RADIO & ELECTRONICS CONSTRUCTOR

NOVEMBER 1980
60p

TREMOLO MODULATION UNIT

EASILY MADE CIRCUIT ADDS BRILLIANCE TO GUITARS, ORGANS AND ELECTRONIC MUSIC.

INDUCTIVE COUPLING TO M.W. RADIO – NO WIRES.

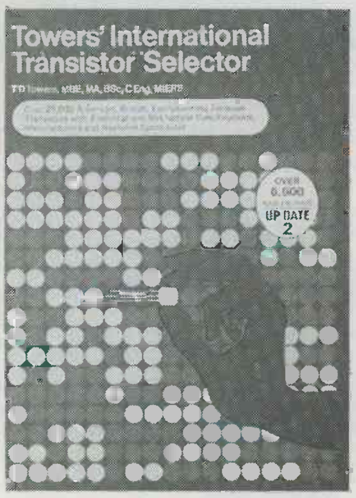
COIL-COUPLED S-W-CONVERTER

19 TO 67 METRES

DIRECT SUPPLY SERVICE TO READERS

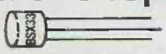
TOWERS INTERNATIONAL TRANSISTOR SELECTOR

(NEW REVISED EDITION)



This is dead! 

Would this replace it?



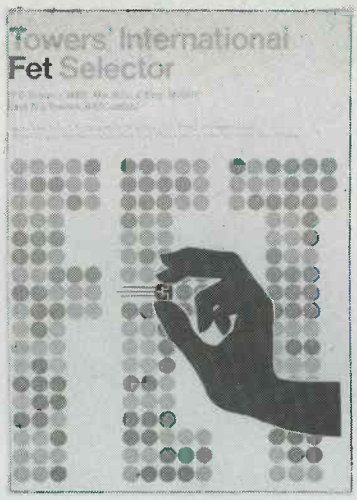
If it takes you longer than 1 minute to find out all about these transistors then you need a copy of TOWER'S INTERNATIONAL TRANSISTOR SELECTOR. It's one of the most useful working books you will be offered this year. And probably the cheapest!

In it, you will find a really international selection of 13,000 transistor types — British, Continental European, American and Japanese. And we think that they will solve 90% of your transistor enquiries.

Current and widely used obsolete types were carefully selected and arranged in Numero-Alphabetical order by an author who was uniquely qualified to do the job. With his compendium, all you need to know is the type number and you can learn all about a transistor's specification; who made it and where to contact them; or what to use to replace it.

Price **£10.35** inc P&P

TOWERS INTERNATIONAL FET SELECTOR



If you deal with field effect transistors, or fet's — whether as a student, a hobbyist, a circuit engineer, a buyer, a teacher or a serviceman — you often want data on a specific fet of which you know only the type number.

Specifications apart, you may be even more interested in where you can get the device in question. And perhaps more important still (particularly with obsolete devices), you may want guidance on a readily available possible substitute.

This fet compendium, a comprehensive tabulation of basic specification, offers information on:

1. Ratings
2. Characteristics
3. Case details
4. Terminal identifications
5. Applications use
6. Manufacturers
7. Substitution equivalents (both European and American)

The many fet's covered in this compendium are most of the more common current and widely-used obsolete types.

It is international in scope and covers fet's not only from the USA and Continental Europe, but also from the United Kingdom and the Far East (Japan).

Price **£4.00** inc P&P

(Please allow 21 days for delivery)

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by T. D. Towers
MBE, MA, BSc, C Eng, MIERE
£10.35
inc. post and packing

To:—DATA PUBLICATIONS LTD.
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LONDON W9 1SN

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RADIO & ELECTRONICS CONSTRUCTOR

NOVEMBER 1980
Volume 34 No. 3

Published Monthly

First published in 1947

Incorporating The Radio Amateur

Editorial and Advertising Offices
57 MAIDA VALE LONDON W9 1SN

Telephone
01-286 6141

Telegrams
Databux, London

Annual Subscription: £9.50, Eire and Overseas £10.50 (U.S.A. and Canada $25.00) including postage. Remittances should be made payable to "Data Publications Ltd". Overseas readers, please pay by cheque or International Money Order.

Technical Queries. We regret that we are unable to answer queries other than those arising from articles appearing in this magazine nor can we advise on modifications to equipment described. We regret that queries cannot be answered over the telephone, they must be submitted in writing and accompanied by a stamped addressed envelope for reply.

Correspondence should be addressed to the Editor, Advertising Manager, Subscription Manager or the Publishers as appropriate.

Opinions expressed by contributors are not necessarily those of the Editor or proprietors.

Production – Web Offset.

Published in Great Britain by the Proprietors and Publishers, Data Publications Ltd, 57 Maida Vale, London W9 1SN.

The *Radio & Electronics Constructor* is printed by LSG Printers, Portland Street, Lincoln.

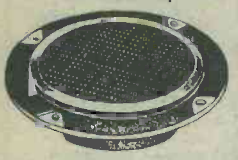
OUR NEXT ISSUE WILL BE PUBLISHED IN LATTER PART OF NOVEMBER

MOTORS
1.5-6VDC Model Motors **22p.** Sub. Min. 'Big Inch' 115VAC 3rpm Motors **32p.** 6 volt standard cassette motors new **£1.20.** 8 track 12V Replacement Motors **55p.** Cassette Motors 5-8VDC ex. equip. **70p.** Geared Mains Motors (240V) 2.5 rpm **75p.** 115VAC 4rpm Geared Motors **95p.**

SEMICONDUCTORS
LM340 **80p.** BY103 **10p.** 2N5062 100V 800mA SCR **18p.** BX504 Opto Isolator **25p.** CA3130 **95p.** TBA800 **50p.** 741 **22p.** 741S **35p.** 723 **35p.** NE555 **24p.** 2N3773 **£1.70.** AD161/2 **70p.** ZN414 **75p.** BD238 **28p.** BD438 **28p.** IN4005 **10** for **35p.** TIL305 alpha numeric displays **£2.50.** TIL209 Red Leds 10 for **75p.** Man3A 3mm Led Displays **40p.**

PROJECT BOXES
Sturdy ABS black plastic boxes with brass inserts and lid. 75 x 56 x 35mm **65p.** 95 x 71 x 35mm **75p.** 115 x 95 x 37mm **85p.**

MOTOROLA PIEZO CERAMIC TWEETERS
No crossover required



2.5" Direct Radiating Tweeter, maximum rating 25 volts R.M.S. 100 watts across 8 ohms. Freq. range **3.8kHz-28kHz, £3.65**

TOOL SALE
Small side cutters 5" insulated handles **£1.** Radio-pliers, snipe nosed insulated handles **£1.** Heavy duty pliers insulated handles **£1.10.** Draper side cutters spring loaded **£1.**

SWIVEL BASE VICES
(with anvil)

With anvil, bench clamp, and plated parts, body smooth, lacquered finish. Jaw width 2", jaw opening 2¼" **£5.55** *D* **£1.20 P&P.**

MORSE KEYS
Beginners practice key **£1.05.** All metal full adjustable type. **£2.60**

MINIATURE LEVEL METERS
1 Centre Zero 17 x 17mm **75p.** 2 (scaled 0-10) 28 x 25mm **75p.** 3 Grundig 40 x 27mm **£1.25.**

JVC NIVICO STEREO CASSETTE MECHANISM. Music centre type. Rev. counter, remote operation **£13.50 and £1.00 p&p.**

JUMPER TEST LEAD SETS
10 pairs of leads with various coloured croc clips each end (20 clips) **90p per set.**

TRANSFORMERS
All 240VAC Primary (postage per transformer is shown after price). MINIATURE RANGE: 6-0-6V 100mA, 9-0-9V 75mA and 12-0-12V 50mA **all 79p** each **(15p).** 0-6, 0-6V, 280mA **£1.20 (20p).** 6V 500mA **£1.20 (15p).** 12V 2 amp **£2.75 (45p).** 15-0-15V 3 amp Transformer at **£2.85 (54p).** 30-0-30V 1 amp **£2.85 (54p).** 20-0-20V 2 amp **£3.65 (54p).** 0-12-15-20-24-30V 2 amp **£4.75 (54p).** 20V 2.5 amp **£2.45 (54p).**

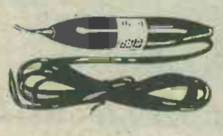
TRIAC/XENON PULSE TRANSFORMERS
1:1 (gpo style) **30p.** 1:1 plus 1 sub. min. pcb mounting type **60p each.**

MICROPHONES
Min. tie pin. Omni, uses deaf aid battery (supplied), **£4.95,** ECM105 low cost condenser, Omni, 600 ohms, on/off switch, standard jack plug, **£2.95.** EM507 Condenser, uni, 600 ohms, 30-18kHz., highly polished metal body **£7.92.** DYNAMIC stick microphone dual imp., 600 ohms or 20K, 70-kHz., attractive black metal body **£7.75.** EM506 dual impedance condenser microphone 600 ohms or 50K, heavy chromed copper body, **£12.95** CASSETTE replacement microphone with 2.5/3.5 plugs **£1.35.** INSERT Crystal replacement 35 x 10mm **40p.** GRUNDIG electric inserts with FET pre-amp, 3-6VDC operation **£1.00.**

LIGHT DIMMER
240VAC 800 watts max. wall mounting, has built in photo cell for automatic swich on when dark **£4.50**

RIBBON CABLE
8 way single strand miniature **22p per metre.**

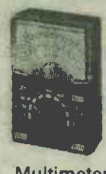
SPECIAL OFFER TAPE HEAD DEMAGNETIZER



240VAC with curved probe suitable for reel to reel or cassette machines, **£1.95.**

STEREO FM/GRAM TUNER AMPLIFIER CHASSIS, VHF and AM. Bass, treble and volume controls, Gram. 8-track inputs, headphone output jack, 3 watts per channel with power supply. **£14.95 and £1.20 p&p** (CCT supplied).

MULTIMETER BARGAINS



Pocket Multimeter, 1,000 opv sensitivity. Ranges 1KV AC/DC Volts, 150ma DC current, resistance 0-2.5K, 0-100K, **£4.50**

20,000 opv., 1,000 volts AC/DC, DC current to 500ma, 5 ranges, resistance 4 ranges to 6 meg. Mirror scale, carrying handle, **£9.75**

2,000 OPV. 250 volts AC/DC., 0-100ma DC current, resistance to Meg in 2 ranges, mirror scale **£5.75p.**

40kHz Transducers. Rec/Sender **£3.50 pair.**

TELEPHONE PICK UP COIL
Sucker type with lead and 3.5mm plug **62p.**

Hand drill, double pinion with machine cut gears, ⁵/₁₆", only **£2.75p** plus 50p p&p.

Dalo 33PC Etch Resist printed circuit maker pen, with spare tip, 79p.

TERMS:
Cash with order (Official Orders welcomed from colleges etc). 30p postage please unless otherwise shown. VAT inclusive.

S.A.E. for illustrated lists

TMK500 MULTIMETER

TMK500 30,000 ohms per volt. IKV AC/DC., D.C. Current to 12 amps. Resistance to 60 meg in 4 ranges, mirror scale, with built in buzzer for continuity testing **£20.95**

YN360TR MULTIMETER

YN360 M/Meter. 20,000 ohms per volt. IKV AC/DC volts, 250ma dc current, 4 resistance ranges to 20meg, also has built in transistor tester with leakage and gain ranges. **£12.50**

CRIMPING TOOL
Combination type for crimping red blue and yellow terminations also incorporates a wire stripper (6 gauges) and wire cutter, with insultated handles only **£2.30.**

POWER SUPPLIES
SWITCHED TYPE, plugs into 13 amp socket, has 3-4.5-6-7.5 and 9 volt DC out at either 100 or 40 0mA, switchable **£3.45.** HC244R STABLISED SUPPLY, 3-6-7.5-9 volts DC out at 400mA max., with on/off switch, polarity reversing switch and voltage selector switch, fully regulated to supply exact voltage from no load to max. current **£4.95.**

AMPHENOL CONNECTORS
(PL259) PLUGS **47p.** Chassis sockets **42p.** Elbows PL259/SO239 **90p.** Double in line male connector (2XPL259) **65p.** Plug reducers **13p.** PL259 Dummy load, 52 ohms 1 watt with indicator bulb **95p.**

Disco Strobe lights, adjustable speed, 80 joules, **£22.50p.**

TOOLS
SOLDER SUCKER, plunger type, high suction, teflon nozzle, **£4.99** (spare nozzles **69p each**).
All Antex irons still at pre increase prices, order now as new stock will be going up next month.
Antex Model C 15 watt soldering irons, 240VAC **£3.95**
Antex Model CX 17 watt soldering irons, 240VAC **£3.95**
Antex Model X25 25 watt soldering irons, 240VAC **£3.95**
ANTEX ST3 iron stands, suits all above models **£1.65**
Antex heat shunts **12p** each.
Servisol Solder Mop **50p** each.
Neon Tester Screwdrivers 8" long **59p each.**
Miyarna IC test clips 16 pin **£1.95**

SWITCHES
Sub. miniature toggles: SPST (8 x 5 x 7mm) **42p.** DPDT (8 x 7 x 7mm) **55p.** DPDT centre off 12 x 11 x 9mm **77p.** PUSH SWITCHES, 16mm x 6mm, red top, push to make **14p each,** push to break version (black top) **16p each.**

Mercury (Tilt) switches, 1" x ³/₈" cylinder **35p each.**

RES. SUB BOX

Resistance Substitution Box. Swivelling disc provides close tolerance resistors of 36 values from 5 ohms to 4 meg. **£3.95.**

Signal Generator. Ranges 250Hz-100MHz in 6 Bands, 100MHz-300MHz (harmonics) internal modulator at 100Hz. R.F., output Max. 0.1vRMS. All transistorised unit with calibrating device. 220-240VAC operation, **£48.95.**

TAPE HEADS
Mono cassette **£1.75.** Stereo cassette **£3.90.** Standard 8 track stereo **£1.95** BSR MN1330 ½ track **50p.** BSR SRP90 ¼ track **£1.95.** TD10 tape head assembly — 2 heads both ½ track R/P with built in erase, mounted on bracket **£1.20**

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TEL: 0920 3182
TELEX: 817861

EXPERIMENTOR BREADBOARDS
CONTINENTAL SPECIALITIES CORPORATION
FROM CSC

No soldering breadboards. Simply plug components in and out of letter number identified. Nickel-silver contact holes. Start small and simply snap-lock boards together to build a breadboard of any size.
All EXP Breadboards have two bus-bars as an integral part of the board. If you need more than two buses, simply snap on 4 more bus-bars with the aid of an EXP 48.

EXP 325 The ideal breadboard for 1 chip circuits. Accepts 8, 14, 16 and up to 22-pin IC's — ONLY £1.84 — 48mm (1.9")

EXP 350 270 contact points with two 20-point bus-bars. ONLY £3.62 — 91mm (3.6")

EXP 300 550 contacts with two 40-point bus-bars. ONLY £6.61 — 152mm (6.0")

EXP 650 For Micro-processors. ONLY £4.14 — 91mm (3.6")

EXP 48 ONLY £2.65 — 152mm (6.0")

EXP 600 As EXP 300 but accepts 24 pin DIL and over. ONLY £7.25 — 152mm (6.0")

All EXP 300 Breadboards mix and match with 600 series.

ANTEX IRONS

1943	15 watt quality soldering iron with 3/32" bit	£5.12
1947	Replacement element for 1943	£2.33
1944	Iron coated bit 3/32" for 1943	£0.58
1945	Iron coated bit 1/8" for 1943	£0.58
1946	Iron coated bit 3/16" for 1943	£0.58
1948	18 watt iron with iron coated bit	£5.12
1952	Replacement element for 1948	£2.22
1949	Iron coated bit 3/32" for 1948	£0.58
1950	Iron coated bit 1/8" for 1948	£0.58
1951	Iron coated bit 3/16" for 1948	£0.58
1931	X25 25 watt iron, ceramic shaft and another shaft of stainless steel to ensure strength	£6.12
1935	Replacement element for 1931	£2.05
1932	Iron coated bit 1/8" for 1931	£0.58
1933	Iron coated bit 2/16" for 1931	£0.58
1934	Iron coated bit 3/32" for 1931	£0.58
1953	SK1 soldering Kit – contains 15 watt soldering iron with 3/16" bit plus two spare bits, a reel of solder, heat-sink and a booklet 'How to Solder'	£7.28
1939	ST3 iron stand made from high grade bakelite chrome plated steel spring, suit all models – Includes accommodation for six bits and two sponges to keep the iron bits clean	£1.89
1724	Model MLX as X25 iron but 12 volts	£5.59

CASES AND BOXES

VERO plastic case box. These boxes consist of top and bottom sections which include fixings points for horizontal mounting PC boards/chassis plates, the two sections are held together by four screws which enter through the base and are concealed by plastic feet.

No.	Length	Width	Height	Price
170	140mm	40mm	205mm	£4.35
171	140mm	75mm	205mm	£4.85
172	140mm	110mm	205mm	£6.30

INSTRUMENT CASES in two sections vinyl covered top and sides, aluminium bottom, front and back.

No.	Length	Width	Height	Price
155	8in	5½in	2in	£2.01
156	11in	6in	3in	£3.10
157	6in	4¾in	1¾in	£1.93
158	9in	5¼in	2½in	£2.59

ALUMINIUM BOXES made from bright alli, folded construction each box complete with half inch deep lid and screws.

No.	Length	Width	Height	Price
159	5½in	2¼in	1½in	£0.98
160	4in	4in	1½in	£0.98
161	4in	2¼in	1½in	£0.98
162	5¼in	4in	1½in	£1.10
163	4in	2½in	2in	£0.98
164	3in	2in	1in	£0.67
165	7in	5in	2½in	£1.54
166	8in	6in	3in	£1.98
167	6in	4in	2in	£1.32

SLOPE front aluminium boxes with black vinyl base and sides & aluminium back, top & front – strong construction easily accessible.

169	2¹/₈in	5⁵/₈in	2¾in	12in	3½in	8in	£5.45
168	2⁵/₈in	7½in	4in	16in	4½in	11in	£8.21

AUDIO MODULES

AMPLIFIERS

AL10	3 watt Audio Amplifier Module 22-32v supply	£3.63
AL20	5 watt Audio Amplifier Module 22-32v supply	£4.11
AL30A	7-10 watt Audio Amplifier Module 22-32v supply	£4.78
AL60	15-25 watt Audio Amplifier Module 30-50v supply	£5.92
AL80	35 watt Audio Amplifier Module 40-60v supply	£9.28
AL120	50 watt Audio Amplifier Module 50-70v supply	£15.11
AL250	125 watt Audio Amplifier Module 50-80v supply	£22.54

STEREO PRE-AMPLIFIERS

PA12	Supply voltage 22-32v input sensitivity 300mv suit AL10/AL20/AL30	£9.83
PA100	Supply voltage 24-36v inputs – Tape, Tuner, Mag P.U. Suit AL60/AL80	£20.30
PA200	Supply voltage 35-70v inputs:– Tape, Tuner, Mag P.U., Suit: AL80/AL120/AL250	£20.98

MONO PRE-AMPLIFIERS

MM100	Supply voltage 40-65v inputs: Mag. P.U., Tape Microphone Max. output 500mv	£14.29
MM100G	Supply voltage 40-65v inputs: 2 Guitars, Microphones Max. output 500mv	£14.29

POWER SUPPLIES

PS12	24v Supply suit 2 - AL10, 2 - AL20, 2 - AL30 & PA12/S.450	£1.90
SPM80	33v Stabilised supply – suit 2 - AL60, PA100 to 15 watts	£5.57
SPM120/45	45v Stabilised supply – suit 2 - AL60, PA100 to 25 watts	£7.34
SPM120/55	55v Stabilised supply – suit 2 - AL80, PA200	£7.34
SPM120/65	65v Stabilised supply – suit 2 - AL120, PA200, 1 - AL250, PA200	£7.34
SG30	15-0 15 Stabilised power supply for 2 - GE100MKII	£4.37

MISCELLANEOUS

MPA30	Stereo Magnetic Cartridge Pre-Amplifier Input 3.5mv Output 100mv	£3.76
S.450	Stereo FM Tuner Supply Voltage 20-30v – Vericap tuned	£29.39
STEREO30	Complete 7 watt per Channel Stereo Amplifier Board – Includes amps, pre-amp. power supply, front panel, knobs etc. – requires 2050 Transformer	£24.25
BP124	5 watt 12v max – Siren Alarm Module	£4.43
GE100MkII	10 channel mono-graphic equaliser complete with sliders and knobs	£26.46
VPS30	Variable regulated stabilised power supply 2-30v 0-2amps	£8.74

TRANSFORMERS

			P&P
2034	1.7 amp 35v suit SPM80	£6.21	£1.21
2035	2 amp 55v	£7.30	£1.47
2036	750mA 17v suit PS12	£3.68	
2040	1.5 amp 0-45v-55v suit SPM120/45, SPM120/55v	£5.98	£1.21
2041	2 amp 0-55v-65v suit SPM120/55, SPM120/65v	£7.82	£1.47
2050	1 amp 0-20v suit Stereo 30	£3.74	£0.75
1725	150mA 15-0-15v suit SG30	£2.04	

ACCESSORIES

139	Teak Cabinet suit Stereo 30, 320 - 235 - 81mm	£8.05
140	Teak Cabinet suit STA 15 425 - 290 - 95mm	£9.78
FP100	Front Panel for PA100 & PA200	£2.07
BP100	Back Panel for PA100 & PA200	£1.84
GE100FP	Front Panel for one GE100MKII	£2.05
2240	Kit of parts including Teak Cabinet, chassis sockets, knobs to build 15 watt stereo amplifier (Does not include modules)	£22.94

SPECIAL OFFERS

MINIDRILL 12v hand held battery-operated mini drill, 7,500 r.p.m. Collet chuck. Ideal for drilling printed circuits or model making. No. 1402. Complete with 2 drills .1 and .15 — £6.33

TRANSFORMER 240v Primary 0-20v at 2A Secondary. By removing 5 turns for each volt from the secondary winding, any voltage up to 20v at 2A is obtainable. Ideal for the experimenter. No. 2042. — £150 + 86p P & P

ANTEX MLX Soldering Iron. Sturdy 25 watt iron complete with: 4¼ metres of 2 core cable. Works off a 12 volt battery. Ideal for Car, Boat, Caravan, No. 1724. — £5.29

METAL FOIL CAPACITOR PAKS

16204 – Containing 50 metal foil capacitor like Mullard C280 series. Mixed values ranging for 01uf – 2.2uf. Complete with identification sheet — £1.38

TRIACS

2 amp TO5 case

volts	No.	Price
100	TR12A/100	£0.36
200	TR12A/200	£0.59
400	TR12A/400	£0.82

6 amp

volts	No.	Price
100	TR16A/100	£0.59
200	TR16A/200	£0.70
400	TR16A/400	£0.88

10 amp

volts	No.	Price
100	TR110A/100	£0.88
200	TR110A/200	£1.06
400	TR110A/400	£1.29

10 amp

volts	No.	Price
400	TR110A/400P	£1.29

DIACS
BR100 £0.23 D32 £0.23

SILICON RECTIFIERS

200mA

IS920 50V	£0.07
IS921 100V	£0.08
IS922 150V	£0.09
IS923 200V	£0.10
IS924 300V	£0.12

1 Amp

IN4001 50V	£0.05½
IN4002 100V	£0.06
IN4003 200V	£0.07
IN4004 400V	£0.08
IN4005 600V	£0.09
IN4006 800V	£0.10
IN4007 1000V	£0.12

1.5 Amp

IS015 50V	£0.10
IS020 100V	£0.12
IS021 200V	£0.13
IS023 400V	£0.15
IS025 600V	£0.16
IS027 800V	£0.18
IS029 1000V	£0.23
IS031 1200V	£0.29

60 Amp

IS70/50 50V	£0.86
IS70/100 100V	£0.97
IS70/200 200V	£1.38
IS70/400 400V	£2.01
IS70/600 600V	£2.59
IS70/800 800V	£2.88
IS70/1000 1000V	£3.45

3 Amp

IN5400 50V	£0.16
IN5401 100V	£0.17
IN5402 200V	£0.18
IN5404 400V	£0.20
IN5406 600V	£0.24
IN5407 800V	£0.29
IN5408 1000V	£0.35

10 Amp

IS10/50 50V	£0.22
IS10/100 100V	£0.24
IS10/200 200V	£0.26
IS10/400 400V	£0.40
IS10/600 600V	£0.48
IS10/800 800V	£0.59
IS10/1000 1000V	£0.69
IS10/1200 1200V	£0.79

30 Amp

IS30/50 50V	£0.64
IS30/100 100V	£0.79
IS30/200 200V	£1.07
IS30/400 400V	£1.44
IS30/600 600V	£2.02
IS30/800 800V	£2.33
IS30/1000 1000V	£2.66
IS30/1200 1200V	£3.31

THYRISTORS

600ma TO 18 Case

Volts No.	Price
10 THY600/10	£0.17
20 THY600/20	£0.18
30 THY600/30	£0.23
50 THY600/50	£0.25
100 THY600/100	£0.29
200 THY600/200	£0.44
400 THY600/400	£0.51

1 amp TO 66 Case

Volts No.	Price
50 THY1A/50	£0.30
100 THY1A/100	£0.32
200 THY1A/200	£0.37
400 THY1A/400	£0.44
600 THY1A/600	£0.52
800 THY1A/800	£0.67

3 amp TO 66 Case

Volts No.	Price
50 THY3A/50	£0.32
100 THY3A/100	£0.35
200 THY3A/200	£0.38
400 THY3A/400	£0.48
600 THY3A/600	£0.58
800 THY3A/800	£0.75

5 amp TO 66 Case

Volts No.	Price
50 THY5A/50	£0.41
100 THY5A/100	£0.52
200 THY5A/200	£0.58
400 THY5A/400	£0.66
600 THY5A/600	£0.79
800 THY5A/800	£0.93

5 amp TO 220 Case

Volts No.	Price
400 THY5A/400P	£0.86
600 THY5A/600P	£0.79
800 THY5A/800P	£0.93

7 amp TO 48 Case

Volts No.	Price
50 THY7A/50	£0.55
100 THY7A/100	£0.59
200 THY7A/200	£0.66
400 THY7A/400	£0.71
600 THY7A/600	£0.90
800 THY7A/800	£1.06

10 amp TO 48 Case

Volts No.	Price
50 THY10A/50	£0.59
100 THY10A/100	£0.66
200 THY10A/200	£0.71
400 THY10A/400	£0.81
600 THY10A/600	£1.14
800 THY10A/800	£1.40

16 amp TO 48 Case

Volts No.	Price
50 THY16A/50	£0.62
100 THY16A/100	£0.67
200 THY16A/200	£0.71
400 THY16A/400	£0.89
600 THY16A/600	£1.04
800 THY16A/800	£1.60

30 amp TO 94 Case

Volts No.	Price
50 THY30A/50	£1.38
100 THY30A/100	£1.64
200 THY30A/200	£1.87
400 THY30A/400	£2.06
600 THY30A/600	£4.03

No.	Price
BT101/500R	£0.92
BT102/500R	£0.92
BT106	£1.44
BT107	£1.07
BT108	£1.13
2N3228	£0.81
2N3525	£0.89
BTX30/50L	£0.38
BTX30/400L	£0.53
C106/4	£0.69
BT116	£1.73

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400 mw (Bzy88) D007. Glass encapsulated range of voltages available. 1.3v, 2.2v, 2.7v, 3.3v, 3.9v, 4.3v, 4.7v, 5.1v, 5.6v, 6.2v, 6.8v, 7.5v, 8.2v, 9.1v, 10v, 11v, 12v, 13v, 15v, 16v, 18v, 20v, 22v, 24v, 27v, 30v, 33v, 39v. — No. Z4 10p

1w-1.5w Plastic and Metal encapsulated. Range of voltages available. 1.3v, 2.2v, 2.7v, 3.3v, 3.9v, 4.3v, 4.7v, 5.1v, 5.6v, 6.2v, 6.8v, 7.5v, 8.2v, 9.1v, 10v, 11v, 12v, 13v, 15v, 16v, 18v, 20v, 22v, 24v, 27v, 30v, 33v, 43v, 47v, 51v, 68v, 72v, 75v, 82v, 91v, 100v. — No. Z13 18p

10w Metal stud type SO10 case. Range of voltages available. 1.3v, 2.2v, 2.7v, 3.3v, 3.9v, 4.3v, 4.7v, 5.1v, 5.6v, 6.2v, 6.8v, 7.5v, 8.2v, 9.1v, 10v, 11v, 12v, 13v, 15v, 16v, 18v, 20v, 22v, 24v, 27v, 30v, 33v, 43v, 47v, 51v, 68v, 72v, 75v, 82v, 91v, 100v. — No. Z10 44p

BRIDGE RECTIFIERS

SILICON 1 amp

Type	No.	Price
50v RMS	R1/50	£0.23
100v RMS	BR1/100	£0.25
200v RMS	BR1/200	£0.29
400v RMS	BR1/400	£0.41

SILICON 2 amp

Type	No.	Price
50v RMS	BR2/50	£0.52
100v RMS	BR2/100	£0.55
200v RMS	BR2/200	£0.60
400v RMS	BR2/400	£0.67
1000v RMS	BR2/1000	£0.78

SILICON 10 amp

Type	No.	Price
50v RMS	BR10/50	£1.73
200v RMS	BR10/200	£1.96

SILICON 25 amp

Type	No.	Price
50v RMS	BR25/50	£2.19
200v RMS	BR25/200	£2.53

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935	65p
937	55p
944	65p
946	55p
957	55p
962	55p
9099	90p

7400

7400	11p
7401	12p
7402	12p
7403	13p
7404	17p
7409	18p
7410	16p
7412	18p
7513	28p
7420	16p
7430	18p
7432	25p
7440	16p
7442	68p
7448	75p
7473	32p
7474	32p
7475	40p
7476	40p
7490	35p
7492	50p
7493	50p
7496	45p
74121	35p
74123	45p
74154	90p
74157	55p
74122	45p
74125	50p
74195	100p
74196	100p
74283	140p
74290	120p
74365	90p
74366	90p

74LS

74LS00	18p
74LS01	12p
74LS04	15p
74LS08	20p
74LS10	19p
74LS11	30p
74LS12	30p
74LS14	60p
74LS15	38p
74LS20	19p
74LS30	19p
74LS32	25p
74LS40	26p
74LS42	56p
74LS47	78p
74LS48	85p
74LS49	99p
74LS73	30p
74LS74	30p
74LS75	39p
74LS86	39p
74LS90	40p
74LS107	40p
74LS123	69p
74LS125	50p
74LS132	79p
74LS138	69p
74LS151	75p
74LS153	75p
74LS155	65p
74LS161	78p
74LS163	90p
74LS164	90p
74LS168	190p
74LS174	99p
74LS175	99p
74LS195	87p
74LS221	110p
74LS244	175p
74LS245	325p
74LS251	120p
74LS257	110p
74LS290	95p
74LS293	120p
74LS366	57p
74LS373	170p
74LS374	170p
74LS376	140p
74LS377	188p
74LS393	135p
74LS490	140p
74LS670	260p

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4002	19p
4006	75p
4007	19p
4008	80p
4009	35p
4010	45p
4011	20p
4012	24p
4013	38p
4014	70p
4015	75p
4016	35p
4017	60p
4018	76p
4019	42p
4020	88p
4021	100p
4022	88p
4023	22p
4024	50p
4025	20p
4026	130p
4027	45p
4028	75p
4029	80p
4030	50p
4031	195p
4033	145p
4035	104p
4036	290p
4037	105p
4038	110p
4039	290p
4040	99p
4041	75p
4042	73p
4043	86p
4044	88p
4045	160p
4047	99p
4048	56p
4049	38p
4050	40p
4051	69p
4052	75p
4053	73p
4054	111p
4055	121p
4056	121p
4059	560p
4060	112p
4063	112p
4066	56p
4067	422p
4068	19p
4069	19p
4070	28p
4071	25p
4072	25p
4075	20p
4076	88p
4077	23p
4078	29p
4081	23p
4082	25p
4085	86p
4086	68p
4089	130p
4093	68p
4094	225p
4095	99p
4096	325p
4098	110p
4099	180p
4501	25p
4502	112p
4503	68p
4507	52p
4508	288p
4510	76p
4511	125p
4512	75p
4514	250p
4515	290p
4516	109p
4518	99p
4520	99p
4521	230p
4526	105p
4527	130p
4528	99p
4529	140p
4531	150p
4532	125p
4538	150p
4543	160p
4556	70p
4560	225p
4569	240p
4572	46p
4584	79p
4585	125p

74C

74C20	30p
74C76	60p
74C85	145p
74C97	125p
74C98	125p
74C107	100p
74C160	110p
74C161	145p
74C162	145p
74C163	145p
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74C193	175p
74C194	175p
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ICM7216A	1875p
ICM7216B	1675p
ICM7555	80p
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LM311	50p
LM318	75p
LM324	45p
LM339	45p
LM380	65p
LM1496	65p
LM1871	550p
LM1872	550p
LM3990	50p
LM3914	225p
LM3915	225p
LM13600	125p
NE555	18p
NE556	50p
RC4136	85p
SN76477N	175p
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TL071	55p
TL074	130p
TL082	75p
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FD1794 B-01 S/D True Bus	3495p
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FD1797 B D/D True Bus, side select	5995p

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6522	795p
6532	895p
6551	1095p
6810	375p
6820	425p
6821	425p
6850	425p
6852	425p
8212	395p
8214	450p
8216	395p
8224	395p
8228	395p
8251	495p
8253	1125p
8255	495p
8257	1050p
8259	1325p
MC 144 12VL	797p
Z80 P10	595p
Z80 CTC	595p
Z80A P10	695p
Z80A CTC	695p
Z80 DMA	1995p
Z80A DMA	2495p
Z80 S10/0	2995p
Z80A S10/0	3495p
Z80 S10/1	2995p
Z80A S10/1	3495p
Z80 S10/2	2995p
Z80A S10/2	3495p

INTERFACE LINEAR

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75154	125p
75182	195p
75322	250p
75324	325p
75325	325p
75361	350p
75365	295p
75451	50p
75491/2	75p
8T26	175p
8T28	175p
8T95	175p
8T97	175p
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TIL209	9p
TIL211	13p
TIL212	15p
TIL220	12p
TIL222	15p
TIL224	18p
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FND500	80p
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DL707	85p
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6505	795p
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93453 1k x 4 40 NS	p.o.a.
93451 1k x 8 45 NS	p.o.a.
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SPECIAL OFFER! ! !

