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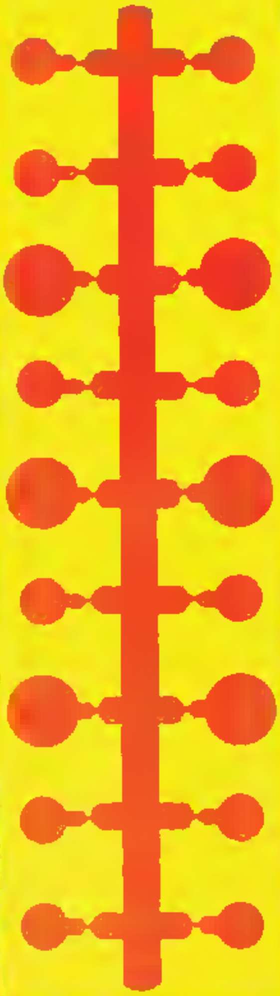

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OCTOBER 1978
VOLUME 54
NUMBER 6
ISSUE 860

BRITAINS LEADING JOURNAL FOR THE RADIO & ELECTRONIC CONSTRUCTOR

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NEWS & VIEWS

FOR OUR CONSTRUCTORS

GENERAL INTEREST

Our November issue will be published on October 6th
(for details see page 43)

We regret that part 4 of our series "Introduction to Logic" has been held over due to pressure on editorial space

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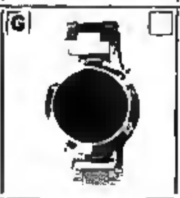
G 

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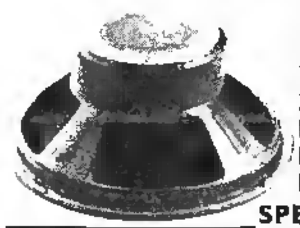

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Thermostat Pocket. To fit the above thermostat into a tank without heater then you need a pocket to hold the thermostat, 18" long threaded complete with nut and washer, price **£1·62** —also available 8" long for 7" thermostat same price.

Hot Wire Vacuum Relay Switch. 4 pin plug in type. This has a heater coil wound around a bi-metallic strip causes switch-on after a time which is adjustable. The energising voltage varies between 4v & 7v time delay time—from a few seconds upwards price **£1·08.**

Boiler Stat 60-90°C remote phial type capillary length approx. with control knob marked 20 to 80°C, price **£2·16p.**

Transistor holder for TO5 (OC 26 etc) allows transistor to be replaced quickly, also threaded for holding screws. AC capacitor 1 25uf for 40 volts rms. Aluminium can with tag connections ex new equipment covered by normal guarantee **30p+2p.**

Mains operated Siren. Don't let intruders get away with your possessions—they will never stay in a house when one of these sirens is going. Quite small but very alarming **£13·50.**

Lever Switch as fitted to modern telephone switch boards. 8 pole changeover contacts made by Pye/TMC biassed to return when pushed up, stays down when pushed down, price **£1 08p.**

Pulsing Switch. Motorized unit which gives pulses every 30 seconds, length of pulse can be adjusted up to 30 seconds and the pulse can be up to 20 amps at normal mains voltage. Made up by famous Cramer Company of America, the drive motor of this device is 115v 50hz but we supply complete with series voltage dropping device to make it suitable for our mains. This is in a cylindrical plastic case overall size, with a knob on the front for adjusting the pulse length. 20 amp switch "inside" is a changeover switch so this device could also be used as a time sharing switch, when one circuit is on the other circuit would be off for a length of time determined by switch control setting, price **£4·82.**

16 Line Connecting Box. This is 16 way twin grub screw type connecting strip mounted in a standard 2 gang MK white surface box with cover made for Satchwell so obviously a good product. The cables, are brought in through breakaways in the plastic box 16 connection points are all numbered for easy identification, price **£1·92.**

Air Thermostat with remote setting dial. This is a Satchwell thermostat using a sensor connected to the switch by a 26" length of capillary. The control setting adjustable from 30° to 140°F complete with control knob showing temperature setting **£2·48.**

Twin 13 amp Rocker Switches (DOT) price **49p** the pair.

Pressure Gauge. standard airline thread. Reads 0-30lbs per sq. inch price **81p.**

Bargain for callers only. VDU with 18" CR Tube rather large **£18 50p.**

4 Way Terminal Blocks twin grub screw type, PVC covered 10 for **65p.**

Spares for Dimplex Heaters. We have just taken delivery of a large quantity of various spare parts for Dimplex heaters including storage heaters, if you need any of these then please let us have your enquiries.

Heavy Duty Casters. Four of these would carry a ton, set of 4 **£2·65.**

MULLARD UNILEX

A mains operated 4+4 stereo system. Rated one of the finest performers in the stereo field this would make a wonderful gift for almost anyone in easy-to-assemble modular form and complete with a pair of Plessey speakers this should sell at about £30—but due to a special bulk buy and as an incentive for you to buy this month we offer the system complete at only **£15** including VAT and postage. 10 watt amps to upgrade unilex **£3·50** each.

UNISELECTORS

These are pulse operated switches as used in automatic telephone switchboards, etc. The pulse moves the switch arm through one position. Except where indicated the selectors are 25 position types and 50v Coil is standard. 24v or 12v operation extra at **£2** per switch.

3 pole	£5 90	10 pole	£13 60
4 pole	£6 98	12 pole	£15 88
5 pole	£8 20	2 pole 50 way	£8 60
6 pole	£9 25	3 pole 50 way	£11 40
8 pole	£11 40		

24 HOUR TIMERS

The one illustrated is the 'E' control, this uses the Smiths mechanism as in their autoset. 2 on/off's per 24 hours, 13 amp contacts, override switch **£6 50.**

Smiths 100 amp model one on/off per 24 hours **£10·50**, extra contacts **£1·60** per set. AEG 60 amp model with clockwork standby, one on/off per 24 hours **£9·50**, extra contacts **£1 90** per set.

RELAYS

12 volt two 10 amp changeover plug in **85p** 12v three 10 amp changeover plug in **£1·28.** 12v two changeover miniature wire ended **95p.** 12 volt open single screw fixing two 10 amp changeovers **85p** 12 volt open three 10 amp changeovers **£1 25.** Latching relay mains operated 2 c/o contacts **£2·11.** Mains operated three 10 amp changeovers open type one screw fixing **£1 25.** Many other types with different coil voltages and contact arrangements are in stock, enquiries invited.

ROTARY PUMP

Self priming portable, fits drill or electric motor, pumps up to 200 gallons per hour depending upon revs. Virtually uncorrodable, use to suck water, oil, petrol, fertiliser, chemicals, anything liquid. Hose connectors each end. **£2** post paid.

DELAY SWITCH

Mains operated—delay can be accurately set with pointers knob for periods of up to 2½ hrs. 2 contacts suitable to switch 10 amps—second contact opens few minutes after 1st contact **95p.**

HUMIDITY SWITCH

American made by Ranco, their type No. J11. The action of this device depends upon the dampness causing a membrane to stretch and trigger a sensitive micro-switch adjustable by a screw, quite sensitive—breathing on it for instance will switch it on. Micro 3 amp at 250V a.c. Overall size of the device approx. 3½ long, 1 wide and 1½ deep **75p.**

INDUCTION MOTORS

One illustrated is our reference MM11 made for ITT ½ stack 1½ spindle **£2·25.** ½ stack model **£1 75.** 1 stack **£2 75.** 1½ stack **£3 25.**

SMITHS CENTRAL HEATING CONTROLLER

push-button gives 10 variations as follows (1) continuous hot water and continuous central heating (2) continuous hot water but central heating off at night (3) continuous hot water but central heating on only for 2 periods during the day (4) hot water and central heating both on but day time only (5) hot water all day but central heating only for 2 periods during the day (6) hot water and central heating on for 2 periods during the day time only—then for summer time use with central heating off (7) hot water continuous (8) hot water day time only (9) hot water twice daily (10) everything off.

A handsome looking unit with 24-hour movement and the switches and other parts necessary to select the desired programme of heating. Supplied complete with wiring diagram. Originally sold we believe at over £15—we offer these, while stocks last at **£7 50** each including VAT & Postage.

Terms: Prices include Post & VAT. But orders under £6·00 please add 50p to offset packing. Bulk enquiries—Please Phone for Generous Discounts 688 1833.

J. BULL (ELECTRICAL) LTD

(Dept. P. W.), 103 TAMWORTH RD., CROYDON CR8 1SG

Super power 2N3055. RCA52360 in our tests this does all that the 2N3055 will do but very much better—truly a remarkable transistor 85p.

200 Watt Transformer 40v-0-40v normal type construction and primary wound for 230 50hz **£6 65.**

High Voltage Rectifier. 5kv working at 5mA, these are ex unused equipment but have good length leads, ideal for use with the EHT transformer if joined in series. price **33p.**

Speaker Cabinets. Simulated teak finish, nice handy size modern black sponge type front **£3·75.**

In Car Speaker Cabinet. White with black edge very modern looking plastic with threaded studs for mounting speaker complete with back, price **£2·25.**

AC Capacitors for use on fluorescent lighting for power factor correction or as a voltage dropping device, these are very rugged and will stand DC voltages up to 3 times their RMS voltage. A big purchase enables us to offer these at about one third of the current manufacturers price, all are 300v RMS working or higher and are in aluminium cans with tags or wire ends, following values: 1·25uf **38p**, 1·5uf **49p**, 3uf **59p**, 4uf **78p**, 7uf **92p**, 8uf **£1·07**, 15uf **£1·35.**

Numerical Display Tubes (Nixie tubes) Mullard ref. ZM 1175, this is a sideways viewing device which displays all figures from 0-9, has wire leadouts, new in box **82p** each.

Waterproof Diecast Box very suitable for protecting a switch or a thermostat or a similar device where this is mounted outside or in a greenhouse, price **£1·62.**

Multiway Switches. GEC silver finished metal box with cable knockouts each complete with switch mounting grid and matching recessed cover, suitable for conduit or TRS. Single switch 50p, twin switch 60p, 4 switch 75p, 6 switch £1, 12 switch £1 50p.

Modern toggle type miniature switches by GEC to fit above boxes, mains rating 5 amp on/off **35p**, 15 amp on/off **45p**, 5 amp 2 way **30p**, 2 way and off **50p**, intermediate (polarity) changeover **60p**) bell push **35p** (available in several colours). Please add 8% VAT to total cost of boxes and switches.

Most of the above switches can be supplied without toggles but operated by a special key, add 10p per switch and 25p per key.

Can Any Reader help? We have recently acquired some very nice American made motors 50 cycle for 50hz 220v working obviously made for the British Market but they have 5 lead out wires and we have not been able to find out the correct method of working. It is possible that they need a capacitor. The colours of the leadout wire are red, white, yellow and blue. The maker's name is Robbins and Myers and the model number of the motor is KS-PP30-601 rated at 1/12 hp single phase 1425 rpm. Price of the motor **£5·50p+44p.** Post and packing £2.

Boiler Stat. Satchwell remote dial type with knob calibrated 20-90°C. price **£2 42**

Project Boxes. Nicely made in black plastic with threaded brass inserts to hold the lid which is fixed by four corner screws. There are three sizes available 75 x 56 x 35mm, price **60p**, 95 x 71 x 35mm price **70p** and 115 x 95 x 35mm price **80p.**

Instrument Buzzers, made for the GPO ex unused equipment price **54p.**

Klaxton Type Alarm. Battery operated gives a good loud note with only a 1·5v battery, gets unbearable as voltage increases, ideal for personal or car alarm, price **80p.**

Stereo Headphone Lead. Black curly 10ft approx. terminations, stereo jackplug one end—miniature two in plugs the other. Price **56p**

Stereo Decoder Kit uses latest techniques, size approximately 3½" x 1" x ½" complete price **£3·05** or made up and tested **£1 50** extra.

Stereo Beacon Light if required **45p** extra.

Cassette Microphone. Dynamic 600 ohm with on/off switch and stand for desk top work, price **£1·42.**

Mains Operated Pump. Most readers will know that we stock the Jebsco pump which was made to work with portable drills, the price is **£2·00**, now in response to demand for a mains operated pump we have coupled this to a 110 rpm motor, mounted them on a metal chassis and offer this as a general purpose pump. It is suitable for most liquids and certainly for water. The pump is self priming and will lift the liquid up to quite a head but naturally the delivery will fall off depending upon the lift. Price **£11 28.**

Flexible Conduits made from a thin but very tough plastic ribbed to give extra strength but very lightweight and very flexible and can be bent through a very small radius. Uses in addition to carrying most fluids, these conduits can also be used for cable tidying and protection and even make do flexible drive for a slow speed turning operation. Two sizes available ½" and ¾" internal diameters approximately. It is interesting to note that the ½" one is a reasonably good fit on the inlet/outlets of the above mentioned Jebsco pump. Price **27p** per metre, post **11p** per metre.

Double Ended Motor, mains operated, capacitor run approx. ¼ h.p., this has spindle coming out each side and should be very suitable for converting into a double ended polisher or grinder, holes conveniently placed in the housing make it very easy to stand in the right position and the speed although not high is adequate. Limited quantity only, we are offering these with capacitor at **£6·50.**

¼ H.P. Motors. Normal base mounting, ex computors but tested, 230-240v 50hz good length spindle mostly American make, **£8·50.**

13 Amp Rocker Switch made by Carr Fastener Co. (Dot) again available, price **27p.**

Luminous Rocker Switch, suitable for 13 amps at mains voltage, these are illuminated with neon through amber panel, snap-in fixing into hole size 1⅛" x 1⅛" Special bargain **38p.**

Three position Rocker Switch. 10 amp changeover with a centre off standard size clip fixing pushes into hole area size approximately 1" x $\frac{7}{16}$" which is standard for many rockers. Special bargain this month, 10 for **£1·62.**

60 Minute Clockwork Time Switch made by Smiths and as fitted to many tumble dryers, washing machines, etc. Very useful for other timed applications, when rotated 15 double pole main switch makes circuit and stays on for up to 1 hour depending on the amount you turn the spindle. Special snip price **£1·23.**

Clockwork Air or Gas Switch made by the famous Smiths Company, winding the clockwork opens the valve and lets the air or gas come through for maximum of two hours depending upon the amount the clockwork is rotated. Inlet and outlet are threaded normal gas size, price **£3·76.**

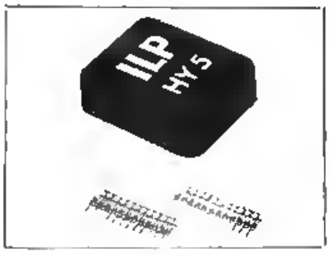
Connecting Wire Bargain 100 yards PVC insulated connecting wire 14/36 on a drum, conductors made by BICC, price **£1·38.**

EXTRACTOR FAN

Ex-computers made by Woods of Colchester ideal for fixing through panel—reasonably quiet running—very powerful 2500 rpm. Choice of two sizes 5 or 6½ dia **£5** and **£6.**

15—240 Watts!

HY5
Preamplifier



The HY5 is a mono hybrid amplifier ideally suited for all applications. All common input functions (mag Cartridge, tuner, etc) are catered for internally. The desired function is achieved either by a multi-way switch or direct connection to the appropriate pins. The internal volume and tone circuits merely require connecting to external potentiometers (not included). The HY5 is compatible with all I.L.P. power amplifiers and power supplies. To ease construction and mounting a P.C. connector is supplied with each pre-amplifier.

FEATURES: Complete pre-amplifier in single pack—Multi-function equalization—Low noise—Low distortion—High overload—Two simply combined for stereo.

APPLICATIONS: Hi-Fi—Mixers—Disco—Guitar and Organ—Public address

SPECIFICATIONS:
INPUTS. Magnetic Pick-up 3mV; Ceramic Pick-up 30mV; Tuner 100mV; Microphone 10mV; Auxiliary 3-100mV; Input Impedance 4·7kΩ at 1kHz.
OUTPUTS. Tape 100mV; Main output 500mV R.M.S.
ACTIVE TONE CONTROLS. Treble ± 12dB at 10kHz; Bass ± at 100Hz.
DISTORTION. 0·1% at 1kHz. Signal/Noise Ratio 68dB.
OVERLOAD. 38dB on Magnetic Pick-up. SUPPLY VOLTAGE ± 16-50V.

Price £6 27 + 78p VAT P&P free.

HY30
15 Watts into 8Ω

The HY30 is an exciting New kit from I.L.P. It features a virtually indestructible I.C. with short circuit and thermal protection. The kit consists of I.C., heatsink, P.C. board, 4 resistors, 6 capacitors, mounting kit, together with easy to follow construction and operating instructions. This amplifier is ideally suited to the beginner in audio who wishes to use the most up-to-date technology available.

FEATURES: Complete Kit—Low Distortion—Short, Open and Thermal Protection—Easy to Build.

APPLICATIONS: Updating audio equipment—Guitar practice amplifier—Test amplifier—audio oscillator.

SPECIFICATIONS:
OUTPUT POWER 15W R.M.S. into 8Ω: DISTORTION 0 1% at 1·5W.
INPUT SENSITIVITY 500mV. FREQUENCY RESPONSE 10Hz-16kHz—3dB.
SUPPLY VOLTAGE ± 18V.

Price £6 27 + 78p VAT P&P free.

HY50
25 Watts into 8Ω

The HY50 leads I.L.P.'s total integration approach to power amplifier design. The amplifier features an integral heatsink together with the simplicity of no external components. During the past three years the amplifier has been refined to the extent that it must be one of the most reliable and robust High Fidelity modules in the World.

FEATURES: Low Distortion—Integral Heatsink—Only five connections—7 amp output transistors—No external components

APPLICATIONS: Medium Power Hi-Fi systems—Low power dis o—Guitar amplifier

SPECIFICATIONS: INPUT SENSITIVITY 500mV
OUTPUT POWER 25W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0·04% at 25W at 1kHz
SIGNAL/NOISE RATIO 75dB FREQUENCY RESPONSE 10Hz-45kHz—3dB.
SUPPLY VOLTAGE ± 25V SIZE 105 50 25mm

Price £8 18 + £1 02 VAT P&P free

HY120
60 Watts into 8Ω

The HY120 is the baby of I.L.P.'s new high power range. Designed to meet the most exacting requirements including load line and thermal protection this amplifier sets a new standard in modular design.

