Essex CB11 3AQ circle no 17

It's OK

OK Machine & Tool (UK) Ltd's Electroware division, which supplies tools and accessories for everyone involved in building electronic equipment has just published a new catalogue.

Apart from containing various products from OK's bench tool range, wire-wrapping kits, IC tools, PCBs, cases, enclosures, connectors, sockets and test, gear the catalogue also includes NiCad battery chargers, instruments such as multimeters, pH meters and capacitance meters plus soldering equipment.

30p to cover p&p, to the address below will secure you a copy.
OK Machine & Tool (UK) Ltd
Dutton Lane
Eastleigh
Hants. circle no 18



The Logical Choice

The LP10 is a new, low cost, 10MHz logic probe from Sabtronics.

The devices high speed operation ensures that pulses as narrow as 50 nS may be 'stretched' and displayed. 'Floating' inputs, caused by open circuits or bad connections can also be identified. The input impedance of 100k means that the circuit under test will not be unduly loaded.

Two LEDs indicate the presence of a logic 'O' or a logic '1'. The relative brightness of these two LEDs, in a rapidly switching signal, indicates the amount of time spent at each logic state. Invalid logic outputs fail to light either of the LEDs. Logic transitions are detected and displayed on a third LED.

Clip leads, supplied with the unit, allow the approximately 35 mA required to power the probe to be supplied from the circuit under test.

For further details, contact:
Stotron Ltd
Haywood Way
Ivyhouse Lane
Hastings
Sussex circle no 20

PAL Generator

A new Leader PAL generator is now available from Thandar Electronics Ltd, of London Road, St Ives, Cambridgeshire.

Designated the LCG399, the specially designed pattern generator provides the most useful test patterns for checking PAL colour television systems. The new unit is useful for adjusting and checking colour and black-and-white television receivers as well as VTRs, CATV, MATV, CCTV, and other video equipment.

Other features include: PAL standard colour bars which can be inverted, line by line, to show tuning conditions of colour circuits whilst retaining luminance and moving markers for working tests of double-spread VTRs; eight colour rosters for checks and for adjustments of linearity, centring, and deflection yoke polarity; and scope-trigger output.

Inquiries to:
Thandar Electronics Ltd
London Road
St Ives
Huntingdon circle no 19

World of Radio and Electronics

The third issue of Ambit's concise, 'price-on-the-page', components catalogue is now on sale at newsagents for 70p.

The catalogue introduces a 'blue chip' service, offering a guarantee that customer's orders will be processed and packed within six hours of receipt.

A wide range of components is featured in the catalogue, new additions including the high quality range of TOKO switches, and the lowest priced, full spec. NiCads you are likely to find.

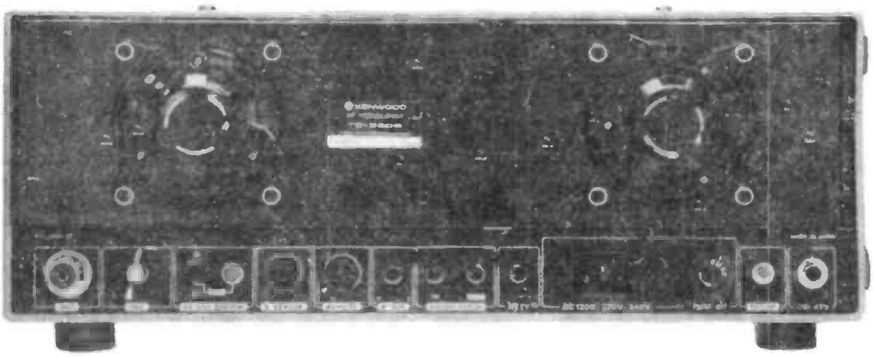
Colour Prints

Centronics have announced a colour option for their low cost dot matrix graphics printer Model 739. The colour unit comes in the form of a kit which can be added to existing 739's or purchased as an additional option on new machines.

The 739 provides full high resolution graphics and proportional spaced high quality text as well as standard mono spaced print. Other features include three way paper handling (A4 sheet, continuous fan fold or roll paper), quiet operation, rugged design, right justification and half line steps for mathematical applications.

The additon of the two colour option kit will enhance the versatility of the 739 and enable more interesting presentation of graphics and easier highlighting of business and financial information. Typical application areas for this option will be in legal, accounting and financial institutions, schools and educational establishments.

For further information contact:
Marketing Executive
Centronics Data Computer (UK)
Victoria Way
Burgess Hill circle no 22
Sussex



the rig worth waiting for

With the advent of amateur band transceivers/ general coverage receivers in one package, the question all the inquiring Trio owners asked was "when will Trio produce their answer/ equivalent to the FT-one?" We are delighted to say that it's here right now and, if previous experience is anything to go by, Trio have got it right first time (as always).

The basic package is apparently straightforward. The TS930S is all solid state, gives 120W out from transistors run from a 28V supply for "better than the rest" linearity; covers all amateur bands and general coverage from 150 kHz to 30 MHz; uses a built in power supply; has digital readout; has twin VFO and multi-channel memory facilities and so on and so on.

What makes the TS930S stand out from the rest is, once again, the Trio attention to detail. I have always said, Trio design their equipment to be used by the average amateur, whereas some rigs look like the control panels for the space shuttle. The acid test is to sit down in front of the TS930S and compare it IN USE to anything else. Notice how the RF and AF gain controls are together, as are the mic gain and carrier level controls.

Need the variable bandwidth? Trio have come up with the most versatile system ever, with completely independent adjustments for the upper and lower sides of the filter pass-band, so you can have any bandwidth you like anywhere around the signal you want — think about it.

Now switch on and operate on 14 MHz. So simple, just touch the button marked 14. Need to go to 21? Just push the button marked 21. Compare that to some rigs which need four hands and a degree in computing science to even get switched on!

What about general coverage? Equally simple using the 1 MHz step buttons. If you are on 14 MHz and you need to listen to the 15 MHz broadcast band just touch the 1 MHz UP button and there you are. Keep going and you step right through the spectrum in 1 MHz bands.

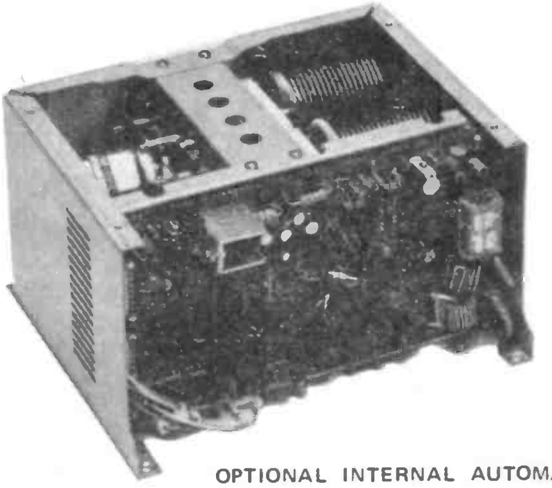
Now just mention some of the other features, look at the display which is bright white on a black background. Frequency readout is to 100 Hz whilst the synthesiser tunes in 10 Hz steps for true "VFO feel". Also included in the display are an analogue dial and the RIT offset in KHz away from dial frequency.

The memory facilities not only remember frequency but also mode in use, and because of the operating simplicity of the TS930S, you don't have to fill the memories with the amateur bands. RF speech processing is fitted together with tunable audio filtering and full break In keying for the real CW operator. The noise blanker system has switchable gate times to cope with not only impulse noise but also the infamous "woodpecker" and it works.

Finally, there is provision for fitting internally a fully automatic aerial tuner for the amateur bands.

Alan, just back from Tokyo where he tried out the 930, is walking about in a daze muttering, "I've got to have the first one." Judging by his impressions of the rig, it's simply fabulous and we can't wait. By the time you read this, we should have them on show (and in use), so come, see, try out the new leader in HF rigs. The family is now completed from TS130 TS130S/V through TS530S, TS830S to the amazing TS930S. There is now a rig to suit everyone in the Trio range.

FOR FULL DETAILS ON THE NEW RIG WORTH WAITING FOR WRITE IN MARKING YOUR ENQUIRY "REW" OR BETTER STILL TELEPHONE:



OPTIONAL INTERNAL AUTOMATIC TUNING UNIT

LOWE electronics

Chesterfield Road, Matlock, Derbyshire DE4 5LE.
Telephone: 0629 4995. Telex: 377482 Lowlec G.

191 for further details

Scope and Tester

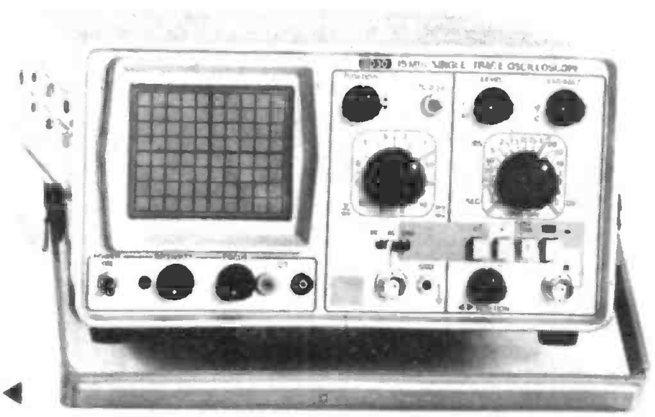
The 3030 single trace oscilloscope features a built-in component tester; active and passive components, including diodes, transistors and FET s can be tested in and out of circuit, test results are displayed on the CRT. Front panel controls are clearly marked and related functions and controls colour linked.

Having a 15 MHz bandwidth and deflection coefficients from 5 mV to 20V/div, it is ideal for investigating low level circuits and allows the on-screen measurement of high level signals. The wide range time base features 18 sweep speeds plus a variable, covering the range 200 nS to 200mS/div.

With two trigger modes, automatic and level, the 3030 will lock to any repetitive waveform and display a base line at all sweep speeds in the absence of an input signal in the auto mode. The level mode features reliable triggering from complex signals.

Giving 50 percent more display area than normally found for this price, it has an 8 x 10 div rectangular CRT, with bright high definition display. It also has a 200 mV calibration signal.

With the increased usage available in the incorporation of a component tester, this scope would be an ideal test and measuring instrument for any hobbyist or experimenter. Priced at £145 (plus p&p at £12.00 and VAT), the scope is available mail order from
Electronic Hobbies Ltd
17 Roxwell Road
Chelmsford
Essex CM1 2LY
Tel: (0245) 62149 circle no 23



Bubbling Under

A bubble memory system that can be removed and replaced like a cassette has just been released. Known as the Intel iPAB Plug-a-Bubble memory system, it comprises a 128K byte bubble memory cassette and cassette holder, a multimodule interface card and a chassis designed to accommodate two cassette holders. One of the main advantages of the system is that it offers customers an extremely rugged, non-volatile memory that can be used in hazardous environments while affording the versatility of replaceable magnetic disc systems.

The Plug-a-Bubble cassette contains a one megabit bubble memory storage device with its support components and three LEDs, all contained within a sealed, aluminium casing. The cassette holder provides logic for selection of the cassette, bidirectional data gating circuitry and write protection circuitry. In addition to the necessary connector to mate with the cassette, the holder also contains a 27 pin jack plug for connecting the holder to and from an external signal source.

Like disc systems, the iPAB systems has write protection (a switch on the cassette holder provides this), and protection against power failure (an integral part of the cassette).

For further information:
John Weatherhead
Rapid Recall Limited
Rapid House
Denmark Street
High Wycombe
Bucks HP11 2ER circle no 25

The DMM

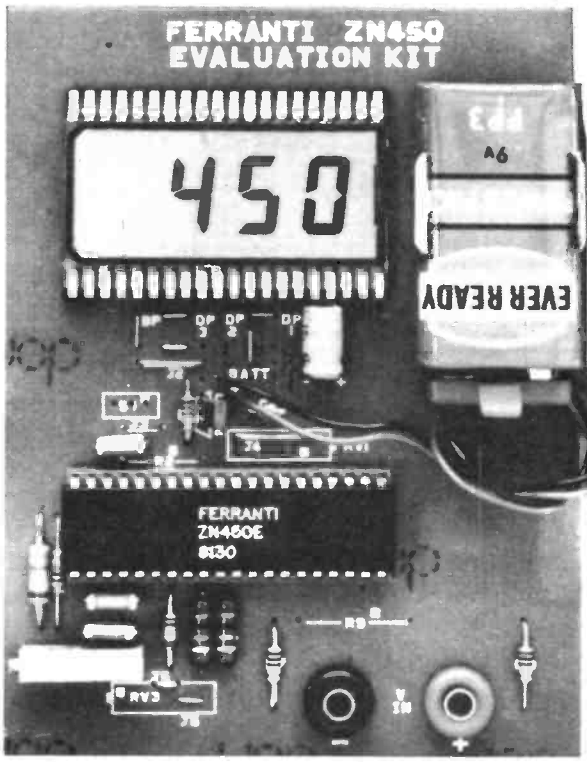
Ferranti Electronics Limited has produced an Evaluation Kit for its ZN450, 3.5 digit, single-chip, digital voltmeter integrated circuit. The kit includes a ZN450 and all the peripheral components and instructions necessary to produce a complete digital voltmeter. The kit enables designers and engineers to evaluate the performance of the ZN450 IC without the problems of designing and constructing a system from scratch.

The ZN450 is a complete digital voltmeter fabricated on a monolithic chip and requires only ten external, passive components in order to function. A novel feature is the charge-balancing conversion technique which ensures excellent linearity. The auto-zero function is completely digital, obliviating the need for a capacitor to store the error voltage. Operating over the range +/—199.9mV, the ZN450 also features an on-chip clock and precision reference voltage and consumes less than 35 mW of power.

Apart from the more obvious uses as a DVM or multimeter, the ZN450 can equally well be applied to such devices as digital thermometers, pressure gauges and weighing machines.

The DVM evaluation kit is available, price £19.95 including VAT from Ferranti franchised distributors.

circle no 26



The DCM

A new digital capacitance meter recently introduced by Lascar Electronics is claimed to be nearly half the price of competing instruments.

The DP600 features three ranges and will measure capacitance between 1p and 20u. The capacitance display is automatically updated making the instrument ideal for setting up variable capacitors. It may also be used for a wide variety of tests, including cable length, cable capacitance, PCB track capacitance etc. Accuracy is 0.75% +/—3 digits.

A 0.5" LCD read-out gives excellent readability and extended battery life, with indication on display when battery replacement is necessary.

The DP600 is housed in a moulded case. The unit is ideal for field or bench use and is priced at £39.95 + VAT.

For further details
Lascar Electronics Limited
Unit 1, Thomasin Road
Burnt Mills
Basildon
Essex SS13 1LH circle no 24

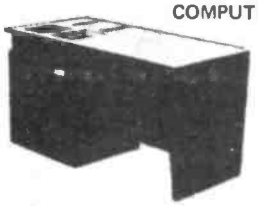
THIS MONTH'S NEW KITS

For the musically inclined	
Drum Synthesiser	£29.50
Mixer/Pre Amp	£16.00
Stylus Organ	£4.95
For the Service Engineer	
Micro Volt Multiplier	£3.95
Sign Wave Generator	£5.75
Linear Power Output Meter	£11.50
For the Ham or CB Enthusiast	
Aerial Rotator	£24.50
Aerial Direction Indicator	£5.90
For the Motorist	
Electronic Ignition Kit	£19.50
For all of you	
Electric Jigsaw Puzzle	£5.30
Blow Heater Kit	£6.45
And if you are having TV Interference Problems	
High-Pass Filter	£1.95
Low-Pass Filter	£3.45

UNIVAC KEYBOARD BARGAIN

Ideal for use with ZX80/81. Has 50 keys and many other parts for your spares box. Probably cost in excess of £100. In very good used condition – £13.50 + £2.00 post. Diagram showing how to connect to ZX80/81 – £2.00 extra.

COMPUTER DESK



Size approx. 4'x 2' x 2'6" high. These were made for hard work, the top being formica covered. Suitable for housing instruments or for use as office desks. Beautifully made, these cost over £100 each, our price only £11.50 each, however, you must arrange to collect.

EXTRACTOR FANS

Mains operated – ex. Computer.

5" Woods extractor £5.75 Post £1.00.

6" Woods extractor £6.90 Post £1.25

6" Plannair extractor £7.50 Post £1.00

4" x 4" Muffin 115v. £4.50 Post 50p.

4" x 4" Muffin 230v. £5.75 Post 50p.

INTERRUPTED BEAM

This kit enables you to make a switch that will trigger when a steady beam of infra red or ordinary light is broken. Main components – relay, photo transistor, resistors and caps. etc. Circuit diagram but no case. Price £2.30

INSTRUMENT BOX WITH KEY

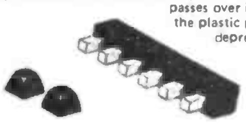
Very strongly made (ply-wood sides with hard board top and bottom). This is black grained effect, vinyl covered, very pleasing appearance. Internal dimensions 12½" long, 4¼" wide, 6" deep. Ideal for carrying your multi range meter and small tools and keeping them in a safe place. £2.30. Post paid if ordered with other goods, otherwise £1.00.

ROPE LIGHT

4 sets of coloured lamps in translucent plastic tube arranged to give the appearance of a running or travelling light. With variable speed control box, ideal for disco or shop window display. Complete, made up, ready to plug into mains. £36.00 + £2 post.

COMPUTER KEY SWITCHES (make your own keyboard)

These are for making up on a p.c.b. and consist of a vertical mounting computer type reed switch, which makes circuit when a magnet passes over it. The magnet is located in the plastic plunger which in turn is depressed by a push rod, to which the legended top is fixed. These are made up in banks of 6, price £2.30 per bank of 6 (including tops)

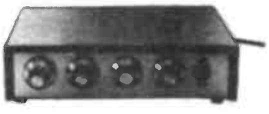


OUR CAR STARTER AND CHARGER KIT has no doubt saved many motorists from embarrassment in an emergency you can start car off mains or bring your battery up to full charge in a couple of hours. The kit comprises: 250w mains transformer, two 10 amp bridge rectifiers, start/charge switch and full instructions. You can assemble this in the evening, box it up or leave it on the shelf in the garage, whichever suits you best. Price £11.50 + £2.50 post.

GPO HIGH GAIN AMP/SIGNAL TRACER. In case measuring only 5¼in x 3¼in x 1¼in is an extremely high gain (70dB) solid state amplifier designed for use as a signal tracer on GPO cables, etc. With a radio it functions very well as a signal tracer. By connecting a simple coil to the input socket a useful mains cable tracer can be made. Runs on standard 4½v battery and has input, output sockets and on-off volume control, mounted flush on the top. Many other uses include general purpose amp, cueing amp, etc. An absolute bargain at only £1.85. Suitable 80ohm earpiece 69p.

FREE OUR CURRENT BARGAIN LIST WILL BE ENCLOSED WITH ALL ORDERS.

3 CHANNEL SOUND TO LIGHT KIT



Complete kit of parts for a three-channel sound to light unit controlling over 2000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for disco work. The unit is housed in an attractive two-tone metal case and has controls for each channel, and a master on/off. The audio input and output are by ¼" sockets and three panel mounting fuse holders provide thyristor protection. A four-pin plug and socket facilitate ease of connecting lamps. Special snip price is £14.95 in kit form or £25.00 assembled and tested.

MULLARD UNILEX

A mains operated 4 + 4 stereo system. Rated one of the finest performers in the stereo field this would make a wonderful gift for almost anyone. In easy to assemble modular form this should sell at about £30 – but due to a special bulk buy and as an incentive for you to buy this month we offer the system complete at only £16.75 including VAT and post. FREE GIFT – buy this month and you will receive a pair of Goodman's elliptical 8"x5" speakers to match this amplifier.

THIS MONTH'S SNIP

POCKET AUDIO COMPONENT TESTER

With it you can quickly test diodes, rectifiers, transistors, capacitors, check wiring and p.c. boards for open circuits, find the anode and cathode of a diode or rectifier and whether a transistor is PNP or NPN, which are the base collector and emitter connections. Condensers, if bad, give a continuous signal, but if good, give intermittent signals of varying length depending on their value. The test current is very low (2uA) and the voltage only 1.4v, so it is also possible to check MOS devices, as well as sensitive transistors without fear of damaging them. The unit is supplied complete with internal battery, which should last many months. **Price £3.45p**

THERMOSTAT ASSORTMENT

10 different thermostats. 7 bi-metal types and 3 liquid types. There are the current stats which will open the switch to protect devices against overload, short circuits, etc., or when fitted say in front of the element of a blow heater, the heat would trip the stat if the blower fuses; appliance stats, one for high temperatures, others adjustable over a range of temperatures which could include 0 – 100°C. There is also a thermostatic pod which can be immersed, an oven stat, a calibrated boiler stat, finally an ice stat which, fitted to our waterproof heater element, up in the loft could protect your pipes from freezing. Separately, these thermostats could cost around £15.00 – however, you can have the parcel for £2.50.

6 WAVEBAND SHORTWAVE RADIO KIT

Bandspread covering 13.5 to 32 metres. Based on circuit which appeared in a recent issue of Radio Constructor. Complete kit includes case materials, six transistors and diodes, condensers, resistors, inductors, switches, etc. Nothing else to buy if you have an amplifier to connect it to or a pair of high resistance headphones. Price £11.95.

MEDIUM & 2 SHORT WAVE CRYSTAL RADIO

All the parts to make up the beginner's model. Price £2.30. Crystal earpiece 65p. High resistance headphones (gives best results) £3.75. Kit includes chassis and front but not case.

TRANSMITTER SURVEILLANCE

Tiny, easily hidden but which will enable conversation to be picked up with FM radio. Can be made in a matchbox – all electronic parts and circuit. £2.30. (Not licenceable in the U.K.).

RADIO MIKE

Ideal for discos and garden parties, allows complete freedom of movement. Play through FM radio or tuner amp. £6.90 comp. kit. (Not licenceable in the U.K.).

RADIO STETHOSCOPE

Easy to fault find – start at the aerial and work towards the speaker – when signal stops you have found the fault. Complete kit £4.95.

MUGGER DETERRENT

A high-note bleeper, push latching switch, plastic case and battery connector. Will scare away any villain and bring help. £2.50 complete kit.

POPULAR SNIP – STILL AVAILABLE

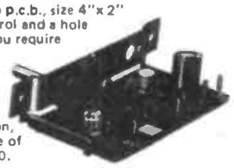
And it still carries a free gift of a desoldering pump, which we are currently selling at £6.35p. The snip is perhaps the most useful breakdown parcel we have ever offered. It is a parcel of 50 nearly all different computer panels containing parts which must have cost at least £500. On these boards you will find over 300 IC's. Over 300 diodes, over 200 transistors and several thousand other parts, resistors, condensors, multi-turn pots, recifiers, SCR, etc. etc. If you act promptly, you can have this parcel for only £8.50, which when you deduct the value of the desoldering pump, works out to just a little over 4p per panel. Surely this is a bargain you should not miss!

When ordering please add £2.50 post and £1.27 VAT.

BURGLAR ALARM CONTROL PANEL

Contains labelled connection block, latching relay, test switch and removable key control switch. Simplifies the whole installation, all you have to do is to take wires to pressure pads end to alarm bell. Price £7.95, with complete diagram.

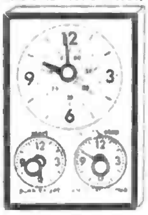
MINI MONO AMP on p.c.b., size 4"x 2"



approx. Fitted volume control and a hole for a tone control should you require it. The amplifier has three transistors and we estimate the output to be 3W rms. More technical data will be included with the amplifier. Brand new, perfect condition, offered at the very low price of £1.15 each, or 10 for £10.00.

DELAY SWITCH

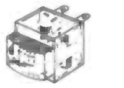
Mains operated – delay can be accurately set with pointers knob for periods of up to 2½hrs. 2 contacts suitable to switch 10 amps – second contact opens a few minutes after 1st contact. £1.95.



TIME SWITCH BARGAIN

Large clear mains frequency controlled clock, which will always show you the correct time + start and stop switches with dials. Complete with knobs. £2.50.

LEVEL METER



Size approximately ¾" square, scaled signal and power but cover easily removable for rescaling. Sensitivity 200 uA. 75p.

WATERPROOF HEATING WIRE

60 ohms per yard, this is a heating element wound on a fibre glass coil and then covered with p.v.c. Dozens of uses – around water pipes, under grow boxes in gloves and socks.

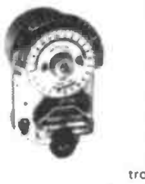
TANGENTIAL BLOW HEATER

2.5 Kw quiet, efficient instant heating from 230/240 volt mains. Kit consists of blower as illustrated, 2.5 Kw element, control switch and data all for £4.95. post £1.50.

12V SUBMERSIBLE PUMP

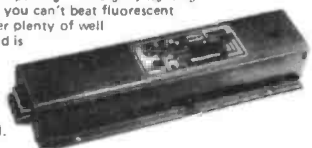
Just join it to your car battery, drop it into the liquid to be moved and up it comes, no messing about, no priming, etc. and you get a very good head. Suitable for water, paraffin and any non-explosive non-corrosive liquid. One use if you are a camper, make yourself a shower. Price: £8.50.

VENNER TIME SWITCH



Mains operated with 20 amp switch, one on and one off per 24 hrs. repeats daily automatically correcting for the lengthening or shortening day. An expensive time switch but you can have it for only £2.95. These are without case, but we can supply metal case with window £2.95. Also available is adaptor kit to convert this into a normal 24hr. time switch but with the added advantage of up to 12 on/offs per 24hrs. This makes an ideal controller for the immersion heater. Price of adaptor kit is £2.30. Post any or all items £1.

12V FLUORESCENT LIGHTING

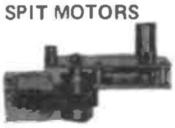


For camping – car repairing – emergency lighting from a 12v battery you can't beat fluorescent lighting. It will offer plenty of well distributed light and is economical. We offer an inverter for 21" 13 watt miniature fluorescent tube. £3.45. (tube not supplied).

FIVE UNUSUAL SWITCHES

For inventors, experimenters, service engineers, students or in fact anyone interested in making electrical gadgets. The parcel contains: – delay switch – motor driven switch – two-way and off switch – polarity changing switch – and humidity switch. Our regular price for these switches bought separately is over £10, but this month you can have the 5 for £2.50.

SPIT MOTORS



These are powerful mains operated induction motors with gear box attached. The final shaft is a ½" rod with square hole, so you have alternative couplingmethods – final speed is approx. 5 revs/min, price £5.50. – Similar motors with final speeds of 80, 100, 160 & 200r.p.m. same price.

COMPONENT BOARD
Ref. WO998

This is a modern fibreglass board which contains a multitude of very useful parts, most important of which are: 35 assorted diodes and rectifiers including 4 3amp 400v types (made up in a bridge) 8 transistors type BC 107 and 2 type BFY 51 electrolytic condensers. SCR ref 2N 5062, 25 Ouf 100v DC and 100uf 25v DC and over 100 other parts including variable, fixed and wire wound resistors, electrolytic and other condensers. A real snip at £1.15.

J. BULL (Electrical) Ltd.

(Dept. REW), 34 - 36 AMERICA LANE, HAYWARDS HEATH, SUSSEX RH16 3QU.

Established 30 YEARS

MAIL ORDER TERMS: Cash, P.O. or cheque with order. Orders under £10.00, add 60p service charge. Monthly account orders accepted from schools and public companies. Access & Barclaycard orders.phone Haywards Heath (0444) 54563. CALLERS: to Haywards Heath (closed Sat.), or 2, Bentham Road, Off Elm Grove, Brighton (closed Wed.). BULK ORDERS: Write for special quotation. Normally delivery is by return.

4 CHANNEL DIGITAL PROPORTIONAL RC SYSTEM PART 1

A no frills design offering performance combined with ruggedness and low cost.

RADIO CONTROL MODELLING has a large following throughout the world and **R&EW** have designed a 4 Channel Digital Proportional System that should be of interest to many modellers - this month we describe the transmitter which is based on the Toko KB4445 and not a lot else.

DP FOR THE LAZY

Many avid radio modellers go through life blissfully unaware of what actually makes their control link tick. It's another case of a little learning being a dangerous thing, (e.g. CB), where a limited amount of understanding gets enshrined in varying degrees of folk lore culminating in assumptions such as you can't fly on a green channel when there's an 'R' in the month.

Like a lot of folk lore, it is usually possible to trace some grain of truth in these fondly held beliefs, but on the whole, a member of a club that can tell the difference between a resistor and capacitor is looked upon as an electronics expert. Let us hastily say that this is not to decry those who choose to concentrate on the modelling and leave the RC to the electronics enthusiasts, but merely to warn those **R&EW** readers who have come to expect nothing but the leading edge in technology, to bear with this series whilst we bring the class up to standard.

A BRIEF REFRESHER

Early RC used valves. Yes, really — big glass things with little red glowing bits. No doubt there are many readers who have fond memories of resonant reed systems and the like. But the advent of the transistor was gratefully accepted, without all the ungrateful grumblings that can still be heard in the communications fraternity, and the digital proportional control system was developed.

The basic principles of operation of a DP system are quite straight-forward and a description of the theory behind the **R&EW** system is contained within the circuit description block.

The transmitter provides two dual axis control sticks which provide an analogue 'XY' output so that the two basic movements in an aircraft application, such as the rudder and ailerons, can be controlled by a single movement. The analogue of the encoder control potentiometer, is the potentiometer that is mechanically linked to the servo output. Thus the movement of the servo will be proportional to the movement of the control stick potentiometer.

In land based vehicle control, the use of a single rotary potentiometer is preferred, since the action is obviously rather more like steering a car. The skills required in any form of RC cannot be stressed too highly — it may seem easy enough whilst the model is going away from the controller, but when you turn around to come back and find the steering is suddenly 'back to front', the fun is just starting.

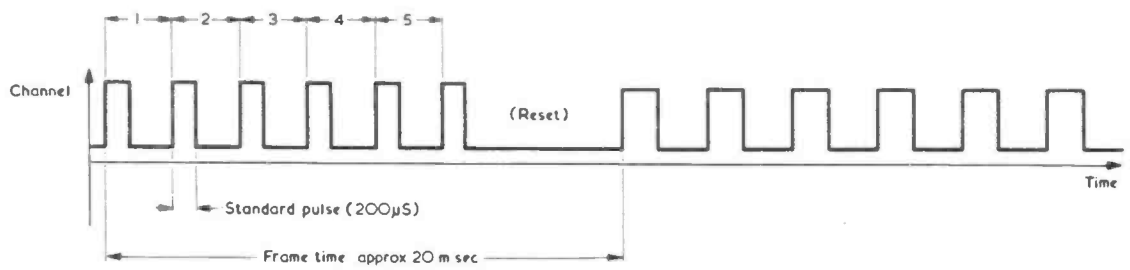


Figure 1: The control waveform at the encloder output and decoder input.

CIRCUIT DESCRIPTION

SYSTEM PRINCIPLES

The basic principle of a Digital Proportional (DP) system is that a series of 'Digital' pulses are transmitted across a radio link. The stream of pulses consist of one pulse per channel plus a reset pulse. The reset pulse ensures that the receiver's decoder keeps in 'sync' with the transmitter. This 'frame' of data is repeated approximately 50 times a second.

The period between the leading edges of the channel control pulses is nominally 1.5 mS but can be varied between 1 mS and 2 mS, by means of the transmitters control sticks.

It is this 'pulse width' variation that the decoder detects, and according to its duration positions the output angle of the servo arm.

The decoder must also separate the stream of pulses into an individual control pulse for each servo.

Each channel's output pulse width is compared to a reference pulse in the servo driver system (which is usually an IC like the NE544). The size of the reference pulse is determined by the position of the servo output arm, which is physically linked to a preset potentiometer controlling the reference pulse width monostable circuit.

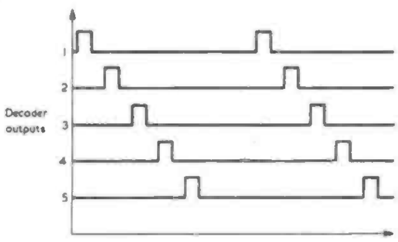


Figure 2: The decoded output pulses for driving the servos

This may seem like a good idea, since it frees the designer from the constraints of accurate overall control stick resistances — but the high input impedance of this type of encoder usually makes it susceptible to RFI. So remember to decouple the input lines as near to the encoder as possible.

There is one other approach (other than the 4017 system mentioned in the March issue), which is the Toko KB4445 combining not only 4 digital proportional channels, but most of the RF and modulator bits for a complete FM transmitter in the 27 MHz or 35 MHz bands. This device is shown in *Fig 5*, together with its timing format — and you will see that the control potentiometers are used in 'rheostat' formation; but this does mean that the 'C' half of the R/C time constant on the encoder inputs acts as an effective means of decoupling.

The choice of modulation mode is not compulsorily NBFM, since the modulator output at pin 12 could conceivably be used in an AM system. However, since Toko have been good enough to present a system on a plate, it seems churlish to want to be different.

The use of FM should not however be taken too lightly. There is a major problem over the compatibility of different crystal types (AM systems invariably seemed to use 3rd overtone, 20pF or 30pF parallel load) for the FM system. The receiver crystal spec is usually still 3rd overtone, 20/30pF parallel load, 455 kHz low of the output frequency.

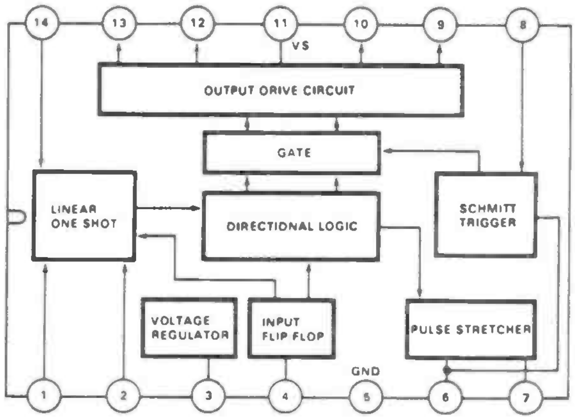


Figure 3: Block diagram of the NE544 servo driver IC. It provides good positional accuracy for minimum component count.

The problem comes with the transmit crystals — since the oscillator runs at half the output frequency in a fundamental mode, so that adequate deviation can be applied. Overtone modes of operation just don't take to NBFM very graciously. The problem is that not only does a fundamental mode crystal allow NBFM more readily, it is (by the same token), going to be more easily lead astray by incorrect loading conditions.

The problem is compounded further at the receiver by the more critical nature of the detector alignment. In the good old days of 50 kHz AM channelling, setting up an RC link was relatively simply — with 50 kHz to wallow around in it's hardly surprising. The modern requirement for 10 kHz channelling demands a far more precise alignment anyway, coupled to the fact that any basic frequency error will cause the detector characteristic to be offset.

Many problems arise from the accuracy of the matching of crystal pairs, and it is not unreasonable to suggest that the avid enthusiast should now add a DFM to his 'kit' to ensure accuracy when changing channels. However, part of the heritage of 50 kHz channelling is the belief that frequency changing should be accomplished without any need to trim the crystal frequencies. Whereas the odd 2 or even 4 kHz doesn't make too much difference to a relatively wide AM system (which is inherently less bothered about frequency inaccuracy anyway), an FM system operating on 10 kHz channelling needs to be within 1 kHz — or better. If you see just how much the FM detector output varied with changing input frequency, the scope of the problem becomes apparent. So much so that certain designs for UHF FM radio control incorporate AFC as a matter of course, and it is debatable whether or not an advanced design for 27 or 35 MHz might not benefit likewise.

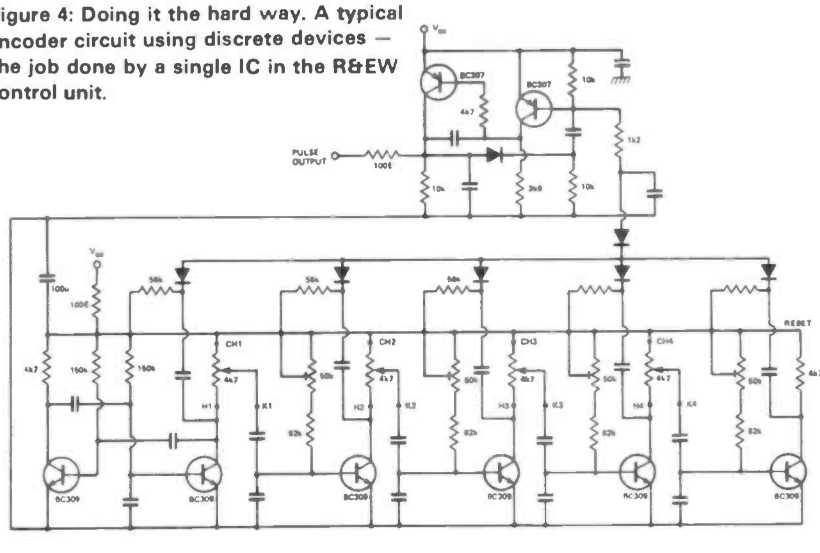
ANTENNA MATCHING

For antennas that are no longer than one tenth of a wavelength, the transmitting antenna presents a load to the driving circuit that may be represented as a capacitor (Ca) in series with a resistor (Ra).

The equivalent capacitance (Ca) is approximately

$$Ca = \frac{1.42L}{((n \times 2L/d)-1) \times (1-(fL/2808)^2)} \text{ pF}$$

Figure 4: Doing it the hard way. A typical encoder circuit using discrete devices — the job done by a single IC in the R&EW control unit.



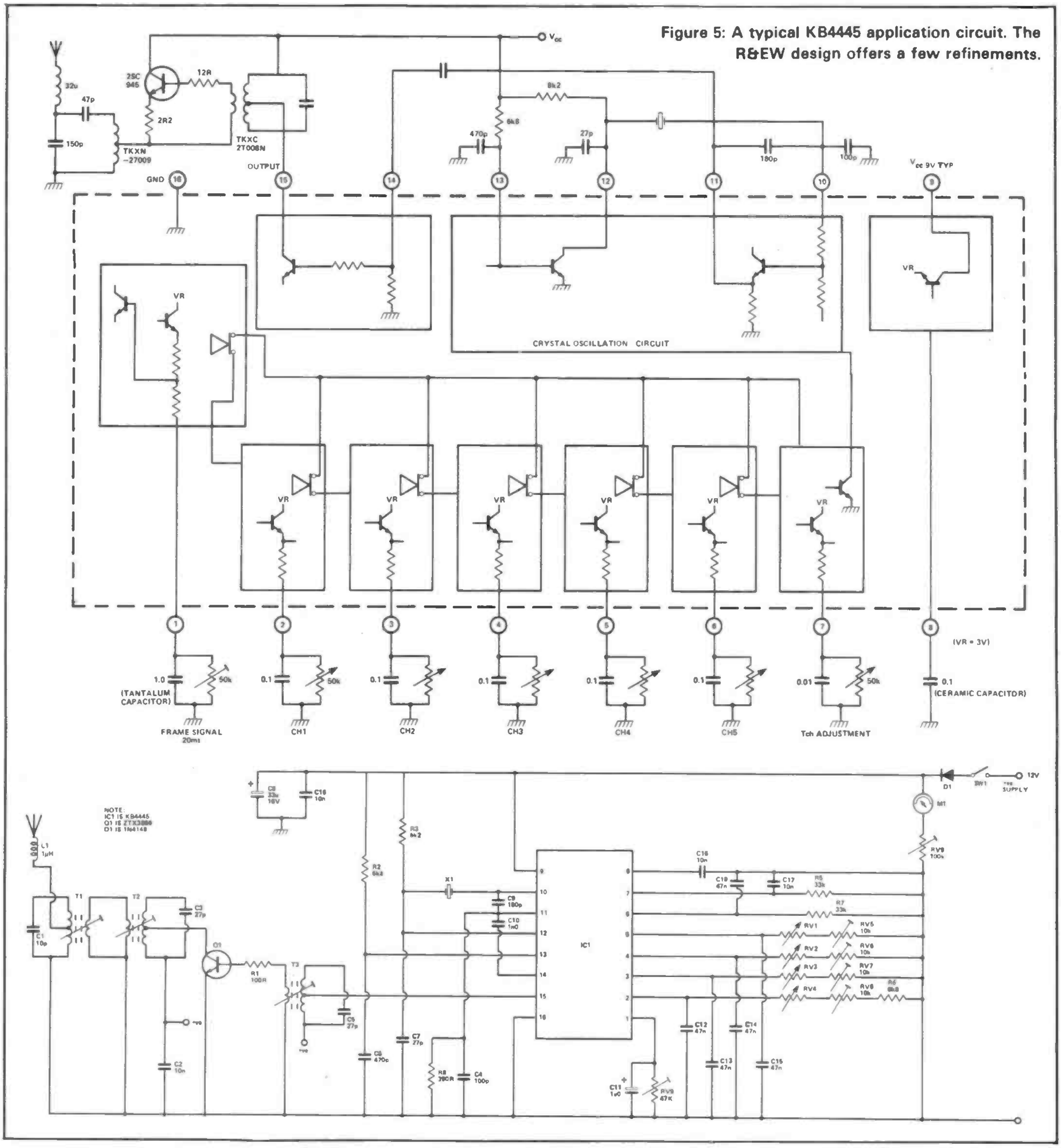


Figure 5: A typical KB4445 application circuit. The R&EW design offers a few refinements.

where L is the antenna length (in inches), d is the antenna's diameter and f is the frequency in MHz.

The equivalent resistance is given by

$$L1 = \frac{1}{(2 \times pi \times fc)^2 \times Ca} \text{ uH}$$

The radiated power is the power that would be dissipated in this resistor if the antenna were replaced by its equivalent circuit.

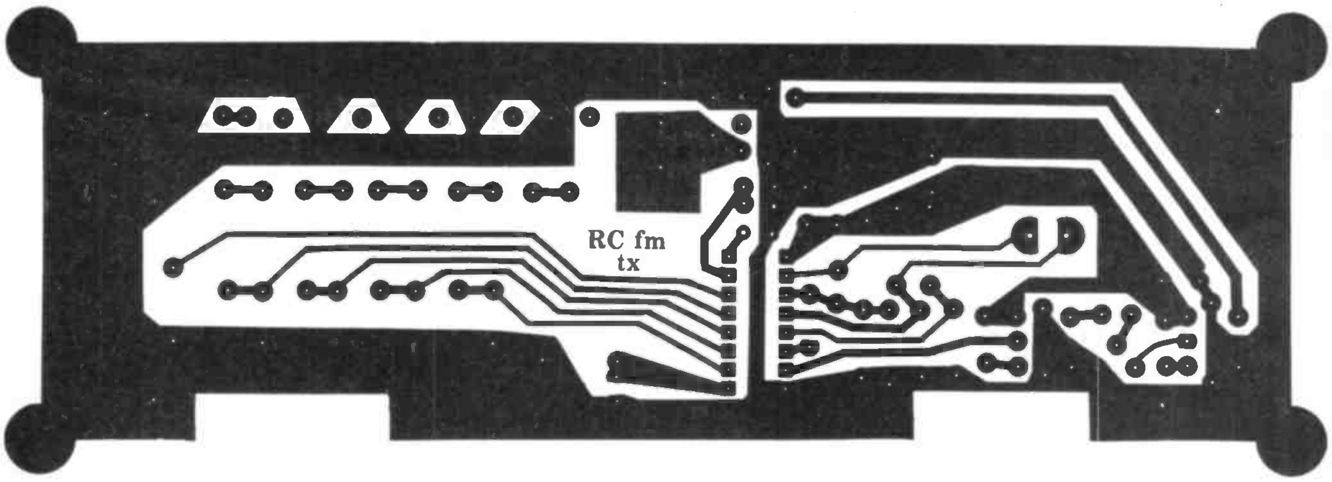
Using typical values in the above expression it can be shown that to achieve, even low voltages, across Ra at 27/35 MHz, would require unrealistically high drive voltages. The loading inductor placed in series with the antenna overcomes this problem. Its value is chosen so that it will resonate with Ca at the carrier frequency. This value is found by

$$R = 273\ (Lf)^2 \times 10^{-8} \text{ ohms}$$

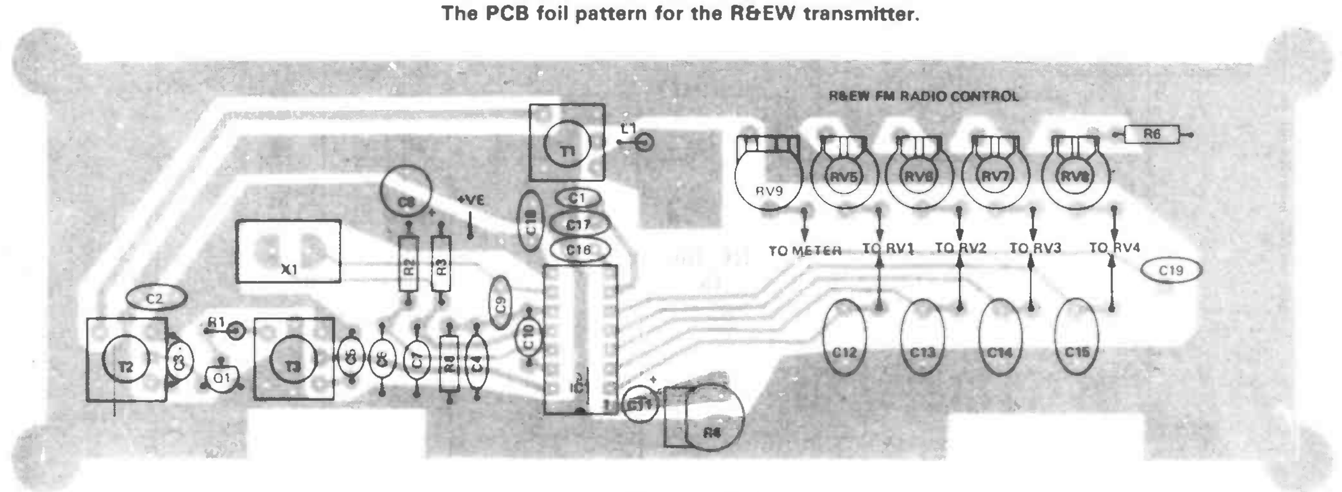
Figure 4 details what goes on inside the NE544: if the incoming pulse is narrower than the pulse set by the positional feedback preset, the servo is driven round to decrease the period of the linear one shot until it matches the incoming signal — and vice versa.

It may seem a shade premature to discuss the servo driver at this stage, but the essence of a radio control system is that it is a closed loop system, analogous to AFC on an FM tuner, with servos very much part of the loop.

The theory of digital proportional RC is straight-forward, translation into practise is where the trouble starts — and where better to start than with the transmitter. It's easy enough to generate a stream of pulses of varying width. Apart from doing it the hard way with discrete devices, there are the inevitable 'custom ICs' such as the NE5044, ▶



The PCB foil pattern for the R&EW transmitter.



The overlay.

PARTS LIST

Resistors (All .25W 5%)

R1	100R
R2,6	6k8
R3	8k2
R5,7	33k
R8	390R

Capacitors

C1	10p ceramic
C2,16,17,18	10u mylar
C3,5,7	27p ceramic
C4	100p ceramic
C6	470p ceramic
C8	33u 16V electrolytic
C9	180p ceramic
C10	1n0 mylar
C11	1u0 16V electrolytic
C12,13,14,15,19	47n mylar

Potentiometers

RV1-4	in hardware kit
RV5-8	10k preset
RV9,R4	47k preset

Semiconductors

IC1	KB4445/10170
Q1	ZTX3866
D1	IN4148

Miscellaneous

Hardware Kit (includes M1 and SW1) PCB etc.

Inductors

T1,2,3,	K x NK 3335
L1	1u0 miniature choke

or the less well known OKI MSL9362 which can be configured for either four Digital Proportional channels, or two DP, and two switched on/off when used in conjunction with its companion decoding device, the MSL9363.

Basically, any form of encoder is either a series of monostables that triggers subsequent sections 'domino' fashion where the monosable R/C time constant is directly set with the control pot, or as in the case of the NE5044 and MSL9362, it is a series of comparators, whose outputs are then gated to control the monostable time constant in sequence. Here the control potentiometers are used in genuinely potentiometric fashion — i.e. the value of the pot is immaterial, what matters is the voltage developed at the slider.

CONSTRUCTION

We are making the radio control transmitter available as a complete kit which features a professional looking case that will ensure the finished unit looks as if it means business.

Carefully follow the overlays shown, paying attention to the correct orientation of any polarity sensitive components, and construction should pose no problems.

Setting up the project is quite straightforward. Firstly, the RF stages should be aligned as follows.

Set the cores of T1, 2 and 3 to their mid positions. Monitor the current supplied to the transmitter and the RF field strength (the latter using a field strength meter or diode probe). Adjust T3 for maximum supply current and T2 and T3 for maximum RF field strength. Readjust all coils for maximum output. The supply current should be about 150mA.

As for the encoder, ideally a scope should be used to monitor the train of digital pulses and RV9 adjusted to give a frame period of 20mS, but in practice RV9 can be set to its mid position.

THE R&EW CIRCUIT

The final circuit of the transmitter is shown in *Fig 6* and the discussion above has covered most of the points of note, however, a few more words on the RF output stage may be in order.

NEXT MONTH THE RECEIVER.

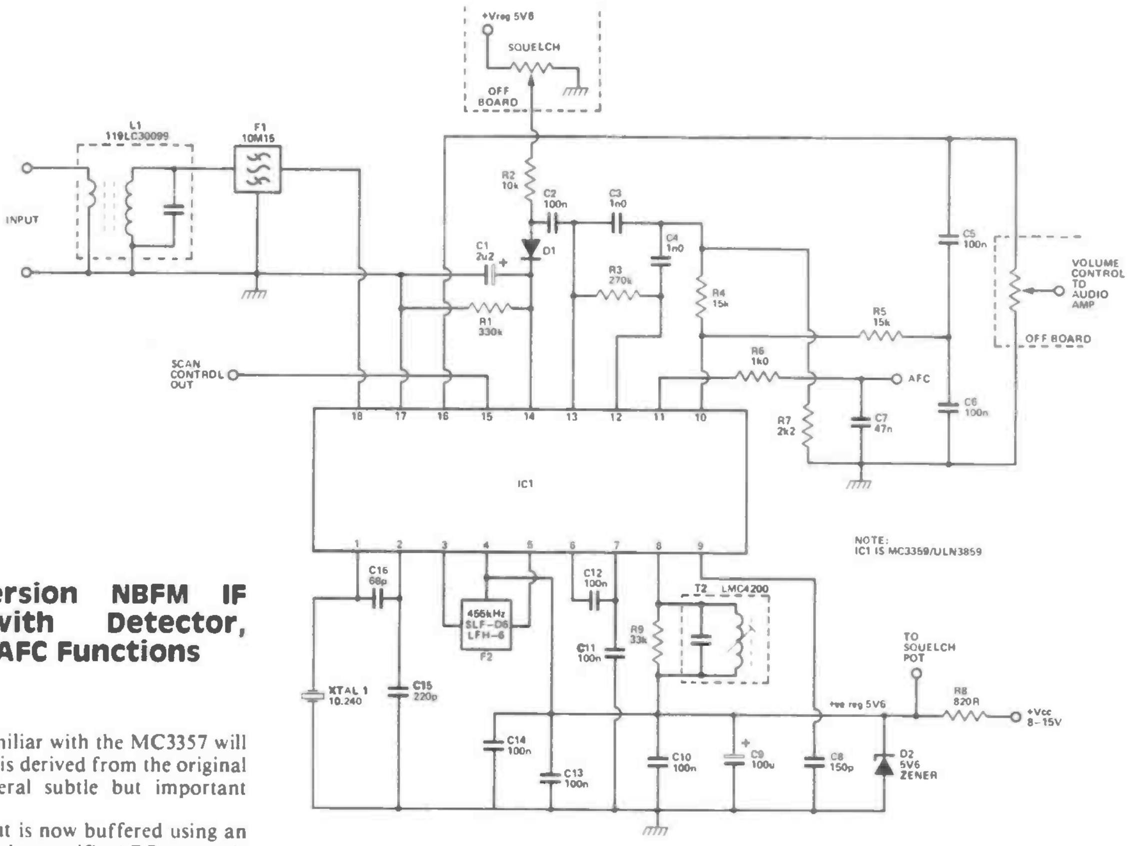
□ R & EW

Your Reactions.........	Circle No.
Excellent - will make one	90
Interesting - might make one	91
Seen Better	92
Comments	93

R&EW Data Brief

MC3359

TEST AND APPLICATION CIRCUIT



Dual Conversion NBFM IF System, with Detector, Muting and AFC Functions

As those of you familiar with the MC3357 will see, this new device is derived from the original MC3357, with several subtle but important changes.

The audio output is now buffered using an emitter follower, and a specific AFC output is available for fine tuning, or 'scan stop' detectors. The input sensitivity (at 10.7 MHz) has been improved from 5 to 2 uV, and the audio output is doubled to 700 mV. Filter matching resistors have been taken inside the device, reducing the total parts count of the system.

The internal diagram reveals several changes that are not immediately obvious from the external configuration. Steps seem to have been taken to stabilise the bias arrangements to the first mixer, along with tighter control of the mute amplifier bias. Some designs using the MC3357 have been known to respond temperamentally to thermal extremes.

The mute trigger circuit has undergone some fairly major changes, with the scan output becoming an NPN open emitter (it was previously a loaded collector of a PNP). The scan output will now source up to 4 mA with the mute 'off' during signal input conditions. The mute output of the MC3357 (a rather delicate PNP open emitter) has been replaced with an NPN open collector in the 3359/3859 — and this seems to withstand the **R&EW** fumble test rather more readily.

For mute to occur, the voltage on pin 14 needs to rise above 700 mV — and it looks as if a mask option on the Sprague ULN3859 permits selection of an alternative input where the mute switches off with increasing input voltage. The ULN3859A operates using the 'A' input, whereas the original MC3357 works by shifting the equivalent pin (12) low — analogous to the 14B input of the new device.

The audio stages of the 3359/3859 are substantially different, with a number of additional buffers hung on the quadrature detector outputs. This results in improved audio output (pin 10), as well as providing an AFC function (pin 11), independent of audio decoupling considerations. If the AFC is not required, the output can be connected back to pin 9, summing the audio and doubling the output from the emitter follower buffer.

As a general point, the low power consumption of the device (3-4 mA at 5V) is reflected in the strong signal performance of the mixer stage. Although the 3359/3859 has a better IMD margin than the 3357, an external mixer should be used in exacting applications — although the internal oscillator can be used if required, with pin 3 providing an effectively buffered output. Pin 10 should be grounded.

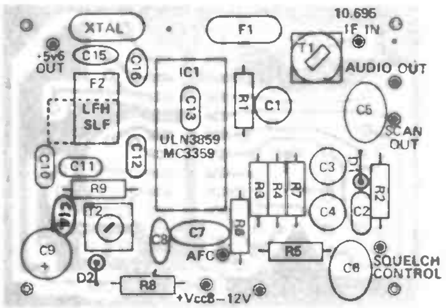
The versatility of the MC3357 is unaffected by the improvements, and the device itself is readily adaptable to a multitude of applications other than as a dual conversion NBFM receiver subsystem. The MSF receiver described in the April issue is a good example of a 'lateral' application, and others include tuneable IFs, direct conversion SSB receivers, metal locators, mains intercoms, radio control receivers etc.

Application Notes

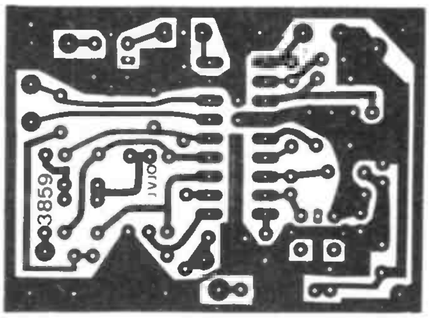
1. **In a typical application with a 3.6k crystal filter source, the ULN-3859A will give typically 23 dB conversion gain.**
2. **Because crystal filters are extremely sensitive to reactive loading, radio designers frequently have added a coil and/or capacitor at pin 18 to cancel the reactive input component. This practice is not required with the ULN-3859A since its input is specifically designed to match typical 10.7 MHz crystal filters. However, if a reactive component is used, it is important to adjust it for optimal passband shape and not simply to peak it for maximum sensitivity.**
3. **Pin 11 provides AFC. If AFC is not required, pin 11 should be grounded, or tied to pin 9 to double the available recovered audio.**
4. **Pin 10 may require an external resistor (2 k min.) to ground to prevent the audio from rectifying with some capacitive loads.**

ELECTRICAL CHARACTERISTICS at T_A = +25°C, V_{cc} = 8.0V, f_o - 10.7MHz, f_m = 1.0kHz, (unless otherwise noted)

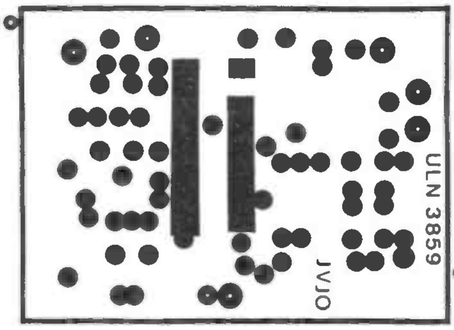
Characteristic	Test Pin	Test Conditions	Limits Min.	Typ.	Max.	Units
Operating Voltage Range	4		4.0	8.0	9.0	V
Quiescent Supply Current	4	V_{14} = 0, Mute OFF	-	3.0	6.0	mA
		V_{14} = 0.7V, Mute ON	-	4.0	7.0	mA
Input Limiting Threshold	18	−3dB Limiting	-	2.0	6.0	uV
Mixer Conversion Gain	3	Also, See Note 1	-	24	-	dB
Mixer Input Resistance	18		-	3.6	-	kΩ
Mixer Input Capacitance	18	Also, See Note 2	-	2.2	-	pF
Mixer Output Impedance	3		-	1.8	-	kΩ
Limiter Input Impedance	5		-	1.8	-	kΩ
Quiescent D-C Output Voltage	10	V_{in} = 0	2.4	3.6	4.4	V
Audio Output Impedance	10		-	500	-	
Recovered Audio Output	10	V_{in} = 3.0mV	450	700	-	mV
Amplifier Gain	13	f = 4.0kHz, V_{in} = 5.0mV	40	53	-	dB
Quiescent D-C Output Voltage	13	V_{in} = 0	-	1.7	-	V
Mute Switch Resistance	16	I_{16} = 2.5mA, V_{14} = 0.7V	-	4.0	10	
Scan Source Current	15	V_{14} = V_{15} = 0, Mute OFF	2.0	4.0	-	mA



PCB Component Overlay.