Compare our prices before you buy elsewhere! All devices are brand new, factory prime, full spec. and fully guaranteed!

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2716 Single 5V 450 NS	595p	550p	495p
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DON'T DELAY – BUY TODAY – SPECIAL OFFERS DON'T LAST FOR EVER! ! !

NEW — STEREO! S100 SOUND COMPUTER BOARD!

At last, an S-100 Board that unleashes the full power of two unbelievable General Instruments AY-3-8910 NMOS Computer sound IC's. Allows you under total computer control to generage an infinite number of special sound effects for games or any other program. Sounds can be called in BASIC, ASSEMBLY LANGUAGE, etc.

KIT FEATURES

- *Two GI Sound computer IC's (AY-3-8910)
- *Four parallel I/O ports on Board
- *Uses on Board audio Amps or your STEREO
- *On Board proto typing area
- *All sockets, parts and hardware are included
- *PC Board is soldermasked, silk screened with gold contacts
- *Easy, quick and fun to build, with full instructions
- *Uses Programmed I/O for maximum system flexibility
- *Both BASIC and ASSEMBLY language programming examples are included

COMPLETE KIT . . . . ONLY £59.96 includes 60 page data Manual
BARE BOARD . . . . ONLY £25.00 includes 60 page data Manual
AY-3-8910 chip special price with purchase of BARE BOARD (2 chips) £15.

SOFTWARE

SCL is now available! Our Sound Command Language makes writing Sound Effects programs a SNAP! SCL also includes routines for Register-Examine-Modify, Memory-Examine-Modify and Play-Memory. SCL is available on CP/M compatible diskette or 2708/2716. Diskette — £19.95, 2708 — £14.95, 2716 — £24.95. Diskette includes the source. EPROM'S are ORG at EOOOH.

SE 01 Sound Effects Kit NEW

The SE-01 is a complete kit that contains all the parts to build a programmable effects generator. Designed around the new Texas Instruments SN 76477 Sound Chip, the board provides banks of MINI DIP switches and pots to program the various combinations of the SLF Oscillator, VCO, Noises, One Shot, and envelope Controls. A quad Op Amp IC is used to implement an Adjustable Pulse Generator, Level Comparator and Multiplex Oscillator for even more versatility. The 3½" x 3" PC Board features a prototype area to allow for user added circuitry. Easily programmed to duplicate Explosion, Phaser Guns, Steam Trains, or almost an infinite number of other sounds. The unit has a multiple of applications. The low price includes all parts, assembly manual, programming charts, and detailed 76477 chip specifications. it runs on a 9V battery (not included). On board 100MW amp will drive a small speaker directly, or the unit can be connected to your stereo with incredible results! (Speaker not included).

COMPLETE KIT ONLY £14.99
P&P 67p plus VAT

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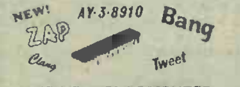
C106D 400V/5A Sale 30p



THE NEW GI COMPUTER SOUND CHIP

The amazing AY-3-8910 is a fantastically powerful sound and music generator, perfect for use with any 8-bit micro processor. Contains 3 tone channels, noise generator, 3 channels of amplitude controls, 16-bit envelope period control, 2 parallel I/O, 3D/A converters plus much more. All in 40 pin DIP. Super easy to interface to the S-100 or other Busses. ONLY £8.50 plus VAT, including FREE reprint of BYTE '79 article! Also, add £2.25 for 60-page data manual.

"Perhaps the next famous composer will not direct a 150-piece orchestra but, rather, a trio of microcomputers controlling a bank of AY-3-8910s." BYTE July '79.

NEW — EXCITING, ENTERTAINING SOFTWARE FOR THE APPLE II AND APPLE II PLUS! !

ASTEROIDS IN SPACE! ! !

If you liked 'Invaders' you'll love ASTEROIDS IN SPACE by Bruce Wallace! Your spaceship is travelling in the middle of a shower of asteroids. Blast the asteroids with lasers, but beware – BIG ASTEROIDS FRAGMENT INTO SMALL ASTEROIDS! The Apple game paddles allow you to rotate your spaceship, fire its laser gun, and give it thrust to propel it through endless space. From time to time, too, you'll encounter an alien spaceship whose mission is to DESTROY YOU, so you'd better destroy it first! High resolution graphics and sound effects add to the arcade-like excitement this program generates. RUNS ON ANY APPLE II WITH AT LEAST 32K AND ONE DISK DRIVE!

ON DISKETTE ONLY **£14.95**

NEW — 6809 S-100 SINGLE-BOARD COMPUTER

- *Meets IEEE S-100 Standard!
- *Uses Motorola's Powerful MC6809 CPU!
- *4K, 8K, 16K ROM!
- *2K RAM!
- *ACIA, PIA, 8080 Simulated I/O!
- *RS – 232 Handshake! *Selectable BAUD Rates!
- *Manual includes: 11" x 7" Schematic, Parts List, User Notes, Software Listings and MORE!

All this, yet for only **£49!**
(plus p&p £1.00)

NEW — NEW FROM INTERSIL ICL 7660 VOLTAGE CONVERTER

The Intersil ICL7660 is a monolithic MAXCOMOS power supply circuit which offers unique performance advantages over previously available devices. The ICL7660 performs the complete supply voltage conversion from positive to negative for an input range of +1.5V to +10.0V, resulting in complementary output voltages of –1.5 to –10.0V.

FEATURES

- *Simple Conversion of +5V Logic Supply to ±5V Supplies.
- *Simple Voltage Multiplication (VOUT = (–) nVIN)
- *99.9% Typical Open Circuit Voltage Conversion Efficiency.
- *98% Typical Power Efficiency
- *Wide Operating Voltage Range 1.5V to 10.0V
- *Easy to use – Requires only 2-External Non-Critical Passive Components

APPLICATIONS

- *On Board Negative Supply for up to 64 Dynamic RAMs.
- *Localized u-Processor (8080 type) Negative Supplies
- *Inexpensive Negative Supplies
- *Data Acquisition Systems

ONLY **£1.95** EACH

AUTORANGING, AUTO UNIT DISPLAY, 3½–DIGEST LCD DMM for ONLY £39.95 inc. VAT!

The nationally advertised 6200, giving 200mA AC/DC current measurement; AC voltage to 750V (DC to 1000V); 100µA resolution and o.1 Ohms – 2 Megohms. Accuracy is 0.8% and it displays mV, V and mA. You won't find a cheaper DMM with these features AND batteries, test leads, spare fuse and one year guarantee are INCLUDED in the low, low price of just

£39.95 in. VAT.

MUSIC FOR YOUR EARS

Bullet's Electronic Music Maker TM Kit has a single 28 Pin Microprocessor Chip with ROM that has been programmed to play the first 6 to 10 notes of the 25 popular tunes listed below. Each tune can easily be addressed individually or played sequentially at the push of a button. The 3 chime sequences are activated at any time by separate switch closures, so wehen used as a doorbell, one door can play songs while two others will play different chimes. The unit has a 5 watt audio Amp and will run on either 12 VAC or 12 VDC. Construction is very simple, works with any 8 or 16 ohm speaker, or horn speaker, (not included). Tunes can be remotely programmed using a single rotary switch, (not included), if desired. COMPLETE KIT £9.95. 240 V Transformer optional.

Tunes: Toreador * William Tell * Hallelujah Chorus * Star Spangled Banner * Yankee Doodle * America America * Deutschland Leid * Wedding March * Beethoven's 5th and 9th * Hell's Bells * La Vien en Rose * Star Wars Theme * Clementine * Marseillaise * O Sole Mio * Santa Lucia * The End * Blue Canube * Brahms Lullaby * Westminster Chime * Simple Chime * Descending Octave Chime * Augustine * Jingle Bells * God Save the Queen * Colonel Bogie.

Ordering information. Unless otherwise stated, for orders under £50 add 50p p&p. Add 15% VAT to total (no VAT on books) All devices are brand new, factory prime and full spec and subject to prior sales and availability. Prices subject to change without notice. Minimum telephone order using ACCESS is £10. If ordering by post with ACCESS, include name, address and card no. written clearly. Please allow 4/6 weeks delivery on books.

Micro Circuits

DEPT. R.E.C. 2,
4 Meeting Street, Appledore,
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Tel: Bideford (02372) 79507
Telex: 8953084

AND THERE'S MORE WHERE THIS CAME FROM

It's a long time since one of our adverts was presented in 'list' form - but simply because we do not try to squeeze this lot in every time doesn't mean that it's not available. Our new style price list (now some 40 pages long) includes all this and more, including quantity prices and a brief description. The kits, modules and specialized RF components - such as TOKO coils, filters etc. are covered in the general price list - so send now for a free copy (with an SAE please). Part 4 of the catalogue is due out now (incorporating a revised version of pt.1).

LINEAR ICs - NUMERIC LISTINGS

TBA120S	1.00
L200	1.95
U237B	1.28
U247B	1.28
U257B	1.28
U267B	1.28
LM301H	0.67
LM301N	0.30
LM308H	0.96
LM308N	0.65
LM339N	0.66
LM348N	1.86
LF351N	0.38
LF353N	0.76
LM374N	3.75
LM380N-14	1.00
LM380N-8	1.00
LM381N	1.81
ZN419CE	1.95
NE544N	1.80
NE555N	0.30
NE556N	0.50
NE560N	3.50
NE562N	4.05
NE564N	4.29
NE565N	1.00
NE566N	1.60
NE570N	3.85
SL624	3.28
TBA651	1.81
uA709HC	0.64
uA709PC	0.36
uA710HC	0.65
uA710PC	0.59
uA741CH	0.66
uA741CN	0.27
uA747CN	0.70
uA748CN	0.36
uA753	2.44
uA758	2.35
TBA810AS	1.09
TBA820M	0.75
TCA940E	1.80
TDA1028	2.11
TDA1029	2.11
TDA1054	1.45
TDA1062	1.95
TDA1072	2.69
TDA1074A	5.04
TDA1083	1.95
TDA1090	3.05
HA1137	1.20
HA1196	2.00
HA1197	1.00
TDA1220	1.40
LM1303	0.99
LM1307	1.55
MC1310P	1.90
MC1330	1.20
MC1350	1.20
HA1370	1.90
HA1388	2.75
TDA1490	1.86
MC1496P	1.25
SL1610P	1.60
SL1611P	1.60
SL1612P	1.60
SL1613P	1.89
SL1620P	2.17
SL1621P	2.17
SL1623P	2.24
SL1624C	3.28
SL1625P	2.17
SL1626P	2.44
SL1630P	1.62
SL1640P	1.89
SL1641P	1.89
TDA2002	1.25
TDA2020	3.00
ULN2242A	3.05
ULN2283B	1.00
CA3080E	0.70
CA3089E	1.84
CA3090AQ	3.35
CA3123E	1.40
CA3130E	0.80
CA3130T	0.90
CA3140E	0.46
CA3189E	2.20
MC3357P	2.35
LM3900N	0.60
LM3909N	0.68
LM3914N	2.80
LM3915N	2.80
KB4400	0.80
KB4406	0.60
KB4412	1.95
KB4413	1.95
KB4417	1.80
TDA4420	2.25
KB4420B	1.09
KB4423	2.30
KB4424	1.65
KB4431	1.95
KB4432	1.95
KB4433	1.52
KB4436	2.53
KB4437	1.75
KB4438	2.22
KB4441	1.35
KB4445	1.29
KB4446	2.75
KB4448	1.65
NE5044N	2.26
NE5532N	1.85
SD6000	3.75
SL6270	2.03
SL6310	2.03
SL6600	3.75
SL6640	2.75
SL6690	3.20
SL6700	2.35
ICL8038CC	4.50
MSL9362	1.75
MSL9363	1.75
HA11211	1.95
HA11223	2.15
HA11225	1.45
HA12002	1.45
HA12017	0.80
HA12402	1.95
HA12411	1.20
HA12412	1.55
LF13741	0.33
SN76660N	0.80

FREQUENCY DISPLAY & SYNTHESISER ICs

SAA1056	3.75
SAA1058	3.35
SAA1059	3.35
11C90DC	14.00
LN1232	19.00
LN1242	19.00
MSL2318	3.84
MSM5523	11.30
MSM5524	11.30
MSM5525	7.85
MSM5526	7.85
MSM5527	9.75
MSM55271	9.75
ICM7106CP	9.55
ICM7107CP	9.55
ICM7216B	19.25
ICM7217A	9.50
SP8629	3.85
SP8647	6.00
95H90PC	6.00
HD10551	2.45
HD44015	4.45
HD12009	6.00
HD44752	8.00

CMOS 4000 SERIES

4001	0.17
4000	0.17
4002	0.23
4008	0.80
4009	0.58
4010B	0.58
4011AE	0.20
4011B	0.20
4012	0.55
4013	0.55
4015	0.95
4016	0.52
4017	0.80
4019	0.60
4020B	0.93
4021	0.82
4022	0.90
4023	0.17
4024	0.76
4025	0.17
4026	1.80
4028	0.72
4029	1.00
4030	0.58
4035	1.20
4040	0.83
4042	0.85
4043	0.85
4044	0.80
4046	1.30
4047	0.99
4049	0.52
4050	0.55
4051	0.65
4052	0.65
4053	0.65
4063	1.09
4066	0.56
4068	0.25
4069	0.20
4070	0.20
4071	0.20
4072	0.20
4073	0.20
4075	0.20
4076	0.90
4077	0.20
4078	0.20
4082	0.20
4093	0.78
4175	0.95
4503	0.69
4506	0.51
4510	0.99
4511	1.49
4512	0.98
4514	2.55
4518	1.03
4520	1.09
4521	2.36
4522	1.49
4529	1.41
4539	1.10
4549	3.50
4554	1.53
4560	2.18
4566	1.59
4568	2.18
4569	3.03
4572	0.30
4585	1.10

TTL N and LSN

7400N	0.13
74LS00	0.20
7401N	0.13
74LS01	0.20
7402N	0.14
74LS02	0.20
7403N	0.14
74LS03	0.20
7404N	0.14
74LS04	0.24
7405N	0.18
74LS05	0.26
7406N	0.28
7407N	0.38
7408N	0.17
74LS08	0.24
7409N	0.17
74LS09	0.24
7410N	0.15
74LS10	0.24
7411N	0.20
74LS11	0.24
7412N	0.17
7413N	0.30
7414N	0.51
74LS15	0.24
7416N	0.30
7417N	0.30
7420N	0.16
74LS20	0.24
7421N	0.29
74LS21	0.24
7423N	0.27
7425N	0.27
7427N	0.27
74LS27	0.44
7428N	0.35
74LS28	0.32
7430N	0.17
74LS30	0.24
7432N	0.25
74LS32	0.24
7437N	0.40
7438N	0.33
74LS38	0.24
7440N	0.17
74LS40	0.24
7441N	0.74
7442N	0.70
74LS42	0.99
7443N	1.15
7444N	1.12
7445N	0.94
7446N	0.94
74LS47	0.89
7448N	0.56
74LS48	0.99
74LS49	0.99
7451N	0.17
74LS51	0.24
7453N	0.17
7454N	0.17
74LS54	0.24
74LS55	0.24
7460N	0.17
74LS63	1.24
7470N	0.28
7472N	0.28
7473N	0.32
74LS73	0.38
7474N	0.27
74LS74	0.28
7475N	0.38
7476N	0.37
74LS76	0.38
74LS78	0.38
7480N	0.48
7481N	0.86
7482N	0.69
7485N	1.04
74LS85	0.99
74LS86	0.40
7489N	2.05
7490N	0.33
74LS90	0.90
7491N	0.76
74LS91	1.10
7492N	0.38
74LS92	0.78
7493N	0.32
74LS93	0.99
7494N	0.78
7495N	0.65
74LS95	1.14
7496N	0.58
74LS96	1.20
7497N	1.85
74LS107	0.38
74109N	0.63
74LS109	0.70
74110N	0.54
74111N	0.68
74LS112	0.38
74LS113	0.38
74LS114	0.38
74118N	0.83
74120N	1.15
74121N	0.42
74122N	0.46
74123N	0.73
74LS124	1.75
74125N	0.38
74LS125	0.44
74126N	0.57
74LS126	0.44
74128N	0.74
74132N	0.73
74LS132	0.78
74LS136	0.40
74LS138	0.60
74141N	0.56
74142N	2.65
74143N	3.12
74144N	3.12
74LS145	0.97
74147N	1.75
74148N	1.09
74LS148	1.19
74150N	0.99
74151N	0.55
74LS151	0.84
74153N	0.64
74LS153	0.54
74154N	0.96
74155N	0.54
74LS155	1.10
74156N	0.80
74157N	0.67
74LS157	0.55
74LS158	0.60
74159N	2.10
74160N	0.82
74LS160	1.30
74161N	0.92
74LS161	0.78
74LS162	1.30
74163N	0.92
74LS163	0.78
74164N	1.04
74LS164	1.30
74165N	1.05
74LS165	1.04
74167N	2.50
74LS169	2.00
74170N	2.30
74LS170	2.00
74LS174	1.20
74175N	0.87
74LS175	1.10
74176N	0.75
74177N	0.78
74181N	1.65
74LS181	3.50
74LS183	2.10
74184N	1.35
74185N	1.34
74LS190	0.92
74192N	1.05
74LS192	1.80
74193N	1.05
74LS193	1.80
74194N	1.05
74196N	0.99
74LS196	1.10
74LS197	1.10
74198N	1.50
74199N	1.60
74LS247	0.93
74LS257	1.08
74LS260	1.53
74LS279	0.52
74LS283	1.20
74LS293	0.95
74LS365	0.49
74LS366	0.49
74LS367	0.43
74LS368	0.49
74LS374	1.80
74LS377	1.95
74LS379	1.30
74LS393	1.40

VOLTAGE REGULATORS

78series	0.95
79series	1.00
78Mseries	0.65
78Lseries	0.35
79L05	0.85
78MGT2C	1.75
79MGT2C	1.75
723CN	0.65
L200	1.95
TDA1412	0.75
NE5553N	1.25
LM317MP	1.48
LM337MP	1.48

MICROMARKET

8080A/2	7.50
8212	2.30
8214	3.50
8216	1.95
8224	3.50
8251	6.25
8255	5.40
6800P	7.50
6810	5.95
6820	7.45
6850	4.90
6852	4.85
MC2708	7.50
2114	6.50
4027	5.78
2102	1.70
2112	3.40
2513	7.54
HM4716	4.50
81LS97	1.25

VARICAP TUNING DIODES

BA102	0.30
BA121	0.30
ITT210	0.30
BB204B	0.36
BB105B	0.36
BB109	0.27
MVM125	1.05
BB212	1.95
KV1210	2.45
KV1211	1.75
KV1226	1.95
KV1225	2.75
KV1215	2.55
KV1225	2.75

SWITCHING AND PIN DIODES

SHOTTKY DIODES

1N6263	0.62
BA182	0.19
BA244	0.17
BA379	0.35
TDA1061	0.95

SIGNAL DIODES & RECTIFIERS

1N4148	0.06
1N4001	0.06
1N4002	0.07
1N5402	0.15
OA91	0.07
AA112	0.25
BRIDGES:	
1A/50V	0.35
6A/200V	0.75

TRANSISTORS

AUDIO DEVICES

BC237	0.08
BC238	0.08
BC239	0.08
BC307	0.08
BC308	0.08
BC309	0.08
BC413	0.10
BC414	0.11
BC415	0.07
BC416	0.08
BC546	0.12
BC556	0.12
BC550	0.12
BC560	0.12
BC639	0.22
BC640	0.23
2SC1775	0.18
2SA872A	0.14
2SD666A	0.30
2SB646A	0.30
2SD668A	0.40
2SB648A	0.40
2SD760	0.45
2SB720	0.45
2SC2546	0.19
2SA1084	0.20
2SC2547	0.19
2SA1085	0.20

AUDIO POWER DEVICES

2SB753	2.34
2SB723	2.34
2SK133	3.00
2SJ 48	3.00
2SK134	3.10
2SK135	3.75
2SJ 50	3.75
BD535	0.52
BD536	0.52
BD377	0.33
BD378	0.33
BD165	0.30
BD166	0.31

SMALL SIGNAL RF DEVICES

BF194	0.18
BF195	0.18
BF224	0.22
BF241	0.18
BF274	0.18
BF440	0.21
BF441	0.21
BF362	0.49
BF395	0.18
BF479	0.66
BF679S	0.55
BFR91	1.33
BFW92	0.60
BFT95	0.99
BFY90	0.90
40238	0.85

RF POWER DEVICES

VN66AF	0.95
2N3866	0.85

SMALL SIGNAL RF FET/MOSFET

BF256	0.38
2SK55	0.28
2SK168	0.35
J310	0.69
J176	0.65
40823	0.65
40673	3SK51
3SK45	0.49
3SK51	0.54
3SK60	0.58
MEM680	0.75
BF961	0.70
BF960	1.24
3SK48	1.64

CAPACITORS

All 5mm or less spacing

CERAMIC 50v
2P2,3P3,4P7,6P8
8P2,10P,15P,18P..0.04
22P,27P,33P,47P
56P,68P,82P,100P.0.05
150P,220P,270P
330P,390P,470P...0.055
1N0,2N2,3N3,4N7..0.06
10N (0.01uF).....0.05
22N,47N.........0.06
100N,220N........0.09
MONOLITHIC CERAMIC
10N,100N.........0.16
FEEDTHRU
1N0 SOLDER IN....0.09
POLYESTER (SIEMENS)
10mm LEAD SPACING
10N,22N,33N......0.17
47N,68N,100N.....0.19
220N,470N........0.22
1uF..............0.29
POLYESTER (GENERAL)
10mm LEAD SPACING
10N,15N,22N,33N..0.06
47N,68N,100N.....0.08
220N.............0.11
20mm LEAD SPACING
220N,330N,470N...0.18
MYLAR
5mm LEAD SPACING
1N0,10N,22N,33N..0.08
100N.............0.09
20mm LEAD SPACING
220N,470N....... 0.17
POLYSTYRENE
10P,15P,18P,22P,
27P,47P,56P,68P..0.08
100P,180P,220P,
270P,330P,390P...0.09
470P,680P,820P...0.10
1N0,1N2,1N5,1N8..0.11
2N2,2N7,3N3,3N9..0.12
4N7,5N6,6N8,10N..0.13
TANTALUM BEAD CAPS
16v: 0.22,0.33,
0.68,1.0.........0.18
16v: 2.2,4.7,10..0.19
6v3: 22,47.......0.30
10v: 22,100......0.35

ALUMIN ELECTROLYTICS RADIAL (VERT. MOUNT)
(uF/voltage)
1/63,2.2/50,4.7/35
10/16,15/16,22/10
33/6.3...........0.08
22/16,33/10,
47/10............0.09
10/63,22/50,33/50,
47/16,100/16.....0.10
47/63,100/25,220/16
470/6.3..........0.12
100/63,470/16,
1000/10..........0.18
1000/16,470/63...0.23
1000/63,2200/16..0.30
3300/25..........0.69
1000/100.........0.88
10000/70.........3.00
AXIAL (HORIZ. MOUNT)
1/25,4.7/16,6.4/25
10/16............0.08
4.7/63,22/10,22/16
33/16............0.09
47/25,100/16.....0.10
100/25...........0.11
1000/16..........0.25
2200/16,1000/25..0.36
1000/35,4700/16..0.45
1000/50..........0.58

RESISTORS
0.25W, 5% E12 CARBON
1ohm-10M.........0.02
0.25W 1% E12 METAL FILM
1.1ohm-1M........0.05
HORIZ CARBON PRESETS
10mm TYPE
100ohms-2M5......0.12
HORIZ CERMET PRESETS
1k, 10k.........0.27

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7BA series 1uH-1mH	0.16
8RB series 100uH-33mH	0.19
10RB series 33mH-120mH	0.33
10RBH series 120mH-1.5H	0.55
PIEZO SOUNDER PB2720	0.44

CRYSTAL FILTER PRODUCTS

10.7MHZ 2 POLE TYPES:
10M15A 15KHZ BW 2.49
10.7MHZ 8 POLE TYPES:
10M4B1 15kHz BW 14.50
H4402 7.5KHZ BW 15.50
10M22D 2.4KHZ SSB 17.20
HF FIRST FILTER:
B34F8A 34.5MHz HF 32.00

RADIO CONTROL CRYSTALS

(No splits available)
AM TX:-
3rd OT 30pF HC25U 1.65
AM/FM RX:-
3rd OT 30pF HC25U 1.65
FM TX :-
Fund 20pF HC25U 1.85
Pairs FM 3.25
Pairs AM 3.10

CRYSTALS

32.768 kHz	2.70
100kHZ	3.85
455kHZ	5.00
1.0MHz	3.00
3.2768MHz	2.70
4.000MHz	2.00
4.19439MHz	2.30
6.5536MHz	2.10
10.0MHz	2.50
10.6985MHz	2.50
10.7015MHz	2.50
10.245MHz	2.50
10.7MHz	3.00
11.52MHz	2.50
100MHz	3.00

LEDs

5MM RED	0.12
3MM RED CLEAR	0.15
3MM RED	0.15
2.5 X 5MM RED	0.17
5MM GREEN	0.15
3MM GN CLEAR	0.16
3MM GREEN	0.16
2.5 X 5MM GN	0.20
5MM YELLOW	0.15
3MM YELLOW CL	0.16
3MM YELLOW	0.18
2.5 X 5MM YE	0.20
5MM ORANGERED	0.20
5MM ORA CL	0.29
3MM ORANGERED	0.19
2.5 X 5MM ORA	0.24
5MM INFRA RED	0.56
BPW41 IR DET	1.51
IR OPT CPLR	1.44
5MM CLIP	0.04

LCDs

3.5 digit	9.45
4 digit	8.95
5 digit	8.95

SCHOTTKY DIODE BAL MIXERS (SBL1=MD108)

SBL1 1-500MHz	4.25
SBL1-8 .1-200MHz	4.55
SBL1-X 10-1000MHZ	5.75
SRA1 .5-500MHz	8.45
SRA1-1 .1-500MHz	9.25
SRA1H .5-500MHz	13.35
SRA3 .025-200MHz	10.25

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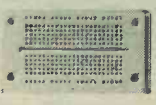
No soldering modular breadboards, simply plug components in and out of letter number identified nickel-silver contact holes. Start small and simply snap-lock boards together to build a breadboard of any size.

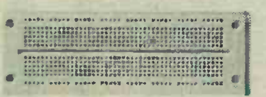
All EXP Breadboards have two bus-bars as an integral part of the board, if you need more than 2 buses simply snap on 4 more bus-bars with the aid of an EXP 4B.

EXP 325 £1.60 The ideal breadboard for 1 chip circuits. Accepts 8, 14, 16 and up to 22 pin ICs. Has 130 contact points including two 10 point bus-bars.

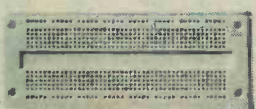
EXP 350 £3.15 Specially designed for working with up to 40 pin ICs perfect for 3 & 14 pin ICs. Has 270 contact points including two 20 point bus-bars.



EXP 300 £5.75 The most widely bought bread-board in the UK. With 550 contact points, two 40 point bus-bars, the EXP 300 will accept any size IC and up to 6 x 14 pin DIPS. Use this breadboard with Adventures in Microelectronics.



EXP 600 £6.30 Most MICROPROCESSOR projects in magazines and educational books are built on the EXP 600.



EXP 650 £3.60 Has ·6" centre spacing so is perfect for MICROPROCESSOR applications.

EXP 4B £2.30 Four more bus-bars in "snap-on" unit.

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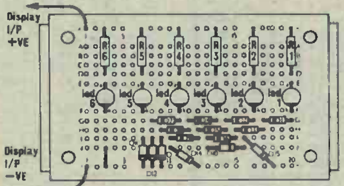
Roll the dice – the electronic way! The digital dice gives you an instant score randomly chosen from 1 to 6, every time you press the button. No losing this under the table!

No. 8 QUIZ MASTER
Play your own 'Sale of the Century'! Up to four contestants pit their wits; the first one to get the answer lights up his 'win' light, and stops anybody else from having a go.

No. 9 MOVING TARGET GAME
Test your reactions! A moving 'line of light' travels along from left to right, over and over again. You've got to 'fire' at just the right moment to score a hit. Fun for all the family!

Want to get started on building exciting projects, but don't know how? Now using EXPERIMENTOR BREADBOARDS and following the instructions in our FREE 'Electronics By Numbers' leaflets, ANYBODY can build electronic projects. For example, take one of our earlier projects, a L.E.D. Bar Graph;



You will need; One EXP 300 or EXP 350 breadboard, 15 silicon diodes, 6 resistors, 6 Light Emitting Diodes.

Just look at the diagram, Select R1, plug it into the lettered and numbered holes on the EXPERIMENTOR BREADBOARD, do the same with all the other components, connect to the battery, and your project's finished. All you have to do is follow the large, clear layouts on the 'Electronics by Numbers' leaflets, and ANYBODY can build a perfect working project.