FEATURES: Very low distortion—Integral heatsink—Load line protection—Thermal protection—Five connections—No external components

APPLICATIONS: Hi-Fi—High quality disco—Public address—Monitor amplifier—Guitar and organ

SPECIFICATIONS
INPUT SENSITIVITY 500mV.
OUTPUT POWER 60W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0 04% at 60W at 1kHz
SIGNAL/NOISE RATIO 90dB FREQUENCY RESPONSE 10Hz-45kHz – 3dB SUPPLY VOLTAGE ± 35V
SIZE 114 50 85mm

Price £19·01 + £1 52 VAT P&P free.

HY200
120 Watts into 8Ω

The HY200 now improved to give an output of 120 Watts has been designed to stand the most rugged conditions such as disco or group while still retaining true Hi-Fi performance.

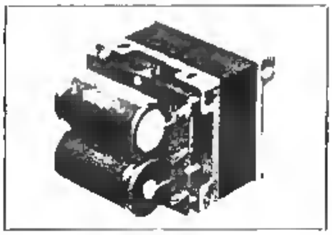
FEATURES: Thermal shutdown—Very low distortion—Load line protection—Integral heatsink—No external components

APPLICATIONS: Hi-Fi—Disco—Monitor—Power slave—Industrial—Public Address

SPECIFICATIONS
INPUT SENSITIVITY 500mV
OUTPUT POWER 120W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0 05% at 100W at 1kHz.
SIGNAL/NOISE RATIO 96dB FREQUENCY RESPONSE 10Hz-45kHz – 3dB SUPPLY VOLTAGE ± 45V
SIZE 114 50 85mm

Price £27 99 + £2·24 VAT P&P free.

HY400
240 Watts into 4Ω



The HY400 is I.L.P.'s "Big Daddy" of the range producing 240W into 4Ω! It has been designed for high power disco address applications. If the amplifier is to be used at continuous high power levels a cooling fan is recommended. The amplifier includes all the qualities of the rest of the family to lead the market as a true high power hi-fidelity power module.

FEATURES: Thermal shutdown—Very low distortion—Load line protection—No external components.

APPLICATIONS: Public address—Disco—Power slave—Industrial

SPECIFICATIONS
OUTPUT POWER 240W RMS into 4Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0 1% at 240W at 1kHz
SIGNAL NOISE RATIO 94dB FREQUENCY RESPONSE 10Hz-45kHz – 3dB SUPPLY VOLTAGE ± 45V
INPUT SENSITIVITY 500mV SIZE 114 100 85mm

Price £38·61 + £3·09 VAT P&P free.

POWER SUPPLIES

PSU36 suitable for two HY30's £8·44 plus 81p VAT. P/P free.
PSU50 suitable for two HY50's £8 18 plus £1·02 VAT. P/P free
PSU70 suitable for two HY120's £14·58 plus £1·17 VAT. P/P free.
PSU90 suitable for one HY200 £15·19 plus £1 21 VAT. P/P free.
PSU180 £25 42 + £2 03 VAT.
B1 £0·48 + £0 06 VAT.

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OSTS new from ambit international ®

One Stop Technology Shopping starts here:

ONCE UPON A TIME, a manufacturer's stamp on an IC was an indication of almost total product reliability. But as complexities have multiplied, and prices have become competative - the delineation between 100% functional and 95% functional ICs has got a lot less clear. But now more than ever, you cannot afford to waste time and effort on anything less than the very best - so at the OSTS, we have a strict policy to supply parts only from BS9000 approved sources. No nondescript clearance lines of dubious pedigree, only the very best. If you are a designer, or simply a keen hobbyist, you may buy from the OSTS with total confidence.

As you may already know, we make a point of backing our products with extensive lab and technical facilities; so next time you want to buy your components, ask what support your present supplier can offer and if it comes from BS9000 sources......we look forward to supplying you !!

*Please note that OSTS prices exclude VAT at 8% throughout this side of the page. Most ambit items are at 12½% except those marked *. Please keep orders separately totalled, although a single combined payment, and 25p postage charge, will be sufficient.*

CD4000 CMOS

4000	17p	4059	563p	4522	149p
4001	17p	4060	115p	4527	157p
4002	17p	4063	109p	4528	107p
4006	109p	4066	53p	4529	141p
4007	18p	4067	400p	4530	90p
4008	80p	4068	25p	4531	141p
4009	58p	4069	20p	4532	125p
4010	58p	4070	20p	4534	614p
4011	17p	4071	20p	4535	380p
4012	17p	4072	20p	4538	150p
4013	55p	4073	20p	4539	110p
4015	52p	4075	20p	4541	141p
4017	80p	4076	90p	4543	174p
4018	80p	4077	20p	4549	399p
4019	60p	4078	20p	4553	440p
4020	93p	4081	20p	4554	153p
4021	82p	4082	20p	4556	77p
4022	90p	4085	82p	4557	386p
4023	17p	4086	82p	4558	117p
4024	76p	4089	150p	4559	388p
4025	17p	4093	50p	4560	218p
4026	180p	4094	190p	4561	65p
4027	55p	4096	105p	4562	530p
4028	72p	4097	372p	4566	159p
4029	100p	4098	110p	4568	281p
4030	58p	4099	122p	4569	303p
4031	250p	4160	90p	4572	25p
4032	100p	4161	90p	4580	600p
4033	145p	4162	90p	4581	319p
4034	200p	4163	90p	4582	164p
4035	120p	4174	104p	4583	84p
4036	250p	4175	95p	4584	63p
4037	100p	4194	95p	4585	[illegible]
4038	105p	4501	23p		
4039	250p	4502	91p		
4040	83p	4503	68p		
4041	90p	4506	51p		
4042	85p	4507	55p		
4043	85p	4508	248p		
4044	80p	4510	99p		
4045	150p	4511	149p		
4046	130p	4512	98p		
4047	99p	4513	206p		
4048	60p	4514	260p		
4049	55p	4515	300p		
4050	55p	4516	125p		
4051	65p	4517	382p		
4052	65p	4518	103p		
4053	65p	4519	57p		
4054	120p	4520	109p		
4055	135p	4521	236p		

Micromarket

6800 series

6800P	£13
6820P	£6
6850P	£6.75
6810P	£4
6852	£15

8080 series

8080	£16
8212	£2.25

8216	£2.25
8224	£4
8228	£5.25
8251	£8
8255	£5.40

MEMORIES

2102	£1.70
2112	£3.40
2513	£7.54
4027	£5.78
2114	£10
2708	£10.55

Development
MEK6800
TK80
AMI, Signetics
TI Intersil,
Harris etc. OA

Voltage Regs

NEW LOW PRICES

7800 series UC TO220 package 1A	all 95p
7900 series UC TO220 package 1A	all £1
78MUC series TO220 package ½A	all 90p
78LCP series TO92 100mA	all 35p
L200 up to 3A/adjustable V&A	195p
78MGT2C ½amp adjustable volts	175p
79MGT2C ½amp adjustable volts	175p
723C precision controller	65p

MAINS FILTERS FOR NOISE/RFI etc

1 amp in IEC connector	£4.83
5 amp in 'wire in' case	£3.87
NE550A	73p

LINEARS non-consumer

BIMOS

CA3130E	84p
CA3130T	90p
CA3140E	35p
CA3140T	72p
CA3160E	90p
CA3180T	99p

Op amps

LM301AH	67p
LM301AN	30p
LM308H	121p
LM308N	97p
LM318H	279p
LM318N	224p

LM324N	71p
LM339N	66p
LM348N	186p
LM3900N	60p
709HC to5	64p
709PC dil	36p
710HC to5	65p
710PC dil	59p
723CN	65p
741CH to5	66p
741CN 8dil	27p
747CN	70p
748CN	36p
NE531T	120p
NE531N	105p

OPTO 7 seg displays

0.43" High Efficiency HP:

5082-7650	red CA	182p
5082-7653	red CC	182p
5082-7660	yellow CA	182p
5082-7663	yellow CC	182p
5082-7670	green CA	185p
5082-7673	green CC	185p

0.3" Standard HP

5082-7730	red CA	117p
5082-7740	red CC	117p

0.5" Fairchild

FND500	red CC	150p
FND507	red CA	150p

TLL: Standard AND LP Schottky

All prices listed in pence *

	'N'	'LSN'		'N'	'LSN'		'N'	'LSN'		'N'	'LSN'		'LSN'
7400	13	20	7455	35	24	74126	57	44	74185	134		74382	375
7401	13	20	7460	17		74128	74		74188	275		74365	49
7402	14	20	7463		110	74132	73	78	74190	115	92	74366	49
7403	14	20	7470	28		74133		29	74191		92	74367	43
7404	14	24	7472	28		74136		40	74192	105	180	74368	49
7405	18	26	7473	32	38	74138		60	74193	105	180	74373	70
7406	38		7474	27	38	74139		60	74194	105	187	74374	70
7407	38		7475	38	40	74141	56		74195	95	137	74375	60
7408	17	24	7476	37	38	74142	265		74196	99	110	74377	100
7409	17	24	7478		38	74143	312		74197	85	110	74378	90
7410	15	24	7480	48		74144	317		74198	150		74379	130
7411	20	24	7481	86		74145	66	96	74199	160		74386	55
7412	17	24	7482	69		74147	175		74200		374	74390	140
7413	30	52	7483A		110	74148	109	106	74202		374	74393	140
7414	51	130	7484	97		74150	99		74221			74395	110
7415		24	7485	104	99	74151	64	84	74240		100	74396	133
7416	30		7486	31	40	74153	64	54	74247		75	74398	200
7417	30		7489	205		74154	96		74248		90	74399	150
7420	16	24	7490	33	90	74155	54	110	74249		90	74445	92
7421	29	24	7491	76	110	74156	80	110	74251		90	74447	90
7422	24	24	7492	38	78	74157	67	55	74253		105	74490	140
7423	27		7493	32	99	74158		60	74257		108	74668	110
7425	27		7494	78		74159	210		74261		295	74670	220
7426	35	27	7495A	65	99	74160	82	130	74266		40		
7427	27	29	7496	58	120	74161	92	78	74273		90		
7428	35	32	7497	185		74162	92	130	74275		175		
7430	17	24	74100	119		74163	92	78	74279		52		
7432	25	24	74104	63		74164	104	130	74283		120		
7433	40	32	74105	62		74165	105	110	74289	340			
7437	40	24	74107	32	38	74166		110	74290		90		
7438	33	24	74109	63	38	74167	20		74293		95		
7440	17	24	74110	54		74169		200	74295		120		
7441	24		74111	68		74169		200	74298		100		
7442	70	99	74112	88	38	74170	230	200	74299		300		
7443	115		74113		38	74172	625		74300		350		
7444	112		74114		38	74173	170		74302		350		
7445	94		74116	198		74174	87	120	74324		115		
7446	94		74118	83		74175	87	110	74325		140		
7447	87	99	74119	119		74176	75		74326		140		
7448	56	99	74120	115		74177	78		74327		145		
7449		99	74121	25		74180	85		74352		95		
7450	17		74122	46	50	74181	165	350	74353		100		
7451	17	24	74123	48	55	74182	160		74258		110		
7453	17		74124		88	74183		210	74260		26		
7454	17	24	74125	38	44	74184	135						

MISC

NE555	30p
NE556	78p
NE558	180p
LM3909	72p

ICM7217 - counter ic
ICL7106CP- DVM ic 955p
KIT
ICL7107CP
LCD DVM
KIT

Due to rapid price changes in ICs, please check for current and quantity prices

From the World's leading radio innovation source:

On this side of the page, we offer you the leading products from the world of wireless. We are continually reviewing and adding to our range, and this month we feature some of the more significant additions to our range. All available in depth, and usually ex-stock too !

Moving Coil Meters

Ambit offers a very wide range of low cost meters, together with the unique 'Meter Made' scale system for professional grade scale customizing:

Series	Scale Area	illumination	cost*
900	14x31mm	internal 12v	250p
920	30x50mm	from behind	275p
930	36x63mm	internal 12v	375p
940 twin	35x45mm	from behind	350p
950	55x45mm	from behind	300p

Stock movement 200uA/750Ω. The 930 series is 5% linear, others are 77uA at 50% FSD. These and many others available in quantity for OEMs
SAE for full scale details please (Not in cat.)

Radio; Audio; Comms ICs:

Only the very best quality and only types we have used in our own laboratory tests

Radio frequency + mixers + oscillator(s)

TDA1062	DC to VHF front end system	1.95
TDA1083/ULN2204	am fm/audio in one IC	1.95
TDA1090/ULN2242	am fm hifi tuner system	3.35
HA1197	LF/30MHz am receiver system	1.40
CA3123E/uA720	LF/30MHz linear system	1.40
TBA651	LF/30MHz linear system	1.81
SD6000	DMOS RF/Mixer pair	3.75

IF amplifiers

CA3089E/KB4402	famous FM IF system	1.94
HA1137W/KB4420	as 3089 + deviation mute	2.20
CA3189E	update with deviation mute	2.75
TBA120s/SN76660N	FM if and detector	0.75
TBA120S	hi gain version TBA120	1.00
MC1350P	agc IF amp	1.70
MC1330P	synch AM demodulator	1.35
MC1495L	precision 4 quad multiplier	6.86
MC1496P	popular double balanced mixer	1.25

Communications circuits

KB4406	differential amplifier	0.50
KB4412	2 bal.mixers/agc/gain/doub conv	2.55
KB4413	am/fm/ssb det. AGC, ANL, mute	2.75
KB4417	3mV mic processor preamp	2.55
KB4423	FM noise blanker system	2.55

Audio preamps

LM381	stereo high gain/low THD	1.81
LM1303	stereo audio optimized OA	0.99
TCA1054	high quality with alc option	1.95
KB4417	see above	

Audio Power amps

TBA810AS	7W RMS overload protected	1.09
TDA2002	8W 2Ω in pentawatt package	1.95
TDA2020	15W RMS hifi power dc coupled	2.99
TCA940	10W higher voltage 810	1.80
ULN2283	1W 2.5 to 12 v supply capability	1.00
LM380N8	1W power	1.00
LM380N14	2.5W power	1.00
HA1370	HiFi 15w in easy heatsink pack	2.99

Stereo Decoder Devices

MC1310/KB4400	original pll decoder	2.20
CA3090AQ	RCA's pll decoder	3.25
uA758	Buffered version of 1310	2.20
LM1307/uA707	non pll type	1.55
HA1196	advanced adj.sep pll low thd	3.95
HA11223	newpilot cancel low thd/imd	4.35

All ambit decoders are supplied with the LED beacon of your choice. Please state colour.

Discrete semiconductors

Some of the biggest stocks of specialist MOS and FET transistors for radio in the UK

BF900	80p*	40673	55p*	40822	43p*
40823	51p*	MEM680	75p*	BF256S	34p*

Most types for most RF circuitry, inc new UHF T package types etc. See price list.

Hitachi VMOS 100W power devices:

Start saving now for the biggest breakthrough in power transistor technology yet. Ambit has the new Hitachi VMOS data (£1) and by the time you read this, we should have received our first stock order. But they aren't cheap.

DISCRETE LEDS the best value of all:

LED size	2.5x5mm	5mm dia	clip
RED	17p	14p	2p
YELLOW	20p	15p	2p
GREEN	20p	18p	2p

10% disc for 10 off 25% discount per 100

Switch Systems: Check our combinations !

A very wide selection of BOTH Alps SUB series units, (Schadow/AB/Oreor compatible) & the miniature Dialrstat units. Available in DIY systems for maximum flexibility and low cost.

And Finally

Further details of these, and many more of the wonders of the world of wireless in the new Ambit catalogue with magazine supplement, 45p inc pp etc.
Phone (0277) 216029/227050 9am-8pm
callers welcome anytime

Coils & Filters by TOKO

After a period of relative price stability, please note that some prices are increased- as a direct result of the failure of £ versus stronger trading currencies. (Mainly Yen)

7 & 10mm IFTs for AM/FM - 1000s ex

455/470kHz	most types of appens	30p
10.7MHz		33p

Short Wave Coils sets

Now two ranges of impedance/coupling ea	33p

TV video and sound IFs/detectors

Another new range in 10mm	33p
6MHz ceramic IF sound filte	80p

Molded VHF coils full catalogue 15p

Ultra stable coils for 30 200MHz from	20p

Chokes - biggest range/biggest stocks

Most E12 values ex stock, any to order

7BA series	1uH to 1mH	16p
8RB series	100uH to 33mH	19p
10RB series	33mH to 120mH	33p

FM IF FILTERS ceramic and linear phase

CFSE/SFE10.7	stereo ceramic IF 1 MHz filters in 5 groups	50p
CFSB10.7	mono/roofing IF filte	50p
BBR3125N	4pole linear pahe 10.7MHz	150p
BBR3132A	6pole linear phase 10.7MHz	250p

MPX pilot tone filters for 19 & 38kHz

BLR3107N	Stereo 4k7 impedance	215p
BLR2007	Stereo 3k3 impedance	220p
BLR3152	Mono 4k7 impedance	100p
BLR3157	Mono 4k7 3k0 imp	100p

AM/FM/SSB IF FILTERS

MFL series 2.4kHz ssb /455kHz carrier	895p
MFH series 4/5/7kHz BW on 455kHz	195p
MFK series 7/9kHz BW on 455kHz	165p
LFY455D 12kHz 4 ele ladder on 455kHz	125p
CFM2455 6kHz micro mechanical	65p
SFD455/470kHz murata IF filter	85p
CFT455B/C 6/8kHz min. 1 21FTs	60p
CFU470C 6kHz on 470kHz	65p

Ratio Detectors for FM/NBFM

1A651/7	455kHz ratio det	135p
KAN1508/9	10.7MHz ratio detector	66p
94ACS15106/7	10.7MHz ratio detector	66p

Quadrature detectors for CA3089E etc

KACSK586HM	single	33p
KACS34342 3	double	66p

Polyvaricon tuning capacitors + trimmers

2A20ST7	2x266pF AM	95p
CY22717Z	2x335p AM 2x20pF FM	175p
CY23217PX	2x335pF AM 3x20pF FM (2 trimmers)	245p

Tuner Modules

From the biggest and best range..................