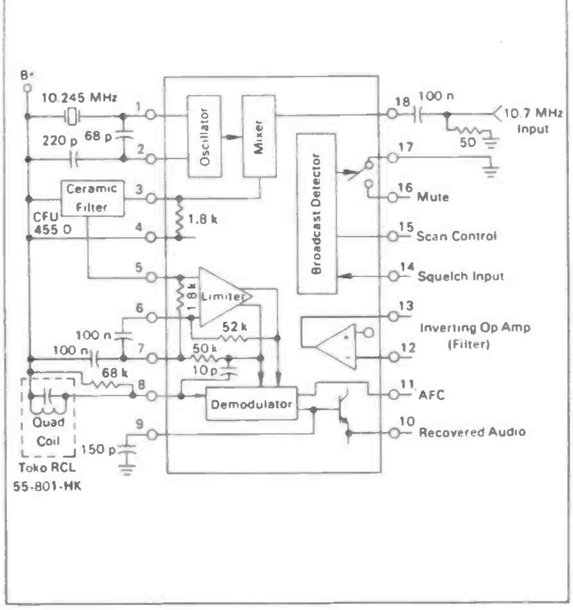


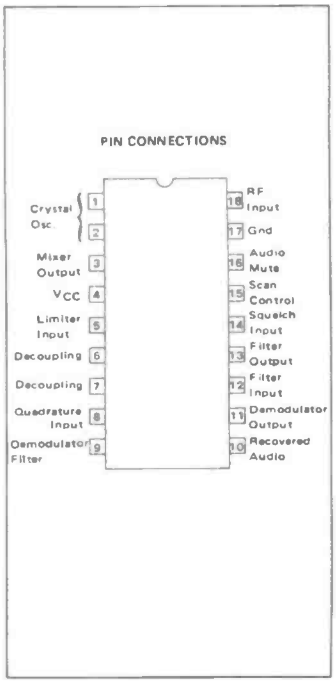
PCB Foil Pattern - Bottom.



PCB Foil Pattern - Top, Negative.

FIGURE 1 — FUNCTIONAL BLOCK DIAGRAM





SPECIAL OFFER

TWO MC3359s FOR £2.50 INCLUSIVE TYPICAL ONE OFF RETAIL PRICE £3.50.

We don't want you to tear your copy of R&EW but we have to make sure that this special price deal is only available to readers of the magazine — so to take advantage of the offer place your cheque/PO (payable to Radio & Electronics World) in an envelope together with the readers response card from this issue and post to: R&EW, 200 North Service Road, Brentwood, Essex, CM14 4SG.

If you subscribe to R&EW, enclose your address label and the price to you will be only **£2.00** for two devices.

OFFER CLOSES June 30th UK, August 31st Overseas.

Price for PCB only £0.96p+ 50p p&p But order the PCB together with two MC3359s and we'll pay the postage.

You could do with a Helper on your test bench.

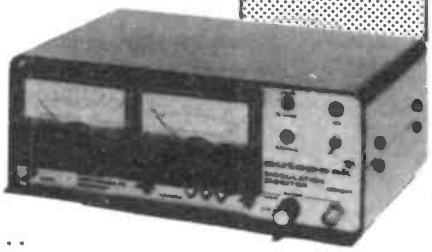
Helper low cost instruments are specially designed for 'fiddle-free', instant bench testing or mobile servicing of two-way radio equipment.

They'll make life easier for the busy technician whilst giving extremely reliable, lasting service.

The Autopeak Modulation Monitor..

For reading peak modulation and modulation density on any FM receiver whose 2nd I.F. is 400, 450 or 455KHz. Other frequencies may be accommodated on special order.

£290
exc. VAT&P & P



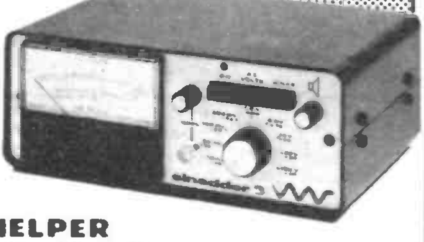
The Sinadder 3...

Ideal for bench or mobile service van use, with 3 functions in one. Automatic SINAD meter with audio monitoring plus a 1000Hz tone generator. Sensitive AC voltmeter, 1M Ω input impedance, with audio monitor for tracking down distortion and locating defective stages.

These are just two of our Helper range.

£220
exc. VAT&P & P

Write now for a product guide and free copy of the mobile radio desk reference.



HELPER

LYONS INSTRUMENTS

Lyons Instruments Limited, Hoddesdon, Herts. EN11 9DX, England
Telephone 67161 Telex 22724 A Claude Lyons Company

162 for further details

GAREX (G3ZV1)
SX200-N

THE ULTIMATE SCANNER

COMPARE THESE FEATURES

* SPECIALLY DESIGNED FOR EUROPEAN MARKET
* MICROPROCESSOR CONTROLLED 32,000 CHANNELS
* AM & FM ALL BANDS
* WIDER COVERAGE: 26-58, 58-88, 108-180, 380-514MHz; includes 10m, 4m, 2m & 70cm Amateur bands.
* 5kHz & 12½kHz FREQUENCY INCREMENTS
* 16 MEMORY CHANNELS WITH DIRECT ACCESS
* 2 SPEED SCAN/SCAN DELAY CONTROL
* 2 SPEED SEARCH UP AND DOWN
* SEARCH BETWEEN PRESET LIMITS UP AND DOWN
* 3 SQUELCH MODES inc. CARRIER & AUDIO
* RELAY OUTPUT FOR Aux. CONTROL
* INTERNAL SPEAKER
* EXTERNAL SPEAKER & TAPE OUTPUTS
* LARGE GREEN DIGITRON DISPLAY BRIGHT/DIM
* AM-PM CLOCK DISPLAY
* 12V DC, 230V AC OPERATION
* 12 MONTH WARRANTY FACTORY-BACKED SPARES & 'KNOW-HOW' AND THE ALL-IMPORTANT PRE-DELIVERY CHECK BY GAREX THE

MAIN SERVICE & SALES AGENTS

£264.50 INC VAT Delivered

"SCAN-X" VHF/UHF BROADBAND FIXED STATION AERIAL £19.90.
Ideal for SX-200 and other VHF/UHF receivers.

SR-9 monitor: 2m FM with 144-146MHz full coverage VFO + 11 xtal controlled channels; ideal for fixed,/M,/P use. 12V DC operation £47.50

Marine Band SR-9, 156-162MHz, same spec. and price.

CRYSTALS FOR NR-56, SR-9, SR-11, HF-12, TM-56B All 2m channels from 0(145.00) to 33(145.825). Also 144.80, 144.825, 144.85 Raynet at £2.46 (+20p post per order). Over 40 popular marine channels at £2.85 (+20p post).

RESISTOR KITS a top-selling line for many years. E12 series, 5% carbon film, 10Ω to 1M, 61 values, general purpose rating ¼W or ½W (state which)

Starter pack 5 each value (305 pieces)	£ 3.10
Standard pack 10 each value (610 pieces)	£ 5.55
Mixed pack, 5 each ¼W + ½W (610 pieces)	£ 5.55
Giant pack, 25 each value (1525 pieces)	£13.60

NICAD RECHARGEABLES physically as dry cell: AA(U7) £1.30; C(U11) £3.35; PP3 £5.55. Any 5+: less 10%, any 10+: less 20%.

CRYSTAL FILTER 10.7MHz, 12½kHz spacing, ITT 901C £6.90

CO-AXIAL CONNECTORS & ADAPTORS SAE full list.

PL259 UHF plug with reducer 75p; SO239 UHF socket, panel mtd. 60p; Inline coupler (2 x sockets) £1.00; Inline coupler (2 x plugs) £1.00. Any 5+ connectors: less 10%

HT TRANSFORMER multi-tap mains pri.; 5 secs: 35V 200mA, 115V 150mA, 50V 500mA, 150V 300mA, 220V 300mA £5.50

PYE CAMBRIDGE SPARES (our speciality, SAE full list) Ex. equip., fully guaranteed. Rx RF board 68-88MHz £5.95. 10.7MHz IF £3.65. 2nd mixer 10.7MHz to 455kHz £3.00. 455kHz block filter 12½kHz £9.40, ditto 25kHz £3.00. 455kHz AM IF £3.65. Audio bd. £1.95, and many more. Vanguard & Westminster spares also.

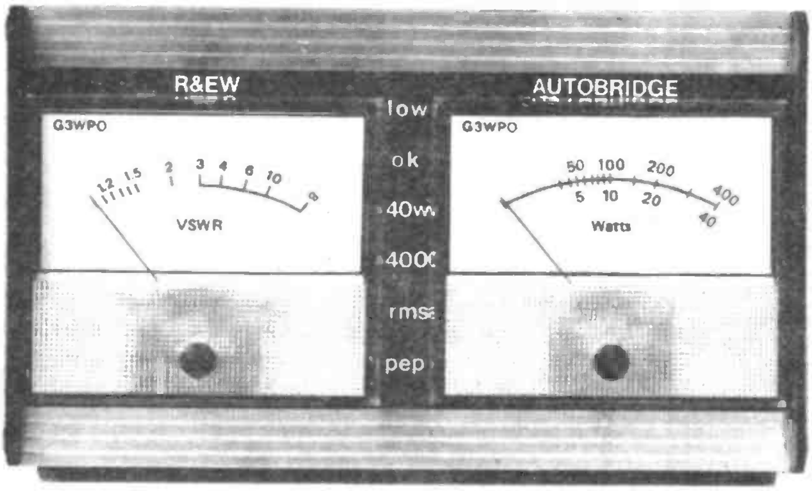
GAREX FM DETECTOR and squelch conversion for Pye R/T equipment Ready assembled, full instructions. Tailor-made, easy-fit design, replaces existing squelch board, with minimum of modifications. For AM Cambridge £5.95; for Vanguard AM25B (Valve RX) £5.75; for Translstor Vanguard AM25T £6.60

MAIN DISTRIBUTOR OF REVCO AERIALS & SPECIAL PRODUCTS
(trade enquiries welcome)

PRICES INCLUDE UK P&P and 15% VAT

GAREX ELECTRONICS
7 NORVIC ROAD, MARSWORTH, TRING, HERTS HP23 4LS
Phone 0296 668684. Callers by appointment only.

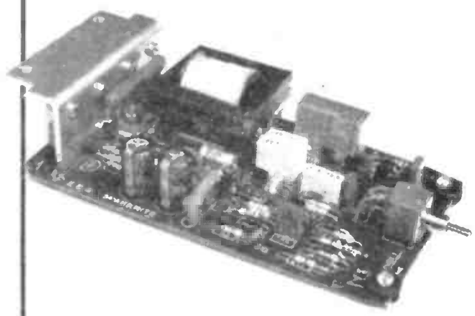
WHAT TO LOOK FOR IN JULY



THE R&EW AUTO BRIDGE

An automatic power tracking VSWR bridge and self-ranging RMS/peak power meter.

- Twin meters, one reading VSWR, the other, forward power.
- Self tracking — no adjustments for continuous VSWR reading, from 4W to 400W.
- **RMS** or peak power indication.
- **LED** status indicators.



ELECTRONIC IGNITION

Another **R&EW** project to help you get the most out of motoring.

- Reactive discharge
- Switchable contactless
- 4 or 6 cylinder operation
- Auxiliary back up circuit

The ultimate system

R&EW — THE BEST VALUE FOR MONEY ELECTRONICS MAGAZINE

COMMENT

The **R&EW** comment boxes, at the end of many projects and features, offer readers a chance to directly influence the contents of **R&EW** completed reader response cards are the subject of extensive computer analysis which means that within a week of an issue appearing we have a good idea which items you like and those areas in which we 'could do better'.

Next month, at the risk of giving away a few trade secrets, we publish the results of our analysis of some past issues of **R&EW**.

PANASONIC RF3100 REVIEWED

Although not generally seen on the amateur communications market this set is one not to be overlooked.

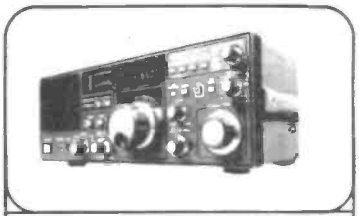
A battery mains counterpart of the Trio R600, with an FM band thrown in, the set is a delight to use.

Read next month's **R&EW** for an in-depth look at the set featuring our unique circuit analysis section.

DOPPLER DF AND POWER MOSFETS

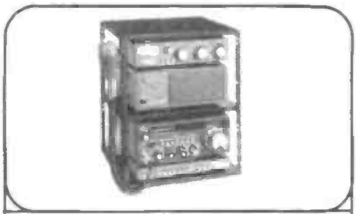
Next month we give full circuit details of the Doppler DF unit described in this issue and Ian Campbell moves on to look at some practical applications of VMOS power devices.

PROJECTS, DATA, REVIEWS, FEATURES, NEWS, COMMENT IT'S ALL IN THE JULY ISSUE OF R&EW.



HF RECEIVERS

FRG7700: 0.15-30 MHz, continuous coverage AM/SSB/CW/FM. (Memory option) £329 inc.



AMATEUR H.F.

FT707 10-80m, 100W PEP, SSB/AM/CW. Variable IF bandwidth, Digital £569 inc.

MARINE MF

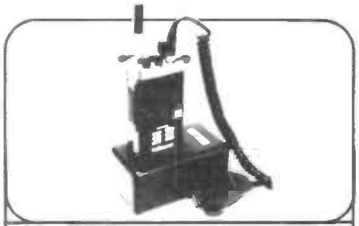
Voyager, 5 channel, 1.6-4.2 MHz, 20W PEP. Auto alarm 2182 etc, to MPT 1271 £495 + VAT.

HF SYNTHESISED

FT–DNE 0.15-30 MHz Rx, 1.5-30MHz Tx, AM/SSB/CW/FSK/FM 100W £1,295 inc.

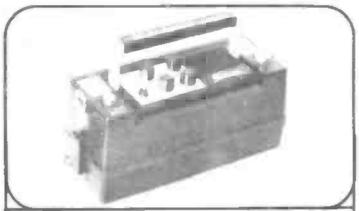
2 METRE TRANCEIVERS

FT480R Synthesized 25/12½/1 kHz on FM 1 kHz 100/10Hz SSB, 10W PEP, £379 inc.



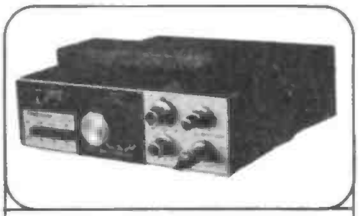
MARINE VHF

MARINER 6 channel, 1 watt handheld. c/w 6,8,16 etc. to MPT 1251 £175 inc.



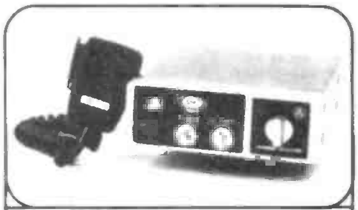
HF SSB PORTABLES

JSB–20. 4 channel 3-9MHz. 10W PEP Options of 3 antennas, 4 power supplies.



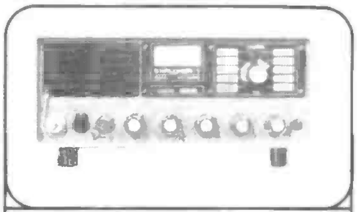
70cms. TRANSCEIVERS

KLM Jumbo. 432-432.48MHz USB/LSB 10W PEP Auto scan, etc. £129 inc.



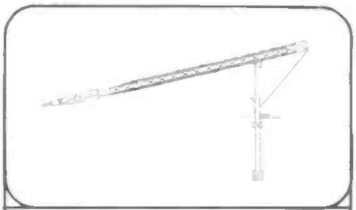
CITIZENS BAND

OSCAR–ONE: 27 MHz, 40 channel, 4W, Delta tune, channel 9, to MPT 1320 £85 inc.



HF TRANSCEIVERS

Explorer. 100W PEP, 10 Channel 12V, To Vol. fit spec £1,350

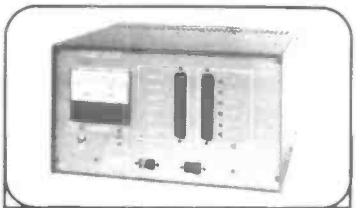


MASTS

Minitower. Telescopic, crank over, Nom 30', 10' sections from £360 + VAT

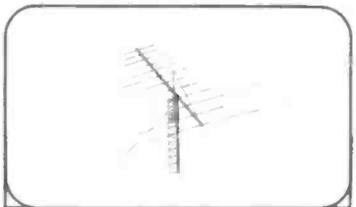
PRIVATE MOBILE RADIO

COMPACT 10W, single channel mobile. Highband, to MPT1301. Unit cost £250 + VAT.



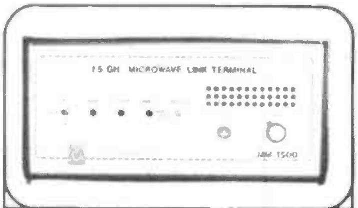
LINEAR AMPLIFIERS

T1000. Solid state broadband, 2-30MHz, 1000W PEP, Remote.



ANTENNAS

LP1007. Log Periodic. 13-30 MHz to 4kW PEP, Ex-stock £1,282 + VAT



MICROWAVE LINKS

Full duplex, single channel, 1.5 GHz, 4W, 230/24V, 19" rack, to MPT 1401.

SOUTH MIDLAND COMMUNICATIONS LTD

S.M. HOUSE, OSBORNE ROAD, TOTTON, SOUTHAMPTON, SO4 4DN, ENGLAND
Tel: Totton (0703) 867333, Telex: 477351 SMCOMM G, 'Gram: "Areial" Southampton

LEEDS
S.M.C. (leeds)
257, Otley Road,
Leeds 16, Yorkshire
Leeds (0532) 782326
9-5.30 Monday-Saturday

GRIMSBY
S.M.C. (Humberside)
247a, Freeman Street,
Grimsby, Lincs.
Grimsby (0472) 99288
10-6 Tuesday-Saturday

SMC

STOKE-ON-TRENT
S.M.C. (Stoke)
76, High Street,
Talke Pits, Stoke
Kidsgrove (07816) 72644
9-5.30 Tuesday-Saturday

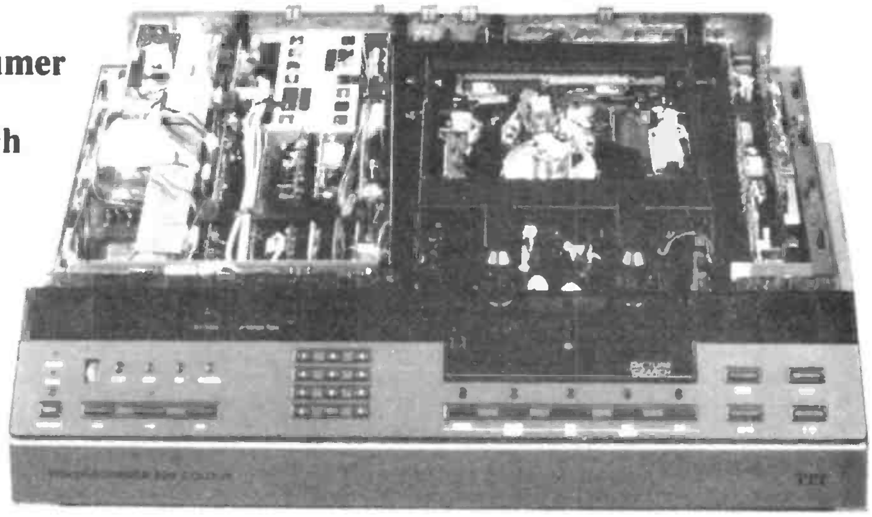
CHESTERFIELD
S.M.C. (Jack Tweedy)
102, High Street,
New Wellington, Chesterfield.
Chesterfield (0246) 453340
9-5 Tuesday-Saturday

SMC AGENTS

Stourbridge	Brian	G3ZUL	(03843) 5917
Bangor	John	GI3KDR	(0247) 55162
Tandragee	Mervyn	GI3WWY	(0762) 840656
Edinburgh	Jack	GM8GEC	(031665) 2420
Buckley	Howarth	GW3TMP	(0244) 549563
Neath	John	GW4FO1	(0639) 55114/2942
Jersey	Geoff	GJ4ICD	(0534) 26788

177 for further details

The VCR, like any good consumer phenomenon, minds its own business and is taken very much for granted.
In the next few pages we explain what makes it tick.



VIDEO CASSETTE RECORDERS: INS AND OUTS

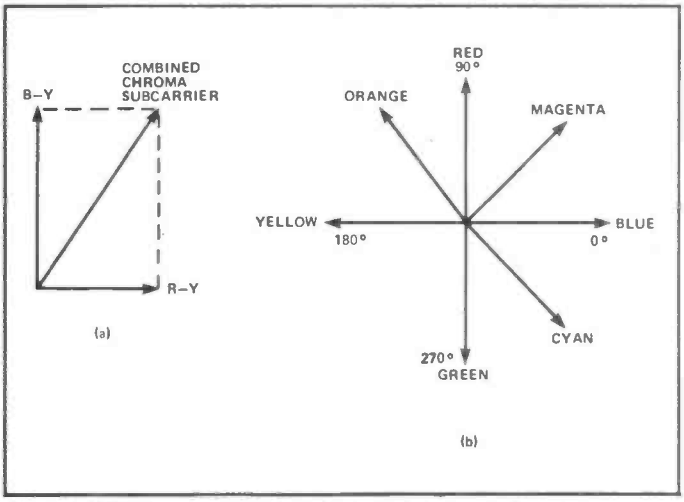


Figure 1: NTSC vectors; (a) the addition of the two subcarriers to produce the chrominance signal and (b) the colours produced by different subcarrier phase angles.

RECORDING COLOUR TV SIGNALS is a complex problem to which modern VCR machines provide an elegant answer with their wealth of electronic and mechanical sub-systems. Before getting to grips with the machinations of VCR's, however, a brief run down of the principles involved with colour TV systems is probably in order since many people involved with electronics never really get to grips with the 'mechanics' of the CTV broadcast system.

THREE'S COMPANY

There are three basic systems, the first one to be developed being the American NTSC standard — that's National Television System Committee, not as some would have us believe 'Never The Same Colour'.

In all systems the Red (R), Green (G) and Blue (B) signals produced by the camera are mixed in the proportions 0.3R + 0.59G + 0.11B to produce the 'luminance' signal Y.

These values are chosen to match the response of the human eye and correctly reproduce a monochrome view of the scene. 100% Y is white (R, G and B all 100%), 0% Y is black (R, G and B all zero).

Colour information is transmitted, not as direct representations of the R, G and B signals but as 'chrominance' (or chroma) information, this being the difference between the individual 'colour' signals and the luminance signal: R-Y, G-Y and B-Y.

This approach is adopted as it means that in practice only two of the three chrominance signals need to be broadcast as the third can be obtained by a decoder matrix at the receiver.

PARTING OF THE WAYS

So far, the approach is common to all broadcast systems — the differences occur in the way that luminance and chroma information is modulated onto the TV carrier.

NTSC uses quadrature AM on a suppressed subcarrier of 3.58 MHz: The R-Y and B-Y signals modulated onto subcarriers that are 90 degrees out of phase with one another. The vector diagram of *Fig 1* illustrates the point. By approaching the problem in this way, complete compatibility with monochrome (and monochrome bandwidth requirements) is maintained.

The hue of the colour is represented by the phase angle of the resultant phasor, and colour saturation by the amplitude of the subcarrier — and it is here that the problem with NTSC arises. Since the phase of the chrominance signal will vary slightly from station to station, as well as in the course of processing through filters and VTRs, it will cause a change of colour to occur on the screen. It's not from any American fetish for extra knobs to twiddle that most NTSC sets have an extra one labelled 'Hue' or 'Tint'. (There's no truth in the rumour that the Incredible Hulk started life as a phase error in a VTR editing room.)

At the receiver, the suppressed subcarrier must be re-inserted by a locally generated signal (as in MPX sound broadcasting), and this signal must be in phase with the transmitted signal or the colour tint goes to pot, as mentioned previously. In other words, a reference is required. In CTV, the signal cannot be broadcast continuously, or patterning and other interference will occur. It is sent as burst of some ten cycles of 3.58 MHz in the back porch of the line sync pulse as shown in *Fig 2*.

By using only an occasional burst, the local carrier regenerator system cannot rely on a free running oscillator, so a crystal is used in a much more stable oscillator that can maintain the necessary accuracy using only the periodic prod from the colour burst. (Or should that read 'color'?). Current NTSC techniques now employ a further correction signal, transmitted in the field blanking interval, which can be used by receivers fitted with the appropriate decoder. The need for stabilising the hue has provided much scope for the ingenuity of IC manufacturers, and the Hitachi HA11436 sums up a reasonably recent solution to NTSC decoding, including 'auto flesh'. (?) *Fig 4* shows a simpler and less cluttered approach to NTSC with the HA11222.

As you will see by comparing with PAL processor circuitry, NTSC seems a shade ragged — the value of hindsight for the PAL system engineers.

ENTER THE DELAY LINE

In view of the problems with NTSC, the French standard of SEECAM (sequential colour and memory) was evolved — here the R-Y and B-Y signals are transmitted separately on alternate line scans, using frequency modulation of a 4.433619 MHz subcarrier. Colour burst information is replaced by signals at the beginning of each field that instruct the decoder what to expect next; R-Y or B-Y. A 64uSec delay line delays the chrominance signal by exactly one line scan period.

So on one scan line, the direct B-Y signal is combined with the 'stored' R-Y signal from the line before. The switching between the direct and delayed signals is controlled by the line scan pulses, using the instructions sent at the start of the field.

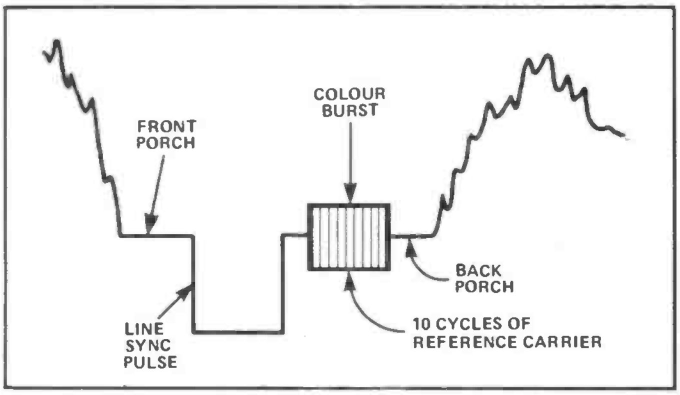


Figure 2: The reference carrier is sent during the line sync's back porch. This is at 3.58 MHz for NTSC and at 4.43 MHz in the PAL system.

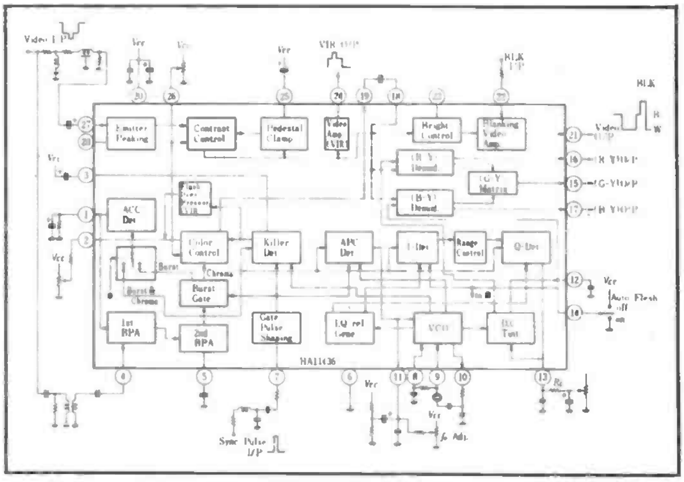


Figure 3: Block diagram of a recent IC solution to the problems of NTSC decoding, the HA11436 from Hitachi.

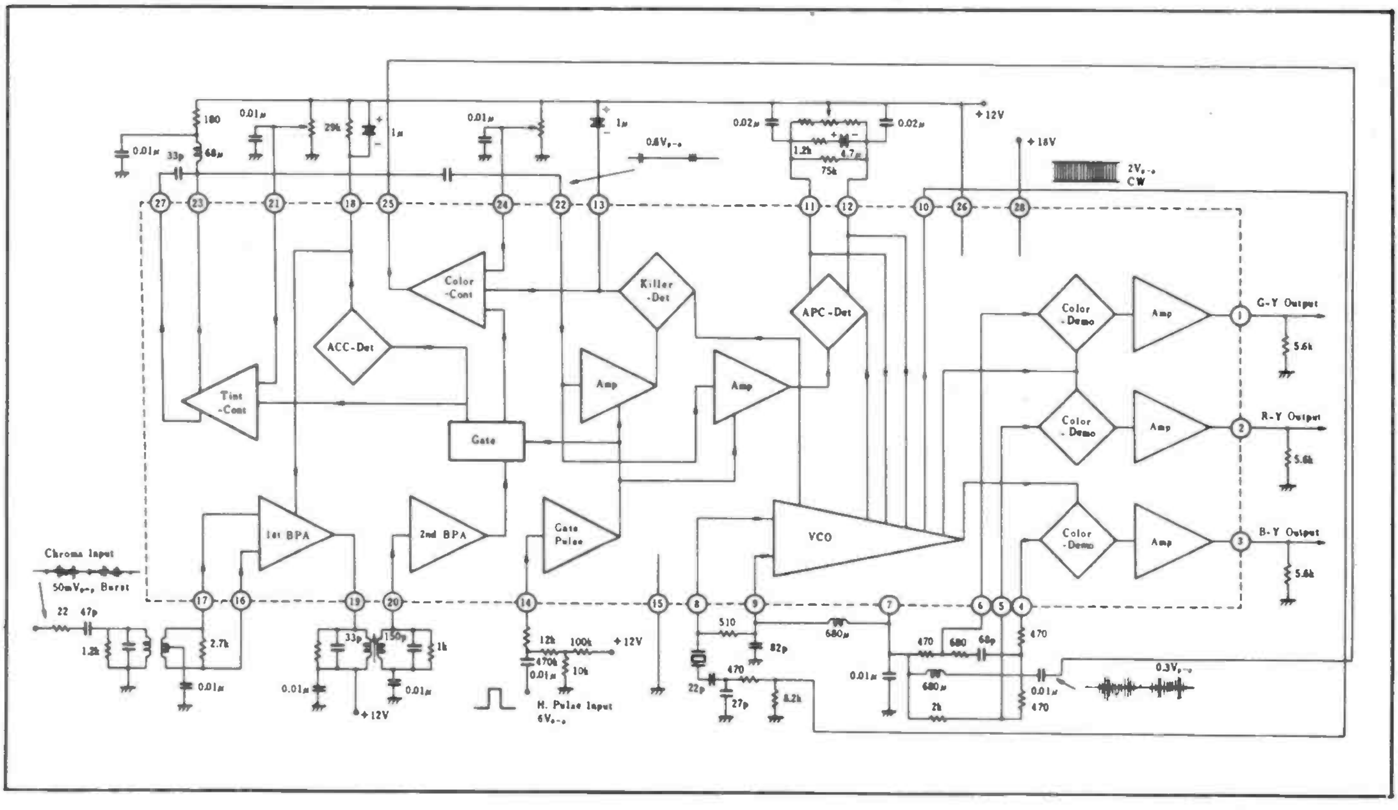


Figure 4: A simpler approach to NTSC decoding is used in the HA11222.

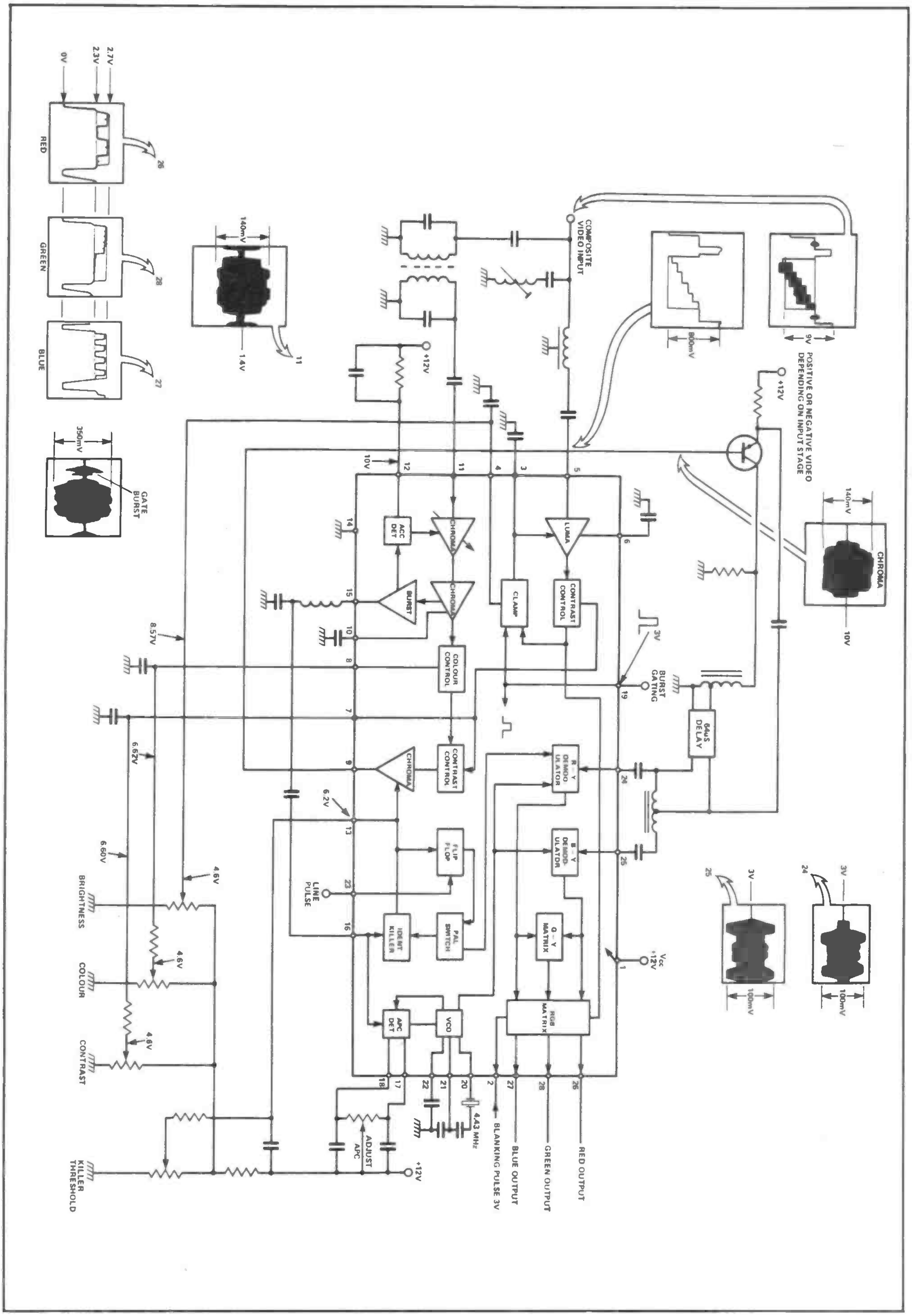


Figure 5: A current generation PAL decoder IC, the TDA 1365.

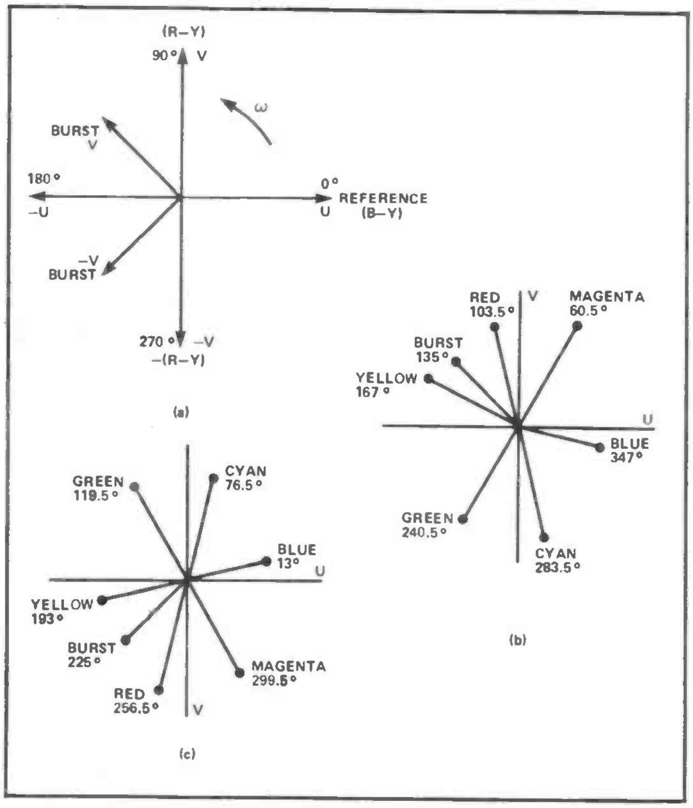


Figure 6: PAL vectors; (a) the basic vectors, (b) lines with non-inverted R-Y (often referred to as the V signal), (c) lines with inverted R-Y.

PLAYING THE ANGLES

The Phase Alternation Line system (PAL) was developed by Telefunken and is a variant of the basic NTSC concept of quadrature modulation of a subcarrier, except that the phase of the R-Y signal reverses on alternate lines. *Fig 6* illustrates this. The direct and delayed signals from two successive scan lines are then combined to produce the colour output signals.

The colour burst in the PAL system shifts phase by 90 degrees on alternate scan lines, which permits the decoder to determine the correct R-Y phase for each of the scan lines. The colour resolution is then only half the number of lines — but this is adequate in the 625 line system used in countries with 50 Hz mains.

One of the best ways of illustrating a PAL decoder at work is to consider a current generation device combining all the PAL decoder functions in a single IC, such as the TDA1365 shown in *Fig 5* together with associated waveforms. This device is also suitable for NTSC with minor modificaion, and the omission of the strictly PAL parts, such as the delay line.

The chroma signals are separated from the 'luma' signals by a bandpass filter, and then amplified under control from the reference chroma-burst signal, using the auto chroma control (ACC). A manual gain control is used in the next stage to suit individual tastes.

The 4.43 MHz crystal oscillator is phase-locked to the chroma-burst, to provide a phase coherent reference signal for the matrix demodulator. The flip-flop swaps the phase of the subcarrier signal to the R-Y demodulator, corresponding to the transmitted format. The correct sense is established by checking that the phase of the burst has increased when the circuit expects it to — otherwise the ident killer on pin 16 causes the FF to miss a step, and start up on the correct phase with the next signal.

The chroma signal emerging at pin 9 is then passed through the delay line — and combined with the direct signal at the input to the demodulator. The B-Y signal results from the sum of the direct and delayed signals, the R-Y from the difference, see *Fig 7*. The remaining section of the decoder comprises the G-Y matrix, and finally the RGB matrix itself, achieved quite simply by adding the Y (luma) signal to the various chroma difference signals.

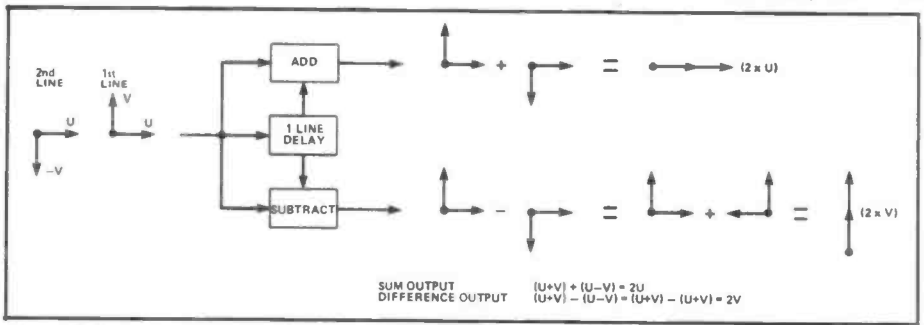


Figure 7: Seperation of the B-Y (or U) signal and the R-Y (or V) signal using a delay line with add and subtract networks.

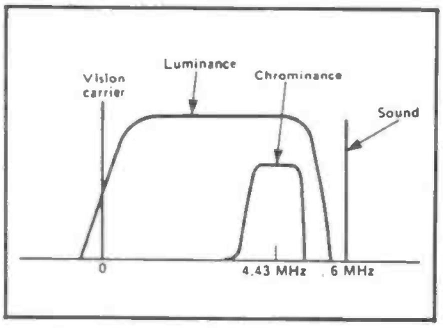


Figure 8: Spectrum of the PAL UK video signal.

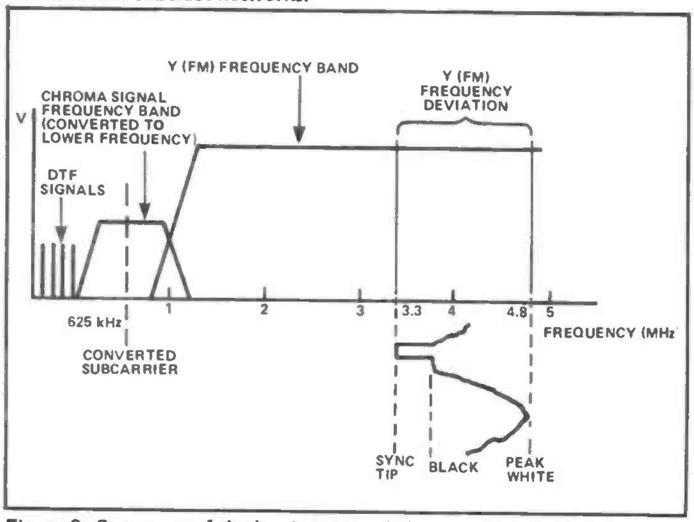


Figure 9: Spectrum of the luminance and chrominance signals as recorded by domestic VCR S. Note the DTF signals are only present in the Video 2000 format.

ON WITH THE VCRs

The complete spectrum of the PAL UK system video signal, with luma, chroma and sound is illustrated in *Fig 8*. The bandwidth occupied is somewhat more than 6 MHz — so how does the VCR tape travelling at 2cm/sec (or thereabouts) cope with that? After all, 2cm/sec limits at around 20 kHz being less than half the playing speed of a standard audio cassette tape. It is the extinction frequency of a magnetic recording system which limits the maximum frequency to that where the cycle length equals the head gap — in other words, the positive and negative going halves of the cycle will cancel. To achieve a 5 MHz extinction frequency (which is greater than the 3 dB bandwidth anyway) a head gap of 0.2 micron would have to combine with a writing speed of 1m/sec — neither of which is feasible for a VCR that sells for £500, and records for 3+ hours. However, the effective writing speed can be greatly increased by the use of helical scanning heads. ▶

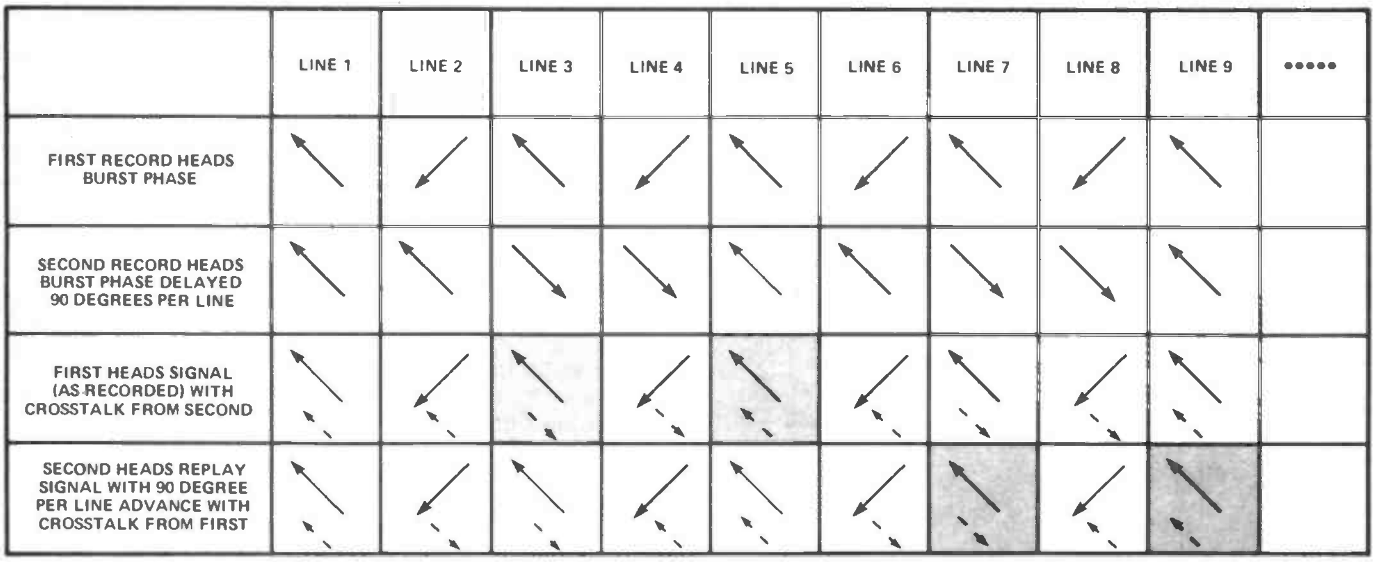


Figure 10: Chroma crosstalk is eliminated by means of a two line delay. The shaded boxes show that with such a delay the main vectors are reinforced while crosstalk vectors cancel.

TWO HEADS ARE BETTER THAN ONE?

In a helical scan system two heads are mounted 180 degrees apart on a drum capable of being rotated at high speed. The tape is wound round the drum in a spiral, helical path. This arrangement produces a series of narrow diagonal tracks recorded on the tape and raises 'writing speed' to around 7m per second.

As anyone familiar with audio recording techniques may suspect, this system is wide open to problems arising from crosstalk — one solution would be to place a guard band between tracks, but this would effectively halve the tape time. However, as anyone who has fiddled with a tape head azimuth (angle relative to travel of tape) adjustment will appreciate, the HF response of the head falls away dramatically as the error is increased.

The clue offered by this simple observation is that adjacent tracks should be recorded with head azimuth adjustments that are separated by an 'error' angle. Slant azimuth recording, with a 30 degree angle between adjacent tracks has been adopted by the domestic VCR formats. The head assembly contains two heads — each head recording a complete field.

Figure 9 shows that the luminance signal, which has components from DC to several MHz, is recorded using frequency modulation of a HF carrier signal. As we have mentioned the slant azimuth recording technique will provide adequate crosstalk for this HF luminance signal but will not be effective at the low frequency of the carrier onto which the chroma information is modulated.

All domestic recorders shift the chroma information from the 4.43 MHz, broadcast frequency, to a lower, about 750 kHz, signal in order to reduce the bandwidth requirement of the machines. The major difference between the best selling video formats, VHS and Betamax, is the way in which the effects of crosstalk on this signal are minimized.

VHS

The technique used to protect the recorded chroma signal from the effects of crosstalk is much the same as the delay line system used in PAL TV receivers to provide immunity against phase variations in the transmitted chroma subcarrier. The major difference being that it involves a *two* line delay.

Reference to the phase diagram of *Fig 10* is essential if the following description of the system is to be understood.

During recording one of the two helical heads records the colour subcarrier in 'direct' phase, the first line of the vector diagram, while the other records the signal with a lag that increases by 90 degrees per line. The colour burst which occurs at 135/225 degrees on the vector diagram of *Fig 6* is thus retarded by the second head in steps of 90 degrees, the second line of *Fig 10*.

Combining the effects of PAL and 90 degree lag, the second head records the colour burst as:

135-0 equals 135 degrees
225-90 equals 135 degrees
135-180 equals 315 degrees
225-270 equals 315 degrees

During playback the first head's signal is reproduced as recorded, the third line of the vector diagram shows this signal along with crosstalk due to the second head. While replaying this second head's signal is *advanced* by 90 degrees per line — the effect of this on the signal and the first head's crosstalk is shown in the fourth line of *Fig 10*.

VHS doesn't do this just to be awkward, since if we now examine the phase of the main colour vector and crosstalk vector of either head, the addition of a direct signal and a signal with a two line delay produces an interesting effect. The main burst vectors reinforce while the crosstalk vectors cancel.

Needless to say this is a very involved process in practice and we shall leave a close look at the systems used for a future article.

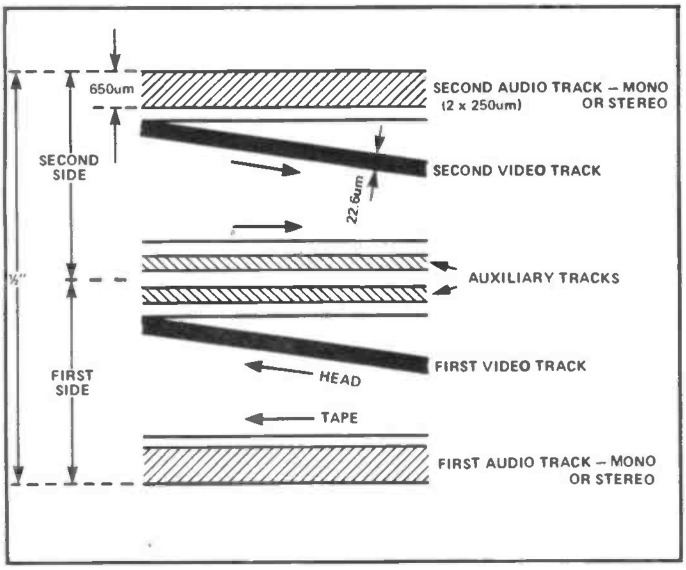


Figure 11: Arrangement of the tracks on the tape in the Video 2000 format.

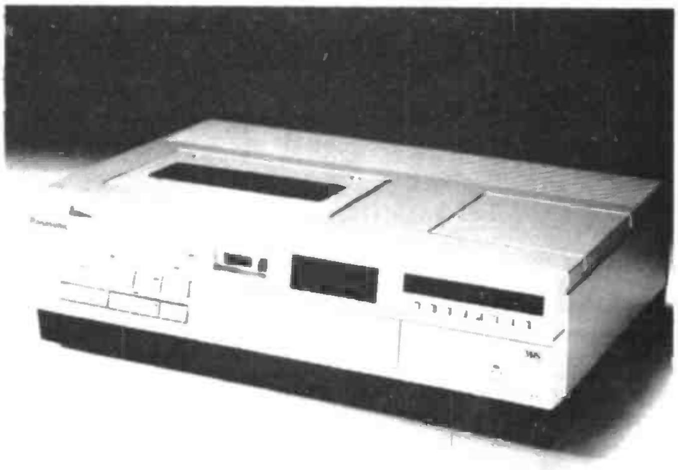
BETAMAX

The way in which the Betamax system tackles the problem of chroma crosstalk is quite different in its practical implementation although the basic philosophy is much the same.

Instead of applying a 90 degree phase change to one head the Betamax system employs two colour subcarriers:

1st head equals Line Frequency x (44 — 1/8)
2nd head equals Line Frequency x (44 + 1/8)
685.54688 kHz and 689.45312 kHz respectively.

A bit of maths can show that the result is 45 degree phase rotation per line in each head (wrt line frequency) — retardation and advance respectively, so the net effect is a 90 degree shift between heads, and the vector analysis is thus the same as for VHS in *Fig 10*. The same crosstalk cancellation, although using a completely new technique to achieve it. Arguably, it is the absence of phase switching in Betamax that leads to a smoother result — with 'calmer' linear processes involving balanced modulators to process the analogue path.



VIDEO 2000

Final entrant in the home video stakes is the Video 2000, developed by Philips and Grundig. The main difference to the consumer is the fact that the cassette can be turned over and used 'compact cassette' style for up to 8 hours playing time. The half inch tape is thus divided into narrow 1/4" tracks (*Fig 14*), which is swept in 3 degree diagonal field tracks. The spectrum of the Video 2000 signal is the same as the VHS and Beta formats, except that dynamic track following (DTF) signals are included to provide the fine tuning of the head positioning demanded in the narrow track system.

The fine positional control is brought about by mounting the heads on piezoelectric plates, and deriving control signals from four more subcarriers laid down on the main tracks during the 96uSec field flyback period: f1-102 kHz, f2-117 kHz, f3-149 kHz, f4-164 kHz. The order in which they are recorded is set out in *Fig 16*.

Now, during playback, in addition to all else going on, there will be crosstalk between DTF tracks. This crosstalk will produce mixing products — e.g. f4-f3 equals 15 kHz if the head is high, or f4-f2 equals 47 kHz if the head is low. (Vice versa for the other head). In fact, any three track group will produce either 15 kHz or 47 kHz difference frequencies. The relative amplitude of the beat signal is then used to control the height positioner in a servo-locked loop.

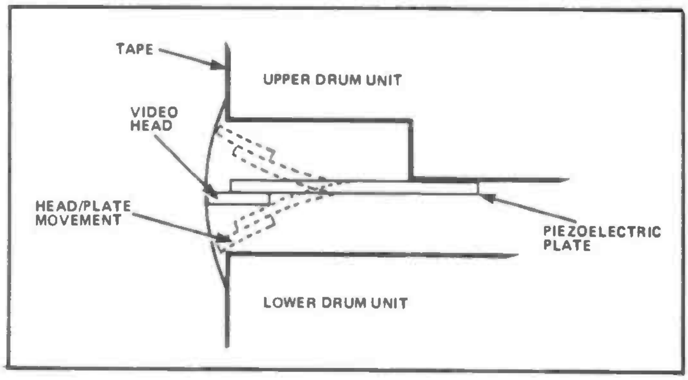


Figure 12: In the Video 2000 format the heads are mounted on Piezo electric elements controlled by the DTF signals.

SIDE TRACKED

All three systems use auxiliary tracks to record audio, indexing and various other control functions.

No special techniques are used for recording the audio signal, except for noise reduction systems on some more expensive models, and with the low linear tape speeds used this means that the quality of audio recording on most machines is far from Hi-Fi. Sound in sync. techniques are still a little way off.

With the complexity of the electronics and the precision engineering demanded by the tape transport mechanism it is a wonder that video recorders have been produced in large quantities at all. That they are reliable and cost from about £350 borders on a miracle.

■ R & EW

Next month we put some of the latest video recorders through their paces.

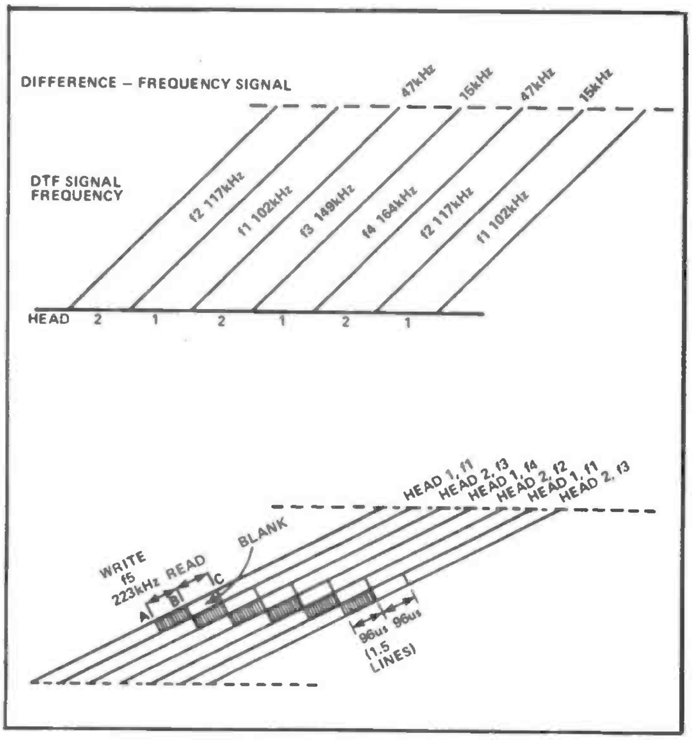


Figure 13: The pattern of DTF signals laid down by a Video 2000 format recorder.

Your Reactions	Circle No.		Circle No.
Immediately Interesting	9	Not Interested in this Topic	11
Possible Application	10	Bad Feature/Space Waster	12

READERS LETTERS

Facts and opinions; Yours and Ours

The response to the views expressed in April's News Background revealed some very strong opinions. Here is a selection from our postbag.

28MHz instead of 144MHz?

Dear Sir,

Re your 'News Background' item on the use of morse, and the RAE:

First, let's get the present set-up working. I sat the RAE on December 7th 1981, received the pass slip on March 8th 1982, and have applied to the Home Office for a licence. I received a note saying that it will take 2-3 months to process.

So let's get that sorted out. 5000 computer marked papers do not take three months to process — I could mark them by hand in less than 3 months.

I agree with your proposition that morse should become an optional extra — and how about then using the 28 MHz FM section instead of 2m, since any competent amateur should be able to modify a cheap CB to work in that band. This would seem a lot safer than leaving an expensive 2m rig in a car, waiting for someone to pinch it.

And how about exposing the main dealer's cartel? No other product costing hundreds of pounds is exactly the same price from a small hobby shop to a main London dealer selling a rig a day!

And finally, as you are a responsible 'new breed' of journal, how about refusing to accept adverts for illegal transmitters. The adverts are blatent enough: you've a lead on quality, how about honesty?

S C
Newmarket

REW:
No-one is safe when Mr Coad takes up his pen! His comments regarding the state of RAE processing are quite frequently repeated up and down the country — and the HO insist that the problem is lack of staff/funds. Maybe the initial amateur licence should cost a lot more to cover this situation, since there will be many prepared to pay a premium to get on the air before they forgot what was in the RAE anyway.