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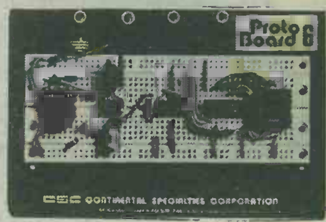

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33	4p	220	7p		
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10	5p	47	5p	330	22p
15	7p	50	7p	470	22p
22	5p	100	6p		
33	5p	150	11p		
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8	7p	50	7p	470	9p
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16	7p	150	8p	2200	36p
25	5p	220	7p		
32	5p	250	15p		
50 Volt					
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3	7p	16	7p	250	9p
3.3	4p	25	5p	330	9p
4	7p	33	5p	470	22p
5	7p	47	6p	500	22p
8	7p	50	7p	1000	22p
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BY266	900	3	15p
BY274	300	5	14½p
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BY299	800	2	4p
BY1202	2kV	10mA	6p
BYX20-200	200	25	72p
BYX22-200	300	1½	25p
BYX38-300R	300	2½	48p
BYX38-600	600	2½	52p
BYX38-900	900	2½	60p
BYX38-1200	1200	2½	65p
BYX42-300	300	10	36p
BYX42-600	600	10	46p
BYX42-900	900	10	92p
BYX42-1200	1200	10	£1.07
BYX46-300R	300	15 Avalanche	£1.19
BYX46-400R	400	15 Avalanche	£1.75
BYX46-500R	500	15 Avalanche	£2.00
BYX46-600	600	15 Avalanche	£2.30
BYX48-300R	300	6	47p
BYX48-600	600	6	60p
BYX48-900	900	6	70p
BYX48-1200R	1200	6	92p
BYX49-300R	300	3	35p
BYX49-600	600	3	42p
BYX49-900R	900	3	47p
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BYX52-300	300	40	£2.05
BYX52-1200	1200	40	£2.90
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E250C50	250	½	14p
KS11394	800	3	23p
LT102	30	2	15p
M1	68	1	5p
MR856	600	3	24p
OA210	400	5	33p
RAS3 1OAF Avalanche	1250	1½	48p
REC53A	1250	1½	16p
S10BR30	1000	30	£2.00
SKE4G	200	6	30p
SR100	100	1½	9p
SR400	400	1½	10p
IN3254	400	1	4p
IN4002	100	1	3p
IN4004	400	1	4½p
IN4005	600	1	6p
IN4006	800	1	6p
IN4007	1250	1	6p
IN5059	200	1½	10p
IN5401	100	3	10p
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1½" track 100K LIN. with knob 11p

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1	140	OSH01-200	25p
1	200V	WO2 Ex Equip	15p
1	400V	WO4	28p
1	400V	MDA104	29p
1	800V	WO8	27p
1	1000	W10	36p
1½	75V	IBIBY234	11½p
1½	150V	IBIBY235	15p
2½	100	I.R.	40p
2½	350V	9F2	70p
2½	500V	9E4	85p
3	50	KBS005	30p
3	100	KB601	30p
3	200	KBS02	30p
3	400	KBS04	30p
3	600	KBS06	30p
3¼	100	B40C 3200	58p
5	400	Texas	85p
Miniature	Meter	Type	34p

Thyristors

Amp	Volt		
1	240	BTX18-200	35p
1	240	BTX30-200	35p
1	400	BTX18-300	41p
4	500	40506 with heatsink	58p
4	600	2N3228	36p
6.5	500	BT109/SCR957	71p
2	400	S2710D with heatsink	40p
8	100	S2800A	36p
4	600	C106M sensitive gate	36p
20	600	BTW92-600RM	£3.40
15	800	BTX95-800 Pulse Modulated	£1
.4	50	S107F Sensitive Gate	36p
0.8	200	2N5064	18p
3	600	T3N06C00	53p
3	100	T3N1C00	36p
110	20	72RC2A	£3
75	800	71CG80	£6
150	1000	151RA100	£10
150	1200	151RA120	£11
12	1000	CR121103-RB	£8
10	200	S2800B	54p
5	600	S5800M	44p
8	600	S122M	54p
5	400	S3700D	44p
4	50	S2060F Sensitive gate	36p
7	400	S2620D	45p
7	600	S2620M	45p
4	400	S2061D Sensitive gate	38p

BT 106 70p
BT 121 70p
BT 107 £1

TRIACS

Amp	Volt		
0.1	40	7W84	3p
2.5	600	2N5757	44p
4	400	T2716D/40730	74p
6	200	T2500B/41014	54p
6	400	T2500D	72p
8	400	T2850D	72p
25	100	BTX94-100	£2.25
25	1200	BTX94-1200	£5

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4/500MW. BZY88, BZX97, etc. 5p
2v. 2v7. 3v. 3v3. 3v6. 3v9. 4v3. 4v7. 5v1. 5v6. 6v2. 6v8. 7v5. 8v2. 9v1. 10v. 11v. 12v. 13v. 13v5. 15v. 18v. 20v. 22v. 24v. 27v. 30v. 33v. 43v.

BZY61 Laboratory Standard 400MW 7v5. Voltage Regulator Diode 12p

1.3/1.5WT BZX61, BZY97, etc. 11p
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2.5WT BZX70, etc. 13p
v75. 1v. 2v4. 3v6. 3v9. 5v6. 6v2. 7v. 7v5. 8v. 9v. 10v. 11v. 14v. 15v. (8p). 20v. 22v. 24v. 26v.

5WT BZV40, etc. 15p
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10WT Z5D, ZX, etc. 20p
4v3. 4v7. 5v1. 5v6. 6v2. 6v8. 7v5. 8v2. 11v. 12v. 13v. 16v. 18v. 21v. 22v. 33v. 36v. 39v. 68v. 150v.

15WT BZV15C12R 12volt 37p

20WT BZY93, etc. 44p
8v2. 12v. 39v.

1 WATT RESISTORS 1½p

1, 1.5, 3, 5.6, 10, 12, 15, 18, 22, 25, 27, 30, 33, 39, 42, 45, 47, 50, 51, 55, 56, 58, 68, 82, 100, 120, 150, 180, 200, 220, 240, 250, 260, 270, 280, 300, 330, 350, 360, 390, 400, 450, 470, 510, 560, 600, 620, 680, 700, 750, 800, 820, 850, 1K, 1K2, 1K3, 1K5, 1K6, 1K8, 2K, 2K1, 2K2, 2K5, 2K7, 3K, 3K3, 3K5, 3K9, 4K5, 4K7, 5K1, 5K6, 6K2, 6K5, 6K8, 7K, 7K5, 7K6, 7K7, 8K, 8K2, 9K, 9K1, 10K, 11K, 12K, 13K, 15K, 18K, 20K, 22K, 24K, 25K, 27K, 30K, 33K, 36K, 39K, 40K, 42K, 43K, 45K, 47K, 50K, 51K, 56K, 60K, 61K, 62K, 68K, 70K, 75K, 80K, 82K, 91K, 100K, 110K, 120K, 130K, 150K, 180K, 200K, 220K, 240K, 250K, 270K, 330K, 390K, 400K, 450K, 470K, 500K, 510K, 550K, 560K, 680K, 800K, 820K, 1M, 1M2, 1M5, 1M8, 2M, 2M2, 2M7, 3M, 3M3, 3M9, 4M7, 5M6, 6M8, 7M5, 8M2, 9M1, 10M, 15M.

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3 WATT 39, 47, 50, 100, 150, 180, 220, 470, 600, 1K, 1K5, 2K2, 2K5, 2K7, 3K, 3K9, 4K3, 4K7, 6K2, 6K8, 9K1, 18K, 24K, 27K, 30K, 47K, 62K, 68K, 100K, 220K, 270K, 470K, 680K, 2M2, 2M7, 3M9.

5 WATT 30, 50, 220, 270, 1K, 2K2, 2K7, 3K3, 5K1, 6K8, 8K2, 10K, 82K, 100K, 390K, 8M2.

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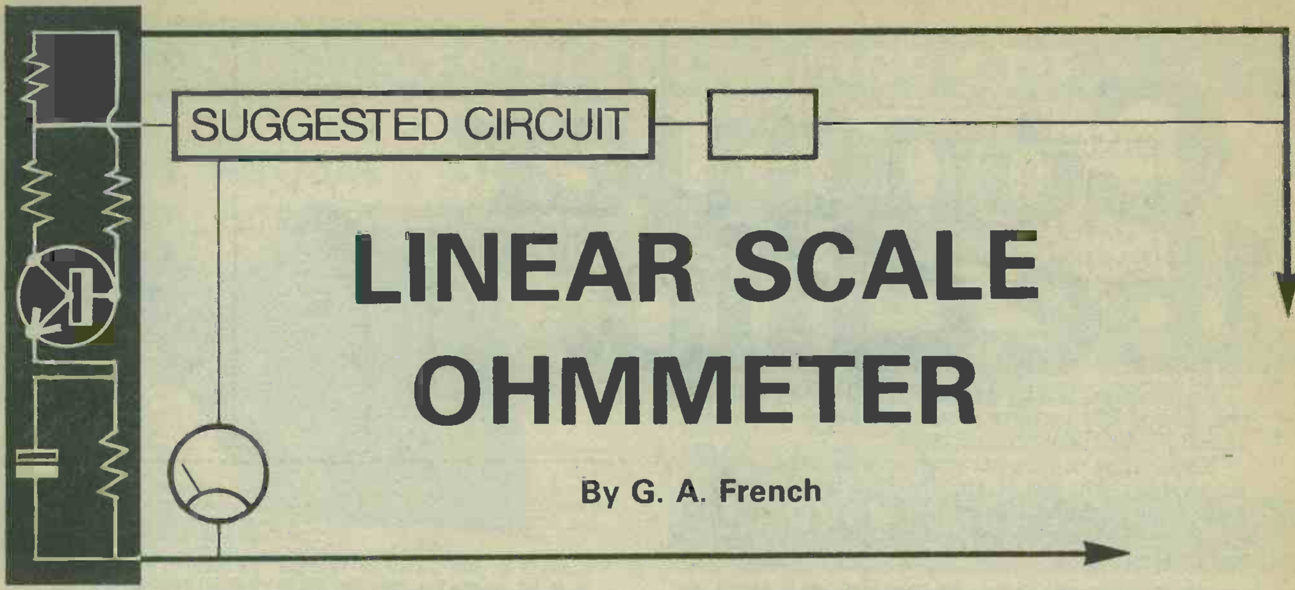


LINEAR SCALE OHMMETER

By G. A. French

The more inexpensive analogue multi-testmeters have resistance ranges and scales which are notoriously inaccurate and difficult to read. The scales are cramped at the high resistance end and accuracy normally worsens with falling voltage in the internal meter battery. It is, in particular, not an easy matter to obtain meaningful indications of resistance when these approach and exceed 1MΩ.

The circuit to be described this month is for a low cost adaptor which can be used with an analogue testmeter when the latter is switched to a suitable voltage range, and it provides linear indications of resistance in five ranges, the lowest range being 0-1kΩ and the highest range being 0-10MΩ. The adaptor does not give results which have the accuracy of a true laboratory measuring instrument, but the accuracy is very much better than is that given with the testmeter ohms ranges themselves. Also, all the resistance readings are directly proportional to meter voltage indications, and are in consequence free from scale cramping as well as being very easy to evaluate.

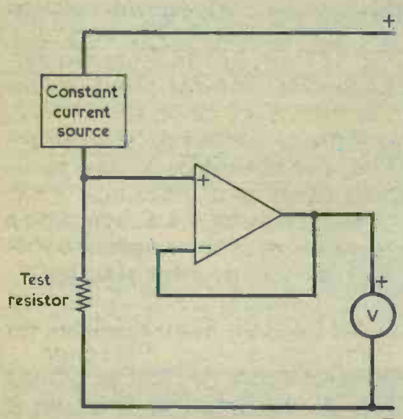


Fig.1. The basic circuit for obtaining linear resistance readings by means of an analogue voltmeter

CONSTANT CURRENT SOURCE

The basic mode of operation of the adaptor is shown in Fig.1. Here, a constant current source causes a constant current to be passed through the test resistor whose value is to be ascertained. Since the current is constant the voltage across the resistor is proportional to its resistance value. The voltage at the upper end of the test resistor is applied to an operational amplifier having an extremly high input resistance. The op-amp output is returned to the inverting input and the op-amp thus functions as a voltage follower. The voltage across the resistor, and hence an indication of its value, is then read from the analogue voltmeter connected to the op-amp output.

This method of measuring resistance is not, of course, new but the fairly recent introduction of modern devices to the home constructor component market, including in particular an integrated constant current source, makes it possible to make up delightfully simple circuits which are capable of measuring resistances up to 10MΩ by the constant current technique.

The integrated constant current source is the LM334Z, and this is available from Maplin Electronic Supplies. It is encapsulated in a 3-pin T092 package and, for operation at room temperatures, requires only one external resistor to establish the value of the constant current. The device is connected as shown in Fig.2 and the constant current, in amps, is equal to 0.0677 divided by the value of the external resistor. The range of constant currents available extends from 1μA to 10mA. The first current is given when the resistor has a value of 68kΩ and the second current when the resistor has a value of 6.8Ω.

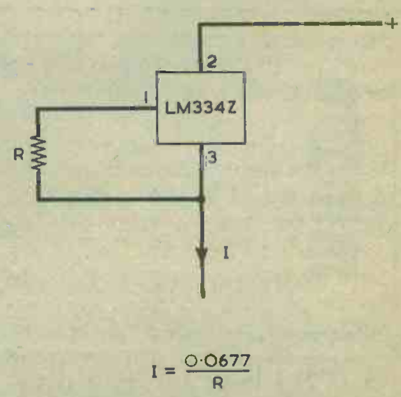


Fig.2. Obtaining a constant current from the LM334Z

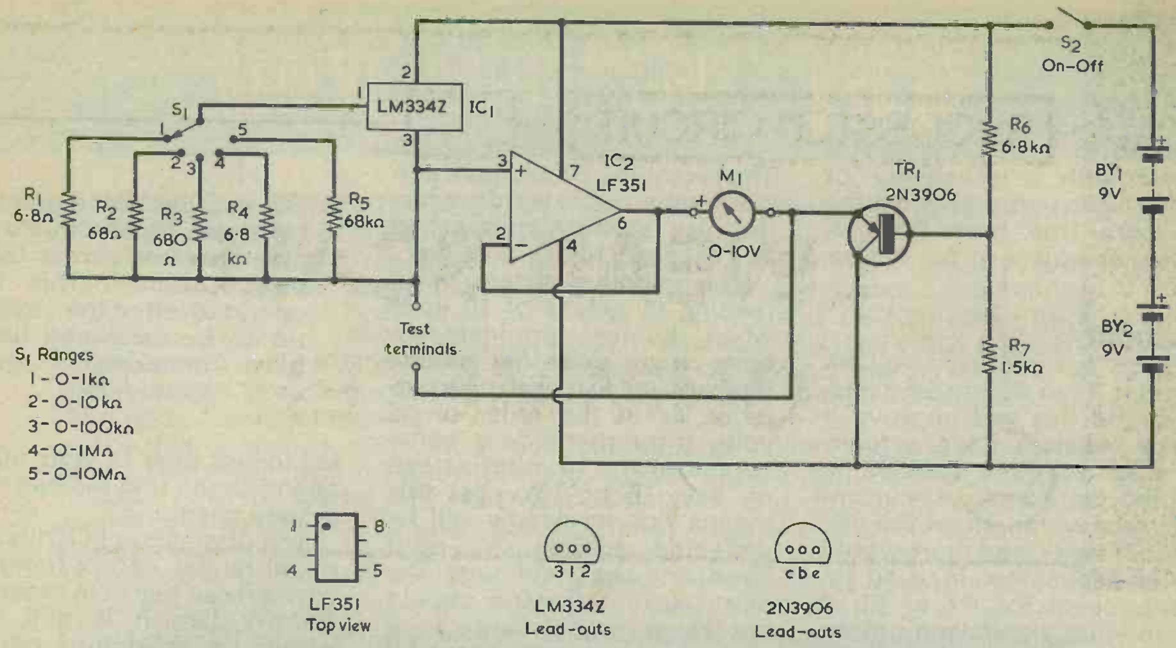


Fig.3. Full circuit of the linear scale ohmmeter, which offers resistance readings up to 10MΩ. Meter M1 is a testmeter switched to read 0 – 10 volts. In the insets showing pinning for IC1 and TR1, the lead-outs point towards the reader.

ADAPTOR CIRCUIT

The full circuit of the adaptor is given in Fig.3, and it will be seen that the range switch S1 switches in five different values of external current control resistor. On Range 1 the constant current is 10mA, on Range 2 it is 1mA and on Range 3 the current is 100μA. Range 4 gives 10μA and Range 5 allows 1μA to flow. A current of 10mA through a 1kΩ resistor causes 10 volts to be developed across that resistor, and a current of 1mA through a 10kΩ resistor similarly produces a voltage of 10 volts. On each of the five ranges the maximum resistance shown for the range causes a voltage of 10 volts to be given. Lower resistances within the range produce proportionately lower voltages.

The resistor being measured is connected to the test terminals and the voltage on the upper terminal is applied to the non-inverting input of the op-amp, IC2, which is connected as a voltage follower. The i.c. chosen for the circuit is an LF351 with an input resistance of 1 tera-ohm, or 1 million megohms. This has J-fet inputs and does not need the handling precautions that are required with devices having MOS inputs, although it is wise to solder to the input pins with an iron having a reliably earthed bit. The only main precaution needed is to ensure that neither of the LF351 inputs is taken negative of the negative supply pin, as damage to the device can then result.

The LF351 ceases to function as a voltage follower if the input at the non-inverting input passes below about 2 volts positive of the negative supply rail and so it is necessary to raise the voltage follower and meter circuit above the negative rail by a suitable voltage. This is achieved with the aid of the potential divider consisting of R6 and R7, the junction of these two resistors connecting to the base of emitter follower TR1. The voltage at the emitter of TR1 is around 4 volts positive of the negative rail, and falls as battery voltage drops. A precise voltage is not required as the lower test terminal and the negative side of the analogue meter are both returned to the emitter, and the constant current from IC1 is not affected by the voltage at this point. The emitter follower copes comfortably with the varying currents required on the different resistances ranges. The standing current in the potential divider is about 2.2mA. A 3.9 volt zener diode could have been employed instead of the emitter follower, but it would have required a standing zener current of at least several milliamps to bring it on to the flat part of its characteristic.

As has been already explained, the voltage applied to the non-inverting input of the LF351 is 10 volts maximum on each range. The input voltage varies therefore, from zero to 10 volts. With the 4 volt delay given at the emitter of TR1, the LF351 output voltage swing, relative to the negative rail, is from 4 to 14 volts. Such a swing is comfortably within the capability of an LF351 having an 18 volt supply. In practice, the circuit provides accurate resistance readings even when the supply voltage drops to 14 volts, as the reference voltage at TR1 emitter also falls.

The total current consumed by the circuit is about 4mA on Ranges 5, 4 and 3, this rising to around 5mA on Range 2 and 15mA on Range 1. The two 9 volt batteries may be any type, ranging from PP3 to PP9, as preferred.

The meter, M1, is a testmeter

switched to read 0-10 volts. The circuit will function with quite insensitive meters, and it is only required that the meter resistance should be 1,000Ω per volt or more. A 0-10 volt meter with a sensitivity of 1,000Ω per volt will consume an extra 1mA from the batteries when it is at full deflection.

ACCURACY

Quite fair accuracy will be given if R1 to R5 are 5% resistors, and this will improve if these resistors have a tolerance of 2%. The LM334Z is quoted as having a current accuracy within 3% of the calculated value, and there would be little advantage in using 1% components for R1 to R5 if these were significantly more expensive than 2% types. If difficulty is experienced in obtaining the 6.8Ω resistor required for R1 in close tolerance, it may be made up from an 11Ω and an 18Ω resistor in parallel. These have a combined calculated value of 6.83Ω. R6 and R7 can be standard 5% ¼ watt components.

The circuit may be made up in any convenient case with S1 and S2 on the front panel, in company with two terminals for the test resistor and two terminals to which the testmeter connects. Resistance readings are then proportional to test-meter voltage reading. If, for instance, a reading of 3.4 volts is given on Range 4, the test resistor has a value of 340kΩ. The prototype circuit gave perfectly satisfactory results when the test resistors approached and reached 10mΩ in value.

The analogue meter gives a reading in excess of 10 volts when the test terminals are open-circuit and the voltage then applied to it, with new batteries, is of the order of 14 volts. If the meter f.s.d. value happens to be 10 volts (instead of, say, 15 or 20 volts) this means that its needle will be deflected against the right hand end-stop, although the extra current flowing should not cause any damage to a normal meter movement. If this effect is disliked, a press-to-break push button can be added to the circuit, it being connected across the test terminals as shown in Fig.4. The button is pressed, to take a reading, after the test resistor has been connected to the terminals. Incidentally, the fact that the voltmeter gives a reading in excess of 10 volts with the test terminals open-circuit provides an automatic check on battery voltage. If the open-circuit voltage readings fall to less than 11 volts this is an indication that the batteries require changing.

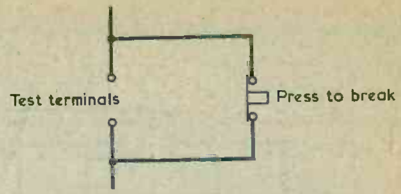


Fig. 4. If desired, a press-to-break push button may be wired across the test terminals. This is operated after the resistor to be measured has been connected to the terminals

The dissipation in IC1 is low on all ranges except Range 1, where it can rise to in excess of 100mW (which is still well within its maximum rating). There may be a slight drift in readings if the ohmmeter is used for long periods on Range 1 due to the consequent rise in temperature inside the device, but there should be no problems in the short term. The adaptor should not be left switched on with Range 1 selected for excessive times when the push-button of Fig.4 is incorporated, as apart from any other effect there would be an excessive drain on the batteries. ■

NEW CATALOGUE

Now available from Magenta Electronics is their new 1980-81 catalogue. With 52 large pages and a separate 6 page Price List, this gives details of a very wide range of electronic components, including printed circuit materials, cases, semiconductors, coils, transformers, resistors, capacitors, connectors and testmeters. Detailed illustrations of components are provided. Five pages of the catalogue are devoted to circuit ideas which can be built by the experimenter.

An unusual feature is the inclusion of a large quantity of kits for constructional projects published in this magazine and others. These kits include our current "INStructor" series and, in all, there are well over 150 projects listed. Each kit provides, nuts, bolts, and all hardware needed, as well as the purely electronic parts.

The Magenta Electronics 1980-81 catalogue can be obtained from Magenta Electronics Ltd., 98 Calais Road, Burton-on-Trent, Staffs, DE13 OUL by sending payment of six 10p stamps.

RECENT PUBLICATIONS

THE PERSONAL COMPUTER BOOK. By Robin Bradbeer. 226 pages, 210 X 140mm. (8¼ X 5½in.) Published by Input Two-Nine. Price £5.25.

Robin Bradbeer is a free-lance writer on personal computing, as well as being Senior Lecturer in the Department of Electronic and Communications Engineering at the Polytechnic of North London. In this book (which is distributed by MCB Publications Limited, 198/200 Keighley Road, Bradford, BD9 4JQ, Tel. 0274 499821) he sets out to explain what the personal computer can do and how the beginner in the computer world can obtain and take advantage of a suitable machine for his own particular requirements.

The text is concise, pleasant in style and easy to follow. The first five of the seven chapters which make up the body of the book introduce the computer, indicate how the reader can start with computers, and discuss hardware and software. The sixth chapter gives specifications and details for some 50 commercially produced computers and systems which are currently available, as well as for 15 printers and 10 visual display units. Chapter 7 describes the uses to which the computer can be put. There are eight appendices, the first four of which cover binary arithmetic, interface standards, addresses of manufacturers and distributors, and computer clubs and specialist groups in the U.K. The fifth appendix gives an extensive list and evaluation of computer magazines in the U.K., U.S.A. and the Continent, and the sixth a selected bibliography. A glossary of terms appears in the seventh appendix, and advice is given on building kit systems in the final appendix.

This is a comprehensive and carefully prepared publication offering much useful information to the newcomer to computers.

110 IC TIMER PROJECTS FOR THE HOME CONSTRUCTOR. By Jules H. Gilder. 125 pages, 230 x 145mm. (9 x 5½in.) Published by Newnes Technical Books. Price £3.10.

The 555 must surely be one of the most widely employed i.c.'s in use today. Basically intended as a monostable or astable multivibrator, it has appeared in very many widely varying applications since its introduction. The book under review gives an excellent idea of the versatility possessed by this unique integrated circuit.

The book commences with a description of the internal circuitry and pin functions of the 555 and then deals with monostable and astable circuits. In both instances, circuits are presented which offer enhanced performance. The section on astable circuits includes, for example, an astable with continuously variable duty cycle and an astable with crystal frequency control.

The following sections cover logic circuits, timer-based instruments, automobile applications, alarm and control circuits, and power supplies and converters. As the title of the book promises, there are 110 different circuits. These are all good and practical and will not only be of considerable interest to the experimenter as well as the constructor but may also, in themselves, spark off further ideas and uses for the 555.

A GUIDE TO AMATEUR RADIO, 18th Edition. By Pat Hawker, G3VA. 144 pages, 245 x 180mm. (9½ x 7in.) Published by Radio Society of Great Britain. Price £2.40.

A Guide To Amateur Radio first appeared in 1933, and it has now arrived at its 18th edition. Its continuing popularity gives clear evidence that it is a welcome occupant of the bookshelf of anyone having an interest in amateur radio, whether this be for transmitting or simply for listening.

The prime aim of the book is to advise the newcomer to amateur radio, and to assist in the obtaining of a transmitting licence. But in so doing it also provides a great deal of technical information which will help any beginner in electronics in general and in short wave radio in particular. Among the subjects covered are communications receivers, transmitters, aerials, workshop practice and electronic fundamentals. The book also gives specific information on amateur matters, including amateur station operation, the function of the RSGB, international amateur organisations and working to pass the transmitting licence examination.

The book is well set up and laid out, with clear illustrations and diagrams. In cases of difficulty it can be obtained direct from Radio Society of Great Britain, 35 Doughty Street, London WC1N 2AE, for £2.99 post paid.

NEWS . . . AND

HANDHELD DMM REDUCED IN PRICE

Fluke's latest low cost handheld DMM, the 3½ digit 8022A Troubleshooter model, has just been reduced in price from £89 to £75, making it even more attractive in design, service and field test work.

The 8022A is a simple yet versatile general purpose DMM providing 6 functions (AC + DC Volts, AC + DC Amps and high and low Ohms) with 24 ranges, including 3 diode test ranges.

A clear 3½ digit LCD display makes it easy to read with the single row of buttons down one side allowing single handed operation when required. Extensive overload protection up to 6 kV for transients and 1000 V or 20 Amps make it practically indestructible in use. The LCD display on the 8022A also provides a battery low, over-range and negative polarity indication. Basic DC accuracy is 0.25%.

The safety leads are especially designed to prevent accidental shock and a full range of accessories are available including probes for high voltage, high current, RF, temperature as well as a battery eliminator for bench work.

"BROADCASTING TECHNOLOGY FOR THE 1980's"

The IBA has published a 12-page, fully-illustrated, description of current engineering progress and development work being carried out at Crawley Court, Winchester under the title "Broadcasting Technology for the 1980s". This describes the engineering of the "Fourth Channel" under the IBA Act 1979; recent developments for Independent Local Radio; the present state of digital technology in broadcasting, including ORACLE teletex and digital techniques for the application of space satellites.

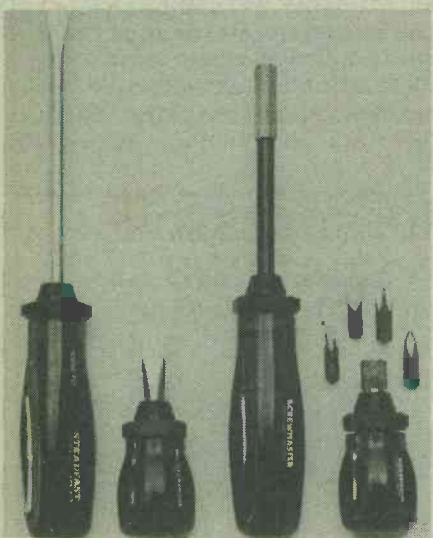
In a foreword by Tom Robson, IBA's Director of Engineering, he writes:

"The 1980s offer the challenge of the all-digital systems; the new methods of video distribution including optical fibres and satellites; the exploitation of bandwidth at SHF and beyond; the new mobility of lightweight equipment – especially where microwatts of power consumption can match the micro size of the devices. It is a challenge that will call for new skills and new training for a very different world."

Contents: UHF transmitters and the Fourth Channel; RTS award for SABRE; ILR – the new force in sound radio; the ubiquitous digit – digital video processing; IBA digital 'firsts'; the expanding world of teletext; space satellites – questions for the future; IBA – an engineering service.

Copies are available, free of charge, from IBA Engineering Information Service, Crawley Court, Winchester, Hants. SO21 2QA.

'FOUR SCREWDRIVERS IN ONE'



The Screwmaster ratchet range, l to r – the 8½" screwdriver, the 3" Chubby, the new bit holder Screwmaster and the new Chubby with their set of bits.

'Four screwdrivers in one' is the latest addition to the Steadfast Screwmaster family of screwdrivers from J. Stead & Co Ltd, of Netherlane, Ecclesfield, Sheffield.

The new screwdriver adaptors incorporate the patented roller ratchet Screwmaster mechanism which was successfully launched earlier this year. There is a sleeve at the end of the driver shaft to hold all types of standard ¼" A/F screwdriver bits.

The bit holder is available in two sizes. The Chubby model is only 3" in length – a size which has already proved its popularity as a ratchet Screwmaster. The larger model is 8¼" in length. Both sizes come with either a magnet or retaining clip at the base of the sleeve to hold the bit in place.

The magnet will also attract a screw – a particular feature if working in tight or awkward conditions. However, in situations where a magnetised blade is not suitable the retaining clip is the alternative.

The adaptor and bits are available separately or in kit form comprising an adaptor, together with No 1 Pozidriv, No 2 Pozidriv, 3/16" and ¼" flat bits.

Retail prices range from £3.35 to £4.90, plus VAT, for the bit holders and £5.95 to £7.50, plus VAT, for the kit form.

. . . COMMENT

As we grow increasingly security conscious, our pockets progressively fill with keys of all shapes and sizes. Apart from the wear and tear these may cause, the danger of loss is always present. An obvious solution is an electronic combination switch, which can be ideal for controlling electrically operated devices such as alarm systems and solenoid releases, etc. To meet this need we are featuring in this issue an article – 'CMOS Combination Switch'.

Since a combination switch involves expenditure in addition to the expense of the device it controls, it is essential to design its circuit such that costs are kept to a minimum. This requirement is achieved in the foregoing design to such an extent that it costs little more than an electrical locking switch!

SATELLITE DATA BUOY

McMichael has successfully installed a satellite data collection platform (DCP) on a buoy which is moored off the coast of the Isle of Wight.

Data is collected, processed and stored from the on-board sensors and at regular time intervals is transmitted back to the home base in Slough via satellite, satellite receiving station (in W. Germany) and then telex.

Due to the processing capability of the DCP, the transmission time is much reduced and thereby saves battery power during transmission.

A wide beam aerial on the buoy mast ensures that data is still transmitted even during rough weather, which was simulated in this trial by using a buoy with a shortened keele which was kindly supplied by the British Met. Office.

Such data buoys can be moored anywhere in the world whilst the user receives his information at the home base and will gradually replace weather ships which are increasingly expensive to operate, as well as being used on large lakes and other inland water.

There has been interest in this project from many parts of Europe and the Dutch Water Authority have asked for an extension to the trial period whilst they undertake some of their own measurements.

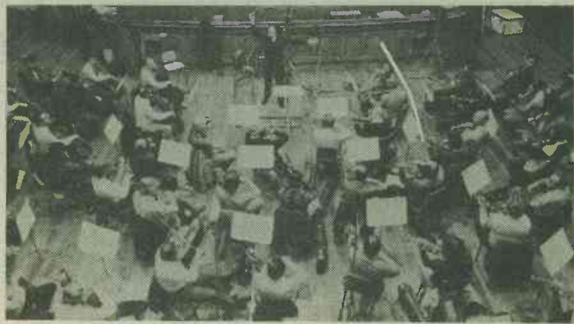
CASIO ENTERING THE MUSIC BUSINESS

CASIO is a name that most people readily associate with quality calculators and digital watches. Some also recognise Casio as a manufacturer of cash registers and computers.