TUNERHEADS for 88 108MHz band 2 (varicap)

EF5803	8 cct, 3 MOSFETs, amp. etc.	19.75
EF5801	8 cct, 2 MOSFETs osc op	17.46
EF5600	5cct, MOSFET RF, by TOKO	14.95
EF6400	4cct balanced mixer/pin agc	9.75
EC3302	3cct FET input miniature	8.25

TUNERSETS by LARSHOLT (head+IF)

7252	Dual MOS head/low dist IF	26.50
7253	FET head, mpx decoder inc	26.50

IF AMPLIFIERS all with deviation mute agc etc, meter drives etc

7020	HiGain dual ceramic filter	8.95
7030	Mos preamp, linear phase filter	10.95
7130	2 mos preamps, 3 lpfilters	16.25
NBFM1	455/470kHz NBFM module	9.95

MPX decoders, all with pilot tone filters and buffer amplifiers for min 300mV RMS

92310	1310 based system	6.95
93090	3090AQ based system	8.85
91196	HA1196 based + birdy filter	1299
91196B	HA1196 based + birdy filter + 2 x LM380 audio monitor amps	16.45
911223	HA11223 based system	12.50

AM RADIO -

91197	The original MW/LW varicap tuner with electronic switch	11.85
9122	The uniband tuner module	13.22

AM FM RADIO UNITS

71083	Using TDA1083, provides a complete MW/LW/FM portable radio chassis for clock radio etc	12.95
71083D	Drive/dial system for 71083	1.75

SPECIALS TUNERHEADs in the range 40-200MHz to special order

The EF5803 and EF5400 are available to cover bands in the region described. The costs depend on quantity and actual mods required to cover the desired band. Max coverage approx. 20% of centre frequency selected. Also, please allow 3-5 weeks delivery for these items

2 Gresham Road, Brentwood, Essex.

BOOKS AND COMPONENTS

BOOKS BY BABANI

Purchase books to the value of £5·00 from the list below and choose any 60p pak from this page *FREE*

BP2	Handbook of Radio, TV & Industrial & Transmitting Tube & Valve Equivalents	60p†
BP6	Engineers and Machinists Reference Tables	40p†
BP7	Radio & Electronic Colour Codes and Data	15p†
BP10	Modern Crystal and Transistor Set Circuits for beginners	35p†
BP15	Constructors Manual of Electronic Circuits for the Home	50p†
BP22	79 Electronic Novelty Circuits	75p†
BP23	First book of Practical Electronic Projects	75p†
BP24	52 Projects Using IC741(or equivalents)	75p†
BP26	Radio Antenna Handbook for Long Distance Reception and Transmission	85p†
BP27	Giant Chart of Radio Electronic Semi-conductor and Logic Symbols	60p†
BP29	Major Solid State Audio Hi-Fi Construction Projects	85p†
BP32	How to Build Your Own Metal & Treasure Locators	85p†
BP34	Practical Repair & Renovation of Colour TVs	95p†
BP35	Handbook of IC Audio Preamplifier & Power Amplifier Construction	85p†
BP36	50 Circuits Using Germanium, Silicon & Zener Diodes	75p†
BP37	50 Projects Using Relays SCR's and TRIACS	£1·10†
BP39	50 (FET) Field Effect Transistor Projects	£1·25†
BP43	How to make Walkie-Talkies	£1·25†
BP44	I.C.555 Timer Projects	£1·45†
BP47	Mobile Discoteque Handbook	£1·35†
129	Universal Gram-motor Speed Indicator	10p†
160	Coil Design and Construction Manual	75p†
196	AF-RF Reactance Frequency Chart for Constructors	15p†
202	Handbook of Integrated Circuits (ICs) Equivalents and Substitutes	75p†
205	First Book of Hi-Fi Loudspeaker Enclosures	75p†
213	Electronic Circuits for Model Railways	85p†
214	Audio Enthusiasts Handbook	85p†
216	Electronic Gadgets and Games	85p†
217	Solid State Power Supply Handbook	85p†
219	Solid State Novelty Projects	85p†
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222	Solid State Short Wave Receivers for Beginners	95p†
223	50 Projects Using IC CA3130	95p†
224	50 CMOS IC Projects	95p†
225	A Practical Introduction to Digital IC's	95p†
226	How to Build Advanced Short Wave Receivers	£1·20†
RCC	Resistor Colour Code Disc Calculator	10p†

BOOKS BY NEWNES

No. 229 Beginners Guide to Electronics	Price £2·25†
No. 230 Beginners Guide to Television	Price £2·25†
No. 231 Beginners Guide to Transistors	Price £2·25†
No. 233 Beginners Guide to Radio	Price £2·75†
No. 234 Beginners Guide to Colour Television	Price £2·25†
No. 235 Electronic Diagrams	Price £1·80†
No. 236 Electronic Components	Price £1·08†
No. 237 Printed Circuit Assembly	Price £1·08†
No. 238 Transistor Pocket Book	Price £3·90†
No. 225 110 Thyristor Projects Using SCRs & Triacs	Price £2·50†
No. 227 110 COS/MOS Digital IC Projects For the Home Constructor	Price £2·25†
No. 226 110 Operational Amplifier Projects for the Home Constructor	Price £2·50†
No. 242 Electronics Pocket Book	Price £3·90†
No. 239 30 Photoelectric Circuits & Systems	Price £1·80†

NUTS AND BOLTS

BA BOLTS packs of BA threaded cadmium plated screws slotted cheese head.
Supplied in multiples of 50.

Type	No.	Price	Type	No.	Price
¼in 0BA	839	£1·20	¼in 4BA	846	£0·32
½in 0BA	840	£0·75	1in 4BA	847	£0·25
1in 2BA	842	£0·65	1in 6BA	848	£0·40
½in 2BA	843	£0·45	½in 6BA	849	£0·21
¼in 2BA	844	£0·52	¼in 8BA	850	£0·25
1in 4BA	845	£0·44			

BA NUTS packs of cadmium plated full nuts in multiples of 50.

Type	No.	Price	Type	No.	Price
0BA	855	£0·72	4BA	857	£0·30
2BA	856	£0·48	6BA	858	£0·24

BA WASHERS — flat cadmium plated plain stamped washers supplied in multiples of 50.

Type	No.	Price	Type	No.	Price
0BA	859	£0·14	4BA	861	£0·12
2BA	860	£0·12	6BA	862	£0·12

SOLDER TAGS — hot tinned supplied in multiples of 50.

Type	No.	Price	Type	No.	Price
0BA	851	£0·40	4BA	853	£0·22
2BA	852	£0·28	6BA	854	£0·22

SWITCHES

Description	No.	Price
DPDT miniature slide	1973	£0·11*
DPDT standard slide	1974	£0·14*
Toggle switch SPST 1½ amp 250V a.c.	1975	£0·33*
Toggle switch DPDT 1 amp 250V a.c.	1976	£0·42*
Rotary on-off mains switch	1977	£0·50*
Push switch — Push to make	1978	£0·13*
Push switch Push to break	1979	£0·18*

ROCKER SWITCH

A range of rocker switches SPST – moulded in high insulation. Material available in a choice of colours ideal for small apparatus.

Colour	No.	Price
RED	1980	£0·26*
BLACK	1981	£0·26*
WHITE	1982	£0·26*
BLUE	1983	£0·26*
YELLOW	1984	£0·26*
LUMINOUS	1985	£0·26*

Description	No.	Price
Miniature SPST toggle, 2 amp 250V a.c.	1958	£0·50*
Miniature SPST toggle, 2 amp 250V a.c.	1959	£0·55*
Miniature DPDT toggle 2 amp 250V a.c.	1960	£0·70*
Miniature DPDT toggle, centre off, 2 amp 250V a.c.	1961	£0·85*
Push button SPST 2 amp 250V a.c.	1962	£0·78*
Push button SPST, 2 amp 250V a.c.	1963	£0·83*
Push button DPDT, 2 amp 250V a.c.	1964	£0·98*

MIDGET WAFER SWITCHES

Single-bank wafer type — suitable for switching at 250V a.c. 100mA or 150V d.c. in non-reactive loads make-before-break contacts. These switches have a spindle 0·25in dia and 30° indexing.

Description	Order No.	Price
1 pole 12 way	1965	£0·48*
2 pole 6 way	1966	£0·48*
3 pole 4 way	1967	£0·48*
4 pole 3 way	1968	£0·48*

MICRO SWITCHES

	Order No.	Price
Plastic button gives simple on-off action Rating 10 amp 250V a.c.	1969	£0·20
Button gives 1 pole change over action Rating 10 amp 250V a.c.	1970	£0·25

FUSE HOLDERS AND FUSES

Description	Order No.	Price
20mm x 5mm chassis mounting	506	£0·07*
1¼in x ¼in chassis mounting	507	£0·12*
1¼in car inline type	508	£0·15*
Panel mounting 20mm	509	£0·20
Panel mounting 1¼in	510	£0·30

QUICK BLOW 20mm

Type	No.	Type	No.	Type	No.
150mA	611	1A	615	3A	619
250mA	612	1·5A	616	4A	620
500mA	613	2A	617	5A	621
800mA	614	2·5A	618		

All 5p each excepting 616 which is 7p.

ANTI-SURGE 20mm

Type	No.	Type	No.	Type	No.
100mA	622	1A	625	2·5A	628
250mA	623	2A	626	3·15A	629
500mA	624	1·6A	627	5A	630

All 7p each

QUICK BLOW 1¼in

Type	No.	Type	No.	Type	No.
250mA	631	500mA	632	800mA	634

All 7p each

Type	No.	Type	No.	Type	No.
1A	635	2·5A	638	4A	641
1·6A	636	3A	639	5A	642
2A	637				

All 6p each

CASES AND BOXES

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

No.	Length	Width	Height	Price
155	8in	5¼in	2in	£1·52*
156	11in	6in	3in	£2·12*
157	6in	4¾in	1¾in	£1·30*
158	9in	5¼in	2½in	£1·76*

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

No.	Length	Width	Height	Price
159	5¼in	2½in	1½in	62p*
160	4in	4in	1½in	62p*
161	4in	2¼in	1½in	62p*
162	5¼in	4in	1½in	74p*
163	4in	2½in	2in	64p*
164	3in	2in	1in	44p*
165	7in	5in	2½in	£1·04*
166	8in	6in	3in	£1·32*
167	6in	4in	2in	86p*

METAL FOIL CAPACITOR PAK

Containing 50 metal foil Capacitor—like Mullard C280 series. Mixed values ranging from ·01uf—2·2uf. Complete with dentification sheet O/N 16204 **£1·20***

TRANSFORMERS

MINIATURE MAINS Primary 240V

No.	Secondary	Price
2021	6V-0-6V 100mA	90p*
2022	9V-0-9V 100mA	90p*
2023	12V-0-12V 100mA	95p*

MINIATURE MAINS Primary 240V
with two independent secondary windings

No.	Type	Price
2024	MT280 0-6V, 0-6V RMS	£1·50*
2025	MT150 0-12V 0-12V RMS	£1·50*

1 AMP MAINS Primary 240V

No.	Secondary	Price	
2026	6V-0-6V 1 amp	£2·50*	P. & P. 45p
2027	9V-0-9V 1 amp	£2·00*	P. & P. 45p
2028	12V-0-12V 1 amp	£2·60*	P. & P. 55p
2029	15V-0-15V 1 amp	£2·75*	P. & P. 66p
2030	30V-0-30V 1 amp	£3·45*	P. & P. 86p

STANDARD MAINS Primary 240V
Multi-tapped secondary mains transformers available in ½ amp, 1 amp and 2 amp current rating Secondary taps are 0-19-25-33-40-50V

Voltages available by use of taps.
4 7 8 10, 14 15 17, 19, 25, 31, 33 40, 25-0-25V

No.	Rating	Price	
2031	½ amp	£5·50*	P. & P. 86p
2032	1 amp	£6·60*	P. & P. 86p
2033	2 amp	£7·40*	P. & P. £1·10

AUDIO LEADS

107	FM Indoor Ribbon Aerial	£0·60*
113	3.5mm Jack plug to 3.5mm jack plug. Length 1.5m	£0·75*
114	5 pin DIN plug to 3.5mm Jack connected to pins 3&5. Length 1.5m	£0·85*
115	5 pin DIN plug to 3.5mm Jack connected to pins 1&4. Length 1.5m	£0·85*
116	Car aerial extension. Screened insulated lead. Fitted plug & skt.	£1·10*
117	AC mains connecting lead for cassette recorders & radios. 2 metres	£0·68*
118	5 pin DIN phono plug to stereo headphone jack socket	£1·05*
119	2+2 pin DIN plugs to stereo jack socket with attenuation network for stereo headphones. Length 0.2m	£0·90*
120	Car stereo connector. Variable geometry plug to fit most car cassette, 8 track cartridge & combination units. Supplied with inline fused power lead and instructions.	£0·60*
123	6·6m Coiled Guitar Lead Mono Jack Plug to Mono Jack Plug BLACK	£1·50*
124	3 pin DIN plug to 3 pin DIN plug. Length 1.5m	£0·75*
125	5 pin DIN plug to 5 pin DIN plug. Length 1.5m	£0·75*
126	5 pin DIN plug to Tinned open end Length 1.5m	£0·75*
127	5 pin Din plug to 4 Phono Plugs. All colour coded. Length 1.5m	£1·30*
128	5 pin DIN plug to 5 pin DIN socket. Length 1.5m	£0·80*
129	5 pin DIN plug to 5 pin DIN plug mirror image. Length 1.5m	£1·05*
130	2 pin DIN plug to 2 pin DIN inline socket Length 5m	£0·68*
131	5 pin DIN plug to 3 pin DIN plug. 1&4 and 3&5. Length 1.5m	£0·83*
132	2 pin DIN plug to 2 pin DIN socket Length 10m	£0·98*
133	5 pin DIN plug to 2 phono plugs Connected pins 3&5. Length 1.5m	£0·75*
134	5 pin DIN plug to 2 phono sockets. Connected pins 3&5. Length 23cm	£0·68*
135	5 pin DIN socket to 2 phono plugs. Connected pins 3&5 Length 23cm	£0·68*
136	Coiled stereo headphone extension lead Black. Length 6m	£1·75*
178	AC mains lead for calculators etc.	£0·68*

ELECTROLYTIC PAKS

A range of paks each containing 18 first quality, mixed value miniature electrolytics.

16201—values from ·47mFD—10mFD	60p*
16202—values from 10mFD—100mFD	60p*
16203—values from 100mFD—680mFD	60p*

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COMPONENTS SHOP: 18 BALDOCK STREET, WARE, HERTS.

High quality audio modules for Stereo and mono

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STEREO FM TUNER Fitted with phase lock-loop

£22·30 + 40p p&p + 12½% VAT

FREQUENCY RANGE	88–108 Mhz
SENSITIVITY	3 0 µV
BANDWIDTH	250 kHz
SPURIOUS REJECTION	50 dB
SELECTIVITY ± 400 kHz	55 dB
AUDIO OUTPUT (22·5 kHz deviation)	100 mV
STEREO SEPARATION	30 dB
SUPPLY REQUIREMENTS	20 to 30V (90mA max)
AERIAL IMPEDANCE	75 ohms
DIMENSIONS	240mm × 110mm × 32mm

The 450 Tuner provides instant programme selection at the touch of a button ensuring accurate tuning of 4 pre-selected stations, any of which may be altered as often as you choose, simply by changing the settings of the pre-set controls. Features include FET input stage. Vari-Cap diode tuning. Switched AFC LED Stereo Indicator.

Stereo 30

COMPLETE AUDIO CHASSIS

£18·95 + 40p p&p + 12½% VAT

7 + 7w R.M.S.

OUTPUT POWER	7 Watts RMS
LOAD IMPEDANCE	8 ohms
TOTAL HARMONIC DISTORTION	Less than ·5% (Typically ·3%)
FREQUENCY RESPONSE	50 Hz to 20 kHz ± 3dBs
TONE CONTROL RANGE	± 12 dBs at 100Hz and 10kHz
SENSITIVITY	190 mV for full output
INPUT IMPEDANCE	1 M ohms
TRANSFORMER REQUIREMENTS	22 V.A.C. rated at 1A
DIMENSIONS (Less controls and panel)	200mm × 130mm × 33mm

The Stereo 30 comprises a complete stereo pre-amplifier, power amplifiers and power supply. This, with only the addition of a transformer or overwind will produce a high quality audio unit suitable for use with a wide range of inputs i.e. high quality ceramic pick-up, stereo tuner, stereo tape deck etc. Simple to install, capable of producing really first class results, this unit is supplied with full instructions, black front panel, knobs, main switch, fuse and fuse holder and universal mounting brackets.

AL60

25w R.M.S.

AUDIO AMPLIFIER MODULE 25 Watts RMS

£4·55 + 35p p&p + 12½% VAT

OUTPUT POWER	25 Watts RMS
SUPPLY	30–50 V
LOAD IMPEDANCE	8–16 ohms
TOTAL HARMONIC DISTORTION	Less than ·1% (Typically ·05%)
FREQUENCY RESPONSE	20 Hz to 30 kHz × 2 dBs
SENSITIVITY	280 mV for full output
MAX. HEAT SINK TEMPERATURE	90°C
DIMENSIONS	103mm × 64mm × 15mm

This high quality audio amplifier module is for use in audio equipment and stereo amplifiers and provides output powers up to 25 RMS with distortion levels below 0·1%.

AL80

35w R.M.S.

AUDIO AMPLIFIER MODULE

£7·15* + 35p p&p + 8% VAT

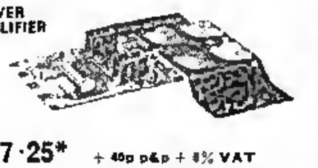
OUTPUT POWER	35 Watts RMS
SUPPLY	40–80 V
LOAD IMPEDANCE	8–16 ohms
TOTAL HARMONIC DISTORTION	Less than ·1% (Typically ·06%)
FREQUENCY RESPONSE	20 Hz to 30 kHz × 2 dBs
SENSITIVITY	260 mV for full output
MAX. HEAT SINK TEMPERATURE	90°C
DIMENSIONS	103mm × 64mm × 15mm

The AL80 is similar in design to the AL60 above and is of the same high quality but provides output powers up to 35W with distortion levels below 0·1%.

AL250

125w R.M.S.

POWER AMPLIFIER



£17·25* + 40p p&p + 8% VAT

OUTPUT POWER	125 Watts RMS continuous
OPERATING VOLTAGE	50–80 V
LOADS	4–16 ohms
FREQUENCY RESPONSE	25 Hz 20 kHz measured at 100 Watts
SENSITIVITY FOR 100 WATTS O/P AT 1 kHz	450 mV
INPUT IMPEDANCE	33 K ohms
TOTAL HARMONIC DISTORTION 50 WATTS into 4 ohms	0·1%
50 WATTS into 8 ohms	0·06%

This unit, designated AL250, is a power amplifier providing an output of up to 125W RMS, into a 4 ohm load.

AL30A

10w R.M.S.