The suggestion for using 10m like 2m is not entirely new — last month's 'Shack' column mentioned G3LWM's efforts along these lines. The fact that it would encourage technical daring is also interesting — although some purveyors of 2m black boxes may not be so keen.

The point about the equipment cartel is another 'regular' in the columns of the amateur radio press. We have spoken with several main importers in the ARRA group, and feel that they haven't really a fair opportunity to respond. As you all know, this publication exists in the real 'commercial' world, and consequently we have a better appreciation of the problems besetting the equipment retail market.

When the pound rode along at 2.40 dollars, then the margins were generous — but that wasn't for long, and now the situation is completely changed again.

Re the illegal transmitters: yes, we confess. The advertisement department is essentially entirely independent from the editorial department, but we have taken steps to ensure that advertisements for illicit gear are taken out whenever we have the chance to catch them before going to press.

Go West, young man

Dear Sir:
The relative price of amateur radio equipment in Europe is higher than in the USA and Japan for several very good reasons:
1) The import tax in the USA ranges from zero to two percent. The UK is obliged to pay 13%.
2) VAT is 15% in the UK. In the USA local state sales tax ranges from 2-4% — or nothing if you buy out-of-state.
3) Market volume commands better buying prices.
4) Freight and insurance costs are much lower in the USA. The Japanese/US sea route takes only 1 week. The shipping costs to the UK are more like 20% of the retail price.
5) UK dealers simply cannot trust the sea freight system to the UK. It's either on strike, or loosing things.
6) Many ARRA members offer 2 years warranty. You get 90 days in the USA.
7) Low overhead costs in the US enable dealers to work on low margins. In the UK, the true cost of an employee is generally more than double the direct gross salary. Equivalent commercial property costs roughly 2-3 times as much in the UK.

Having got that lot off my chest, I feel better. This does not mean that we are dissatisfied with our lot as importers, it's just that too many customers do not understand the problems.

D Stockley
Thanet Electronics

REW:
Dave Stockley's views are widely echoed throughout the trade, and whilst this does not quite cover the aspect of 'price fixing' that is frequently cited as being a major concern, we would like to add that our own experiences of the amateur radio market lead us to suspect that there would be a number of small dealers prepared to cut margins — but that they wouldn't be around too long after the PAYE, NI, VAT, rent, rates, guarantee claims, advertising bills, insurance, shipping costs began to arrive.

You can always order direct from the USA (over the 'phone if you like), and if you sneak past the postal customs charges, then you can be marginally better off... until something goes wrong. Support your UK dealer, by all means keep them on their toes, and do your best to reduce them from their fabled Rolls Royces, down to Granada Ghias instead!

Morse Mania (2)

Dear Sir,
There should be an incentive to learn extra skills to earn extra privileges of full use of the amateur bands, and I see no reason why this shouldn't include morse code. I for one do not believe it to be an obsolete art.

But I can see no logical argument against the use of morse code by the B licencees, on the B licence bands. After all, RTTY operators do not have to pass typing tests. It would be very useful for anyone learning morse to be able to use a band for practice and tuition. No one would be under any obligation to make contact unless they wanted to — but I don't think that there would be any shortage of operators willing to assist the learners.

R O
Pontefract

Red flags and CW

Dear Sir,
I heartily agree with the comments made by Wayne Green. Perhaps the truth hurts old time and ex-service operators who have struggled through the CW barrier. I wonder how many still use the mode regularly, I'd guess less than 5%.

I can't see why abolishing the CW requirement in any way belittles or demeans those who wish to use CW — and most are unquestionably skilled and brilliant purveyors of the mode. When the man with the red flag who rode on a horse ahead of the early motor cars was abolished it did not diminish the popularity or skill of equestrian events.

I would certainly agree that new amateurs should have a qualifying period, prior to being permitted maximum power etc.

It's emphatically 'Green for Wayne'.

R P N
Chelmsford

Disgusted of Shipley

Dear Sir,
Again with disgust I find another attempt by the 'B' class to get an easy ride to a full 'A' class.

It is a well known fact among radio hams that a considerable number of very highly educated, highly skilled graduates do not have the ability to absorb and to pass a 12 wpm morse test, do they??? So they use any means to by-pass this simple and easy test. And they always use the same arguments — they are all there in your **little piece for the boys!!!**

I see Wayne Green is 'at it' now, and no doubt he will be giving your 'little effort' similar space in his magazine next month, to help support his views. After all, if enough pressure is put on by a vocal minority, things could happen.

Why not admit the ability to absorb and pass a simple 12 wpm morse test is not given to the educated, highly skilled electronic graduate, is it? A B class operator has a very limited view of ham radio. A good 90% use FM, work DX through the local 2m repeater, and would be better off on CB.

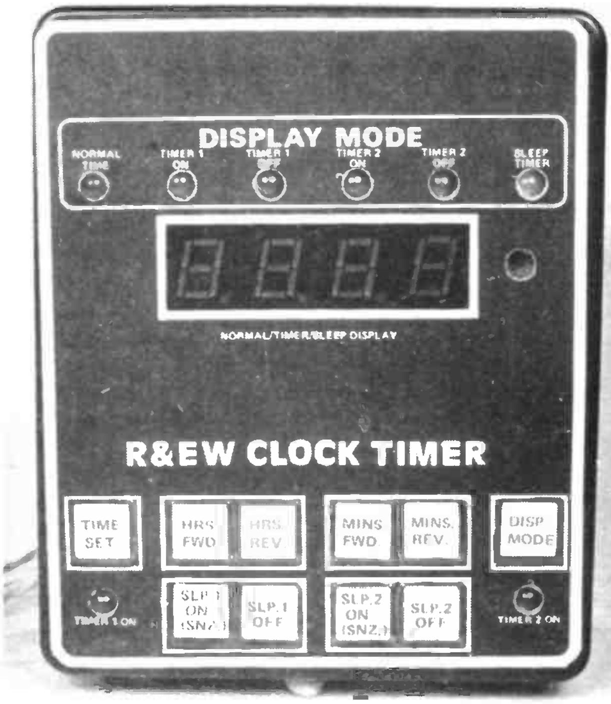
They have never — or very nearly never — worked true DX. Stop all forms of mod. on 2m for class B hams. Make it CW only, 5-12 wpm, shut down repeaters..... (and so it goes on — ed)

F H
Shipley

REW:
Well, that's the one we were all expecting.

Now that's off the chest, no more correspondence please. The computer analysis of the readers' responses to the feature showed an 83% top rating — which also reflects the postbag on the subject. We have intentionally left call signs off this item — you might like to guess why for yourselves!

TWO CHANNEL MAINS TIMER



Versatile mains timer based on four bit custom MPU.

Design by J Burchell and J Oliver.

- Two independent on/off outputs
- Sleep/Snooze facilities
- 24 hour display
- Automatic display brightness control.

ALTHOUGH VARIOUS circuits for mains on/off timers have appeared before, we believe our design, with its dual channel control, to be more versatile than most.

The design is split into two physical sections, the clock and control circuitry and the mains interface board.

The timer offers the following facilities. A display of *Time of Day* in 24 hour format is the 'normal mode'. *Timer 1* ON and OFF times may be set by the appropriate momentary action switches while independent control of *Timer 2's* ON/OFF times is also available. A *Sleep Time* of between 1 and 59 minutes is settable and is used in conjunction with *Sleep* and *Snooze*. *Sleep* causes either timer's output to become active for the period set by *Sleep Time*. Note that *Sleep* can only be activated for ne channel at a time. Finally *Snooze* causes an active output to become inactive for ten minutes. *Snooze* can only be applied to one channel at a time, it also acts as a *Sleeep* cancel for a channel that has had sleep activated.

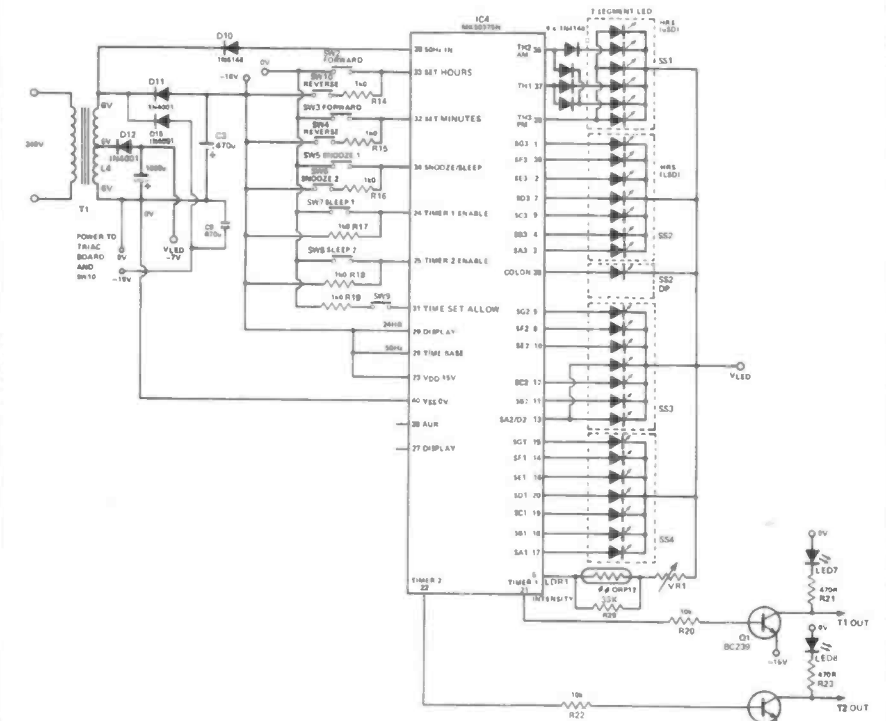


Figure 1: Circuit diagram of clock board.

CIRCUIT DESCRIPTION

The clock timer functions are provided by IC4, (MK50375). The device is capable of driving seven segment displays directly, and an ambient level related brightness control the display is provided by the LDR network on pin 5. The MK50375 derives its timing information from the 50 Hz signal on pin 30. The desired display function is indicated by the pattern of logic ones and zeros at the high impedance inputs on pins 26,27. (NB the 50375 uses three state logic thus six functions can be encoded onto only two pins).

The various momentary push button switches connected to pins 33,32,34,24,25,31 allow forward and backward setting of hours and minutes, as well s the timer on/off times plus the sleep time, and snooze select functions. It is only possible to set a select function to a particular time if the set interlock button is also depressed.

The timer outputs appear on pins 22, 21 and are active high during the selected period, except when being affected by the snooze and sleep functions.

The function select circuitry consists of IC1, 2 and 3. The outputs of the 4017 are buffered to drive the Function Selected LEDs and decoded via a diode matrix to switch pins 27 and 27 of IC4 either high, low or open circuit. Pressing SW1 causes the display select to move on one function, automatic wrapa-round is provided via the D3, R7 network. Whilst R4 and C2 provide an automatic return to display of normal time after 1 minute has elapsed, unless a new function has been selected.

The output circuitry consists of transistor buffer driving an opto-isolated triac whose output is used as the gate signal of the control Triac. This device will handle loads of up to 800 Watts without heatsink, with additional heatsinking loads up to 8 amps may be handled.

The prototype version also employed a six position 2 pole switch to give additional versatility to the output switching, the various functions are listed in *Fig 3* and the similarity between these and a central heating control are apparent.

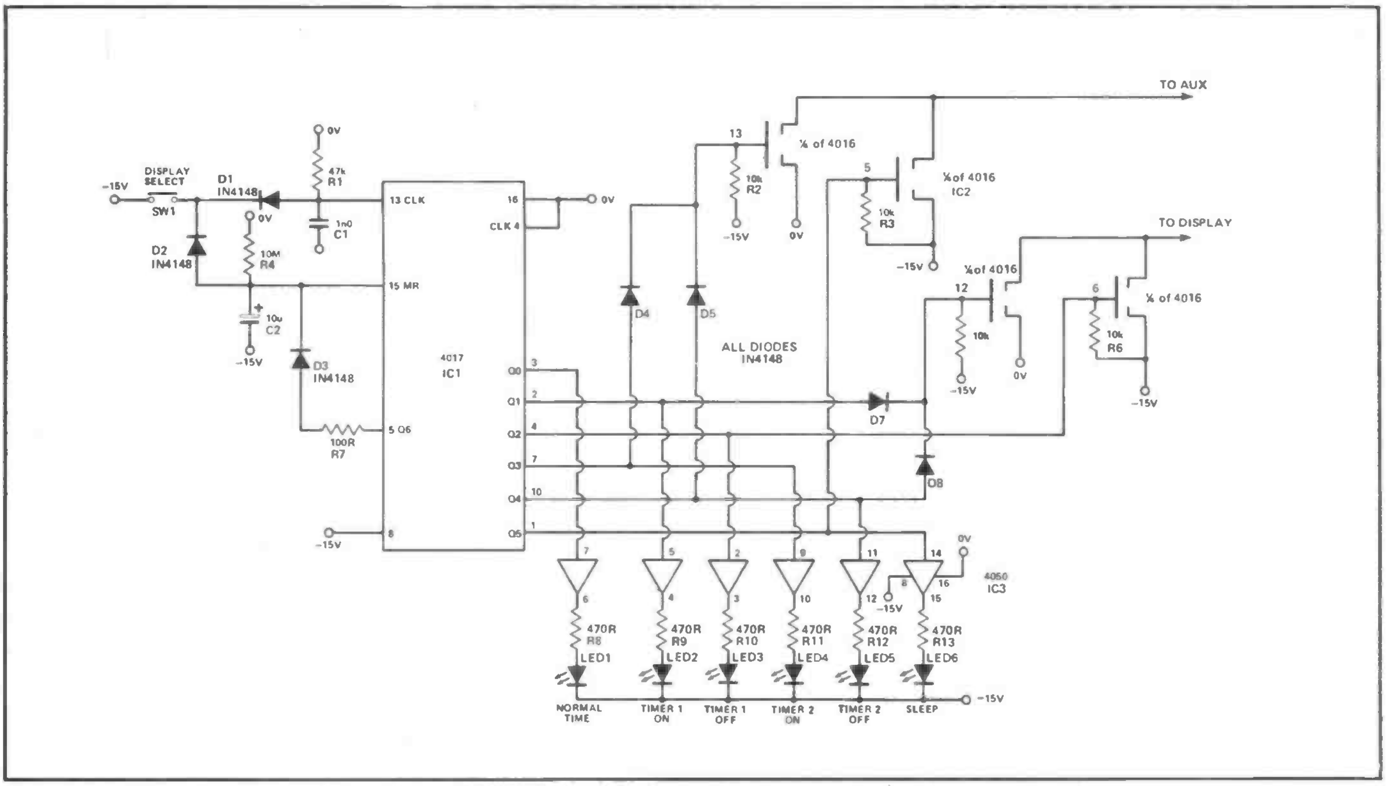
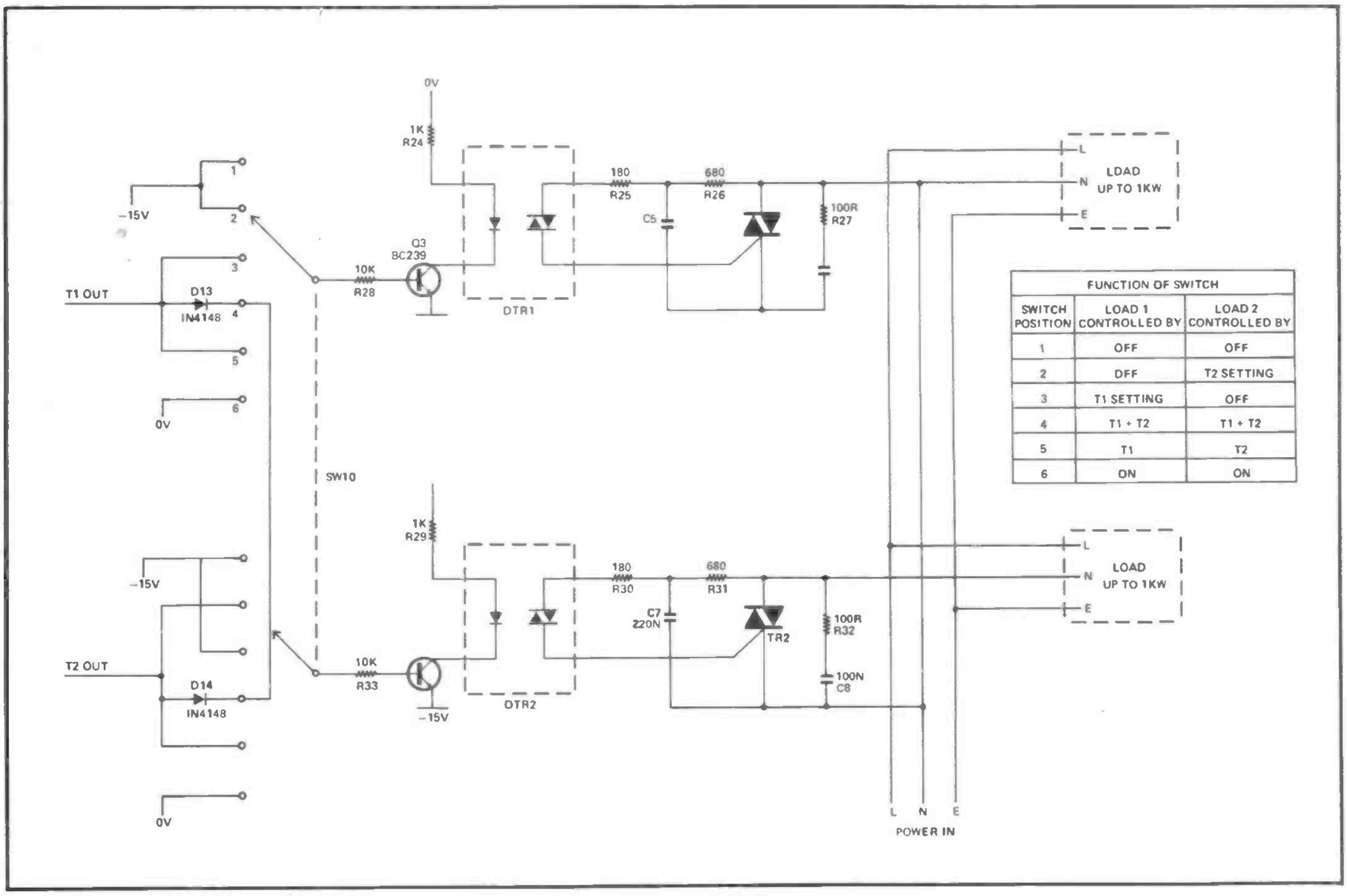


Figure 2: Circuit diagram of Function Select logic.



FUNCTION OF SWITCH		
SWITCH POSITION	LOAD 1 CONTROLLED BY	LOAD 2 CONTROLLED BY
1	OFF	OFF
2	OFF	T2 SETTING
3	T1 SETTING	OFF
4	T1 + T2	T1 + T2
5	T1	T2
6	ON	ON

Figure 3: Circuit diagram of Output circuitry.

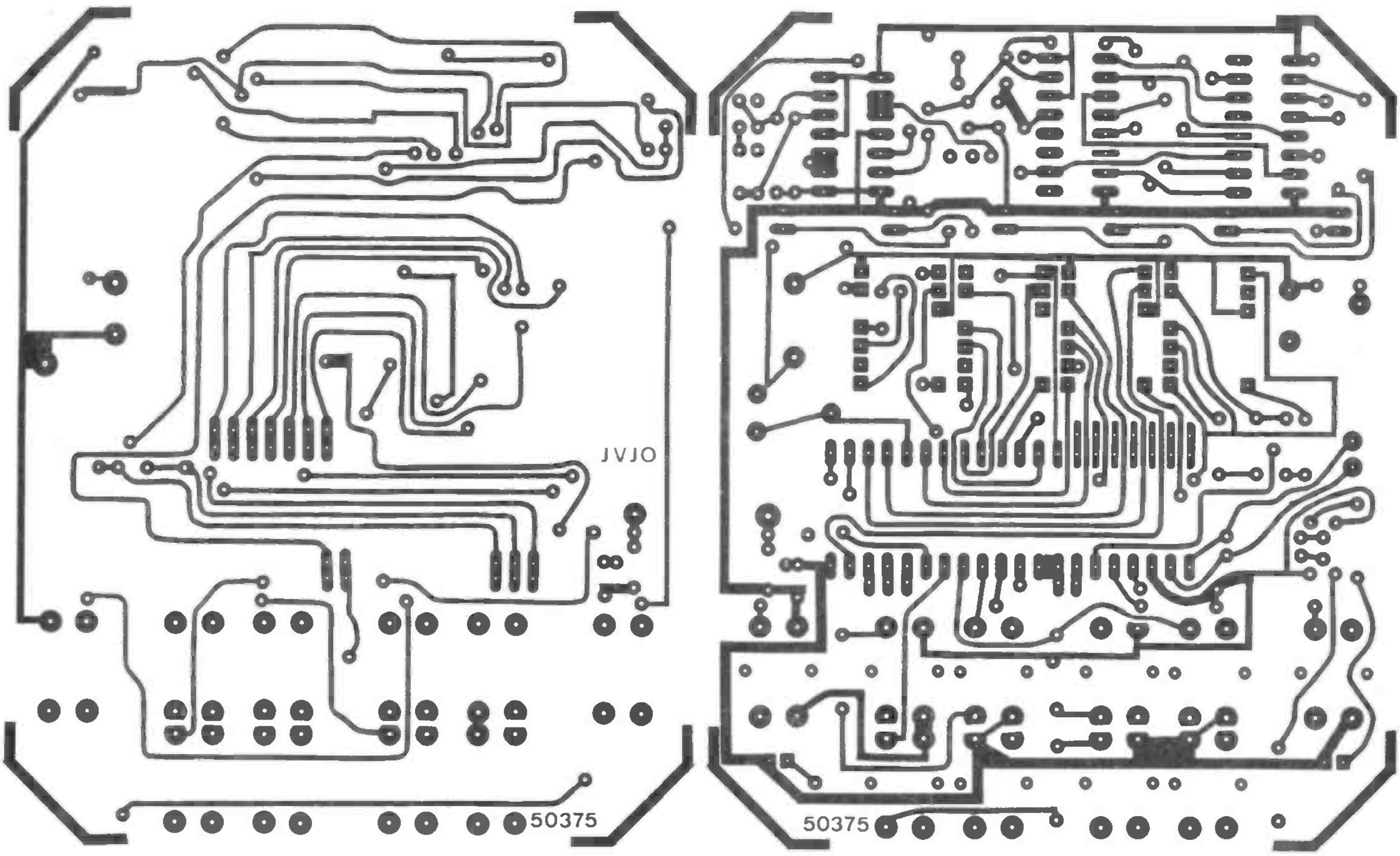


Figure 4: PCB foils of top and bottom track of clock unit.

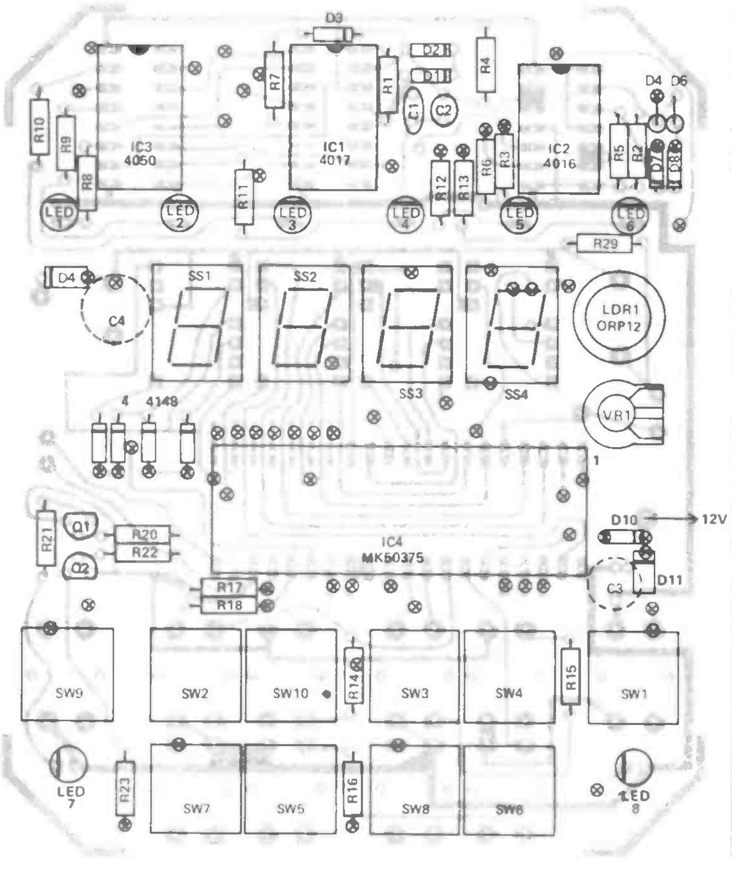
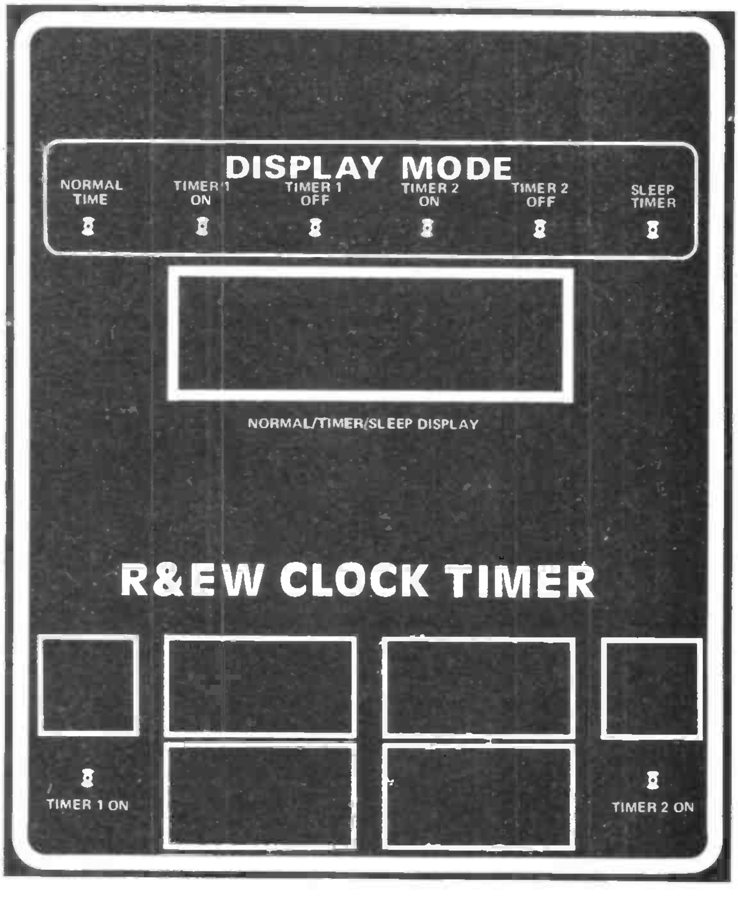


Figure 5: Overlay of clock board.



Front panel of timer and control unit.

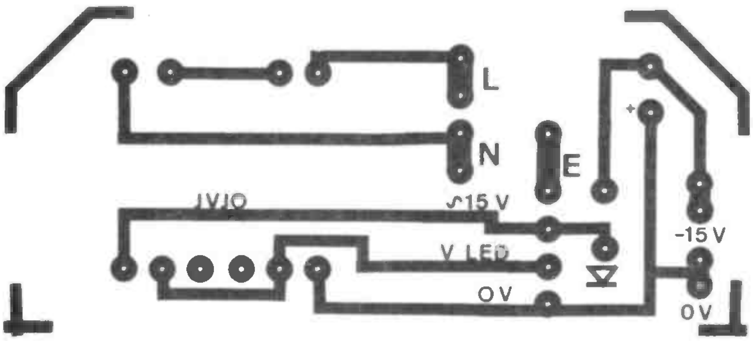


Figure 6: PCB foil of transformer board.

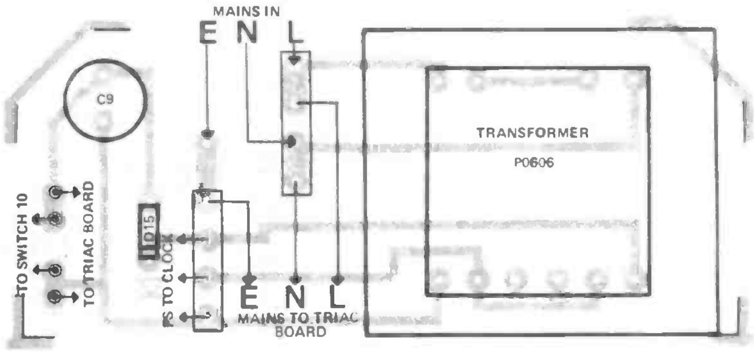


Figure 7: Overlay of transformer board.

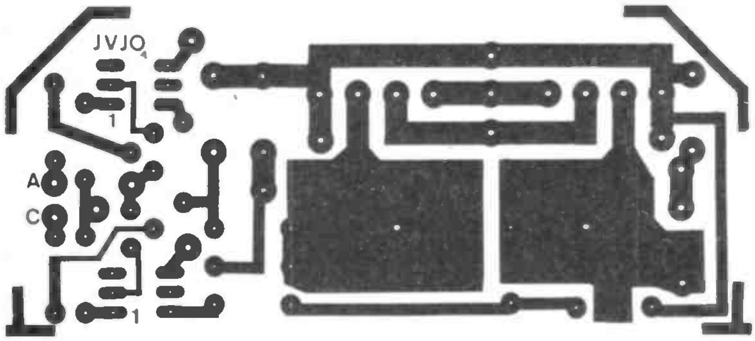


Figure 8: Foil pattern of the Triac board.

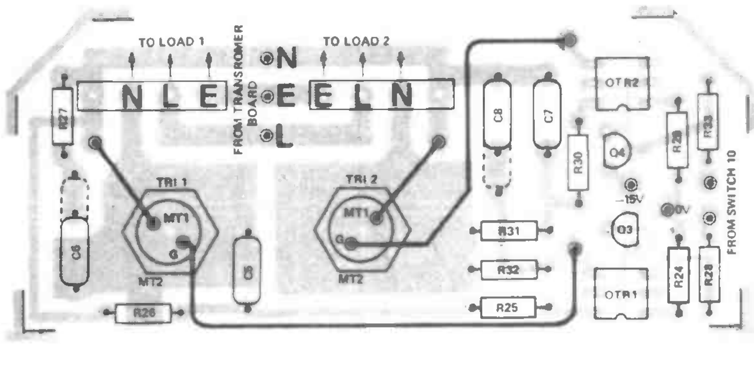


Figure 9: Overlay for the Triac board.

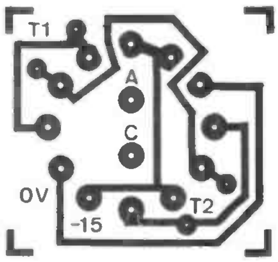


Figure 10: PCB foil of output logic and switch board.

CONSTRUCTION

The unit is straight forward to construct providing the overlays *Figs 5,7,9* are followed. The clock module is designed to be mounted remotely from the transformer and has only low voltages present on it.The transformer, switch, and output circuitry should be mounted in a plastic box, and considerable care taken in the interwiring, in view of the potentially lethal voltages present.

The mains control boards have been designed to allow the time to control a wide range of appliances, from central heating systems to Hi-Fi units.

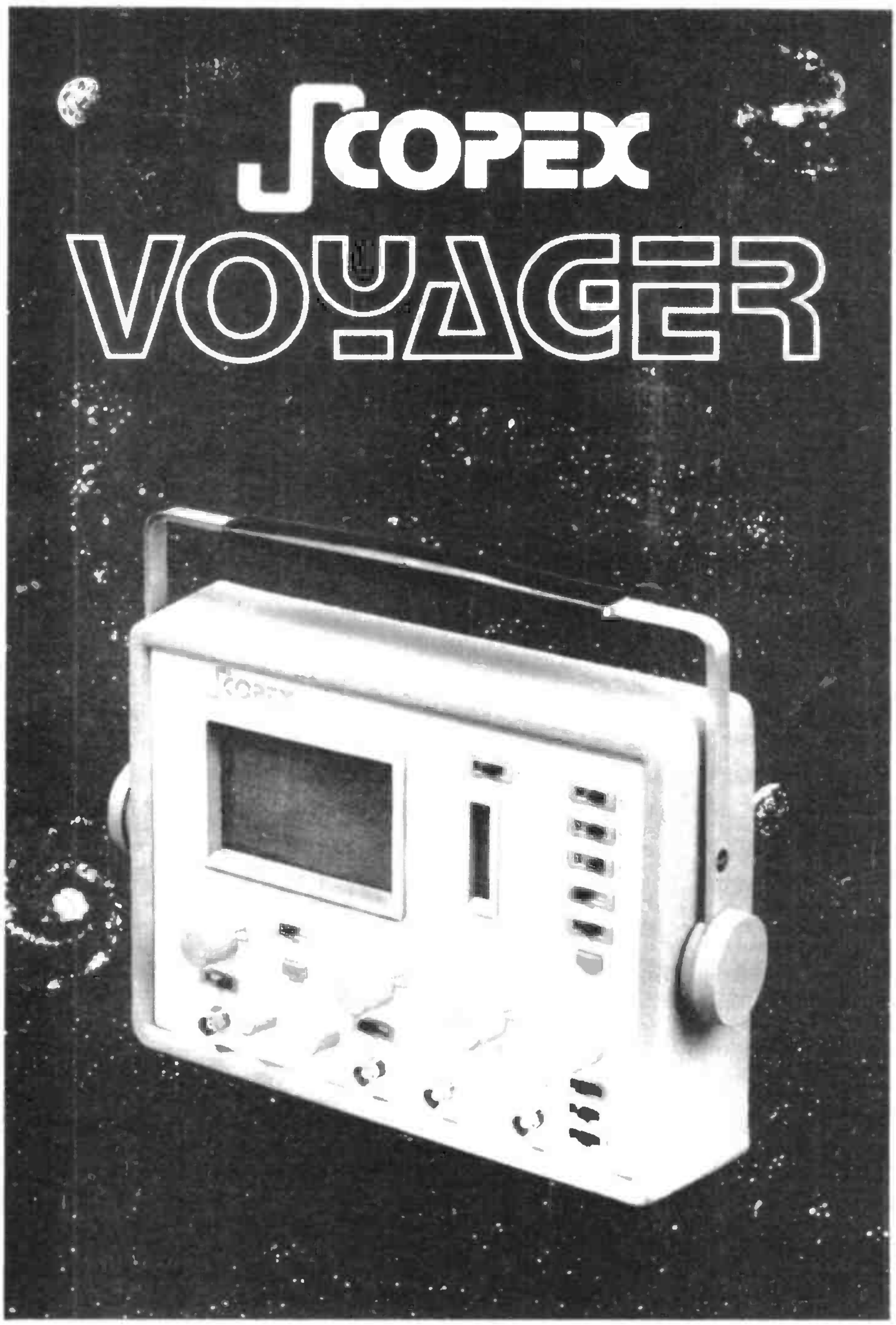
PARTS LIST

Resistors (all .25W 5%)	
R1	47k
R2,3,5,6,20,22,-28,33	10k
R4	10M
R7,27,32	100R
R8,9,10,11,12,13 21,23	470R
R14,15,16,17,18,19	1k0
R20	33k
R25,30	180R
R25,31	680R
VR1	4k7
Capacitors	
C1	1n0
C2,3	470u
C4,5,7	2200u
C6,8	100n
Semiconductors	
Q1,2,3,4	BC239
TR1,2	8 amp triac
IC1	4017
IC2	4016
IC3	4050
IC4	MK50375N
D1-10,13,14	IN4148
D11,12	IN4001
LED1-8	Red LED
OPT1,2	Opto isolators
SW1-10	Push to make
Miscellaneous	
Transformer, ORP 12 LDR, 12V lamp, 4 seven segment displays, PCBs, case etc.	

■ R & EW

Your Reactions.........	Circle No.
Excellent - will make one	34
Interesting - might make one	35
Seen Better	36
Comments	37

166 for further details



The World's first flat screen oscilloscope and it's all British.

THE SCOPEX VOYAGER represents a major advance in oscilloscope design for not only is it a flat screen, dual trace, digital storage oscilloscope, but the method used to produce the display is not a 'squashed' cathode ray tube but a liquid crystal display module. In fact it was the development of the display and driving system that prompted Scopex to go ahead with the development of the Voyager. This low voltage display will allow the voyager's use in areas where, for safety reasons, conventional 'scopes, with their high CRT voltages, are not allowed. The display is also far more robust than a CRT of similar display area.

ANALOGUE CIRCUITRY

The technical specification reveals that the analogue circuitry of the 'scope, vertical amplifier, trigger, timebase etc., offers the performance expected from a 'quality' conventional 'scope.

The vertical amplifiers follow standard design practice using low noise BIFET amplifiers with input protection. Channel switching is achieved with an IC multiplexer, the output being fed to a fast sample and hold gate. This achieves 7 bit resolution and, with a 1.25 MHz conversion rate, means a sample time of 60 nS.

The power supply makes use of a VMOS FET based switch mode design to provide the three rails required by the analogue (5V) and digital (+5V and +15V) circuitry.

The internal battery supply consists of six C size Ni-Cads which give up to eight hours continuous use. A low battery indicator, on the flag display panel, operates about 15 minutes before the display is blanked.

The extensive features offered by the digital storage system are controlled by six slide switches.

DIGITAL SECTIONS

After A/D conversion the 7 bit word produced is written into RAM in a location that corresponds to its position in relation to the time base signal. This information is then read out of RAM at 'scan' rate and used to control the display drivers. The A/D conversion and storage technique used in Voyager gives rise to a number of facilities not found on conventional 'scopes.

Firstly, a display may be 'saved' so that waveforms may be held for future reference. In this mode power to the RAM is maintained while other, more power consuming, sections of circuitry are powered down.

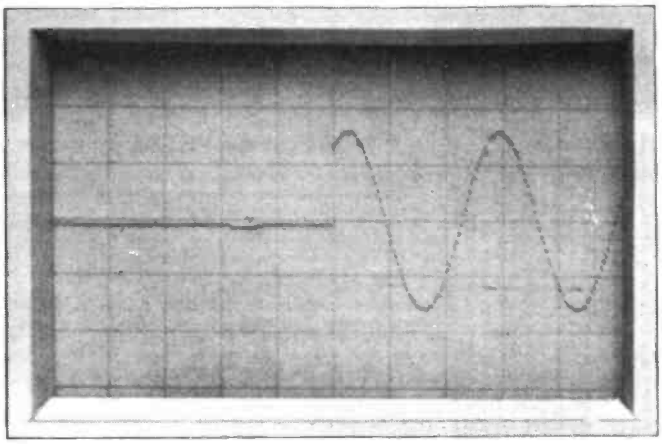
Another major feature is the pre-trigger function. In this mode, the trigger can be made to react at a point ¼, ½ or ¾ of the way across the display area and thus, by virtue of the fact that the display RAM is continually being updated in this mode, display events that occurred before the 'trigger event'. This ability to 'look back in time' can be very useful in detecting random or occasional faults.

The display also forms a useful X-Y plotter when used in conjunction with an external T/B, and enables any form of single value function to be displayed.

The flag display provides information as to which mode the voyager is in and also alerts the user to the Alias Effect.

Aliasing affects any instrument using a sampling system to examine waveforms and occurs if the input signal has a significant component with a frequency approaching or above the sampling frequency. It can give rise to very misleading screen displays — the visual, plus audio, alarms on the 'scope prevent the user being misled by these effects.

An expansion bus at the rear of the Voyage gives access to the control and data signals of the system. Scopex will be developing a number of peripherals that will make use of this feature one of which will be a recorder that will 'dump' display information to magnetic tape. The use of such a machine, in conjunction with the Voyager's pre-trigger facility will be of great use in areas such as fault tracing in remote locations.



Display showing the pre-trigger in operation.

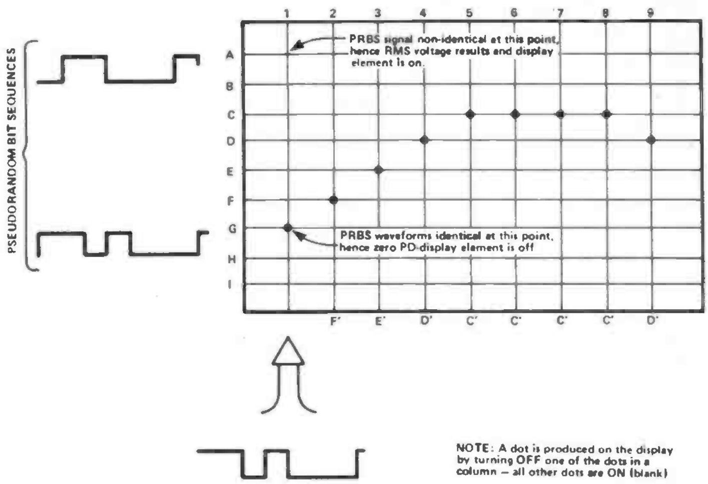


Figure 1: The drive waveforms used to produce the Voyager's Display.

THE LIQUID CRYSTAL DISPLAY

The LCD that forms the voyager's display is a dye phase change design. Unlike the 'twisted nemantic' LCDs used in calculators and watches, which require the LCD to be placed between polarising sheets and produce a dull display with restricted viewing angle, this system uses special dyes dissolved in the liquid crystal. These displays can be made to appear much brighter and do not suffer from the viewing angle restrictions of twisted nemantic displays.

The method of driving the display in the voyager is not the time division multiplexing system used in most 7 segment displays but a new drive method developed at the Royal Signals and Radar Establishment at Malvern.

The method is based on the fact that, although a complex matrix LCD must be used to display signal waveforms, it is usually only necessary to distinguish one element in each column from the others in order to display the shape of a waveform. Thus the amount of information displayed is far less than an alpha-numeric display where state-of-the-art is a four line message display, this restriction being imposed by the limit on multiplexing rate imposed by the 'turn on' characteristics of each LCD display element.

As shown in the diagram, the drive system in the Voyager makes use of pseudorandom bit sequencies (PRBS), a different PRBS being fed to each row electrode of the display. Each column electrode can be fed with any one of the row signals or another PRBS.

If a column has any one of the row PRBS signals applied to it, the display element at the intersection of that column and the particular row will experience identical signals on both electrodes. The potential across the cell will be zero and it will be OFF. All other elements in the column will receive non-identical row and column drives and the average value of the potential across these cells will be sufficient to turn them ON.

The display circuitry thus 'scans' the columns applying any one of the 128 row PRBS, the particular sequence required being selected by the 7 bit A/D value for the column being formed.

Note that the elements forming the display are OFF, this makes the display less sensitive to the variations of cell turn-on voltage with temperature, a variation which limits the temperature range over which many LCDs can be used.

ROUNDING UP

This brief look at the Voyager has, we hope, given a flavour of the technological innovation that has gone into the design of the system.

We shall be reviewing the 'scope in more depth in a future issue of **R&EW**.

At £2 500 the Voyager will find a ready market in areas for which it is the only solution as well as in situations that demand a 'performance' storage 'scope in which portability is an added bonus.

Our thanks to P A Holland and P Waugh of Scopex and to Dr Shanks of RSRE.

SPECIFICATION

DISPLAY

128 x 256 matrix dye phase change LCD.

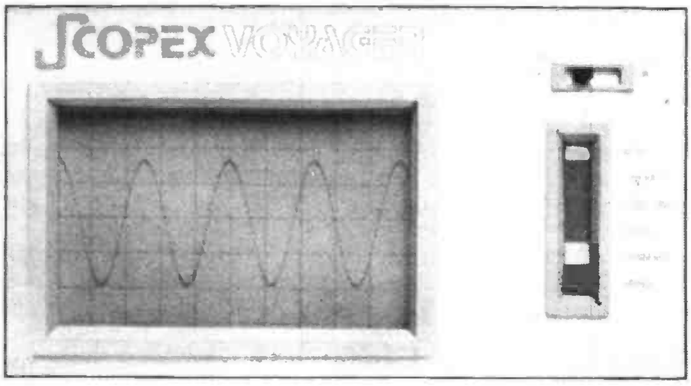
VERTICAL AMPLIFIERS

Bandwidth:	DC coupled DC-150 kHz at 8 samples per second AC coupled 3 Hz-150 kHz
Sensitivity:	10 mV/cm — 5V/cm
Rise Time:	800 nS single trace 1.6 uS dual trace
Input Impedance:	1M and 22p

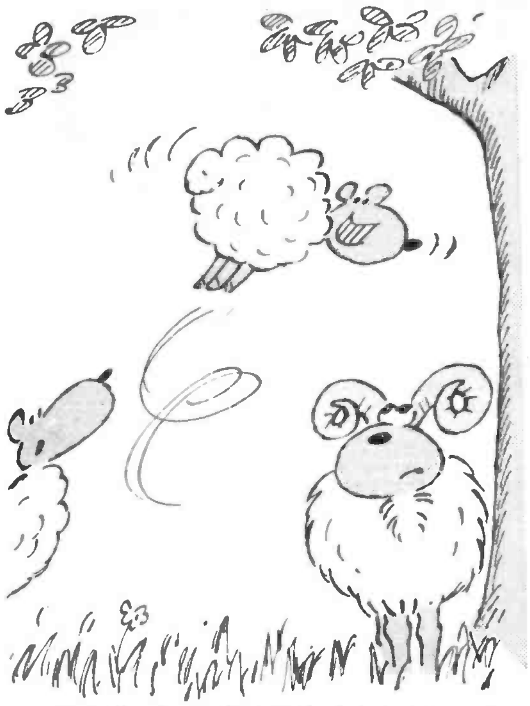
HORIZONTAL

Internal Timebase:	20 uS/cm — 50s/cm (0.01%)
External Timebase:	1.25 MHz max, 4V75 0.25V
FLAG DISPLAY	indicates operating mode
LOCATE	Returns overscanned trace to display area
DIMENSIONS	330 x 260 x 100mm
WEIGHT	2.5kg

Your Reactions..........	Circle No.
Immediately Interesting	13
Possible application	14
Not interested in this topic	15
Bad feature/space waster	16



The main display screen of the Voyager is supplemented by the flag display panel, again a die phase change LCD, that gives information of the Voyager's mode of operation.



DON'T ASK YOUR FATHER TO LEAP AND FROLIC, DEAR,... YOU KNOW HE'S A STATIC RAM....

COMPUTING NEWS

Gary Evans looks at a new computer store with a pedigree and an MPU board that's an ideal dogsbody.

WITH MORE THAN 1000 computer retailers opening for business last year the appearance of another shop front displaying VICs, ATARIs, PETs etc., may well go unnoticed by all but a few. The opening of a new Micro-C store deserves a closer look however, as it brings with it the skill and experience of what is fast becoming Britain's largest computer store chain.

Micro-C began trading in 1980 and is part of the well known Currys Group. This gave Micro-C the benefit of the marketing experience and sound financial base of the main group from the start.

The first stores to be opened shared floor space with existing Currys branches. The decision to site computer outlets in the same shop as washing machines and toasters was only taken after a market research survey. Would you buy a £4 000 word processor from the guy who sold you a toaster? The survey in fact revealed that the name of Currys was well respected in terms of the service offered and providing that the Micro-C part of any shop was clearly a separate entity, with its own specialised sales staff, there would be no credibility gap.

Seven such stores are operating to date in places as far apart as Leeds and Southampton, New Malden and Nottingham. It was becoming evident however, that the 250 or so square feet that could be spared for a Micro-C outlet in an existing Currys branch was not enough to accommodate the expanding service and support facilities that it was evident customers required. The next stage of development was the opening of dedicated Micro-C stores.

Three such stores are now open, in Manchester, Leicester and most recently a London branch at 23 Hampstead Road, NW1 in the shadow of Capital Radio.

Micro-C sales figures indicate that the market at present splits into — home use (25%), education (30%), computer professionals (15%) and business (30%). Their systems range from VIC-20's and ATARI 400/800 machines, through PET 4000/8000's to top of the market multi-user systems.

All systems stocked by the company, and the software to run on them is subjected to an extensive testing program at their High Wycombe Head Quarters. After such a testing program, the resulting report is returned to the manufacturer who is then expected to correct any major defects which have been identified. It was Micro-C who identified the fault in early VIC-20 PSU's.

QUALITY COUNTS

If a manufacturer does not act on the quality control report, Micro-C may refuse to stock the product. On the software side a number of packages tested, and found wanting by Micro-C, are still commonly available elsewhere complete with bugs and shortcomings.

This testing program together with 100% quality control on the first 100 units put into shops mean that Micro-C offer a 12 month guarantee on all hardware and software sold in an area where 90 days is the norm.

Staff training is given a high priority and each branch has a full complement of field sales and retail sales staff, installation and commissioning engineers plus a service facility. Business customers can expect their system to be installed and demonstrated up and running with two free staff training days before parting with any money.

To maintain this level of customer service each branch will operate only over a 25 mile radius, thus with 10 branches there is a lot of room for expansion. Micro-C hope to double their sales base over the next year and to push their share of the market up from its current level of 5% to 7.5% and higher.

In buying a system from Micro-C, one has the confidence of doing business with a company that is part of a national group with a good reputation and is secure in the knowledge that any item, hardware or software, will have been thoroughly tested and is not likely to fail.

CONTROLLED DEVELOPMENT

Using the likes of a TRS-80 to control your central heating system would, without a doubt, represent a technological overkill. Developing a central heating control program on a 'Micky Mouse' minimal system with LEDs and switches represents a programming nightmare. A more sophisticated development system comes into the realms of a financial headache.

The solution to the above problems comes in the form of a system that can make use of software downloaded from your Tandy. Editors, assemblers or compilers run on the TRS-80 will make the writing of software a straightforward matter and when fully debugged it can be run on a low cost system freeing the expensive machine for more demanding chores.

Such systems are starting to appear in the States, one being the M-80. This Z-80 based system sells for 99 dollars and communicates with a host system via an RS232 interface. Interfacing to the TRS-80 it is straightforward and the system opens up exciting possibilities in the area of quick and painless development of MPU based, minimal control systems.

■ R & EW

Your Reactions.........	Circle No.
Immediately Applicable	42
Useful & Informative	43
Not Applicable	44
Comments	45

CB SELCALL SYSTEM

Be selective in your listening, this unit mutes all but coded calls. Design by Roger Ray.

THE R&EW SELCALL SYSTEM puts an end to the often distorted and sometimes irritating sound of breakers conversations when you are waiting for a call from your office, home or the friend who is ahead of you in the traffic jam.

Any channel can become almost personalised simply by prearranging with another Selcall unit owner, a channel to call on and of course your coded signal.

The **R&EW** Selcall unit will mute the output of a receiver until it detects a transmission prefaced by a coded signal. Upon receipt of a coded call, the unit will activate the speaker and flash the front panel display. The Selcall can respond to 2560 different codes, 40 being selected via a front panel control (with a dual 7 segment display of the code selected) while an internal switch selects one of 64 groups.

When transmitting the Selcall call button will send a similar coded signal.

The use of two or more Selcall units will provide an efficient communications system, one in which only 'authorised' calls are received — the babble of other transmissions on channel being muted.

An additional feature of the Selcall unit is that it guards against the possibility of false triggering by requiring four coded groups of data to be received before

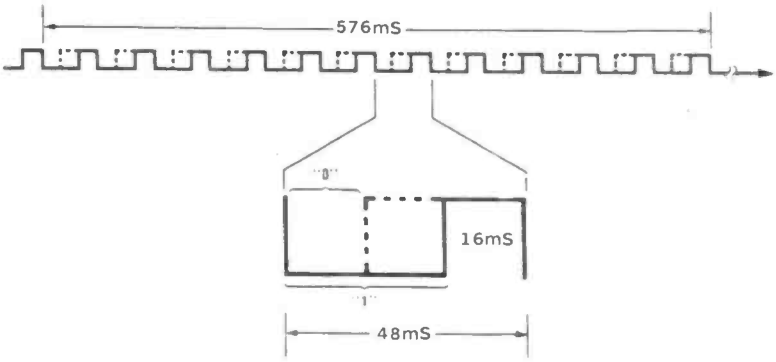


Figure 1: The output waveform of IC1, the encoder/decoder.

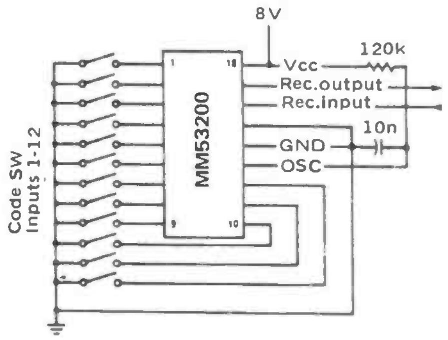


Figure 2: IC1 Pin connections in the receiver mode.

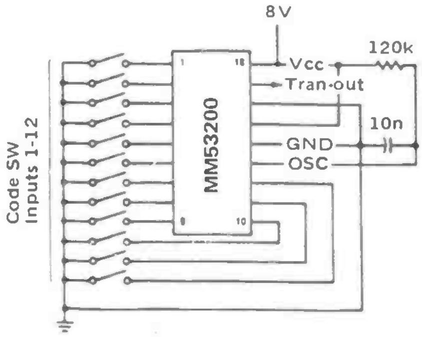


Figure 3: Pin connections for transmitter mode.

CIRCUIT DESCRIPTION

The circuit (*Fig 4*) is centred around two integrated circuits (IC1 & 2). IC1 is a MOS/LSI digital code transmitter (encoder) /receiver (decoder) system. In the transmit mode a 12 bit word is generated representing the code selected by the front panel 40 position switch, and the internal DIL switch. The rate at which this code is generated depends on the timing components C12 and R14 (*Fig 1*). In the receiver mode (*Fig 2*) the incoming code is compared to that set on the switches. When four correct words have been received pin 17 goes low to indicate a correct decode.

IC2 is phase locked loop tone decoder (*Fig 6*). When a tone is received within the preset bandwidth pin 8 goes low until the tone ceases. The centre frequency of the loop is determined by C6 and R8 (approximately) 2.5 kHz in this case), while the loop bandwidth is controlled by the value of C5. A tone is decoded when the internal oscillator locks onto the received tone. As this oscillator normally sits in the centre of the detection band it can also be used as the transmitted signal, this output is available on pin 5.

In the transmit mode, data from IC1 gates the oscillation by turning on and off Q3. To make a Selcall the call button (S1) is depressed taking pin 5 of IC4 high and turning ON Q1. This has a number of effects, pin 15 of IC1 goes high and pin 16 goes low by Q2 being turned on, thus putting IC1 into the transmit mode (*Fig 3*). At the same time Q4 is turned on shorting the PTT line and hence turning on the transmitter. Data from pin 17 of IC1 is routed through IC4b and c to Q3 turning the tone from IC2 on and off at the data rate.

When the 'call' button is released C1 discharges through R1 until the negative going threshold of schmitt trigger NAND gate IC4a is exceeded and Q1 is turned off. R2/C2 combination provide 'power on' conditioning holding pin 6 low until C1 has had a chance to charge up. This stops a call being transmitted as the unit is turned on.

With S3 in the 'normal' position the two flip-flops IC3a, b and IC3c, d are held in the reset position. In this state IC3 pin 4 is low so that Q4 is turned off, and the relay de-energised, thus the speaker is connected to the output of the receiver. IC3 pin 3 is low so that the output of the Schmitt trigger NAND gate oscillator IC4d is permanently high, holding on Q6 giving a permanent display on the 7 segment LEDs.

In preparation to receive a Selcall code, S3 is switched to the 'Selcall' position. This provides a negative going pulse onto pin 6 of IC3 which 'sets' that flip-flop tuning on Q5 and thus disconnecting the speaker. The speaker will be re-connected if (a) a valid Selcall is received, (b) the call button is pressed (c) the microphone pressel is used (d) S3 is switched back to the normal position.

When a valid Selcall code has been received pin 17 of IC1 goes low. This resets IC3a, b reconnecting the speaker, and sets IC3c, d. Pin 3 of IC3 goes high activating IC4d which acts as a low frequency oscillator, C15 being alternatively charged and discharged through R36.

The output of IC4d turns Q6 on and off hence causing the 7 segment display to flash. The flip-flop comprising IC3c and d is reset when the PTT line is grounded or S3 switched to the 'Normal' position. Q8 clamps the audio input, and D10 turns Q5 on (energising the relay), during the Selcall transmit period. This is required on some CB rigs that leave the receive AF amplifier connected during transmission.