Casio are breaking new ground by entering the music business with a product called Casiotone. It is a keyboard instrument that can reproduce the sounds of piano, organ, violin, flute, and a couple of dozen other instruments that are normally struck, plucked, bowed or blown. Moreover it is polyphonic – able to play chords of up to eight notes simultaneously.

Technology employed is a development from Casio's earlier electronics expertise. Casiotone's functions are performed by two-chip LSI circuitry. It makes sounds that are pleasing to professional musicians, yet it will sell at a price appealing to amateurs.

"PATHÉTIQUE" RECORDED USING 3M DIGITAL EQUIPMENT



The first classical recording in England using the 3M Mincom digital multi-track mastering system took place during June at the Kingsway Hall in London.

Carlos Païta conducted the National Philharmonic Orchestra under the leadership of Mr. Sidney Sax for a recording of Tchaikovsky's Symphony No. 6, "The Pathétique". The 3M Mincom 4-track digital recorder was on hire from the Townhouse Recording Studios in Shepherd's Bush. The digital recording was backed up by both 8-and 2-track analogue recorders with Dolby noise reduction equipment on hire from Decca.

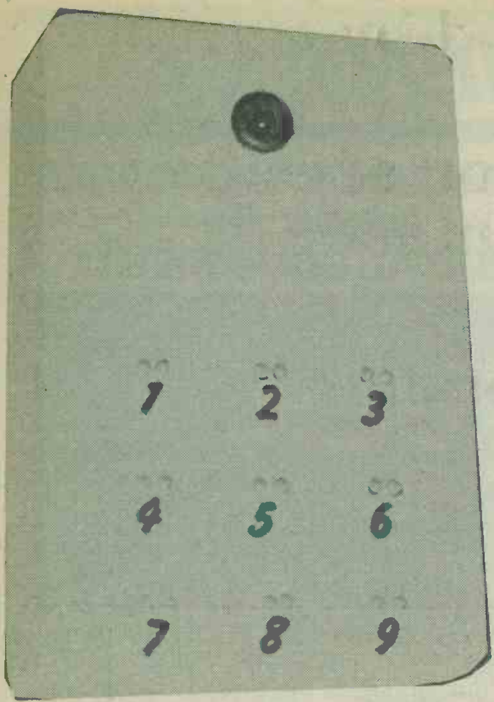
The programme was mixed and edited at the Roundhouse Recording Studios on 20th and 21st June using the studio's 3M Mincom 32-track and 4-track digital recorders and electronic editor, as well as new cross fade units also manufactured by 3M. Cutting will shortly take place at The Townhouse, again using the 3M digital preview unit. The Townhouse can probably claim the best cutting facilities in Europe at present since its acquisition of the 3M digital equipment and a new Neuman lathe.

The digital recording of Tchaikovsky's "Pathétique", with Carlos Païta conducting the National Philharmonic Orchestra, is due for release in October.

MICROPROCESSOR APPLICATIONS UNDERWATER

The introduction of microprocessors to the underwater scene represents yet another step forward on the road to extending our knowledge of a range of environmental conditions, and provides yet another precise tool for the better information of designers, engineers and offshore operators. If programmed to recognise and record particular non-typical events events and conditions, microprocessors can fill in vital gaps in information which may be missed by instruments performing routine sampling.

The subject is to be dealt with in a one day seminar to be held in November under the auspices of the Society for Underwater Technology of 1 Birdcage Walk, London SW1H 9JJ.



The prototype combination switch is housed in a neat plastic case. Each of the combination numbers is selected by touching the corresponding contact pair with a finger.

CMOS COMBINATION SWITCH

By

M. P. Horsey

As we grow increasingly security conscious, our pockets progressively fill with keys of all shapes and sizes. Apart from the wear and tear these may cause, the danger of loss is always present. An obvious solution is an electronic combination switch, which can be ideal for controlling electrically operated devices such as alarm systems and solenoid releases, etc.

Since a combination switch involves expenditure in addition to the expense of the device it controls, it is essential to design its circuit such that costs are kept to a minimum. This requirement was achieved with the present design to such an extent that it costs little more than an electrical locking switch.

One of the most expensive parts of a combination switch can be the keyboard, press-buttons or other circuit controlling switches which are employed. It was therefore decided to use a "touch contact" system, which may be home produced at almost zero cost. One word of caution, however: touch contacts require clean dry conditions, and are only suitable for indoor applications. CMOS devices can be readily controlled by touch contacts and they incur very low battery current consumption. The design incorporates two CMOS chips, these being a 4081 (quad 2-input AND gate) and a 4001 (quad 2-input NOR gate).

OPERATING THE DEVICE

The switch is activated by touching contacts 1,2, 3, 4 (as numbered in the circuit diagram) in that order. If any other numbered contact is touched the circuit is de-activated and remains in that state for a period of seconds or minutes according to the values chosen for C2 and R9. Thus, the potential thief has to touch the correct contacts in the proper order the *first time* to

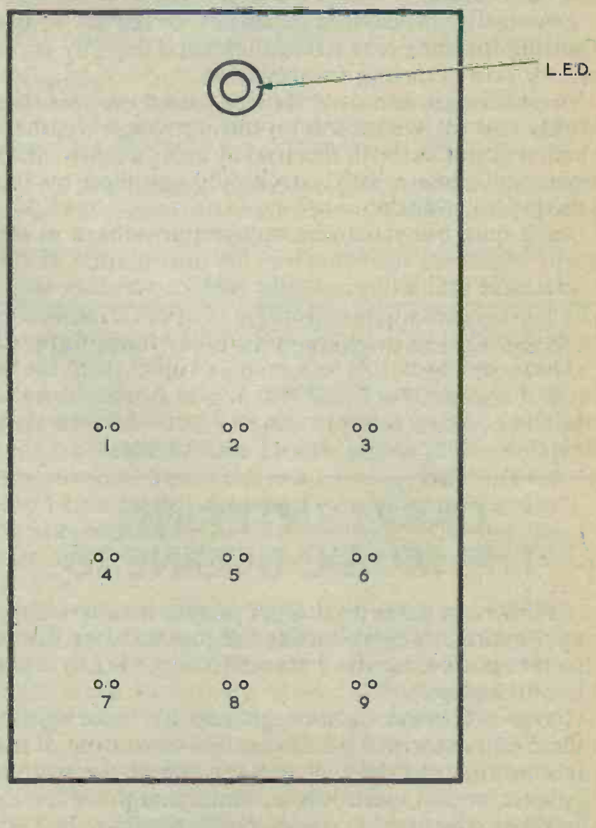


Fig.1. Front panel layout of the combination switch. Pairs of contacts are bridged by a finger in the correct sequence to operate the switch. Touching an incorrect contact pair disables the switch for a pre-set period.

•Negligibly low stand-by current.

•Automatic inhibit on selection of incorrect contacts.

•Finger-tip operation

secure operation of the switch. If a wrong contact is touched, even the correct sequence will not operate the switch until the pre-determined delaying period has elapsed.

The layout of the front panel is shown in Fig.1 and the photographs. The pairs of touch contacts are numbered 1 to 9 but these numbers do not correspond with the numbers allocated to the touch contacts in the circuit diagram. The wiring combination to the contacts is carried out as desired by the constructor and it could, for example, produce a correct sequence of 9, 5, 8, 1, with all the other contacts setting up the delay inhibit period.

Most readers will be familiar with the NOR gates in the 4001 chip. The output of each gate will be high, at logic 1, only when both inputs are low, at logic 0. If either input or both inputs are at 1 the gate output goes to 0. In the 4081, each AND gate produces an output 1 only when both inputs are at 1. If either or both inputs are at 0, the output of the gate is also at 0.

THE CIRCUIT

The circuit appears in Fig.2. In this diagram, both C2 and C3 are discharged at the instant of applying the 9 volt supply. At this instant, pin 8 of IC2 is held low, because of R7 and R8, and the gate output will be high. This output, coupled via the discharged capacitor C2, keeps pins 12 and 13 high and pin 11 low. The two gates concerned latch into this state. The low output at pin 11 passes to pins 1 and 2 of the third gate of IC2, whereupon pin 3 of that gate goes high, causing C3 to charge via R10 after a very short delay.

However, C3 is discharged at the instant of supply application, thereby biasing the top AND gate of IC1 so that it takes up the state where pin 3 is low, as also is pin 2. These last two pins stay low after C3 has charged. The low output at pin 3 of IC1 is applied to pin 5 of the second AND gate, whose output at pin 4 is consequently low. Following the chain of AND gates, pin 10 is also low as, finally, is pin 11.

When contacts 1 are touched, pin 2 of IC1 goes high, as also does pin 3, and the top AND gate latches into this new state. Pin 5 of the second AND gate is now high so that, if contacts 2 are bridged by the finger, its output goes high also, at pin 4. The progression continues by touching contacts 3 and then contacts 4, whereupon pin 11 of IC1 goes high, turning on transistor TR1 and energising the relay. The relay

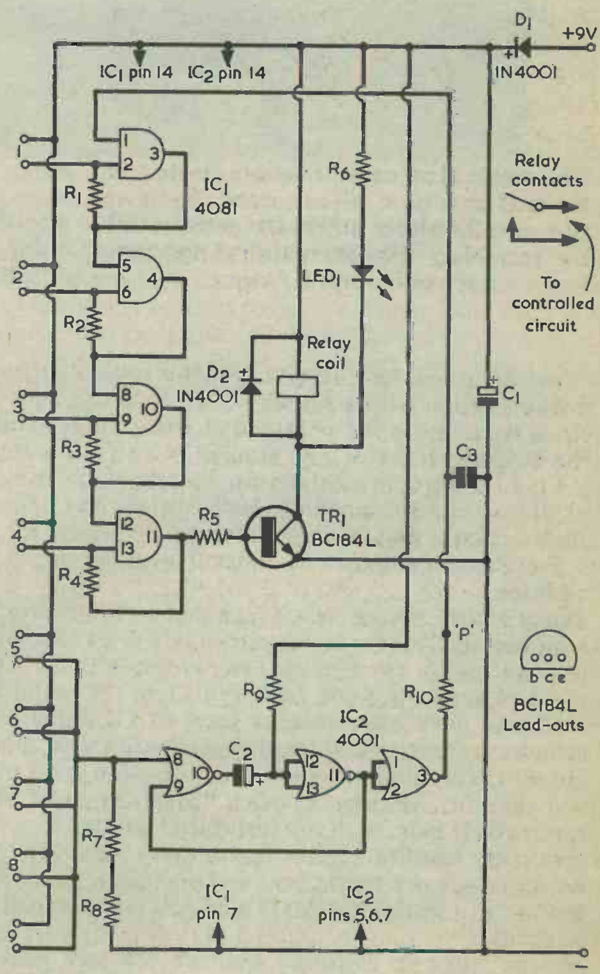
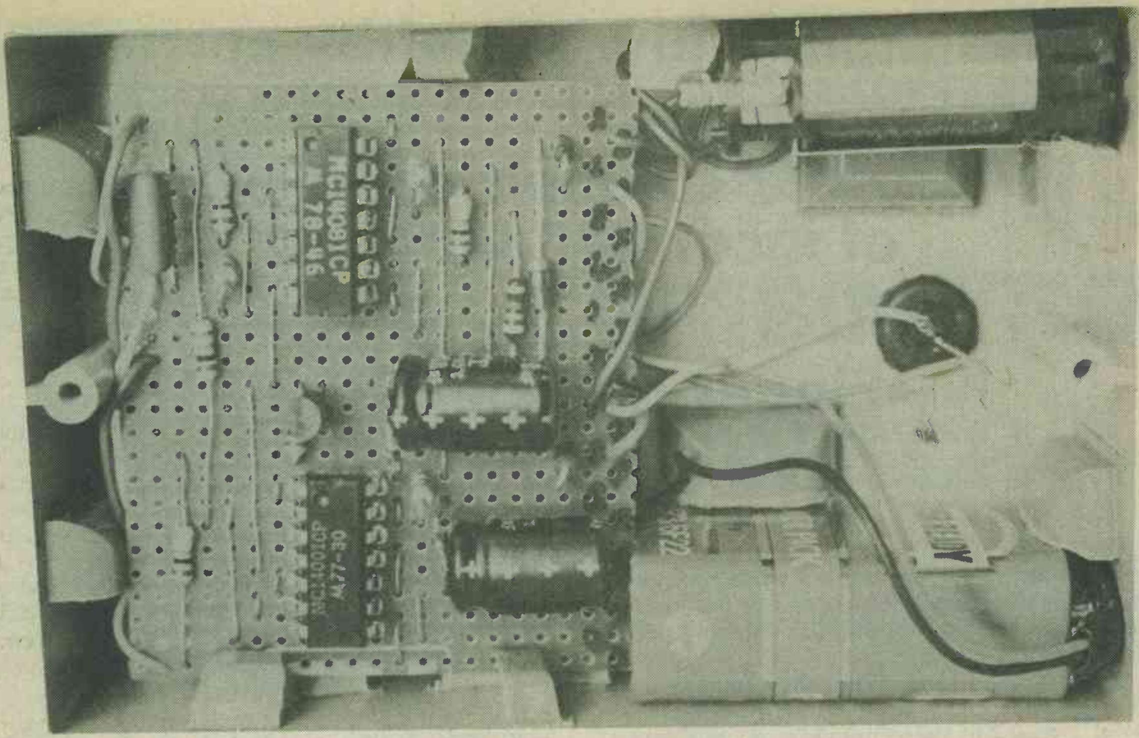


Fig.2. The circuit of the combination switch. Contact sets 1 to 4 have to be touched in numerical order to actuate the switch. Touching any of the other contact sets inhibits the switch for a period dependent upon the values of C2 and R9. Contact set numbering does not, of course, correspond with the numbers on the front panel of the switch.



Looking inside the combination switch case. The author's unit is powered by a PP3 battery and incorporates a dry reed relay, which is mounted opposite the battery.

contacts then turn on whatever circuit is controlled by the combination switch. Diode D2 protects the transistor against high inductive voltages when the relay is subsequently released. The transistor also turns on the l.e.d. in its collector circuit, thereby indicating that the correct sequence of touch buttons has been selected. LED1 and its current limiting resistor, R6, are not essential and may be omitted from the circuit, if desired.

If any of the "wrong" contact pairs, 5 to 9 inclusive, is touched, pin 8 of the NOR gate in IC2 is taken high and its output at pin 10 goes low, as also do pins 12 and 13 of the next NOR gate. Pin 11 of the second NOR gate goes high and, as long as C2 remains discharged, these two gates stay latched in this new condition. The high output at pin 11 causes pin 3 of IC2 to go low. This low is passed via R10 to pin 1 of the top AND gate, with the result that contact sets 1 to 4 become inactive. Even if one or more of the AND gate outputs has already been latched high, the low input at pin 1 of the top AND gate will take them all low again.

When, after a "wrong" contact set has been touched, pin 10 of IC2 goes low, capacitor C2 is discharged. It then begins to charge slowly via R9 until, eventually, pins 12 and 13 of IC2 go sufficiently high to cause pin 11 to go low and pin 3 to go high. The first two NOR gates latch back to their initial state and the combination switch may again be operated by touching contacts 1 to 4 in the correct order. The values of C2 and R9 are chosen by the constructor to suit his particular requirements. A very long time delay is not recommended as it would be irritating for the authorised user to have to wait too long if he accidentally touched a wrong contact set. As an example, a value of 1MΩ for R9, with 4.7μF for C2, will provide a delay of about 3 seconds. Increasing either R9 or C2, or both, will increase the delay. In practice a delay of about 3½ minutes is suggested, and this will be obtained with R9 at 4.7MΩ and C2 at 100μF.

COMPONENTS

Resistors

(All ¼ watt 5% unless otherwise stated.)

R1 10MΩ10%	R6 1kΩ
R2 10MΩ 10%	R7 10MΩ 10%
R3 10MΩ	R8 10MΩ 10%
R4 10MΩ 10%	R9 see text
R5 4.7kΩ	R10 1MΩ

Semiconductors

IC1 4081	D1 1N4001
IC2 4001	D2 1N4001
TR1 BC184L	LED1 red l.e.d.

Capacitors

C1 100μF electrolytic, 10V. Wkg.
C2 see text
C3 0.01μF polyester, type C280

Miscellaneous

9-volt battery type PP3 (see text)
Battery connector
Plastic case (see text)
Relay (see text)
18-off touch contacts (see text)
2-off 14-way i.c. holders

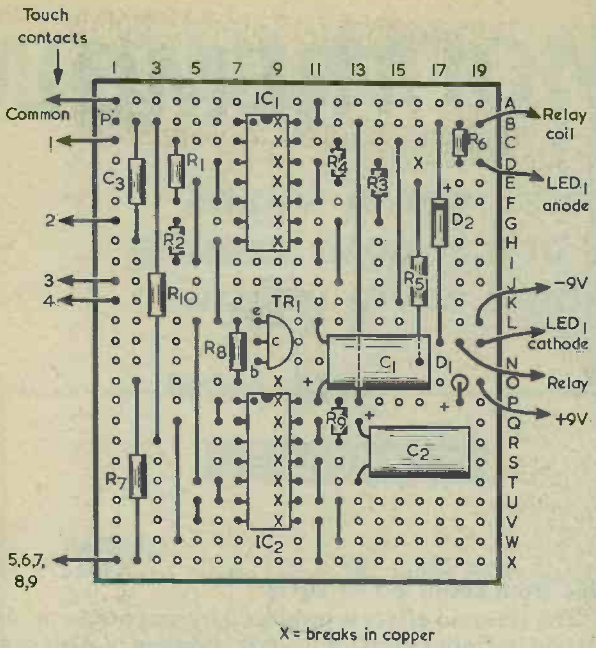
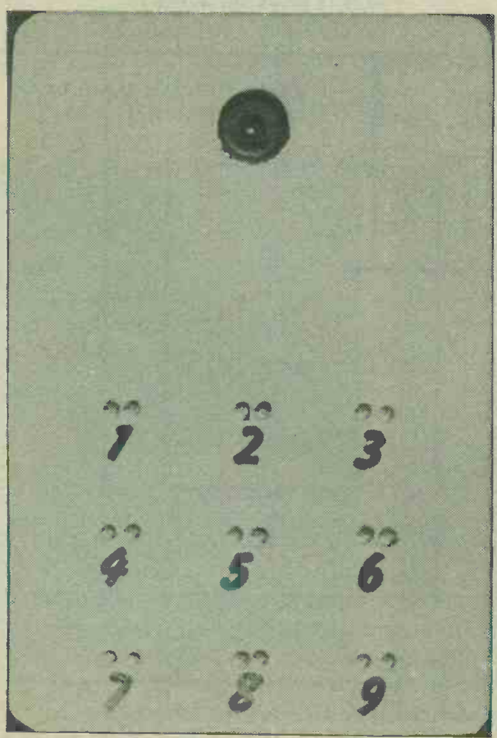


Fig.3. Veroboard layout as seen on the component side of the board. The "common" lead from hole A1 connects to one contact of all the contact pairs.



Also mounted on the front panel is a light-emitting diode which lights up when the correct combination has been selected.

Diode D1 is optional, but is included to ensure that no damage is done should the battery be momentarily connected the wrong way round, as can easily happen with a PP3 type connector.

Point "P" is provided to turn off the combination switch once entry has been gained or an alarm switched off, etc. A push-button may be connected between point "P" and the negative rail, and if this is momentarily pressed it will cause all the AND gates to latch low. This switching option was not used with the author's circuit. Touching one of the "wrong" contact pairs will also, of course, cause the AND gates to latch low.

CONSTRUCTION

The relay can be any type having a coil resistance of 150Ω or more which will energise reliably at some 8 volts. The prototype used a reed relay. The quiescent current consumed by the circuit is negligibly low and the author's unit was powered by a PP3 battery. Once the switch has operated the current drawn is that required by the relay plus some 1 to 2mA in the base circuit of TR1 and about 7mA in LED1. If it is desired that the relay remain energised for relatively long periods, some constructors may prefer to use a 9 volt battery that is larger than PP3 size.

Most of the components are assembled on a 0.1 in. matrix Veroboard having 19 holes by 24 strips. Component layout is shown in Fig.3. Before soldering components in place, make the breaks in the copper strips as indicated. There are 16 of these breaks. To avoid damage to the two CMOS devices it is advisable to solder i.c. holders to the Veroboard and then plug in the two i.c.'s after all wiring has been completed.

The switch may be housed in any plastic case which will take the Veroboard, relay and battery. That employed by the author measured 4½ in. high by 3 in. wide. The contact sets consisted of large stainless steel pins, the diameters of the heads being about 2mm. Each pair is mounted with centres about 4mm. apart, 18 pins being required for the 9 contact pairs. The holes drilled in the front panel of the case allow the pins to be tight push fits. The wires from the Veroboard to the pins are routed to provide the required combination. Avoid overheating the pins when soldering as the plastic may then melt, causing the pins to become loose. Contacts can also be provided by small screws with nuts, the screws having heads with a bright plated finish.

The Veroboard is held in place by pieces of plastic glued to the sides of the case. In the prototype it is at the same end of the case as the contact pins, and its underside is kept well clear of the pin ends. Any other means of mounting the Veroboard which will not interfere with its circuit operation can be used. The l.e.d. is a push fit in a rubber grommet which is also mounted on the front panel.

The completed switch is checked by touching the 4 sequence contact sets in correct order. The l.e.d. should then light up. Next, touch one of the remaining contact sets and the l.e.d. should extinguish. It should not be possible to light it again, by touching the 4 correct sequence contacts, until the time delay imposed by C2 and R9 has elapsed.

The prototype has proved reliable in operation over a long period of time. The touch contacts must be kept clean and dry. Avoid spraying the contacts with ordinary cleaning agents such as are used for dusting, etc., as these can easily produce an insulating film which makes the contacts inoperative. ■

TREMOLO

By

I. M. Attrill

Although it is one of the easiest forms of electronic musical effect, tremolo is still used very frequently these days. Tremolo units can be simple and inexpensive, and they make an ideal project for the constructor who is interested in electronic music. The design featured in this article produces very low levels of noise and distortion, and is suitable for use with a low level input such as that provided by a guitar pickup. It can handle inputs of up to several hundred millivolts r.m.s. without clipping, and is therefore also suitable for use with many organs and tone generators, etc.

The unit is powered by an internal 9 volt battery and is self-contained. The tremolo frequency is variable from about 2.5 to 10Hz.

The tremolo effect is produced by amplitude modulating the input signal at tremolo frequency. This can be achieved by a unit consisting of two stages: a modulator which has a voltage gain proportional to a voltage fed to its control terminal, and a low frequency oscillator which provides the control voltage. The frequency of the oscillator should be variable to give what is considered the most desirable effect, and it should cause the signal amplitude to be varied smoothly.

Fig.1 shows the complete circuit of the tremolo unit.

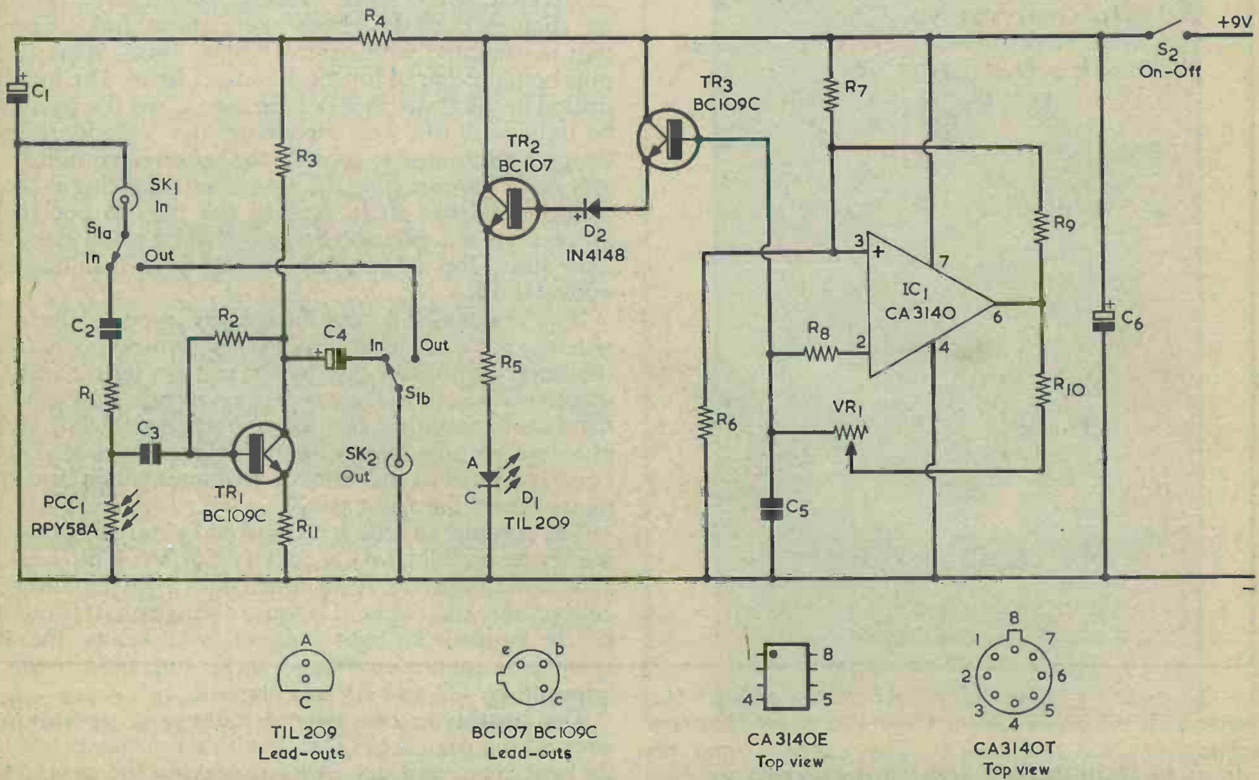


Fig.1. The circuit of the tremolo unit. IC1 appears in an oscillator circuit, the output of which is fed to the TIL209 light-emitting diode. The light from the l.e.d. falls on PCC1 and amplitude modulates the signal applied to TR1.

MODULATION UNIT

Easily made circuit adds brilliance to guitars, organs and electronic music. Opto coupling gives smooth modulation.

COMPONENTS

Resistors
(All fixed values ¼ watt 5% unless otherwise stated)
R1 8.2kΩ
R2 1.8MΩ 10%
R3 4.7kΩ
R4 470Ω
R5 1.2kΩ
R6 100kΩ
R7 100kΩ
R8 10kΩ
R9 100kΩ
R10 33kΩ
R11 820Ω
VR1 100kΩ potentiometer, linear

Capacitors
C1 100μF electrolytic, 10V. Wkg.
C2 1.5μF polyester type C280
C3 0.1μF polyester type C280
C4 4.7μF electrolytic, 10V. Wkg.
C5 1.5μF polyester type C280
C6 100μF electrolytic, 10V. Wkg.

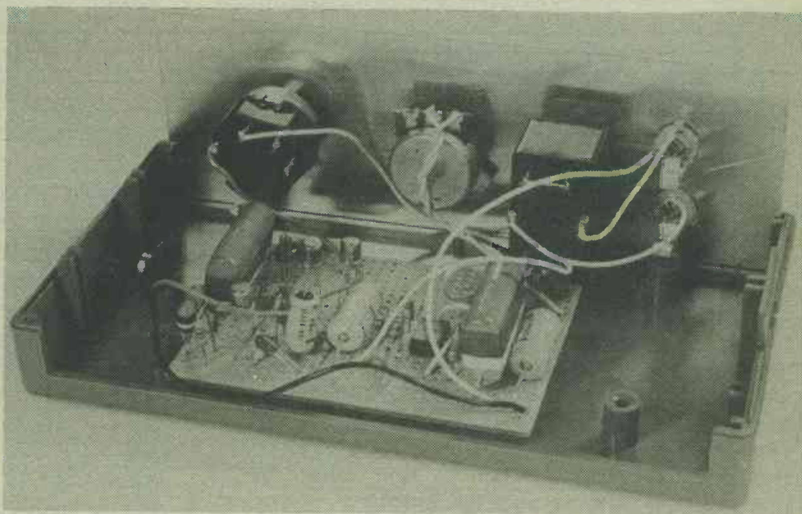
Semiconductors
TR1 BC109C
TR2 BC107
TR3 BC109C
IC1 CA3140E or CA3140T
D1 TIL209
D2 IN4148

Photoconductive Cell
PCC1 RPY58A

Switches
S1 d.p.d.t. (see text)
S2 s.p.s.t. rotary

Sockets
SK1 3.5mm. jack socket (see text)
SK2 3.5mm. jack socket (see text)

Miscellaneous
Case (see text)
9-volt battery type PP3
Battery connector
Veroboard, 0.1in. matrix
2 control knobs
Nuts, bolts, wire, etc.



Layout inside the case. There is plenty of room available for the 9 volt battery.

The input signal at socket SK1 is applied via S1(a) and d.c. blocking capacitor C2 to the attenuator consisting of R1 and PCC1. The output from the attenuator is fed via C3 to the common emitter amplifier, TR1, and the output signal at TR1 collector passes through C4 and S1 (b) to the output socket, SK2. Due to the unbypassed emitter resistor, R11, the voltage gain of TR1 is of the order of 6 times only. The transistor has an input impedance at its base of several hundred kilohms.

PCC1 is a cadmium sulphide photo-resistor which has a minimum resistance of 200kΩ in total darkness. This resistance falls to less than 1kΩ under reasonably bright conditions. The signal input to TR1 base can in consequence be varied by varying the light intensity on PCC1, and this effect produces the tremolo amplitude modulation.

The light which falls on PCC1 is provided by the light-emitting diode, D1. The tremolo oscillator employs operational amplifier IC1 in a circuit which has appeared in previous articles in this magazine, and whose functioning will only be briefly described here. The upper plate of C5 couples via the protection resistor, R8, to the inverting input of the i.c., whilst the non-inverting input is connected to the three equal value resistors, R6, R7 and R9. At switch-on, C5 will be discharged, whereupon the i.c. output will be high and the non-inverting input will be at two-thirds of the supply potential. C5 will then charge via R10 and VR1 until its upper plate takes up the same potential as that at the non-inverting input. The i.c. output then triggers to the low state, causing the non-inverting input to be at about one-third of supply potential, and C5 commences to discharge. When the voltage across C5 falls to that at the non-inverting input the output triggers to the high state and C5 charges once more. The oscillation then continues, with C5 alternately charging and discharging. Oscillator frequency is controlled by VR1.