AUDIO AMPLIFIER MODULES

£3·75 + 35p p&p + 12½% VAT

MAXIMUM SUPPLY VOLTAGE	30 V
POWER OUTPUT for 2% THD	10 Watts RMS
TOTAL HARMONIC DISTORTION	Less than ·25%
LOAD IMPEDANCE	8–16 ohms
INPUT IMPEDANCE	100 K ohms
FREQUENCY RESPONSE	50 Hz–25 kHz ± 3 dBs
SENSITIVITY	75 mV for full output
DIMENSIONS	74mm × 63mm × 28mm

These low cost 5 and 10 watt modules offer the utmost in reliability and performance, whilst being compact in size.

SPM80

STABILISED POWER SUPPLY

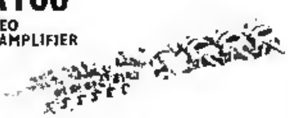
£4·25 + 35p p&p + 12½% VAT

INPUT A.C. VOLTAGE	33–40V
OUTPUT D.C. VOLTAGE	33 V nominal
OUTPUT CURRENT	10 mA–1·5 amps
OVERLOAD CURRENT	1·7 amps approx.
DIMENSIONS	105mm × 63mm × 30mm

Designed to power two AL60s at 15 Watts per channel simultaneously. Circuit Techniques include full short circuit protection.

PA100

STEREO PRE-AMPLIFIER



£15·80 + 40p p&p + 12½% VAT

FREQUENCY RESPONSE	20 Hz to 20 kHz × 1 dB
TOTAL HARMONIC DISTORTION	Less than ·1% (Typically ·07%)
SENSITIVITY INPUTS 1. TAPE	100 mV/100 K ohms (For an output 250 mV)
2. RADIO TUNER	100 mV/100 K ohms
3. MAGNETIC P.U.	3·5 mV/50 K ohms
EQUALISATION	Within ± 1 dB from 20 Hz to 20 kHz
BASS CONTROL RANGE	± 15 dBs at 75 Hz
TREBLE CONTROL RANGE	+ 10–20 dBs at 15 kHz
SIGNAL/NOISE RATIO	Better than 65 dBs (All inputs)
INPUT OVERLOAD	Better than 26 dBs (All inputs)
SUPPLY	20 to 40 V
DIMENSIONS	300 × 90 × 33mm (less controls)

A top quality stereo pre-amplifier and tone control unit, the PA100 provides a comprehensive solution to the front end requirements of stereo amplifiers or audio units. The six push button selector switch gives a choice of inputs together with two filters for high and low frequencies.

MPA30

MAGNETIC CARTRIDGE PRE-AMPLIFIER

£2·95 + 35p p&p + 12½% VAT

Enjoy the quality of a magnetic cartridge with your existing ceramic equipment using the MPA 30 which is a high quality pre-amplifier enabling magnetic cartridges to be used where facilities exist for the use of ceramic cartridges only.

SENSITIVITY	3·5 mV for 100 mV output
EQUALISATION	Within ± 1 dB from 20 Hz to 20 kHz
INPUT IMPEDANCE	50 K ohms
SUPPLY	18 to 30 V—ve earth
DIMENSIONS	110 × 50 × 25mm (inc DIN socket)

PA12

STEREO PRE-AMPLIFIER

£7·10 + 30p p&p + 12½% VAT

The PA12 Stereo Pre-Amplifier chassis is designed and recommended for use with the AL 20/30 Audio Amplifier Modules, the PS12 power supply and the T538 Transformer. Features include on/off volume, Balance, Bass and Treble controls. Complete with tape output

FREQUENCY RESPONSE	20 Hz–20 kHz (—3dB)
BASS CONTROL	± 12 dB at 60 Hz
TREBLE CONTROL	± 14 dB at 10 kHz
INPUT IMPEDANCE	1 Meg. ohm
INPUT SENSITIVITY	300 mV
CROSSTALK	—60 dB
SIGNAL/NOISE RATIO	—65 dB
OVERLOAD FACTOR	± 20 dB
TAPE OUTPUT IMPEDANCE	25 K ohms
DIMENSIONS	152mm × 84mm × 25mm

PS12 POWER SUPPLY

Designed for use with the AL30A S.450 and MPA30 in conjunction with transformer T538.

INPUT VOLTAGE	17–20v AC
OUTPUT VOLTAGE	27–30v DC
OUTPUT CURRENT	800mA
SIZE	60mm × 43mm × 26mm

£1·30 + 35p p&p + 12½% VAT

GE 100 NINE CHANNEL MONO-GRAPHIC EQUALIZER

The GE100 has nine 1 octave adjustments using integrated circuit active filters. Boost and Cut limits are ± 12dB Max Voltage handling 2 V RMS, T.H.D., 0·05%. Input impedence 100K. Output impedence less than 10 K. Frequency response 20 Hz –20 KHz (3dB). The nine gain controls are centred at 50, 100, 200, 400, 800, 1,600, 3,200, 6,400 and 12,800 Hz. The suggested gain controls are 10 K LIN sliders (not supplied with the module) See Paks S31 and 16192.

£22·00 + 35p p&p + 12½% VAT

SG30 POWER SUPPLY BOARD for GE100 15-0-15 VOLT £3·50 + 12½% VAT + 35p p&p

SIREN ALARM MODULE

American Police screamer powered from any 12 volt supply into 4 or 8 ohm speaker. Ideal for car burglar alarm, freezer breakdown and other security purposes Order No S15. No. BP124
Only £3·50 + 8% VAT + 35p p&p

MA60 HI-FI AMPLIFIER KIT

Build you own top quality amplifier, save yourself pounds. The MA60 kit comprises the following Bi-kits modules, 2 × A 60 amps, 1 × PA100 pre-amp, 1 × SPM80 stab power supply, 1 × BMT80 trans giving 17 watts RMS per channel STEREO. All modules r ered by the Bi-PAK sat sfaction or money back guarantee. eta s of the above modules are in this ad.
Price £32·00 + 12½% VAT + 62p p&p.

TC60 KIT

A beautifully designed genuine TEAK WOOD veneered cabinet to put the professional touches to your home built amplifier. Full set of parts incl. Front & Back Panels, Knobs, Chassis, Fuses, Sockets, Noen, etc. Ideal for the MA60. Size: 425mm 290mm × 95mm.
Price £19·95 + 12½% VAT + 65p p&p

TRANSFORMERS

T538 For use with S.450 AL30A MPA30
Order No. 2036 Price: £3·20 + 55p p&p + 12½% VAT
T2050 For use with Stereo 30
Order No. 2050 Price: £3·25 + 55p p&p + 12½% VAT
BMT80 For use with AL60 SPM80
Order No 2034 Price: £5·40 + 86p p&p + 12½% VAT
BMT250 For use with AL250
Order No. 2035 Price: £6·35 + £1·10 p&p + 12½% VAT

BI-PAK

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Caveat Emptor

LET THE BUYER BEWARE!—a very old Latin tag, but one which is still sound, even with the advent of present-day consumer protection legislation. Perhaps not quite its usual application, but none the less important for the home constructor of electronic projects, would be in warning readers to make sure that they can still get the specialised bits and pieces used in a past design, before spending out money on the rest of the components.

Every few months we seem to get a spate of letters from readers who have suddenly decided to build something which we published five, ten or even more years ago. They have gone ahead and spent a considerable sum getting together the "easier" components, only to find that they can't find a source of one awkward one anywhere. Then they write to us for help.

If it's a semiconductor device, it's usually not too difficult to find an equivalent, though to replace some early audio i.c.s. will often involve modifying a printed circuit board layout. The real problem area is that of transformers, sometimes for power supplies for valved equipment. A careful check through the advertisement pages, or some suppliers' catalogues, will often reveal something suitable for these.

More difficult are audio transformers, particularly inter-stage coupling or push-pull output types for early transistorised power amplifiers. The coming of direct-coupled amplifier designs with complementary or quasi-complementary output stages, and the more recent single-chip audio power amplifiers, has meant that the demand for such transformers has largely disappeared, and as a result many manufacturers have stopped producing them. Obviously it's possible to use a more modern design if just a straightforward audio amplifier is involved, but if it's doing a special job, things can sometimes be more complicated.

While we will always try to help a reader in difficulty with a project (but do please send an s.a.e.) we simply do not have the manpower to research and produce modifications to past designs to accommodate new components. It is often tempting to store away a circuit for future use—I know, I have a box-file full at home which I have collected over the past ten years or so. To any reader contemplating building a project from previous years, I would say please, please check that you can still get the "difficult" bits and pieces before you invest many pounds in the remainder.

PW PERSONALITY

Ted Parratt BA—Technical Editor

Ted's entry into the world of electronics began with RAF service as a Wireless Operator, followed by spells as a Test Engineer in industry with GEC and Solartron.

During a period as a freelance Audio/Visual Aids Technician he studied for an Open University degree, graduating in 1974, and just before coming to PW worked as a contract technician with another university.

Apart from active involvements as a musician (a classical and jazz guitarist with a quartet), he enjoys jogging and real ale, although not simultaneously! Ted is married (his wife has an unusual "mobile" museum of domestic items), with one daughter a Legal Executive in the City, and a younger daughter and son just beginning work.

NEWS... NEWS... NEWS...

Club news

Plymouth Radio Club, G3PRC are now meeting at their new venue, The TAVR Centre, Lambhay Hill, Plymouth, on alternate Mondays commencing 17th July. Visitors and newcomers are particularly welcome. Beginners and those who may feel uncertain are invited to phone or write to the secretary at the following address, *Len England, 62 Fullerton Road, Milehouse, Plymouth, Devon. Tel: 0752 58841.*

The Sully and District Amateur Radio Club formerly the Sully and District Short Wave Club, would like to extend a warm welcome to prospective new members. At the moment the club is quite small and although they have their own call sign there are not quite enough members to keep it operational, so, for the time being it is in 'cold storage'. The club meets fortnightly at The Sully Bowls Club at 7.30pm until 10.15pm. Those interested please contact the new secretary at, *13 Nailsea Court, Sully, Cardiff, S. Glam. Tel: 0222 530787.*

Shine on

Amalgamated Wireless (Australasia) Ltd., has commenced work on a $600,000 scheme to convert the entire trunk telecommunications network in Papua New Guinea from battery to solar power.

This is believed to be the first time such a project has been undertaken, and involves the installation of power cells at about 20 microwave repeater stations located at strategic points throughout the Territory.

Many outstations currently using mechanical generators will also be included in the scheme.

Long Distance TV

We have been asked to advise readers that Roger Bunney's book *Long Distance Television*, formerly available from Weston Publishing, Romsey, is now out of print. A revised and expanded version of the work is to be published shortly by Babani Press.

Girls, Girls, Girls

The Caroline Haslett Memorial Trust and The Institution of Electrical and Electronics Technician Engineers have introduced an annual electrical and electronic engineering award valued at £250 for 'The Girl Technician Engineer of the Year'. With a closing date of 1st October for nominations, the announcement of the 1978 Award will be made in December.

The engineering industry needs to attract more young people of the highest calibre and the aim of the Award is to focus attention on electrical and electronic engineering as a worthwhile career for women. By selecting the most outstanding girl technician engineer—who will have successfully undertaken the necessary technical education and training, and have proved herself capable of holding a responsible job—it is the Award sponsors' express hope that she will, by her example, encourage more girls to enter the electrical and electronic engineering profession.

For further details and copies of the Award nomination form please apply to: *Joan Ashton, IEETE, 2 Savoy Hill, London WC2R 0BS. Tel: 01-836 3357.*

Diary Date

I am informed by Blackwood & District Amateur Radio Society that this year's Welsh Amateur Radio Convention will be held on Sunday, 24th September at the usual venue, Oakdale Community College, Oakdale, Blackwood, Gwent. The Convention will be opened by Dr D. S. Evans, G3RPE, President of the R.S.G.B.

Apart from a Trade Exhibition, demonstrations and advice on amateur TV (Gwent TV Group), RTTY (BARTG), satellite communication (AMSAT UK) and 'ORACLE', the I.B.A. teletext system, the programme will include a film of the 1978 Clipperton Island DXpedition, the ARRL film 'Ham's Wide World', an illustrated lecture by S. Cherry, G3SJK, of the Appleton Laboratory on 'Telemetry Communications from High Altitude Transatlantic Balloons Using Low Power h.f.', and a talk on R.S.G.B./W.A.R.C. 1979' by Dr. D. S. Evans.

There will be increased exhibition space this year and advice on overnight accommodation is available from *F. B. Davies GW3KYA, 16 Vancouver Drive, Penmain, Blackwood, Gwent NP2 0UQ. Tel: 0495 225825.*

RAE courses

RAE courses are available this Autumn at the following locations:—

Hemel Hempstead (Herts.)—Commencing Tuesday 12th September, enrolment on 4th and 5th September. The course lecturer will be C. Burke G3VOZ, tel: 0442 833300. *Hemel Hempstead College of Further Education, Marlowes, Hemel Hempstead, Herts.*

Knottingley (West Yorks.)—Commencing mid-September, enrolment on 11th September. Course lecturer G3HCW. *Knottingly High School, Knottingly, West Yorks.*

Birkenhead (Cheshire)—Commencing mid-September on Thursday evenings, enrolment from 4th to 11th September, or at class meetings. Course lecturer D. E. Owen G4GGB. *Dept. of Electrical Engineering, Birkenhead College of Technology, Borough Road, Birkenhead, Wirral.*

Openshaw (Manchester)—Commencing Tuesday 18th September, enrolment 4th, 5th and 6th September between 6pm and 8pm. Course lecturer A. B. Langfield G3IOA. *Openshaw Technical College, Whitworth Street, Openshaw, Manchester 11.*

Swinton (Manchester)—Commencing Thursday 28th September. Details from G8BFP, tel: 061-794 3706. *Moorside High School, East Lancashire Road, Swinton, Manchester.*

Gosforth (Newcastle upon Tyne)—Theory and morse classes to be held on Tuesdays and Thursdays respectively, between 7pm and 9pm, commencing in September. For further information telephone the course lecturer on 0632 668439. *Gosforth High School, Knightsbridge, Gosforth, Newcastle upon Tyne.*

RAE reprint

For full details of availability and price, see page 64.

2m Mosfet Converter

*A. J. NAILER G4CFY

The circuit to be described was developed as a simple and effective version of a more complex converter which has been in use at the Author's station for the past five years. It was decided that the new converter should use the most up-to-date circuit techniques in order to achieve low noise figures, good gain and good cross-modulation performance.

The previous converter employed cascode f.e.t. i.f. stages and performed well but it had been tricky to set up and therefore would not be reproducible by the newcomer to amateur radio. Replacing the cascode f.e.t.s with a new MOSFET r.f. stage made it possible to achieve a greater signal-handling capability, about the same gain but a slight degradation in the noise figure. The new stage presents no problems with regard to stability and is easy to tune. Although the noise figure for the converter is about 2·5-3·5dB this is perfectly adequate and not exceeded by many commercial units aimed at the amateur market.

The new stage was exhaustively tested using sophisticated equipment, including a spectrum analyser, to optimise its performance.

During the tests it was found that non-linearity did not become severe until a signal of 120mV r.m.s., (350mV p-p) was applied. The gain of the stage was about 18dB (x8), there were no signs of instability with or without the aerial connected, and it was simple to tune.

Principle of Operation

The signal arriving at the aerial is matched into the input of a MOSFET r.f. amplifier which magnifies its amplitude by 8 times and passes the larger signal to the mixer. Here the input signal is fed to the most sensitive electrode (gate 1) of another MOSFET, and a signal from the oscillator/multiplier chain is fed to the other control electrode (gate 2). These are then mixed together in the electron stream of the device emerging at the drain, together with the sum and difference of the two frequencies.

The biasing conditions for the mixer do not allow it to provide much gain but it does amplify the signal by a further two-and-a-half times. The signal selected from those present at the drain is the difference signal, which is 144−116=28MHz. This is now matched to a low impedance suitable for feeding via coaxial cable to the receiver.

The local oscillator signal is developed from an oscillator running at 38·6666 MHz as a reference, and a multiplier stage which produces multiples of this frequency. Then it selects the tripled frequency at 116MHz and filters it before injection into the mixer.

*Development Engineer,
Electronic Laboratories Ltd., Poole.

Circuit Description

The 144MHz signal enters the input terminal at an impedance of 50Ω and is coupled via capacitor C1 to a low impedance tapping point on L1. This coil steps up the voltage in a manner which is proportional to the ratio of input turns to output turns. Similarly, the impedance is transformed up by the square of the turns ratio to provide a suitable match into gate 1 of Tr1. The trimmer TC1 tunes L1 to resonance in the 2 metre amateur band.

Resistors R1 and R2 provide bias at 33% of the supply voltage to the gain control electrode gate 2.