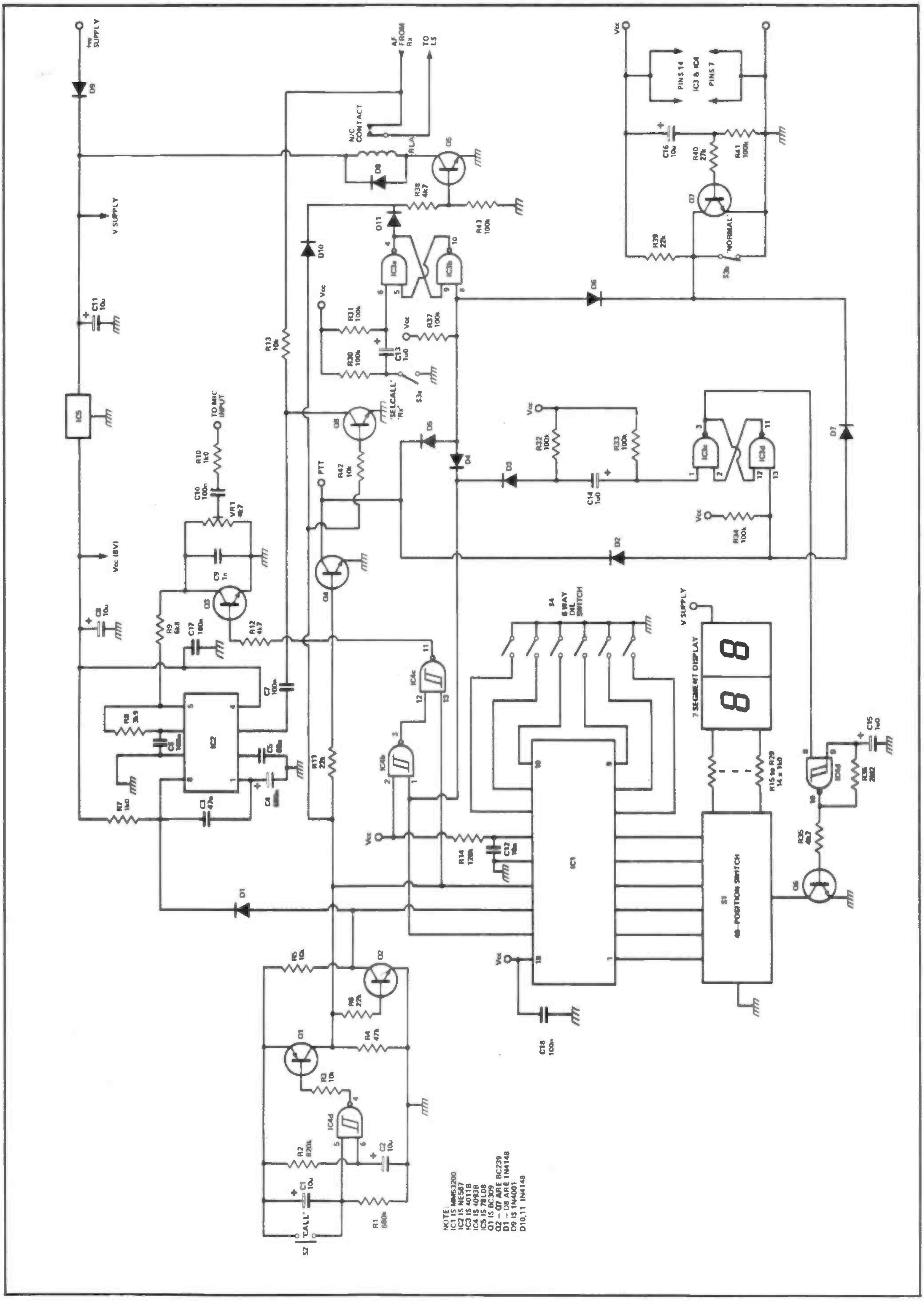


Figure 4: Circuit diagram of the Selcall unit.

activating the speaker. The flashing display that results upon receipt of a coded call also means that attention is drawn to any code call that was received whilst the transceiver was unattended.

Although designed primarily for use with CB sets, the design can be used with any communication system, even intercomms.

R&EW SELCALL

The **R&EW** Selcall system can be used with any CB transceiver factory fitted with a selective call accessory socket, enabling easy installation of sophisticated selective calling systems.

The unit itself sets a new standard for Selcall, using a digital encoding technique, with 40 Selcall channels selectable from the front panel control — although the total capacity is 64 x 40, using an internal 'bank switching' system that ensures total immunity from other Selcall users in the vicinity. We anticipate that the industry will wish to adopt this selective call format since it offers several advantages over previous systems:

a) The system provides 2560 codes in its standard form — other units could operate using one of up to 4 different audio carrier frequencies, providing over 10,000 possible 'unique' codes.

b) The use of a familiar 40 channel switch will allow regular users to adopt a system of local 'code numbers', whereby users can have a recognised standby number — just like a telephone number. This will encourage users to remain monitoring the band for specific calls, without the bother of listening to casual traffic. Emergency services will find this a considerable benefit.

c) The nature of the code format permits digital processing of the code information.

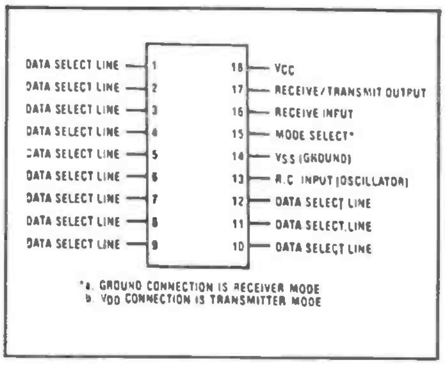


Figure 5: IC1's pin out..

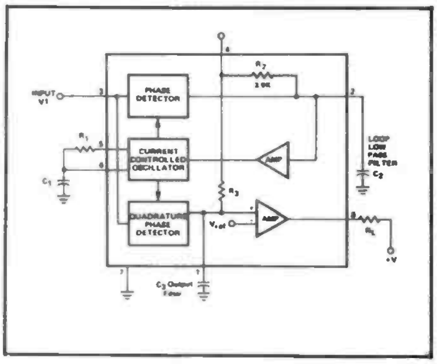


Figure 6: Block diagram of IC2, the PLL.

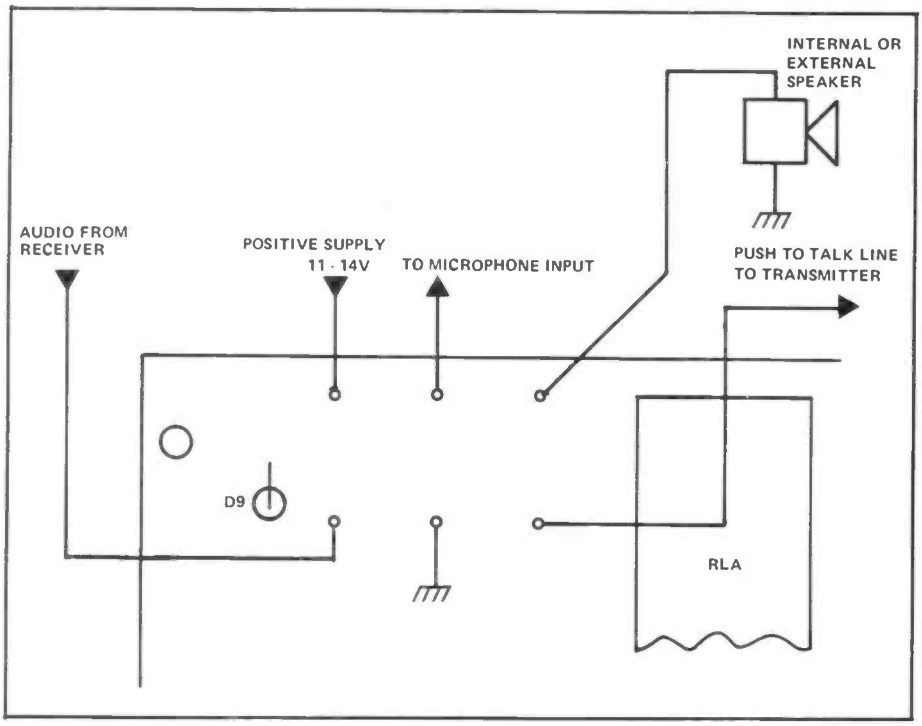


Figure 7: Connections between the Selcall unit and transceiver.

CONSTRUCTION AND TESTING

A single sided PCB etched as shown in *Fig 8* is used to construct this project. Solder in the resistor and link under S1 first. Continue construction by assembling the rest of the components following the overlay of *Fig 9*. Do not insert the ICs into their sockets until all of the other components have been soldered in place. The dual 7-segment display is connected to the PCB using flexible ribbon cable. For correct orientation of the display the edge with markings must be nearest the PCB. Wire up the inter-board links and solder the leads to the rear panel socket or interconnecting cable. As S2 and S3 are mounted underneath the PCB the connections to these switches are more easily made by soldering directly to the copper pads on the underside of the board.

It is wise to check the operation of the completed board before assembling into the case.

Using a 11-14 volt DC supply (preferably current limited) connect up the unit. The LED display should light up, and the number displayed be selectable by the 40 position switch S1. Switching S3 from 'normal' to Selcall should cause the relay to be activated (check for the click of the relay changing over). Depressing S2 will cause the display to 'blink' if all is well. If these tests are satisfactory the board can now be fitted into the case. Fit switches S2 and S3 first and then the board, checking that the display lines up with the aperture in the front panel.

If the board does not function as above, begin the fault finding by measuring the output of regulator IC5 (8V0). Next look carefully for incorrectly orientated components, dry joints, and broken or shorted tracks on the PCB.

Most problems will have been revealed by this stage, if not refer to the circuit description to localise the problem area.

The completed unit can now be wired up to the transceiver with which it is to be used (*Fig 7*). The only adjustment to be made is that of VR1, which sets the audio level into the transmit audio circuitry. Monitor the transmitted signal and adjust VR1 from zero to give a similar result to that produced when whistling into the microphone. Alternatively for an FM transmitter adjust VR1 to give 60% of the peak deviation using a modulation meter.

SPECIFICATION

Tone	2.5 kHz pulse width modulated.
Code	12 bit word (4 valid words required before operation)
Message Duration	About five seconds
Current	Normal 130mA typical Selcall 160mA typical
Dimensions	113 x 60 x 36mm

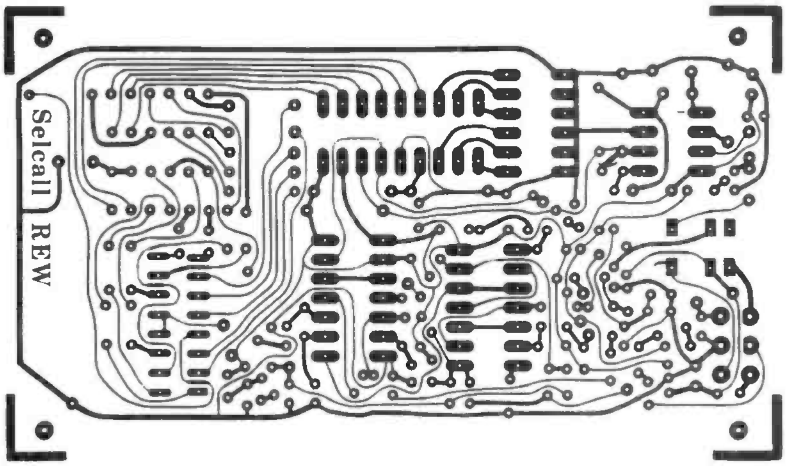


Figure 8: Foil pattern of the Selcall's PCB.

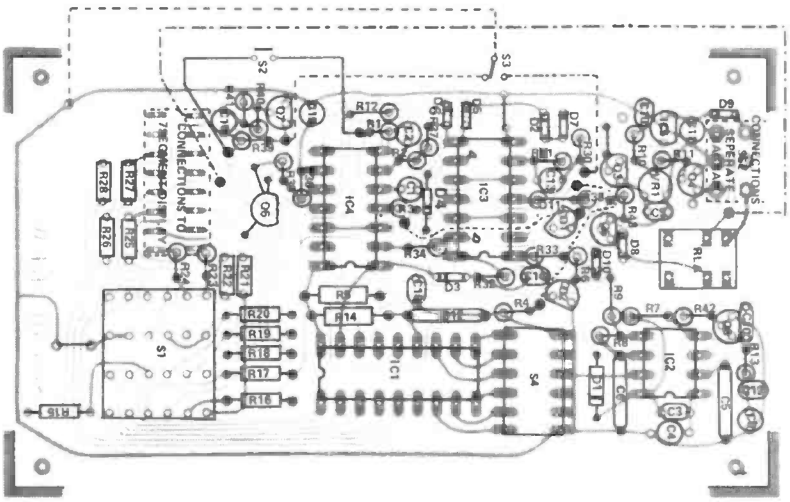


Figure 9: The Selcall overlay and connection.

COMPONENTS LIST

Resistors (all .25W, 5%)

R1	680k
R2	820k
R3,5,13,42	10k
R4	47k
R6,11,39,42	22k
R7,10,15-29	1k
R8	3k9
R12,35,38	4k7
R9	68k
R14	120k
R30-34,37,41	100k
R36	2M2
R40	27k

Capacitors

C1,2,11,16	10u 16V
C3	47n ceramic
C4	680n tantalum bead
C5	68n polyester
C6	100n polyester
C8	10u tantalum bead
C9	1n ceramic
C10,17,18,7	100n monolithic
C12	10n polyester
C13,14,15	1u0 tantalum bead

Semiconductors

D1-8,10,11	IN4148
D9	IN4001
	Dual 7 segment display (common anode)
Q1	BC309
Q2-8	BC239
IC1	MM53200
IC2	NE567
IC3	4011B
IC4	4093B
IC5	78L08

Switches

S1	40 position BCD/Dual 7 seg (SRS303U)
S2	Push to make
S3	SPCO min toggle
S4	6 way DIL

Miscellaneous

12V relay (OUC series), PCB, case, IC sockets etc.

CODE SELECTION AND OPERATION

The Selcall unit allows 40 different codes to be selected on the front panel as indicated by the display number. Internally S4 allows 64 'groups' to be selected giving a total of 2560 different codes! For the Selcall system to operate both ends of the communication link must have a Selcall unit set to the same code. Two units displaying the same number on the display are not necessarily set to the same code because S4 may be set differently on each. To verbally communicate a code call the switches of S4 '1' when they are set ON and 'O' when they are set off. Read the switches from left to right, and prefix this number with the code displayed on the front panel. i.e. 27-011001. This gives a unique number for each possible code setting. Generally S4 will be set to the same number for all members of a Club, Company, etc. Individuals can then have a code number 1-40.

When S3 is in the 'normal' position, reception will be the same as that without the Selcall in circuit. With S3 set to 'Selcall' the speaker is muted, (disconnected) until a correct Selcall is received. Operation of the transmitter will also cause the speaker to be reconnected, allowing any incoming message to be received. When a correct Selcall code has been received the display will flash on and off to give a visual indication of a correct decode. Switching back to 'normal' or transmitting will cancel the flashing display.

To transmit a Selcall simply press the call button S2, the code displayed will then be transmitted. A call can be transmitted in either the 'normal' or 'Selcall' settings of S3.

Generally a clear channel should be used to send out a Selcall. Interference on the same frequency will have the effect of reducing the range over which a call will be effective.

SILENCE IS SELCALL

Selective calling systems enable users of shared communications channels to receive only those calls that are specifically directed for their attention. The attraction of a system in connection with CB radio is obvious — the set remains completely silent until a specific message is received when operated in the 'Selcall' mode.

■ R & EW

Your Reactions..........	Circle No.
Immediately Interesting	70
Possible application	71
Not interested in this topic	72
Bad feature/space waster	73

May 1982 EVENTS : MOBILE RALLYS

M	T	W	T	F	S	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

May 9th	Lincoln Hamfest	Lincolnshire Showground	J R Hunt, City Engineers Club, Central Dept, Waterside South, Lincoln.
May 16th	Swindon ARC Rally	Park School, Marlow Ave, Swindon 10am.	522/SU8-GB3TD Talk-in K A Saunders, G8SFH
May 23rd	Northern Mobile Rally	Gt Yorkshire Showground, Harrogate 10am-6pm	GBKRU, 14 Fieldhead Road, Guiseley, Leeds.
May 23rd	Barry College of FE RS Mobile Rally		RV Belcher GW8TCF
May 30th	Hull & DARS Mobile Rally	Hull University, Cottingham Road, Hull. 12am-4pm	H Cunliffe, 142 Hall Road, Hull HU8 8SB (0482) 447355
May 30th	Plymouth RC Mobile Rally	School Hall, Tamar Indry School, Paradise Road, Millbridge, Plymouth	Julie Butcher G4HKZ (0752) 338417
May 30th	East Suffolk Wireless Revival	Ipswich Area Civil Service Sports Assoc, Straight Rd, Ipswich (adjacent to Suffolk Show Ground)	Jack Toothill, G41FF (0473) 44047

NB. Would Rally organisers please send details of forthcoming events to the Editor — and please also include a list of exhibitors.

CODECALL 4096

A selective call system that may be used without transceiver modifications.

THE CODECALL 4096 IS the first selective calling system to be aimed at the British Amateur and CB markets.

Selective calling is a system that allows a radio channel to be monitored, an alarm (audio or visual) being generated when a 'coded' call is received on channel.

The Codecall 4096 can be used with any transceiver that boasts an external speaker socket without any modifications to the set. For reception it is connected to the external speaker output, while for transmission it is placed next to the microphone and the call button pressed.

As the unit's name suggests, 4096 different codes are available, these being selected via front panel 16 way switches.

ENCODING & DECODING

The Datong Codecall makes use of a versatile digital encoder/decoder integrated circuit. This IC generates the digital code sequence for transmission and detects the same sequence on receive. When transmitting the data modulates an audio oscillator, the output of which is connected to a piezo electric transducer. The use of this transducer is quite cunning as it produces the audio for transmission, as well as the bleeping sound to show a call has been received.

On the receive side some clever circuitry is used to keep the 'no signal input' current consumption to a minimum (typ 10uA). An op amp detects whether a signal is present and this information is then used as the input to the decoding IC. A transistor switch illuminates a LED when a signal of sufficient strength is being received. When the correct code has been received the bleeper is activated from the output of the decoder. The operation of the decoding IC is such that a false call is very unlikely, and therefore all 4096 codes can be used without fear of one being decoded in error.

ON THE AIR

As soon as the Codecall arrived in the **R&EW** laboratory, it was put through its paces on 27 MHz CB and on the 144 and 432 MHz Amateur bands. It was easily adapted to any communication equipment it was tried with, being simply a matter of plugging the interconnecting cable provided into the external speaker socket.

In use it proved to be very effective as long as there was not an undue amount of interference on the same channel. The audio output required from the receiver for correct operation is relatively high, generally requiring the volume control to be turned down after a call has been received. When used 'mobile' this was not necessary due to the generally higher background noise.

In the car the Codecall proved to be a bit of a handful. In fact while driving it is impossible to send out a call. This is because the unit has to be held next to the microphone and both the call button and pressel activated. Try doing that with one hand — definitely not to be recommended while driving!

Receiving a call is not as bad as long as an external speaker is used. The alternative is to remove the external speaker plug which again is pretty difficult with dash mounted transceivers.

The five seconds or so that the call button needs to be pressed seems quite a long time at first, but bearable when more used to the operation of the system. Call detection was 100% in high signal levels, and about as good as could be expected in weak signal or noisy environments. Despite extended periods of use no false decodes have occurred showing the system used to be a very reliable one.

IN CONCLUSION

A well made British device that should prove very useful for many clubs and professional organizations as well as keeping in touch with the wife on CB.

SPECIFICATION

Principle of Operation:	pulse width modulated audio tone
Message Duration:	approx 5 seconds
Number of Code Combinations:	4096
Power requirements:	9 volt PP3 battery
Current drain:	Squelched channel 10uA
	receiving or sending a signal 11uA
Size:	102 x 60 x 31mm
Weight:	130 grams

The Codecall 4096 is available from Datong Electronics Ltd, Spence Mills, Mill Lane, Bramley, Leeds LS13 3HE.

Current price is **£25.50** + VAT.

GENIE II

Evolved from the popular Genie I, this machine is designed to meet the needs of the professional user.

THE GENIE I COMPUTER has been with us for some time now and has proved a popular machine, this popularity is to some extent due to the fact that it is a Tandy TRS-80 II lookalike. Thus the extensive range of software packages available for the Tandy machine will run, without modification, on the Genie.

The Genie II machine reviewed here is a development of the Genie concept, taking the machine into the professional market.

The most notable difference between the two machines is that the Genie II features a separate numeric pad in place of the Genie I's cassette deck, there are however other more subtle differences. The Genie II's main unit features a Z80 CPU, 16K of user RAM, 13K of ROM, a cassette interface, a video interface and the typewriter style QWERTY keyboard with separate numeric pad.

Of the 13K onboard ROM, 12K is occupied by a 12K microsoft BASIC package that is TRS-80 level II compatible. The remaining 1K contains keyboard and display routines that simplify operation of the Genie II. To enable these routines a SYSTEM command is entered on power up making available the following functions:— REPEAT, pressing any key longer than one second will automatically repeatedly enter the character; PRINTSCREEN, this command will dump the screen's display to a printer; SHIFTLOCK, there are two modes for this command, Basic, in which unshifted characters are printed as upper case and shifted as lower case and Typewriter, in which the function of the shift key is reversed, operation being 'a la' typewriter.

The ROM also enables the Genie II to be used as a dumb terminal, operating in either full or half duplex modes, with a 15K data buffer and selectable baud rates. To make full use of this facility the Genie II must be used with its expander unit with an RS232 card fitted. The expander box is a necessary part of any Genie system intended to meet the needs of the business/professional user. It enables a variety of peripheral devices (printers, disks etc) to be connected to the basic machine as well as allowing for memory expansion.

The printer interface featured as a standard on the expansion is a Centronics parallel configuration, although as stated above, an optional RS232 card is available and will slot into one of the expander's vacant slots.

The expander's Disk Controller can handle single or double-sided mini-floppy drives with single or double-sided density storage option. System memory expansion is also possible (to 32K or 48K) using the 4116 dynamic RAM ICs slotted into the sockets provided.

An optional bus expansion card enables the Genie II to support S-100 bus cards.

The system we tested consisted of the Genie II, expander box, two 35 track mini disk drives and a 12" green phosphor monitor.

Getting the system 'up and running' is a straightforward procedure, although an awful lot of inter unit connections are required and no less than five mains plugs. AC power outlets built into the expander box would be a help but even so the full system could hardly be described as portable.

The most obvious application for the system around the R&EW was as a word processor. Hooking up an OKI 80 printer to the expander's printer port, we loaded Scripsit, the word processing package for the Tandy II.

As stated above, Genie II is able to run Tandy software and our machine loaded Scripsit without any problems.

The 12" green display was not tiring to the eye while the Genie's keyboard was sufficiently typewriter like to ensure that long sessions using the system did not produce undue operator fatigue.

All in all the machine performed well in its word processor role as it should in many other applications.

The range of add ons available for the Genie is very large, too large to list here, suffice it to say everything from sound and colour cards to 32K RAM cards are produced for the system.

If you like the look of the Tandy TRS-80, take a look at the Genie, it offers the same facilities at a lower price. Buying the Genie will also ensure that whatever application you have in mind, a software package to suit your needs will probably be in existence as the Tandy machine is very popular, particularly in the States.

Our thanks are due to Lowe Electronics for help in preparing this review.

■ R & EW

Your Reactions..........	Circle No.
Immediately Interesting	86
Possible application	87
Not interested in this topic	88
Bad feature/space waster	89

SUBSCRIBE AND MAKE SURE YOU DON'T MISS AN EDITION OF R&EW

PROJECTS FEATURED IN PAST ISSUES

MAY
UOSAT Receiver
TV Splitter/Distributor
pH Meter

APRIL
MSF Clock
2m Preamp
Radiation Monitor

MARCH
23cm Converter
Car Anti-Theft System
Converter PSU

FEBRUARY
TV Pattern Generator
Z8 Development System

JANUARY
3 Digit DMM
70cm-2m/TV Converter

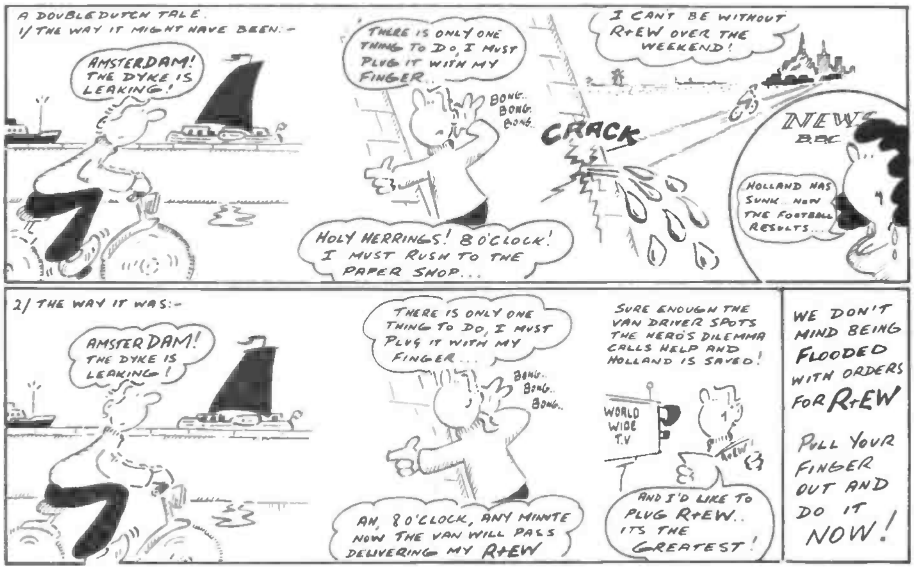
PLUS Many features and reviews keeping you up to date with the world of Radio and Electronics.

It's not too late to get any of the issues you may have missed, simply send 95p for each copy you require, this includes postage. Use the reply paid card/order form or send a cheque/PO to:
R&EW BACK NUMBERS
45 Yeading Avenue,
Rayners Lane,
Harrow, Middlesex HA2 9RL

SUBSCRIBE AND LET THE POSTMAN DO THE WALKING

The easiest way to avoid marching from newsagent to newsagent on the trail of the latest R&EW is to take out a subscription. You'll pay for it in saved shoe leather alone and be sure of receiving each and every months copy of the magazine.

Subscribers also benefit from a FREE news sheet that is included with every subscription copy. This contains any news that reached us after the magazine had closed for press as well as occasional 'limited stock' reader offers.



If you want to be sure of getting YOUR copy of Britain's most informative Radio/Electronics magazine, PLAY SAFE AND SUBSCRIBE. Fill in the form below.

SUBSCRIPTION ORDER FORM

I would like to subscribe to Radio & Electronics World for one year (12 issues). Please start my subscription from the ____________ issue.

SUBSCRIPTION RATE:
(tick ✓ as appropriate)
UK £10.00 for 12 issues
Overseas £11.00 for 12 issues

PAYMENT:
(Access/Barclaycard orders may be sent using reply-paid order card)
I enclose my (delete as necessary) Cheque/Postal Order/International money order for £

Please use BLOCK CAPITALS and include postal codes.

Name (Mr/Mrs/Miss) ____________________

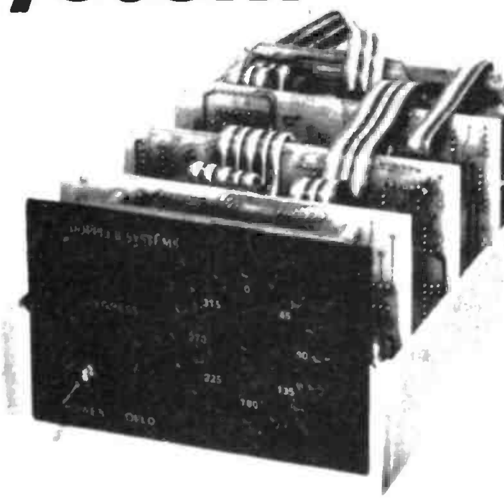
Address: ____________________

____

Signed: ____________________ Date: ____________

Please send this order form, with your remittance, to Radio & Electronics World, Subscriptions Department, 45, Yeading Avenue, Rayners Lane, Harrow, Middlesex. HA2 9RL

A Doppler DF System



Courtesy of Wayne Green's *'73 Magazine'*, we present David Cunningham's guide to practical Doppler tracking techniques.

RADIO DIRECTION-FINDING (RDF) systems tend to fall into two general categories depending on whether or not they use the Doppler shift principle. Most non-Doppler RDFs employ directional antennas which produce peaks or nulls in the received signal amplitude as they are rotated. Doppler-type systems, on the other hand, detect the phase modulation imparted to the received signal by translational motion of the receiving antenna. As a consequence of the "capture effect" of the FM receiver which detects the phase modulation, Doppler-type systems generally are less sensitive to site errors than amplitude measurement systems.

The first known RDF based on detecting the Doppler shift was patented by H T Budenbom and used a motor driven antenna. Doppler RDFs today do not mechanically rotate an antenna, but instead rely on sequential switching between a series of antennas placed in a circular array to approximate the continuously rotating single element.

IN A SPIN

A serious drawback to some systems is the drastic loss in sensivity which occurs during operation. A second problem is the appearance of mysterious false bearing vectors apparently due to off-channel frequencies being shifted onto the received frequency by something in the commutation (electrical rotation) process. Both of the above problems disappear when the antenna commutation is halted, i.e., on-channel stations would immediately regain their signal strength into the receiver and off-channel carriers will disappear.

Theorising that the switching transients related to turning on and off the various antennas cause receiver desensitization and, in addition, modulate off-channel signals into the receiver passband, several methods were investigated to smooth out the switching transients. These included:

1) overlapping the antenna selection so that at least one antenna was always connected to the receiver;
2) rounding the antenna switching waveforms and using PIN diodes to create a more gradual on/off transition; and
3) generating a complex analog control waveform matched to the gain characteristics of the PIN diodes to further reduce switching transients.

None of these solutions produced especially note-worthy results. In addition, it was felt that an antenna array of the size being used was impractical, especially for mobile use. Reducing the number of elements would help this problem, but with discrete commutation, the linearity of the system deteriorates as the number of antennas decreases.

ON THE RIGHT TRACK

The solution which ultimately was discovered uses only four antennas which are located in a square pattern, the sides of which are typically 1/4 wavelength long. The received signal induced into all four antennas is continuously mixed in a precision summing circuit in such a manner that the resultant rf voltage produced is very nearly identical to that which would be induced in a single antenna rotating at a uniform rate around the circle which inscribes the square formed by the four actual antennas.

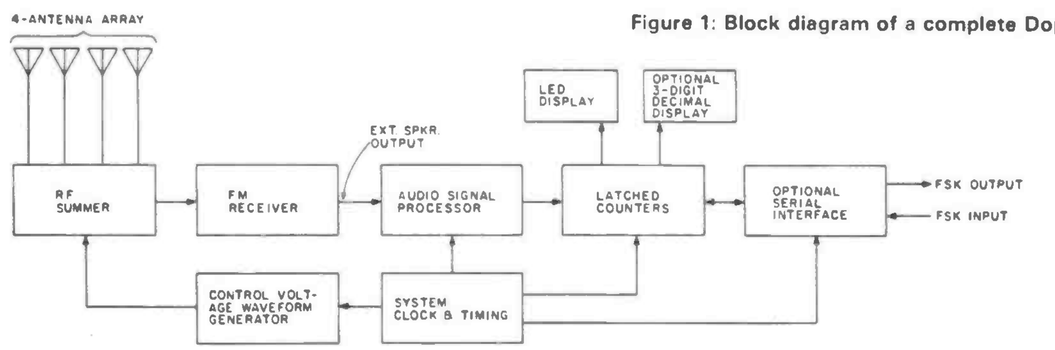
Tests have demonstrated that this system does not possess the loss of gain or off-channel susceptibility problems of previous designs. Antenna size for VHF applications is very compact. Electronic processing is relatively involved, but considering the performance which is obtained, it is justified for serious direction-finding applications. The system described here works with any FM receiver to detect the Doppler-induced phase modulation and does not require any modification of the receiver.

OUTPUT OPTIONS

Depending on the application, three different outputs are available. For mobile application, a circular array of 16 light-emitting diodes (LEDs) provides an immediate analog bearing relative to the vehicle's direction. For more demanding mobile or fixed station applications, a 3-digit panel display provides the bearing directly in degrees. Finally, a serial interface is available in a format suitable for remote-display (utilising the same or similar electronics for readout), recording the bearing data on an ordinary audio tape recorder, or connection to a microprocessor.

A simplified functional block diagram of the complete system is shown in *Fig 1*. The rf summer combines the output of the four antennas in a manner which phase-modulates the rf signal to the receiver. As explained in the next section, the phase modulation

Figure 1: Block diagram of a complete Doppler DF System.



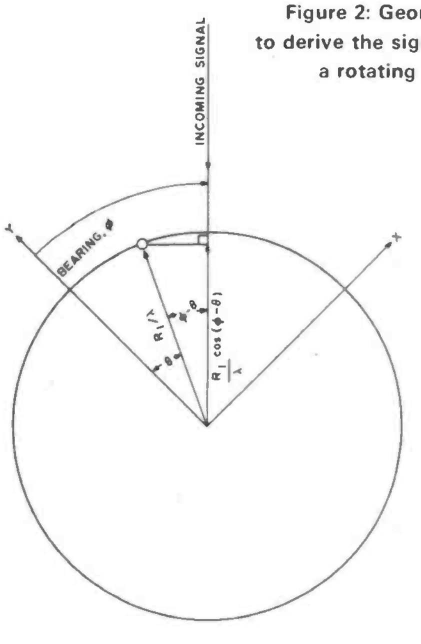


Figure 2: Geometry used to derive the signal received by a rotating antenna.

contains the bearing information. A conventional FM receiver provides the audio input to the Doppler signal processor via connection to the external speaker output. Synchronous filtering removes the normal voice content leaving a sine wave having the same frequency as was used to modulate the antenna signals and a phase angle equal to the bearing angle. This sine wave acts as a trigger to latch the outputs of counters for display of the bearing in either a circular LED array and/or a 3-digit decimal display. An optional serial interface transmits the bearing data displayed by the unit or receives external bearing data as input for the display.

DOWN TO BASICS

Figure 2 illustrates a simple antenna located at distance R_1/λ and angle θ from the reference position. Assume the incoming signal is located far (relative to the wavelength, λ) from the receiving antenna at the bearing ϕ shown. Then the voltage induced in the antenna can be written as shown in Equation (1), where A is the received amplitude in volts, ω_C is the carrier frequency in radians per second, t is the time in seconds and is selected to start with a zero crossing of E_R at the origin, and ψ is the phase shift in radians due to the antenna being closer to or further from the transmitter. If the antenna is closer to the source, ψ would be positive, indicating a phase lead, etc. For the geometry shown, see Equation (2).

Now suppose the receiving antenna is permitted to rotate with velocity ω_D in a circular path of radius R_1/λ. Then $\theta = \omega_D t$ and the phase of the received signal is as shown in Equation (3).

Equation (3) indicates that the rotating antenna has caused the incoming carrier to become phase (and frequency) modulated. The modulation frequency is the same as the rotation frequency, ω_D, so the frequency deviation which is equal to the rate of change of the phase is as shown in Equation (4) or Equation (5).

A standard FM receiver with de-emphasis will produce an audio output equal to the phase which is modulating the received signal (assuming the deviation is small compared to the discriminator full-scale range). See Equation (6).

Thus the receiver's audio output is a sinusoid having a frequency equal to the antenna commutation frequency, ω_D, and a phase angle equal to the bearing angle, ϕ. The commutation frequency should be selected to be at the low end of the receiver's audio passband to facilitate filtering out the normal voice modulation of the received signal.

Another way of looking at the problem is to consider the situation when the rotating antenna is at the angle where it is directly approaching the incoming signal. The maximum relative velocity causes an apparent increase in the carrier frequency at this point. Similarly, when the antenna has moved 180 degrees to the point where it is travelling away from the transmitter, the relative velocity is a minimum and the carrier frequency appears to be lower. This is the familiar Doppler shift phenomenon, but here the rotation of the antenna produces a periodic up/down shift, the phase of which is set by the bearing angle between receiver and transmitter.

Figure 3(a) shows Equation (3) plotted against time for an assumed bearing angle of 45 degrees. To indicate graphically what sort of waveforms are generated by discretely commutated antenna arrays, the theoretical audio output for a system of 16 and 8 antennas is plotted in *Figs 3(b) and 3(c)* respectively. The antenna, of course, receives many different signals in addition to the channel of interest. The phase modulation of all of these signals by a complex waveform such as shown in *Fig 3(b) or 3(c)* may generate a variety of frequency components within the receiver passband. It is believed that these spurious frequencies are responsible for the false bearing problems noted earlier.

DOING IT OUR WAY

The technique for electronically producing the phase modulation of *Fig 3(a)* with four antennas will now be described. Consider the

(Continued on page 50) ▶

EQUATIONS

Equation (1): $E_R = A \sin(\omega_C t + \Psi)$

Equation (2): $\Psi = \frac{2\pi R_1}{\lambda} \cos(\phi - \theta)$

Equation (3): $\Psi(t) = \frac{2\pi R_1}{\lambda} \cos(\phi - \omega_d t)$

Equation (4): $\omega_{deviation} = \frac{2\pi R_1 \omega_d}{\lambda}$ radians/second

Equation (5): $f_{deviation} = \frac{R_1 \omega_d}{\lambda}$ Hz

Equation (6): $E_{audio} = K_A \frac{2\pi R_1}{\lambda} \cos(\phi - \omega_d t)$

Equation (7): $E_S = K_A E_A + K_B E_B + K_C E_C + K_D E_D$

Equation (8): Phase at S $= \Psi_S = \Psi_{C \text{ or } D} + \left[\frac{(1 + \sin\theta) R_1/\lambda}{2 R_1/\lambda}\right] (\Psi_{A \text{ or } B} - \Psi_{C \text{ or } D})$

$= K_X \Psi_{A \text{ or } B} + (1 - K_X) \Psi_{C \text{ or } D}$

where $K_X = (1 + \sin\theta)/2$

Equation (9): $\Psi_S = \Psi_{B \text{ or } C} + \left[\frac{(1 + \cos\theta) R_1/\lambda}{2 R_1/\lambda}\right] (\Psi_{A \text{ or } D} - \Psi_{B \text{ or } C})$

$= K_Y \Psi_{A \text{ or } D} + (1 - K_Y) \Psi_{B \text{ or } C}$

where $K_Y = (1 + \cos\theta)/2$

Equation (10): $E_S = K_X K_Y E_A + K_X(1 - K_Y) E_B + (1 - K_X)(1 - K_Y) E_C + (1 - K_X) K_Y E_D$

Equation (11): $K_A = K_X K_Y = 1/4\,(1 + \sin\theta)(1 + \cos\theta)$

ICOM

TRIED, TESTED AND TRUSTED

See revue in February Rad.Comm.

IC-720A
Possibly the best choice in HF. £883.inc.

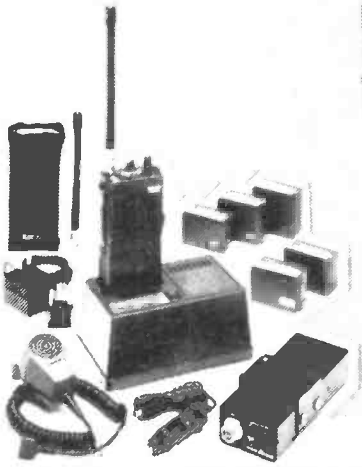
The main problem that the amateur of today has to deal with is deciding just which rig out of the many excellent products available he is going to choose. Technology is advancing at such a rapid rate and getting so sophisticated that many cannot hope to keep up.
Some go too far!

Perhaps one way of dealing with the problem is to look at just what each model offers in its basic form without having to lay out even more hard earned cash on "extras". The IC-720A scores very highly when looked at in this light. How many of its competitors have two VFOs as standard or a memory which can be recalled, even when on a different band to the one in use, and result in instant retuning AND BANDCHANGING of the transceiver? How many include a really excellent general coverage receiver covering all the way from 100kHz to 30MHz (with provision to transmit there also if you have the correct licence)? How many need no tuning or loading whatsoever and take great care of your PA, should you have a rotten antenna, by cutting the power back to the safe level? How many have an automatic RIT which cancels itself when the main tuning dial is moved? How many will run full power out for long periods without getting hot enough to boil an egg? How many have band data output to automatically change bands on a solid state linear AND an automatic antenna tuner unit when you are able to add these to your station?

Well you will have to do quite a bit of hunting through the pages of this magazine to find anything to approach the IC-720A. It may be just a little more expensive than some of the others – but when you remember just how good it is, and of course the excellent reputation for keeping their secondhand value you will see why your choice will have to be an IC-720A!

IC-PS15 Mains PSU £99

IC-2E £159.inc.
IC-4E £199.inc.
The World's most popular portables & now the marine version IC-M12



Nearly everybody has an IC2E – the most popular amateur transceiver in the world – now there is the 70 cm version which is every bit as good and takes the same accessories. Check the features.

Fully synthesized – Covering 144 – 145 995 in 400 5KHz steps. (430-439.999 4E)
Power output – 1.5W with the 9v rechargeable battery pack as supplied – but lower or higher output available with the optional 6v or 12v packs. Rapid slide-on changing facility.
BNC antenna output socket – 50 ohms for connecting to another antenna or use the Rubber Duck supplied (flexible ¼ λ whip – 4E)
Send/battery indicator – Lights during transmit but when battery power falls below 6v it does not light, indicating the need for a recharge.
Frequency selection – by thumbwheel switches, indicating the frequency. 5KHz switch – adds 5KHz to the indicated frequency.
Duplex simplex Switch – gives simplex or plus 600KHz or minus 600KHz transmit (1.6MHz and listen input on 4E)
Hi-Low switch – reduces power output from 1.5W to 150mW reducing battery drain.
External microphone jack – if you do not wish to use the built-in electret condenser mic an optional microphone speaker with PTT control can be used. Useful for pocket operation.
External speaker jack – for speaker or earphone. This little beauty is supplied ready to go complete with nicad battery pack, charger, rubber duck.

A full range of accessories in stock.		£ p			
ICML1	10W mobile booster for IC2E	49 00	BC25	Mains charger as supplied	4 25
BP5	11 volt battery pack	30 00	DC1	12 volt adapter pack	8 40
BP4	Empty battery case for 6 x AA cells	5 80	HM9	Speaker microphone	12 00
BP3	Standard battery pack	17 70	CP1	Mobile charging lead	3 20
BP2	6 volt pack	22 00	IC123	cases	each 3 60
BC30	Base charger for above	39 00	All prices include VAT		

The IC4E is going to revolutionise 70 CM!

ICOM

See us at ELVASTON CASTLE RALLY JUNE 13th

Free carriage on direct sales – call us.

Remember we also stock Yaesu, Jaybeam, Datong, Welz, G-Whip, Western, TAL, Bearcat, RSGB Publications.

Please note: Access Barclaycard owners – goods must be sent to address registered with credit card company

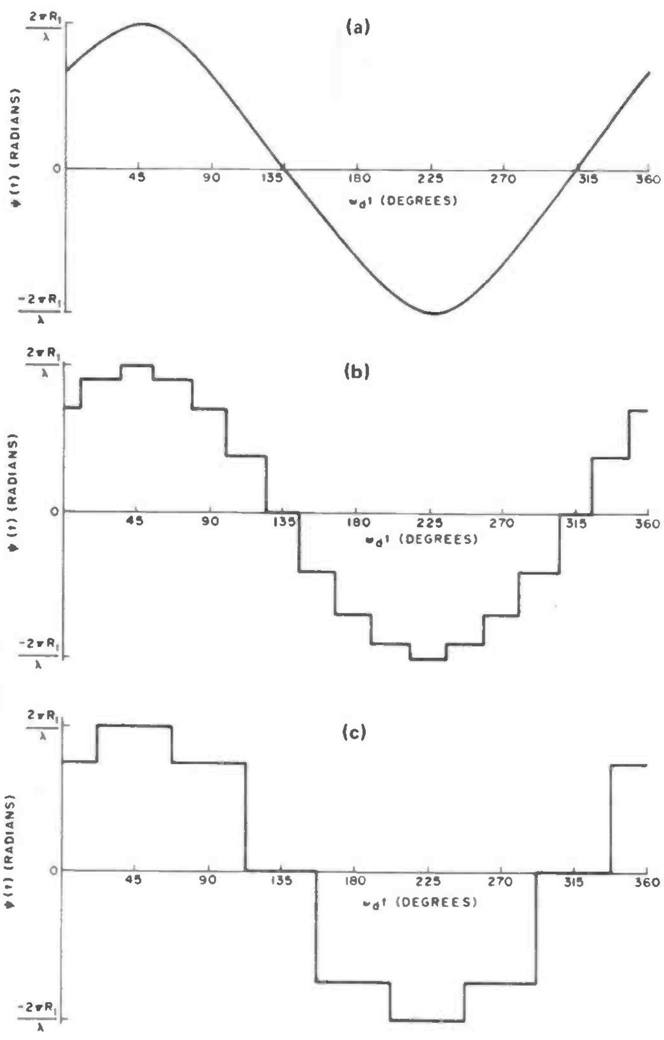


Figure 3: Waveforms illustrating the phase modulation imparted to the received signal when the bearing angle is 45 degrees.

system of antennas A, B, C and D shown in *Fig 4* and assume for the moment that the antennas are not coupled, i.e., there is no mutual impedance between them. The signals received by the four antennas can be summed electronically as shown in Equation (7), where K_A, K_B, K_C, K_D are gains and E_A, E_B, E_C, E_D are the rf voltages induced in the four antennas. We wish to find the value of the four gains which will create a voltage E_S equal to that induced in an antenna S located on the inscribed circle of radius R_1/λ at the angle θ shown in *Fig 4*.

If an incoming signal were arriving from the left or right in *Fig 4*, the phase at A and B would be equal, and the phase at C and D would also be equal. As long as the array is less than 1/2 wavelength on a side, the phase at point S may be computed by interpolating linearly between the phases to the left and right as indicated in the plot directly below the sketch of the antenna array in *Fig 4*. See Equation (8).

For example, if S is midway between A and D, $\theta = 0^\circ$, $K_X = 1/2$, $(1-K_X) = 1/2$, and the phase is the simple average of the phases measured at A and D. If we now consider a signal originating from the top in *Fig 4*, the phase at S can be computed from that at A or D and that at B or C by interpolating along the Y direction. Referring to the graph to the left of the antennas in *Fig 4* see Equation (9).

Equations (8) and (9) may be combined to give a two dimensional interpolation of phase. From similarity, Equation (7) can then be written as in Equation (10).

The mixing is not perfect since rf voltages rather than phase angles are being mixed; the errors, however, are small, as discussed below. The gain for antenna A is given in Equation (11), which is shown plotted in *Fig 5* over one cycle of rotation in θ. Note that the gain peaks, as would be expected, at 45 degrees where the imaginary antenna is closest to antenna A. A second small gain increase also occurs 180 degrees from this location. The other antenna gains, K_B, K_C and K_D, have identical shapes to K_A, but are displaced 90 degrees in phase (K_B lags K_A by 90 degrees, etc).

To evaluate the accuracy of the mixing given by (10), the instantaneous amplitude and phase of E_S was computed for antennas of different size with various bearing angles, ϕ. A typical result is shown in *Fig 6* for an antenna of dimension $2R_1/\lambda = 1/4$ on each side. In *Fig 6*, the bearing angle ϕ is 0 (signal coming from top in *Fig 4*). The composite rf signal contains some amplitude modulation (about 18% at twice the commutation frequency) in addition to the desired phase modulation. Note that the phase modulation error relative to an ideal (physically rotating) antenna is very small (less than 8%).

At bearing angles of 22.5 and 45.0 degrees, the amplitude modulation is lower and the phase modulation error is about the same — better than 8%. Antenna symmetry causes the amplitude and phase error characteristic to repeat every 45 degrees of bearing. Decreasing the antenna size improves the error characteristic over that shown in *Fig 6*, but antenna tolerances become more critical and the magnitude of the phase modulation (deviation) which must be detected decreases as given by Equation (5).

THE REAL WORLD

The above results were based on an antenna array in which the elements do not interact with each other — that is, a current flowing in one antenna element does not induce a voltage in one of the other elements. This is generally not the case for antennas spaced at these distances.

A detailed analysis has been made which takes into account the actual coupling between elements (mutual impedance). If each antenna element is terminated into a 50-Ohm load, the antenna currents and hence the coupling between elements are significant and the rf output voltage to the receiver is affected. For the

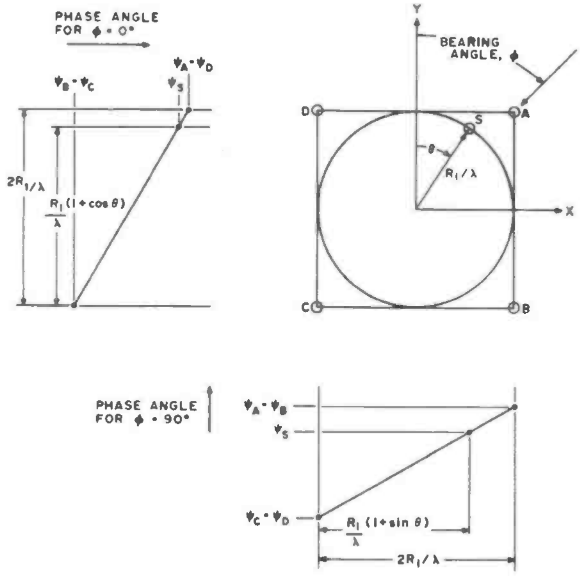


Figure 4: Top view of a four-antenna array showing the interpolation of phase angle between opposite sides of the array.

1/4-wavelength array, amplitude modulation increases to about 65% and the phase modulation waveform becomes noticeably distorted.

The situation is considerably better with smaller antennas. For example, if the array size is 1/8 wavelength on a side, the amplitude modulation is only 19% and the phase modulation is very nearly sinusoidal.

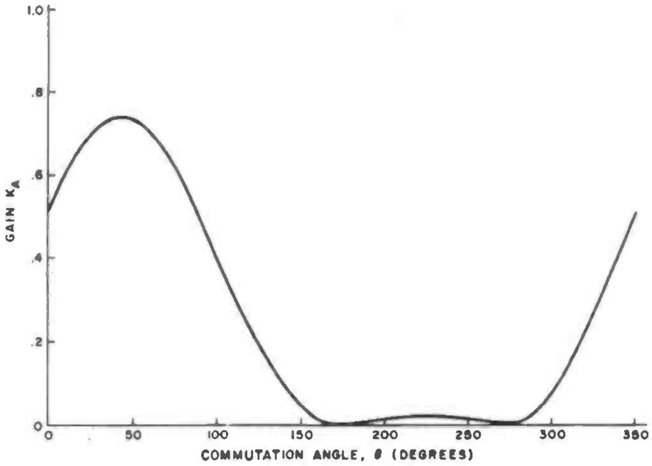


Figure 5: Theoretical gain variation for antenna 'A' required to produce an equivalent continuously rotating antenna signal.

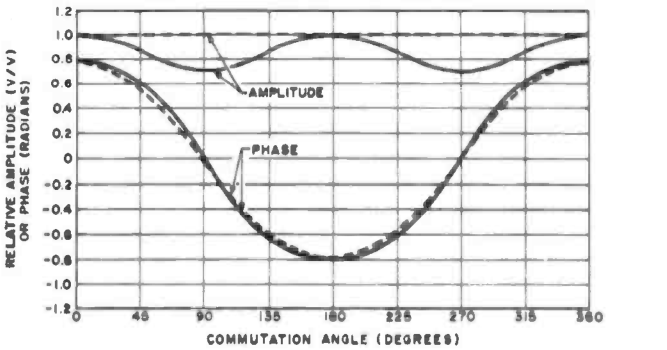


Figure 6: Amplitude and phase modulation for an uncoupled antenna array of 1/4 wavelength and bearing angle of 0 degrees. The dotted lines represent the ideal (continously rotating) case.

An alternative to reducing the array size is to increase the effective load impedance across each antenna element. This may be accomplished using an impedance step-down transformer at the antenna and an impedance step-up transformer at the receiving end of the transmission line. See *Fig 7*. It should be kept in mind that in a receiving application, the antenna is acting as the source and the receiver (or rf summer here) is the load. We wish to minimize standing waves on the transmission line to prevent rf pickup other than from the antenna. Therefore, the line must be matched to the rf summer. At the antenna we are interested in having the maximum voltage developed across the antenna terminals. This is obviously obtained by presenting a high impedance load to the antenna. An impedance match between line and antenna is generally regarded as essential to proper system operation but that is the case only for transmitting where the antenna acting as the load determines the line swr and maximum power transfer occurs when line and load are matched.

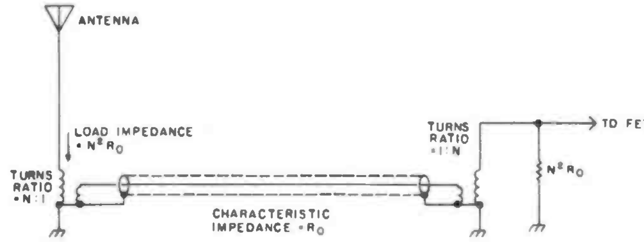


Figure 7: Use of impedance transformers to minimise the effect of mutual impedance coupling between array antennas.

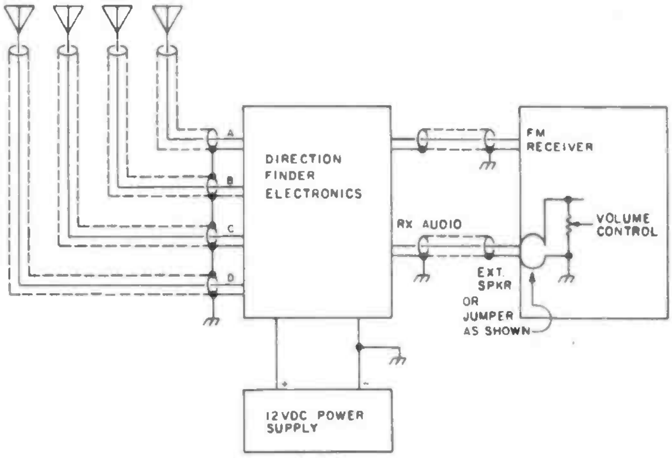


Figure 8: Basic system connection to antenna, power source, and FM receiver. If a transeiver is used, be sure to disable the transmitter to prevent inadvertent transmission into the RDF electronics.

DISTORTED TRUTH

The receiver provides limiting which will remove most of the AM and the phase detector provides synchronous filtering which will remove most of the harmonic distortion in the phase modulation. Initially it was feared that any amplitude modulation would cause modulation products from adjacent channel signals to be formed which might appear on the selected channel and cause interference. Also, distortion of the phase modulation could lead to bearing errors at specific bearing angles. Neither of these problems has been observed in either the testing or the field use of this system. Therefore, while a solution is at hand, the need to employ it has not been evidenced and the design to be discussed in the remainder of this article does not include impedance transformers. The subject of antenna array optimisation and coupling for this system is an area for much additional experimentation and development. □ R & EW

Next month: The circuit diagrams of a complete Doppler DF Finder.

Your Reactions	Circle No.		Circle No.
Immediately Interesting	1	Not Interested in this Topic	3
Possible Application	2	Bad Feature/Space Waster	4

ZX81 KEYBOARD UPGRADE

A vast improvement over the standard keyboard featuring a unique two PCB construction.

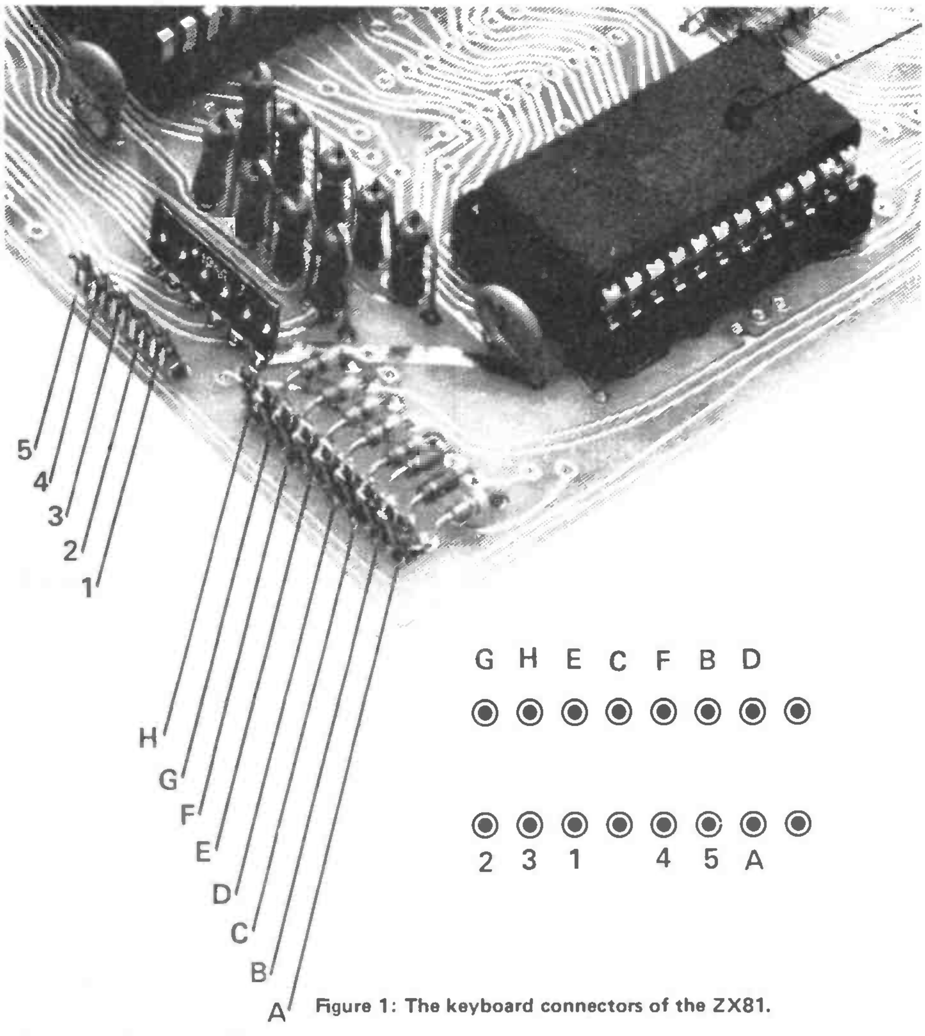


Figure 1: The keyboard connectors of the ZX81.

There is no doubt that the Sinclair ZX81 represents value for money but there is equally no doubt that the standard machine's keyboard is the victim of a cost cutting exercise that leaves it awkward to use at the best of times. Adding our keyboard will greatly ease the task of data entry which, with the touch keyboard, is almost impossible to achieve with any accuracy.

The project is quite straightforward, and merely duplicates the switch matrix of the basic ZX81 using standard typewriter like keys.

TWO BOARDS BETTER THAN ONE

When attempting to produce a PCB design for a switch matrix, one of two standard approaches are usually adopted. Either a single sided board is used with many links being made on the top side — very time consuming, or a double-sided, plated through board is used but this is expensive.

Our design uses two, thin, PCBs, the necessary links between them being made by the switch pins. These links also impart a ruggedness to the finished assembly.

The switches are fitted with the ZX81 keyboard legends, a set of these can be

The two board construction of the keyboard can clearly be seen in this photo.