A roughly triangular waveform is given at the

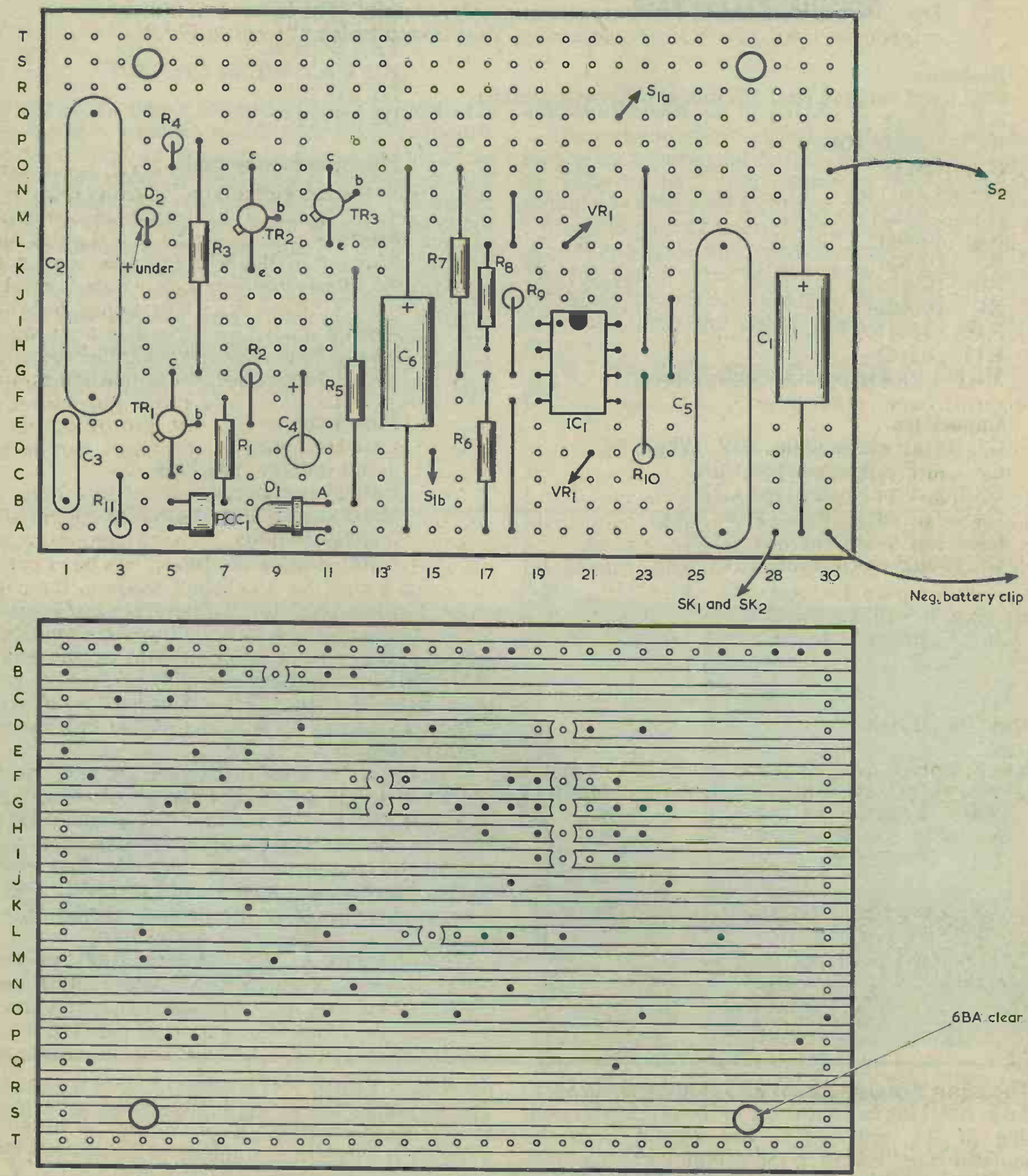


Fig.2. Most of the components are assembled on a Veroboard panel. This diagram shows the component and copper sides of the panel.

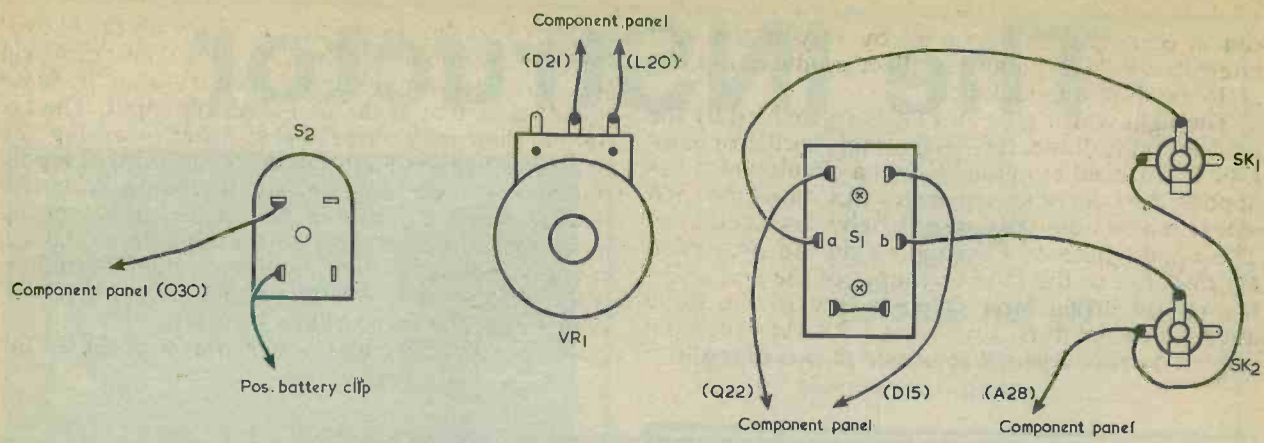


Fig.3. The wiring to the components on the front panel. The letter and number references apply to the corresponding Veroboard holes shown in Fig.2

upper plate of C5 and this is applied to the base of emitter follower TR3. TR3 couples via D2 to the base of a second emitter follower, TR2, with the result that the input impedance at TR3 base is very high and there is negligible loading on the oscillator. The emitter of TR2 drives the l.e.d., D1, and thereby causes the intensity of the light it emits to vary at oscillation frequency. D2 is interposed between the two transistors to increase the voltage drop from TR3 base to TR2 emitter and to thereby ensure that D1 is fully extinguished when the voltage from the oscillator is at its minimum level.

Switch S1(a)(b) can be used to bypass the unit, so that the tremolo effect can be switched out when it is not required. VR1 controls the tremolo frequency. S2 is the on-off switch for the unit, and current consumption from the 9 volt battery is only 3.5mA. The RPY58A specified for PCC1 is available from Maplin Electronic Supplies. Capacitor C4 is specified as 10V. Wkg., but it will be quite in order to employ a capacitor having a higher working voltage.

CONSTRUCTION

The prototype tremolo unit is housed in a Verocase type 75-1238D, which has approximate dimensions of 153 by 84 by 59mm. The general layout can be seen from the accompanying photographs, whilst Fig.3 shows the layout of the front panel components as seen from the rear. S1(a)(b) is a d.p.d.t. toggle switch. However, if the unit is to be used with a guitar, or in other circumstances, where it would be preferable for S1 (a)(b) to be a foot operated switch, the components should be housed in a strong case such as a diecast box. S1 (a)(b) could then be a heavy duty successive action push button switch mounted on the top of the case. The input and output jack sockets were 3.5mm. with the prototype but any other jack sockets, such as ¼in. types, can be employed if these are more convenient.

Most of the circuitry is assembled on a 0.1in. matrix Veroboard having 30 holes by 20 copper strips. The layout is shown in Fig.2. The two mounting holes should be drilled after the board has been cut out, following which the breaks are made in the copper strips. IC1 has a MOSFET input stage and is susceptible to damage by high static voltages. It should be the last component to be soldered into circuit, and the soldering iron must have a reliably earthed bit. Either the CA3140E (8 pin d.i.l. version) or the CA3140T (T099 cased) can be employed. The pin layout of both types is shown in Fig. 1.

PCC1 and D1 must be oriented so that the light output of D1 is directed at the sensitive surface of PCC1. If PCC1 is examined it will be found that the lead-out wires can be clearly seen connecting to one side of the component. It is the other side which is light-sensitive and which should face D1. The two components should be positioned so that they are touching each other, or are virtually so.

The wiring from the board to the front panel components is very straightforward and is illustrated in Fig.3. When this wiring is completed it is merely necessary to mount the component panel to the bottom of the case using 6BA bolts and nuts with spacing washers under the panel. After a final check of the wiring the unit is then ready for testing and use. It will, of course, be necessary to fit the case lid for correct operation, in order that external light cannot fall on PCC1.

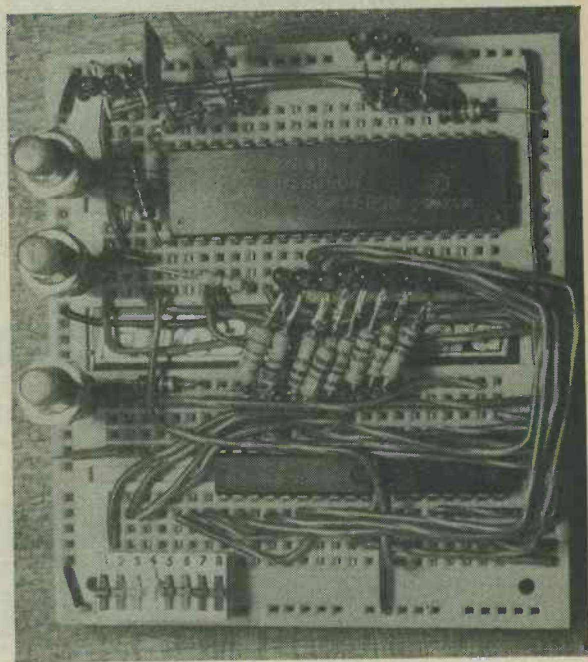
■

On the front panel the input and output sockets are to the left. Switch S1(a)(b) is to the right of these, followed by VR1 and S2.

The INStructor

Part 4

By Ian Sinclair



A PRACTICAL INTRODUCTION TO MICROPROCESSORS

Subtraction and the use of negative numbers.

In Part 3 we saw how the microprocessor deals with addition, and the use of the carry/link bit to "catch" the ninth bit in an addition. We're going to take a further look at this carry/link bit now because it's important in any arithmetical operation. If, for example, you have the carry/link bit set from some previous operation it will, unless you clear it, be automatically added in to a later addition. This may give you the impression that the microprocessor doesn't add very well!

STATUS TO ACCUMULATOR

Last time, we detected whether the carry/link was set by doing an addition, and checking to see if an extra 1 had been added in. This is a rather roundabout method, so we'll start this month with something easier. It's a single byte instruction, coded as CSA, meaning Copy Status to Accumulator. The effect of this instruction, which is 00000110, is to set all the flip-flops of the accumulator to the same pattern as the flip-flops of the status register. As we've mentioned, the status register is a collection of flip-flops, each of which is used for some different signal. The carry/link bit is bit number 7 of the status register, so that when we carry out the CSA instruction the 7th data bit of the accumulator is set to 1, and we can use the display routine to look at the effect on the data l.e.d.'s. Fig. 1 shows a short routine which gives you a bit of practice in this – it starts, after reset, with the instruction SCL, set carry/link, which sets the carry/link to logic 1. The next step, CSA copies this into the accumulator and then the two display steps let you see the l.e.d.'s lit. Providing you remembered to reset (so that all registers started at zero), the display will show 10000000, with only D7 lit, indicating that bit 7 of the status register was set. Remember that counting of these flip-flops always starts at 0, so that D7 is what one would normally call the 8th bit.

Just to make certain, the next part of the program in Fig. 1 resets the carry bit. The NOP instruction allows the 8060 to return to normal memory addressing, then CCL clears the carry/link (to zero). Once again, we look at the result by using CSA followed by the display routine. This time, all the data l.e.d.'s are extinguished showing that the carry/link was cleared.

Being able to inspect the carry/link in this way is useful, and it also lets us look at the other bits in the status register. If, by the way, you're wondering why the word "link" is used along with

```
RESET
SCL  00000011
CSA  00000110
Display
NOP  00001000
CCL  00000010
CSA  00000110
Display
```

Fig.1. Reading the status register.

RESET
LDI 11000100
196 11000100
ADI 11110100
244 11110100
CSA 00000110
Display

Fig.2. Setting the carry/link by a binary addition.

RESET
LDI 11000100
128 10000000
ADI 11110100
192 11000000
CSA 00000110
Display

Fig.3. A sum which sets another part of the status register.

RESET
00101101 complements to
11010010
Then add 1 to get
11010011 which is the 2's complement, the number in its negative (SIGNED) form.

Fig.4. Forming a 2's complement.

"carry" – be patient, all will be revealed later. Meantime, let's flex our muscles a bit and check if a binary sum has caused the carry/link to be set. The program is shown in Fig.2 – try it, and see if the carry/link is set.

That was straightforward, so now try something for yourself. Question is, does a decimal add cause the carry/link bit to be set? Try adding 10000011 and 10010101 (DCB for decimal 83 and 95), remembering that the add instruction has to be DAI (11101100).

Once you've sorted that out for yourself, it's time for a puzzle. Fig.3 shows the program, which is a simple binary addition of 10000000 and 11000000, followed by a look at the status register. Try it out. You'd expect to find D7 lit, because there's certain to be a carry – but why is D6 lit? The answer briefly is that mhis is another bit of the status register which has been set by this addition. It's called the overflow, and very shortly we'll see why it has been set.

SUBTRACTION AND NEGATIVE NUMBERS

The arithmetic circuits of microprocessors consist entirely of adders – so how do we subtract one number from another? The answer is that we don't – we add a negative number to a positive number, which comes to the same thing. The obvious next question is – how do we represent a negative in binary? Since we have only the two digits 1 and 0, we have to make use of these, and the answer is that we use a 1 in the most significant place (D7) of the number to show that a negative number is intended. Now this conversion of a positive number to a negative number can be done very easily by a process called 2's complement. The number we're going to subtract must consist of seven bits, because the eighth (D7) is reserved for the "negative sign" bit, and we convert it to negative form by writing all eight bits (Fig.4) and then complementing – swopping each 0 for a 1, and each 1 for a 0. When this has been done, we add 1 to the lowest place (D0) and that's our number in negative form, ready to *add* to the other one. A substraction of this type, incidentally, involves discarding any carry from D7 so that if we carried out two substractions in a row we would normally have to clear the carry/link bit. Do we hear an objection? Using seven bits only lets us use numbers up to 01111111, 127 in decimal. It's no problem, really because we can take larger numbers eight bits at a time, and only the highest bit of all needs to be used as a sign bit. Fig.5 shows an example of 15-bit arithmetic, with the 16th bit used as the sign bit. When this is done,

Number (A) is 01001001 11001011
Number (B) is 00110111 11100101 and is to be subtracted from (A).
UPPER BYTE LOWER BYTE

Complement the UPPER BYTE of B to 110010000
Then 2's complement the LOWER BYTE of B to 00011011
Then add:
01001001 11001011
11001000 00011011
———— ————
00010001 11100110 and the carry bit is set
UPPER BYTE LOWER BYTE of answer.

Fig.5. 15-bit arithmetic.

```
RESET
SCL   00000011
LDI   11000100
5     00000101
CAI   11111100
3     00000011
Display
NOP   00001000
CSA   00000110
Display
```

Fig.6. A simple subtraction program.

```
RESET
SCL   00000011
LDI   11000100
3     00000011
CAI   11111100
5     00000101
Display
NOP   00001000
CSA   00000110
Display
```

Fig.7. A subtraction which gives a negative answer.

only the lower byte of the number which is to be substracted has 1 added to it, the upper byte is only complemented.

Back to the hardware. The instruction for subtraction is Complement and Add, and we'll use this in its immediate form, CAI, whose binary code is 11111100. This will only complement the number and add it in, it won't add 1. The reason is that 1 only has to be added to the lower byte, when a two byte number is used, so that addition is not part of the instruction. How do we add 1? We could, of course, load in a 1 and add it, but a much simpler method is to set the carry link before the complement and add step. This way, the 1 is automatically added in at the time when the complement is added – simple. Now try this out. A simple binary subtraction program is shown in Fig.6 – we're subtracting 00000011 from 00000101 (decimal 3 from 5) to get the expected answer of 00000010 (decimal 2). The program now goes on to check the status register – which should show the carry which we ignore. Now what happens if we do this the other way round and subtract 5 from 3? Fig. 7 shows the program steps. Try it out and jot down the answer, then find out what's happened to the status register.

No carry in the status register? The answer looks a bit odd too, doesn't it? The reason is that this is a negative answer, and the 1 in the eighth (D7) place indicates this. To make sense of it we have to convert it back to ordinary form by reversing the 2's complement process. This is done by subtracting 1 or by adding 11111111, which is the two's complement of – 1, giving the sum 11111101, which is complemented to 00000010, or decimal 2. We can make the microprocessor go through this routine by using the program in Fig.8. Note that we have started with the result of the subtraction loaded in, because it saves having to start again from scratch. When we copied the status register to the accumulator we lost the data which was in the accumulator.

EXTENSION REGISTER

There is a way of preserving that data byte, though, when we want to copy status, and it's shown in the programs of Figs. 8 and 9. The two new instructions are XAE and LDE. XAE means Exchange Accumulator and Extension, and it swops the byte in the accumulator with the byte in another register called the extension register. If we always start a program with a reset, we can expect that the extension register will be full of zeros when we make this step, so that the result is to tuck away the byte which was in the accumulator and leave a clear accumulator. We can then copy the status register and look at it, knowing that the two sets of bytes are preserved. To look again at the byte which is now in the extension register we use the instruction LDE – Load Accumulator from Extension. This doesn't erase the byte in the extension register, it merely copies it into the accumulator.

Now for some problems. Suppose we use the microprocessor to add two numbers, and one or both of these numbers starts (8th place, D7) with a 1. Does the microprocessor treat this as a negative number, or does it have some magical way of being able to tell the difference between, say 10011010, meaning plus 154, and 10011010, meaning – 102?

```
RESET
LDI   11000100
-2    11111110
ADI   11110100
-1    11111111
CCL   00000010
XAE   00000001
CAE   01111000
Display
```

Fig.8. "Unscrambling" a 2's complement number.

```
RESET
SCL   00000011
LDI   11000100
3     00000011
CAI   11111100
5     00000101
XAE   00000001
CSA   00000110
Display
NOP   00001000
LDE   01000000
Display
```

Fig.9. Using the extension register to store an answer.

10011010 as an unsigned number is 2 + 8 + 16 + 128 = 154.
10011010 taken as a signed number is found by subtracting 1 (or ADDING 11111111) to get 10011001, then complementing to get 01100110. This number is 102 in decimal and, because it was a signed number, we must write it as – 102.

Fig.10. Two identical binary numbers with different meanings.

```
   00111101
 + 00011001
 ----------
   01010110
     (a)

   11000101
 + 11101001
 ----------
   10101110
     (b)

   10100010
 + 10011001
 ----------
   00111011
     (c)

   01010110
 + 01110011
 ----------
   11001001
     (d)
```

Fig.11. Additions which cause different effects on carry and overflow.

See Fig. 10. The answer is simpler than you might think – it can't! The microprocessor simply carries out binary arithmetic and what you make of the numbers is entirely up to you. As a help, though, there's a warning signal which lets you know if you have to be careful about an answer. It's called the overflow bit (OV) and it's bit 6 (counting 0 to 7) on the status register.

To see this in action, try out the four addition programs which are shown in Fig. 11, note the answers and check the OV bit by using the CSA, Display, procedure. The reasons go like this. In example (a) the numbers are positive, no matter how you look at it, and the answer is also positive. There's no carry out of the 7th or 8th place (D6 or D7). The answer is correct, and the OV is not set. In example (b) there are carries out of D6 and D7, and the carry out of D7 causes the carry/link to be set. If we think of this as straightforward unsigned arithmetic, then we're adding decimal 197 to decimal 233, and getting (remembering the 9th bit in the carry/link) the answer decimal 430. Looks all right, but suppose we were thinking of these two as negative numbers? If we were using signed arithmetic, then 11000101 is decimal – 59, and 11101001 is decimal – 23, giving the answer – 82, which is correct. No matter what *we* make of the figures, then, the arithmetic is correct.

Now for (c). If we take both numbers as unsigned, so that the highest order 1 (in D7) represents decimal 128, then the answer is correct (remembering the carry bit). What if we take the D7 1's as meaning negative sign? 10100010 then means decimal – 94, and 10011001 is decimal – 103, adding to – 197. The biggest number we can handle with seven digits, though, is 128, and the eighth digit has become 0, indicating a positive number! This is an overflow, and the overflow status is set to warn us. If we are using signed numbers, then the 0 at the start is false; the number is really negative. If we reverse the 1's complement on the result, we get the correct answer, – 197.

Next, example (d). Once again, the sum causes no difficulties with unsigned arithmetic, but the answer looks wrong when we think of these as positive numbers, and the answer as negative! Once again, the overflow bit is set as a warning

```
RESET
LDI   11000100
      11100111 lower A
SCL   00000011
CAI   11111100
      01011001 lower B
XAE   00000001 stores result in extension
LDE   01000000 brings it back (but leaves a copy in the extension)
Display . . so that you can look at it
LDI   11000100
      00101000 upper A
CAI   11111100
      00011010 upper B
Display
The lower byte of the answer is still in the extension.
```

Fig.12. The carry used in double-byte subtractions.

Mnemonic	Code	Operation
LDE	01000000	Load the accumulator from the extension.
XAE	00000001	Exchange accumulator and extension
ANE	01010000	AND extension with accumulator
ORE	01011000	OR extension with accumulator
XRE	01100000	X-OR extension with accumulator
DAE	01101000	Decimal add extension to accumulator
ADE	01110000	Binary add extension to accumulator
CAE	01111000	Complement and add extension to accumulator

Note. In each of these instructions, apart from the exchange instruction, the number stored in the extension register is not cleared nor changed. The accumulator ends up with the result of the instruction.

Fig.13. The extension register instructions summarised.

that two positive numbers don't produce a negative answer. What the overflow flag warns, then, is that we can use the D7 bits as part of the number, but that its sign is wrong. This bit is used as a warning only – it's never added in anywhere. If it has to be checked in a program, the procedure is to copy the status register to the accumulator (carrying any valuable data byte in memory or in the extension register) and then use logical AND to the byte with the pattern 01000000 – we'll explain that later. These status register bits, incidentally, are often called "flags", so that we refer to the carry/link flag and the overflow flag as being set (to 1) or reset (to 0).

Now what does the carry/link bit do when we subtract? Common sense leads to the conclusion that it simply does exactly as it always does – if it's set, it adds in on the next byte. to see what this does we can try a two byte subtraction, as shown in Fig. 12. What we're doing is subtracting (B) 0001101001011001 from (A) 0010100011100111, and it's done in two bytes, as you would expect. We start by loading the lower byte of the number (A), 11100111 and setting the carry/link so that when we complement and add immediate (CAI), we have carried out a 2's complement subtraction.

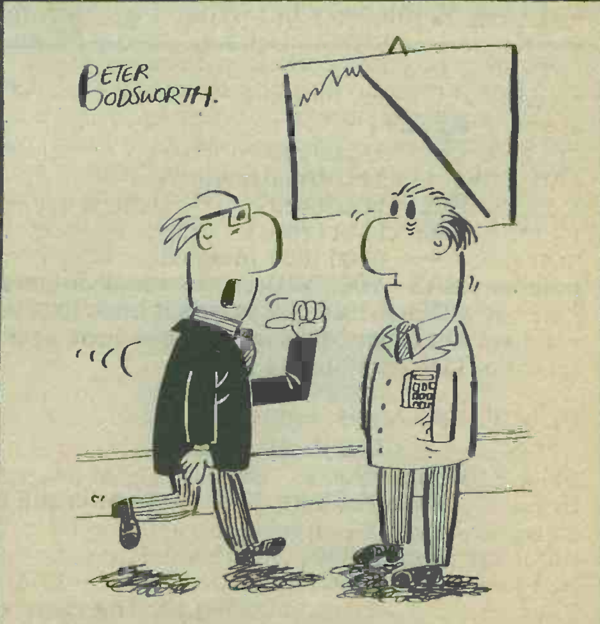
We can display this byte and also preserve it in the extension register, and then load in the upper byte of number A. Using the complement and add on the upper byte of number B then gives the result of upper byte subtraction, which can be displayed in the usual way. Note that we only need to set the carry/link bit for the lower byte, after that everything is automatic – the carry/link is reset when the first complement and add is put in, then set again by the carry from this stage, to be added in at the next complement and add step.

Now for some homework. Could you write and try out a program so that you could look again at the lower byte of the answer, which was stored in the extension register? Remember that this will be stored only if you haven't reset.

Just one final point. All the arithmetic operations we've looked at so far can also be carried out on numbers in the extension register, using the commands shown in Fig.13. This lets us carry out arithmetic operations on two bytes separately, but the same carry/link is used, so that we need to take great care that a carry from an operation in one register is not taken to the other register unless we want it. Obviously, if we're carrying out double byte arithmetic we'll want the carry, but whatever we're doing we mustn't forget it!

Next month – Logic Operations.

(To be continued)



"We really are in trouble, the computer's just resigned!"

COIL – COUPLED

S. W. CONVERTER

By R. A. Penfold

INDUCTIVE COUPLING TO M.W. radio — no wires.

19 to 67 metres. Full superhet selectivity.

In conjunction with an ordinary medium wave superhet receiver having a ferrite aerial this unit permits reception on the short wave broadcast bands in the range of 4.5 to 16MHz. The range gives full coverage of the 19, 25, 31, 41 and 49 metre bands. The 20 and 40 metre amateur bands are also covered, but the converter is not recommended for amateur bands reception and is really intended as a means of increasing the number of broadcast stations which can be received with an ordinary domestic radio.

There is no need to make any modifications to the receiver with which the converter is used, and there are no direct connections between the converter and the receiver. The converter radiates a strong local signal at a nominal frequency of 1.6MHz, or 188 metres, and this is picked up by the ferrite aerial of the radio. It is merely necessary to place the converter near the receiver and then tune the latter to a quiet point around 1.6MHz. Short wave tuning is then carried out with the converter controls, which alter the received short wave signal frequencies to the 1.6MHz reception frequency of the radio.

BLOCK DIAGRAM

The stage line-up of the converter is shown in the block diagram of Fig. 1. The aerial signal is selected by the input tuned circuit and is applied to the mixer stage. So also is the output of a tunable oscillator. The difference frequency is then extracted from the mixer by a tuned radiator coil which is resonant at 1.6MHz. The signal and oscillator tuning capacitors are ganged and the two tuned circuits are set up so that the oscillator frequency is always higher than the aerial signal frequency by 1.6MHz. The principle is the same as that encountered in the first stages of a conventional superhet, and the aerial and oscillator coils specified would produce an intermediate frequency of 1.6MHz in a normal superhet application.

As with the superhet, this line-up can be subject to interference by image signals. If, for instance, it is desired to receive a signal of 10MHz, the oscillator would be set to 11.6MHz to give the difference frequency of 1.6MHz. An image signal at 13.2MHz, which also gives a difference frequency with the oscillator of 1.6MHz, could then break through. It is the

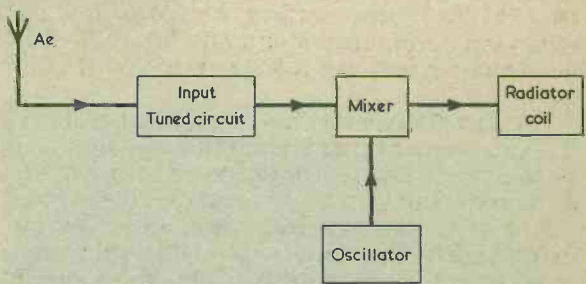


Fig. 1. The stage line-up of the short wave converter. The radiator coil causes an output signal at a nominal frequency of 1.6MHz to be coupled into the ferrite rod aerial of a medium wave receiver. No interconnecting wires are needed between the converter and the receiver.

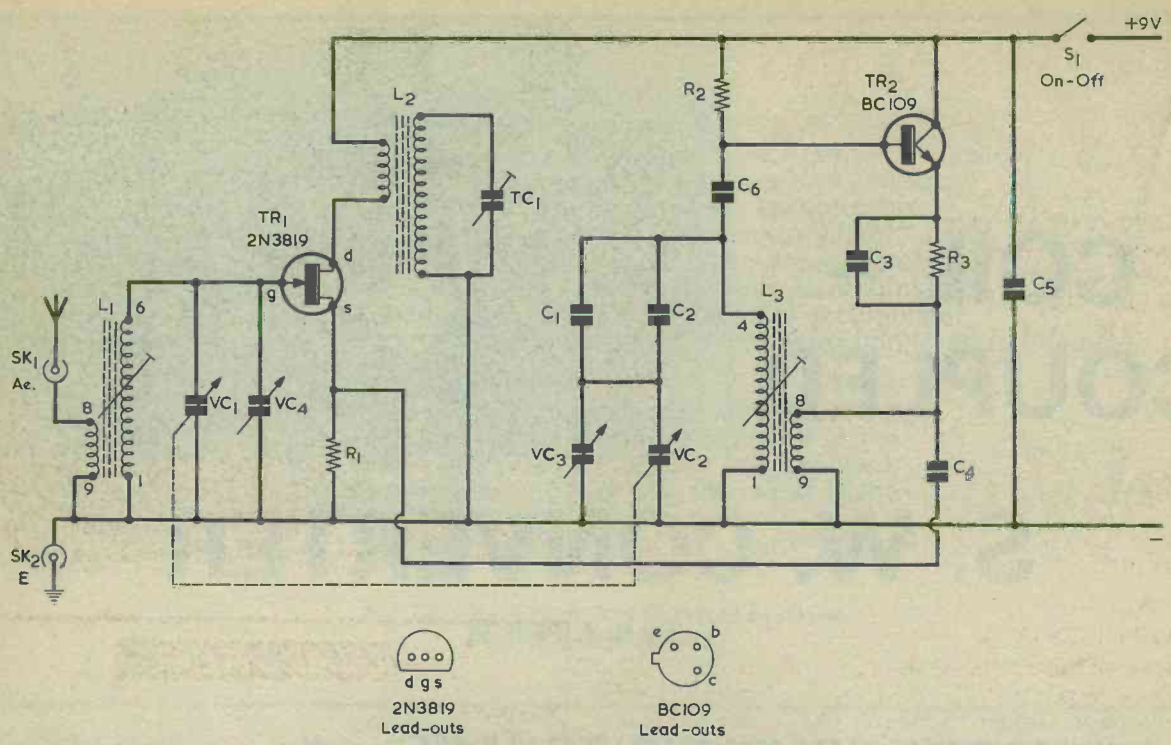


Fig. 2. The circuit of the short wave converter. L1 is the aerial input coil, L3 the oscillator coil and L2 the radiator coil.

function of the aerial tuned circuit to boost the strength of the required aerial signal and to attenuate the unwanted image signal.

The mixer output is coupled to the radiator coil. A tuned coil is used here since, although it makes initial alignment of the converter a little more difficult, it produces a much stronger field strength than does an untuned coil. The coil is, in fact, the coil of a standard medium wave ferrite aerial. The local field strength from the radiator coil is quite high, but it rapidly falls in strength with distance from the coil, and there is no danger of the converter radiating sufficiently strongly to cause interference with other receivers.

Two sockets, for aerial and earth, are mounted on the rear panel of the case.

CIRCUIT OPERATION

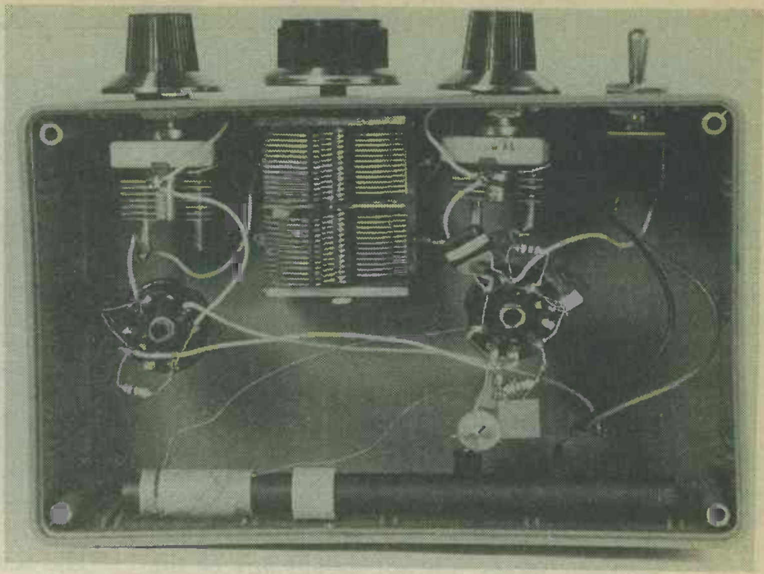
The circuit of the converter is shown in Fig. 2. The aerial is coupled to the tuned winding of L1 via the coupling winding, and the tuned winding connects directly to the gate of the mixer, TR1, which has a very high input impedance. The main tuning capacitor is VC1, with VC4 acting as an aerial trim capacitor. There is a third coupling winding on L1 which is not used in the present circuit, and this winding is not shown in the circuit diagram. Source bias for TR1 is provided by R1.

TR2 is the oscillator, and is employed in the emitter follower mode. The tuned winding of L3 couples via C6 to the transistor base, and positive feedback is provided via the coupling winding in the emitter circuit of TR2. Like L1, L3 has a third winding which is not used, and which is not shown in Fig. 2. The main oscillator tuning capacitor is VC2, which is ganged with VC1. VC3 is an oscillator trim capacitor and functions as the bandspread control. Fine tuning is carried out by VC3, which is much easier to adjust than VC2 because of the limited frequency coverage it offers. C1 and C2 in parallel form the oscillator padding capacitor and ensure good tracking over the range covered. The oscillator output couples through C4 to the source of TR1.