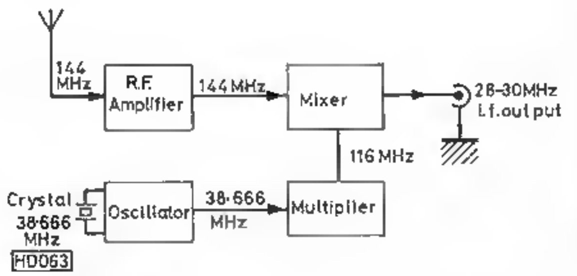


Fig. 1: Block diagram of the converter

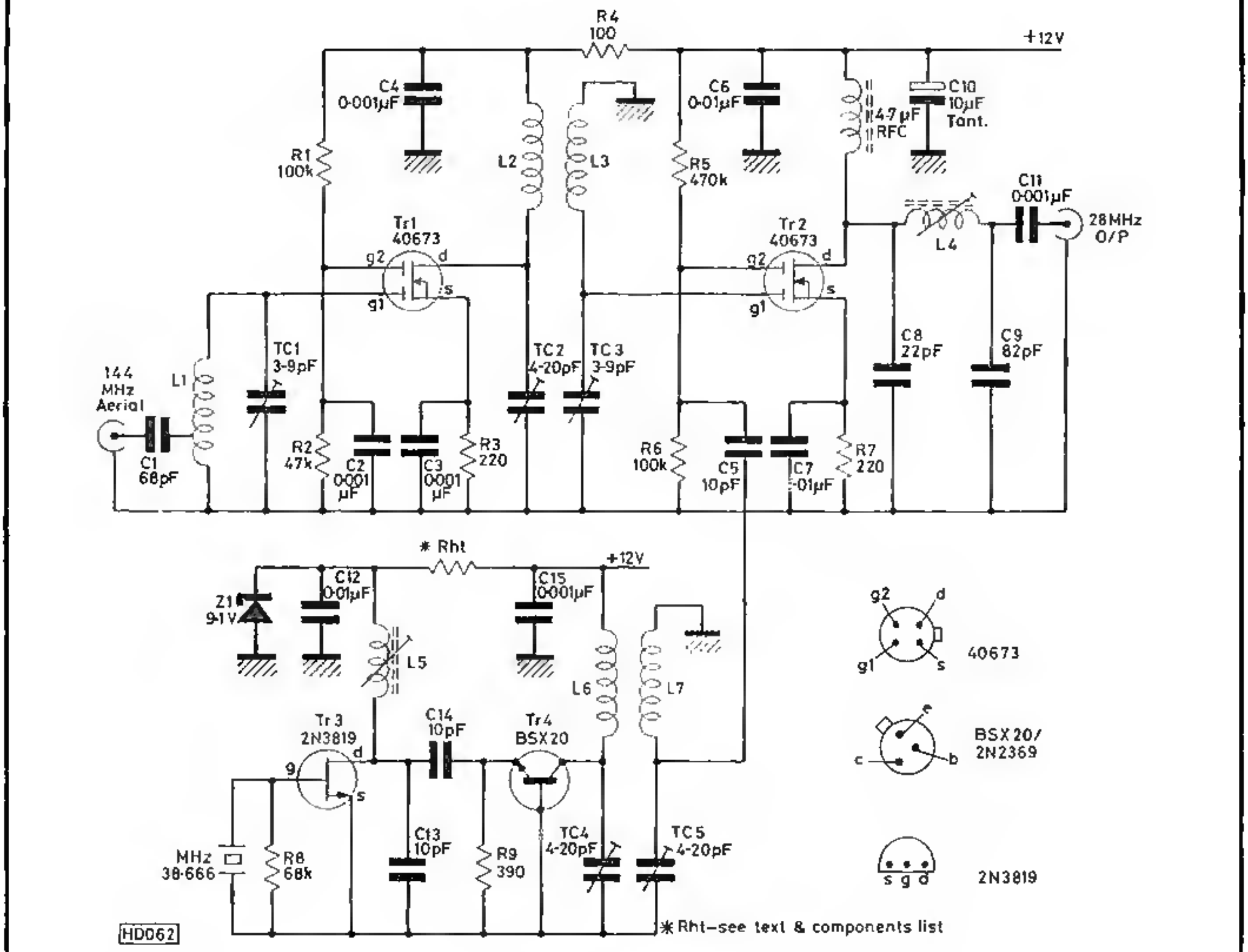


Fig. 2: Complete circuit diagram

Capacitor C2 decouples any variations of this voltage at radio frequencies to maintain constant gain conditions in the stage. Resistor R3 provides a voltage drop from the source/drain current flowing through it, making the source more positive than gate 1, or conversely, making gate 1 more negative than the source. This is the manner in which gate 1 bias is achieved and again this voltage is smoothed at signal frequency by the decoupling action of C3.

The amplified signal appears at the drain electrode and is developed across L2, this being tuned to resonance by TC2. The coil is closely coupled to L3 and draws off any signals that appear on it at their mutual frequency, other unwanted signals being heavily attenuated. Trimmer TC3 tunes L3 to resonance at the same frequency as L2 and TC2. The signal then passes into gate 1 of Tr2, as the impedance of L3/TC3 presents a fairly good match to the gate. Bias for this gate is developed in a similar fashion to Tr1 by the operation of R7 and C7.

The bias for gate 2 of Tr2 is more critical than for Tr1, as this device, when acting as a mixer, must be driven well down on its characteristic curve for good mixing to take place. The bias voltage developed by the combination R5 and R6 should normally be 1/11th of the supply rail voltage but its precise value for good mixing is solely dependent on oscillator drive. For a mass-produced unit such as this one, it is better to bias the gate slightly higher than normal—i.e. 1/16th of the supply voltage—to take account of low gain devices in the oscillator strip and ensure that all units will work fairly well. For the perfectionist, it would be worth trying a 47k resistor for R6 to take full benefit of the low noise figures that can be obtained with this converter.

The r.f. choke in the drain circuit allows all the products of mixing to be developed across it whilst the pi circuit C8, C9 and L4 tune out the required difference signal at 28-30MHz for feeding to the receiver. One of the principal purposes of the pi arrangement is to match the signal to the low impedance coaxial output capacitor. Capacitor C11 separates the d.c. connection via RFC and L4 from the output terminal.

Supply line components C4, C6 and C10 decouple any r.f. signals leaving the unit and prevent undesirable interaction between the various stages.

Resistor R4 aids the decoupling whilst providing good isolation from large local oscillator signals appearing on its supply.

The oscillator works due to feedback from the drain of Tr3 being passed back to the gate by virtue of the internal capacitance of the device, thus maintaining tuned gate/tuned drain oscillation in a similar manner to that developed by Miller for thermionic devices. To start and maintain the oscillation, the resonant circuit formed by L5, C13 and C14 must be tuned to the same frequency as the crystal.

Resistor R8 provides a d.c. path for the gate without damping the crystal, at the same time limiting the voltage across it to a reasonable level. This ensures that the f.e.t. works over a fairly linear section of its characteristic curve, to reduce the generation of harmonics.

The components Z1, C12 and R_{ht} stabilise the oscillator supply voltage to minimise frequency shift due to variations of the supply line voltage. The value of resistor R_{ht} is dependent on the I_{dss} of the f.e.t. and may be determined by the expression shown in the components list.

$$\text{e.g. } R_{cht} = \frac{12 - 9 \cdot 1}{0 \cdot 005 + 0 \cdot 004} = \frac{2 \cdot 9}{0 \cdot 009} = 322\Omega$$

Therefore, in this case use a 330Ω resistor.

The I_{dss} can be found by coupling the source of the f.e.t. to the gate and connecting the combination to the negative rail of a low voltage supply—say 6V. Wire the drain via a 50mA meter to the positive pole of the supply: the I_{dss} can then be established.

The multiplier transistor Tr4 operates in the grounded-base mode and is normally non-conducting. This is because no forward bias is applied to the base/emitter junction. The transistor requires 0·6V to switch on and thus does not conduct during negative half-cycles of the oscillator output signal; only for that proportion of the *positive* half-cycle which exceeds 0·6V. In this manner, only short-duration pulses arrive at the collector and these are transformed into a rough sine wave by the flywheel action of the tuned circuit L6/TC4. The composite waveform contains many multiples of the original or *fundamental* frequency, but usually the signal of greatest magnitude is that to which the circuit is tuned. The coil L7 extracts the required signal by mutual coupling at a specific frequency, rejecting, to a large extent, those frequencies which are unwanted. The trimmer TC5 tunes L7 to the same multiple frequency as L6/TC4. In this way the 116MHz signal has an amplitude 50dB (300 times) greater than any of the unwanted multiples, providing virtually a pure sine waveform to the mixer and a relatively clean mixing action.

Construction and Layout

The component layout provided puts the circuit into a small and stable form. Copper-clad chassis techniques could be employed, but would probably result in a reduction in overall performance. The board is easy to assemble and no problems should be encountered provided the coils are wound to the specified dimensions and the screens reproduced as shown.

The board may be mounted within the cabinet of a receiver, which will tend to reduce stray pick-up at the intermediate frequency of 28-30MHz. No difficulties should arise from internally mounting the unit unless the local oscillator of the receiver should happen to be poorly screened, and be producing harmonics which fall within the 2 metre band.

★ components

Resistors

0 25W 5% Carbon Film

100Ω	1	R4
220Ω	2	R3, 7
390Ω	1	R9
47kΩ	1	R2
68kΩ	1	R8
100kΩ	2	R1, 6
470kΩ	1	R5

Rht:—330Ω if f.e.t. Idss 4mA
270Ω if f.e.t. Idss 8mA
otherwise,

$$Rht = \frac{12 - 9 \cdot 1}{0 \cdot 005 + Idss}$$

Capacitors

Sub-miniature Plate Ceramic

10pF	3	C5, 13, 14
68pF	1	C1
82pF	1	C9
0·001μF	5	C2, 3, 4, 11, 15
0·01μF	3	C6, 7, 12

Silver Mica

22pF	1	C8

Tantalum Bead

10μF	1	C10

Trimmers

Miniature Single-turn Ceramic

3-9pF	2	TC1, 3
4-20pF	3	TC2, 4, 5

Semiconductors

Transistors

40673	2	Tr1, 2
2N3819	1	Tr3
BSX20	1	Tr4 (2N2369 can also be used)

Diodes

9V1 Zener	1	Z1

Crystal

38·6666MHz 3rd overtone 30pF series-resonant HC18U

Coil Data

L1 4t 6mm i.d. 8mm long 19s.w.g. tinned.
L 2, 3, 6, 7 4t 6mm i.d. 8mm long 19s.w.g. enam.
L4 17t on 5mm slug-tuned former. 30s.w.g. enam.
L5 9t on 5mm slug-tuned former. 30s.w.g. enam.
RFC 4 7μH choke (RS type 228–135).

Hardware

BNC Sockets 50Ω 2
** Die-cast box. Bopal 102 or 103.
** *Available from West Hyde Developments, Unit 9, Park Industrial Estate, Aylesbury, Buckinghamshire HP20 1ET*

Miscellaneous

Switch, Miniature SPDT, if required

Another method of using the converter is as an out-board unit, connected to the receiver at its aerial socket and to a 12V supply line. In this case it would be ideal if the unit were fitted in a 111·1 x 60·3 x 27mm die-cast box, such as the Eddystone EDD 20, or West Hyde "Bopal" 102/103 with suitable coaxial connectors fitted and a supply input socket.

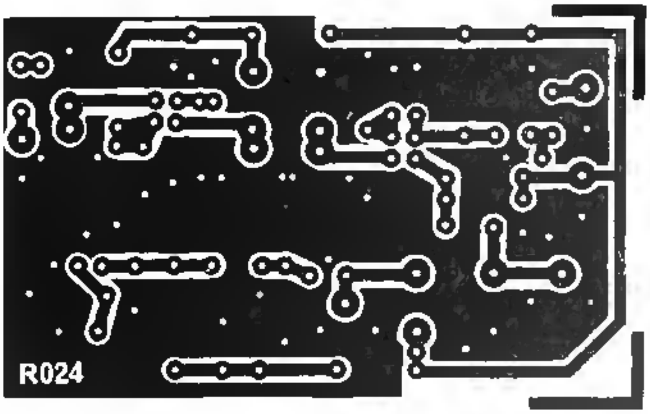
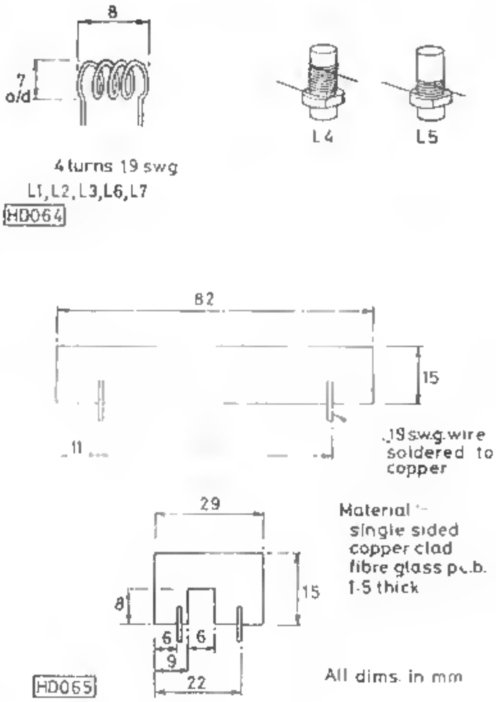
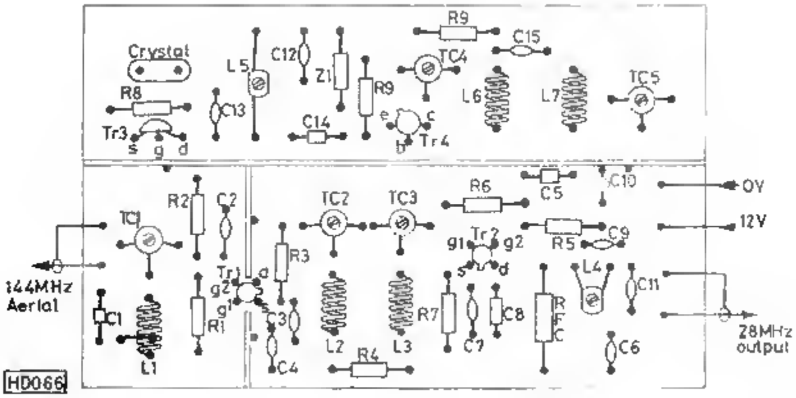


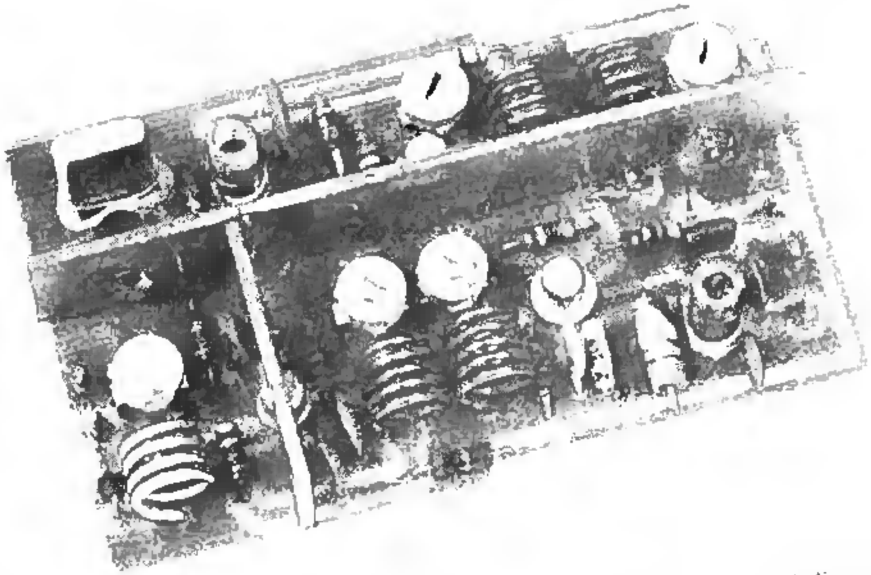
Fig. 3: Printed circuit board track pattern, shown full size (above)

Fig. 4: Component layout on the p.c.b. (below)

Fig. 5 and 6: Coil and p.c.b. screen details (right)







continued on page 64 ▶

using TRANSISTOR PADS

To help you achieve that professional finish for your constructional projects, Practical Wireless give away FREE this month a dual set of polypropylene transistor pads mounted on a sprue. Each sprue consists of 12 pads for type TO18 packages and 6 pads for type TO5 packages. So, good luck and keep looking good!

Have you ever wondered how manufacturers of high quality equipment manage to get their components arranged so neatly on their printed circuit boards, indeed just why do they go to such lengths to achieve such neatness?

With our free gift this month you too can mount your transistors neatly and evenly on your p.c.bs and reap the benefits.

What then are these benefits? Our mounting pads hold each transistor the correct distance away from the board allowing you to solder the leads with less fear of damaging the transistor itself. The very act of pushing the transistor leads through the holes in the mounting pad ensures that the leads are not twisted or touching each other.

Having a solid pad of plastic between the transistor envelope and the board surface provides a means of mechanically supporting the transistor, preventing it from being displaced with the consequent danger of lead fracture or short circuits.

Reliability of equipment is usually improved as a result of using such aids as transistor mounting pads. This comes about as a direct result of neatness assisting visual inspection as well as improving your pride in your work. This lifts the standard of work giving better joints with less damage to p.c.b.s and components.

A properly designed and constructed printed circuit board should be a work of art. Take care with mounting components and the reliability and operation of your projects should improve.

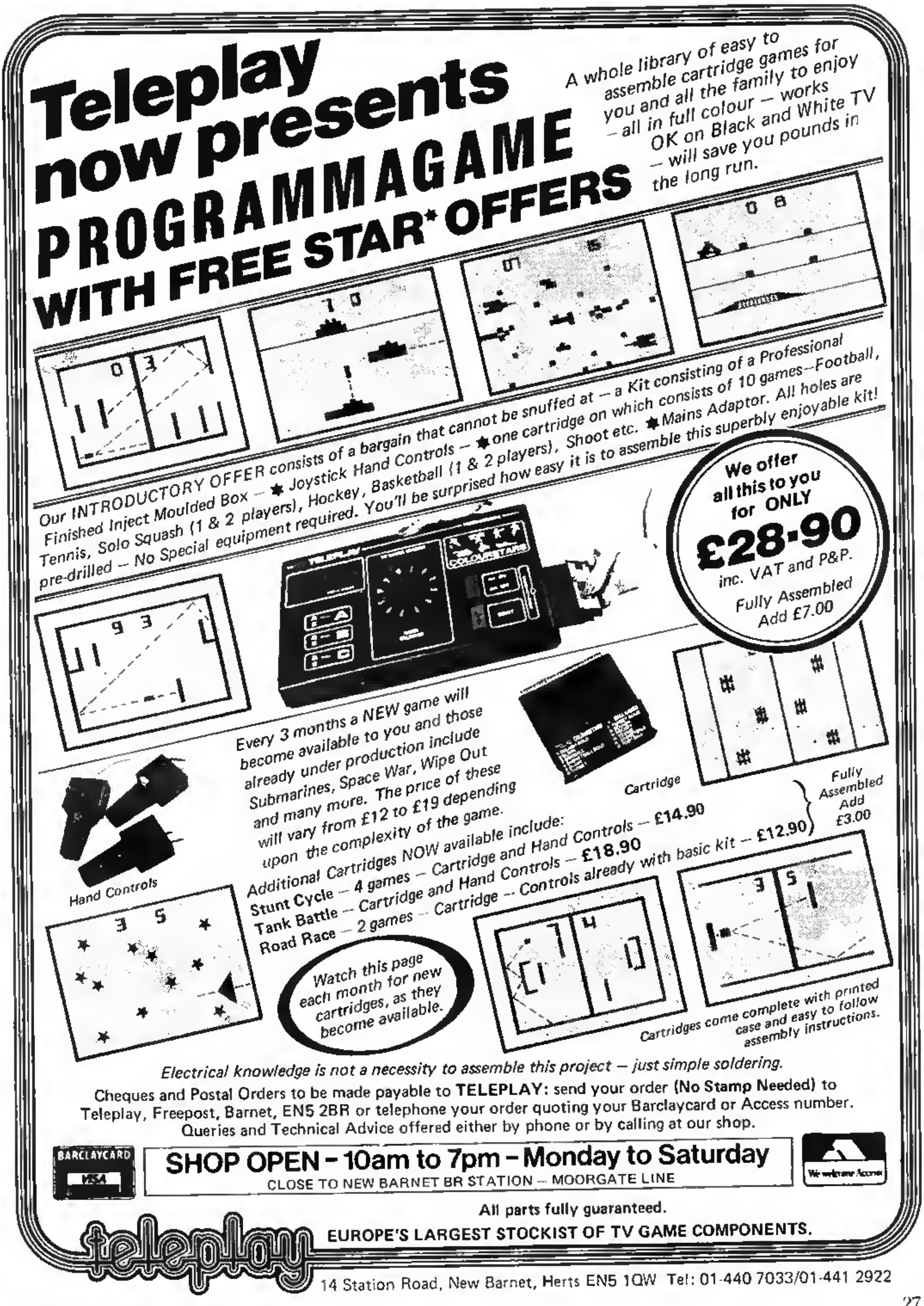
To use our free transistor mounting pads carefully remove each one from the sprue to leave a disc of plastic with four holes and a small tab. Select the appropriate size of pad for the transistor you are fitting. The small pads fit TO18 size packages and can be used for the small plastic encapsulations as well although they cannot be seated right down onto the pad. The larger pads fit TO5 packages.