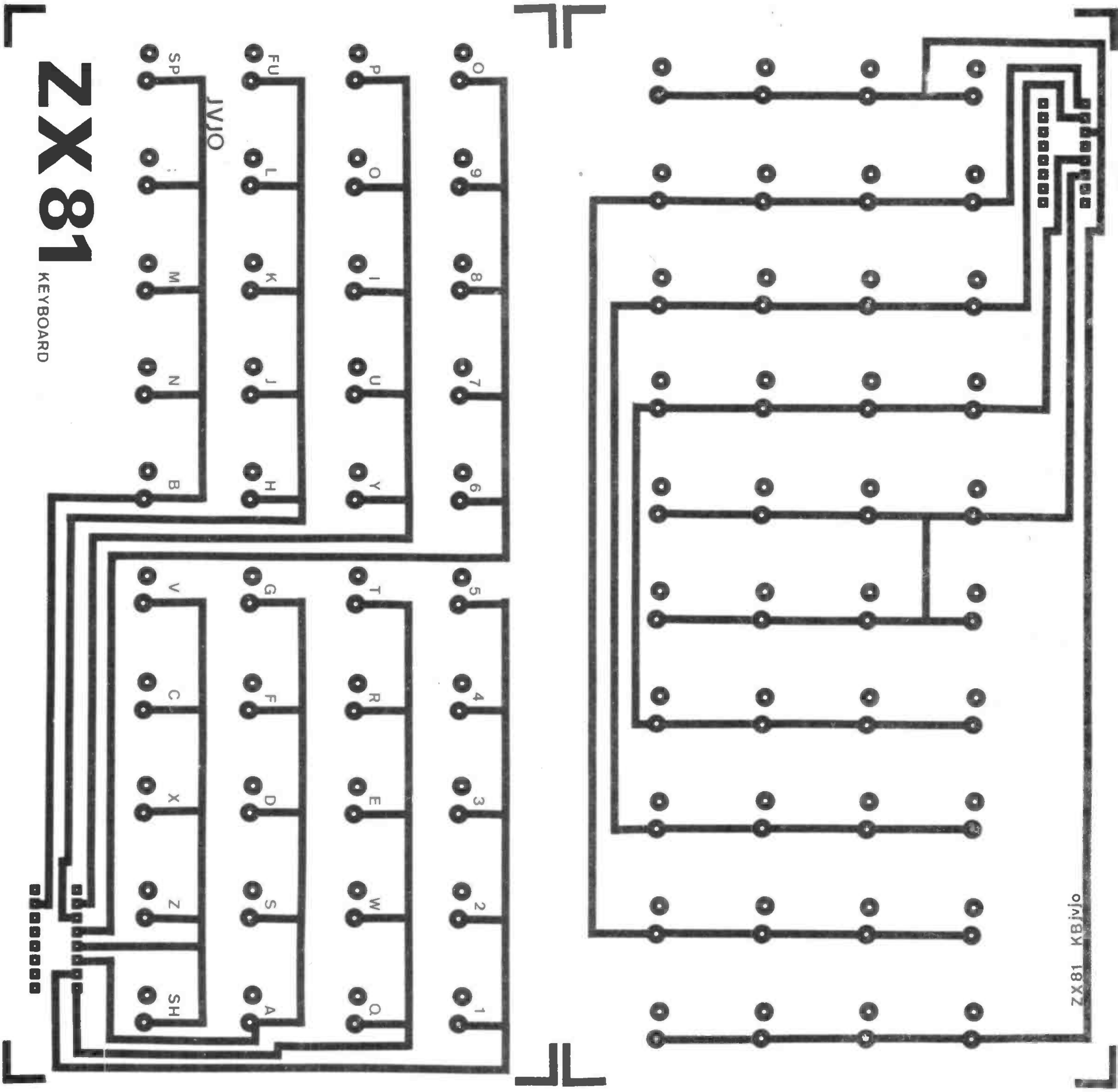


Figure 2: The foil patterns for the two boards used to construct the keyboard. The PCBs available from R&EW will be thinner than a standard PCB.
The switches form a 10 x 4 matrix with through board links being made by the switch pins.

■ R & EW

found in the ZX81 user's manual.

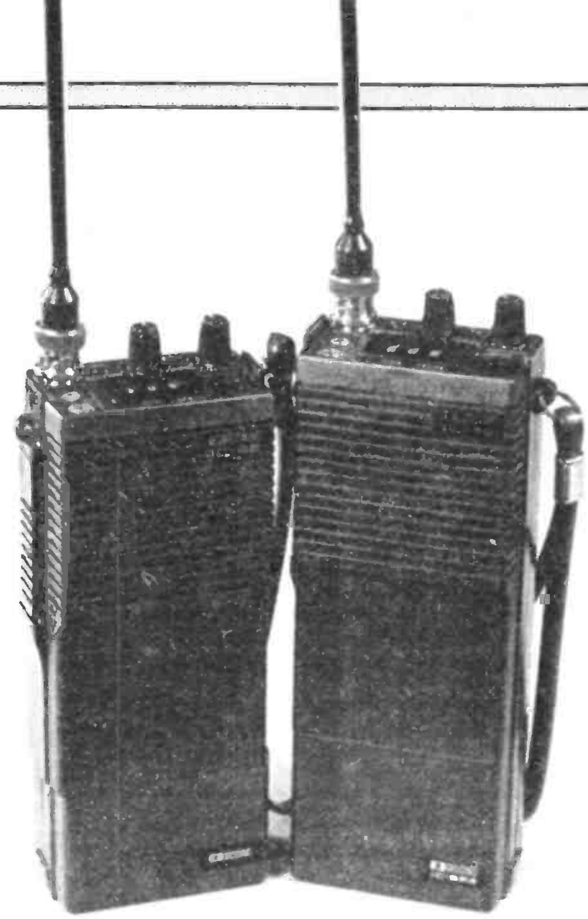
After completion, the board is connected to the ZX81 via a ribbon cable. We chose to solder the ends of this cable to the underside of the ZX81's PCB rather than attempt a connection to the PCB mounted keyboard connectors. In this way the new keyboard may be used in parallel with the original.

The diagrams show the arrangement of the keyboard and its connections to the ZX81.

Your Reactions.........	Circle No.
Excellent - will make one	82
Interesting - might make one	83
Seen Better	84
Comments	85

ICOM's IC4

Icom's 70cm handheld is evaluated by William Poel.



THE ENORMOUS POPULARITY of Icom's IC2 series of transceivers has encouraged them to do the same for 70cm users in the shape of the IC4E. If you have read our report on the IC2 (way back in the first **R&EW**, October 1981), you will find our enthusiasm for the IC2 stemmed largely from the overall thought that had gone into providing a complete 'system' that was quite simply as concise as possible.

The earlier Icom portables had been anything but 'concise', and it is interesting to see that the 70cm version has now emerged in exactly the same format as the IC2. Even the Japanese occasionally stick with a winner without gratuitous modifications. The US market is also blessed with a 3m version (220-225 MHz). Would it be greedy to suggest that if no one else wants 220 MHz in the UK, then this might be a particularly useful additional band — primarily for ASCII data transmissions?

We digress, on with the IC4.

OPEN THE BOX

The transceiver comes complete with flexible quarter wave antenna, strap, clip, Nicad battery pack (BP3) and mains charger. The only major gripe we have concerns the dreadful US style two prong mains plug on the battery charger. Someone has had the decency to put an adapter in the box — but this only adds insult to injury, as the adapter is to the Euro two pin plug system.

It's bad enough being commercially obliterated by the Japanese, without having to suffer the ignominy of finding our market is even then not big enough to warrant a mains adapter to local standards.

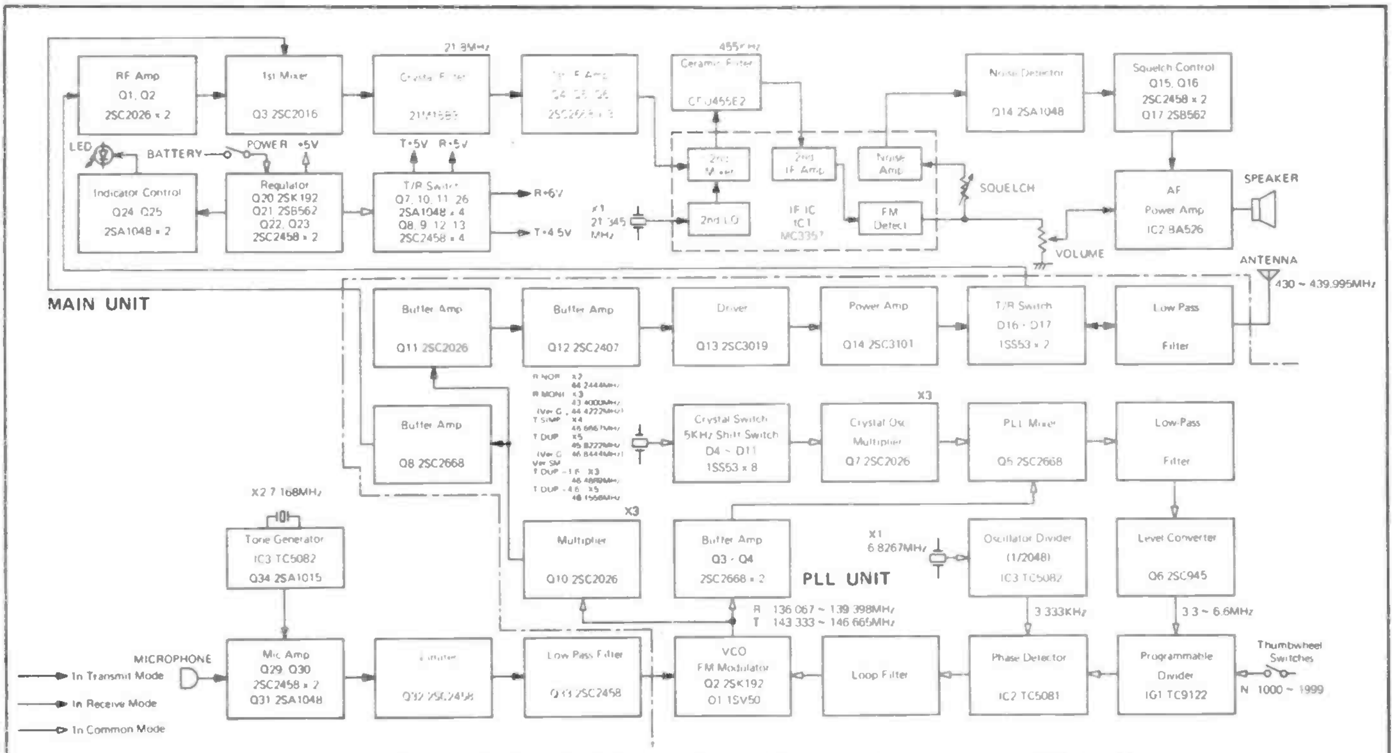


Figure 1: The block diagram of the IC4 reveals that the IC4's synthesiser is much the same as that of the IC2.

CIRCUIT DESCRIPTION

The circuit of the IC4 is very similar to the IC2. Refer to your back issue of **R&EW**. The RF tuned circuits are bashed out of sheet metal as opposed to being wound on formers, and the first IF is 21.8 MHz, apart from which there is precious little difference in the signal processing path. In spite of the use of bipolar transistors throughout, the receiver performance is exemplary (see Table 1), in keeping with other equipment we have seen. We couldn't even catch it out over the range —30 to +60 degrees C in the Astell Dutaform test chamber.

In view of the thermal jitters experienced in many designs that rely on the MC3357's internal mute threshold trigger, our intrepid Communications Editor decided to establish the performance of this slightly rearranged system favoured by Icom. The results in *Table 1* bear out the efficacy of the Icom approach, although with a 'tight' squelch sensitivity of under 0.5uV the operational range is rather limited.

The block diagram (*Fig 1*) reveals that the synthesiser remains very much the same animal as in the IC2, with the use of crystal mixing techniques to provide the programmable divider with the right frequency range.

The transmitter strip (*Fig 2*) is a tidy collection of multipliers with bandpass inter-stage coupling, resulting in an output with no visible spurious products for 70 dB or better — so we haven't bothered to print a picture of the analyser trace this time. It's interesting to note that the power increases from a nominal 1.7W at room temperature, to 2.3W at —30 degrees C. Not many people know that.

IC4E TEST RESULTS
Serial No 15601216

RECEIVER

Sensitivity	The signal level required (pd) to give 12dB SINAD was between 0.20 and 0.25uV over the entire frequency range and between —30 and +60°C
Adjacent Channel Rejection	60dB
Blocking Rejection	80dB
IMD Rejection	63dB
Spurious Response Rejection	424.1MHz 75dB All others greater than 80dB

Mute Operation

Signal level required to open Mute when set to maximum	Temp (°C)	—30	+25	+60
	Level (uV)	0.35	0.35	0.46

TRANSMITTER

Power Output

Frequency (MHz)		430	435	440
Output (W)		1.7	1.7	1.8
Output Low		0.20	0.20	0.21
Temperature (°C)	-30	-15	+25	+60
Power O/P (W)	2.3	2.2	1.7	1.6

TAKE THE MONEY

As with many transceivers of this type, the basic unit is attractively cheap. Start to throw in a few extras, like a spare BP3 300 mAh battery pack, (£17.70), 12V adapter (£8.40) & you'll appreciate the old addage about sprats and mackerels. The empty case for 6AA cells (£5.80) and 6,550 mAh AA Nicads (£5.52) looks like a better deal.

To forestall those engaged in comparing prices with US vendors — the IC4E sells there for around $270 (with 90 day local warranty): which at the time of writing equates to a UK price of around £199 including VAT, duty and at least a 12 month warranty.

COMPETITION

The Yaesu FT708R at £219 isn't too far removed. Certainly not as far as the 2m FT208 (£209) is from the IC2 (£169). The FT708R is basically a 1W/0.1W unit, with a quoted 0.4uV for 12 dB SINAD — but the keyboard and scanning systems are mighty tempting for the extra £20. However, so many users are likely to have bits of the IC2 system, the IC4 is going to have a head start with many amateurs.

So perhaps the clincher is the Icom battery system, but don't throw away the piece of card supplied with the battery pack to prevent shorting of the contacts. A battery pack rolling around a pocket (or car parcel shelf) can very easily find a key or coin and the result is a hot pocket and a flat battery.

We now await the arrival of an FT790 with interest, although it is doubtful if this will usurp the function of the very handy IC4.

REVELATIONS

The IC4E behaved as well as we had expected. There are many repeaters accessible from Brentwood on 70cm — too many, since we always manage to access NS with ER. The audio quality is excellent, although the optional hand mike/speaker does not appear to enhance reports received.

The vast empty tracts of MHz that lie beyond 430 MHz are quite a revelation for shell shocked 2m users. It's a bit like a Londoner moving to the Outer Hebrides. In view of the fact that the IC4 uses a real quarter wave antenna, as opposed to the IC2's helical antenna, the perceived performance is about the same.

The +/—600 kHz switch on the rear panel of the IC2 has become a more useful 'monitor/normal' function with the IC4E, enabling instant assessments of the repeater input signal to be made.

Various reports put a helical antenna about 3-5 dB down on a 'real' quarterwave, although the loss in case of a transceiver clipped near the body can be

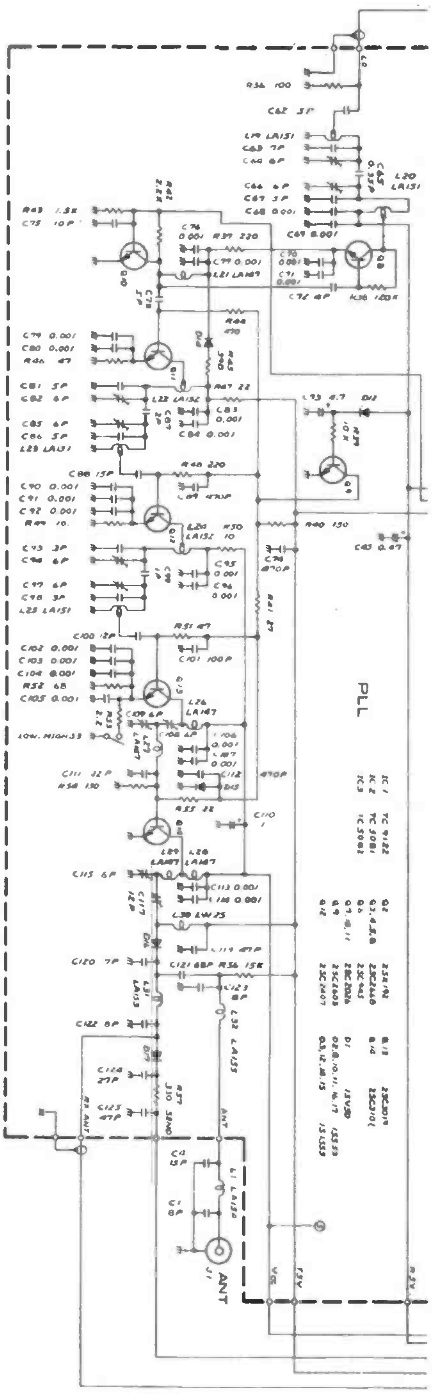


Figure 2: The transmitter strip reveals a tidy collection of multipliers with bandpass interstage coupling.

as much as 15-20 dB. The **R&EW** loft mounted discone which is such a sterling performer on 144 MHz, is a wash out at 70cms. The supplied antenna does a better job — and plans are now afoot to acquire a colinear. ■ **R & EW**

Your Reactions.........	Circle No.
Immediately Applicable	66
Useful & Informative	67
Not Applicable	68
Comments	69

R&EW Data Brief

LM 1035

LM1035 Dual DC Operated Tone/Volume/Balance Circuit

The LM1035 is a DC controlled tone (bass/treble) volume and balance circuit for stereo applications in car radio, TV and audio systems. An additional control input allows loudness compensation to be simply effected.

Four control inputs provide control of the bass, treble, balance and volume functions through application of DC voltages from a remote control system or, alternatively, from four potentiometers which may be biased from a zener regulated supply provided on the circuit.

Each tone response is defined by a single capacitor chosen to give the desired characteristic.

Zener Voltage

A Zener voltage (pin 17 5.4V) is provided which may be used to bias the control potentiometers. Setting a DC level of one half of the Zener voltage on the control inputs. Pins 4, 9, 14, results in the balanced gain and flat response conditon. Typical spread on the Zener voltage is +/—100 mV and this must be taken into account if control signals are used which are not referenced to the Zener voltage. If this is the case then they will need to be derived with similar accuracy.

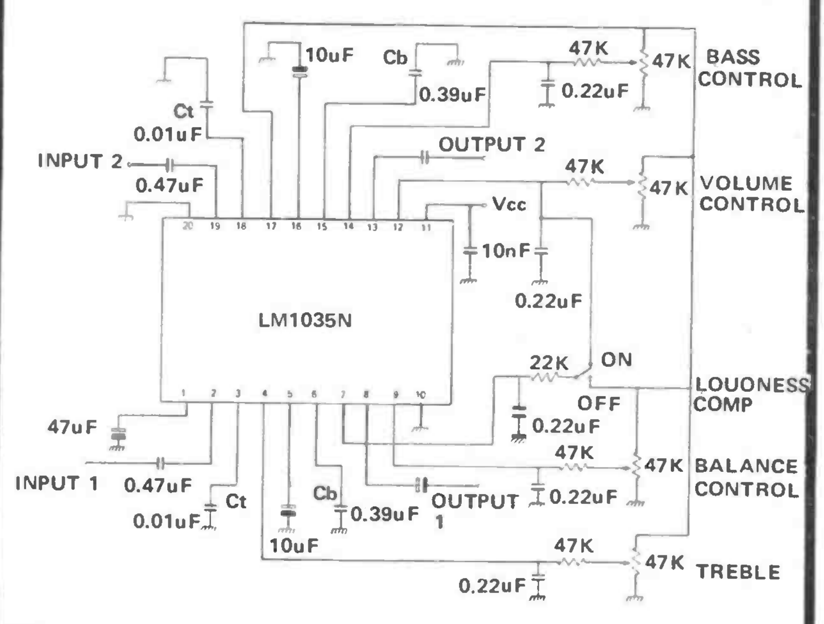
Loudness Compensation

A simple loudness compensation may be effected by applying a DC control voltage to Pin 7. This operates on the tone control stages to produce an additional boost limited by the maximum boost defined by Cb and Ct. There is no loudness compensation when Pin 7 is connected to Pin 17. Pin 7 can be connected to Pin 12 to give the loudness compensated volume characteristic as illustrated without the addition of further external components. (Tone settings for flat response, CB and CT as given in application circuit). Modification to the loudness characteristic is possible by changing the capacitors Cb and Ct for a different basic response or by a resistor network between Pins 7 and 12 for a different threshold and slope.

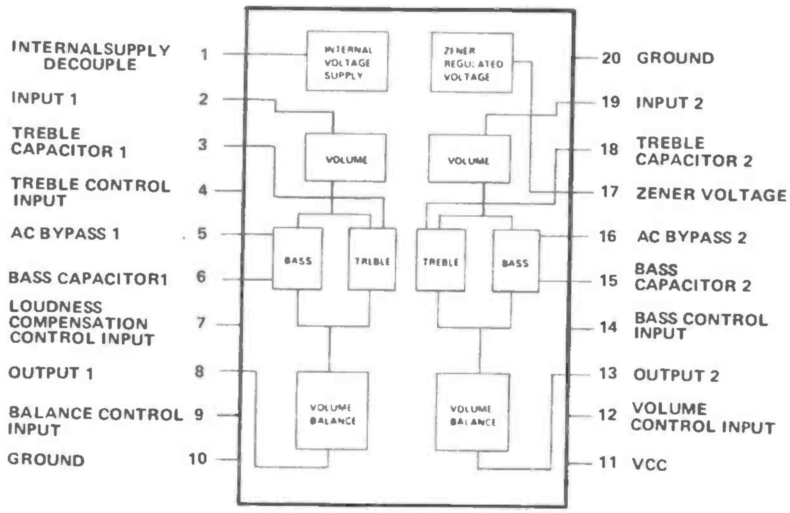
Signal Handling

The volume control function of the LM1035 is carried out in two stages, controlled by the DC voltage on Pin 12, to improve signal handling capability and provide a reduction of output noise level at reduced gain. The first stage is before the tone control processing and provides an initial 15 dB of gain reduction so ensuring that the tone sections are not overdriven by large input levels when operating with a low volume setting. Any combination of tone and volume settings may be used provided the output level does not exceed 2 Vrms, Vcc 12V (1Vrms, Vcc 8V). At reduced gain (— 15 dB) the input stage will overload if the input level exceeds 2Vrms, Vcc 12V (1Vrms, Vcc 8V). As there is volume control on the input stages the inputs may be operated with a lower overload margin than would otherwise be acceptable allowing a possible improvement in signal to noise ratio.

Application Circuit

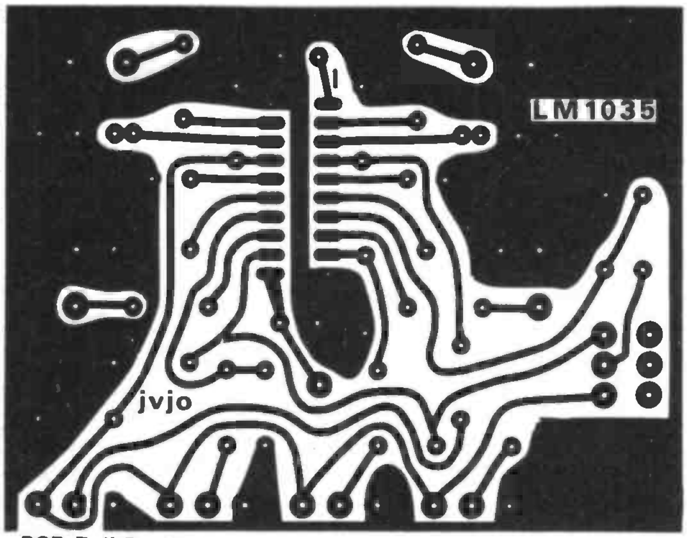


Block Diagram

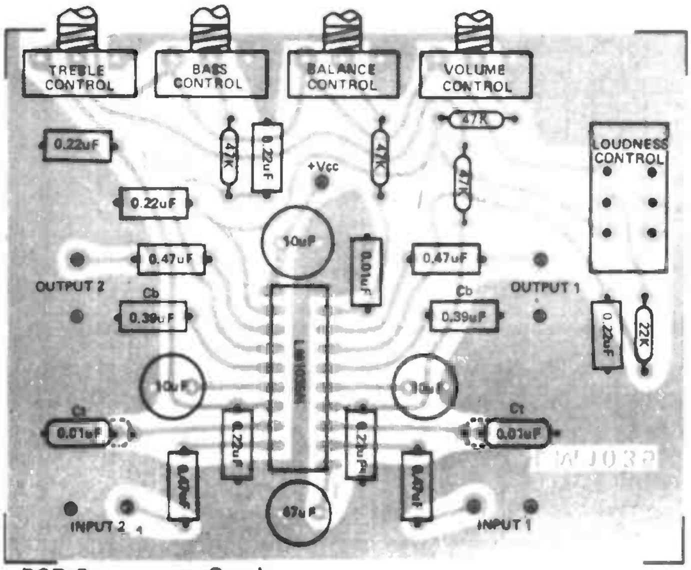


FEATURES

Wide supply voltage range, 8V to 18V.
Large volume control range 80 dB typical.
Tone control, +/—15 dB typical.
Channel separation, 75 dB typical.
Low distortion, 0.05% typical for an input level of 1Vrms.
High signal to noise, 80 dB typical for an input level of 1Vrms.
Few external components required.



PCB Foil Pattern



PCB Component Overlay

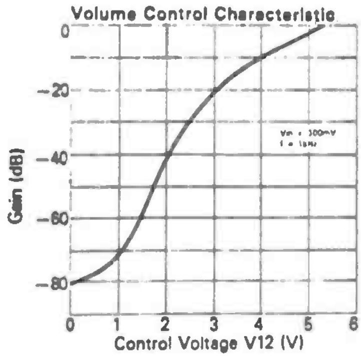
ABSOLUTE MAXIMUM RATINGS

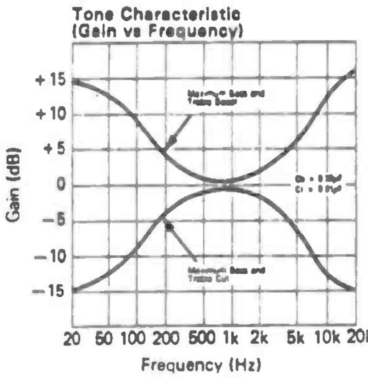
Supply Voltage Vcc	20V
Control Pins Voltage (Pins 4,7,9,12,14)	Vcc
Operating Temperature Range	0°C +70°C

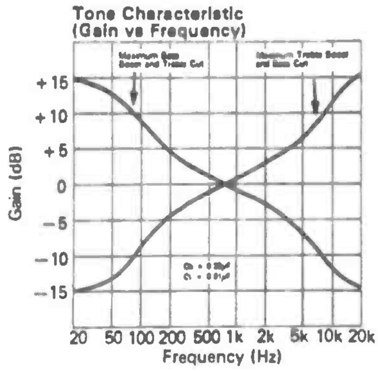
Electrical Characteristics
V_{CC} = 12V, T_A = 25°C (unless otherwise stated.

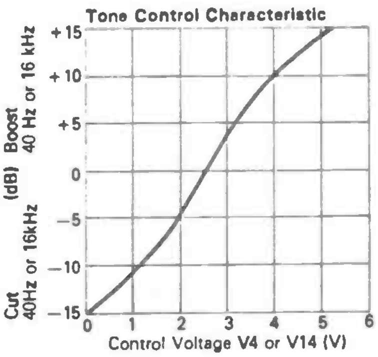
Parameter	Conditions	Typ.	Units
Supply Voltage Range	Pin 11	8-18	V
Supply Current		35	mA
Maximum Output Voltage	Pins 8,13 f = 1kHz Vcc = 12V	2.5	Vrms
Maximum Input Voltage	Pins 2,19 f = 1kHz Flat Response	2.5	Vrms
Maximum Gain	V(Pin 12) = V(Pin 17) f = 1kHz	0	dB
Volume Control Range	f = 1kHz	80	dB
Gain Tracking	f = 1kHz 0 to −40dB	1	dB
Balance Control Range	Pins 8,13 f = 1kHz	+1 −26	dB
Bass Control Range	f = 40Hz Cb = 0.39uF V(Pin 14) = V(Pin 17)	+15	dB
	V(Pin 14) = 0V	−15	dB
Treble Control Range	f = 16kHz Ct = 10nF V(Pin 4) = V(Pin 17)	+15	dB
	V(Pin 4) = 0V	−15	dB
Total Harmonic Distortion	f = 1kHz Vi = 1Vrms, Maximum Gain	0.05	%
Channel Separation	f = 1kHz, Maximum Gain	75	dB
Signal/Noise Ratio	Unweighted 100Hz-20kHz, Maximum Gain 0dB = 1Vrms	80	dB
Frequency Response	−dB (Flat Response 20Hz-16kHz)	250	kHz

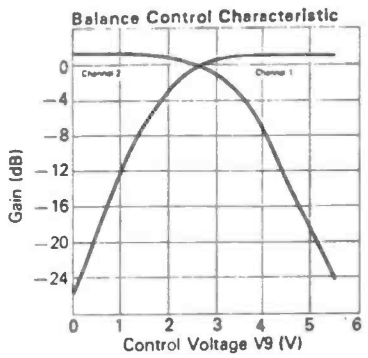
TYPICAL PERFORMANCE CHARACTERISTICS

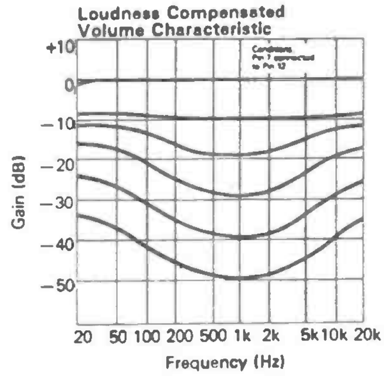












MULTI MODE POWER SUPPLY

APPLYING POWER TO newly designed circuits for the first time can be a harrowing experience without the benefit of a PSU featuring voltage/current limiting. Clouds of smoke and glowing resistors are just a few of the hazards to be faced in such a situation. The **R&EW** PSU should, however, reduce the incidence of such disasters by about 99%. The constructional information for the project has been carefully thought out and this should mean no disasters when building the PSU either.

With this project on your test bench, you can confidently apply power to any circuit knowing that you won't suddenly consume an amp of power up to a 100 mA device.

R&EW will be supporting the design with the usual comprehensive kit of parts to produce a really professional looking piece of equipment.

A lab quality, 0 to 30 volt PSU with audio and visual over current alarms. Design by Tony Bailey G3WPO.

* Voltage variable from 0-30 volts
* Current capability of 1 amp continuous
* Limiting variable from 10mA-1A
* Audio and visual over current warning
* Two presettable fixed voltage outputs
* Constant current or thyristor trip limiting

CONSTRUCTION

The prototypes were built in a Centurion EX2H case, which provides a substantial environment for the power supply together with carrying handles.

As will be seen from the various diagrams, there are a fair number of interconnections to be made from the printed circuit board, but this does not pose any problem if the connections are made in the order suggested later, and each function is checked as it is connected.

The first task is to mount the components on the PCB. There is nothing particularly critical about this, just watch the polarities of capacitors, and the correct orientation of semiconductors (*Fig 3*). It is suggested that the connection pins are inserted first (from the track side of the PCB) as they are difficult to insert with the components in place.

When you have done this, take five minutes to very carefully double check positioning, and also compare the track of your finished PCB with *Fig 2* to make sure you haven't introduced any unwanted bridges between tracks or IC pads!

Rather than checking the functioning of the circuit at this stage with flying leads etc, it is far easier to carry on with the construction putting all the components in place on the front, base and rear panels, and then start checking, stage-by-stage.

So, carry on with this, until you have everything in place on the panels and are ready to start the wiring. Do not assemble the case yet. The position of the piezo resonator is left to the constructor; the author placed it on the left hand side panel behind a small hole, fixed with double-sided tape. The following notes will be helpful:

SAFETY FIRST

It is important for your own safety that ground (mains earth) continuity is preserved on all the panels. To this end, make sure there is a solder tag on each panel with good contact to the metal (scrape off any paint that may be around the inside of the panel in the area of the tag. Then connect a piece of wire from the mains filter earth tag to the nearest tag and so on until all panels are linked. This ensures that all panels are earthed even when the lid or one of the sides is off and ensures safety.

The underside of the 2N3055 should be smeared with thermally conducting grease, and also the underside of the mica insulating washer to ensure good transfer of heat. After assembly of the heatsink and Q1 (use nylon bolts to fix it in place) check with a meter that the case of Q1 is isolated from the heatsink.

The pillars on which the PCB stands must not make contact with the foil of the PCB, as the —ve output is floating with respect to chassis earth.

The green (chassis earth) socket on the front panel must make contact with the metal of the front panel as well as being connected to the tag on one corner of the PCB.

WIRING AND CHECKING

Referring to *Fig 4*, carefully follow these instructions (it will help if a pen is used to mark off the connections as they are made):

a) Make the connections on the front panel shown as connecting lines. Use heavy wire for the connections between the output sockets and the switches on the two potentiometers. Connect C17 across the rear of the +ve and —ve output sockets.

b) Assemble the front, base, rear and right-hand panels of the case.

c) Wire up the connections on the left-hand side of the case. Use sleeving over the EMI filter tags and the mains switch, and to insulate the top row of tags on the transformer.

d) Remove the right-hand panel and fit the left-hand panel in place.

e) Continue wiring up the remainder of the connections shown as connecting lines. Use heavy wire connections between (i) S7 and point T (ii) points S & S (iii) points AB & AB (from now on only one of the connection points will be referred to but there is always a pair) (iv) all points from T1, C2 and the rear panel.

f) Remove F2, switch on and check for approx 42V on the +ve terminal of C2. (Make all voltage measurements with reference to point T as chassis ground is isolated!)

g) Power off (remove plug for safety) discharge C2 with a 470R resistor across its terminals (DON'T use a screwdriver as you will have difficulty in unwelding it from C2, not to mention possible damage of the capacitor). ▶

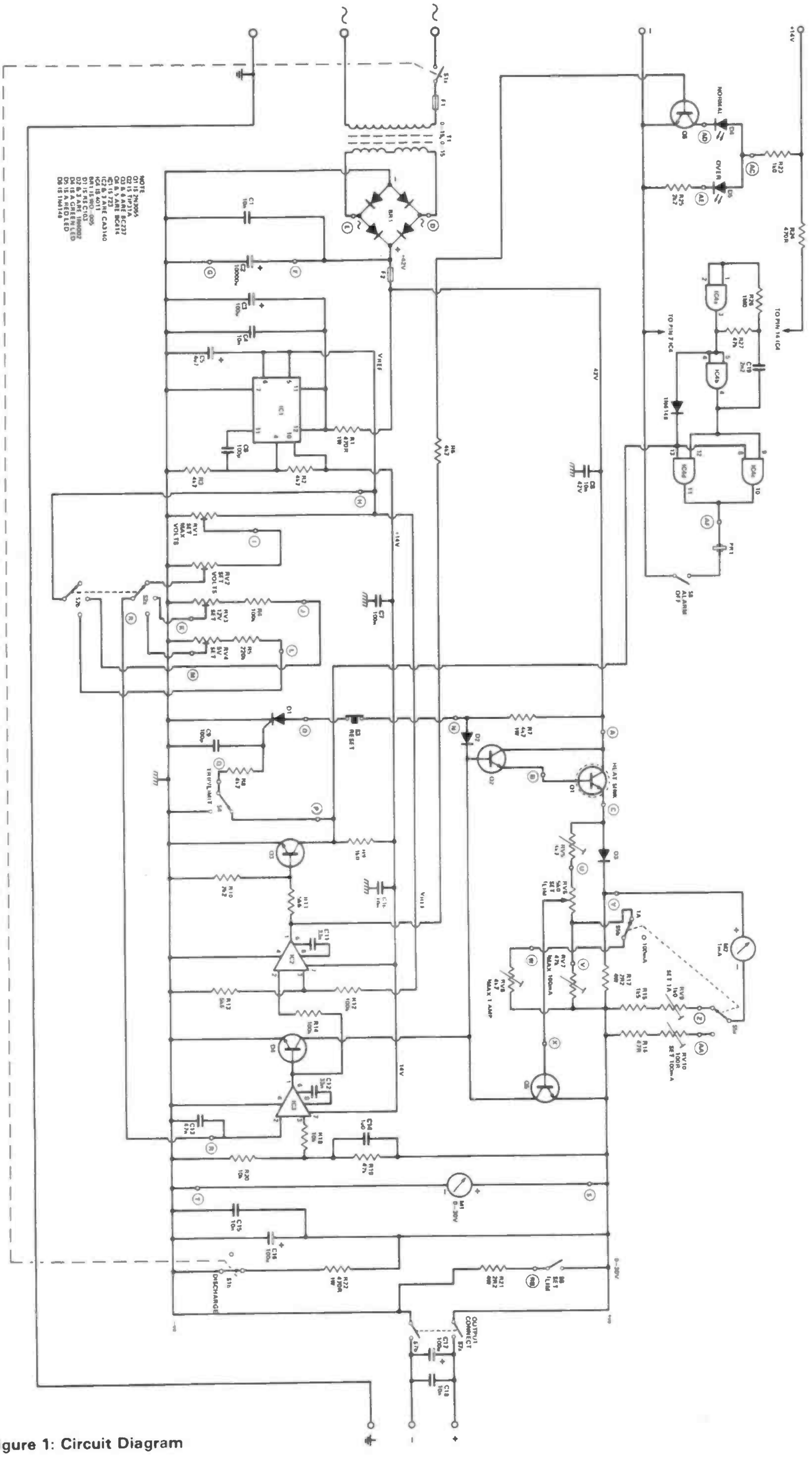


Figure 1: Circuit Diagram

CIRCUIT DESCRIPTION

Referring to *Fig 1*, AC mains is introduced to the power supply via an EMI filter, to remove any 'nasties' which may be present, then via primary fuse F1, and on/off switch S1a to the transformer. S1b places R22 across the supply output to discharge the reservoir capacitors when the supply is switched off.

An encapsulated bridge, BR1, rectifies the output of transformer T1 (0-15, 0-15V connected in series, 1.6A), and after smoothing by reservoir capacitor C2, a DC supply of approximately 42V is obtained. Fuse F2 protects the transformer and remainder of the supply against any fault developing in or prior to the regulating and limiting circuits.

VOLTAGE CONTROL

IC1, a ubiquitous 723 universal voltage regulator, provides stabilised voltage outputs, with its supply dropped across R1 to ensure this does not exceed the IC's maximum voltage rating of 40V. A stabilised supply of approximately 14V is taken from the IC's output (pin 10) for IC2, 3, 4 & Q's 3, 4, 6.

The internal temperature compensated reference voltage of the 723 (7.0V nom.), available at pins 5/6, is also used as the reference voltage for the two preset voltage control networks, and for the variable, voltage supply control, RV2, selectable by S2a/b. Preset RV1 sets the maximum supply voltage to 30V.

Although the 723 could be used as the main voltage control element in its own right, it is limited to a minimum output of approximately 2V, and the design criteria required that this be 0V. Hence a separate control was established consisting of op-amp IC3 and associated circuitry.

In operation, a reference voltage from RV2 (or RV3 or 4 if fixed voltage output) is applied to the inverting input (pin 2) of IC3, and a voltage, divided down by R19/20, from the PSU output is applied to the non-inverting input (pin 3). The op-amp establishes a closed loop and will maintain a zero voltage difference at these two pins. Hence if the voltage at pin 3 is higher than pin 2 (PSU output voltage high), the IC output (pin 6) will go high, turning on Q4. This diverts current from the base of Q2, consequently turning Q1 off and lowering the output voltage. The opposite will occur if the PSU output voltage is low.

All this takes place virtually instantaneously, aided by the high gain of the op-amp (100dB) and the loop.

The emitter follower series transistor, Q1 is a 2N3055, chosen for its ruggedness, although a device of a lower rating could have been used.

CURRENT LIMITING

The current limiting function is controlled by Q5 and the sensing network D3/R17. A reference voltage is established on the base of Q5 by the setting of RV6, the current limit set control. As the current taken by the load increases, a voltage drop occurs across D3/R17, lowering the voltage on Q5's emitter compared to its base. When this difference reaches 0V6, Q5 begins to conduct, diverting base current from Q2, and hence lowering the PSU output voltage. Again, as Q5 is in a closed loop, the effect is to maintain the current at a constant level, lowering the voltage to achieve this.

D3 was included to facilitate limiting at low current levels, as it drops an appreciable voltage even at these low currents, so that only a small additional drop across R17 is required to turn on Q5. Otherwise a very high value resistor would have been required for R17.

RV5, 7 & 8 preset the minimum and maximum current settings, also ensuring that not more than 100mA can be drawn when the meter is in the 100mA position! Current consumption is monitored by M2 (1mA FSD), reading the voltage drop across R17, via the calibration networks R15/RV9 and R16/RV10.

If you wish to use a meter other than that specified, the correct series resistance is given by the formula:

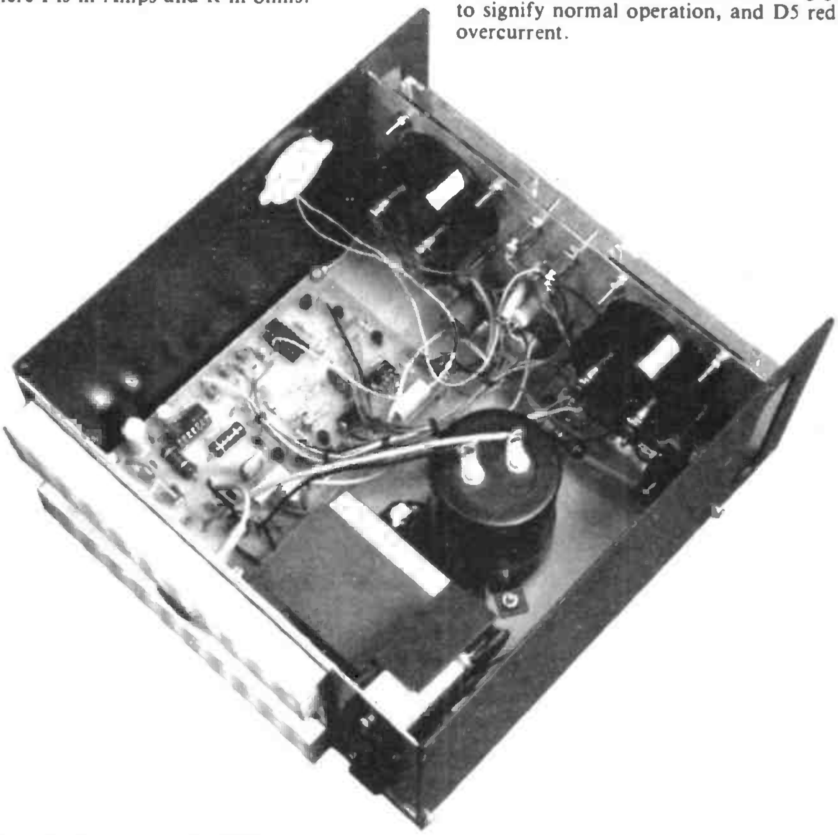
$$Ra = \frac{(I\ load \times R17) - (I\ meter \times R\ meter)}{I\ meter}$$

where I is in Amps and R in ohms.

A choice between limiting and trip modes is given by S4, which grounds the gate of the thyristor in the limiting position, preventing it triggering.

Note that if the trip mode is selected, switching S7 to 'on' (which connects the PSU output to the load) will cause the trip to fire as C17 charges (or as any large C in the load charges). Pressing the reset button will ensure normal operation (unless a fault exists in the load in which case it will not reset until this is corrected). The same occurs on initial switch-on of the PSU as C16 charges.

Both current modes will initiate the audio alarm, PR1, a piezo-ceramic transducer driven by IC4. Gates a & b form a free running audio oscillator, with output enabled or disabled by gates c & d, via the collector of Q3. The alarm can be disabled by S8. In the absence of the alarm, visual indication of the PSU mode is given by D4/5, D4 being green to signify normal operation, and D5 red for overcurrent.



OVERCURRENT TRIP

To provide the trip overload facility, some additional circuitry is required. When in current limit, the voltage comparator IC3, is overidden by Q5 and can no longer control the voltage output. Hence the comparator output at pin 6 goes low when the IC detects the voltage drop caused by the current limit and tries to raise the voltage. This voltage is applied to pin 2 of IC2, and compared with pin 3, which is fixed at about 0V4 by R12/13 from Vref on IC1.

As soon as pin 3 drops below 0V4, the output of IC2 goes low, switching off Q2, which is normally conducting, causing its collector to go high, in turn firing the thyristor D1, which conducts and pulls the bottom of R7 to 0V, thus shutting off the PSU output.

After the cause of the overcurrent is removed, the output will stay off until the reset button is pushed momentarily to disconnect the supply from it and reset the thyristor to its non-conducting state.

The desired current limit can be present without the need to connect any load to the output terminals, by closing S6 (a pull switch on RV6) which connects the PSU output to 0V via R21 (2R2). The PSU is then in current limit and the maximum current can be set on the meter with RV6, and the knob pushed back in before connecting the load with S7.

One of the other uses given by the constant current mode is that the supply may be used to constant current charge ni-cad batteries at any current up to 1A!

The supply output is floating with respect to mains earth. Either output can be earthed via the 3rd socket provided (green) on the front panel. If left floating, it is important that the transformer used either has an earthed screen between primary and secondary windings, or (as the Drake type) is constructed so that a primary to secondary short is impossible. Otherwise in the event of a short, full mains potential could find its way onto the rest of the circuit.

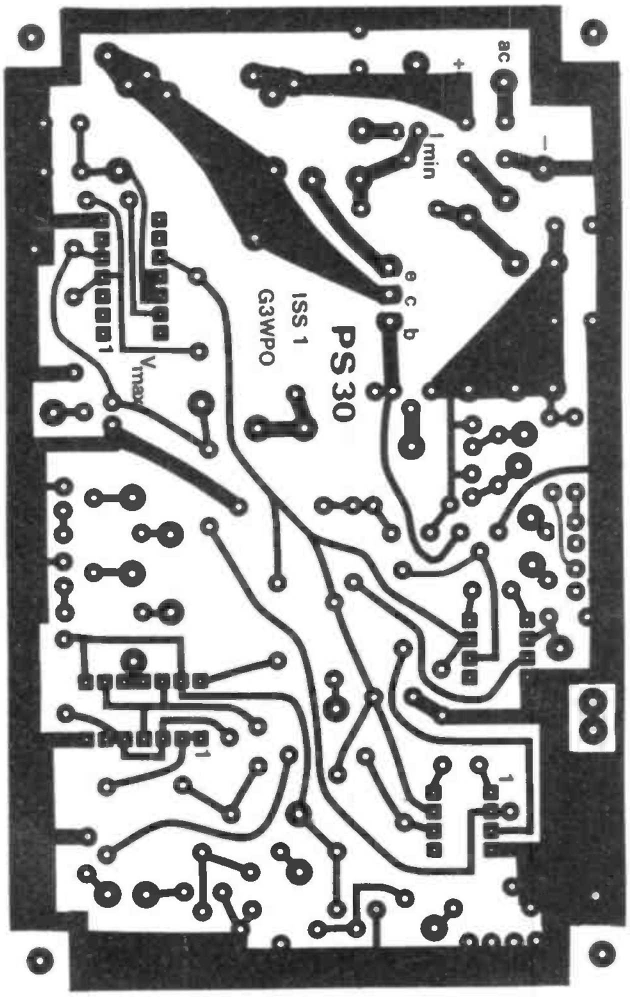


Figure 2: PCB track

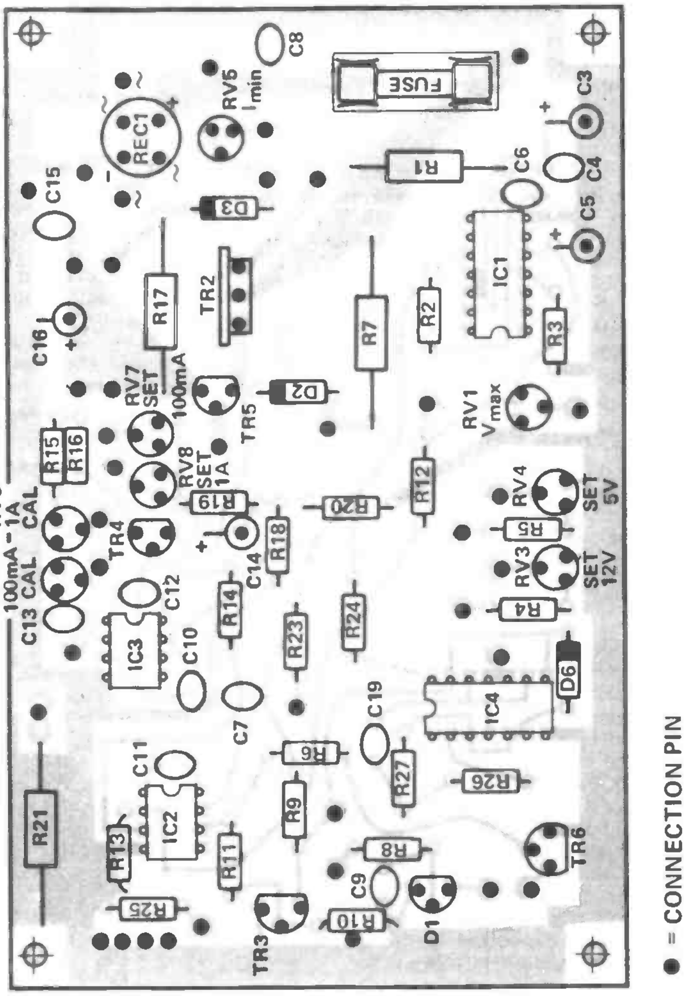


Figure 3: PCB layout

PARTS LIST

Resistors (all .25W 5% unless stated)

R1,22	470R 1 watt
R2,3,6,8	4k7
R4	100k metox
R5	220k metox
R7	4k7 1 watt
R9,23	1k0
R10,25	2k2
R11,13	5k6
R12,14	100k
R15	1k5 metox
R16	47R metox
R17,21	2R2 4 watt
R18,20	10k
R19,27	47k
R24	470R
R26	1M0

Potentiometers

RV1	22k ALPS cermet preset
RV2	100k lin ALPS + p/pull switch
RV3,4	100k ALPS cermet preset
RV5,8	4k7 ALPS cermet preset
RV6	5k log ALPS + p/pull switch
RV7	47k ALPS cermet preset
RV9	1k0 ALPS cermet preset
RV10	100R ALPS cermet preset

Capacitors

C1	10n 63V disc
C2	10 000u 80V electrolytic
C3,16,17	100u 63V PCB mount electro
C4,8,10,-15,18	10n 40V disc
C5	4u7 10V PCB mount electro
C6,9	100p disc
C7,10	100n disc
C11,12	33n disc
C13	47n disc
C14	1u 35V tant or low leakage electro
C19	2n2 disc

Semiconductors

BR1	W0-005 1A 50V rec
D1	RS C103 thyristor
D2,3	1N4002
D4	Green 3mm LED
D5	Red 3mm LED
D6	1N4148
Q1	2N3055 with mounting kit
Q2	TIP31A
Q3,6	BC237/8/9
Q4,5	BC414/5/6
IC1	723 (14 pin DIL)
IC2,3	CA3140 (14 pin DIL)
IC4	4011

Transformer

T1	Drake C5015 or RS207-267 0-15, 0-15V 1.6A

Switches

S1	DPCO toggle 250V AC lamp
S2	2p 3W rotary
S3	Min push to break momentary
S4,8	SPCO min toggle
S5	DPCO min toggle
S6	with RV6
S7	with RV2

Miscellaneous

M1	30V ML52
F1	500mA 20mm fast
F2	1.5A 20mm fast
PR1	PB2720 ceramic resonator

Case (centurion EX2H), Plug, sockets, PCB etc.

h) Push both switches in on the pots. Insert F2. Connect points H, I, R. Turn RV2 (set volts) fully anticlockwise. Set S2 to variable.
i) Power on. Rotate RV2 clockwise — voltage should increase from 0 on the panel meter (no current should be taken). Use RV1 to set 30V maximum with RV2 fully clockwise. (Voltage may not stabilise properly below 10V at this point if RV2 is returned to minimum — this will clear when the current limit circuit is wired in).
j) Power off. Connect points J, K, L, M, AC, AD. Power on. Set S2 to 5V position, adjust RV4 for +5V. Set S2 to 12V position, adjust RV3 for +12V (or desired fixed voltages). The green LED should be on at all times.
k) Power off. Connect points Y, Z, AA. Set RV9 and 10 fully clockwise. Set S2 to +12V. This next step adjusts the calibration of the current meter and can be accomplished in two ways:

CURRENT CALIBRATION

1. Use another ammeter in series with a load resistor and the output terminals, the resistor taking around the desired FSD of the panel meter (100mA equals 120R at 12V, 1A equals 12R at 12V or use any suitable value/voltage that is convenient). With S5 in the 100mA position apply power, connect the load by pulling out the set voltage control knob and adjust RV10 for the same reading as the external meter. Repeat with the 1 amp range.
2. Or accurately measure a suitable load resistor, calculate the current at the voltage setting and use this to set the panel meter as above.

l) Power off. Disconnect load resistor, push in switch on Set Volts control. Connect points U, V, W, X, AE.
m) Set RV6 (Set Current Limit) and RV5 fully anticlockwise, and RV7 & 8 fully clockwise. Set S2 to variable, set volts to 0.
n) Power on. Set S5 to 100mA. Pull out switch on RV6 (Set Limit). Red LED should come on as soon as voltage control is advanced (it may come on at 0V). If the current continues to increase without limiting at a low value there is a fault — power off and check connections.
o) Switch S2 to +12V. Turn Set Limit control clockwise slowly — the current will increase but volts should stay very low. With Set Limit Control fully clockwise, carefully adjust RV7 for 105mA reading (estimate position on meter). Red LED should have remained on all the time.
p) Push in Set Limit switch (green LED should come on) and switch S2 to 1 amp range. Rotate Set Limit control to minimum. Pull out Set Limit switch. Red LED should come on and supply

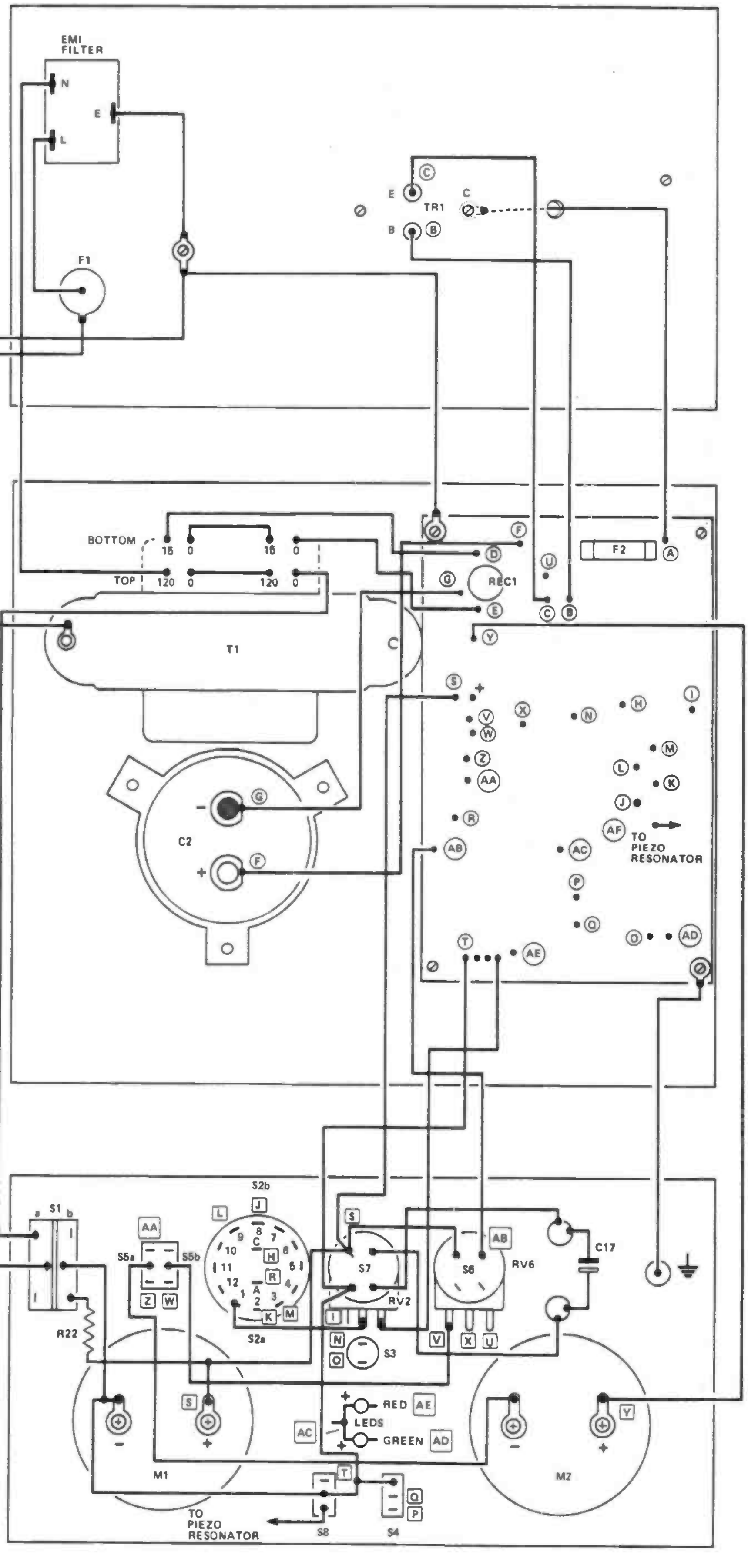
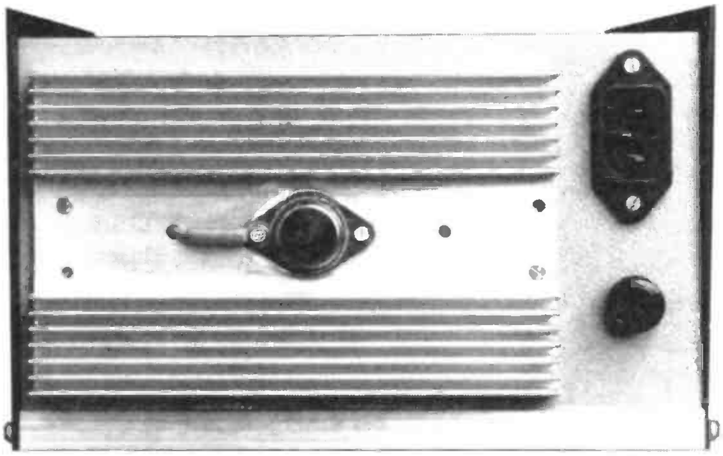


Figure 4: Wiring diagram



should limit at low current and voltage. Rotate limit control to maximum — supply should limit at less than 1 amp when fully clockwise. Adjust RV8 for estimated 1.05 amp reading.