The difference frequency present at the drain of TR1 is applied to the coupling winding on the output coil, L2. The large winding is tuned to the output frequency by TC1.

C5 is the supply bypass capacitor and S1 the on-off switch. The total current consumption is only about 2.5mA, which allows many hours of operation from the PP3 battery.

Layout of components in the converter. The ferrite rod for the radiating output coil is secured to the rear panel of the case with a plastic clip.



COMPONENTS

Most of the components are readily available from various suppliers. VC1, 2 is a 2-gang Jackson type 02 component without trimmers. The ferrite rod is secured in position with a plastic clamp, and a nylon "P" cable clip intended for wires of 10mm. diameter was employed in the prototype. This clip is available from Maplin Electronic Supplies. A metal clamp must not be used. In the author's unit, TC1 was a miniature film dielectric trimmer with a maximum capacitance of 65pF. This can also be obtained from Maplin Electronic Supplies. If difficulty is experienced in obtaining any of the Denco items they can be purchased direct from the manufacturer at Denco (Clacton) Ltd., 357/9 Old Road, Clacton-on-Sea, Essex, CO15 3RH.

The converter must be housed in a non-metallic case since a metallic one would shield L2 and prevent it from radiating the output signal. The author employed a plastic case measuring 160 by 100 by 60mm., and any plastic case of about this size, or slightly larger, which will accommodate the components with the same layout can be used. Parts of L1 and L3 project below the bottom of the case, which must be fitted with four cabinet feet at the corners to provide clearance.

CONSTRUCTION

One of the 160 by 60mm. sides of the author's case forms the front panel. Appearing on this are, from left to right, switch S1, VC3, the 2-gang capacitor VC1,2, and VC4. S1, VC3 and VC4 are secured to the front panel in the normal manner by means of their bush mounting nuts. The hole for VC1,2 takes its ¼in. spindle only. If this component is examined it will be found that there are two 4BA tapped holes in the bottom of its metal frame, and the capacitor is mounted by passing two 4BA bolts through holes in the bottom of the case, passing spacing washers over these bolts inside the case to provide clearance for the ceramic mounts below the capacitor frame and then screwing the bolts into the two 4BA tapped holes. The bolts should be short, so that their upper ends pass only marginally inside the capacitor metal frame. This is an important point to observe because, if the mounting bolts are too long, their upper ends can damage the fixed or moving vanes of the capacitor.

COMPONENTS

Resistors
(All ¼ watt 5%)
R1 1kΩ
R2 1MΩ
R3 2.7kΩ

Capacitors
C1 470pF polystyrene
C2 470pF polystyrene
C3 180pF ceramic plate
C4 0.015µF ceramic plate or polyester.
C5 0.1µF polyester.
C6 220pF ceramic plate
VC1,2 365pF + 365pF 2-gang variable, type 02 (Jackson)
VC3 25pF variable, type C804 (Jackson)
VC4 50pF variable, type C804 (Jackson)
TC1 65pF trimmer, film dielectric

Inductors
L1 Transistor tuning coil, Blue, Range 4T (Denco)
L2 Ferrite rod aerial type MW5FR (Denco)
L3 Transistor tuning coil, White, Range 4T (Denco)

Semiconductors
TR1 2N3819
TR2 BC109

Switch
S1 s.p.s.t. toggle

Sockets
SK1 4mm. insulated socket, red
SK2 4mm. insulated socket, black

Miscellaneous
Plastic case (see text)
9 volt battery type PP3
Battery connector
2 B9A valveholders
3 control knobs
Plastic clip, 10mm. (see text)
4 cabinet feet
Nuts, bolts, wire, etc.

The positions of the holes in the front panel and in the case bottom are measured off from the capacitor itself. With the capacitor employed by the author, the first 4BA bolt was positioned about 15mm. back from the front panel and the second about 34mm. back from the front panel, both being in line with the spindle hole in the panel. However, there is a possibility that the 4BA tapped holes may be positioned differently with some capacitors and so measurements must be taken from the actual component which is to be used. Since the process of marking out and drilling the three holes for the 2-gang capacitor is a little critical, it is recommended that these three holes be drilled first before making the holes for the other three front panel controls.

VC1,2 has a solder tag common with its metal frame on its underside and two p.v.c. covered wires about 6in. long are soldered to this before it is finally mounted. These wires, shortened as necessary, will later be soldered to the moving vane tags of VC3 and VC4. To avoid damage, do not mount any of the variable capacitors until all the remaining holes in the case have been drilled out.

The ferrite rod coil, L2, is mounted near the upper edge of the rear panel, and a hole is required for securing its plastic clamp. SK1 and SK2 are mounted lower down, near the S1 end of the case.

Two mounting holes of about 6.5mm. diameter are required in the bottom of the case for L1 and L3. L1 is positioned behind VC4 and L3 behind VC3, and they should have the tag orientation shown in Fig. 3. Now that all the holes in the case have been drilled the components may be finally mounted. L1 and L3 are secured by the plastic nuts supplied with them. These nuts should be made finger tight only, as the plastic threads in the nuts or formers can be stripped if they are over-tightened.

WIRING

The converter is wired up as shown in Fig. 3. It is not advisable to solder directly to the pins of L1 and L3 as the heat of a soldering iron can cause the plastic of the coil formers to melt. In consequence a B9A valveholder is passed over the pins of each coil, and connections are soldered to the valveholder tags. Tags 3 and 4 of L1 are used as dummy anchor tags, as also are tags 2, 3, 6 and 7 of L3. TC1 is mounted by soldering one of its tags to SK2. The front section of the 2-gang capacitor is VC1 and the rear section is VC2. On L2, the tuned winding is the long winding, and the coupling winding is the short winding. All wiring should be kept reasonably short and direct.

The battery fits in the space behind S1.

AERIAL AND EARTH

The converter is designed for use with an ordinary long wire aerial consisting of some 10 to 40 metres of aerial wire strung up as high as possible and preferably well clear of buildings and other large objects. Where such an aerial is not practicable a short length of ordinary connecting wire, say about 3 metres long, strung around the walls of a room can be used instead. This will give quite acceptable results, but the performance will not of course be as good as is given with a proper outside aerial.

An earth connection is not essential, and it will probably be found to give only a modest increase in signal strengths. The best type of earth is given by a metal pipe buried outside in the soil. A lead, which is as short as possible, connects the pipe to SK2 of the converter.

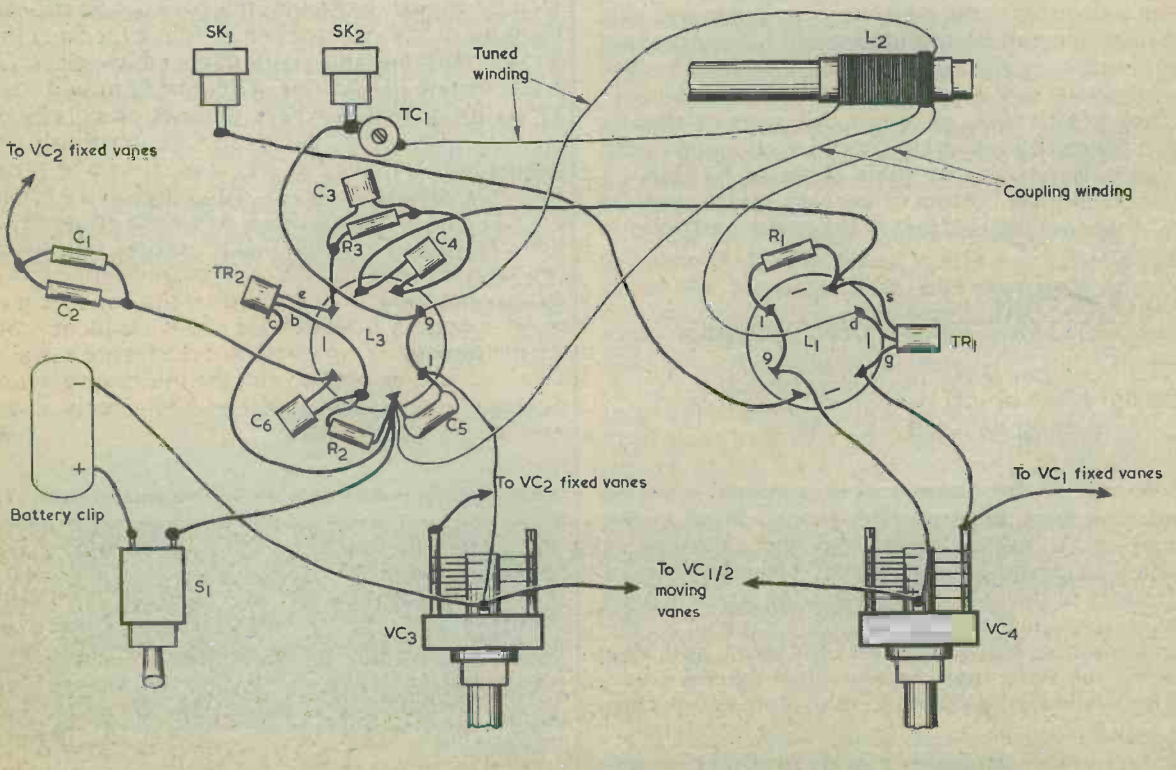
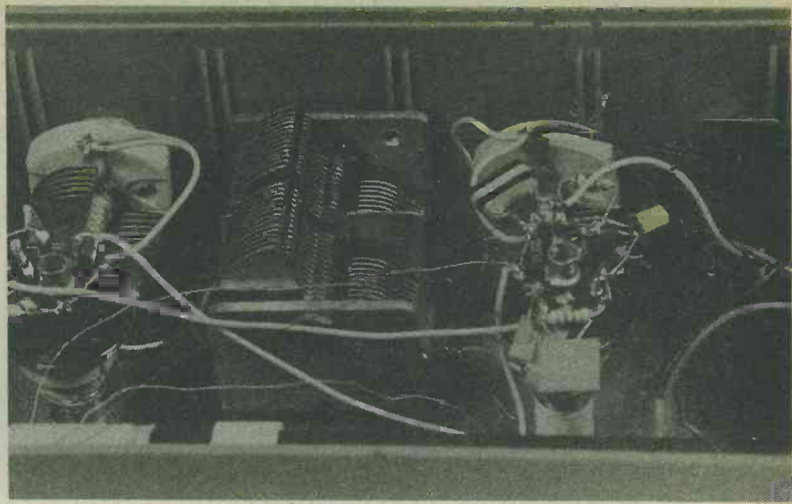


Fig. 3. Wiring up the converter. For ease of presentation, the wiring is shown spread out. In practice, wiring should be kept reasonably short and direct.

Another view of the internal wiring.



ADJUSTMENT AND USE

First tune the radio receiver to the high frequency end of the medium wave band as near as possible to 1.6MHz and search for a quiet spot on the band. It is unlikely that it will be possible, after dark, to find a spot which is completely free of any signal, but it should be possible to find a spot where there are only weak background signals which will not significantly interfere with the much stronger output signal from the converter.

L1 and L3 are supplied with their cores fully screwed in, and these should initially be adjusted so that about 2 to 3mm. of metal screw thread protrudes from the plastic of each coil former. The coil former for L2 should be at or near the end of the ferrite rod, although its precise positioning is not very critical. With the medium wave receiver close to the converter, switch on the latter and adjust VC1,2 in search of signals. If none can be found, repeat the operation with TC1 at various settings. When a station has been found, tune it in as accurately as possible by means of VC3, and then adjust TC1 for optimum results.

The front panel components, from left to right, are on-off switch S1, VC3, the 2-gang capacitor and VC4.

After this, many stations should be received at good strength, with VC4 being adjusted to peak the signals. Next, tune in a signal with VC1,2 at about half maximum capacitance and set VC4 for about half its maximum value. Adjust the core of L1 to peak the signal. It should then be possible to peak received signals with VC4, whatever the setting of VC1,2. It may be found that there are two peak settings for VC4, with different stations appearing at each peak. The correct setting is the one with the vanes of VC4 more fully meshed. It is the image response which is being peaked at the other setting.

The positioning of converter and medium wave receiver relative to each other does not seem to be especially critical. However, this may not be the case with some radios, whereupon a little experimenting will soon indicate the positioning which gives the greatest degree of coupling. There will probably be a few relative positions where there is practically no signal transfer, and these should obviously be avoided. Note that the receiver must always be tuned to the same spot on the band when employed with the converter as, otherwise, TC1 will need to be readjusted each time the converter is used. It may sometimes happen that a station appears quite strongly on what was originally a quiet part of the band. It may then be necessary to search for a new frequency, but often the directional properties of the ferrite aerial in the receiver can be used to null the interfering signal. This simply involves rotating the receiver for minimum interference. ■

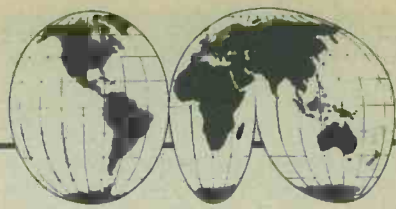
BACK NUMBERS

For the benefit of new readers we would draw attention to our back number service.

We retain past issues for a period of two years and we can, occasionally, supply copies more than two years old. The cost is 73p, inclusive of postage and packing.

Before undertaking any constructional project described in a back issue, it must be borne in mind that components readily available at the time of publication may no longer be so.

SHORT WAVE NEWS
FOR DX LISTENERS



By Frank A. Baldwin

Times = GMT *Frequencies = kHz*

From time to time, the subject of clandestine transmitters is dealt with in this series of articles. Several readers have expressed an interest in these transmissions – an interest shared by the writer – therefore as an opening gambit this month, we again deal with some clandestines recently logged.

"A Voz de Resistencia de Angola" on **4950** at 1820, YL with songs in Portuguese, OM with a harangue in vernacular, YL announcer in a programme of African songs. Carrier abruptly off the air at 1900 without anthem. This is a pro-Unita transmitter which sometimes also identifies as "A Voz de Verdade".

"Radio Freedom From South Yemen" on **9960** at 1900, OM with a revolutionary song in Arabic – very militant and rousing – then suddenly off the air. All this after a preceding harangue in Arabic. This is an anti-communist and South Yemen government transmitter.

"Radio Homeland" on **15555** at 1747, two OM's with a discussion in Persian followed by a programme of Persian songs and music in typical style until 1759, at which time there were several announcements by a YL and then sign-off without any anthem. "Radio Homeland" is an anti-Persian government transmitter.

Readers wishing to log any of the above listed transmitters would be well advised to tune to the frequencies shown well in advance of the times quoted, for each logging will be seen to have been made at the signing-off time. Perhaps someone will even succeed in hearing the opening transmissions. If so, let me know.

AROUND THE DIAL

In which are listed some of the more interesting transmissions logged within recent weeks. Note however that due to publication delay, a few of the time and frequency details may have changed – but not many. To hear the type of programmes stated, all the reader must do is to locate the correct channels at the times quoted here. This article is penned solely for your guidance over the short wave spectrum.

● PORTUGAL

Lisbon on **21530** at 1610, OM with a newscast of world events. (OM = Old Man – a male announcer). Station identification at 1613 "International Service of Radio Portugal". All in the English programme intended for the Middle East, scheduled from 1600 to 1630.

● BELGIUM

Brussels on **6010** at 1605, YL with a local newscast and details of recent events in Belgium in an English programme presumably intended for African consumption. (YL = Young Lady – female announcer).

● SPAIN

Madrid on **9765** at 2030, time-check 'pips', OM with news of internal affairs and events in the English programme for Europe, scheduled from 2010 to 2110.

● WEST GERMANY

Cologne on **17875** at 0626, YL with station identification and announcements at the end of the English programme for West Africa, scheduled from 0600 to 0630.

● FINLAND

Helsinki on **15265** at 1940, OM with the English programmed "Northern Report". The English programme is radiated from 1930 to 2000 to both Europe and Africa.

● NORTH KOREA

Radio Pyongyang on **6575** at 2000, OM and YL with station identification and National Anthem various announcements after a preceding interval signal. This was followed by details of English transmissions from Pyongyang. All this in the English programme for Europe, scheduled from 2000 to 2150.

Radio Pyongyang on a measured **9977** at 1642, YL with a talk about communal projects in North Korea. This programme in English is beamed to the Middle East and Africa and is scheduled from 1500 to 1630 according to announcements.

● SOUTH KOREA

Seoul on **6480** at 1918, YL announcer, OM song in Korean, in the English programme for Europe, scheduled from 1900 to 2000.

Seoul on **9870** at 1629, OM and YL with an English programme for the Middle East and North Africa, scheduled from 1600 to 1700. YL with station identification at 1637.

● **CHINA**
Radio Peking on **9530** at 2039, OM with a newscast of world events from the Chinese point of view in an English programme intended for European consumption, scheduled from 2030 to 2230.

● **INDIA**
AIR (All India Radio) Delhi on **15335** at 1344, a programme of local songs and music in an English programme for South East Asia, scheduled from 1330 to 1500. YL with station identification and schedule details at 1500.

● **PAKISTAN**
Radio Pakistan on **15485** at 1742, YL with the "World Service" English programme to the U.K. OM station identification in English then into an Urdu transmission also for the U.K. at 1744.

● **ISRAEL**
Jerusalem on **17685** at 1927, OM with station identification after a newscast of both local and world events in an English programme announced for Africa, Europe and North America from 1900 to 1930. A programme in French followed at 1930.

● **AUSTRALIA**
Melbourne on **21680** at 0659, YL with station identification, details of frequencies, times and target areas. Time-check 'pips' at 0700 followed by a newscast of both local and world events, OM announcer. On this channel the programme is directed both to Asia and the U.K. Also logged on **9570** in parallel to the same target areas and on **15240** directed to the Pacific Area. Other announced channels were **11740**, **15115**, **17725** and **17870** but a rapid survey resulted in either (a) very poor reception or (b) co-channel QRM.

Melbourne on **15240** at 0558, somewhat earlier than the above transmission, OM announcements in English, including frequencies and target areas in an English programme intended for Africa and the Pacific. Time-check 'pips' at 0600 followed by a newscast in English.

● **SOUTH AFRICA**
RSA (Radio South Africa) Johannesburg on **21535** at 0605, OM with station identification, announcement of frequencies and target areas followed by the news in an English programme for West Africa and Europe, scheduled from 0600 to 0700.

● **GRENADA**
Radio Free Grenada on **15105** at 2022, YL with announcements in English, then into a programme of local music and songs. At 2030, OM with a talk about African origins.

● **USSR**
Radio Moscow on **15350** at 1825, OM with a programme in Swahili to Africa (where else?), typical African music and at 1830 news about African affairs from the USSR point of view.

● **AFGHANISTAN**
Kabul on **4740** at 1845, OM announcer in Pashto, local music and songs. This is the Home Service 1 which is scheduled from 0125 to 0330 and from 1340 to 1940.

● **UGANDA**
Kampala on a measured **5027** at 1903, OM with a newscast in English mainly about local affairs. This is the National Programme which uses English, Swahili and French at various times in the schedule, which is from (weekdays) 1300 to 2100 and from 1400 to 2100. Saturdays and Sundays there is an additional transmission from 0300 to 0545 and on Sundays the afternoon programmes commence at 1430. The power of this recently installed transmitter is 250kW.

● **NICARAGUA**
La Voz de Nicaragua on **5950** at 0155, OM with identification "La Voz de Nicaragua", announcements in Spanish then YL with a folk ballad.

● **COLOMBIA**
Em. Nuevo Mundo, Bogota, on **4755** at 0054, OM with songs in Spanish, local-style music. This one radiates on a 24-hour schedule and the power is 1kW.

La Voz del Cinaruco, Arauca, on **4865** at 0114, OM with announcements in Spanish, local pops on records. The schedule here is from 0900 to a variable 0330 and the power is 1kW.

● **COSTA RICA**
Faro del Caribe (Lighthouse of the Caribbean), San Jose, on **5055** at 0130, OM with station identification in Spanish followed by light orchestral music. The schedule is from 1030 to 0400 (closing time is variable to 0430) and the power is 5kW.

● **VENEZUELA**
Radio Valera, Valera, on **4840** at 0106, OM's with a discussion in Spanish on both local and world sporting events. Radio Valera operates from 0900 to 0400 (variable closing time) and the power is 1kW.

● **BRAZIL**
Radio Ribamar, Maranhão, on **4785** at 0058, OM with a love song in Portuguese. OM with station identification at 0100. The schedule is from 0800 to 0400 and the power is 5kW.

Radio Tabajara, Joao Pessoa, on a measured **4797** at 0103, YL with local pop song, OM announcer. The schedule is from 0730 to 0400 and the power is 2kW. The frequency is liable to vary, nominal is **4795.**

Radio Difusora Taubate, Taubate, on **4925** at 0120, OM announcer in Portuguese, OM with a ballad about the lovelorn. The schedule is from 0830 to 0300 and the power is 1kW.

Radio Cultural do Para, Belem, on **5045** at 0127, OM with local pops in typical style. The schedule is from 0900 to 0300 (variable) and the power is 10kW.

Radio Bare, Manaus, on **4895** at 0117, OM with announcements in Portuguese, local-style dance music on records. The schedule is from 0800 to 0400 (closing time is variable) and the power is 5kW.

Radio Clube do Para, Belem, on **4855** at 0110, local-style pops, OM with lots of commercials. This one operates from 0700 to 0400 and the power is 10kW.

Radio Nacional Brasiliera, Brasilia, on **15125** at 2030, OM with identification and a talk about Brazilian postage stamps in an English programme for Europe, scheduled from 2000 to 2100.

TWO 20dB AMPLIFIERS

1MΩ Input impedance. Flat response from zero to 1MHz. Switching option for a.c. or d.c. working.

The second 20dB amplifier, described this month, has a voltage gain of 10 times, is d.c. coupled (with a switched option for a.c. coupling at the input) and has an input impedance of about 1MΩ. Its response is flat from zero to approximately 1MHz. It is primarily intended for use ahead of an oscilloscope when measuring small direct voltages or when investigating waveforms containing relatively low frequencies which are too small in amplitude to provide a useful display with the oscilloscope on its own.

There are other uses for the amplifier and it can be employed to boost the sensitivity of an audio millivoltmeter. It can also be used in conjunction with an ordinary multimeter to provide a sensitive high impedance voltmeter. If, for example, the multimeter is switched to read 0-5 volts, an input of only 500 millivolts to the amplifier will produce full-scale deflection in the meter. The consequent sensitivity is 2MΩ per volt, as compared with the 20kΩ per volt of many standard multimeters. The amplifier can similarly boost the sensitivity of a multimeter switched to a low a.c. volts range. Note, however, that the maximum d.c. output of the amplifier is plus or minus 7 volts, and the maximum a.c. output is approximately 5 volts r.m.s.

THE CIRCUIT

An operational amplifier is an obvious choice for the unit, and such an amplifier appears in the circuit diagram of Fig.3. The op-amp employed is the CA3130, which has CMOS input and output stages with a bipolar section providing the main voltage gain of the device. With the value specified for the compensation capacitor, C4, the CA3130 gives a unity gain bandwidth in excess of 10MHz and a slew rate of over 20 volts per microsecond.

The op-amp is used in the non-inverting mode with the closed loop gain controlled by the negative feedback resistors, R3 and R2. The gain is equal to the sum of R3 and R2 divided by the value of R2, giving the required figure of 10 times. Both these resistors must be close tolerance types, either 2% or preferably 1%. They are specified as ½ watt because close tolerance resistors are normally available in this rating. rather than in ¼ watt. The calculated level of voltage gain can, of course, only be maintained at frequencies where the op-amp open loop voltage gain is at least 10 times. The frequency at which the gain of an operational amplifier becomes inadequate to maintain the closed loop gain is given roughly by dividing the unity gain bandwidth by the closed loop gain so that the theoretical closed loop frequency response becomes 1MHz. Tests on the prototype bear this out in practice.

The circuit has dual balanced supply rails with a central earth rail, as is the convention with d.c. coupled operational amplifiers. Two small PP3 batteries provide power, and are connected to the CA3130 via voltage dropping resistors R4 and R6. The resistors are needed because the maximum supply rating for the CA3130 is plus and minus 8 volts. The supply current is a fraction under 1mA, producing a voltage drop of about 2 volts across each resistor and a nominal supply of plus and minus 7 volts.

R1 biases the non-inverting input to earth and causes the input impedance of the amplifier to be 1MΩ. This impedance reduces somewhat at high fre-

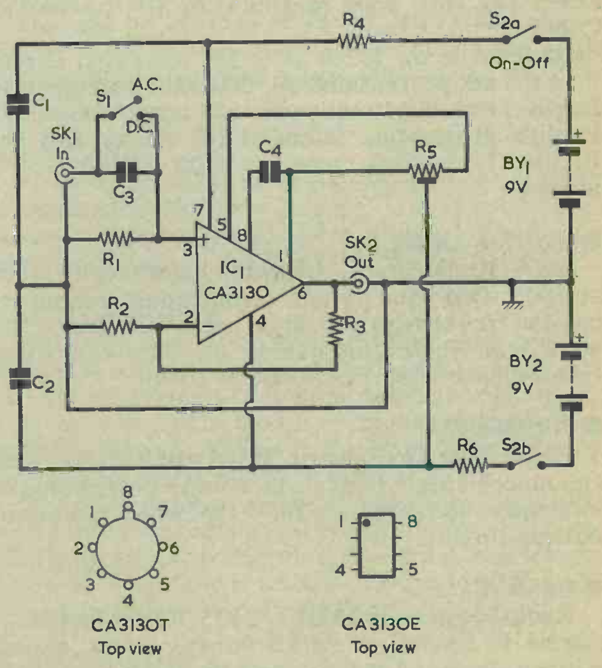


Fig.3. The d.c. coupled 20dB amplifier. This incorporates an operational amplifier type CA3130.

Part 2

By
M. V. Hastings

The amplifier is housed in an all-metal case which provides screening. This is particularly important with the present design because of its high input impedance.

quencies because of stray capacitances and the input capacitance of the CA3130. There is a d.c. path from input socket SK1 when S1 is closed and the circuit is then direct coupled throughout. Opening S1 causes C3 to be in series with the input to provide d.c. blocking, and the low frequency response has a – 3dB point at approximately 10Hz.

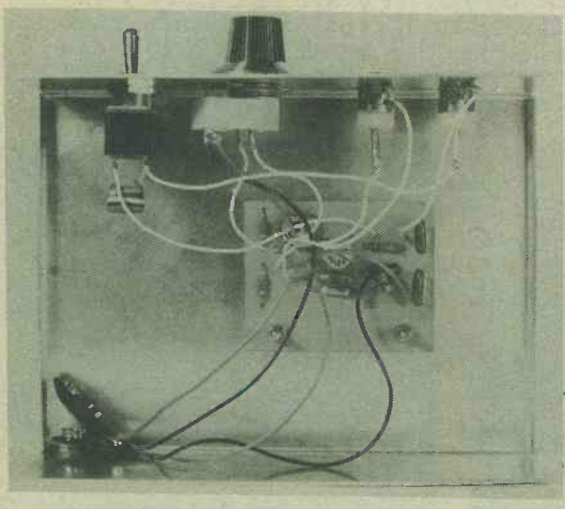
An offset null control is required to ensure that the quiescent output voltage is zero. The offset null adjustment is given by R5. S2 (a) (b) is the on-off switch and controls the two outside supply rails. C1 and C2 are supply bypass capacitors.

CONSTRUCTION

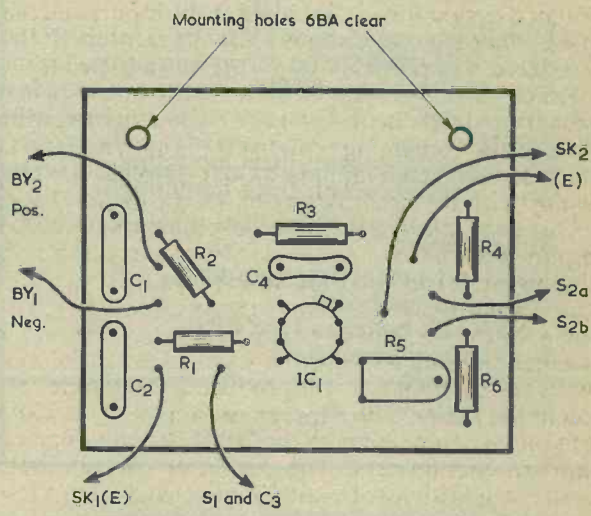
The amplifier must be housed in an all-metal case to screen it from mains hum and other sources of interference. The prototype is fitted in a metal instrument case type BC1, which has approximate dimensions of 6 by 4½ by 2in. This case is available from Harrison Bros., P.O. Box 55, Westcliff-on-Sea, Essex, SS0 7LQ.

The front panel layout can be seen in the photographs. From left to right the items mounted on the front panel are SK1, SK2, S2(a)(b) and S1. The two sockets are flush mounting coaxial types. A solder tag is fitted behind the panel, under the upper securing nut of each socket. C3 is soldered to the tags of S1.

The remaining components are assembled on the printed circuit board, which is shown full size in Fig.4.



The printed circuit module is secured to the bottom of the case with two 6BA bolts and nuts, together with spacing washers.



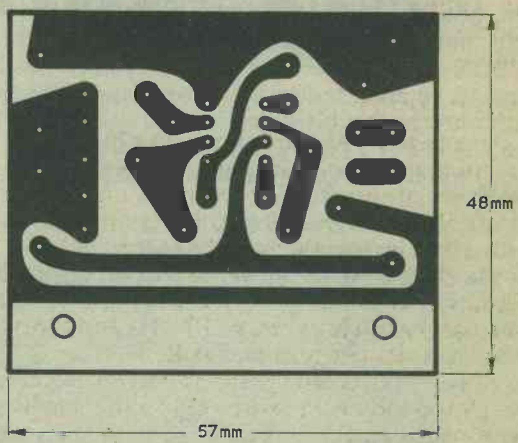


Fig.4. The printed circuit layout pattern. This will take either a CA3130T or a CA3130E.

COMPONENTS

Resistors
R1 1MΩ watt 5%
R2 300Ω ½ watt 1% or 2%
R3 2.7kΩ ½ watt 1% or 2%
R4 2.2kΩ ¼ watt 5%
R5 100kΩ pre-set potentiometer, 0.1 watt horizontal
R6 2.2kΩ ¼ watt 5%

Capacitors
C1 0.1μF polyester type C280
C2 0.1μF polyester type C280
C3 0.1μF polyester type C280
C4 10pF ceramic or polystyrene

Semiconductors
IC1 CA3130T or CA3130E

Switches
S1 s.p.s.t. toggle
S2 (a) (b) d.p.s.t. rotary

Sockets
SK1 coaxial socket, flush mounting
SK2 coaxial socket, flush mounting.

Miscellaneous
Metal instrument case (see text)
Printed circuit board
2-off 9-volt batteries type PP3
2-off battery connectors
Control knob
Nuts, bolts, wire, etc.

On the front panel are the input and output coaxial sockets, the on-off switch and the a.c. – d.c. input selection switch.