To help with feeding the leads through the pads the top of the holes are countersunk and the leads should be fed through from this side. Push the pad right up to the transistor envelope and then insert the leads into the appropriate holes in the p.c.b. Push the transistor right down so that the pad is sandwiched between the transistor base and the board surface and solder the leads to the copper pads, finally cropping off the excess leads. It is important that the pads do not just float around but are firmly sandwiched to ensure that the transistor is properly supported.

Using the small pads with plastic type transistors will help you to change the lead configuration to the same as a TO18 type without fear of the leads shorting together.

Mounting pads are extensively used in industry and are available in many different shapes and sizes including types to convert 10 lead TO5 can i.c.s. to d.i.l. configurations and types to cross transistor leads over. Ours are the simplest type which are designed just to hold the transistor correctly on the board.

Use them on your next project and see for yourself just how much better your board looks.



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Fully Assembled Add £3.00
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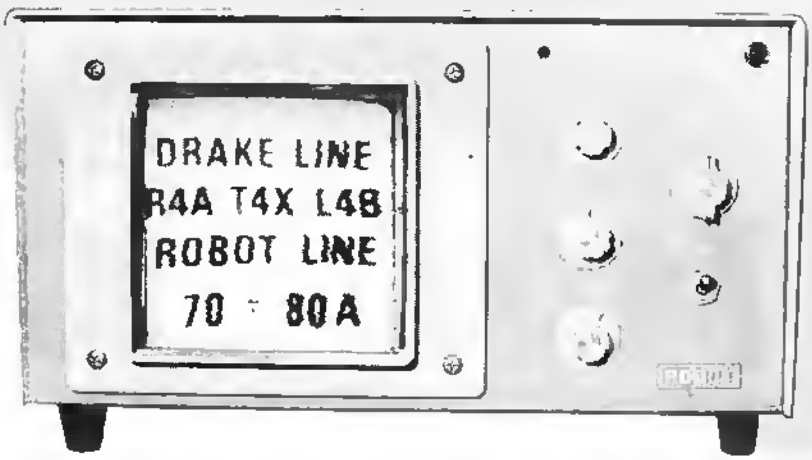


amateur SSTV

P. BARKER

Slow-scan television is a method of transmitting video information within the bandwidth of a normal single-sideband signal. The video occupies the 800Hz between 1·5kHz and 2·3kHz, the former representing black level and the latter peak white.

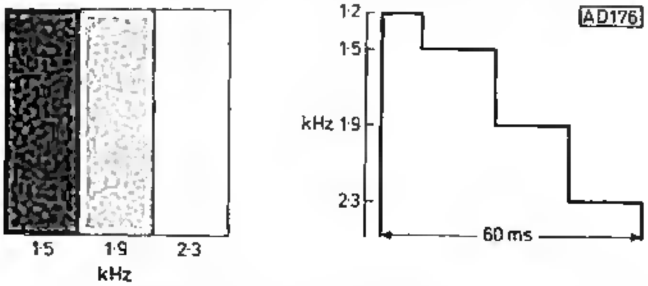


Fig. 1: A typical grey-scale and its corresponding line waveform

Consider the picture suggested in Fig. 1. A 5ms pulse at a frequency of 1·2kHz is used to start the line scan, followed by approximately 18ms of 1·5kHz (black), 18ms of 1·9kHz (mid-grey) then a further 18ms of 2·3kHz (white). After 120 lines have been 'written' a frame pulse of 30ms replaces the line pulse and is used to return the beam to the start of its scan.

Each frame takes about seven seconds to complete and so, in order to retain the information contained in earlier lines, it is necessary to use a long-persistence cathode ray tube as the display. Radar tubes, such as the 5FP7, could be employed and these can often be obtained quite inexpensively from 'surplus' distributors.

continued on page 72

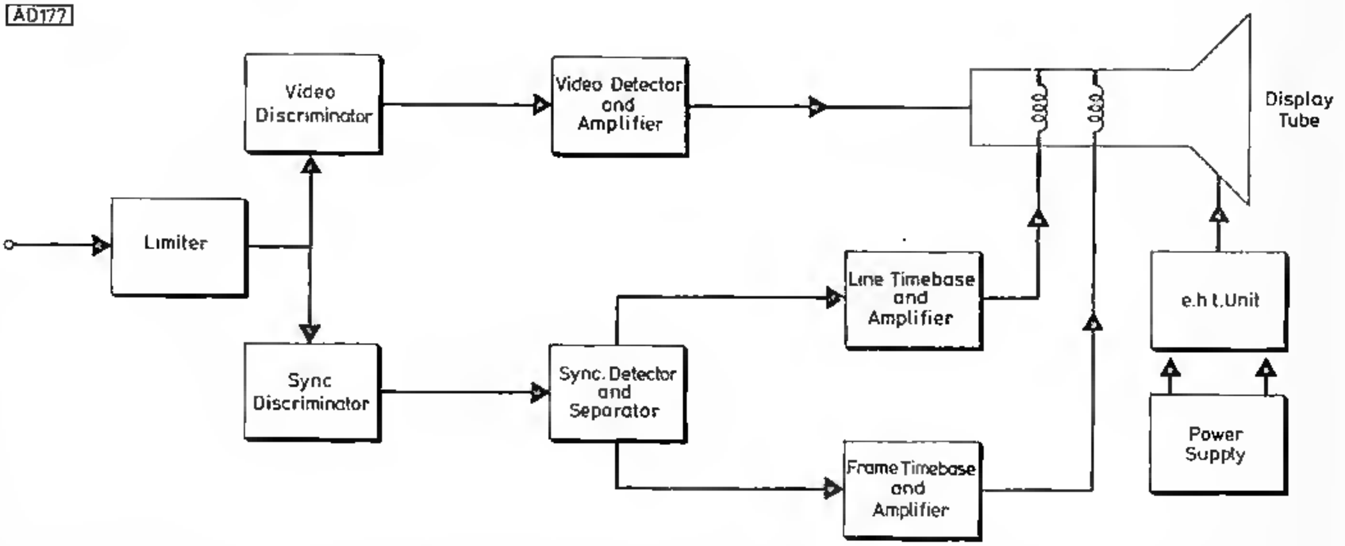


Fig. 2: Block diagram of a typical SSTV monitor

PW WIMBORNE

Music Centre

PART 2 Amplifiers & Supplies **N.B.MATTEY**

Main Amplifiers and Power Supplies

The input stages, power amplifiers and regulated d.c. power supplies are contained on one board, connections being made via plugs and sockets "out" to cassette unit, disc equipment and radio circuitry. Inter-unit connections will be dealt with in later instalments.

Circuit Description

The circuit configuration consists basically of a dual high gain pre-amplifier (LM387), passive tone control circuitry, a dual driver/output amplifier (LM378), and a complementary pair transistor output stage for each channel. Amplifier functions are identical throughout, and so only one channel will be described.

Initial amplification is effected by the use of the LM387, which is a later version of the LM381 although its equivalent input noise figure is an improvement at only $0 \cdot 65 \mu V$ r.m.s., as is supply rejection ($f = 1kHz$) at 110dB. In the description which follows, components prefixed "1" (i.e. R104) refer to the left hand amplifier, while prefixes "2" and "3" refer to right hand amplifier and power supply components respectively.

Each pre-amplifier is used in the inverting a.c. amplifier mode, signal input being applied via R101 and C101 to the inverting input of the LM387. Matching to high impedance inputs (crystal and ceramic cartridges) is direct at this point, although provision will be made later (in part 3) to match to magnetic cartridges (47k impedance), with consequent standard equalisation to the RIAA characteristic. R101 and R102 act as input voltage dividers, while R103 provides feed-back. This technique tends to raise the limits on input voltage, and thereby, produces virtual unity gain stability.

Tone Controls and Output Stage

Due to the fairly high gain of the stage, it is possible to make use of a passive tone control network, insertion loss being rendered less dominant than it might otherwise be. Tape "out" signal is taken from the output of IC1 via C103/R104 and is virtually "flat" in terms of frequency response. VR1 is the bass control, VR2 the treble control, and the R-C network R105 to R108 and C104/C105 provides "tailoring" to effect bass and treble boost and cut.

VR3 is the single balance control, and after balancing the signal is fed via the volume control (VR4) to the non-inverting input of IC2 which acts as a driver/output stage in combination with the complementary pair Tr1 and Tr2. C106 provides a degree of treble roll-off, and R112 provides d.c. feedback.

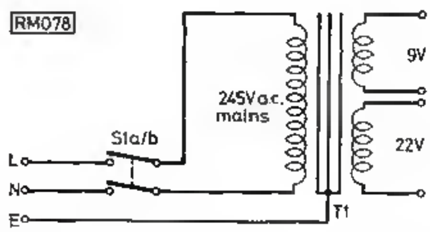
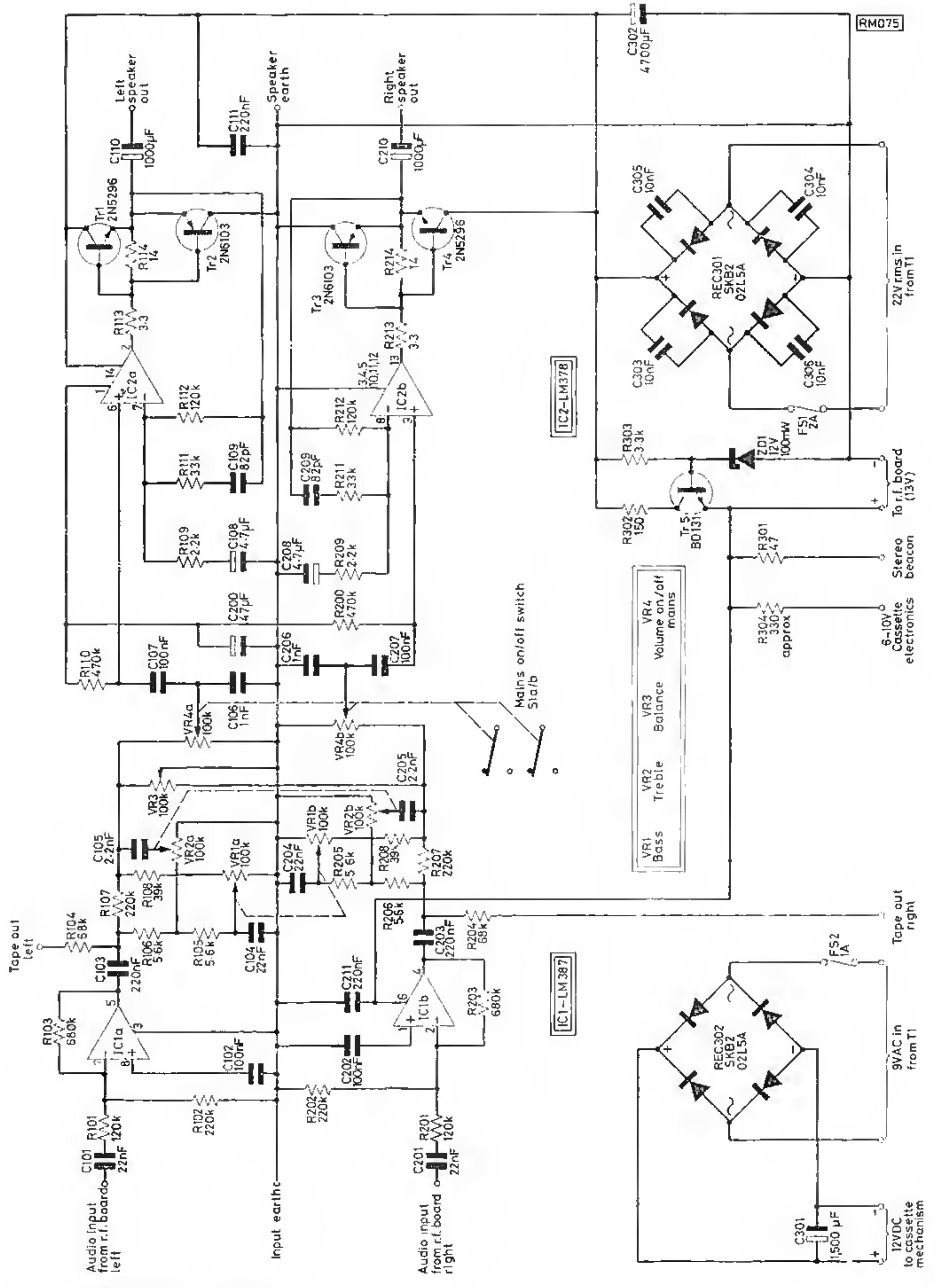


Fig. 1 (above): The mains transformer circuitry, and Fig. 2 (facing page) the circuit diagram of the main amplifiers and power supplies


RM075
C302 4700µF
Left speaker out
Speaker earth
Right speaker out
C110 1000µF
C111 220nF
C210 1000µF
Tr1 2N5296
Tr2 2N6103
Tr3 2N6103
Tr4 2N5296
R114 1Ω
R214 1Ω
R113 3.3
R213 3.3
IC2a
IC2b
R112 120k
R212 120k
R111 33k
C109 82pF
C209 82pF
R211 33k
R109 2.2k
C108 4.7µF
C208 4.7µF
R209 2.2k
C200 47µF
R200 470k
R110 470k
C107 100nF
C206 1nF
C207 100nF
C106 1nF
VR4a 100k
VR4b 100k
Mains on/off switch S1a/b
VR3 100k
C205 2.2nF
C105 2.2nF
VR2a 100k
VR2b 100k
VR1a 100k
VR1b 100k
C204 22nF
R205 5.6k
R208 39k
R207 220k
R107 220k
R108 39k
R106 5.6k
R105 5.6k
C104 22nF
R206 5.6k
C203 220nF
R204 68k
R104 68k
Tape out left
Tape out right
C103 220nF
C211 220nF
R103 680k
R203 680k
IC1a
IC1b
C102 100nF
C202 100nF
R102 220k
R202 220k
R101 120k
R201 120k
C101 22nF
C201 22nF
Audio input from r.f. board left
Input earth
Audio input from r.f. board right
IC2–LM378
IC1–LM387
C305 10nF
C304 10nF
C303 10nF
C306 10nF
REC301 SKB2 02L5A
22V r.m.s. in from T1
FS1 2A
R303 3.3k
ZD1 12V 100mW
To r.f. board (13V)
R302 150
Tr5 BD131
R301 47
Stereo beacon
R304 330 approx
6–10V Cassette electronics
VR1 Bass
VR2 Treble
VR3 Balance
VR4 Volume on/off mains
FS2 1A
REC302 SKB2 02L5A
9VAC in from T1
C301 1,500µF
12VDC to cassette mechanism

★ components

Resistors

¼ Watt 5% carbon

3·3Ω	2	R113, 213
14Ω	2	R114, 214
47Ω	1	R301
150Ω(½W)	1	R302
330Ω*	1	R304
2·2k	2	R109, 209
3·3k	1	R303
5·6k	4	R105, 205, 106, 206
33k	2	R111, 2111
39k	2	R108, 208
68k	2	R104, 204
120k	4	R101, 201, 112, 212
220k	4	R102, 202, 107, 207
470k	1	R110
680k	2	R103, 203

** depends upon cassette unit*

Potentiometers

p.c.b. mounting

100k lin. dual track	1	VR1
100k lin. single track	1	VR3
100k log. dual track	2	VR2, VR4

Semiconductors

LM387	1	IC1
LM378	1	IC2
2N5296	2	Tr1, Tr4
2N6103	2	Tr2, Tr3
BD 131	1	Tr5
BZY 88	1	ZD1
SKB2/02L5A	2	REC301, 302

Capacitors

Polystyrene		
82pF	2	C109, 209
Polyester		
1nF	2	C106, 206
2·2nF	2	C105, 205
22nF	4	C101, 201, 104, 204
100nF	4	C102, 202, 107, 207
220nF	3	C103, 111, 203
Ceramic		
10nF	4	C303, 304, 305, 306
Electrolytic		
4·7μF 50V	2	C108, 208
47μF 50V	1	C200
10000μF 25V	2	C110, 210
1500μF 40V	1	C301
4700μF 40V	1	C302

Fuses

Cartridge

2A	1	FS1
1A	1	FS2

Mains Transformer

240V primary, secondaries 22V(r.m.s.) centre-tapped @ 1·5A, 9V @ 600mA

Miscellaneous

Aluminium heatsink, fuse holders (2) 6BA nuts and bolts, SW1 (ganged with VR4) d.p.d.t. Staver type heatsink for IC2 (fins), heatsink compound, mica washers

while R111 and C109 are responsible for a.c. feedback. C200 (47μF) and C111 (220nF) provide decoupling for the supply rails. C110 feeds the loudspeakers and prevents the establishment of high standing d.c. levels.

Power Supplies

Supply rails are provided by two mains transformer secondary windings from T1, 9V and 22V, (this *must* be 22V r.m.s. to maintain supplies at a safe level) being rectified by bridge unit REC301 for the 30V rail, and REC302 for the 12V supply to the cassette mechanism. Tr5 drops the 30V line and in combination with ZD1 regulates the 13V line to supply the r.f. board. Smoothing is effected by C301 and C302, the bridge rectifier technique providing good regulation overall. The LM387 is supplied from the regulated 13V supply (Vcc pin 6), and the LM378 from the 30V rail (Vcc pin 14). Supplies are fused at a.c., i.e. the inputs to the bridge rectifiers REC301 and REC302.

On no account must the supply rail for the LM387 be allowed to rise above 30V, since the establishment of safe working tolerance demands that the maximum rating of 35V should not be approached too closely.