Note: There is a variation in current limiting between the onset of limiting and the short circuit current of approximately +5% i.e., if the limit is set at 100mA with the internal Set Limit switch, the supply will begin limiting or tripping at 95mA or so, hence the reason for setting the ranges higher to allow the full current to be taken without limiting.

q) RV5 will set the minimum current limit level and should be adjusted on the 100 mA range. It interacts with the high end settings which will need re-adjustment afterwards.

r) Power off. Push in Set Limit switch. Connect points N, O, P, Q and the piezo resonator.

s) Set S4 and S8 to ON. Power on. Trip should operate and the alarm sound. Press RESET button to cancel and the green LED will come on. With no other load connected, pull out the Connect Load switch — trip should operate again as C17 charges.

This completes the setting-up of the PSU.

ON THE BENCH

In use, after switching on, set the desired voltage on the Set Voltage control with the load disconnected, then with S4 in Limit mode, pull out the Set Limit switch and set the limiting current. Then connect the load remembering to reset if in trip mode. The trip is very sensitive and will apparently trip a long way below the maximum current setting if transient peaks are experienced, such as with an audio amplifier or meter.

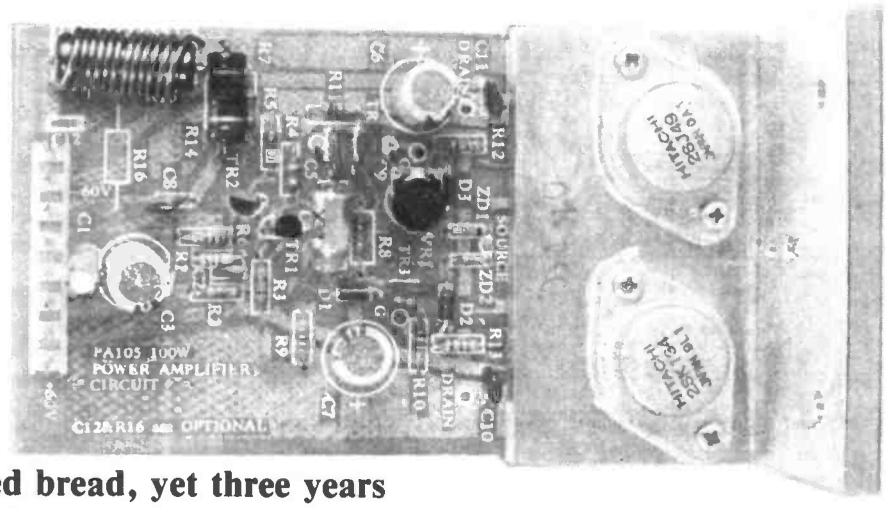
These do not of course register on the meter due to damping, but the trip sees them very clearly! If this is a problem, an RC time constant network could be added between 0V and pin 6 of IC2 to lengthen the trip response time.

Remember that at high currents and low voltages, Q1 is dropping most of the supply voltage and can dissipate up to 40 watts or so. Because of this, ensure that the rear of the case is adequately ventilated.

The supply can be left floating, or one of the output sockets connected to chassis earth at the green socket, depending on the earth polarity required. ■ R & EW

Your Reactions.........	Circle No.
Excellent - will make one	45
Interesting - might make one	55
Seen Better	56
Comments	57

POWER MOSFETS



Power FETS were introduced in 1976 by Siliconix and heralded as the greatest thing since sliced bread, yet three years later they had still not made a large impact. Today the power mosfet has moved onto a plethora of shapes sizes and descriptions, many companies having spent very large sums of money in development of the devices. Ian Campbell takes a close look at these devices.

IN ORDER TO EXPLAIN what power mosfets are and how they are used, it would be a good idea to familiarise ourselves with what a conventional mosfet looks like. *Fig 1* shows a cross-section through part of an N-channel enhancement mode mosfet.

The N+ drain and source are diffused into a P-type substrate, which is also the body of the transistor. The aluminium metalisations which connect the source and drain to the outside world are in electrical contact with the N+ regions. The gate metalisation is, however, insulated from both the N+ and P regions of the device by a layer of silicon dioxide.

When a potential exists between the source and drain, no current flows as long as the potential on the gate is zero. If a potential, which is positive with respect to the source, is applied to the gate, electrons are attracted near to the surface of the P region. These electrons turn the P material into N material which then forms a continuous channel between the source and drain, allowing the flow of current. Increasing the gate potential increases the thickness of the channel which in turn results in an increase in the current flow. This current is lateral, that is, across the device.

INCREASING THE CURRENT

One of the main limiting factors to the current carrying capacity of the mosfet is this lateral current flow. Bipolar transistors, remember, have a vertical current flow which results in a much higher current density and greater current carrying capability. *Fig 2* shows a section through a double-diffused NPN bipolar transistor where the current flows between the collector and emitter i.e. vertically.

In order to obtain a higher current flow in a mosfet an increase in die area would be called for. This is not really a viable solution to the problem for a number of reasons e.g. the lack of accuracy of the photomask system used to make the N+ regions necessitates long channel lengths, which in turn mean a high ON resistance. The connection metalisations are all on the top surface of the die which also tends to make the ON resistance high. The overlapping of the gate metalisation over the N+ drain and source regions increases the input capacitance of the device limiting its speed of operation.

Since an increase in die area is impractical, another solution to the problem is to make the transistor current flow vertically. In order to do this the VMOS (Vertical Metal-Oxide-Semiconductor) type of construction can be used see *Fig 3*.

The beginning of the fabrication process of the VMOS transistor is very similar to that of the epitaxial double-diffused power bipolar transistor shown in *Fig 2*. Both types start with an N+ substrate and an N- epitaxial. The N- epitaxial region has diffused into it a P region, follwed by an N+ layer, thus forming a 4-layer unit.

The VMOS device now has an anistropically-etched V-groove cut through the N+, P and into the N- epitaxial region. A silicon dioxide layer is formed over the device and aluminium metalisation deposited in the groove to form the gate.

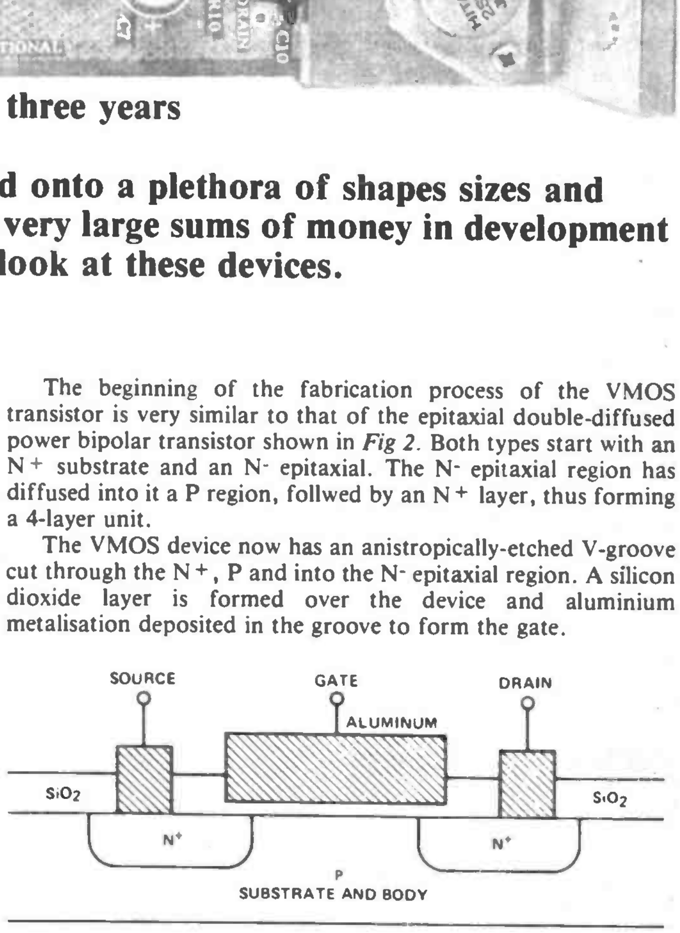


Figure 1: Cross section through a conventional N-channel mosfet.

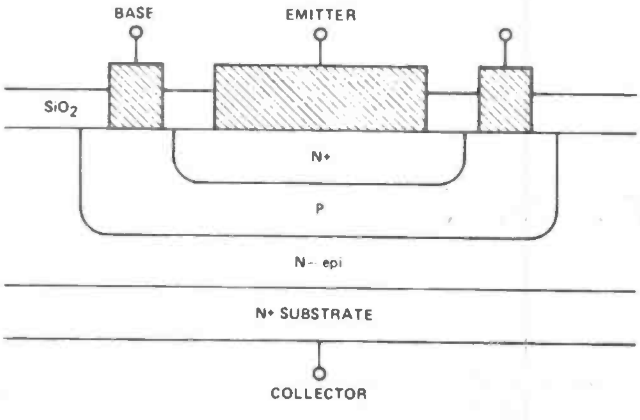


Figure 2: A typical double-diffused NPN bipolar transistor.

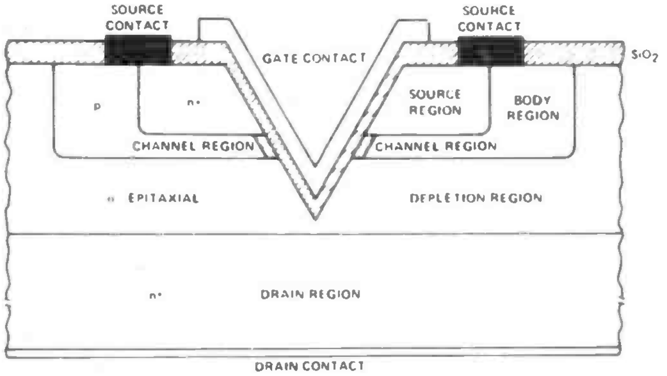
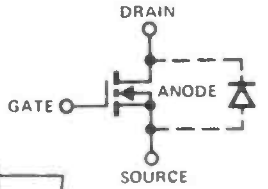


Figure 3: V-groove, N-channel power mosfet.

It will be seen from *Fig 3* that source metalisation overlaps the uppermost N+ region and the P region. Without this electrical bonding a parasitic 4-layer bipolar transistor would exist in parallel with the VMOS device thus preventing its beneficial features from being exhibited. The bond in effect shorts-out the base and emitter of this transistor, turning it into a P—N juntion diode across the source and drain, as shown in *Fig 4*.

Now, since the gate and source connections are on the upper surface of the die and the drain is on the lower, there has to be a vertical current flow via the channel formed in the P material as it is affected by the gate potential. This type of construction gives a large surface area for the source metalisation and the whole of the back of the side for the drain which allows us to talk in terms of amps of current rather than milli-amps, and watts of dissipation not milli-watts.

Figure 4: Electrical bonding produces a source drain parastic diode that by virtue of its polarity does not affect the power mosfet's operation under normal conditions.



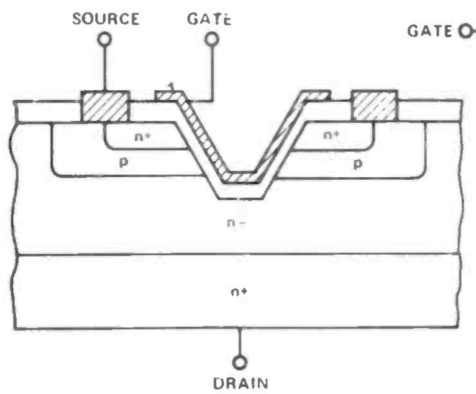


Figure 5: Cross section of a U-groove power mosfet.

There are other benefits to be had from this construction method. These include diffusion processing control of the conducting channel lengths which therefore may be made short with respect to their width, increasing ON conductance and current density; The die has numerous V-grooves each of which creates two channels, further increasing current density. Another advantage the V-groove method has over conventional mosfets is the presence of the N- epitaxial layer, which serves to increase the drain-source breakdown voltage

The sharp "V" does have its limitations, however, since it produces a strong electric field concentration between the gate and drain. This results in a tendency for the gate oxide to breakdown at the tip of the V. This limits the high voltage capabiltiy of the V-groove transistor even though the gate does not see the full drain-source voltage. There are also long term reliability problems in the use of aluminium gate metalisation due to ion migration through the gate oxide leading to variations in gate threshold voltage.

In order to increase the breakdown voltage capability and reduce ion migration in high field concentrations, the etching of the groove can be stopped early. This gives a flat bottomed or "U" shaped groove as shown in *Fig 5*. In addition, after the oxide layer is regrown, a layer of phosphorus-doped polycrystalline silicon is deposited over the groove prior to metalisation. This prevents ions migrating when aluminium gates are used. The U-groove method, despite increasing the source-drain breakdown voltage still does not allow very high voltages.

DMOS, SIPMOS, ET AL

The trend in design of power mosfets is now in the direction of vertical DMOS with a closed cellular structure rather than the V and U-groove technology.

Vertical DMOS is the road that a number of manufacturers have now taken. There are numerous registered names for their variations on the basic DMOS theme e.g. TMOS, SIPMOS, and HEXFET.

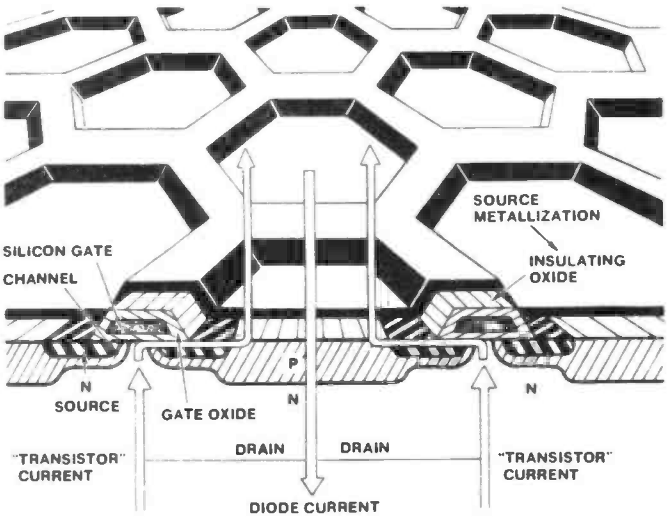


Figure 6: '3-D' view of International Rectifier's DMOS power mosfet — the HEXFET.

Figure 6 shows International Rectifier's contender, the 'HEXFET'. The usual method of manufacture of such transistors is by, firstly growing an N- epitaxial on an N+ substrate. A series of P regions are then diffused into the epitaxial layers followed by the diffusion of N+ source regions into the P type body regions. Silicon gates are then embedded into the silicon dioxide insulating layer. Finally source and gate metalisations are deposited onto the top surface of the die and the drain connection made on the lower.

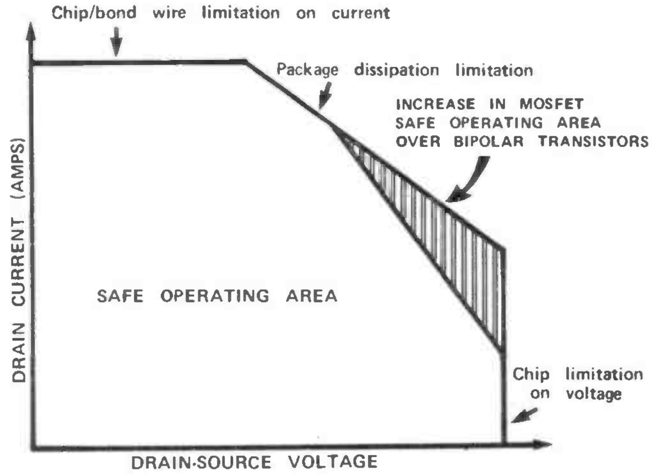


Figure 7: Graphic representation of the extra amount of SAFE OPERATING AREA available with mosfets.

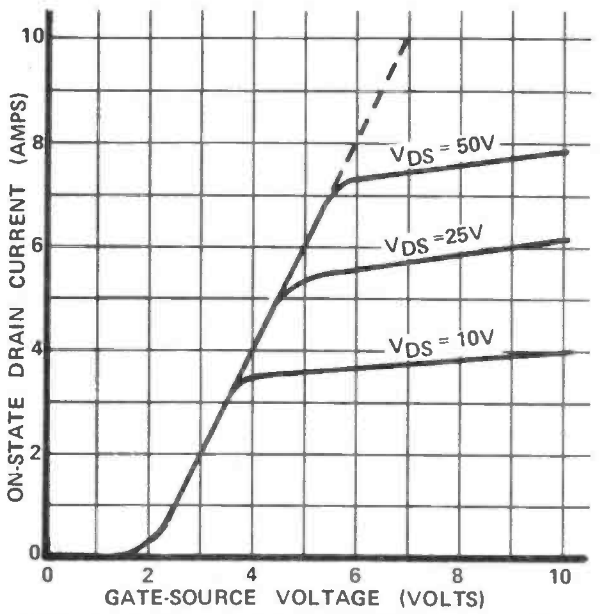


Figure 8: Transfer characteristics of a typical power mosfet.

This system allows for a larger current flow as the conducting channel lengths can be made very short by the diffusion process. The drain is on the bottom of the die with the source on top so there is a greater conductance per unit area. The number of connections on the upper surface of the die are reduced, so the number of conducting channels which can be made there may be increased and so increase the current carrying capacity.

Having looked at the two major groups of devices and how the problem of carrying large currents has been solved in them it would be a good idea to see what advantages power mosfets may have over the power bipolar transistor.

WHY USE POWER MOSFETS?

Power mosfets really are rather attractive devices to use and have a lot of features which make them superior to the bipolar transistor. For instance they have no thermal runaway problems. Mosfets are majority carrier devices and the mobility of these carriers is reduced by increasing temperature. This means that if any localised heating occurs the mobility of the carriers in that region is reduced and in consequence the temperature drops. This is a negative feedback system which has the benefit of forcing the uniform distribution of overload currents through the transistor. *Fig 7* gives a graphic example of the extra amount of SAFE OPERATING AREA available in the power mosfet over that obtained with a comparable bipolar device as regards thermally induced secondary breakdown. The bipolar transistor may burn out because of current crowding!

PERFORMANCE COMPARISON BETWEEN POWER MOSFETS AND BIPOLAR POWER TRANSISTORS.

	MOSFETS	BIPOLAR
Input impedances	10^9 - 10^{11}R	10^3 - 10^5R
Current gain	10^5 - 10^6	100-1000
Breadkown voltage	650V	2000V
Ruggedness	Good	Poor
Parallel operation	Yes	Requires special techniques
SWITCHING PERFORMANCE		
Turn-on time	Fast 10 ns	Moderate 50-500ns
Turn-off time	Fast 10 ns	Slow 0.5-2uS
ON-Resistance	Low	Very low

Table 1.

The input impedance is in the range 10^9 - 10^{11} compared with 10^3 - 10^5 of the bipolar. This means input currents in the order of pico amps, resulting in current gains in the range 10^5 - 10^6. Bipolar transistors produce a current gain of 10^2 - 10^3. It also means that the drive requirements are very small and so power mosfets may, unlike bipolars, interface directly with medium high impedance drivers such as CMOS logic or opto isolators.

Unlike their low power counterparts, power mosfets have a linear transfer characteristic. A glance at *Fig 8* reveals that there is no current flow until a certain voltage is obtained on the gate (the threshold voltage). There follows an approximately logarithmic portion and then a large linear section the length of which increases with increasing drain to source voltage. In the linear region the device's transconductance i.e. the rate of change of drain current with gate voltage, is constant. This is particularly useful in audio and SSB amplifier applications.

As has already been stated, mosfets are majority carrier devices and therefore exhibit no carrier storage time. Switching times are thus extremely fast, being mainly determined by the size of the input capacitance and the current drive capability of the drive source.

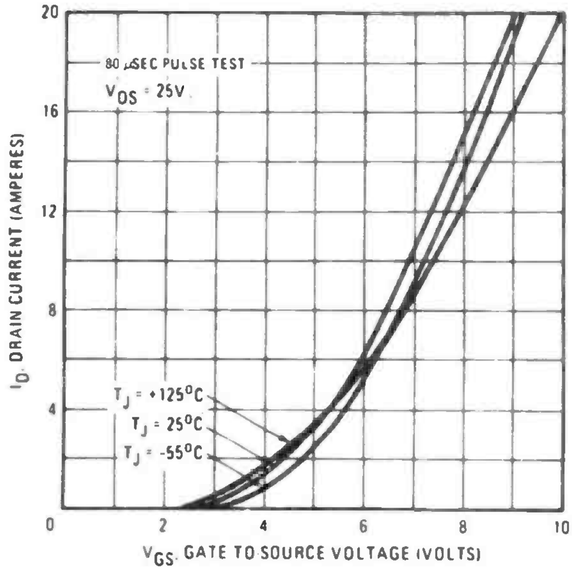


Figure 9: The graph shows the variation in the IRF 130's transfer characteristic as temperature varies.

Bipolar characteristics are very much affected by temperature, however, the transconductance and switching times of power mosfets are largely unaffected. *Fig 9* shows how little International Rectifier's IRF 130's transfer characteristics vary with a junction temperature change between -55 C and +125 C.

At this stage the reader should be saying is there no end to the superiority of the mosfet! Bear with it - there are just two more small points.

In order to obtain a very high current handling performance mosfets may be paralleled without the bipolar problem of current hogging and thermal runaway.

Last but not least, the peripheral component count is lower than with bipolar transistors which results in shorter design times, less complexity, less cost and a lighter more compact system.

Table 1 gives a performance comparison between bipolar transistors and mosfets and makes rather interesting reading.

■ R & EW

Next month we look at some practical applications of power mosfets with plenty of circuits.

Your Reactions

	Circle No.		Circle No.
Immediately Interesting	38	Not Interested in this Topic	40
Possible Application	39	Bad Feature/Space Waster	41

DR600 AIR—BAND RECEIVER REVIEW

MINI REVIEW

The DR600 is an up-market 'air-band' (110 - 137 MHz) receiver with built-in 5-digit LCD frequency display. John Mills reviews the model.

THE DR600 MAKES a pleasant change from the 'usual' airband radio, in that it is manufactured entirely in the UK, by Swinburn Aviation, and has some useful features not seen in radios of Far East origin.

One of the most unusual features of the DR600 is its use of a built-in 5-digit LCD frequency display, which is configured so that it and its pre-scalar automatically switch off when the receiver is scanning or muted, thereby conserving power, and become enabled only when the squelch is opened by a useful air-band signal.

The DR600 has facilities for the use of up to five crystal-controlled receiver channels, along with full manual tuning. The tuning range spans approximately 110 to 137 MHz, allowing reception of those VORs, etc., which most other scanning receivers miss. Manual tuning is virtually drift-free, and very easy to use. The 'manual' position is included in the scanning - a very novel feature. Full lockout facilities are provided on all scan buttons.

Field Tests

In use, the receiver was a delight to carry about the airport. It is fitted with a comfortable carrying strap, and has an adjustable-angle telescopic aerial. In close proximity to the airport control tower, the rod aerial required only a six inch extension, thus preventing damage to both the rod and other peoples eyes!.

Built-in Ni-Cad batteries allow the unit to be used for approximately 30 to 35 hours before needing rechanging via the mains unit that is supplied with the receiver. A socket is provided for powering the receiver from an external 12-15 volt source, and another for connection to an external aerial, thus making the unit suitable for 'mobile' use.

We did not actually measure the sensitivity of the receiver, but concluded from our field tests that it was 'very good': Heathrow tower was heard comfortably from Brentwood, Essex - a range of thirty-six miles. The DR600 incorporates "Automatic Constant Level" circuitry, which enables the unit to accept large variations of singal strength without needing re-adjustment of the volume control.

Conclusions

Overall, the receiver gives a superb performance and is ideal for the dedicated air-band listener. It may seem a trifle expensive at its price of £189 (including VAT), but this price does include the carrying strap, the mains charger, a full one-year guarantee, and five crystals of your own frequency choice. A broad range of spare cyrstals are stocked by the manufacturers of the DR600, Swinburn Aviation, Hanger Road, Birmingham Airport, West Midlands.

Your Reactions..........	Circle No.
Immediately Interesting	74
Possible application	75
Not interested in this topic	76
Bad feature/space waster	77

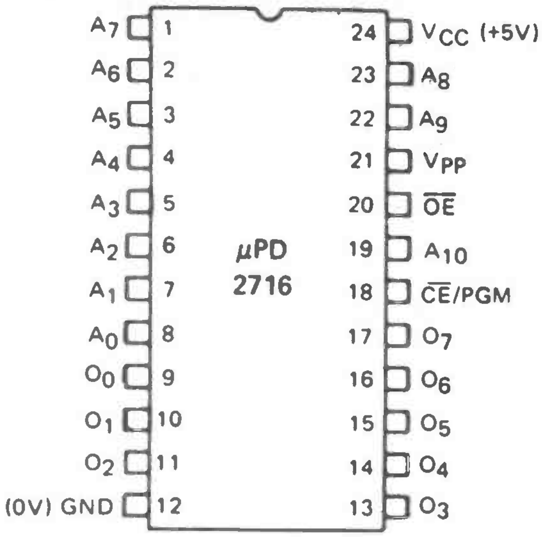
"SURE, THERE'S A REASON MY HANDLE'S 'THE MAD MARCH HARE', BUT YOU AINT GONNA BELIEVE IT..."

'HEY FRED — NONE OF THESE LITTLE BLIGHTERS HAVE GOT BASE LOADED ANTENNAE !!'

CIRCUIT BLOCKS

ZX81 EPROM PROGRAMMER

An elegant circuit that allows programming of 2716 EPROMs. Design by J C Barker.



IN PRODUCING A COMPUTER for the masses with a price tag of under £50 in kit form, Sinclair have had to take a number of shortcuts in the design of the ZX81 hardware (minimal address decoding for example), as well as employing a number of cunning software tricks (using the Z80's registers to do things even Zilog had not envisaged). To paraphrase the manual — you can do almost anything with a ZX81 but the hardware might sometimes get in the way.

Sinclair have however provided a 46 way bus exposing control, data and address signals to the outside world.

Our EPROM programmer plugs into this bus and together with a short machine code program allows single rail 2716 EPROMs to be programmed from any part of the ZX81's memory — taking about 100 seconds for the full 2K bytes. The design also allows a 'master' EPROM to be copied to another.

The programmer has been designed to allow its use on an unexpanded ZX81.

CIRCUIT DESCRIPTION

The design is best considered in two parts. *Fig 1*, along with a short machine code program, provides all the timing and control signals and *Fig 2* which interfaces the EPROM being programmed with the ZX81.

When the system is plugged in and running the following conditions are present in *Fig 2*:

IC6 & IC7	$\overline{OE}$	(PIN 1)	LOW
	$\overline{LE}$	(PIN 11)	HIGH
IC8	$\overline{OE}$	(PIN 1)	HIGH
	$\overline{LE}$	(PIN 11)	HIGH
IC9	$\overline{G1}$	(PIN 1)	HIGH
	$\overline{G2}$	(PIN 19)	PULSING
IC10	$\overline{CE}$	(PIN 18)	LOW
	$\overline{OE}$	(PIN 20)	LOW
IC11	$\overline{OE}$	(PIN 20)	HIGH

Where IC10 is the EPROM being programmed and IC11 is the EPROM being copied.

ICs 6 and 7 are therefore 'following' the low order address (A0-A10), ICs 8 and 9 are in the high impedance state while IC10 is in the read state but is isolated from the ZX81 data bus by IC9.

IC11 is in the high impedance state.

When the EPROM is being programmed the SET UP line goes low allowing ICs 6 and 7 to latch the first address while IC8 captures the data to be programmed. Approximately 2uS later the WRITE toggle goes high for 50mS — programming the data — then returning low. The SET UP signal toggles some 2uS later.

This state of affairs is repeated, incrementing the address latched into IC5, 6 and 7 until the specified number of bytes have been programmed.

To verify the EPROM, a RD instruction is instigated to addresses 12288 ⟶ 14335. This pulses both RD and READ low, inputing data from the EPROM to the ZX81 via IC9.

To copy from a 'master' EPROM, copy is strobed low, which takes data from the master EPROM IC11 and programs it into IC10 as above.

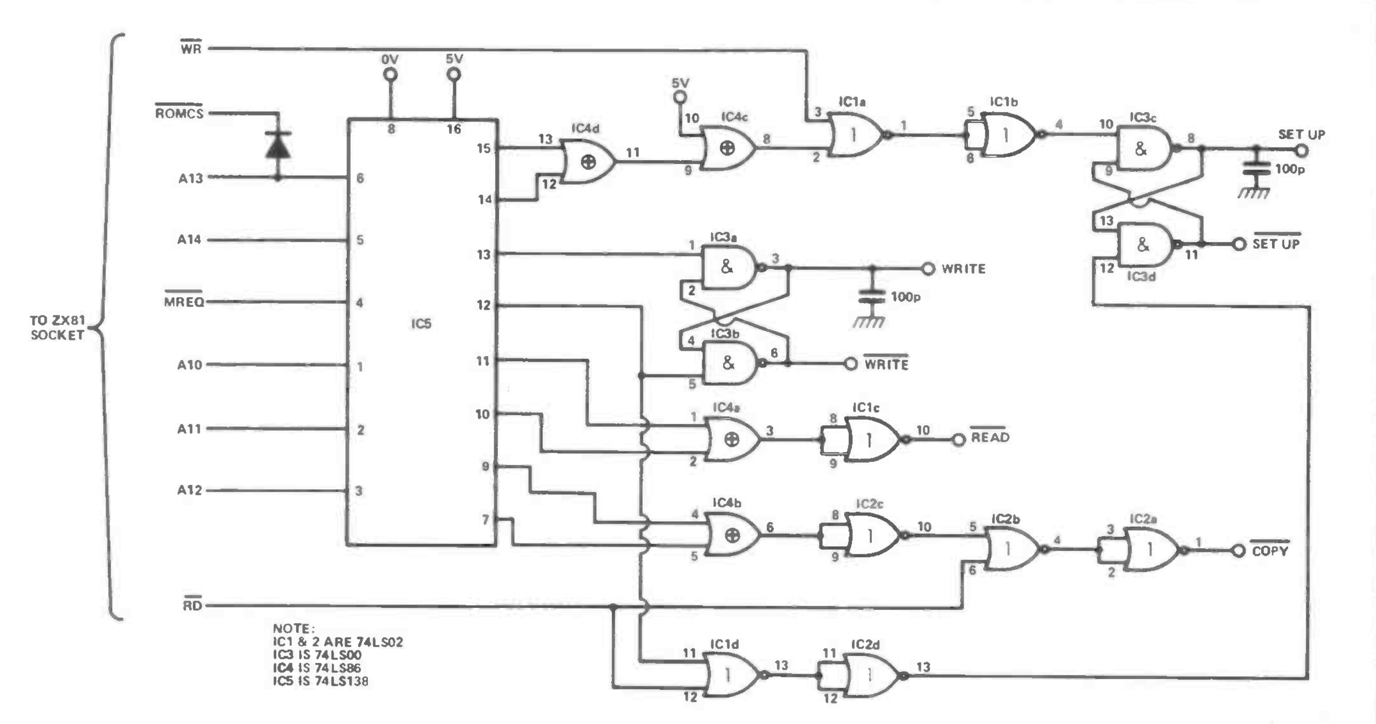


Figure 1: Circuit diagram of the control and timing signal generator.

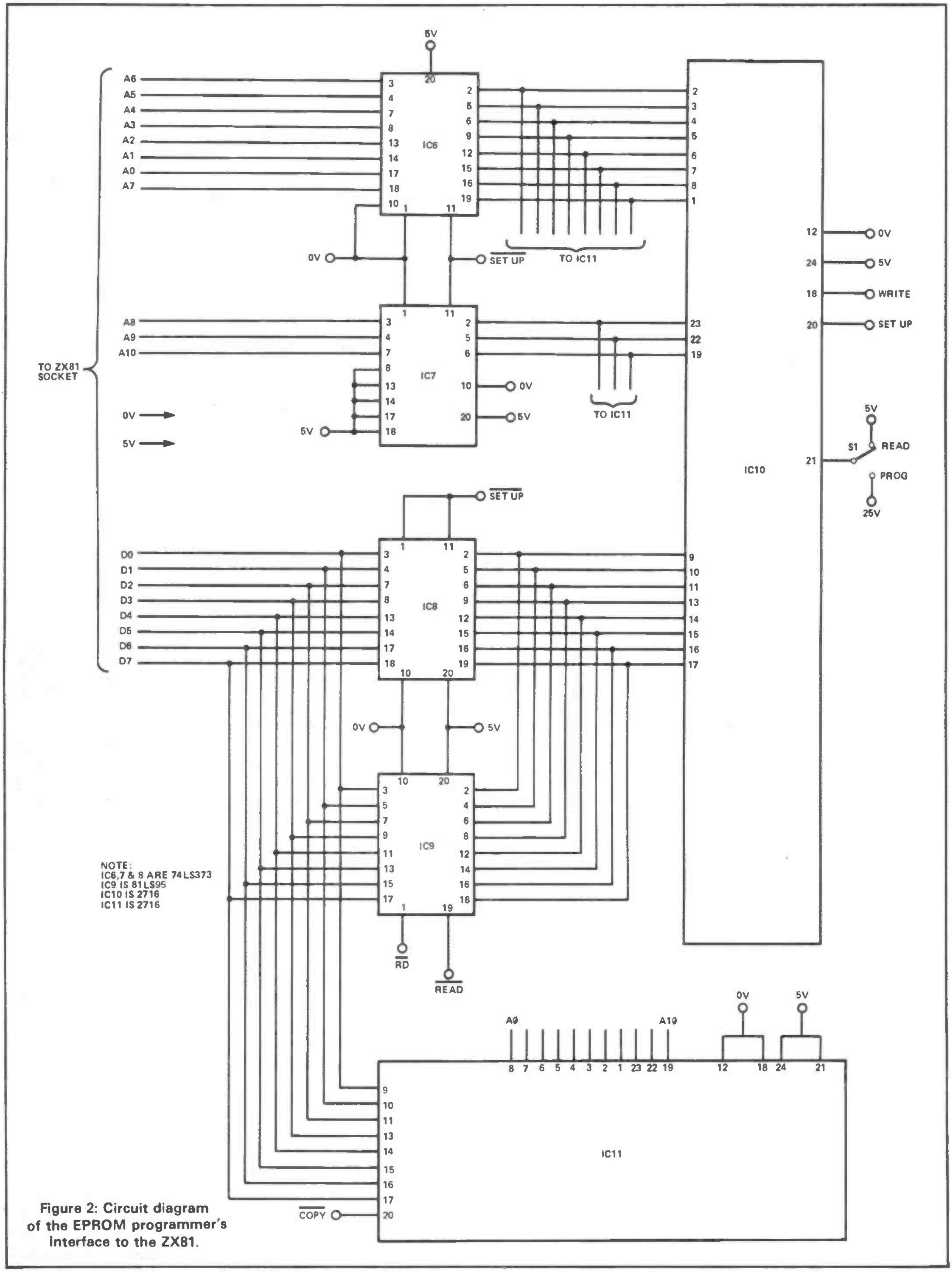


Figure 2: Circuit diagram of the EPROM programmer's interface to the ZX81.

Figure 1 and a 52 byte machine code program provide all the timing pulses for programming.

The program is held in a REM statement and contains three variables that must be entered before the program is run. These are each two bytes long and are POKED to the ZX81 as explained on page 177 of the Sinclair user's manual.

The first variable is the start address in memory from which IC10 is to be loaded 'from' and is POKED to 16518 and 16519. If a copying operation is required (IC11 IC10) this address should be set to 14336.

The second variable is the address to be copied 'TO'. This will usually be set to 8192, the first address of IC10. This value is POKED to 16521 and 16522.

The third variable is the length of the program to be copied, 2K maximum. This is POKED to 16524 and 16525.

The following describes the procedure to be followed when copying a 'master' EPROM.

To set up, the programmer is plugged into the ZX81 and the EPROM to be programmed placed in the IC10 position and the master EPROM in the IC11 socket. Power is then applied to both the programmer and the ZX81.

A direct command FAST should then be executed followed by the program shown in *Fig 3*.

Next RUN 10 is entered followed by the 52 numbers shown in *Fig 4* — these are entered one at a time in response to the input prompt, NEWLINE being pressed after each number.

Lines 10 to 40 are then deleted, line 10 being replaced by

10 GOTO USR 16514

Thus the program consists of lines 1, 5 and the new line 10, this may be 'saved' for use at a later date.

14336 should now be POKED to 16518 and 16519, 8192 to 16521 and 16522 and 2048 to 16524 and 16525.

S1 is put in the 'program' position and RUN 10 entered. The screen should go blank for about 100 seconds then return with an 'error report' 9 in line 5. The data from IC11 has now been copied into IC10. S1 can now be set to read.

To verify the program the program shown in *Fig 5* is entered.

This will list two columns of numbers, the one on the left being the data from the 'master' EPROM whilst the one on the right is that read from the newly 'blown' EPROM.

Pressing CONT when the screen is full will carry on comparing the data.

```
1 REM 999999999999999999
9999999999999999999999999
999999999999
5 STOP
10 FOR N   16514 TO 16565
20 INPUT A
30 POKE N, A
40 NEXT N
```

```
58, 0, 44, 33, 0, 0, 17, 0, 32, 1, 0, 62, 0,
184, 40, 31, 237, 160, 0, 0, 50, 0, 40, 217,
1, 100, 21, 11, 62, 0, 184, 32, 250, 185, 32,
247, 217, 50, 0, 44, 0, 0, 58, 0, 44, 24, 220,
185, 200, 24, 221.
```

```
10 GOTO USR 16514
100 FORN N   0 TO 2048
110 PRINT PEEK (N + 14336), PEEK (N
+ 12288)
120 NEXT N
```

Your Reactions..........	Circle No.
Immediately Interesting	50
Possible application	51
Not interested in this topic	52
Bad feature/space waster	53

165 for further details

R&EWPROJECTPACKSR&EW

0 - 30V POWER SUPPLY

A lab quality 0-30V PSU that features audio and visual over current alarms.
The kit is complete with PCB and all board mounting components, mains transformer, meters, sockets and all hardware (punched and drilled case with painted and screened front panel).

Stock No. 40-13030 Price £68.31

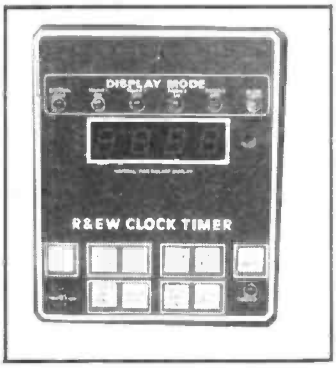
Send your orders to:
"World of Radio & Electronics"
200, North Service Road,
Brentwood, Essex CM14 4SG

All prices include VAT.
Postage and Packing 50p per order.
Please allow 21 days for delivery.

SELCALL

This unit can, with minor modifications, be used with any CB rig.

Stock No. **40-95320** Price **£25.64**

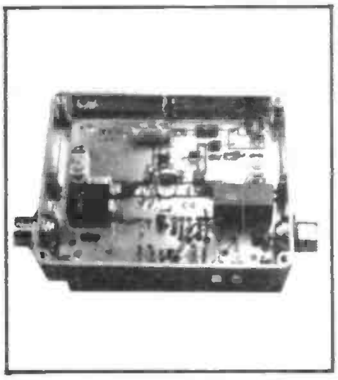


2 CHANNEL MAINS TIMER

A sophisticated design offering independant control of two mains outlets.

Clock and function select PCB and board mounted components plus undrilled case.
Stock No. **40-00375** Price **£14.45**

Transformer board plus two triac boards, all components and undrilled case.
Stock No. **40-10375** Price **£27.79**

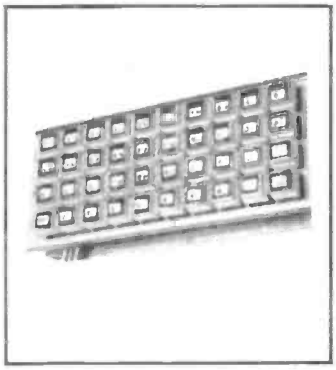


2M Power Amp

An updated version of our popular design; the kit is available with or without preamp.

Stock No.	Price
40-14421 Less preamp	£32.77
40-14422 With preamp	£34.96

ZX–81 KEYBOARD



The kit contains 40 KCC 10002 switches and KT2-I caps, metal supporting plate, 2 PCBs and 16 pin DIL socket.

Stock No. **40-00081** Price **£21.64**

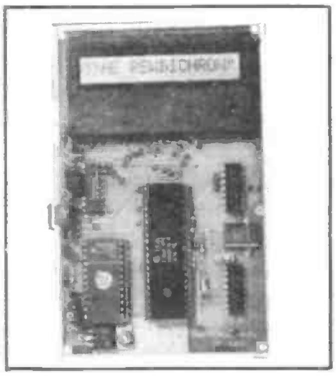
RADIO CONTROL TRANSMITTER

A rugged low cost digital proportional system.
PCB and all board mounted components.
Stock No. **40-10170** Price **£9.08**

Case, joysticks, aerial, meters, etc.

Stock No.	Price
40-10172	**£18.86**
Pair of Xtals	**£3.75**

Don't forget that Project Packs for designs that have appeared in past editions of R&EW are still available.



R&EWPROJECTPACKSR&EW

THE RECENT UK PRESS LAUNCH of Sony's revolutionary Mavica camera system received extensive media coverage — it even made 'News at Ten'. **R&EW** subscribers will have noted that with our usual flair we had covered the 'Mavigraph' hard copy printer before the news broke generally in the UK press. As far as we are aware, we also conducted the first transatlantic hookup of their Typecorder system — all of which was no thanks to Sony UK.

However, **R&EW** was not invited to the launch. Was this due to some fairly terse correspondence over some problems with an ICF2001 we were reviewing (the review was scrapped in view of Sony's hostility)? We thought we had better phone and see if we had blotted our copybook at Sony.

The Public Relations manager is an elusive character at the best of times, but his helpful secretary thought the oversight might have been due to the fact that the Mavica bunfight was staged by the Public Affairs department, not PR.

"What's the difference between an Affair and a Relationship?" We asked cautiously.

'Affairs' it seems, are things conducted in the public gaze, and relations are cosier events within the confines of the industry and their immediate circle of friends. The Pocket Oxford Dictionary provides an interesting definition of each (amongst more boring ones):

"Affair: A temporary sexual relationship..."

"Relationship: sexual intercourse"

We had a strange feeling the Pocket Oxford was trying to tell us something about the way we have been dealt with by Sony. When we had first contacted Sony, they were using an amazingly efficient firm of external PR consultants, whose motto may well have been, "No enquiry is too much trouble". When Sony took PR on board, the outlook changed.

PR started life with the agency in London, then moved down to corporate HQ in Sunbury, then recently moved back to Regent Street, Public affairs are still conducted from Sunbury. OK then how about information on the Sony Typecorder? Ah that's office products... back to Sunbury and yet another department.

Is this just sour grapes in view of the fact that we were not invited to the 'Ball'? We hope not, merely an expression of frustration that one of the largest budgets on advertising and PR should lead to such frustration amongst the very audience it seeks to impress. Sony would be well advised to show their 'awfully nice people' in UK management one of those witty training films produced by their 'mascot' John Cleese, pointing out the perils of ambiguity of the terminology they use to describe their interface with the media. Or maybe that's where JC gets his ideas from anyway...

The Sony Typecorder in its first transatlantic hookup

UNFAIR

The recent announcement that AEG has been forced to withdraw from the small signal plastic transistor market is yet another example of the erosion of volume component manufacturing business in Europe. Virtually unfettered access to the enormous US consumer market gave Japan such a healthy base from which to consolidate its components industry that it is hard to see any opportunities left for European manufacturers to manufacture in Europe.

Philips and Siemens plug away, and the German market has hitherto been prepared to pay well over the odds to avoid too much imported product, but that situation has changed quite markedly — hence the exit of AEG from TO92, and the departure of the LED facility to the Far East.

The cry of, 'Unfair!' has gone up in the US and Europe, and it's getting to be an irresistible force for the politicians. Several EEC law suits pend against household names from Japan, and the knives are being sharpened for plenty more besides. But surely an automatic production line costs the same to run in Kawasaki City, as it does in Tyneside? With no natural resources at their disposal, the Japanese would appear to have the same chance as anyone to dominate the market — and certainly less than us British oil barons of the Western world.

The Japanese cannot understand why they should be so roundly villified for simply being efficient and clinical in the way they take apart a market and dominate it. The unfair part of the whole business is the fact that Japanese industrialists enjoy a more enlightened relationship (that word again) with the government and financial institutions, and have thus been able to think big and plan long term.

Since the last War, Western industrialists have mainly been shackled to short term government policies, short term investment opportunities and short term marketing strategies. Maybe the cry of unfair should be directed elsewhere. Perhaps the bemused Japanese have merely gratefully exploited our own stupidity?

IT AGAIN

R&EW has been making a foray into the Department of Industry to try and see exactly what lies behind the Year of Information Technology, and the various schemes available to aid and assist the technological innovator. We were surprised to see just how many schemes exist, although not surprised to find out that the form filling and paperwork attached to each scheme is worthy of a further grant in its own right. Watch next month for our assessment of what's what in the DoI.

ELECTRONICS IN EDUCATION

Over the past few months we were starting to wonder whether anybody in this country was engaged in the design and development of electronic systems, either in education or as a private individual. Recent offers within the pages of **R&EW** stating that we ▶

NEWS BACKGROUND

First year students with a KIM based stepping motor controller.

were prepared to support such endeavours with technical aid and **FREE** components seems to have fallen on stony ground.

In this climate the phone call from our 'local' university at Colchester, with an invitation to look around their Department of Electrical Engineering, was very welcome indeed.

So it was on one of the windiest days in living memory that we took ourselves off to the University of Essex for a taste of electronics in education. We must confess our motives were slightly mercenary — we were on the lookout for new projects and features to run in **R&EW**. What we found would enable us to schedule the magazine for the next year — there is a lot going on at Essex's Electronic Department.

The event that prompted the Chairman of the Department, Dr J K Fiddler, to ask us along was a display of the work done by final year students on the projects that form an integral part of the degree course. The motive behind the staging of the display is to give second year students on similar degree courses a taste of things to come, but it also serves to provide an opportunity for university staff from other departments a chance to see what the electronics course is all about.

With over 80 final year students, a similar number of keen second year students, plus sundry other individuals it was difficult to move around the lab at some stages during the afternoon.

The range of projects on show was vast. Mini weather stations shared benches with video games experiments while other students were offering to check heart and respiration levels of anyone who cared to breathe their way. The enthusiasm of the students when explaining their projects was evident particularly in the case of two students who treated us to a resume of their work with compact antennas.

A very busy afternoon and proof positive that, in certain educational establishments at least, a lot of interesting and thought provoking work with electronics is taking place. **R&EW** will be keeping in touch with the University with a view to collaborating in some interesting projects in the future. Before leaving the subject of education we would just like to say something about the cutbacks that have affected so many establishments. At Essex the staff were far from disheartened, a reaction that one might have expected, but were determined to carry on with 'normal service'.

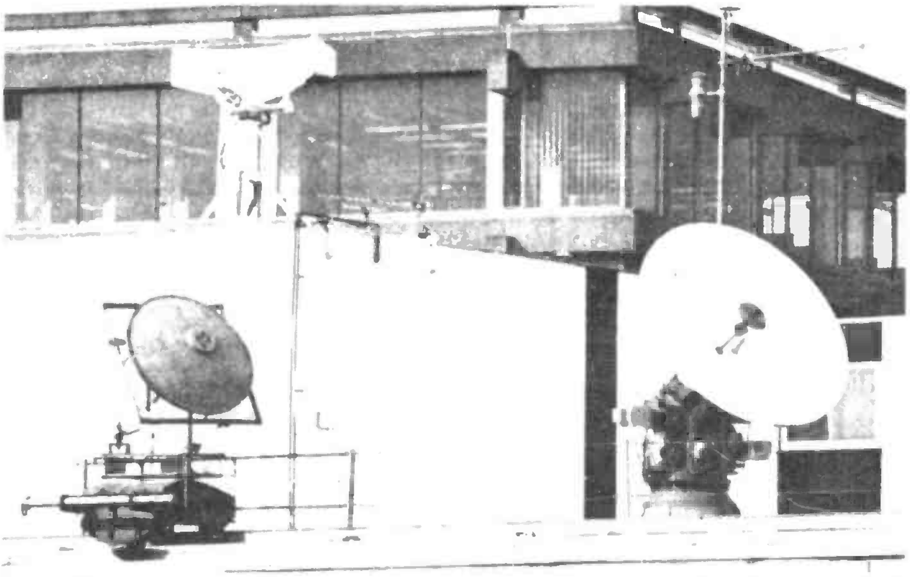
This means each member of staff working that much harder and giving up research time for more mundane tasks. In one case, a word generator designed and built by one lecturer for £100 does all that the department require of it and replaces a £6000 commercial machine!

Not only does a technologically based department, like the Electronics, suffer from financial cutbacks but also from long standing and long out-of-date accounting systems. Thus capital equipment must be written off over a period of eight years while nearly all electronic equipment in these times is out-of-date in about four. The older equipment can however, play its role in first year courses — thus a first year student's first taste of MPU programming is via a good old KIM, NASCOM or PET.

The staff are determined to keep their standards high, one temptation would be to lower their entrance requirements for foreign students who bring in a lot of cash — this has been resisted. One can only hope they continue to do so and that the powers that be will recognise the vital role that well trained engineers have to play in our society.

■ R & EW

Your Reactions..........	Circle No.
Immediately Interesting	5
Possible application	6
Not interested in this topic	7
Bad feature/space waster	8



Some of the radio propagation research group's apparatus for reception of the European orbital test satellite at 12 GHz.

BE A SHARP BUSINESSMAN for only £278 +VAT

COMPUTER AND 4-COLOUR PRINTER

The sensational new PC-1500 Pocket Computer approaches the Personal Computer in ability. Add the revolutionary CE-150 Graphic Printer and a cassette recorder and you have a complete, battery powered, Business Computer System that travels in your briefcase!

SHARP CE-150
4-colour Graphic Printer
£130.39 + VAT;
Total £149.95

SHARP PC-1500
'Basic' Pocket Computer
£147.78 + VAT;
Total £169.95

Price includes **SECURICOR 24 HOUR DELIVERY***.
Same day despatch, subject to availability.

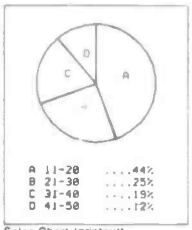
BUSINESS APPLICATIONS

January Sales Attained (display)

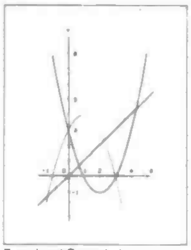
Quick and accurate data processing in daily business. Estimates, records and charts of sales, salaries, invoicing and all other data crucial to efficient business operations can be easily programmed, calculated and summoned.

ENGINEERING APPLICATIONS

Technical calculations in fields such as mathematics, statistics, measurements and mechanics are done superbly and easily. The calculator more than meets the requirements of engineers and scientists.

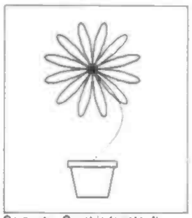


Sales Chart (printout)


Equational Graph (printout)

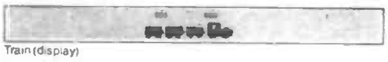
MANAGEMENT APPLICATIONS

Balance sheets, so crucial to management analysis, and profit calculations by break-even point analysis are instantly yours with the PC-1500. By using the integral clock, calendar and alarm functions, this computer can also be used as a schedule reminder.


Computer Graphic (printout)

HOBBY APPLICATIONS

Many popular computer games can be played, including Blackjack, utilising the random number function. Use the clock and alarm for speed games. The Computer Graphics will draw virtually any pattern.


Train (display)

TEMPUS

38 Burleigh Street, Cambridge CB1 1DG.
Tel: 0223 312866

BASIC LANGUAGE
The most simple computer language is used for programming ease. Additional BASIC terms provide variables including two-dimensional arrays, variable strings and many other advanced features.

LARGE MEMORY
16K bytes of ROM and 3.5K bytes of RAM, with 2.6K bytes in the user area. Adding the optional CE-151, 4K byte memory module, expands the RAM to 7.5K bytes. An 8K byte memory module will be available soon. The PC-1500 is battery powered and program and data memories are fully protected, even when switched off.

MINI-GRAPHIC DISPLAY
The 7 x 156 dot matrix allows almost any display, including game symbols. Line width is 26 characters and/or numbers.

HIGH SPEED DATA PROCESSING
The C-MOS 8-bit CPU enables swift data processing. Complicated technical or business calculations require far less time.

QWERTY TYPEWRITER KEYBOARD
The first in a pocket computer. Lower case letters are available. With the optional CE-150 colour graphic printer, the PC-1500 can serve as a small personal typewriter. Word Processor software will be available soon.

SIX SOFTWARE KEYS
These can serve as reservable keys, or as definable keys to define programs.

CE-150 4-COLOUR GRAPHIC PRINTER/CASSETTE INTERFACE
Automatic program, data and calculation printing. It prints virtually any drawing in either red, black, green, or blue. Characters are printed in nine different sizes and in lines ranging from 4 to 36 digits in length. You can control the printer completely and direct the printing either up, down, left, or right. As a **cassette interface** it will connect up to two cassette recorders, one for data and program storage, the other for their recall. The CE-150 has a built-in rechargeable battery and is supplied with a mains adaptor, type EA-150.

AVAILABLE SOON
* RS-232C interface. * Software board to serve as input keys in graphics, or pictures, previously drawn on a template. * ROM (MASK ROM) module also applicable. * A wide range of business software.

DIMENSIONS
PC-1500: 195Wx25.5Hx86Dmm (7-11/16x1x3-3/8") Wt 375g (0.83lb)
CE-150: 330Wx50Hx115Dmm (13x2x4 inches). Wt 900g (1.98lbs).

Full 12 MONTHS guarantee, with EQUIPMENT LOAN SERVICE during downtime.

SAME DAY DESPATCH** of orders – Systems by **SECURICOR** 24 hour service, (to attended premises only) or by first class registered post. **AT NO EXTRA COST

SEND FOR FULL DETAILS to TEMPUS, the Portable Computer Specialists.

To: Tempus, FREEPOST, 38 Burleigh St, Cambridge CB1 1BR.

INFO.	ITEM	QTY	PRICE	TOTAL
	PC-1500 Pocket Computer		£169.95	
	CE-150 Four Colour Printer		£149.95	
	CE-151 4K Byte RAM Module		£ 49.95	
			Total inc VAT	

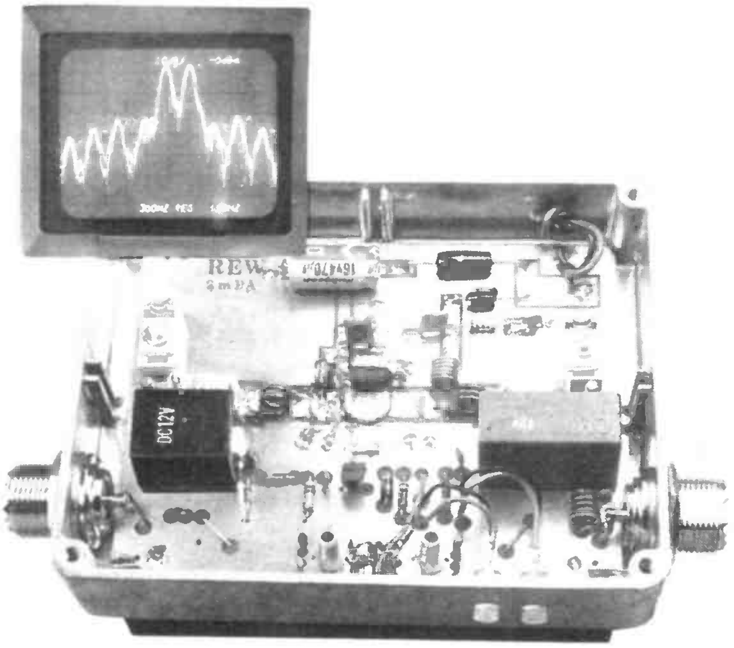
For information only tick appropriate box

I herewith enclose a cheque or Postal Orders value £ __________
or I wish to pay by Access B'card Visa.
My number is: __________
Name: __________
Address: __________

REW6/82

163 for further details

2M POWER AMPLIFIER



Roger Ray takes a fresh look at the R&EW 2 metre PA and has some general Thoughts on VHF power amplifier biasing and construction techniques.

SINCE THE 2M POWER AMPLIFIER appeared in December '81 R&EW, a large number of these amplifiers have been built and put into operation. The majority have performed very satisfactory, a few have caused problems generally due to inadequate heat transfer between transistor and heatsink. When modified to linear operation the gain is increased and the efficiency decreased. Therefore the heat generated by the transistor is much higher and heatsink requirements become more stringent. In practice when operating with SSB, only speach peaks produce maximum power and temperature rise is often less than when FM is used with a class C amplifier.