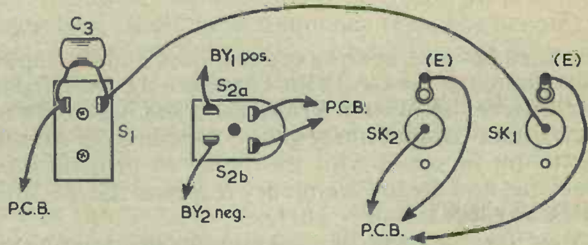
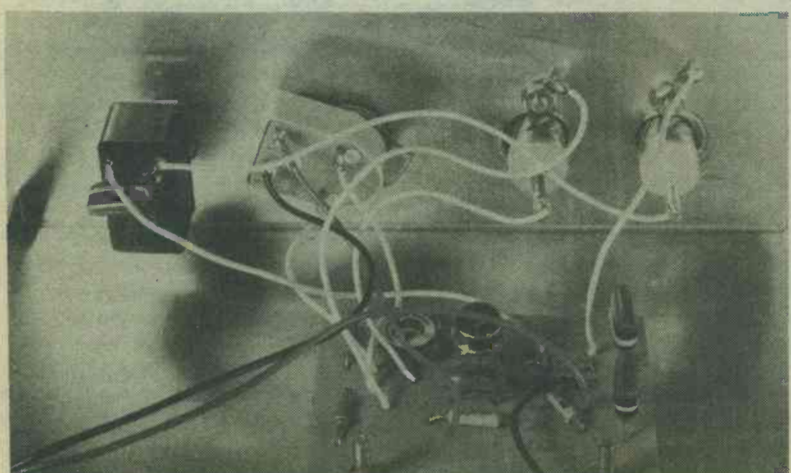


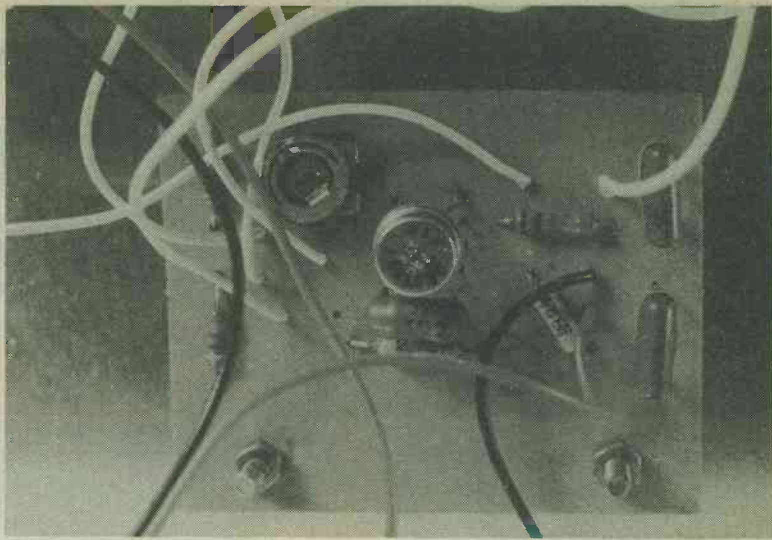
Fig.5. Wiring to the components mounted on the front panel. Use a continuity tester to confirm the appropriate tags of S2(a) (b) before wiring to this switch, as some switches may have a different tag layout

The board is produced and wired up in the normal way, but it should be remembered that the i.c. has CMOS inputs. The i.c. should therefore be the last item to be soldered to the board, and the soldering iron must have a bit which is reliably earthed. Either the CA3130T (TO-99 case) or the CA3130E (8 pin d.i.l.) will fit into the printed circuit layout. The wiring between the board and the front panel components is illustrated in Fig.5. The board is mounted to the base of the case with two 6BA bolts and nuts, spacing washers being used to keep the board underside clear of the inside of the case.

Since this amplifier has a lower bandwidth than the unit described last month, there is no need to use



Looking at the wiring to the rear of the front panel



A close-up of the printed circuit board assembly.

screened leads inside the case for the connections to SK1 and SK2. External test leads connecting to these two sockets should, however, consist of screened wires.

ADJUSTMENT

The only adjustment required to the completed amplifier is the setting up of R5. Connect a multimeter set to read 0-5 volts or more d.c. across the output of the amplifier with negative to chassis. Adjust R5 so that its slider is about 45 degrees anti-clockwise of its central setting and switch on the amplifier. There will probably be a positive deflection in the meter, or a small negative deflection, and R5 is then adjusted for a zero reading. The multimeter is then switched to its lowest d.c. volts range and R5 finally trimmed for the zero reading.

The amplifier is then ready for use.

(Concluded)

NEW DEFENCE AID

HELICOPTER NIGHT VISION

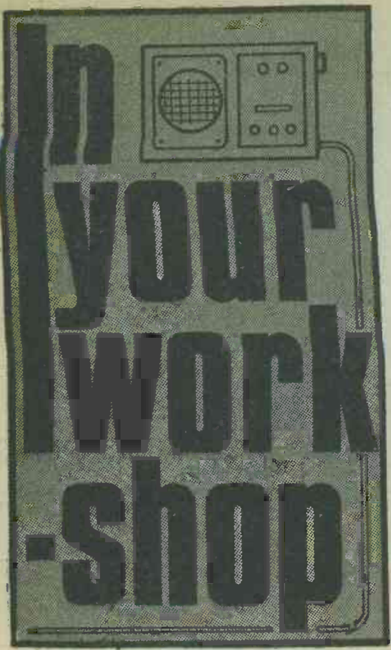
Successfully installed on a Sea King helicopter is the new stabilized night vision system pioneered by Marconi Avionics Limited. This gives what is virtually all-round vision and has been developed under contract from the UK Ministry of Defence.

The system, produced by the Marconi Electro-Optical Surveillance Division at Basildon, is for mounting beneath the nose of a helicopter and it consists of a stabilized platform bearing a night vision sensor. In the case of the Sea King installation, the sensor is a Marconi Avionics V325 Intensified Isocon camera, which is already in production and is in service with the Royal Air Force. It can produce useful television pictures at light levels down to overcast starlight.

A very novel feature of the use of the night vision sensor is that it can be rapidly directed, from side to side and downwards, in synchronism with the pilot's head movement. By projecting an image of the night scene into the pilot's eye via his helmet-mounted display, he can "see" in the dark wherever he happens to be looking, including straight downwards.

The system has an exceptionally fast response (over 100 degrees per second) to directional commands and is highly stabilized against the effects of helicopter vibration and its movements in pitch and yaw. This exceptional performance means that the system can follow virtually every movement of the pilot's head, whether fast or slow. As a result, pilots soon become used to the new equipment, and very rapidly gain confidence in operating with it.

The platform has been constructed to the stringent standards already proven with the highly successful "Heli-Tele" daylight viewing system, now in service with the British Army and the security services of several other nations.



RADIO DISTORTION FAULT

You don't *have* to know what's inside an i.c.!

"What," asked Dick cheerfully, "is white on the top and bottom, green in the middle and jumps all round the room?"

Smithy glanced at him malevolently.

"Look," he prounounced sternly, "there's just an hour to go before we shut up the shop for the weekend, and we've only got this single a.m.-f.m. portable to clear up before we leave. Which means that I don't intend to waste time with these ridiculous jokes of yours."

"Shall I give you a clue?"

"I don't even *want* a clue!"

"It could," said Dick unabashed, "alternatively be brown on the top and bottom instead of white. But it would still be green in the middle and it would still jump all round the room."

Smithy put the portable radio on his bench and studiously ignored his assistant.

"Give up?"

"Give up?" repeated Smithy irately. "I'm not going to start!"

"I'll tell you then," said Dick jubilantly. "It's a frog sandwich!"

I.C. AMPLIFIER

An expression of total incomprehension spread over Smithy's face.

"Is that your joke?"

"That's it," confirmed Dick. "Good, isn't it?"

"I think it's dreadful. Now, for goodness' sake let's get on with finding the fault in this radio."

"What is it," asked Dick, "that's white on the top, white on . . ."

"We will now," interrupted Smithy, "get on with this set. Okay?"

"Well yes, all right then," replied Dick, bringing his thoughts back to the more important matters of the moment. "What's wrong with it?"

Smithy inspected a label attached to the carrying handle of the radio.

"This just says 'Distortion'," he remarked. "Let's hear what it sounds like."

He pressed the medium wave button on the radio and swung its tuning control across the scale. The set was quite lively and picked up a number of signals without any significant second channel whistles. The volume was at a level suitable for listening in a quiet room and there was no noticeable distortion. Smithy tuned in a musical programme and turned up the volume. Distortion at once became evident, increasing in proportion with the loudness of the sound from the speaker.

Smithy pressed the long wave button and tuned to the Radio 4 signal on 1,500 metres. Exactly the same kind of distortion was present here. Finally, he pulled out the telescopic aerial, pushed the f.m. button and tuned in the local v.h.f. signals. There was no change in the distortion.

"That distortion must be being introduced in the a.f. stages," volunteered Dick.

"I wouldn't argue with that at all," stated Smithy, "unless we've got a really weird fault we wouldn't get distortion in *both* the a.m. and the f.m. sections before the volume control. Besides, the a.f. signal going to the volume control must almost certainly be all right because there's no distortion at low volume levels. Would you like to start getting the back off the set while I get the service manual out? With a fault like distortion it's a good idea to have the circuit of the receiver in front of you, and it will often save a lot of time in looking for the snag. Oh, and check battery voltage on load, of course."

As Smithy walked over to the filing cabinet, Dick removed the battery cover and checked the battery voltage with the receiver switched on. His testmeter indicated a satisfactory voltage slightly in excess of 9 volts. He then started to remove the set back. Whilst he was doing so, Smithy returned with the service manual and opened it out at the circuit diagram. He quickly located the section showing

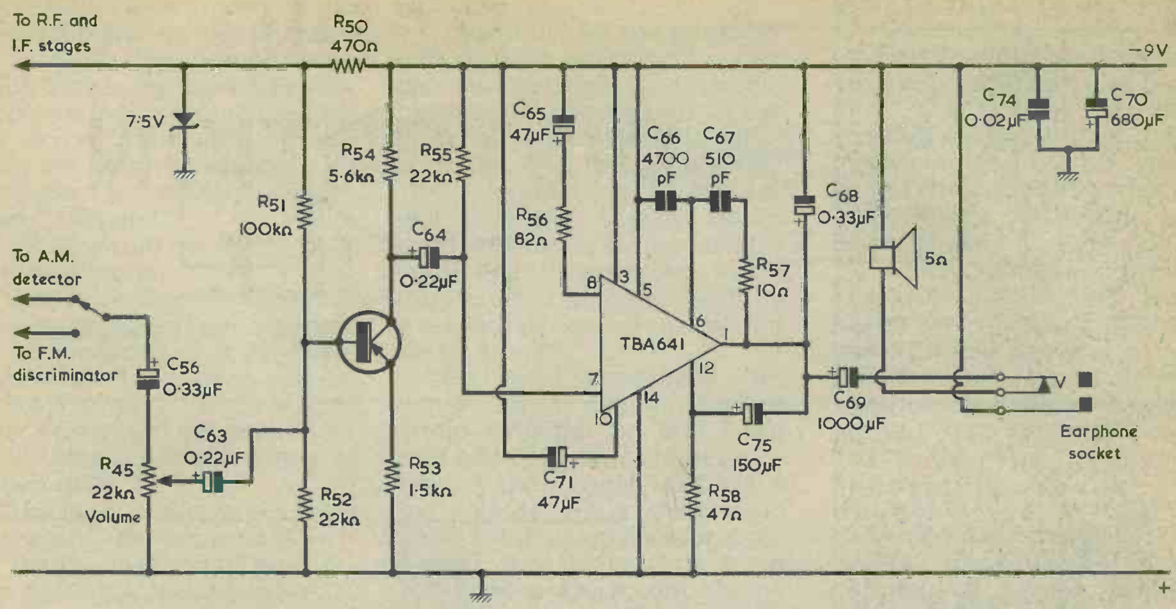


Fig.1. The a.f. stages of the a.m.-f.m. radio examined by Dick and Smithy. Apart from a slight simplification at the a.m.-f.m. switch section and the volume control, this is taken from the circuit of the Ferguson Model 3182 Mains/Battery Portable Radio and shows the same R and C numbers. The 0.22µF and 0.33µF electrolytic capacitors are tantalum.

the a.f. stages, and studied it silently. (Fig.1.)

"Oh no," breathed a voice at his right ear.

Startled, Smithy turned his head to see his assistant gazing unhappily over his shoulder at the circuit.

"What are you oh-no-ing about?"

"Those a.f. stages," wailed Dick. "There's an i.c. at the output!"

"Blimey," snorted Smithy. "We've had integrated circuits in domestic equipment for nearly the last ten years. Why should you suddenly start moaning about them now?"

"I've *always* moaned about them," complained Dick. "Just look at the circuit we've got here. We've got a triangle representing the i.c. amplifier, and a whole lot of resistors and capacitors connected to its pins. What we don't know is what exactly is *inside* that triangle!"

COMPONENT FUNCTIONS

"That's no problem," said Smithy. "With a fairly simple integrated circuit such as the a.f. amplifier one we've got here it's quite adequate to have just a rough general idea of what's going on inside the i.c. without bothering about precise circuitry. I'll agree that things tend to get a bit mind-bending when we get on to i.c.'s like microprocessor chips, and with these the likes of you and me have just got to take the manufacturer's word that if we connect the chip up correctly and put in the right inputs we'll get the proper outputs. But, as I say, there's no need to have such an approach so far as the simpler i.c.'s are concerned."

The Serviceman turned the pages of the service manual and examined the Components List for the radio.

"Here's something interesting," he went on. "The maker of this radio has done us a favour by not only listing the components but also stating what their functions are. But before we look at these there are some obvious facts about this audio i.c. which are staring us in the face."

"What are they?"

"That pins 3 and 5 of the i.c. connect to the negative supply rail and that pin 14 is the positive supply input. Also, that pin 1 is the output pin."

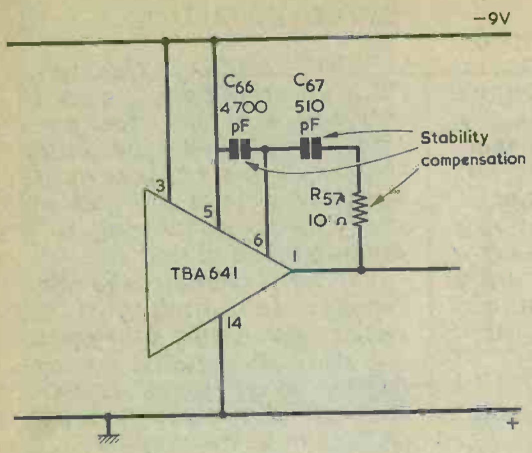
"Ah yes," agreed Dick, "there isn't much deduction needed there! The fact that the negative rail is drawn in this circuit above the positive rail can be a bit confusing at first when you're used to having the two rails the other way round."

"That's true," said Smithy, "but you often meet that sort of thing in these radio circuits. Now let's look at some of the components.

We can start off with C66, C67 and R57. All these are described in the manual as giving stability compensation." (Fig.2(a).)

"That will be like the compensation components which are needed with some op-amps," put in Dick. "The idea is that the capacitors roll off the upper frequencies."

"Exactly," confirmed Smithy. "If the i.c. was allowed to amplify at frequencies which were too high it would be virtually impossible to prevent stray feedback and the whole thing would burst into oscillation. So, when you find relatively low value capacitors, or relatively low value capacitors and resistors in series, connecting to the pins of an unfamiliar audio amplifier i.c. you can be quite certain that they're intended to provide



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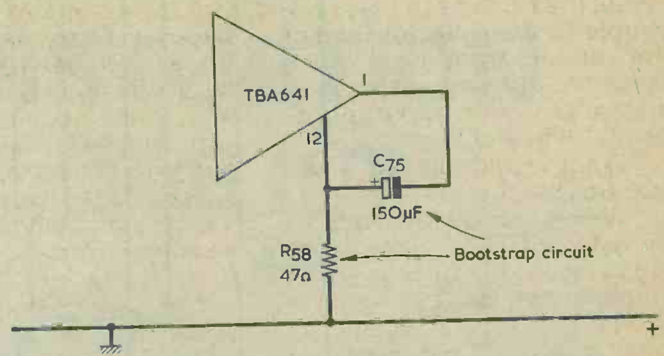

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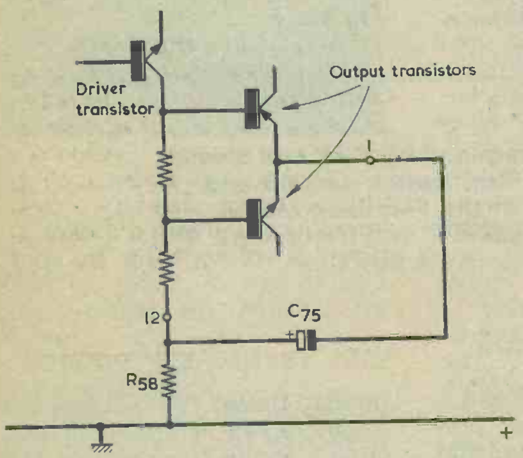

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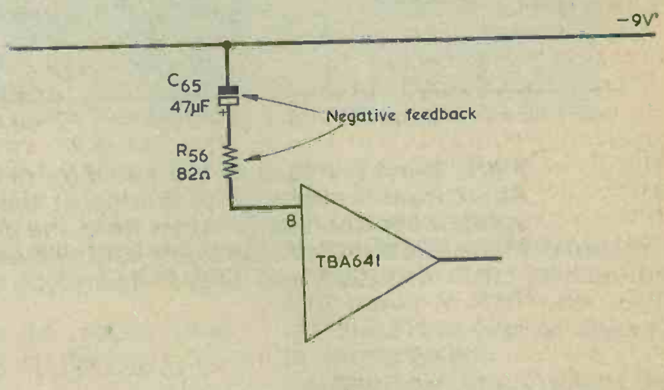
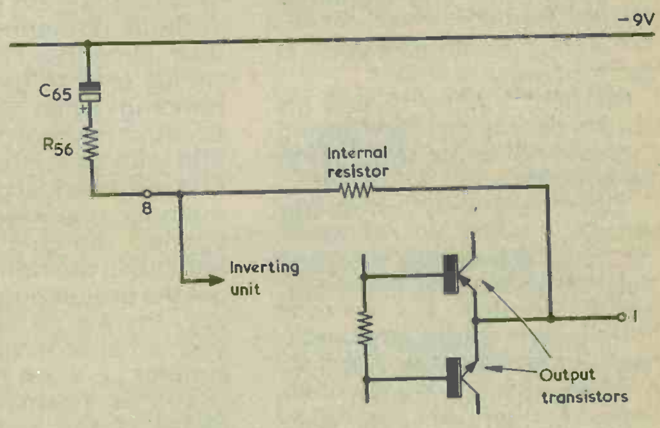


(d)



(e)

Fig.2(a). Relatively low value capacitors around the audio i.c. provide frequency compensation.

(b). A high value capacitor from the output to another pin, in a circuit such as is shown here, provides bootstrap coupling.

(c). The internal bootstrap circuitry will have the basic form illustrated here.

(d). External negative feedback components. The audio gain of the i.c. is controlled by the value of the resistor.

(e). Inside the i.c. an internal resistor will couple back from the output to an early inverting input.

frequency compensation."

"What would happen if you had a fault there?"

"Well," said Smithy, "the most likely thing is that you'd get an open-circuit in a compensation loop. If this open-circuit caused the i.c. to go into violent oscillation at a supersonic frequency you might get a loud hiss from the speaker, or you may even hear nothing at all from it. At the same time, the i.c. will quite possibly draw an excessively high current from the power supply. Should the oscillation be of a mild nature the i.c. might work reasonably well on high level a.f. signals but may burble away quietly to itself with low input signals or with no input signal. Whenever you get symptoms like that with an unknown audio i.c. the compensation components and their connections should be amongst the first things you should check."

"There's another capacitor," said Dick, "which connects the output pin to pin 12 of the i.c. But this one's an electrolytic with a value of 150μF." (Fig.2(b).)

"That one's bound to be a bootstrap coupling capacitor," said Smithy, "and you can recognise it by the fact that it connects to the output and has the sort of high value you'd expect in an a.f. coupling circuit feeding a fairly low impedance. Inside the i.c. the capacitor will couple to the collector load of the driver transistor which feeds the output transistors in a standard bootstrap arrangement." (Fig.2(c).)

"What would happen if you had trouble there?"

"Well," replied Smithy, "if the capacitor went open-circuit the i.c. wouldn't give as much amplification to one set of half-cycles as it does to the other and you'd get distortion when the signal went above a certain level."

"That's what we've got with this radio," commented Dick.

"True," confirmed Smithy, "so we'll check the bootstrap capacitor in a minute. It's more difficult to predict what would happen if the capacitor went short-circuit, but there would most probably be a high loss of output power with distortion at all levels. There would probably be no output at all if the 47Ω resistor coupling pin 12 to the positive rail went open-circuit because there would then be no collector supply voltage for the internal driver transistor."

Dick turned his attention to another part of the circuit.

"There's an 82Ω resistor and a 47μF capacitor going from pin 8 of the i.c. to the negative rail," he announced. "What are they for?" (Fig.2(d).)

"The resistor," said Smithy, looking down at the service manual, "will be for gain control and the capacitor for d.c. blocking. The service manual refers to them as 'negative feedback' and as 'negative feedback and d.c. blocking' respectively."

"How do they work?"

"There'll be an internal resistor inside the i.c. from the output to an inverting point at or near the input of the internal amplifier. This and the external resistor then complete a standard negative feedback loop which allows the i.c. gain to be varied by the external resistor. If that external resistor goes low in value the amplifier gain will increase and if it goes high in value the amplifier gain will reduce." (Fig.2(e).)

"What happens if the resistor or the capacitor go open-circuit?"

"Theoretically, the amplifier gain drops to unity but in practice the i.c. might go unstable because of the lack of a low impedance between the feedback pin and the supply rail. The manufacturer of the i.c. will normally specify upper and lower limits for the resistor value and the set-maker using the i.c. will, obviously, employ a resistor whose value is within these limits."

"So," said Dick slowly, "if I come across an unfamiliar audio amplifier i.c. and I see that one of its pins connects to one of the supply rails via a fairly large value electrolytic and a small value resistor, can I expect the resistor to be a component which controls the amplifier gain, with the electrolytic giving d.c. blocking?"

"You can," stated Smithy. "Incidentally, the resistor value usually lies between some 50Ω and 200Ω."

BYPASS CAPACITOR

"Hey," said Dick cheerfully, "this a.f. amplifier i.c. is not so difficult after all. We don't know exactly just what is lurking inside the i.c. but we do know what jobs the external components connecting to it are supposed to do!"

"Which," chimed in Smithy, "makes fault-finding a lot easier when a snag develops in any of those external components. Well now, there's another electrolytic coupling an i.c. pin to the negative rail. That's the 47μF component connecting to pin 10." (Fig.3(a).)

"And what's that for?"

"It's a decoupling or bypass capacitor," stated Smithy, glancing for confirmation at the service manual. "Inside the i.c. there will be a decoupling supply resistor feeding a pre-amplifier stage and the decoupling is completed by the

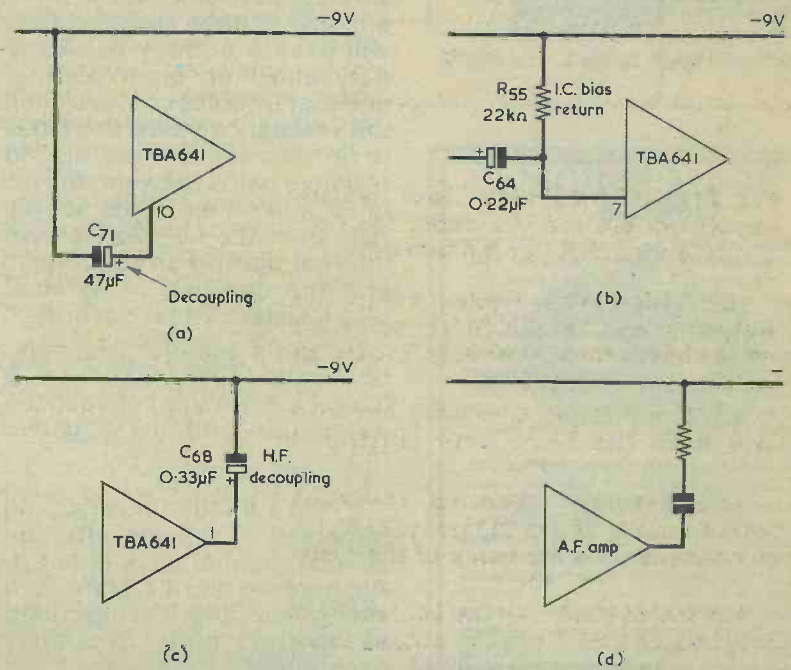


Fig.3(a). In company with an internal supply resistor feeding an internal pre-amplifier, the 47μF external capacitor completes a decoupling circuit.

(b). Audio i.c. input bias arrangements tend to vary between different i.c. types, but a resistor coupling to the negative rail is one of the more common circuits.

(c). The 0.33μF capacitor between the i.c. output and the negative rail maintains a fairly low output load impedance at the higher audio frequencies.

(d). A more common approach is to couple the i.c. output to one of the supply rails via a capacitor and very low value resistor in series.

external 47μF capacitor."

"Why do you need decoupling there?"

"Mainly to reduce hum if the i.c. is run from an a.c. mains power supply. If the i.c. is powered by a battery you can often leave out that external decoupling capacitor without running into any difficulties. Now, let's look next at the 22kΩ resistor connecting to the input of the amplifier. The service manual refers to this as an 'i.c. bias return' resistor."

Smithy pointed to the resistor in the circuit. (Fig.3(b).)

"Now, most audio output amplifier i.c.'s," he continued, "require a resistor between the input pin and the negative rail to set up the input bias conditions, and you can expect trouble if the resistor shifts seriously in value. However, you may encounter input bias arrangements which are different from this. The golden rule here is to assume that whatever resistor or resistors connect between the i.c. input and any voltage supply points will have a primary or secondary effect on input biasing, and that troubles could result if the resistance value or values is not correct. If there are no resistive paths between the i.c. input and either of the supply rails then the i.c. has its own internal biasing arrangements and the question of external bias resistance does not arise."

"There's another electrolytic," said Dick. "There's a 0.33μF electrolytic between the output pin and the negative rail."

Smithy frowned.

"That's a little unusual," he remarked. "Let's see what the service manual says about it. Ah, here we are. It's a tantalum electrolytic and it's described as giving 'high frequency decoupling'."

"What's it for?"

"It's to maintain a low impedance at the output as audio frequency increases," pronounced Smithy, "whereupon it counteracts the effect of rising impedance in the speaker and aids stability. Just a minute."

Smithy took a pen out of his pocket, pulled his note-pad towards him and carried out a quick calculation.

"That 0.33μF capacitor," he stated, "will have a reactance of about 100Ω at 5kHz, and so it doesn't hold the impedance all that low at high audio frequencies. But it will hold it low enough to ensure that there isn't any risk of high frequency instability."

"You said just now," Dick reminded him, "that the 0.33μF capacitor was slightly unusual. Why's that?"

"It's because you usually have a capacitor and resistor in series at the output to reduce high frequency impedance, instead of having a capacitor on its own. The capacitor and resistor form what is called a Zobel network and typical values are around 0.1μF to 0.3μF for the capacitor, with the resistor having quite a low value of around 1Ω. Incidentally, if the i.c. doesn't have a Zobel network or a single capacitor coupling its output to one of the supply rails then you can safely assume that the i.c. is capable of working quite happily without it." (Fig.3(d).)

Smithy looked down at his watch.

"Ye gods," he gasped. "That's twenty minutes gone already, and we haven't even started looking for the fault in this radio!"

"Not to worry, Smithy," Dick consoled him. "At least you've told me how to work my way round an audio amplifier i.c. even when I've got hardly a clue as to what exactly is inside it. And if we do find the fault in this radio before knocking-off time I'll stay on afterwards if necessary to do the actual repair."

FAULT FINDING

"Very well," said Smithy briskly. "We'll start off with obvious fault-finding checks first. Can you get at the printed board?"

"I can."

"Right then, testmeter ready! Switch on with the volume turned low and check the voltage between chassis and the output pin of the i.c."

Dick selected a voltage range on his testmeter, turned on the radio and checked the voltage between the circuit points referred to by Smithy. (Fig.4(a).)

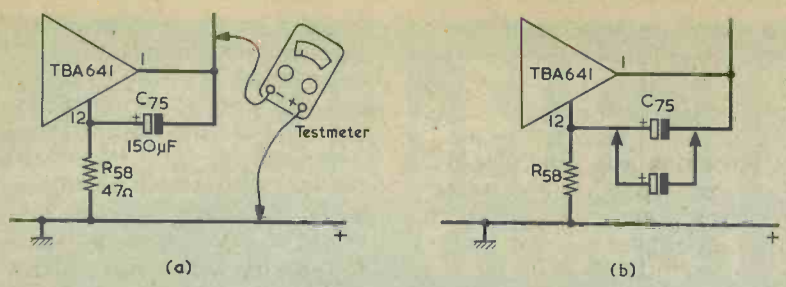


Fig.4(a). Dick first measured the voltage at the output of the audio i.c.

(b). He next checked the bootstrap capacitor by temporarily bridging it with another capacitor of similar value.

"I'm getting a reading of about 4.4 volts."

"Good," stated Smithy. "That's near enough to central voltage for us to assume, for the time being at any rate, that the input bias circuit for the i.c. is all right. Bootstrap circuit next! You may remember I said that an open-circuit bootstrap capacitor could possibly cause the distortion. So that's the next thing for you to check."

"How do I do that?"

"Turn up the receiver volume to give a distorted output and then bridge the capacitor with another 150µF capacitor."

Dick looked through a box of spare components on Smithy's bench.

"I can't find a 150µF," he stated after a few moments. "Will 100µF do?"

"Yes, of course," said Smithy impatiently. "Come on!"

Dick turned up the volume of the receiver and applied the 100µF capacitor across the 150µF capacitor on the printed board. There was a click in the speaker as he connected the 100µF capacitor into the bootstrap circuit but there was no alteration in the distortion level. (Fig.4(b).)

"Okay," said Smithy. "Well, that seems to eliminate the bootstrap circuit. Turn the volume down and let me think for a moment."

"Perhaps the i.c. is duffy," suggested Dick, as he reduced the volume level of the radio.

"Perhaps it is," agreed Smithy, "but it will still be the last thing we suspect."

"Why's that?"

"First, because i.c.'s are usually nearly as reliable as discrete silicon transistors, and secondly because changing it is too big a job to contemplate at this stage. There's a third reason, too."

"What's that?"

"We don't have a replacement in stock! Now let's recap. The distortion is appearing after the volume control and, for the moment, we'll say that there's no fault which is blantantly obvious around the i.c. So we'll do some quick checks around the transistor which precedes it. Testmeter ready again! Check the voltage between the transistor base and chassis."

Dick applied the testmeter prods to the printed board once more. (Fig.5(a).)

"There's about 1.2 volts here," he announced.

"That seems reasonable," said Smithy slowly. "Try the voltage between the collector and chassis next."

"Okeydoke."

Dick once more put the meter prods onto the board. (Fig.5(b).)

"I'm getting about 8.9 volts here," he said.

A beatific smile spread across Smithy's lips and he rubbed his hands together.

"Heh, heh," he cackled, taking on the eldrich tones of a witch. "Blood! I smell blood!"

And there was blood, indeed, to smell. The next checks showed that there was only 0.2 volt across the collector load resistor and that this resistor had its true and proper value of 5.6kΩ. Whereupon anyone armed with a pocket calculator and having a glimmering of Ohm's Law will at once tell you that the transistor

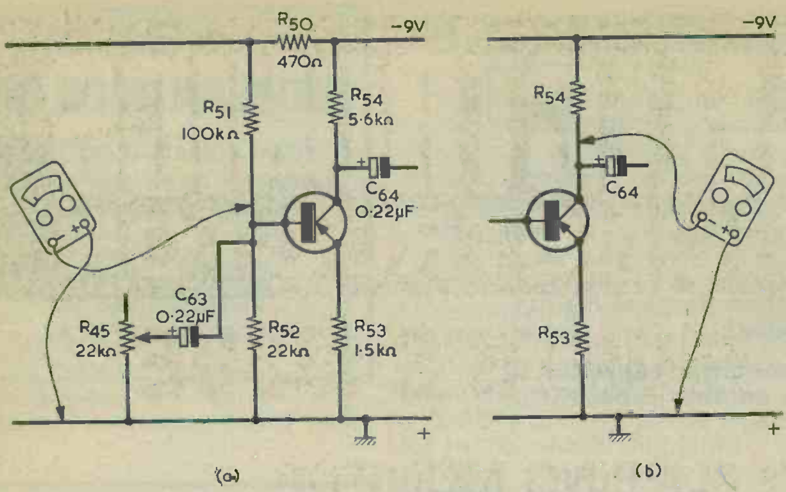


Fig.5(a). A further test consisted of measuring the voltage at the transistor base.