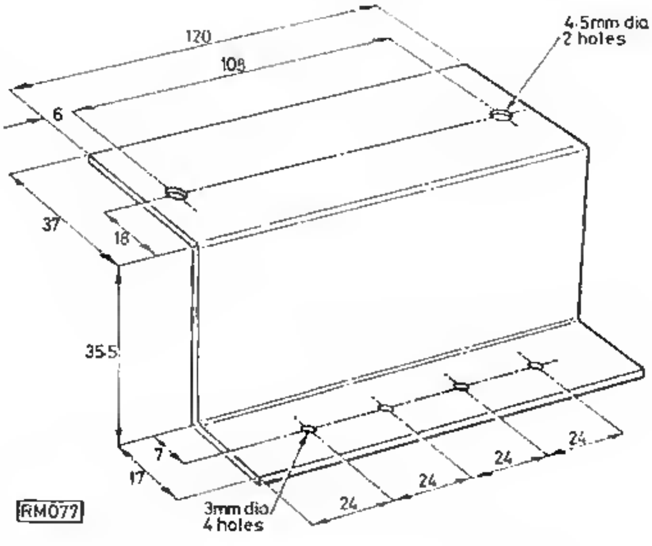


Fig. 3: Dimensions and bending details of the output stage heat sink

Construction

Component assembly on the printed board should present no problems, although it is worth noting one or two points concerning specific items.

While IC1 can be pushed straight into the board and then soldered in, the heatsink for IC2 must be lightly bent onto the body of the device before fitting and soldering. The reason for this is that the large lugs on the heatsink could prove difficult to engage simultaneously with the i.c. pins, and it is as well to keep heating of the unit (from the soldering iron) at a minimum. The aluminium heatsink should be bent as shown.

The output transistors should be bolted in after applying heatsink compound. Tr2 and Tr3 are connected straight to chassis via the heatsink, while Tr1 and Tr4 are installed using standard mica insulating washers. In order to make a good electrical connection to each collector, a wire bridge is connected from the middle pin of each transistor to the relevant part of the track. These are shown as dotted lines on the layout illustration.

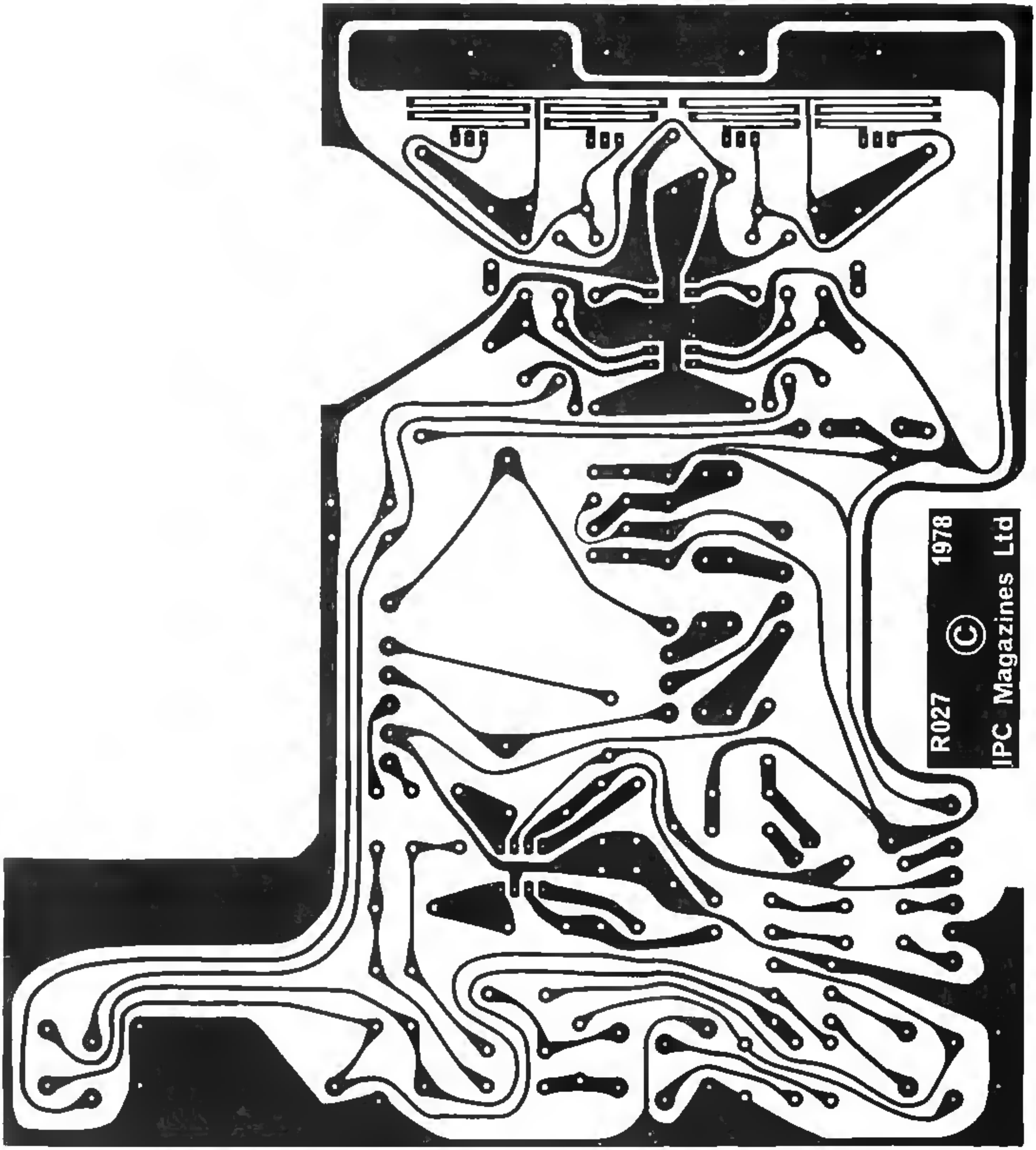


Fig. 4: The p.c.b. copper track pattern; the emitter resistor tracks (see text) are clearly shown at the top of the board

Although not shown on the circuit diagram, the output stage emitter resistors are included on the p.c.b. as a part of the track, but where a different construction is employed, lengths of 32 s.w.g. shellac-covered wire approximately 150mm in length will suffice. Alternatively, if available, 0·5Ω wire-wound resistors may be employed.

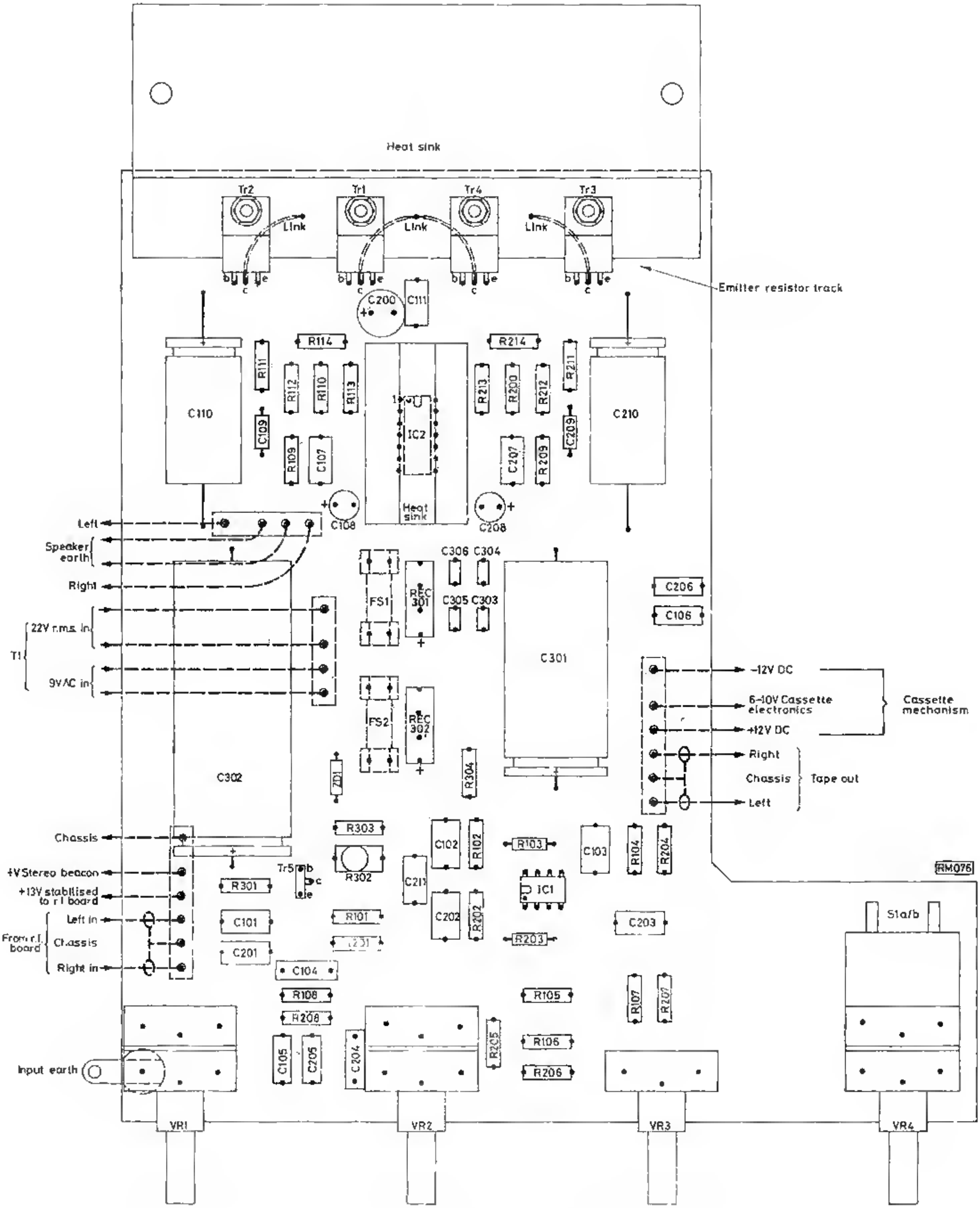


Fig. 5: Component overlay, relating directly to the board details on the previous page

continued on page 59

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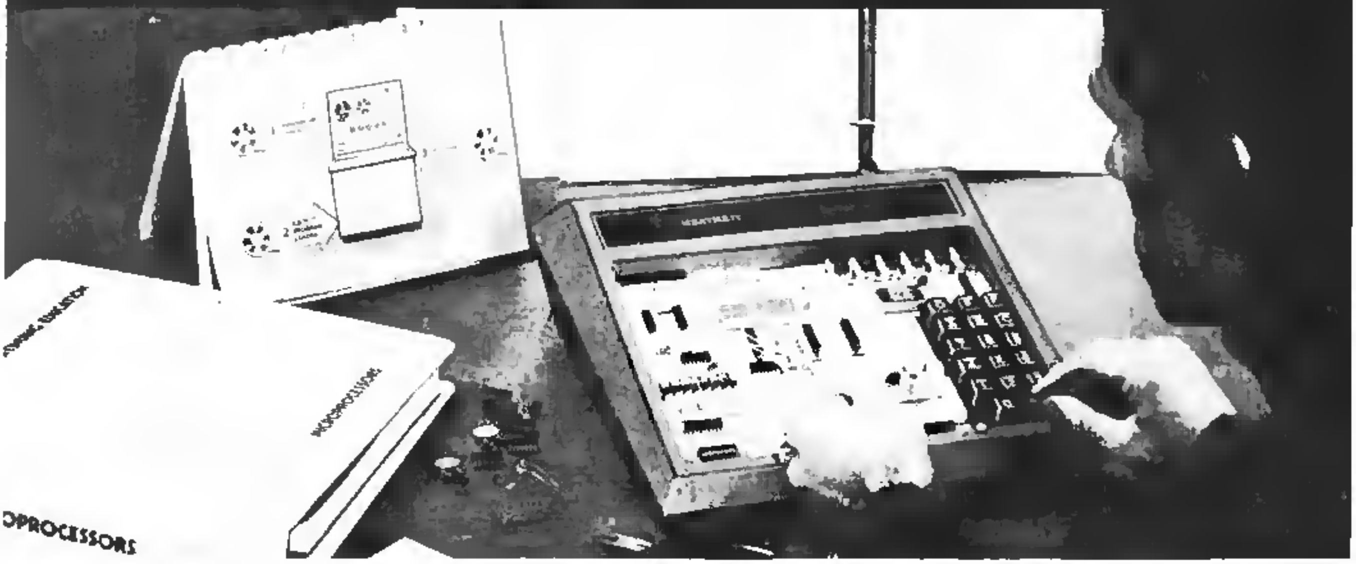

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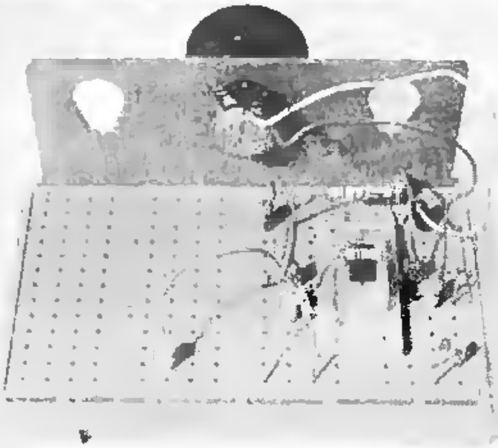
μ-DeCnology



DAVID GIBSON

6

THIS MONTH

'Audio Oscillator'

The Basic Oscillator

Most circuits are designed to do one particular job. This month's μDeC project will do at least three jobs.

Basically, the 741 is made to oscillate and the exact frequency is set by C1/R3/VR1. Making the resistor variable means that by simply turning a single control we can alter the frequency of our oscillator. The output is a series of square waves and because of the very high gain of the op. amp, these have quite steep sides.

Two things to note. Don't forget the three jumper or shorting leads marked as "link wires". Secondly, the circuit requires two separate batteries to give a ±6V supply. If you take the two 6V batteries and connect the +6V of one to the −6V of the other, then this junction becomes zero volts and is connected to hole Q23. The free +6V lead then goes to μDeC hole Q1, while the remaining lead from the negative 6V terminal is plugged into hole G22.

Metronome

Let us now look at the three projects we can have with our circuit. The first is a simple electronic metronome. In this case, you should try a 47μF capacitor for C1. If you have connected a light-emitting diode to the output as shown, this will flash on and off. The rate of flashing can be set by adjustment of VR1. Thus we have a visual metronome. This can be useful when no noise can be tolerated while playing—for example in a group with no drummer and where the "beat" is taken from one player, as in some folk groups.

If an audible output is required, then this can be obtained very simply by connecting an earpiece across the diode or by plugging it in instead of the l.e.d. A cheap crystal earpiece works well. Purists may wish to leave the diode in to form a d.c. path but the circuit works well without it using only the earpiece. A series of clicks was obtained using a small crystal microphone although these are not really loud enough when playing a musical instrument at the same time, hence the need for an earpiece.

★ components

R1	100kΩ	IC1 741 op. amp. (8-pin d.i.l.)
R2	12kΩ	C1 see text
R3	100kΩ	One μDeC
R4	1kΩ	One μDeC i.c. d.i.l. holder
VR1	1MΩ	one l.e.d.
μDeC jumper leads		two 6V batteries (PP6 or similar)

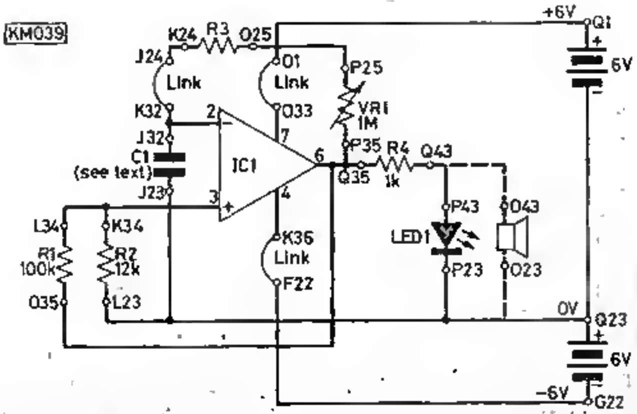


Fig. 1: Circuit diagram of the audio oscillator with μDec hole nos. and optional l.e.d. or speaker output

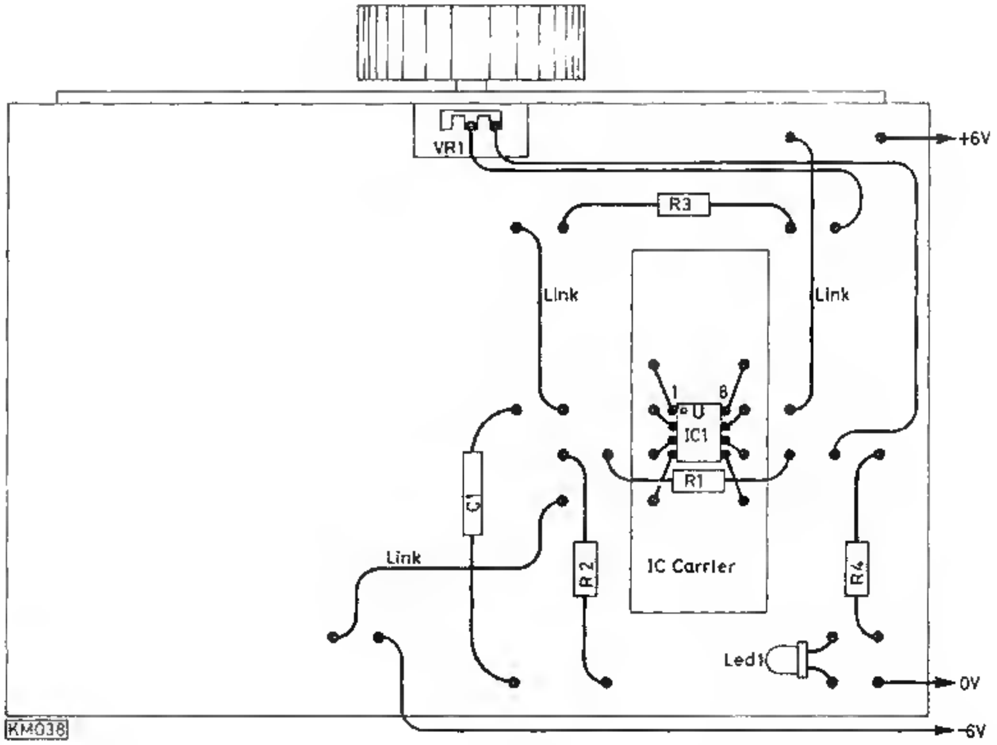


Fig. 2: The component layout of the completed unit

Signal Injector

By making the value of C1 smaller (i.e. less μF) the pitch of the output waveform rises so that it goes above just clicks to being a musical tone or note. By setting VR1 to mid travel and substituting a 0·1μF capacitor for C1, a steady audio tone can be obtained from the earpiece. This tone can be used for injecting into audio equipment for test purposes. Things like loudspeakers, headphones, earpieces, amplifiers etc may be checked very quickly and simply in this manner. If this were to be the prime use of the circuit, then it would be simpler (and cheaper) to make VR1 a 470kΩ fixed resistor, C1 = 0·1μF, and transfer the whole project onto a piece of Blob Board which could then be stuck inside a suitable small case using adhesive on the blank side (no track side) of the Blob Board—switch on, inject signal, listen for tone.