The critical period for linear amplifiers is during tune up. Until properly matched the transistor can be operating extremely inefficiently and dissipating most of the power as heat in the transistor. The tune up operation should be performed very quickly. If it takes more than a few seconds, the temperature of the transistor should be checked and if necessary the amplifier allowed to cool down before recommencing alignment. Some commercial equipment manufacturers make use of a blower to reduce the possibility of device failure during this critical period.

A number of modifications and improvements have been made to the original linear adaption of the **R&EW** 2m PA. The amplifier now uses foil compression trimmers and has the linearising components mounted on the PCB together with a low pass filter in the output to reduce harmonics. The 'High Performance 2 Metre Pre-Amp' described in April '82 **R&EW** is included on the same board and can be used if required. A high quality die-cast box is now used as the case, to meet the thermal requirements as detailed above and to provide a 'low profile' housing for the amplifier.

CONSTRUCTION

Firstly, make all of the through board links marked "X" on the overlay (*Fig* 4) using 1mm diameter tinned copper wire, and solder them to both sides of the board. Next assemble the PCB with all the components except the power transistor Q2.

After construction check for solder splashes and dry joints and cut off all component leads protruding on the underside of the board to minimum length. If the pre-amp is to be used make the links shown as solid lines using tinned copper wire, and solder an insulated wire to its supply marked +12V.

If not use a length of coax in the position of the dotted line, soldering the braid of the coax at either end to the earth plane. Next solder in an inch long piece of tinned copper wire to the input and output connections. Insulated wires should be soldered into place for the connections to the LEDS D4 and D5.

To mount the board in the box fit the RF connectors first. Push the 3mm mounting screws through the heatsink and die-cast box, and then drop over a 2mm thick plastic spacer (conveniently made from an off cut of coax cable). Place the assembled board over the screws and screw down lightly the 3mm nuts.

The RF power transistor Q2 can now be fitted (the stud is a good fit in the 4.0mm dia hole). If it doesn't quite line up DO NOT FILE OUT the hole for the transistor stud move the position of the mounting screws slightly. Tin the leads of the transistor and the board where the leads mount and apply a smear of thermal compound to the heatsink. Place the transistor in position correctly orientated (the 45 degree cut on one lead together with the c mark the collector), and tighten the nut slightly more than finger tight. The leads of the transistor can now be soldered into position.

TESTING AND OPERATION

Slacken off the screws half a turn of capacitors C7, 8, 13 and 14, and attach a load and power meter to the output of the amplifier. Connect to a power supply and turn on S1, D4 should light up. Connect up your transceiver on 145 MHz to the input and key the microphone. Tune C13 and C14 first for maximum power output, and then adjust C7 and C8. As stated previously this operation should be performed quickly.

Several amplifiers have been constructed and generally give 25W pep output for 2.5W drive in the linear mode. Intermodulation products measured on a prototype amplifier are shown above .

Although 30W or more is easily obtainable with increased drive the intermodulation distortion becomes rapidly worse as the transistor approaches saturation, for this reason drive should not exceed 2.5W pep.

SOME ADDITIONAL NOTES

For SSB operation DC switching should preferably be used. The circuit shown is for use with the FT290 or other transceiver that has a positive voltage on the output in the transmit mode. For use with an IC202S an extra switching transistor is required as this transceiver gives a DC voltage on its antenna socket during reception.

When using the amplifier together with the pre-amp it is preferable to omit S1 and wire the amplifier directly to the supply, to prevent transmitting into the pre-amplifier!

For class C operation of the amplifier L4 is connected directly to the earth plane, and bias components R8, C20, C18, C19 and D6 can be omitted. Optimum tuning is slightly different between class AB and C, therefore changing the class of operation will require repeaking the trimmers.

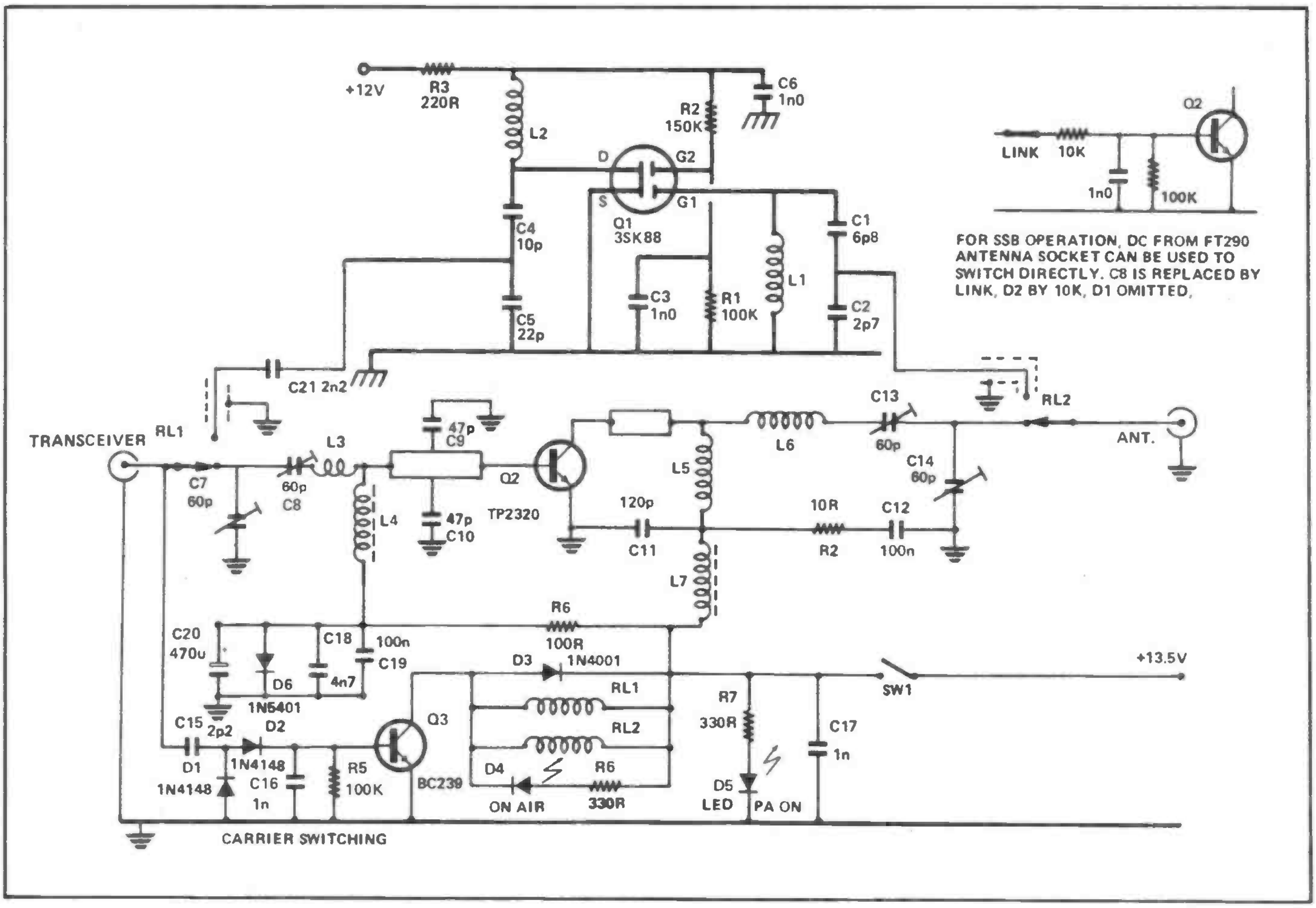


Figure 3: Circuit diagram of the 2m Power Amplifier together with the 2m pre-amplifier.

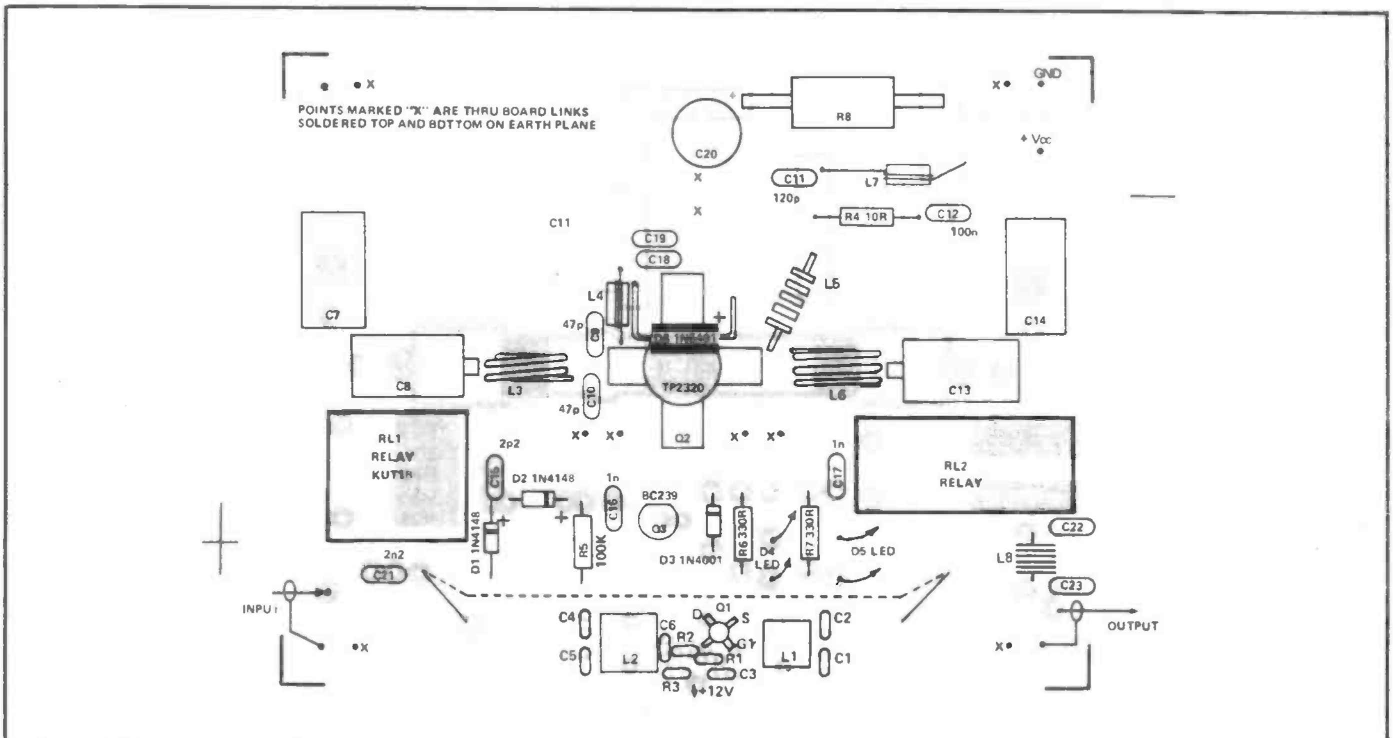


Figure 4: Component overlay (copper shown as white).

BIASING RF POWER TRANSISTORS

RF power amplifiers may be operated in a number of different modes. Each has advantages and disadvantages the choice depending upon the particular application.

CLASS C

RF power amplifiers are usually operated in class C for FM signals or class AB for single sideband (SSB). In class C operation the output transistor takes zero collector current with no signal, the applied drive providing the base bias. (No signal condition Ic equals 0, V_{BE} equals 0). When in class C, operation is inherently non-linear, in other words doubling the applied drive power will not necessarily double the output power. Also the output will be zero until sufficient drive has been applied to supply the base-emitter bias. In many applications non-linear operation does not present major problems. With a single frequency drive signal, the only spurious signals generated are harmonics (assuming a stable amplifier) and these are readily suppressed in the matching networks and output filter. Class C is used where linearity is not required i.e. for CW or FM as it provides a higher efficiency. This means the amplifier takes a lower DC supply current for a given power output and therefore runs cooler as less power is being dissipated in the heatsink.

For SSB, video and other complex signals class C operation is generally not satisfactory. When a signal contains multiplier frequencies at close spacings, odd-order non-linearities will generate spurious outputs which are within the bandwidth of the amplifier and are therefore not suppressed before they reach the antenna. In this case linear amplification is required if the amplified signals are to be free of spurious outputs. Linear amplification at low levels is achieved using stages with class A bias.

CLASS A

In class A amplifiers the base-emitter junction is forward biased so that a large quiescent current flows. The drive signal modulates the collector current equally in either sense giving linear amplification. Class A is not generally used for power amplifiers due to its very low efficiency (typically 20%) and hence low available output power with any given device.

CLASS AB

Class AB is the most popular form of biasing for linear power amplifiers. Here the base-emitter junction is biased to produce a small collector current. A high degree of linearity can be obtained in this mode if the bias point is accurately maintained. The magnitude of the no-signal collector current varys with application and device (typically 20-100mA). The secret to good linearity lies in maintaining the base-emitter DC voltage relatively constant as the RF signal amplitude varies. RF power devices try and bias themselves off with increased drive, therefore a constant voltage source is required for the base voltage. This simple requirement is unfortunately complicated by temperature effects. As the junction temperature of a transistor increases the required base-emitter voltage for a given collector current decreases. VHF power transistors are generally used with their emitters grounded to DC and AC signals. Therefore if the bias voltage remained perfectly constant as the temperature increased, greater and greater

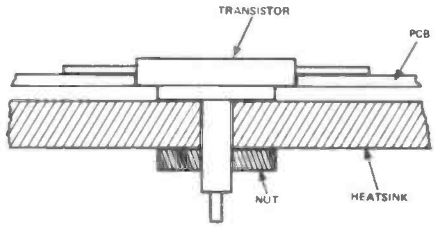


Figure 1: Correct method of Mounting Capstan Transistor

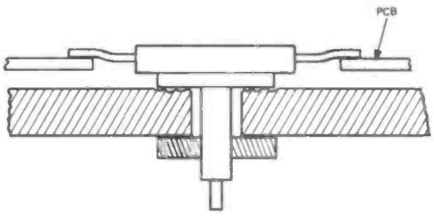


Figure 2: Incorrect method of Mounting Capstan Transistor

collector currents would be taken which could lead to destruction of the device at worst or at least a reduction in output power. Temperature compensated low impedance bias circuits can be very complicated. A simple solution to the bias problem for low to medium power applications, is to use a forward biased diode in thermal contact with the power transistor. Now as the temperature increases the voltage drop across the diode junction decreases and therefore reduces the bias with increased temperature. By choosing the right diode for a given power transistor the correct amount of bias can be provided. Altering the current through the diode gives a fine control of quiescent current, although the current must be sufficient to stop the voltage sagging during peaks of RF. A large electrolytic capacitor across the diode helps to smooth these peak bias requirements as well as providing audio decoupling.

THERMAL CONSIDERATIONS

The use of an adequate heatsink and properly fixing the power transistor to that heatsink are very important requirements if the maximum reliability of a power amplifier is to be achieved. In a stud mounting capstan transistor the heat has to be transferred through the bottom face and stud of the transistor to heatsink. The actual chip inside the transistor casing is mounted in the centre in line with the leads. Heat from the chip is mainly dissipated downward in a circular core. Therefore the bottom face of the device must be mounted flat against the heatsink and the stud be a good fit in the hole (see *Figs 1 & 2*).

The hole drilled for the stud should have parallel sides and not be chamfered. Getting the maximum transference of heat from the transistor to the heatsink is very important as efficiency, power gain and life expectancy are all inversely proportional to chip temperature. A smear of thermal compound will aid thermal conduction by filling up any minute irregularities between the transistor and heatsink. The thinnest possible smear of compound should be used as it has a relatively poor thermal conductivity. The heatsink is responsible for getting rid of the heat to the environment by convection and radiation. To achieve this it must be made from a material with good thermal conduction such as aluminium.

COMPONENTS LIST

Resistors (all .25W 5% except R8)	
R1,5	100k
R2	120k
R3	220R
R4	10R
R6,7	330R
R8	100R 2.5W
R9 •	10k
Capacitors	
C1	6p8 ceramic
C2	2p7 ceramic
C3,6,16,17	1n0 ceramic
C4	10p ceramic
C5	22p ceramic
C7,8,13,14	10-80p compression trimmer (red)
C9,10	47p ceramic
C11	120p ceramic
C12,19	100n monolithic
C15 •	2p2 ceramic
C18	4n7 ceramic
C20	470u 6.3V electrolytic
C21	2n2 ceramic
C22,23	22p ceramic
Semiconductors	
Q1	3SK88
Q2	TP2320
Q3	BC239
D1,2	IN4148
D3	IN4001
D4,5	5mm LEDs
D6	IN5401
Inductors	
L1,2	MC108 7.5 turns Toko + 7mm can.
L3	2.5 turns 6mm dia. 1.25mm (18swg) spaced 1 wire dia.
L4,7	5 turns 0.5mm (25swg) on FX1115 ferrite bead.
L5	6 turns. 6mm dia. 0.71mm (22swg) close wound.
L6	3.5 turns 6mm dia. 1.25mm (18swg) close wound.
L8	5 turns 6mm dia 0.71mm (22swg).
Miscellaneous	
RL1	KUITB 12V
RL2	OM1 12V
S1	SPCO miniature toggle
PL,2	50R BNC or SO239 single hole mounting
PCB	
Die-cast box	
Heatsink	
Screws	

*R9 requird for DC switched version, C15 for RF switched version.

An SAE to the R&EW offices will secure a copy of the PCB foil patterns. ■ R & EW

Your Reactions.........	Circle No.
Excellent - will make one	78
Interesting - might make one	79
Seen Better	80
Comments	81

R&EW offers you the lowest price full-spec Ni-Cads in the UK

		1-9	10-49
AA	500mAH	£ 0.80	£ 0.74
C	2.2AH	£ 2.35	£ 1.99
Sub D	1.2AH	£ 2.15	£ 2.05
D	4.0AH	£ 3.05	£ 2.85
PP3	110mAH	£ 3.70	£ 3.50

A range of low cost chargers to suit above battery types.

Type	Application	Price
CH4/50	4 x AA	£ 4.95
CH6/50	6 x AA	£10.95
CH2/400	2 x D	£ 9.55
CH1/22	1 x PP3	£ 4.95

RADIO & ELECTRONICS WORLD TIES

A touch of class — for those occasions when you want to look your best! Navy blue with logo in light blue and white. **£4.95** inc. P&P and VAT to the 'general public' — only **£4.00** to R&EW subscribers who should send in the mailing label as evidence.

all orders to:

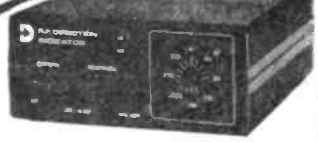
R&EW Offers, 200, North Service Road, Brentwood, Essex CM14 4SG

DATONG

YET MORE INNOVATION

New

MODEL DF DISPLAY UNIT



DOPPLER DIRECTION FINDER

Model DF is a direction finding attachment for use with existing narrow band FM receivers and transceivers.

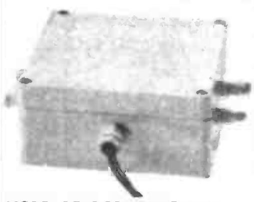
Two units, the display unit and the special antenna combiner convert your NBFM transceiver plus four omnidirectional antennas into a radio direction finder. A built-in r.f. activated antenna relay diverts the transceiver's output to the normal antenna during transmit or when the DF attachment is switched off.

Features

- Works with any existing narrow-band FM receiver or transceiver. No modifications are needed. The only connections required are to the external speaker and antenna jacks.
- Gives a clear directional readout on a circular array of sixteen bright green LEDs.
- Display holds last reading when signal drops out.
- Very easy to use and install.
- Only a single coaxial cable needed between display unit and antenna combiner.
- Professional quality at remarkably low cost. Display unit uses two PTH circuit boards. Gasket sealed combiner unit houses two conventional double-sided PCBs.

Applications

Model DF costs between ten and a hundred times less than conventional RDF systems, and therefore opens up new application areas for both professional and hobby users. Possible applications include:- VHF amateur radio, Citizen's Band radio, aircraft spotting, tracking gliders and light aircraft, locating lost model aircraft, private mobile radio systems, coastal and marine radio, tracking and locating anti-social radio operators, locating 'tagged' animals in the wild, helping to identify or trace unknown transmissions, law enforcement.



MODEL DFA2 COMBINER UNIT

A complete system needs the display unit and the antenna combiner plus four antennas mounted at the corners of a square spaced apart by 0.05 to 0.3 wavelengths.

For fixed station use, four dipoles are suitable while four magnetically mounted quarter wave whips are ideal for mobile use. Depending on the choice of antenna, the system will operate from 20 to 200 MHz

Suitable magmount quarter wave whips are available from Datong for VHF use

***BASIC DF SYSTEM** (Model DF display unit with Model DFA1 combiner) £125.00 - VAT (£143.80)

***DF SYSTEM.** as above but with mobile version of combiner, Model DFA2 (as DFA1 but fitted with magmount and 4 metre coaxial downlead terminated with PL259 plug) £131.00 - VAT (£150.70)

COMPLETE MOBILE DF SYSTEM (Model DF display unit, Model DFA2 combiner, and four Model MA1 quarter wavelength magmount antennas cut for 145 MHz) £173.50 - VAT (£199.50)

* Antennas not included

DATONG ELECTRONICS LIMITED

ALL DATONG PRODUCTS ARE DESIGNED AND BUILT IN THE U.K.

Data sheets on any products available free on request – write to Dept R.C.

DATONG ELECTRONICS LIMITED
Spence Mills, Mill Lane, Bramley, Leeds
LS13 3HE, England. Tel. (0532) 552461

171 for further details

Data File No. 7

SCRs and Triacs are high speed solid-state switches specifically intended for use in AC and DC power control applications. Ray Marston explains their basic principles in this edition of 'Data File'.

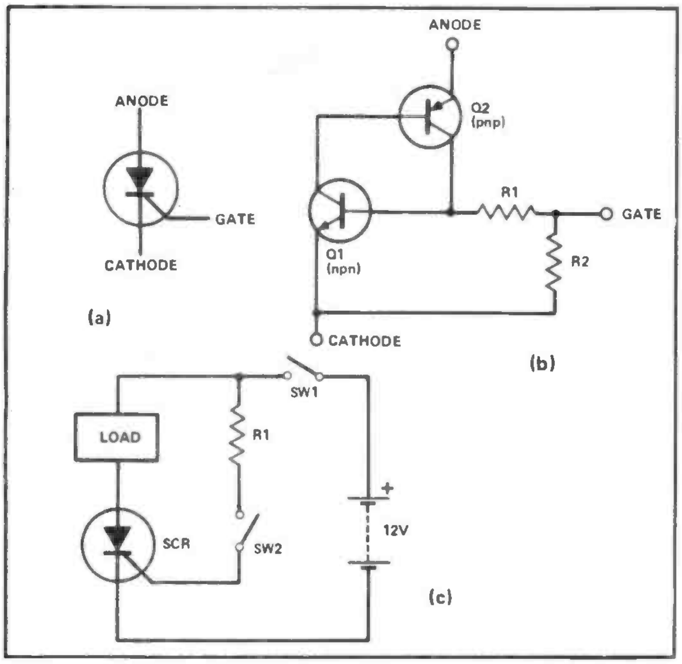


Figure 1: (a) SCR symbol, (b) transistor equivalent circuit of the SCR, and (c) connection for using the SCR as a DC power-control switch.

DEVICE TYPE No.	PIV RATING	TOTAL CURRENT RATING, rms / AVERAGE	V_{GT} (max)	I_{GT} (max)	I_H (max)
TAG1/100	100V	1A / 0.64A	2.5V	10mA	25mA
TAG1/600	600V	1A / 0.64A	2.5V	10mA	25mA
C106D	400V	4A / 2.5A	0.8V	0.2mA	3mA
2N3525	400V	5A / 3.2A	2V	15mA	20mA
BT109	500V	6.5A / 4A	2V	15mA	3mA
IR122A	100V	8A / 5A	1.5V	25mA	30mA
IR122D	400V	8A / 5A	1.5V	25mA	30mA
C116D	400V	8A / 5A	1.5V	20mA	35mA
C126M	600V	12A / 7.5A	1.5V	30mA	35mA

Figure 2: Basic details of some of the most popular SCRs.

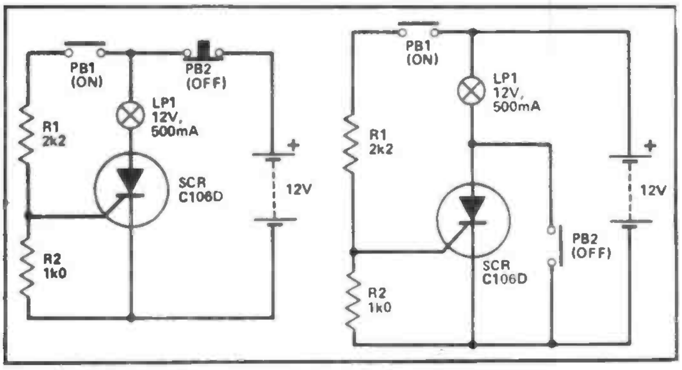


Figure 3: (a) DC ON/OFF circuit. (b) Alternative DC ON/OFF circuit.

THE SCR, OR SILICON CONTROLLED RECTIFIER, is a four-layered pnpn semiconductor 'switching' device. It is represented by the symbol shown in *Fig 1a*. *Fig 1b* shows the transistor equivalent circuit of the SCR, and takes the form of a complementary regenerative switch in which the base current of Q1 is derived from the collector of Q2 and the base current of Q2 is derived from the collector of Q1. *Fig 1c* shows the basic connections for using the SCR as a switch in DC power-control circuitry. The characteristics of the SCR can readily be understood with the aid of *Figs 1b* and *1c*, and are as follows:-

1) When power is first applied to the SCR (by closing SW1 in *Fig 1c*) the SCR is 'blocked' and acts like an open-circuit switch. This action can be understood by looking at *Fig 1b*, where it can be seen that, since Q1 base is shorted to the cathode via R1-R2, Q1 is cut off through lack of base current and thus feeds no base drive to Q2, which is also cut off. Both transistors are thus cut off under this condition, and only a small leakage current flows between the anode and cathode of the device.
2) The SCR can be turned on and made to act like a closed switch (or forward-biased silicon rectifier) by applying positive gate current. Closing SW2 in *Fig 1c* applies such a gate current to the SCR. This gate current will apply base drive to Q1, causing Q1 to start to turn on. As Q1 starts to turn on, its collector current feeds base drive to Q2, causing Q2 to turn on and feed increased base drive into Q1, etc. A fast regenerative action thus takes place, with both transistors switching rapidly into saturation, the total saturation voltage typically being in the range one to two volts.
3) Once the SCR has been turned on and is conducting significant forward current, the gate loses control and the SCR remains latched on even if the gate drive is subsequently removed. Thus, only a brief pulse of gate current is needed to latch the SCR on. Note from *Fig 1b* that, because of the presence of R1 and R2, the SCR can NOT be turned off by shorting or reverse-biasing the gate-cathode terminals of the device.
4) Once the SCR has latched into the on state it can only be turned off again by momentarily reducing its anode below a value known as the 'minimum holding current'. Since turn-off occurs whenever the current is reduced below this critical value, it follows that turn-off occurs automatically in AC circuits near the zero-crossing point at the end of each half cycle.
5) Internal capacitance inevitably exists between the anode and gate of the SCR. Consequently, if a sharply rising voltage is applied to the SCR anode, this internal capacitance can cause part of the rising voltage to break through to the gate and thus trigger the SCR on. This 'rate-effect' turn-on can be caused by supply line transients, and sometimes occurs at the moment that supplies are switch-connected to the SCR anode. Rate-effect problems can usually be overcome by wiring an R-C 'snubber' network between the anode and cathode of the SCR, to limit the rate-of-rise to a safe value.

These, then, are the basic characteristics of the SCR. If you ever need to select an SCR for a particular application, you'll usually find that the most significant parameters are the main voltage and current ratings, plus the gate sensitivity rating and (occasionally) the devices 'minimum holding current' value. The list of *Fig 2* gives these details for a few of the most popular SCRs.

THE SCR: BASIC DC CIRCUITS

SCRs have applications in both DC and AC power-control circuitry. Let's look first at some basic DC circuits. *Figs 3a* and *3b* show two ways of using the SCR as a push-button-controlled ON/OFF power switch, feeding a 12V, 500 mA lamp. In both circuits, the lamp and SCR can be latched on by momentarily closing PB1, thereby feeding gate drive to the SCR via R1. Note that the gate is tied to the cathode via R2, to give improved stability. Once the SCR has latched on, it can only be turned off again by momentarily reducing the anode current below the devices I_H value; in *Fig 3a* this is achieved by momentarily opening PB2; in *Fig 3b* the turn-off action is achieved by using PB2 to place a momentary short between the anode and cathode of the SCR.

Figure 4 shows another way of achieving SCR turn-off. Here, once the SCR has turned on, C1 charges up to almost the full supply voltage via R3 and the SCR anode, with the R3-end going positive. When PB2 is subsequently closed it clamps the positive end of C1 to ground, and the C1 charge forces the SCR anode to momentarily swing negative, thereby reverse-biasing the SCR and causing it to turn off. The capacitor charge bleeds away rapidly under this condition, but has to hold the SCR anode negative for only a few micro-seconds to ensure complete turn-off. Note that C1 must be a non-polarised capacitor.

A variation of the capacitor turn-off circuit is shown in *Fig 5*. A slave SCR is used to replace PB2 of *Fig 4*, and capacitive turn-off of SCR1 is achieved by briefly driving SCR2 on via PB2. SCR2 turns off once PB2 is released, since the anode current provided by R3 is lower than the SCR2 holding current.

Figure 6 shows how the above circuit can be modified so that it acts as an SCR bistable or flip-flop driving two independent lamp loads. Assume that SCR1 is on and SCR2 is off, so that C1 is fully charged with its LP2 end positive. The state of the circuit can be changed by briefly operating PB2. SCR2 is then driven on via its gate, and as it goes on it drives SCR1 off capacitively via its anode. C1 then recharges in the reverse direction. The state of the circuit can then again be changed by briefly operating PB1, thus driving SCR1 on via its gate and driving SCR2 off capacitively via its anode.

The DC circuits that we have looked at so far have all used purely resistive 'lamp' loads and have inevitably produced a self-latching action in the SCRs. *Fig 7*, however, shows a DC alarm circuit driving a self-interrupting load such as a bell or buzzer, and gives a non-latching action.

When self-interrupting devices such as bells or buzzers are connected across a supply, a current flows through a built-in solenoid via a pair of contacts; this current induces a magnetic field in the solenoid, and causes a striker to fly outwards and open the contacts, causing the current to fall to zero and making the magnetic field collapse. Once the field has collapsed the striker falls back again and the contacts close, so current is again applied to the solenoid and the action repeats. Consequently, this type of load acts like a switch that repeatedly opens and closes rather rapidly. When such loads are connected in the *Fig 7* circuit, therefore, the circuit does not self-latch in the normal way, and the alarm operates only as long as PB1 is closed. Because of the inductive nature of such loads, a damping diode must be wired across them when they are used in SCR circuits, as shown in the diagram.

The *Fig 7* alarm circuit can be modified to give a self-latching action if required by simply wiring a 470R (or lower) resistor in parallel with the alarm, as shown in *Fig 8*. In this case the anode

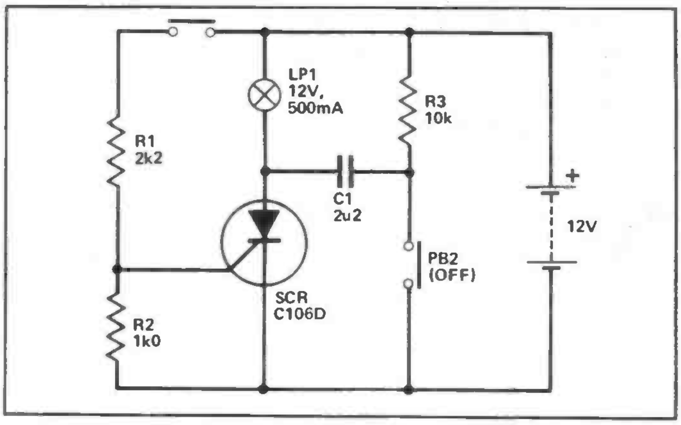


Figure 4: Capacitor-turn-off circuit.

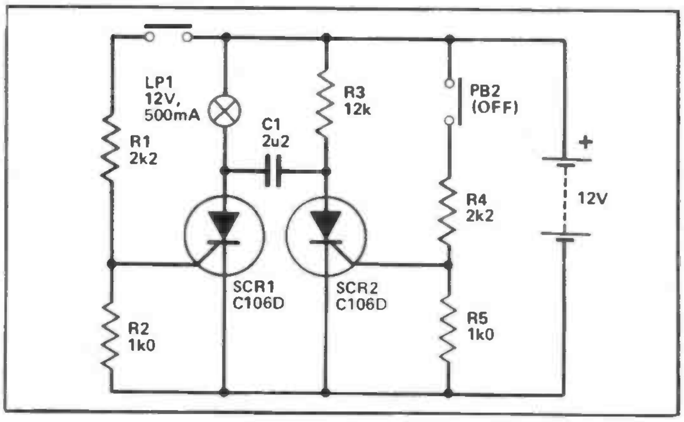


Figure 5: Capacitor-turn-off with SCR slaving.

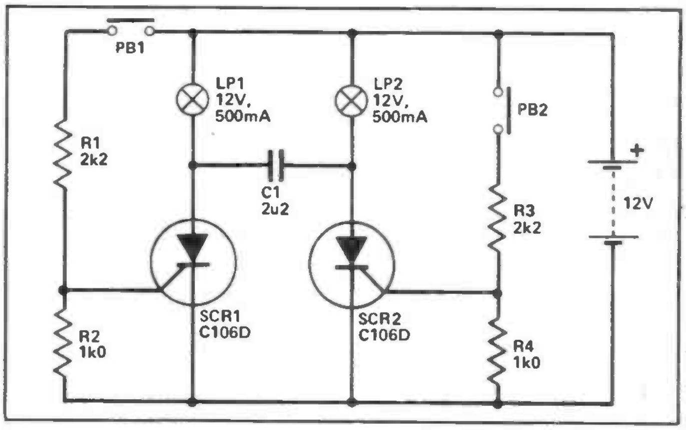


Figure 6: SCR bistable or flip-flop.

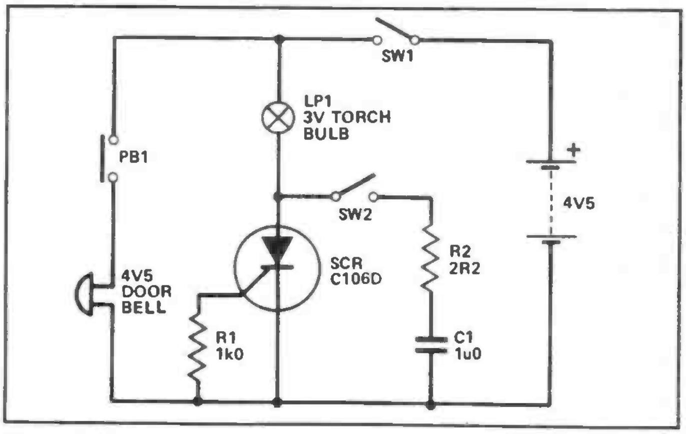


Figure 7: Non-latching alarm circuit.

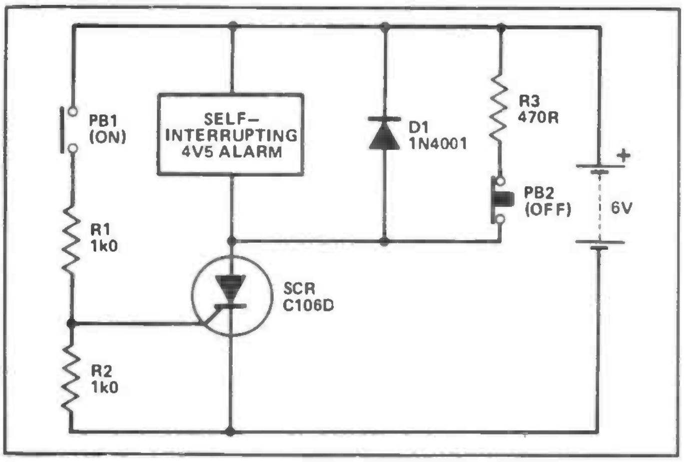


Figure 8: Self-latching alarm circuit.

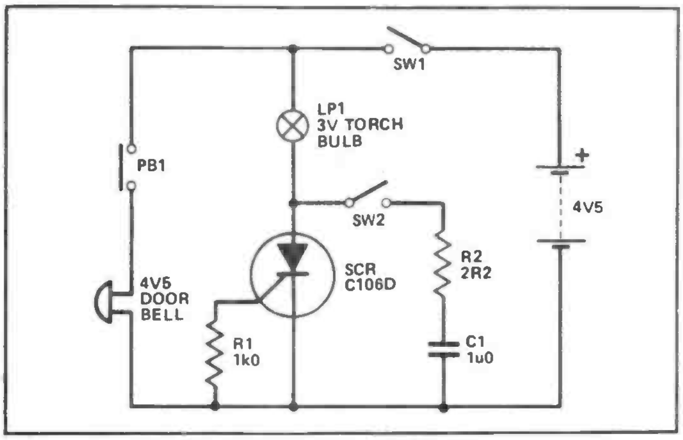


Figure 9: Rate-effect demonstration circuit.

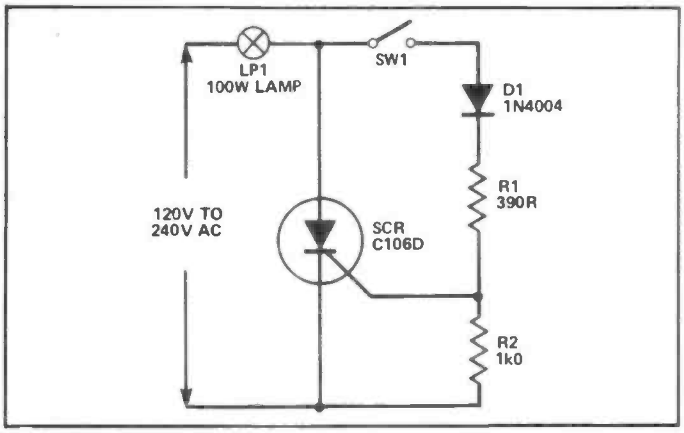


Figure 10: Line driven half-wave ON/OFF circuit.

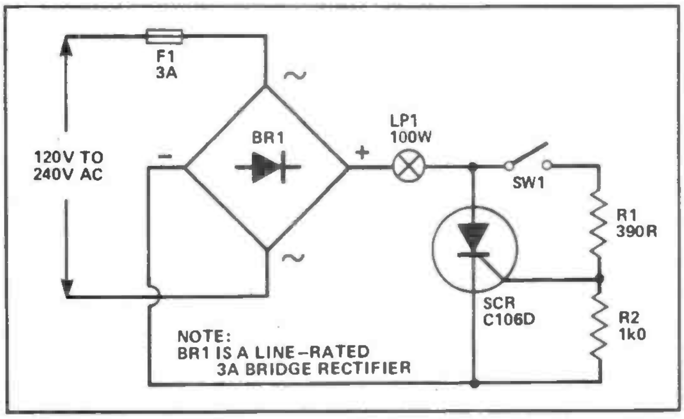


Figure 11: Full-wave ON/OFF circuit.

current of the SCR does not fall to zero when the alarm self-interrupts, but falls to a value determined by R3. If this value is in excess of the SCR's 'holding' value, the SCR self-latches. The circuit can be unlatched by briefly operating PB2, enabling the anode current to fall to zero when the alarm self-interrupts.

Finally, to complete this "BASIC DC CIRCUITS" section, *Fig 9* shows a circuit that can be used to demonstrate the rate-effect turn-on of the SCR, and a method that can be used for rate-effect suppression. Here, the SCR has a 3V lamp as its anode load, and is connected across the 4V5 battery supply via SW1. A 4V5 domestic door bell can be connected across the supply via PB1, and enables transient modulation to be applied to the supply line and thus to the anode of the SCR. This modulation can cause rate-effect turn-on of the C106D SCR, which has a critical rate-of-rise value of 20V/uS. R2 and C1 form a 'snubber' or rate-effect suppression network and can be connected to the SCR via SW2.

To demonstrate the rate effect, open SW2, close SW1, and then close PB1 so that the bell rings. The resulting supply line transients should be enough to trigger to the SCR and turn the lamp on; if not, wire a 1R0 resistor in series with the battery. Once the SCR and lamp have been triggered on, they can be turned off again by briefly opening SW1.

Once the turn-on rate-effect has been demonstrated, the effect of the suppressor network can be demonstrated by closing SW2 and SW1 and then operating the bell via PB1. The lamp resistance (plus R2) acts with C1 as a smoothing network that reduces the rate-of-rise of the anode modulation signal, thereby protecting the SCR against false triggering. R2 is wired in series with C1 to limit the capacitors discharge currents to safe values when the SCR is triggered on via legitimate signals.

THE SCR: BASIC AC CIRCUITS

Figure 10 shows a basic half-wave ON/OFF circuit driving a 100W lamp from a 120V or 240V AC power line. With SW1 open, zero gate drive is applied to the circuit, so the lamp and SCR are off. Suppose, however, that SW1 is closed. On negative half-cycles, the SCR is reverse biased and gate signals are inhibited by D1, so the SCR is off. On positive half-cycles, the SCR is initially off at the start of each half-cycle, so the full available line voltage is applied to the gate via the lamp and D1-R1; shortly after the start of the half-cycle sufficient voltage is available to trigger the SCR, which turns on. As the SCR goes on its anode voltage falls to near zero, thus removing the gate drive, but the SCR remains self-latched for the duration of the half-cycle. The SCR automatically turns off again when the half-cycle ends and the anode current falls to zero.

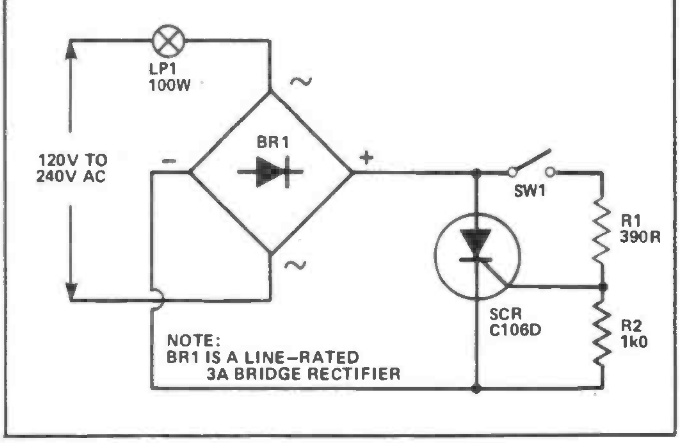


Figure 12: Alternative connection for full-wave ON/OFF circuit.

The *Fig 10* circuit gives half-wave operation only. *Figs 11* and *12* show two ways of obtaining full-wave operation. In these circuits the AC is converted to rough (unsmoothed) DC via a bridge rectifier, and this DC is applied to the SCR.

Note in the *Fig 11* circuit that the load is connected to the DC side of the bridge. A fuse must be placed on the AC side of the bridge, to give protection in the event of a short in the bridge rectifier. In the *Fig 12* circuit the load is placed in the AC side of the bridge, which does not need fuse protection, since the load itself will limit currents to a safe value in the event of a bridge failure.

A pair of SCRs can easily be wired in inverse parallel and used to give full-wave power control without the use of additional rectification. In reality, however, a far more effective way of obtaining full-wave power control is to use a Triac in place of the SCRs. Let's now look at Triac 'basics'.

THE TRIAC: BASIC THEORY

A Triac can be regarded as being two conventional SCRs connected in inverse parallel within a single 3-terminal package, but so arranged that they share a single gate terminal. The Triac acts as a solid-state power switch that can conduct current in either direction and can be switched from the OFF to the ON state by a gate signal of either polarity.

Figure 13a show the Triac symbol, and *Fig 13b* shows a basic connection for using the device as an AC power switch. The load is wired in series with the Triac's main terminals, and the combination is wired directly across the AC power line. DC gate drive can be applied to the Triac by closing SW1. Referring to *Fig 13b*, the characteristics of the Triac are as follows:

1. Normally, with no gate signal applied, the Triac is off and acts (between MT1 and MT2) like an open circuit switch.
2. If MT2 is appreciably positive or negative relative to MT1 the Triac can be turned on (so that it acts like a closed switch) by applying a gate signal via SW1. The device takes only a few microseconds to turn on. A saturation potential of one or two volts is developed across the Triac in the 'ON' mode. Once the Triac has turned on it self-latches and remains on so long as main terminal current continues to flow. Only a brief pulse of gate current is thus needed to turn the Triac on.
3. Once the Triac has self-latched the gate loses control and the Triac can only be turned off again by reducing its main-terminal current below a minimum holding value.
4. The Triac can be turned on by either a positive or negative gate signal, irrespective of the polarities of the main-terminal voltages. The device thus has four possible triggering modes or 'quadrants', signified as follows:

   I+ Mode, MT2 current = +ve, I_{gate} = +ve
   I− Mode, MT2 current = +ve, I_{gate} = −ve
   III+ Mode, MT2 current = −ve, I_{gate} = +ve
   III− Mode, MT2 current = −ve, I_{gate} = −ve

   Gate sensitivities in the I+ and III— modes are approximately equal and about twice as high as in the I— and III+ modes.
5. Triacs can handle very high surge or non-repetitive currents. Typically, a device with a 10A rms rating may be able to handle a single-cycled non-repetitive 50 Hz surge current of 100 amps.

Figure 14 details the characteristics of a limited range of popular Triacs. In most applications this limited information is sufficient for user needs. Let's now move on and look at some basic ways of using the Triac.

THE TRIAC: BASIC CIRCUITS

Figure 15 shows the practical circuit of a simple DC-triggered Triac power switch, in which the DC supply is derived via step-down transformer T1. When SW1 is open, zero current flows to the gate of the Triac, which is thus off. When SW1 is closed, gate

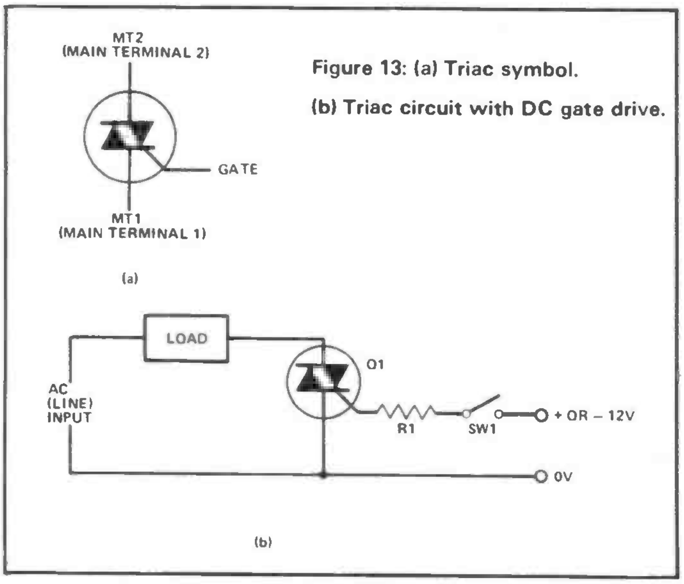


Figure 13: (a) Triac symbol.
(b) Triac circuit with DC gate drive.

DEVICE TYPE No.	PIV RATING	TOTAL CURRENT RATING, rms	VGT (max)	IGT (max)	IH (max)
C206D	400V	3A	2V	5mA	30mA
2N6073	400V	4A	2.5V	30mA	70mA
C226D	400V	8A	2.5V	50mA	60mA
SC146D	400V	10A	2.5V	50mA	75mA
TIC246D	400V	15A	2.5V	50mA	50mA

Figure 14: Details of some popular Triacs.

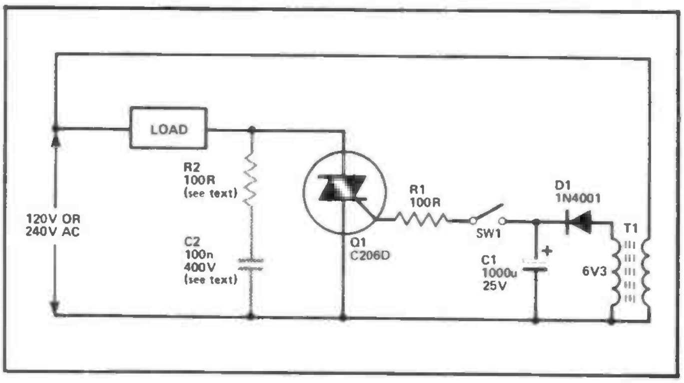


Figure 15: AC power switch with DC gate triggering.

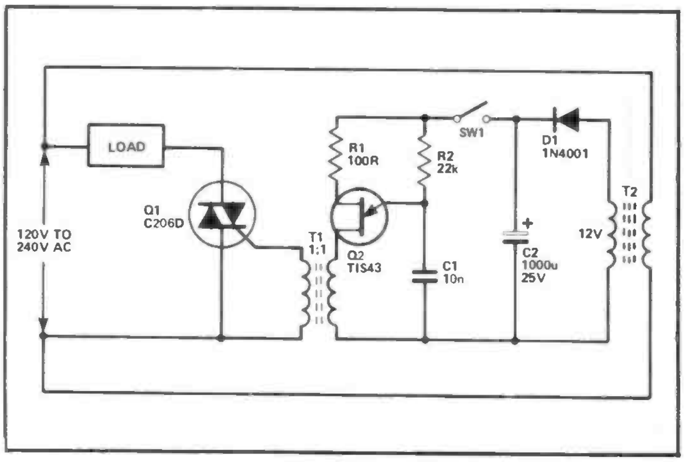


Figure 16: UJT-triggered isolated-input AC power switch.

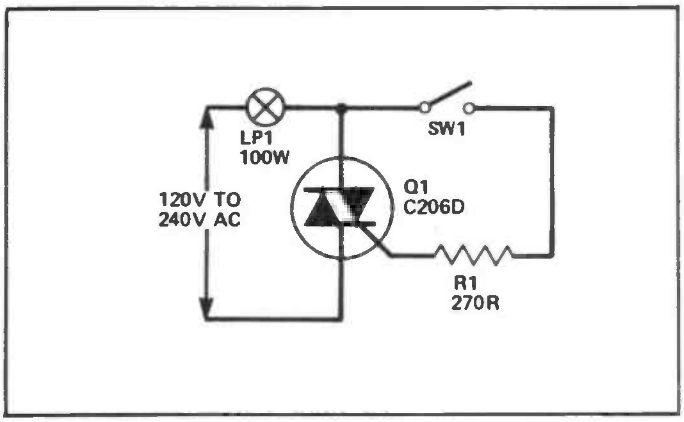


Figure 17: Line-triggered Triac switch.

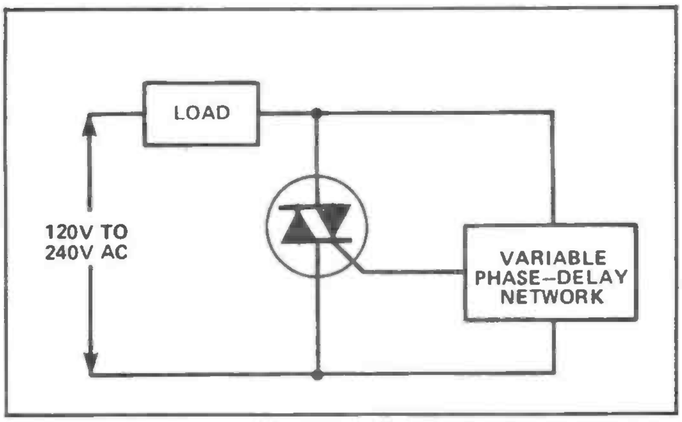


Figure 20: 'Diac-type' variable phase-delay lamp dimmer circuit.

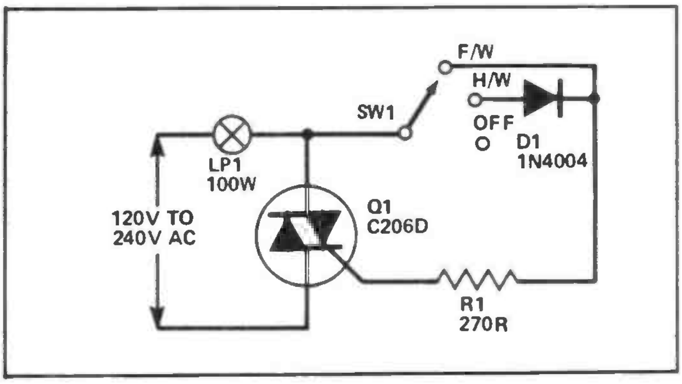


Figure 18: 3-way line switch.

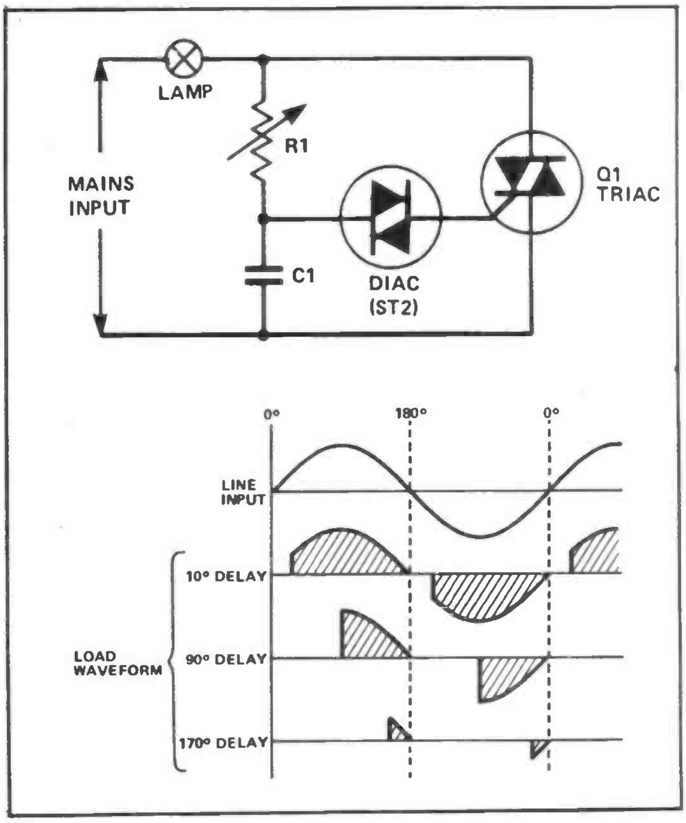


Figure 19: Variable phase-delay 'switch' and waveforms.

drive is applied to the Triac, so it and the load are driven on. If an inductive load such as a motor is used in this circuit, the R2-C2 'snubber' network must be wired in place as indicated, to prevent false-triggering by rate-effects.

Note in the *Fig 15* circuit that the DC side of the circuit is connected directly to one side of the mains and is thus 'live'. This snag is overcome in the UJT-triggered isolated-input circuit of *Fig 16*. Here, the UJT (unijunction transistor) operates at several kHz and thus delivers roughly 50 trigger pulses to the gate of the Triac — via isolation pulse transformer T1 — during each half-cycle of the AC power line waveform. Consequently, the Triac is fired by the first trigger pulse occurring in each mains half-cycle, and this pulse occurs within a few degrees of the start of the half-cycle. The Triac is thus turned on almost permanently when SW1 is closed, and virtually full power is applied to the AC load. The trigger circuit is, however, fully isolated by mains transformer T2 and pulse transformer T1.

Figure 17 shows how the Triac can be used as a simple line switch with line-derived triggering. With SW1 open, zero gate drive is applied, so the Triac and lamp are off. Suppose, however, that SW1 is closed. At the start of each half cycle the Triac is off, so the full line voltage is applied to the gate via the lamp and R1. Shortly after the start of the half-cycle enough drive is available to trigger the Triac, and the Triac and lamp go on. As the Triac goes on and self-latches it saturates and automatically removes the gate drive until the start of the next half-cycle, thus minimising the R1 dissipation.

Finally, *Fig 18* shows how the above circuit can be modified to give either half-way or full-wave operation. In the half-wave mode, the gate drive is applied via D1, so the Triac triggers on positive half-cycles only. In the full-wave mode, the Triac triggers on both positive and negative half-cycles, as in the case of the *Fig 17* circuit.

PHASE-TRIGGERED POWER CONTROL

The SCR and Triac circuits that we have looked at so far have all been designed to give an ON-OFF form of power control. These devices can, however, easily be used to give fully-variable power control in AC circuits, and are widely used in lamp dimmers and electric motor speed controllers, etc. The most widely used system of AC variable power control is known as the 'phase triggering' system.

Figure 19 illustrates the principle of phase-triggering, using a Triac as the power control element. Here, instead of the Triac being triggered 'directly' from the AC power line, it is triggered via a variable phase delay network that is interposed between the power line and the Triac gate. Thus, if the Triac is triggered 10 degrees after the start of each half-cycle, almost the full available line power is fed to the load. If the Triac is triggered 90 degrees after the start of each half-cycle, only half of the available line power is fed to the load. Finally, if the Triac is triggered 170 degrees after the start of each half-cycle, only a very small part of the available power is fed to the load.

The three most popular methods of obtaining variable phase-delay triggering are to use either a line-synchronised UJT, a special-purpose IC, or to use a Diac plus R-C network in the basic configuration shown in *Fig 20*.

The Diac can be regarded as a bilateral threshold switch. When connected across a voltage source, it acts like a high impedance until the applied voltage rises to about 35 volts, at which point it switches into a low-impedance state and remains there until the applied voltage falls to about 30 volts, at which point it reverts to the high impedance mode.

In the *Fig 20* circuit, in each mains half-cycle, the R1-C1 network applies a variably phase-delayed version of the mains waveform to the Triac gate via the Diac, and each time the C1 voltage rises to 35 volts the Diac fires and delivers a trigger pulse to the Triac gate, thus turning the Triac on and simultaneously applying power to the lamp load and removing the drive from the R-C network. The mean power to the load (integrated over a full half-cycle period) is thus fully variable from near-zero to maximum via R1.