(b). This was followed by a check of the transistor collector voltage.

collector current was equal to 0.2 volt divided by 5.6kΩ or 0.035714mA to 5 significant figures or, if you want even greater accuracy, 35.7143μA to 6 significant figures. The only remaining resistor to check was the 1.5kΩ transistor emitter resistor, and the value of this had risen to some 10 times its nominal value. At the reduced collector current available to the transistor, it simply had not been able to handle signals above a low level without introducing distortion.

Dick did not even have to remove the board to fit a new 1.5kΩ resistor. He merely had to snip the leads of the faulty resistor close to its body and then quickly solder the new resistor to these leads. It could be argued that Smithy had devoted all his time to explaining the component functions around the audio amplifier i.c., whereas the fault in *this* particular radio was in a transistor stage that had nothing to do with the integrated circuit. But then who ever said that, in servicing, the fault has to lie in the stage you're devoting all your attention to?

LAST WORDS

"That's great," grinned Smithy happily as Dick switched off the radio, which now had a completely acceptable performance so far as distortion was concerned. He consulted his watch. "Blimey, there's still a couple of minutes to go before packing-up time."

"Good," said Dick quickly. "Then you can tell me what's white on the top, white on the bottom and blue in the middle."

"Trust you to spoil everything," sighed Smithy. "All right, what *is* white on the top, white on the bottom and blue in the middle."

"It's a frog sandwich," replied Dick triumphantly. "It's a frog sandwich which has been left too long in the freezer!" ■

BOOK REVIEW

ELECTRONIC MUSIC PROJECTS. By R. A. Penfold. 110 pages, 180 x 105mm. (7 x 4in.) Published by Bernard Babani (Publishing) Ltd. Price £1.75.

Electronic music effects and sound generators are very popular and it is possible, in many cases, to produce impressive results with the aid of quite simple circuitry. In this book, R. A. Penfold gives details of some 24 music projects which can be readily assembled by the home constructor.

The first chapter covers guitar effects units, and describes two types of tone booster, a fuzz box, a waa-waa unit, an automatic waa-waa unit, and a sustain unit incorporating an opto-isolator. General effects are described in the second chapter, which deals with a tremolo generator, a reverberation unit, an automatic phasor, an audio modulator and an envelope shaper.

The third chapter is devoted to sound generator projects, and includes white and pink noise generators, a glissando tone generator with switched output filters, a vibrato oscillator and a stylus organ. In the fourth and last chapter we find details of an electronic guitar tuning fork, a guitar practice amplifier, a metronome with visible flash, automatic and voice operated faders, a simple sound mixer and a sound-to-light unit with which the apparent speed of a moving light display increases with the volume of the music being played.

This listing shows the wide range of projects dealt with. Each is presented in circuit form with a components list and accompanying text describing circuit operation and giving advice on constructional points. This is another good book from a well-known and prolific author.

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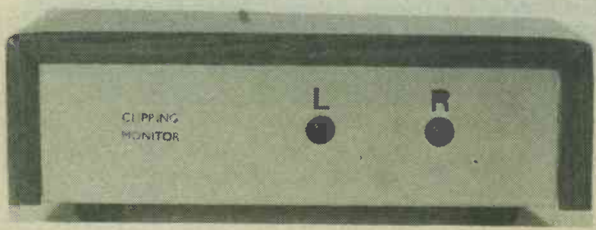

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BASIC MEDIUM RADIO

By T. F. Weatherley

Simple single band loudspeaker radio.

This little radio was originally devised as a practical project in an electronics course to introduce modern components and constructional techniques. The two integrated circuits used have been available for some time but they do serve to illustrate the premise that quite sophisticated equipment can be built with very few discrete components.

The heart of the receiver is the popular ZN414. This integrated circuit contains, to quote the specification, "a ten transistor tuned radio frequency circuit using C.D.I. technology to provide a complete r.f. amplifier, detector and a.g.c. circuit on one chip". The chip is housed in the standard TO18 package and could be mistaken for a BC108. The a.f. amplification in the receiver is provided by an LM380.

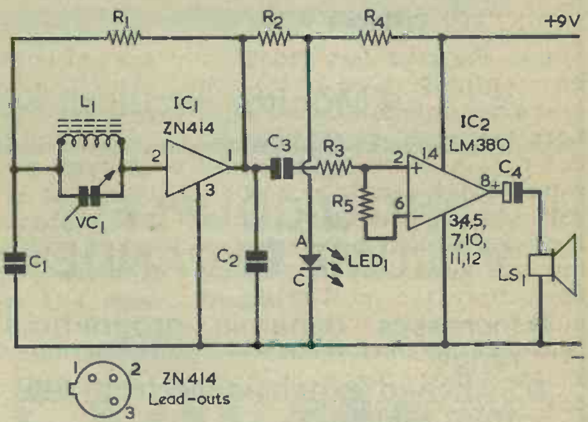


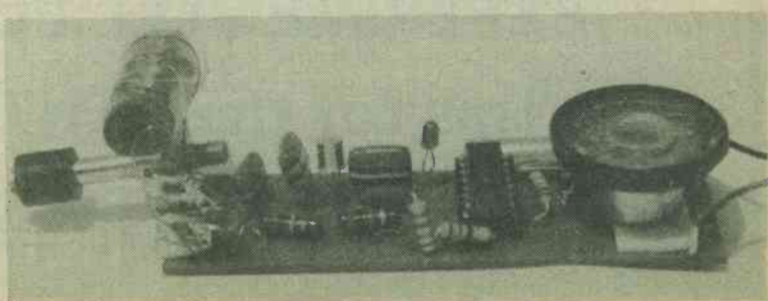
Fig. 1. The circuit of the medium wave radio. The use of two integrated circuits results in a low discrete component count.

CIRCUIT OPERATION

As can be seen from Fig. 1 the circuit is quite straightforward. It can be thought of as comprising three sections: r.f. amplification and detection, a.f. amplification and a power supply. The last is a 9 volt battery.

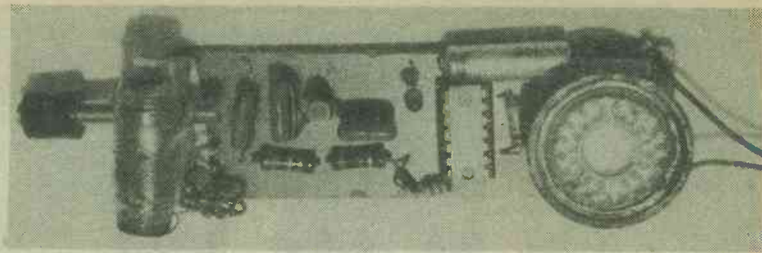
The ferrite aerial coil, L1, and VC1 form the inout tuned circuit, with C1 providing an earth return. R1 and R2 are the ZN414 bias and load resistors respectively. C2 is an r.f. filter capacitor. The ZN414 produces an a.f. output of some 30mV r.m.s. and this is coupled through C3 and R3 to the input of the LM380. A 10MΩ resistor, R5, controls the LM380 gain, and the output is coupled to the speaker through C4.

The ZN414 requires only 1.5 volts and this is provided by R4 and LED1. The voltage dropped across the l.e.d. is held at a stable value of about 1.5 volts, and the l.e.d. also indicates that the receiver is turned on. The full 9 volts is applied to the LM380.



A side view of the printed board assembly.

WAVE



The completed receiver. The prototype employed a very small speaker, but any size speaker may be used.

Inexpensive design requiring few components.

CONSTRUCTION

The radio is built on a printed circuit board measuring 90 by 32mm., or approximately 3½ by 1¼in. This board is shown full size in Fig. 2. After the board has been prepared, the components are fitted and soldered into place as shown. The resistors, and capacitor C4, can be mounted horizontally or vertically as space permits. IC2 can either be soldered to the board directly or mounted in an i.c. holder. In the original, Veropins were used for the connections to the battery, the speaker and to L1 and VC1. The author was lucky enough to obtain a 1in. 8Ω loudspeaker locally and this was positioned on the board as shown in the photographs. A larger 8Ω loudspeaker can, of course, be used and this will need to be mounted away from the board.

FERRITE AERIAL

The ferrite aerial rod has a diameter of ³/₈ in. and is only about 1in. long. This was found by experiment to be the shortest length which still enabled the project to be worth-while. The 1in. length was obtained from a longer rod by the usual method for breaking ferrite rod. First, a groove is filed all around the rod at the point where it is to be broken with a V-edge file, and the body of the rod is then gently tapped against the edge of a wooden bench or table.

The winding consists of 50 turns of 32 s.w.g. enamelled wire close-wound to form a coil about ½in. long at the centre of the rod. The wire gauge is not very critical and slightly thicker or thinner winding wire would also be suitable. It is helpful to fix some Sellotape, sticky side out, on the rod first, since this

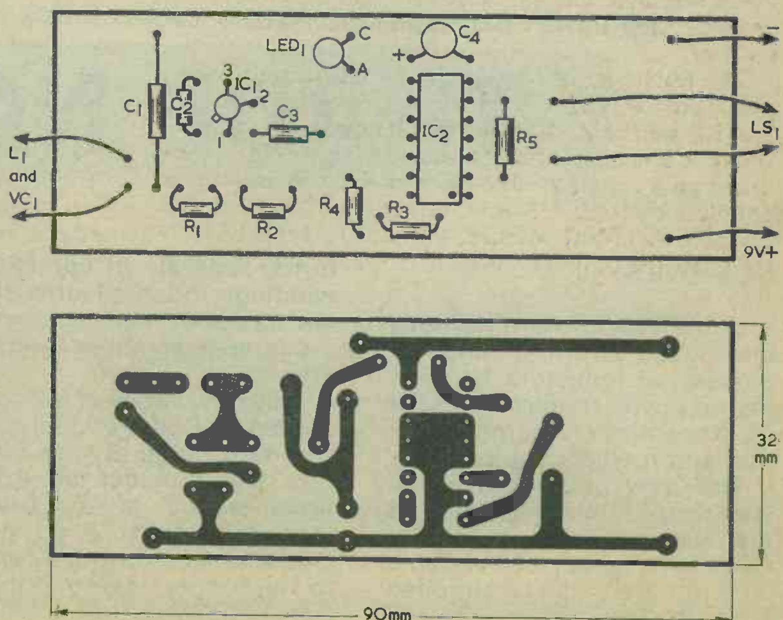


Fig. 2. Component and copper sides of the printed board. This is reproduced full size.

COMPONENTS

Resistors
(All ¼ watt 5% unless otherwise stated)
R1 100kΩ
R2 1kΩ
R3 1MΩ
R4 560Ω
R5 10MΩ 10%

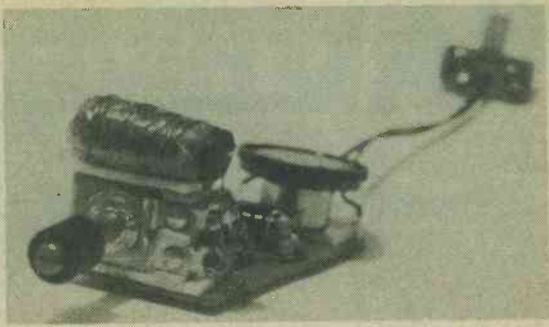
Capacitors
C1 0.01μF polyester, type C280
C2 0.1μF polyester, type C280
C3 0.1μF polyester, type C280
C4 100μF electrolytic, 10 V. Wkg.
VC1 60-200pF trimmer (see text)

Inductor
L1 see text

Semiconductors
IC1 ZN414
IC2 LM380
LED1 red l.e.d.

Speaker
LS1 8Ω speaker (see text)

Miscellaneous
9 volt battery
Printed board materials
I.C. holder, 14 way d.i.l. (if required)
Control knob adaptor (see text)



Looking at the trimmer which functions as the tuning control. A home-made adaptor allows this to be adjusted by a control knob.

holds the turns in place. The whole winding is finally covered with more tape, and the enamel is scraped away from the two coil ends so that these may be soldered to the tags of VC1.

With the prototype VC1 is a mica compression trimmer having a value of about 60pF minimum and about 200pF maximum. It can be adjusted for station selection by means of a screwdriver. However, this does not appear to have universal appeal and so a mechanical adaptor which allows a tuning knob to be employed was fabricated. The adjusting screw for the trimmer was 6BA, and this was removed. A length of rod having a diameter of ¼in. and a central hole capable of taking 6BA studding was located in the spares box. The head was cut from a ½in. 6BA bolt, and one end of the threaded section affixed inside the rod. The rod assembly was then screwed into the trimmer in place of theoriginal adjusting screw and an ordinary control knob fitted at the other end of the ¼in. rod. Similar means of making up an adaptor which allows the trimmer to be adjusted by means of a control knob should suggest themselves to the constructor.

The completed receiver has quite an impressive performance, despite its simplicity. The prototype can pull in a dozen or more stations at the author's home in East Anglia and the a.g.c. provided by the ZN414 makes listening a pleasure.

Current consumption from the 9 volt supply at normal volume levels is around 30mA, and so a fairly large battery is preferable if long listening periods are envisaged. ■

TRADE NOTE

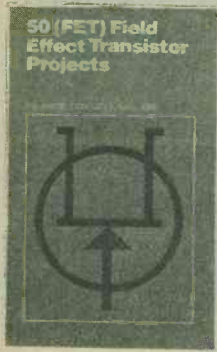
NEW COILS

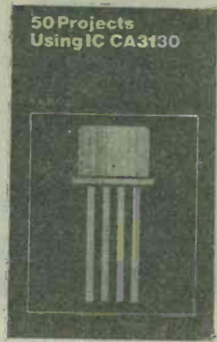
Codar Telecom Limited have introduced a further range of air spaced inductors to meet higher power requirements for r.f. transmission, communication and medical equipment.

The new coils are wound with copper ribbon or tube and are also available in "Roller Coaster" types of variable inductor. Coils can be supplied with variable pitch spaced turns, separate or continuous windings, indented turns, taps, and as basic units for complete mounted assemblies ready for fitting.

This new series of inductors augments Codar's widely used standard range of wire inductors and provides an exceptional range of air spaced inductors from ¾ to 15in. diameter, and having 22 s.w.g. to 1in. copper tube conductors. Applications include r.f. oscillators, interstage coupling, pi-net and conventional L-C output.

In view of the very wide range of applications and differing requirements, coils are made to specification. The service features close co-operation with designers in the early development of new equipment. Further details can be obtained from Codar Telecom Limited, P.O. Box 3, Rottingdean, Brighton, BN2 8AZ.





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'NOTES FOR NEWCOMERS'

SATISFACTORY SOLDERING

By D. Snaith

8 tips to start you soldering successfully.

Quite a few newcomers to the home-constructor hobby run into difficulties when they attempt to make their first soldered joints. The ability to solder is essential if the hobby is to be truly rewarding and, if you have never soldered before, you *do* need a little practice to get the "feel" of things. About half an hour's experience in soldering together odd wires and tags should be more than adequate, and after this you should be able to tell with some reasonable certainty whether or not you have completed a good joint as soon as the solder has set solid.

SOLDERING FACTS

Fig. 1(a) shows a tinned copper wire which is to be soldered to a tag. Although both the wire and the tag may look clean, they will in fact almost certainly be covered with a thin oxide coating. The molten solder has to get past that oxide coating if it is to make a proper joint with the pure metal underneath, and for this reason we apply not only solder to the joint but also *flux*. The flux is a chemical which, when heated, breaks down the oxides. We use cored solders for electronic work, and these consist of solder wires with, typically, five cores containing a suitable flux. So, when we apply the solder we automatically apply the flux as well.

In Fig. 1(b) we apply the soldering iron tip to the work (i.e. the items to be soldered together) so that, preferably, the tip is in contact with both pieces. At the same time we apply the solder to the iron tip and the work. What happens first is that the solder melts at the iron tip and the heated flux at once gets to work on the oxides in the immediate vicinity, allowing the molten solder to "wet" the work pieces. Heat from the iron tip travels quickly through the molten solder to the work pieces, with which the solder is now in intimate contact. The rate of heat flow is faster than would be given by just placing the iron tip on its own on the work. We apply a little more solder, which now flows over the work pieces and then we remove the solder and the soldering iron. If the solder *flows* over the work pieces we have made a good joint. The completed joint should be smoothly covered with just enough solder to do the job. There will almost certainly have been a little more flux than was needed, and what is left sets hard on the outside of the solder.

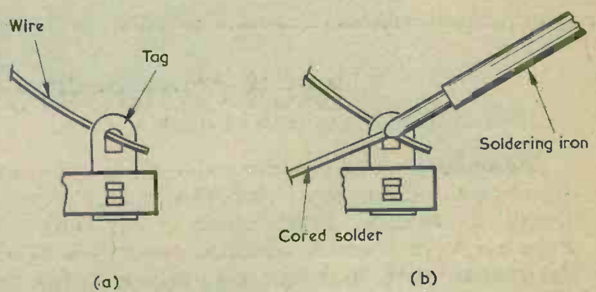

Fig. 1(a). The wire shown here is to be soldered to the tag (b). The tip of the hot soldering iron and the solder are both applied at the same time to the work pieces. The molten solder first speeds the transfer of heat from the iron to the work pieces, and then flows over the pieces to produce the joint.

SOLDERING SNAGS

Now, here are the things which can go wrong and produce an unreliable solder joint.

1. The soldering iron is applied for too short a time. The solder may run over the work and even cover it but, because the work pieces were not raised to a sufficiently high temperature, has not made a proper joint with them. The result is a rough solder outline, and the joint looks as though you've been trying to solder with sealing wax.

2. The soldering iron has been applied for too long. This may not result in a poor joint but it can cause overheating of components whose lead-out wires form part of the joint. One of the main reasons for initial soldering practice is to find how to arrive at a happy medium between this snag and snag No. 1.

3. There is too little solder in the joint. This will be visually obvious. There should be enough solder to give a sound mechanical joint.

4. Too much solder in the joint. Another conflicting snag, and again visually obvious. A joint with too much solder may in fact be sound, but big blobs of solder look unsightly. What's more, they take too long to cool down after the iron has been removed, with possible overheating of components in consequence. Also, there is a greater risk of snag No. 5 occurring.

5. The work pieces are moved just before or at the instant when the solder sets. Solder does not go direct from the liquid to the solid state as it cools, but passes through a "pasty" condition. If the work pieces are moved when the solder is pasty a poor joint results.

6. The work pieces are too oxidised or dirty. All semiconductor device leads, and those of nearly all modern resistors and capacitors should solder straightaway when using cored solder. But the flux may not be able to break down high levels of oxide. Before attempting a joint with wire which looks dirty or highly oxidised, scrape off the dirt or oxide with a sharp knife and then tin the lead with cored solder. After this it will solder directly.

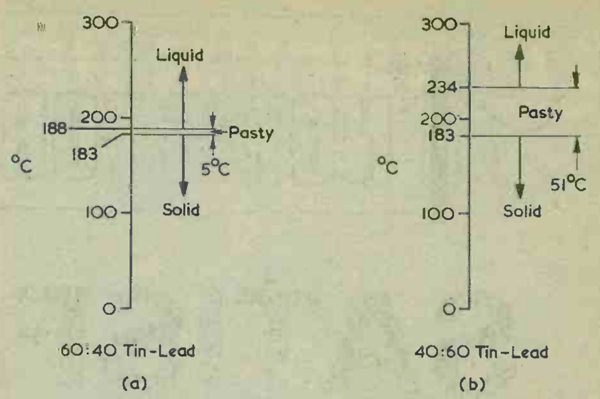

Fig. 2(a). A solder alloy consisting of 60% tin and 40% lead exhibits a very low temperature range in which it is in the pasty state. (b). A 40:60 tin-lead alloy goes from solid to pasty at the same temperature as does 60:40 solder, but the pasty range extends to a very much higher temperature before the solder becomes liquid.

7. Dirty soldering iron bit. Always keep the iron tip nice and shiny with molten solder. This allows heat to travel quickly to the work pieces.

8. Wrong solder. Avoid "electrical grade" or 40:60 solder like a plague. Always use a 60-40 tin-lead alloy or Multicore "Savbit" (which has a little copper added). Fig. 2(a) shows the temperatures at which 60:40 alloy is solid, pasty and liquid, whilst Fig. 2(b) shows the temperatures for the same states in 40:60 alloy. The 60:40 solder is pasty from 183deg. C to 188deg. C, a range of 5deg. C only which in practice is just right. The 40:60 alloy is pasty from 183deg. C to 234deg. C, a range of no less than 51deg. C. The 40:60 solder is hopeless for the small closely spaced solder joints which are encountered in modern electronics. ■

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MODULES. Mullard LP1164 AM/FM i.f. Unused and guaranteed £1.50. P.P. C.W.O. BA screws, hardware, components, Manufacturers' clearance. S.A.E. lists. Tennex Ltd., Stock Road, Southend-on-Sea, Essex.

25 MIXED I.C.'S £1.50. 100 mixed transistors £3.50. Valves. Early radios. Electronic bargains. Interesting lists 15p. Sole Electronics, REC, 37 Stanley Street, Ormskirk, Lancs, L39 2DH.

BIGGEST RANGE SERVICE SHEETS/MANUALS. Any published sheet £1. plus s.a.e. Repair data any named TV £5.50 (with circuit set £7). S.A.E. newsletter, quotations, bargains. G.T., 76 Church Street, Larkhall, Lanarkshire.

BOOKS FOR SALE: *Experiments with Operational Amplifiers,* by George B. Clayton. £3.75. *Digital I.C. Equivalents & Pin Connections,* by Adrian Michaels, £1.20. *Experimenting with Electronic Music* by Brown & Olsen. £1.20. *Electric Model Car Racing* by Laidlaw-Dickson. 60p. *Understanding & Using Modern Signal Generators* by Charles Gilmore. £1.20. *Electronics Unravelled* by Kyle, £1. *How to Use your VOM VTVM Oscilloscope,* by Clifford, £1. *Modern Radio Repair Techniques,* by Art Margolis, £1. Box No. 394.

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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. F. E. Woolley, 9 Rannoch Court, Adelaide Road, Surbiton, Surrey, KT6 4TE.

(Continued on page 189)

SMALL ADVERTISEMENTS

(Continued from page 187)

FOR SALE: Wide angle 9.5mm cine equipment: camera, projector, screen, etc. Also several other 9.5mm cine cameras. S.A.E. for details Box No. G388.

WANTED: Service Manual, circuit diagram of Telequipment Serviscope Type S51A. To buy or borrow copy. Expenses refunded plus small remuneration. 35 Stanhope Road, Swanscombe, Kent, DA10 0AN.

THE BRITISH AMATEUR ELECTRONICS CLUB for all interested in electronics. Four Newsletters a year. Library of technical books and magazines. Help for members by experts. U.K. & Eire £4.50. Europe £6. Airmail £7.50:– Sterling per year. Details from Hon. Sec., J. G. Margetts, 3 Bishopstone Close, Golden Valley, Cheltenham, Glos.

FOR SALE: Non-working CCTV cameras £25.00. each. J. Fulton, Derrynaseer, Dromore, Co. Tyrone, N. Ireland.

HEATHKIT DIGITAL DISPLAY shelf clock with Westminster chimes. Used one month only. £80. (Cost £160). Telephone:– Southend (0702) 711181.

FOR SALE: A number of "D & S" three pin, fused, mains plugs and fuses. S.A.E. for details. Box No. G396.

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WANTED: FAX equipment, manuals, service sheets, etc. G2UK, 21 Romany Road, Oulton Broad, Lowestoft, Suffolk. NR32 3PJ.

BOOKS FOR SALE: *Amateur Radio Antennas* by Harry Hooton, £1. *Ham Antenna Construction Projects* by J. A. Stanley, 75p. *All about Cubical Quad Antennas* by W6SAI, £1. *Radio Astronomy for the Amateur* by Dave Heiserman, £2. *HAM-RTTY* by W2NSD, 50p. *Radio Control for Model Yachts* by C. R. Jeffries, £1.00. All plus postage. Box No. G397.

(Continued on page 190)

MARCO TRADING

To obtain a free copy of our 35 page list simply send a 20p postage stamp or a large SAE. This advertisement shows only a part of our range. (Our new list includes Tants, Electrolytics, Disc ceremics, etc.)

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400V	43p	6.0 Amp 50V	70p
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ELECTRONIC MAILORDER LTD,
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Via Bury, Lancs. BL0 9AGC. Tel. Ramsbottom 3036

SMALL ADVERTISEMENTS

(Continued from page 189)

FOR SALE: KW2000 B Transceiver with trapped dipole antenna to match. £150. Prefer buyer collects. George Oxby, G3RRX, 36 Denmark Road, Beccles, Suffolk. Telephone: 0502-715322.

INTERESTED IN RTTY? You should find the *"RTTY Journal"* of interest. Published in California, U.S.A., 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.

WANTED: Service manual – Ekco car-portable type CP 920. To buy or borrow. Box No. G398.

FOR SALE: Photographic enlarging equipment: Vivitar enlarger. Model E.36 with 50mm f. 3.5 and 75mm f.3.5 lenses. Kodak safety light. Kodak contrast filter set. 11 in. x 14 in. printing frame with copying facilities. Measuring flask. Three trays, three tweezers. Three plastic bottles. Clips. Printing paper. Antistatic brush for cleaning negatives. Kodak Photoguide Booklet. Man's protective apron. £75 o.n.o. Pair of Goodman's speakers 8 ohms, 15 watts, £50 o.n.o. R. L. Gee, 3 Longfellow Drive, Hutton, Essex, CM13 2QQ.

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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.

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(Continued on page 191)

SMALL ADVERTISEMENTS
(Continued from page 190)

PERSONAL

JANE SCOTT FOR GENUINE FRIENDS. Introductions to opposite sex with sincerity and thoughtfulness. Details free. Stamp to: Jane Scott, 3/Con North St. Quadrant, Brighton, Sussex, BN1 3GJ.

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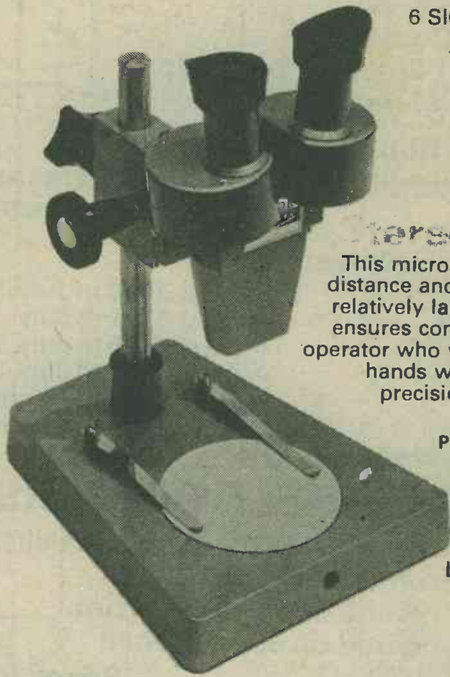

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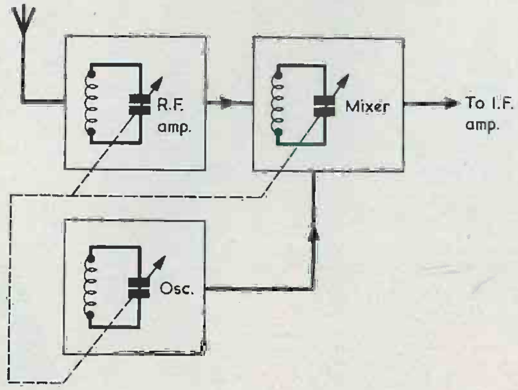
BANDSPREADING

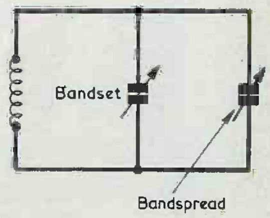
The r.f. amplifier, mixer and oscillator stages of a short wave superhet appear in (a). The r.f. amplifier and mixer input tuned circuits, and the oscillator tuned circuit, are all tuned by a 3-gang variable capacitor. Since tuning at short wave frequencies is sharp the 3-gang capacitor has to be adjusted through a high ratio tuning drive which must have a positive action free of mechanical "back-lash".

An alternative approach towards ease of tuning is to connect a small value variable capacitor in parallel with each main tuning capacitor, as in (b). The main tuning capacitor is then the "bandset" capacitor and the small value capacitor the "bandspread" capacitor. The bandset capacitor is set roughly to the frequency desired, final tuning being carried out with the bandspread capacitor. In our example the bandspread capacitor could be a 3-gang component, with its sections in parallel with the sections of the main 3-gang capacitor. Alternatively, a single-gang capacitor having a very low value can be connected across the oscillator tuning capacitor only, since it is the oscillator which effectively selects the signal frequency to be amplified in the receiver i.f. stages.

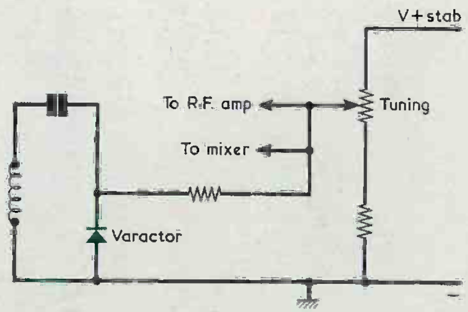
In (c) the oscillator tuned circuit is tuned by a reverse biased variable capacitance, or varactor, diode, whereupon the potentiometer becomes the receiver tuning control with the voltage at its slider being passed also to similar varactor tuned circuits in the r.f. and mixer stages. If a low value potentiometer is inserted in series with the main tuning potentiometer, as in (d), it will function as a bandspread control and provide fine tuning.



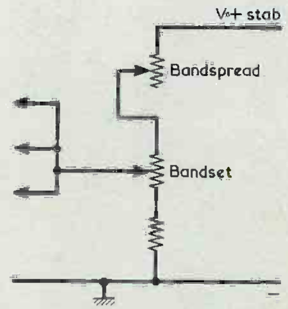
(a)



(b)



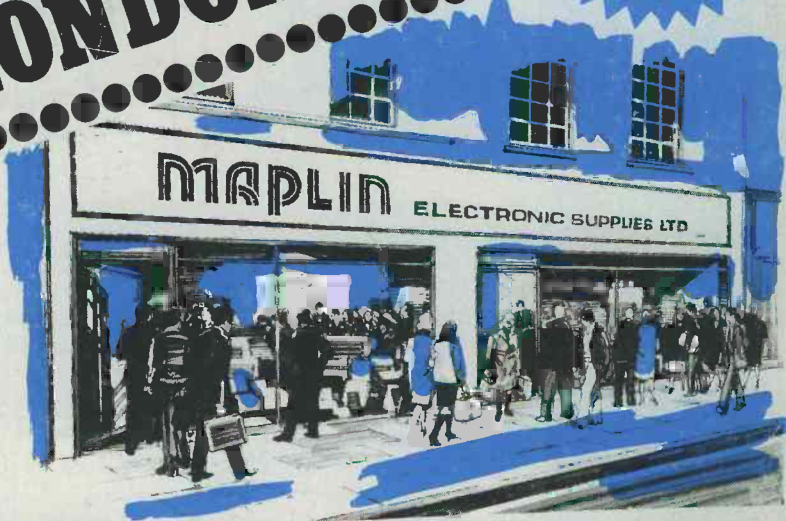
(c)



(d)

MAPLIN announce the opening of their new LONDON shop

159-161 King St. Hammersmith London W6 01-748 0926



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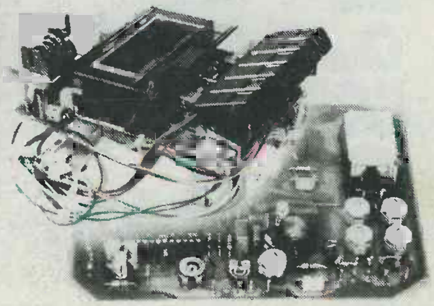

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