RADIO FREQUENCY INTERFERENCE

Note from the *Fig 19* waveforms that, each time the Triac is gated on, the load current changes abruptly (in a few microseconds) from zero to a value determined by the load resistance and the instantaneous mains voltage. The transition action generates radio frequency interference (RFI). The RFI is greatest when the Triac is triggered at 90 degrees, and is least when the Triac is triggered close to the 0 degree and 180 degree 'zero crossing' points of the mains waveform. In lamp dimmer circuits, where there may be considerable lengths of mains cable between the Triac and the lamp load, this RFI may be offensive. In practical lamp dimmers, the circuit is usually provided with an L-C RFI-suppression network, as shown in *Fig 21*, to overcome this problem; note in *Fig 21* that the values in brackets are applicable to 120 volts mains operation.

'ZERO CROSSING' TECHNIQUES

When high power loads, such as electric heaters, are driven from Triac circuitry, special techniques must be used to minimise RFI. Even if the Triac is used as a simple on-off switch in such applications, a 'spurt' of RFI will be generated each time the switch is turned on. RFI problems can be eliminated in high-power applications by using the synchronous or 'zero-crossing' gating technique illustrated in *Fig 22*.

Here, a low-power 12 volt DC supply is generated directly from the mains via R1-D1-ZD1 and C1. A simple zero-crossing detector network (a couple of transistors) is connected directly across the mains, and controls the passage of current from C1 to SW1 in such a way that the C1 current is made available for only 5 degrees or so on either side of each zero-crossing point of the mains waveform. Thus, if SW1 is closed, a pulse of gate current is fed to the Triac at the start of each half-cycle of mains voltage, at which point the mains voltage is close to zero, so the Triac always generates minimal RFI as it turns on.

The 'zero crossing' technique can be used to provide RFI-free variable power control in high-power loads, such as electric heaters, by replacing SW1 of *Fig 22* with a variable mark/space-ratio waveform generator, so that a variable integral number of complete mains power cycles are alternately fed or not fed to the load. *Fig 23* illustrates the basic principle, in which the total integral period is equal to eight mains cycles. Thus, if the power is alternately switched on for four cycles and off for four cycles, the mean load power is equal to half of the total available power, and if the power is on for one cycle and off for seven cycles, the mean power is equal to only one eighth of the total available power.

In next month's edition of 'Data File' we'll look at some practical 'zero crossing' and integral-cycle power controllers, together with a variety of lamp dimmers and motor-speed controllers.

■ R & EW

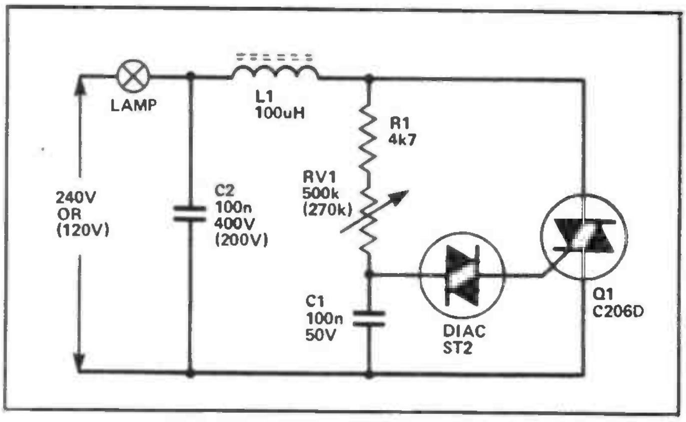


Figure 21: Practical lamp dimmer with RFI-suppression.

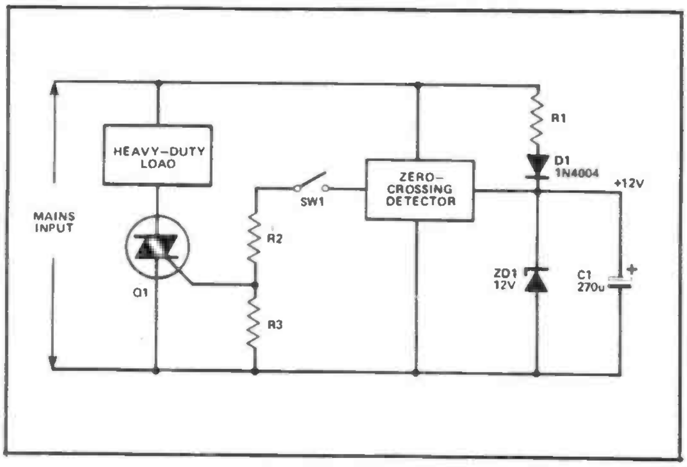


Figure 22: Synchronous or 'zero-crossing' mains power switch.

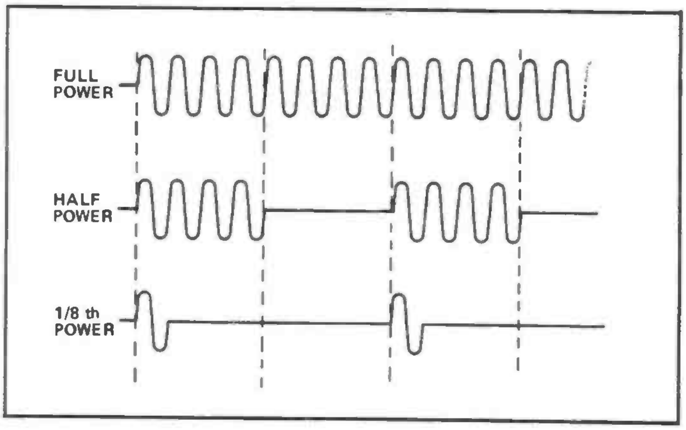


Figure 23: Integral-cycle power control waveforms.

NOTES FROM THE RADIO SHACK...

By Frank A. Baldwin

All times in GMT, bold figures indicate the frequency in kHz.

From time to time I like to bring to your attention some of the latest information on the many clandestine stations currently broadcasting on the short wave bands. For myself, I define clandestine station as those who profess to be other than what they are — and they come in all sorts of guises and with just as many claims. The most common of these is to cloak themselves with democratic principles and purport to represent the views and wishes of the majority. Most of them assume they are the voice of freedom engaged in a struggle with tyranny — but that often depends upon individual viewpoints.

Be that as it may, listen for some of the following:

"Radio 15th September", in Spanish "Radio Quince de Septiembre", which is currently broadcasting on frequencies between **5565** and **5569** inclusive. The language used is Spanish with some short items in English and local vernaculars. That part of the schedule most likely to be heard here in the UK is from 0300 to 0430. The transmitter is thought to be located in Honduras and the programme content is anti-Nicaraguan Government.

"Voice of the Poeple of Burma" is almost certainly located just within the borders of China, the broadcasts being favourable to the pro-Peking orientated Burma Communist Party. Scheduled times are from 0030 to 0240 and from 1200 to 1410 in Burmese, Standard Chinese and various other target area local languages. The channels used are **7570** and **5110**.

"Radio Venceremos" is in support of the Farabundo Marti National Liberation Front which is very much against the government of Salvador. The frequency varies from **6905** to **6911** and that part of the schedule favourable for UK reception is from 0000 to 0130, Monday to Saturday inclusive. As would be expected, the language used is Spanish.

"Voice of the Mojahedin-e Khalq", in Persian "Seday-e Mojahedin-e Khalq-e Irana", is hostile to Khomeini and the Ayatollah dominated leadership. The transmitter operates on a frequency varying from **7500** to **7750** in order to avoid jamming. All in Persian, the programmes are timed from 1600 to 1700 and from 1730 to 1830 — if you can catch them between the frequency limits given and before the jammer catches up with them!

Then we have the "National Voice of Iran", in Persian "Seda-e Melli-e Irana", this one being pro-Soviet and pro-Khomeini (surprise, surprise!) and operating in Persian and a local vernacular from 1730 to 1815 and from 1930 to 2000. No prizes offered for guessing where this transmitter is located! Channels are **5915** and **6025**.

For your delectation we'll offer a few more clandestines next month.

AROUND THE DIAL

It is the to this section of the monthly rendition that regular readers — one of whom contacted me recently via a CB contact much to my surprise — turn their eyes to see just what is listed that they haven't heard so far. What about this —

Nigeria

Radio Kwara on **7145** at 0602, OM (male announcer) with a newscast of both local and world events in English. Radio Kwara is sited in Illorin which is in Kwara State and it is on the air from 0430 to 2305 on this channel, the daily programmes being in English and vernaculars.

A little more difficult owing to 'splash' from surrounding transmitters is Cross River Radio, Calabar, in Cross River State. It operates on **6145** and has been heard here at 0550 with a talk in vernacular, the signal being lost at 0558 just prior to an identification in English at 0600 — grrr! A tentative logging it seems!

Whilst on the subject of reception of Nigerian local transmitters, why not try Kaduna on **4770**, where it was logged a few days ago at 0603 whilst radiating a newscast in English. This one operates from 0430 to 2400 in English and Hausa and identifies as "Radio Nigeria". English newscasts are listed at 2100 and 2300 but I have several times logged the 0600 version.

Or what about this one, not often reported in the short wave listener press —

Oman

Muscat on **11890** at 2037, OM with songs in Arabic together with local-style music, a newscast at 2100, readings from the Holy Quran at 2108 prior to abrupt sign-off at 2113. Muscat is the capital of the Sultanate of Oman, the address for reports being Ministry of information & Youth Affairs, PO Box 600, Muscat.

Pakistan

I discovered Karachi on a new channel — and a new band for that matter — listen on **13607** at 1710 when we logged it radiating songs and music in the local style. This transmission isn't listed in their latest schedule.

Or you could try **11670** at 1702, at which time was featured a newscast of Pakistan affairs in English in the announced World Service to the UK or the **4710** channel at 0248 if you are sleepless.

Iceland

Another dicovery was that of Reykjavik on **13795** at 1920 when the log shows an entry for reception of part of a programme intended for Icelandic seamen at sea. Naturally the programme language is Icelandic and the content is composed mainly of weather reports and news items. The schedule is from 1830 to 2000 and the power is 10 kW.

USA

Another new one logged was that of WRNO New Orleans on **15355** at 2154, surprisingly giving out a commercial for the ARRL (American Radio Relay League) amid a selection of pop records and putting a power-house signal here into the UK. Presumably this programme was part of a test programme, the transmission suddenly terminating at 2200 without announcements of any kind. My thanks are due to Gordon Bennett of Stockport for the landline call that put me on to this transmission. Now back to more established transmitters.

Ecuador

HCJB (Heralding Christ Jesus' Blessings) La Voz de Los Andes, Quito on a measured **21477** at 1930 when announcing programme content, a newscast and station identification during the English programme for Europe, scheduled from 1900 to 2000.

Radio Nacional Espejo, Quito on **4679.5** (also measured) at 0251, when radiating a programme of local pops. Station identification and promos at 0252 — in Spanish of course! This one has a schedule around the clock and a power of 5 kW.

Malta

"Radio Mediterranean", Cyclops on **9515** at 2037, presenting a religious programme in English sponsored by International Christian Radio. Programmes in English are featured by this station from 2015 to 2115 Monday to Friday inclusive.

Brazil

Radio Nacional Brasil on **17805** at 1933, local songs and music in typical style, station identification in English at 1938 — "You are listening to Radio Nacional Brasil, a Radiobras station".

Also logged on **15125** at 1940 when radiating the English programme to Europe which is timed from 1900 to 2000. At the time heard, it was all about the Brazilian economy, exports, imports and all the rest of it.

Cuba

Havana on **17750** at 2049, announcements and station identification at the commencement of the English programme to North America and the Caribbean, scheduled from 2050 to 2140.

Sri Lanka

Colombo on **11800** at 1947, local-style songs and music in the Urdu programme intended for African and Middle East consumption and timed from 1930 to 2000 although I must confess that the closing time is uncertain as far as I am concerned.

Sweden

Nearer to home is Stockholm on **9630** at 1100, at which time there was station identification and the programme entitled "Mailbag", complete with replies. All in the English transmission to Europe and the Pacific from 1100 to 1130.

Rwanda

Kigali relay of Cologne **21540** at 0950, classical music with announcements in an English programme directed to Asia and Australasia, scheduled from 0930 to 1020.

Vatican City

Vatican on **11700** at 2049, station identification and transmission details announced at the end of the English programme for Central and Southern Africa and timed from 2045 to 2100.

Poland

If you are interested in the present situation then you may care to tune to **9525** at 1830 for the English programme for Europe, timed through to 1900. We logged them at 1845 and listened to a programme entitled Panorama, all about the labour force and hopes for the future. Also logged in parallel on **9540**.

South Africa

Whilst you are around this part of the dial at this time why not line up on **9585** for RSA Johannesburg? At 1858 you will hear the interval signal and then identification in English at the start of the Portuguese programme for Angola, Mozambique and Portugal.

Yugoslavia

Or there is Belgrade on **9620** at 1840, with station identification followed by a news commentary in the English programme for Europe, the Middle East and Africa listed from 1830 to 1900.

Hungary

Perhaps you would prefer **9835** at 1920, at which frequency there is Budapest with an English programme for Europe on Tuesday and Friday only at this time. It was all about the medieval history of Hungary. Or would the following interest you.

AMATEUR BANDS

Once again delving into the CW ends of the bands, at least for the majority of the time, some periods proved exciting with DX turning up from time to time whilst at other sessions most of the signals were from locals — according to the band in use at the time.

1800-2000kHz

Although several attempts were made at various times during the month, only one signal from across the pond was heard. Several Eastern Europeans however did put in an appearance as the following list will show.
DF1BT, DF1MD, DJ6MN, DJ6ZB, DJ7QX, DJ8CR, DK2NV, DK2QL, DL6YE, HB9DXE, HB9CM, LA1EKO, OK1AWQ, OK1DDA, OK2PAM, OK2BUV, OK3KAP, OL4BET, OL4BDY, OL9CMU, UB5DCO, UB5HFF, UB5ZAL, UB5WAU, W4PZU.
SSB one evening produced DL3AA and OK1KSO.

7000-7100 kHz

This band extends to 7300 kHz in North America. Diving beneath some of the commercial QRM, especially in the early mornings or late evenings does sometimes produce the goods — although I must confess to the use of an 0.4 kHz bandwidth most of the time — a secondary snag to that mentioned above being the multitude of Eastern European CW signals that now largely predominate this band. The few that didn't get away were — EA8QO, VE7CRU, W3LPL, XE1FAA and YV6MXB.

Nothing very startling but at least an attempt was made on this most difficult of bands.

14000-14350 kHz

A couple of evenings plus some odd moments were spent on this band which resulted in this lot shown below —
CO7WK, FC6ETR, KV4AA, LU6GW, PJ3AH, PT2ADA, PY2FDO, VP2ES, VP2VFI, VP9DR, VU2DMS, XE1FFY, YV4AU, ZS1RA, ZS5WT, ZS6UN, 4U1UN and 5Z4CX.

I know 4U1UN isn't DX, I just slipped it in for interest. Then there was SU1MI which was a surprise to me — see last issue — and Y44YK. What's his QTH?

21000-21450 kHz

For only one session on this band the result achieved was interesting in that the signals from South America predominated, this being from 2100 to 2210 GMT. Those landed were — CX4GL, CX5RV, LU4AC, LU4FEO, LU7BI, PY4YJC and ZS5XI. No prizes for spotting the odd one out — that's why I included it.

CITIZENS' BAND

One-four for a copy, got your ears on? Well, some fun and games have been had on some of the forty channels this month, mainly to do with the various nets which operate late evenings and throughout the night, sometimes even into the mornings at breakfast time.

The local nets here in East Anglia and probably like most other areas are complete with a chairman whose tasks, apart from keeping a rota of transmissions, include linking up those in the net who are most distant from each other. Contacts across the water and into Kent have been achieved in this manner — down to the coastal resorts such as Margate for instance. I even finished up as a Chairman myself on one occasion, relaying the gist of messages from one outlying breaker to another who was unable to make the trip either on transmit or receive.

Nets are not my favourite occupation but at least one such gathering did enable me to make an eighteen mile trip — and that is DX as far as I am concerned to date on the CB channels, although no doubt quite modest compared with many other breakers. We are however, strictly legit which of course imposes some limits on just what is possible.

So, for Nutmeg, Seaweed, Whitecloud and Eagle One, not to mention Speedy and Three-Wheeler and Skeleton and Teapot and Leo Lady many thanks for the enjoyable contacts. Then there is Fisheye and Meridian and Roman Warrior and Collector and...

Your Reactions.........	Circle No.
Immediately Applicable	46
Useful & Informative	47
Not Applicable	48
Comments	49

DX-TV

Reception Reports

Compiled by Keith Hamer and Garry Smith.

FEBRUARY IS NORMALLY a quiet month as far as DX-TV activity is concerned and this year was no exception. For the past four years or so, DX-ers have become accustomed to receiving signals via the ionized F2 layer due to the sun-spot maximum but now that we have passed through the peak, F2 activity has declined. Having said that, we have received reports from DXers in East Anglia of reception from ZTV-Zimbabwe on channel E2 (48.25 MHz vision) via Trans-Equatorial skip (abbreviated to 'TE') which is an associated effect of sun-spot activity. This activity peaks in eleven-year cycles so we will have to wait until about 1990 for the next opportunity to receive signals from transmitters at vast distances from the receiving site. During the past, maximum reception occurred regularly around the vernal and autumnal equinox periods (January, February, March and September, October, November and December respectively). Signals from the USSR (from transmitters operated by the TSS) were received in the UK on many occasions together with transmissions from the United Arab Emirates (normally Dubai), China, the USA, Canada and even Australia, the latter on channel AO (46.25 MHz vision). It remains to be seen whether there will be further F2-layer activity during the autumnal equinox period.

Reception at this location during February consisted mainly of signals which were reflected back to the Earth via ionized trails caused by small meteors entering the atmosphere. Signals propagated via this mode are extremely short in duration ranging between 1 and 10 seconds. It can, therefore, be very difficult to identify the source of reception even if a test card is received especially as most television services now use electronic types, usually the Philips PM5544 or the FuBK.

Figure 1: USSR (TSS) Identification

Figure 2: SR – Sweden, 1800 GMT – Jan 19th

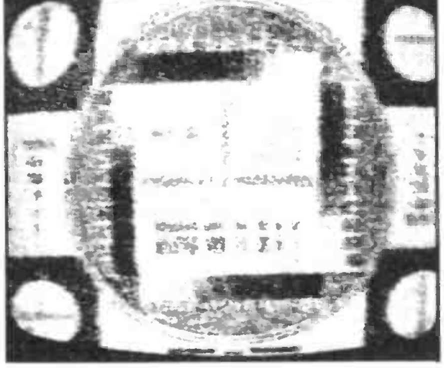


Figure 3: RTS in Albania

Figure 4: Polish News programme caption

On the 7th there was a short 'Sporadic-E' opening to Spain on channel E3 (55.25 MHz vision) with commercials at 1540 GMT. At 1606 signals were received from NRK-Norway from several transmitters operating on channel E3. Fortunately the transmissions included the PM5544 test card with transmitter identification which enabled reception to be confirmed from the outlets located at Bagn and Gamlen.

Due to an anticyclonic system of 1030 millibars centred over Europe, reception from the near-Continent was enhanced via the troposphere (propagation mode abbreviated to 'Trop') which gave rise to signals on UHF from France (TDF), Belgium (RTB:F and BRT), West Germany (ARD and ZDF) and the Netherlands (NOS). Some of the signals were sufficiently strong to be of entertainment quality.

RECEPTION REPORTS

Simon Hamer (Powys, Wales) receives good quality signals from UHF transmitters carrying Midlands programmes plus weak signals from BBC1 and BBC2 West and HTV West (from the Mendip transmitter) using two pre-amps which give three stages of amplification. Simon also receives signals from France (TF1, A2 and FR3), the Netherlands and, on rare occasions, Spain (RTVE), all on UHF. During Sporadic-E (SP.E) openings he has logged an impressive list of countries including Denmark (DR), Poland (TVP), the USSR (TSS), Italy (RAI), Rumania (TVR), Spain (RTVE), Czechoslovakia (CST), Hungary (MTV), Portugal (RTP) and Yugoslavia (JRT), most with good quality signals. For DX-TV, Simon uses Bush TV 176 with a Teleng 'upconverter'. This converts VHF frequencies to UHF so that an unmodified, domestic receiver may be used to receive Continental broadcast television transmissions. For Band I reception he uses a "V" antenna feedings Jostykit HF 395 VHF pre-amp. For UHF he uses a Triax bowtie aerial, a set-top Labgear log-periodic and Jaybeam multi-element group 'A' array.

As mentioned in the previous article, we have received some off-screen photographs of DX reception from our correspondent in Czechoslovakia, Jaroslav Bohac. The countries depicted in these photographs can all be received in the UK with little difficulty. Indeed, Spain is frequently received and it is possible to resolve sound and good quality colour (PAL). We hope to show more photographs from Jaroslav in the near future.

From Finland, Petri Popponen has written with details of his DX-TV installation together with some off-screen photographs. Petri uses three television receivers, one of which is a home-made multi-standard set covering 405, 625 and 819-line standard with facilities for switching between positive and negative vision modulated signals and CCIR (West European)/OIRT (Eastern-bloc countries) sound covering AM and FM DX-TV signals are recorded onto video tape using a Sony T7 ME VCR which can record PAL, SECAM and NTSC colour. Apart from broadcast DX-TV, Petri is also an amateur television enthusiast with equipment for receiving slow-scan television (SSTV) signals.

Jim Maden in Three Rivers (South Africa) has been receiving some extreme long-distance television signals including programmes from Poland (TVP) and Eire (RTE). He has also logged transmissions from Kenya on channel E2 (48.25 MHz vision).

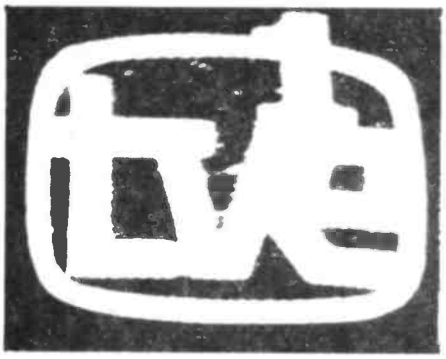


Figure 5: RTVE – Spain

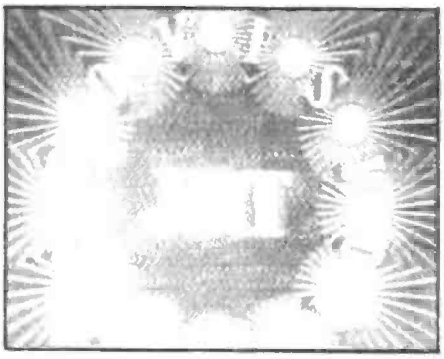


Figure 6: Yugoslavian Caption

Figure 7: The West German Service

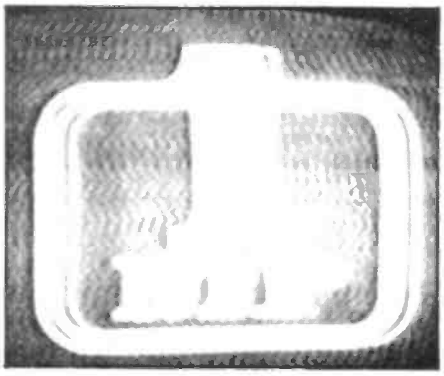


Figure 8: RTP in Portugal

We understand that there is a single-standard (i.e. UHF-only) receiver available, gratis, for any would-be DXer. It's a 24 inch monochrome Bush/Murphy set which has been fitted with a Mullard varicap tuner. The line output transformer is relatively new and the valves are in good working order. Anyone who is interested should write to the authors, via **R&EW**, for further details. It will have to be collected from the Derby area.

Finally this month, a reminder that DX-TV enthusiasts still have time to enter our competition, full details of which were given last month. By the time this article is read, the 1982 Sporadic-E season should be in full swing thanks to the ionization of the Earth's E-layer, so DX-TV signals should be received in abundance from all over Europe. Why not send us, via the **R&EW** Editorial Department, full details of your DX log together with any off-screen photographs of test cards or captions? You could win a book which will certainly help you identify your mystery signals!

Photo's 1-3 courtesy of Petri Popponen, Finland.

Photo's 4-8 courtesy of Jaroslav Bohac, Czechoslovakia.

■ **R & EW**

Your Reactions..........	Circle No.
Immediately Interesting	62
Possible application	63
Not interested in this topic	64
Bad feature/space waster	65

R&EW BOOK SERVICE

Use the reply paid coupon for ordering.

BOOKS OF THE MONTH

BASIC PROGRAMMING ON THE BBC MICROCOMPUTER

By Neil and Pat Cryer

1982; 195 pages; 145 x 230mm; Paperback **£5.95**

This husband and wife team have written a comprehensive book teaching the reader computer language BASIC with particular reference to the BBC Microcomputer.

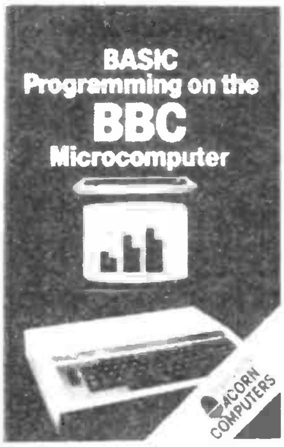
The book is written in non-technical language commencing with an introduction to the subject and gradually progresses from simple, to more sophisticated programming.

At every stage the reader learns through frequent and clearly labelled activities on the computer. All the chapters conclude with activities, followed by questions under the heading 'Some points to think about' and discussions on the questions and activities.

Half-way through the book the fascinating area of pictures, shapes, colour graphics and animation for games is entered. The final chapters deal with mathematical functions, string handling, user-defined functions and procedures, file handling and programmable characters and sound.

The appendices contain a detailed glossary of terms for programming BASIC on the BBC Microcomputer, a discussion of the peripherals and optional extras that are available, and a section showing how hobbyists, teachers and professionals may extend their computing expertise.

JB



MICROCOMPUTER INTERFACING WITH THE 8255 PPI CHIP

By Paul F Goldsbrough

1979; 217 pages; 145 x 230mm; Paperback **£6.95**

This book is a self instructional text designed to introduce the reader to the Intel 8255 Programmable Peripheral Interface (PPI) through discussion and experiments.

The book covers what the device is, where it fits in a microcomputer system, why it is used and how it is used. Much of the material applies to other PPI's, e.g. Motorola 6821, Zilog PIO. etc.

The first part of the book introduces the reader to the idea of interfacing to a microprocessor. It covers a broad spectrum of devices to give the reader a background to the subject. There are experiments to either perform or read as examples. These should not be ignored as they contain some vital information, e.g. experiment 1.5 demonstrates and compares the difference between accumulator I/O and memory mapped I/O.

Having covered the basics, the 8255 is covered in more detail. The chip is a complicated one to understand. It has 24 I/O lines which can be used in a variety of different ways. There are three basic modes of operation. Mode 0 is basic input and basic output. Mode 1 is strobed input and strobed output. Mode 2 is strobed bidirectional I/O. Having given a brief introduction to the modes of operation, the reader is shown how to interface the device to an Intel 8080 microprocessor. The experiments in this section are on software, and how to initialise the device. The chip, if interfaced correctly, should power up in a known state. Before it can be used, there is a software configuration required to set up the required mode of operation. This section covers the topic by giving specific examples, which may be followed as experiments.

Each of the three basic modes of operation is now covered in depth. There are examples and experiments to cover most applications which the user can think of for this device. A book such as this can save most people, professionals included, a lot of time by giving inspiration and by pointing out possible pitfalls. I would have liked to have seen the full Intel data sheets and application notes on the 8255 reproduced in full in the appendix. There are the usual static electricity problems, and limited drive (or fan out) capability associated with these chips, and I would have preferred to see more emphasis placed on these problems. If the book is read in conjunction with the references which it cites, then not much harm should come to the reader. The Intel data sheets and application notes should certainly be read in conjunction with the book.

If you can read the Intel literature and get the design right first time, then good luck. If, like myself, the answer is probably not, then do like I did, and read the book. You will learn more than you probably want to admit to from it.

KM

RADIO BOOKS

AMATEUR ANTENNA TESTS AND MEASUREMENT
by H D Hooton **£6.95**

BEGINNERS HANDBOOK OF AMATEUR RADIO
By C Laster **£9.70**

CB RADIO CONSTRUCTION PROJECTS
by Len Buckwalter **£2.75**

FERROMAGNETIC CORE DESIGN
by M F Doug DeMaw **£16.45**

MICROWAVE DEVICES AND CIRCUITS
by Prof S Liao **£24.70**

QUESTIONS AND ANSWERS ABOUT CB OPERATIONS
by L G Sands **£2.65**

TV ANTENNAS AND SIGNAL DISTRIBUTION SYSTEMS
by M J Salvati **£7.65**

GENERAL BOOKS

ABCs OF INTEGRATED CIRCUITS
by R P Turner **£4.15**

ACTIVE FILTER COOKBOOK
by Don Lancaster **£10.45**

ANALOG I/O DESIGN AQUISITION: CONVERSION: RECOVERY
by P H Garrett **£17.20**

BASIC ELECTRICITY/ELECTRONICS Vol 3 Understanding Electronic Circuits 2nd Edition
by Training & Retraining Inc **£9.70**

BEGINNER'S HANDBOOK OF IC PROJECTS
by D L Heiserman **£9.70**

BUILDING AND INSTALLING ELECTRONIC INTRUSION ALARMS
by J E Cunningham **£4.55**

CMOS COOKBOOK
by Don Lancaster **£9.05**

DESIGN OF OP-AMP CIRCUITS with experiments
by H M Berlin **£7.65**

DESIGN OF PHASE-LOCKED LOOP CIRCUITS — with experiments
by H M Berlin **£7.65**

DESIGN OF VMOS CIRCUITS - with experiments
by R T Stone **£8.35**

EFFECTIVELY USING THE OSCILLOSCOPE
by R G Middleton **£6.95**

HOW TO BUILD A FLYING SAUCER
by T B Pawlicki **£4.45**

HOW TO BUILD YOUR OWN STEREO SPEAKER
by Christopher Robin **£5.20**

INTEGRATED CIRCUIT PROJECTS
by R P Turner **£4.55**

LINEAR INTEGRATED CIRCUITS
By S D Prensky & A H Seidman **£14.95**

LOGIC AND MEMORY EXPERIMENTS USING TTL BOOK 1
by D G Larsen & P R Rony **£8.35**

LOGIC AND MEMORY EXPERIMENTS USING TTL BOOK 2
by D G Larsen & P R Rony **£9.05**

99 PRACTICAL ELECTRONIC PROJECTS (2nd Edition)
by Herbert Friedman **£4.55**

ONE EVENING ELECTRONIC PROJECTS
by Calvin R Graf — £9.95

OP AMP HANDBOOK
by F W Hughes — £16.45

OPERATIONAL AMPLIFIER CHARACTERISTICS AND APPLICATIONS
by R G Irvine — £18.70

OSCILLOSCOPES
by S Prentiss — £8.20

PRACTICAL LOW-COST IC PROJECTS (2nd Edition)
by Herbert Friedman — £4.15

PRINCIPLES OF BIO-MEDICAL INSTRUMENTATION & MONITORING
by R J Traister — £18.70

SECURITY ELECTRONICS (2nd Edition)
by J E Cunningham — £5.25

SON OF CHEAP VIDEO
by Don Lancaster — £6.95

SCRS & RELATED THYRISTOR DEVICES
by C Laster — £9.05

TTL COOKBOOK
by D Lancaster — £8.35

THE 555 TIMER APPLICATIONS SOURCEBOOK - with experiments
by H M Berlin — £5.25

UNIQUE ELECTRONIC WEATHER PROJECTS
by Tom Fox — £6.25

COMPUTER BOOKS

THE ADA PROGRAMMING LANGUAGE
by J C Pyle — £8.95

ADVANCED COMPUTER DESIGN
by J K Iliff — £18.95

APPLE BASIC FOR BUSINESS FOR APPLE II
by A J Parker et al — £11.20

APPLESOFT LANGUAGE
by B D & G H Blackwood — £7.65

THE ARCHITECTURE OF CONCURRENT PROGRAMS
by P B Hansen — £19.45

ATARI ASSEMBLER
by Don & Kurt Inman — £9.70

BASIC BUSINESS SOFTWARE
by E G Brooner — £8.35

CALCULATOR CLOUT — PROGRAMMING METHODS FOR YOUR PROGRAMMABLE
by M D Weir — £6.70

CIRCUIT DESIGN PROGRAMS FOR THE TRS-80
by Howard M Berlin — £10.15

COMPUTER GRAPHICS PRIMER
by M Waite — £10.45

COMPUTER LANGUAGE REFERENCE GUIDE
by Harry L Helms — £5.55

CP/M PRIMER
by S Murtha & M Waite — £10.45

CRASH COURSE IN MICROCOMPUTERS
by Louis E Frenzel — £13.95

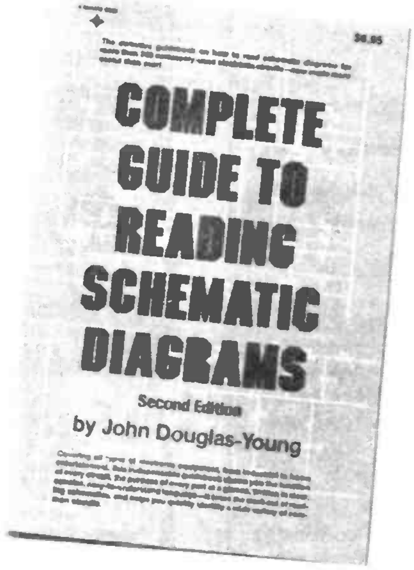
DIGITAL CIRCUITS AND MICROCOMPUTERS
by D E Johnson et al — £10.45

DIGITAL CONTROL USING MICROPROCESSORS
by P Katz — £16.95

AN END USERS GUIDE TO DATA BASE
by J Martin — £16.45

EXPERIMENTS IN ARTIFICIAL INTELLIGENCE
by J Krutch — £6.25

GUIDEBOOK TO SMALL COMPUTERS
by W Barden Jnr. — £4.85



HANDBOOK OF SEMI-CONDUCTOR MEMORIES
by M M Cirovic — £16.45

HEXADECIMAL CHRONICLES
by D Lancaster — £12.55

HOW TO DEBUG YOUR PERSONAL COMPUTER
by J Huffman — £5.95

HOW TO PROGRAM AND INTERFACE THE 6800
by A C Staugaard Jnr — £11.15

HOW TO TROUBLESHOOT AND REPAIR MICROCOMPUTERS
by John D Lenk — £5.95

INTIMATE INSTRUCTIONS IN INTEGER BASIC
by B D & G H Blackwood — £5.55

INTRODUCTION TO MICRO-COMPUTERS FOR THE HAM SHACK
by Harry L Helms — £4.15

LOGIC DESIGN OF COMPUTERS
by M P Chinitz — £11.15

MICROCOMPUTER DICTIONARY
by C J Sippl — £11.15

MICROCOMPUTER INTERFACING WITH THE 8255 PPI CHIP
by P F Goldsbrough — £6.95

MICROPROCESSOR SOFTWARE, PROGRAM CONCEPTS AND TECHNIQUES
by G A Streitmatter — £14.20

MINICOMPUTER IN ON-LINE SYSTEMS
by M Healey et al — £17.20

MOSTLY BASIC: APPLE II
by H Berenbon — £9.05

MOSTLY BASIC: PET
by H Berenbon — £9.05

MOSTLY BASIC: TRS-80
by H Berenbon — £9.05

PET BASIC: TRAINING YOUR PET COMPUTER
by R Zamora et al — £9.70

PET GAMES AND RECREATIONS
by M Ogelsby — £9.70

PET INTERFACING
by J M Downey & S M Rogers — £11.85

PET PERSONAL COMPUTER FOR BEGINNERS
by S Dunn — £4.95

PRACTICAL HARDWARE DETAILS OF Z-80, 8080, 8085 & 6800 MICROCOMPUTER SYSTEMS
by J W Coffron — £17.20

PRACTICAL TROUBLESHOOTING TECHNIQUES FOR MICROPROCESSOR SYSTEMS
by J W Coffron — £15.70

A PRIMER ON PASCAL
by R Conway et al — £9.70

PROGRAMMING AND INTERFACING THE 6502 - WITH EXPERIMENTS
by Marvin L De Jong — £11.15

THE S100 AND OTHER MICRO BUSES
by E C Poe & J C Goodwin — £6.95

SMALL BUSINESS COMPUTER SYSTEMS
by P J Best — £8.40

SOFTWARE MAINTENANCE GUIDEBOOK
by R L Glass & R A Noiseux — £17.25

STRUCTURED COBOL, A PRAGMATIC APPROACH
by R T Grauer & M A Crawford — £13.45

SYSTEMS PROGRAMMER'S PROBLEM SOLVER
by W S Mosteller — £14.20

TELEMATIC SOCIETY: A CHALLENGE FOR TOMORROW
by J Martin — £9.70

THE 8080 A BUGBOOK
by Peter R Rony — £9.05

8085A COOKBOOK
by Titus — £9.75

TRS-80 ASSEMBLY LANGUAGE
by H S Howe — £7.45

TRS-80 INTERFACING BOOK 1
by Jonathan A Titus, Christopher Titus & David G Larsen — £7.65

TRS-80 INTERFACING BOOK 2
As for Book 1 — £8.35

USING THE UNIX SYSTEM
by R Gauthier — £14.20

VIDEO/COMPUTERS, HOW TO SELECT, MIX AND OPERATE PERSONAL COMPUTERS & HOME VIDEO SYSTEMS
by C J Sippl & F Dahl — £5.95

YOUR OWN COMPUTER
by M Waite — £5.55

Z-80 MICROCOMPUTER DESIGN PROJECTS
by W Barden Jnr — £9.75

Z-80 MICROCOMPUTER HANDBOOK
by W Barden Jnr — £8.35

Z-80 MICROPROCESSOR PROGRAMMING AND INTERFACING BOOK 1
by Nichols et al — £9.05

Z-80 MICROPROCESSOR PROGRAMMING AND INTERFACING BOOK 2
by Titus et al — £11.15

6502 SOFTWARE DESIGN
by Leo Scanlon — £9.05

6809 MICROCOMPUTER PROGRAMMING AND INTERFACING - with experiments
by A C Staugaard — £10.45

THE 68000: PRINCIPLES AND PROGRAMMING
by L J Scanlon — £10.45

16 BIT MICROPROCESSORS
by Titus et al — £10.45

Make all cheques/postal orders payable (in sterling only!) to R&EW Book Service. Orders should be sent to R&EW Book Service, 200 North Service Road, Brentwood, Essex CM14 4SG. Note: All prices exclusive of postage and packing please add 75p for first book ordered, plus 25p for each additional title on same order.

198 for further details

200 for further details

199 for further details

159 for further details

160 for further details

CLASSIFIED ADS

BARGAIN OFFER

ANNUAL BOUND VOLUMES

RADIO & ELECTRONICS CONSTRUCTOR

Each of these handsome bound volumes contain more than 150 practical articles in their 700-800 pages of text, published in 12 monthly issues of R&EC.

Subjects cover - Amplifiers, Amplifier Ancillaries, Calculators, Electronics, 'In Your Workshop', Receivers, Receiver Ancillaries, Television, Test Equipment etc. etc.

12 monthly issues to July 1974 (Vol. 27), 1975 (Vol. 28), 1976 (Vol. 29), 1977 (Vol. 30).

ONLY £3.95 each inclusive of post and packing.

12 monthly issues to August 1978 (Vol. 31), 1979 (Vol. 32), 1980 (Vol. 33).

*** Volume 33 contains Ian Sinclair's Databus Series — How Microprocessors Work** Selection & Bussing, CPU Registers; Addressing Memory The Accumulator; Inputs & Outputs; Interrupts; Status Register; Signed Binary Arithmetic; Computing Languages.

ONLY £4.95 each inclusive of post and packing.

Please send remittance payable to **'RADIO & ELECTRONICS WORLD'** stating volumes required to:—

DATA PUBLICATIONS
45, Yeading Avenue,
RAYNERS LANE, HARROW
Middlesex HA2 9RL

LOW COST COMPONENTS. .25 W carbon resistors, full length lead, assorted values, 1000 for £4.50, 3000 for £9.95. Mullard 100uF 10 V electrolytics, 50 for £2.95. Post free. Mail order only.
P. Cockram, 20 Spring Gardens, Knowle, Bristol, BS4 2TZ.

1000 asstd. 5% resistors, pre-formed for PCB mounting, £2.50. 50 asstd. full-spec LED's, 3 & 5mm, all colours £3.20. 50 assts. full-spec transistors, BC182/212/237/308 etc. £3.00. 100 asstd. PC mntg electrolytics £3.00. One of each pack £11. All post free. SAE Wholesale list. PC Electronics, 4 Thornhill Romsey Road, Whiteparish, Salisbury, Wilts.

NEW 1982 ACE COMPONENT CATALOGUE. Let your problems be our business. Be certain; have your components delivered quickly and efficiently and get that project working. Send 30p NOW for the easy to use 1982 Catalogue to: Ace Mailtronix, Dept REW3A, Commercial Street, Batley, West Yorks, WF17 5HJ.

PRE-PACKED, screws, nuts, washers, solder tags, studding. Send for price list. A1 Sales PO Box 402, London SW6 6LU

VLF CONVERTER. 10-500 kHz. Palomar Engineers, £45 ONO.
Box No REW13.

COLLECTORS RECORDS. Huge selection 78s, 45s, LPs. Sheet music Valve radios. "Pastimes", 21 Portland Road, London S.E.25. (Saturdays only).

T&J ELECTRONIC COMPONENTS. Quality components, competitive prices. Send 45p cheque or postal order for illustrated catalogue, 98 Burrow Road, Chigwell, Essex IG7 4BH.

FOR SALE: 2 Meter Converter, Telford Communications, G8AEV. £12. 29.5 MHz pre-amplifier, Telford Communications £10. Box No REW14.

DIGITAL WATCH SPARES. All models, batteries, pins, displays, backlights plus publications. Send SAE for full list. Profords, Copners Drive, Holmer Green, Bucks HP15 6SGF.

NEW YAESU FT290R Multimode with portable case. £180. 31 Dryden Crescent, Stafford, ST17 9YH. Delivery arranged.

FOR SALES AND SERVICE of test equipment, including "Avos", "Meggers", 'scopes, signal generators and other general purpose test equipment. G. Butcher. Telephone Harlow (0279) 419118 (Day) 39516 (Evening).

TELEVISION SERVICE SHEET SPECIALISTS. Large selection Japanese and European manuals. Callers 5.30-7pm. SAE for catalogue, and enquiries Sandhurst Publications, 49c Yorktown Road, Sandhurst, Camberley, Surrey.

ARE YOU INTERESTED in the technical aspects of amateur radio? Are you a home brewer of equipment or customiser? Do you wish to participate in a club furthering those aims? YES!! Well join our increasing ranks. We offer discounted kits, components, etc., etc., and a bi-monthly journal with up to sixteen circuits and ideas to build. Join RATEC as an associate member for £3.50 p.a. For further details send s.a.e. to: RATEC, 17 Laleham Green, Bramhall, Stockport, SK73LJ.

BI-KITS STEREO AMPLIFIER CHASSIS, cabinet, and two 7 inch speaker kits to match £20 ONO.
Box No REW15.

PCB's. Layouts worked out. Masters drawn up. Test boards made. Printing, etching, drilling (11 sizes) and cutting. All or part process, 1-1000 units. Send details/copy masters/samples for costing. Also graphic artwork and screen printing services including stickers. G.N. Slee, (R&EW) 78 Derry Grove, Thurnscoe, Rotherham, South Yorkshire, S63 OTP. Telephone: 0709-895265.

INTERFACE MODULES. Switch 240 v.a.c. at 6 amps directly from TTL or from CMOS with simple extra circuit. Data Provided. Size 40 x 40 x 20mm. £4.75 Data 25p. C. Wright, 5 Carey Road, Towcester, Northants., NN12 7BG.

MASTER OSCILLATOR, M1-19467-A. £10.00 plus carriage. Box No REW16.

VINTAGE RADIOS, TVs, valves and service sheets. Vintage Wireless Co., 64 Broad Street, Staple Hill, Bristol. S.A.E. newsheet.

144 MHz POWER AMPLIFIERS. Heathkit HA201-10W, ETI 40W amplifier. Can be used together or separately. Both cased. £40 or £22 each. Telephone 01-769 0260.

QUALITY PVC FLEXES 7/0.2 to 50/0.25. Also PTFE and low noise. Low Prices — 100m 16/0.2 £3.50. Phone (0634) 666759.

CB SPARES - CHEAP. TA7205P-I/C: 159p 5 x 759p. 2SC2092 FM-AM-SSB RF-PA. Replaces most PA types 1 x 149p, 10 x 1359p. Add 50p post. SAE lists. Free CB Fault-Finder. R. Withers Communications, 245 Stourbridge Road, Halesowen, West Midlands, B63 3QU. Phone: 021-550-9324 or 021-471-1764. Mail Order only.

HB9CV Mk IV 2 mtr. 2E beam ant. New Design. New low price. Over 1500 sold so far. Only £6.99 plus P&P. R. Withers Communications, 245 Stourbridge Road, Halesowen, West Midlands, B63 3QU. SAE for more details or Telephone 021-550-9324.

CLASSIFIED ADS

TEST EQUIPMENT. UHF Pattern Generator 5 patterns £17.25. Colour Bar Generator £49.50. In circuit transistor tester £14.25. Capacitance meter for use with multimeter £7.75. SAE for further details if required. C.M.J. Electronics, 52/54 Worcester Street, Wolverhampton, WV2 4LL.

RTTY/CW READER. Decode the audio tones from your receiver with this easy to build board which automatically displays incoming code on a bright 8-character alphanumeric LED display. 5 to 30 wpm morse, 45 and 50 baud RTTY plus morse keying practice. Available only as kit at £68.50 (excluding case). Display expandable to 12 or 16 characters. PCB and chips available separately — SAE prices. Construction data £3.95 + SAE. N. MacRitchie (Micros), 100 Drakies Avenue, Inverness, IV2 3SD.

YAESU FRG-7 FOR SALE. Good condition. £120 ONO. Dave Bobbett, Houchins Farm Flat, Coggeshall, Colchester, Essex.

FACSIMILE MACHINE Muirhead 180 rpm, 75 lines/inch. Easily converted meteostat pictures. £80. Phone: Erith 37033.

U-PIK RESISTOR PAKS. .25W 5% carbon film resistors, 250 £2.50, 500 £4.50, 1000 £8.50, 1500 £12.25, 2000 £15.95. You pick values, any mix from 61 values between 10 ohms and 1 Mohms. E12 series. D. Hooker, Pennywood, Clarke Road, Greatstone, Kent, TN28 8PD.

TR2300. 2m FM transportable, with case and 10W booster amp., 'rubber duck'... £170 ONO. Phone (0277) 822720. G3XDG.

THE RADIO AMATEUR INVALID & BLIND CLUB is a well established Society providing facilities for the physically handicapped to enjoy the hobby of Amateur Radio. Please become a supporter of this worthy cause. Details from the Hon Secretary, Mrs R E Woolley 9 Rannoch Court, Adelaide Road, Surbiton, Surrey KT6 4TE.

INTERESTED IN RTTY? You should find the **RTTY journal** of interest. Published in California, USA, it gives a wide outlook on the current RTTY scene. RTTY-DX; DXCC Honour Roll; VHF RTTY News; and up to date technical articles are included. Specimen copies 35p from The Subscription Manager, RTTY Journal, 21 Romany Road, Oulton Broad, Lowestoft, Suffolk NR32 3PJ.

INTERESTED IN OSCAR? Then join AMSAT-UK. Newsletters, OSCAR NEWS Journal, prediction charts etc. Details of membership from: Ron Broadbent, G3AAJ, 94 Herongate Road, Wanstead Park, London E12 5EQ

JOIN THE INTERNATIONAL SW LEAGUE. Free services to members including QSL Bureau, Amateur and Broadcast Translation, Technical and Identification Dept, - both Broadcast and Fixed Station, DX Certificates, contests and activities for the SEL and transmitting members. Monthly magazine *Monitor* containing articles of general interest to Broadcast and Amateur SWLs, Transmitter Section and League affairs, etc. League supplies such as badges, headed notepaper and envelopes, QSL cards, etc. are available at reasonable cost. Send for league particulars. Membership including monthly magazine etc., £9.00 per annum UK overseas rates on request, Secretary, 88, The Barley Lea, Coventry, W. Midlands

SMALL ADVERTISEMENTS

Advertisements must be prepaid and all copy must be received by the 4th of the month for insertion in the following month's issue.

The Publishers cannot be held liable in any way for printing errors or omissions, nor can they accept responsibility for the **bona fides** of Advertisers.

Where advertisements offer any equipment of a transmitting nature, readers are reminded that a licence is normally required. Replies to Box Numbers should be addressed to: Box No..., **Radio & Electronics World, 45 Yeading Avenue, Rayners Lane, Harrow, Middlesex**

CLASSIFIED ADVERTISEMENT ORDER FORM — PLEASE COMPLETE BELOW

Write Your Ad. Below In the boxes - one word per box please. Underline words required in Bold type. Your name, address, and/or telephone number, if to appear, must be included in the boxes and must be paid for. Telephone numbers count as two words. Please use BLDCK CAPITALS.

—Advertisements are accepted on the understanding that the details stated comply with the conditions of the Trade Description Act,1968.
—Whilst every care is taken to ensure accuracy, we do not accept liability for inaccuracies should they occur.
—Cancellations must be notified by telephone or in writing by the 6th of the month preceding publication.

			£2.00
£2.04	£2.16	£2.28	£2.40
£2.52	£2.64	£2.76	£2.88
£3.00	£3.12	£3.24	£3.36
£3.48	£3.60	£3.72	£3.84
£3.96	£4.08	£4.20	£4.32

RATES

All cheques should be made payable to Radio & Electronics World.

12p per word - minimum charge £2.00

Tick this box if you require a box number charged at 30p ☐

I enclose remittance of £ : p

NAME .... ADDRESS ....

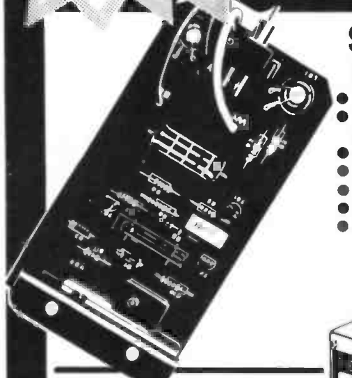
.... POSTCODE ....

Post your completed form to RADIO & ELECTRONICS WORLD, Classified Ads., 45, Yeading Avenue, Rayners Lane HARROW, Middlesex.

Advertisers' Index

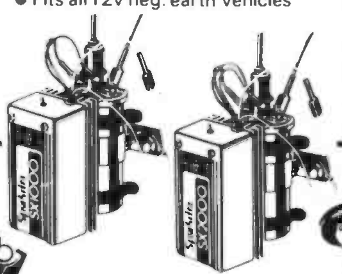
Step-by-step fully illustrated assembly and fitting instructions are included together with circuit descriptions. Highest quality components are used throughout.

Sparkrite
BRANDLEADING ELECTRONICS
NOW AVAILABLE IN KIT FORM



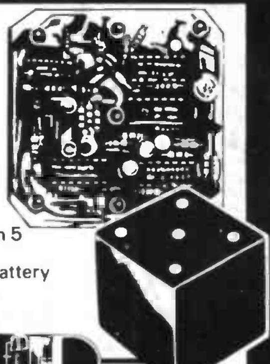
SX1000
Electronic Ignition

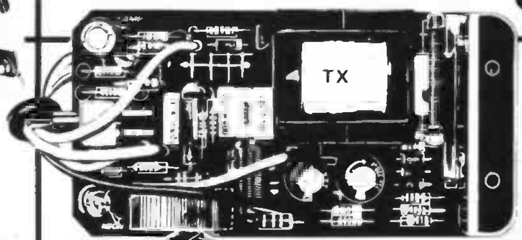
- Inductive Discharge
- Extended coil energy storage circuit
- Contact breaker driven
- Three position changeover switch
- Over 65 components to assemble
- Patented clip-to-coil fitting
- Fits all 12v neg. earth vehicles

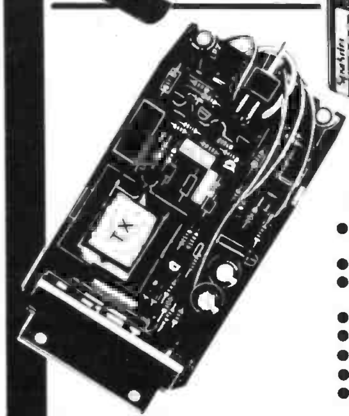


MAGIDICE
Electronic Dice

- Not an auto item but great fun for the family
- Total random selection
- Triggered by waving of hand over dice
- Bleeps and flashes during a 4 second tumble sequence
- Throw displayed for 10 seconds
- Auto display of last throw 1 second in 5
- Muting and Off switch on base
- Hours of continuous use from PP7 battery
- Over 100 components to assemble

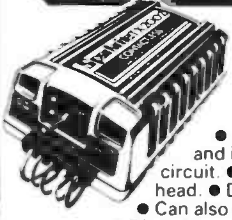






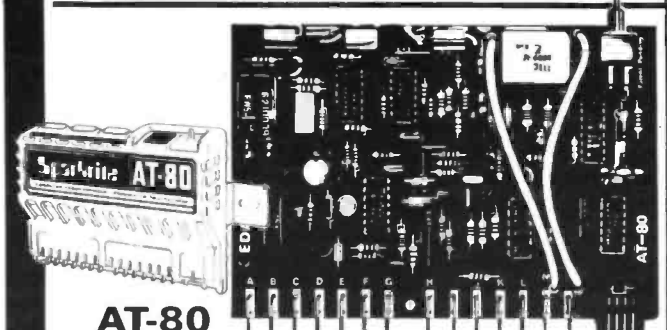
SX2000
Electronic Ignition

- The brandleading system on the market today
- Unique Reactive Discharge
- Combined Inductive and Capacitive Discharge
- Contact breaker driven
- Three position changeover switch
- Over 130 components to assemble
- Patented clip-to-coil fitting
- Fits all 12v neg. earth vehicles



TX2002
Electronic Ignition

● The ultimate system ● Switchable contactless. ● Three position switch with Auxiliary back-up inductive circuit. ● Reactive Discharge. Combined capacitive and inductive. ● Extended coil energy storage circuit. ● Magnetic contactless distributor trigger-head. ● Distributor triggerhead adaptors included. ● Can also be triggered by existing contact breakers. ● Die cast waterproof case with clip-to-coil fitting ● Fits majority of 4 and 6 cylinder 12v neg. earth vehicles. ● Over 150 components to assemble



AT-80
Electronic Car Security System

- Arms doors, boot, bonnet and has security loop to protect fog/spot lamps, radio/tape, CB equipment
- Programmable personal code entry system
- Armed and disarmed from outside vehicle using a special magnetic key fob against a windscreen sensor pad adhered to the inside of the screen ● Fits all 12V neg earth vehicles
- Over 250 components to assemble

VOYAGER Car Drive Computer

● A most sophisticated accessory. ● Utilises a single chip mask programmed microprocessor incorporating a unique programme designed by EDA Sparkrite Ltd. ● Affords 12 functions centred on Fuel, Speed, Distance and Time. ● Visual and Audible alarms warning of Excess Speed, Frost/Ice, Lights-left-on. ● Facility to operate LOG and TRIP functions independently or synchronously. ● Large 10mm high 400ft-L fluorescent display with auto intensity. ● Unique speed and fuel transducers giving a programmed accuracy of + or − 1%. ● Large LOG & TRIP memories. 2,000 miles. 180 gallons. 100 hours. ● Full Imperial and Metric calibrations. ● Over 300 components to assemble. A real challenge for the electronics enthusiast!

All EDA-SPARKRITE products and designs are fully covered by one or more World Patents.

EDA SPARKRITE LIMITED 82 Bath Street, Walsall, West Midlands, WS1 3DE England. Tel: (0922) 614791

	SELF ASSEMBLY KIT	READY BUILT UNITS
SX 1000	£12.95	£25.90
SX 2000	£19.95	£39.90
TX 2002	£29.95	£59.90
AT. 80	£29.95	£59.90
VOYAGER	£59.95	£119.90
MAGIDICE	£ 9.95	£19.90

PRICES INC. VAT. POSTAGE & PACKING

Please allow 28 days for delivery

NAME ______ REW/6/82

ADDRESS ______

I ENCLOSE CHEQUE(S)/POSTAL ORDERS FOR

£ ______ KIT REF. ______

CHEQUE NO. ______

24 hr. Answerphone

PHONE YOUR ORDER WITH ACCESS/BARCLAYCARD

SEND ONLY SAE IF BROCHURE IS REQUIRED

BRANDLEADING BRITISH ELECTRONICS

CUT OUT THE COUPON NOW!

172 for further details

DISCOVER

'The World of Radio & Electronics'

The third issue of Ambit's new style concise *'price-on-the-page'* component catalogue is available now. We have listened carefully to the comments and suggestions arising from the first two issues, and are pleased to say that we have now managed to incorporate many of the aspects of stock and service policy that have been requested.

New ranges include:

'Fair-Rite' ferrite cores: toroids, baluns, tube cores, multihole ferrite beads etc., for HF/VHF RF designs. The Z8-TBDS and support systems. A new range of battery chargers, more instruments, more tools, more books, more components.

Prices have changed — in both directions, although mainly reduced. A further 3 £1 discount vouchers are included, making the initial investment of 70p immediately returnable with interest.

Thanks to a substantial expansion of the staff, orders are being despatched within 24 hours of receipt — and a new guaranteed *'Blue Chip'* service is available if you're in a panic at 4.30pm on a Friday.

It all adds up to *more* of what you want, and *less* of what you don't want.

Available at your newsagent for **70p** — or direct from:

Ambit International, 200 North Service Road, Brentwood, Essex CM14 4SG