Electronic Organ

By suitable choice of C1, the circuit can be made to oscillate over an extremely wide range; from well below 1Hz to well over 15kHz. To make a simple electronic organ one has only to select a series of fixed resistors and connect this string of components between holes P25 and P35 in the place of VR1. This idea is shown in Fig. 3. If really accurate notes are required, then it would pay to use 13 (for one octave) skeleton slot potentiometers. In this way each note can be individually adjusted spot on. Fig. 4 shows this plus a refinement of an octave switch and a set pitch pot. With none of the keys depressed all the skeleton pots will be in circuit and the lowest note will be obtained if the two pots (VR2/VR3) are set at maximum resistance. With the 1MΩ pot shorted out, the 100k pot is adjusted to bring the lowest note to one octave *above* that required. The individual pots in the chain are tuned and the lowest note again checked and adjusted by the 100kΩ pot. Now remove the short across the 1MΩ pot and adjust it to bring the lowest note to one octave below the pitch which it was when the 1MΩ pot was shorted out. The switch now becomes an octave switch and will take the whole keyboard *down* one octave when the switch is opened removing the short across the pot.

Fig. 3: Connection points for a basic organ

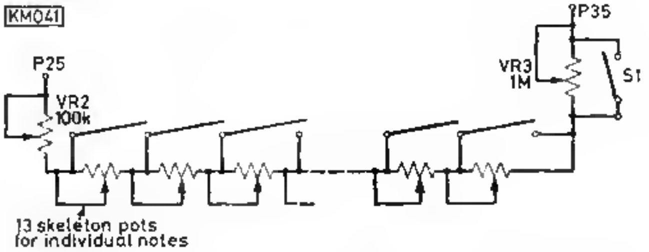


Fig. 4: A more "sophisticated" version of the organ

To give some indication of the range of the Fig. 1 circuit, a coverage from G below middle C to over three octaves above was obtained in the prototype using 0·01μF for C1 and a 1MΩ pot for VR1.

One word of warning. When using the circuit to inject audio signals, care should be exercised—especially in mains equipment. It would be prudent to use 0·1μF 1kV capacitors in series with each lead i.e. the audio inject output from μDeC holes 043 and 023 should have a capacitor in series with each lead. These capacitors should be permanently connected into the circuit.

HOTLINES

A REVIEW OF RECENT DEVELOPMENTS

In general, the author does not have any more information on products than appears in the article.

Digital r.f. meter

Measuring voltage is a thing commonly carried out fairly easily with the aid of a simple meter. Measuring radio frequency voltage is a little more difficult. But it's no problem for a new instrument from Germany. This beautiful little box will give you an immediate digital readout of r.f. voltage from 300μV up to 1kV over the frequency range 10kHz to 2GHz. Besides the digital readout, an analogue readout is simultaneously given in dBs. This is effected by a single line of l.e.d.s which move a light point along and are calibrated in 1dB steps. The whole instrument can be run from a 12V battery (mains, too), consumes less than 4W, and weighs only 2·6 kilograms. Launched in the US it costs around 2,000 dollars. Wonder if the Germans run a Christmas Club?

Power!

For those who like to be "with it", the in word for Autumn is "Transcalent". This is the name for a comparatively new type of semiconductor. Basically it means that you can push extremely high currents through the device without arc-welding it to your collar stud. The wafer on which the business area is contained measures 50mm. The substrate is bonded to a heat pipe which will get rid of the generated heat efficiently. The devices will not suit miniaturisation enthusiasts. We're talking about things weighing around 2 kilograms and measuring some 190 × 150 × 150mm However, these devices include 900A rectifiers, 1,400A thyristors, and 400A transistors. Pop groups will doubtless welcome the latter!

Stable resistors

How stable is stable, especially when it comes to resistors? A British company has just announced a range of resistors with values from 0·1Ω to 1·5MΩ which have exceptional stability. The stability is claimed to be so good that it is almost impossible to measure any slight deviations reliably; typically they vary between 5 and 10 p.p.m. (parts per million) over several years. They also offer a resistance tolerance matching capability of 0·001%. Called NPRL21 resistors, they cost around 90p each.

Bubbles

Things are bubbling at IBM—literally. Some time back, bubble memories were a novelty. Then they became practicalities. One of the materials used for bubble memories is garnet. The IBM researchers have now discovered a way in which a 25mm square piece of garnet can be made to hold 100 million bits of information—instead of the 3 million bits more common so far. But it doesn't stop there. From the same company comes news of mobile "light" bubbles which hide in magnesium-doped thin films of zinc sulphide. The current theory is that these light bubbles might be electrical analogues of the magnetic bubbles which are already well established.

Sonar Snooper

Mix microprocessors with submarines and you end up with a kind of sonar snooper. That's what French researchers have done. Their sonar transducer fires out low frequency signals, between 6 and 8kHz, which gives them a range of about 40km. But it's no ordinary transducer. The head consists of 48 arrays of piezoelectric transducer elements. These can all be powered in a single shot, or individually in sequence. The enormous amount of information coming back from this complex array is handled by the microprocessors and the net effect is that the system can electronically divide the sea around it into something like 500,000 little cells. The electronics processes the signals received from the transducers and can differentiate between the various echoes received.

Certain things give known echoes, and these are stored in a memory, so the system can compare anything it receives with all things in its memory for immediate check on identification. It also compares the echoes in time, checking if the same echo came from the exact same place for each sweep.

Look out little sardine; big brother is watching!

Invest in technology

Buy British was a cry not too long ago, and if you want random access memories you may soon be able to do just that. The National Enterprise Board, no less, may "invest" something like £50 million in a semiconductor manufacturing facility in the UK. This could be interesting because, starting from scratch, only the very latest equipment would be purchased so the new venture could be in the forefront of technology.

But I do remember another fantastic, latest, state-of-the-art semiconductor facility in Essex which cost a lot of money—and died. Watch this space!

Thin Television

Flat screen television time is booming again. The Japanese have a 16in colour display on the go which uses plasma techniques, while at the recent Chicago Consumer Electronics Show one exhibitor proudly displayed an electroluminescent screen which was just 50mm thick. Although the size was only 7 inches brightness has reached 15ft/lamberts with power consumption barely 7W. This manufacturer reckons that it will be marketing portable television sets using such a screen within two years.

Better Photocells

An American scientist from a University talked at a special conference on photovoltaics, and caused a very big stir among energy producers. He claimed that a team at the university had produced a cadmium sulphide/copper sulphide cell, using thin film techniques, which produced an efficiency of well over 9 per cent. This represented an impressive increase on earlier efforts when efficiency stood at around 7·8 per cent.

By 1980, this scientist believes that the cost will be down to 30 cents/watt. A final shattering fact was the cost comparison of the materials. Silicon cells (single crystal) work out at around 150 dollars per square metre, whereas the cadmium sulphide/copper sulphide thin film approach costs just 3 dollars per square metre.

Ginsberg

The NORTON amplifier

S. H. DAVIES

Introduction

Most readers will by now be familiar with the conventional operational amplifiers, such as the 741 and 709. In recent years a new type of op-amp has come onto the scene. This has received the title "Norton Amplifier", and it amplifies the difference between two currents rather than two voltages. The Norton amplifier is best suited to amplifying a.c. signals where the utmost precision is not required—in such situations its ability to operate from a single power supply is very useful. When used as an audio pre-amplifier, it can give up to 10dB more gain than a 741 before the bandwidth suffers. The ability to operate at supply voltages as low as 4V means that it can replace discrete component amplifiers in many situations. The four amplifiers come in a 14-pin DIL package, for around 80p, making it economical as well as space-saving. Its main disadvantage is the difficulty of designing d.c. amplifiers, since it is also necessary to consider the biasing of the amplifier in such cases.

There are at least three manufacturers of the Norton amplifier—Motorola (MC3401), RCA (CA3401), and National Semiconductor (LM3900). The Motorola and RCA devices are completely compatible. Specifications of the various devices are given in Table 1, and circuit diagrams of one amplifier in **Fig. 1**. For clarity the biasing circuitry has been omitted. The significant differences are the wider supply range and additional transistor Q5 of the National Semiconductor device.

TABLE 1—Typical characteristics of the LM3900 and MC3401

Parameter	LM3900	MC3401
Supply Range (V+)	4–36V	5–18V
Supply Current	6·2mA	6·9mA
Power Dissipation	570mW	625mW
Operating Temperature Range	0–70°C	0–75°C
Open Loop Voltage Gain	70dB	66dB
Unity Gain Bandwidth	2·5MHz	5MHz
Output Voltage Swing	V+ −1	V+ −1
Output Current—High	3mA min	5mA min
Low	0·5mA min	0·5mA min
Output Slew Rate	0·5V/us	0·6V/us
Output Resistance	8kΩ	8kΩ
Power Supply Rejection	70dB	55dB

The output resistance figure is quoted at 100Hz. This value is maintained until 1kHz, and then starts to decrease, reaching 200 ohms at approx 200kHz for the MC3401.

This additional transistor is useful for sinking large output currents—up to 30mA. Motorola also make the MC3301, which will operate with a supply of up to 28V, and is specified over a wider temperature range. For more detailed information the reader is referred to the manufacturers' data sheets, in particular the National Semiconductor application note AN-72, which gives comprehensive information on the amplifier itself and design requirements.

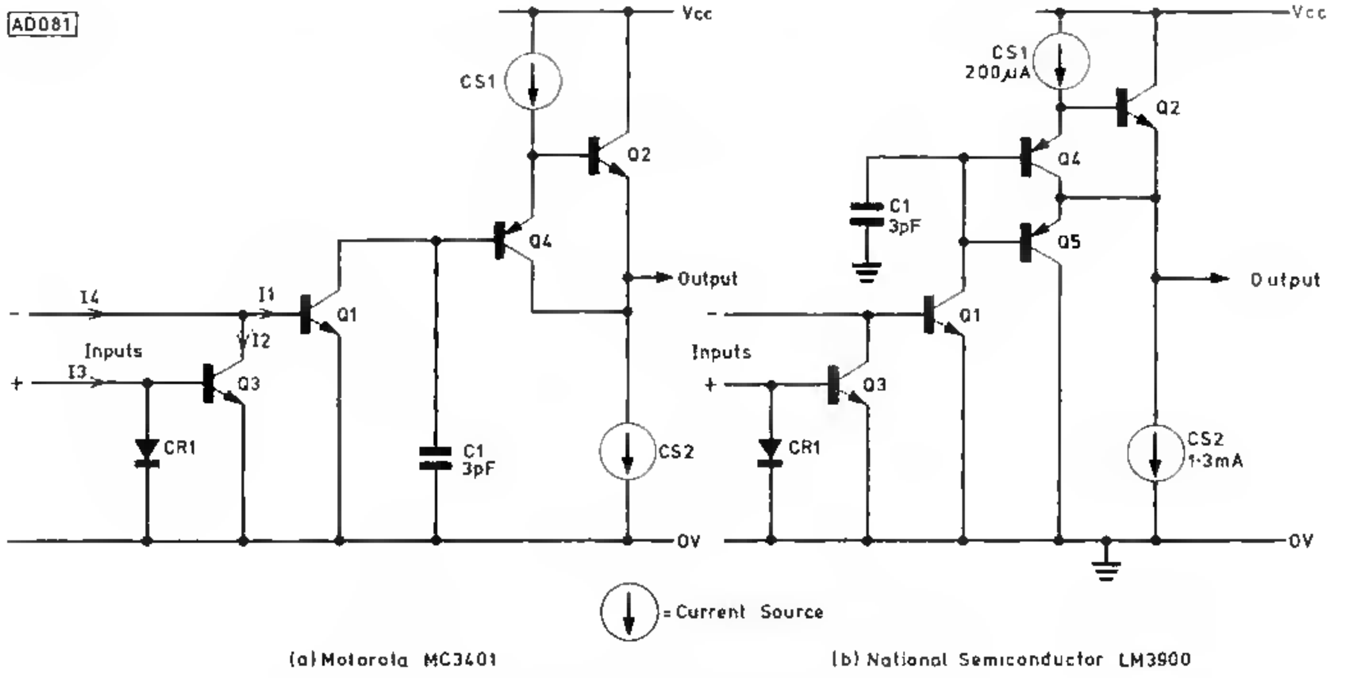


Fig. 1: The Motorola and N. Semiconductor variations in type.

The Circuit

Consider first the circuit of **Fig. 1(a)**, with Q3 and CR1 omitted for the present. It is then essentially an inverting amplifier with considerable current gain, the output voltage and current being controlled by I_1. The main limitation on output current is the current source CS2 at the output. The values of the current sources are set by biasing circuitry on the chip, and since they depend on diode voltage drops, are essentially independent of supply voltage. C1 rolls off the amplifier gain at high frequencies, giving the open loop voltage gain frequency characteristic of **Fig. 2**, where it is compared with that of a 741. This voltage gain is the gain between inverting input and output, and provides a useful comparison with conventional operational amplifiers. Thus, although the open loop gain of the Norton amplifier is lower than that of a 741 at d.c., it is about 10dB higher above 1kHz, making it more suitable for a.c. amplifiers.

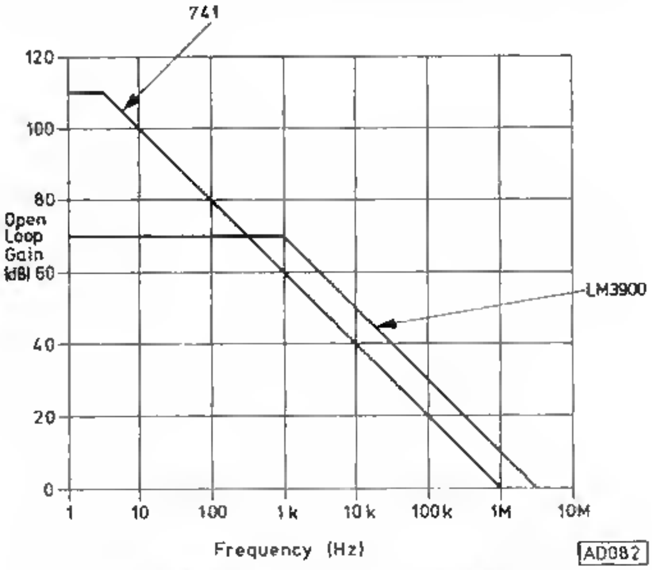


Fig. 2: Essential gain and frequency response (open-loop)

We now come to the operation of CR1 and Q3, which together form a "current mirror". The bulk of the input current I_3 will pass through CR1, causing a voltage drop across it, the same as the base-emitter voltage of Q3. A small part of I_3 will enter the base of Q3, causing an emitter current to flow. If Q3 and CR1 are properly matched, this emitter current will be approximately equal in magnitude to I_3, as will the collector current of Q3 (provided Q3's current gain is high). It can then be seen that if the collector of Q3 is connected to the base of Q1, the current into the base will be the difference between I_2 and I_1, which is in turn equal to $I_1 - I_3$. Thus the amplifier will amplify the difference between the two input currents—the current mirror has effectively inverted I_3. It can also be seen from the circuit that the input potential will remain approximately constant at about 0·5V (i.e. one base-emitter junction voltage drop). The additional transistor Q5 in the NS amplifier is of little consequence until the output is required to sink large currents—then if Q1 is driven hard on, Q5 will turn on to provide the additional capacity.

A slightly different symbol is used for the Norton amplifier in order to differentiate it from the more common type. This is shown in **Fig. 3**, and will be used in future.

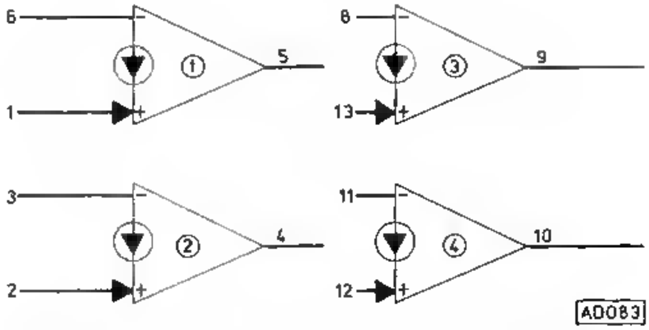


Fig. 3: Circuit symbols for the Norton Amp.

Biasing the Amplifier

The Norton amplifier requires particular attention to be paid to biasing—this unfortunately does not look after itself as with conventional op-amps. It will be assumed here that the amplifier is being used with a single supply rail.

When both inverting and non-inverting inputs are being used it is necessary to maintain a certain average current through the current mirror. This entails feeding equal currents into the two inputs, one of the currents being derived from the output in order to set the output voltage. The simplest and commonest way of achieving this is shown in **Fig. 4(a)**. A current is fed into the non-inverting input via R1, from the positive supply rail. The inverting input is fed from the output via R2. Thus we have a feedback system—if the output voltage rises above its equilibrium value, it will increase the current into the inverting input, which will act to decrease the output voltage. This fact can be used to set the d.c. level of the output voltage—normally to half supply voltage to obtain maximum voltage swing. Since the currents into the two inputs must be equal, it is clear that in this case R1 should be twice R2. The recommended bias current for the current mirror is in the range 10-100μA, with 10μA being a suggested value for many applications.

A disadvantage of the simple type of biasing described is that any ripple on the power supply is fed into the amplifier by R1, and appears on the output at half the amplitude. This can be eliminated by using the circuit of **Fig. 4(b)**. Here the bias supply for the non-inverting input is derived from a potential divider which provides a well-smoothed supply at half supply voltage. Biasing resistors for all such amplifiers in a circuit may be taken from this one potential divider, so the extra cost is minimal. Needless to say, to maintain equal currents into the inputs, R1 and R2 should now be equal in value.

There is a third method of biasing, using only the inverting input, and therefore only really suited to inverting amplifiers. This method will be described later.

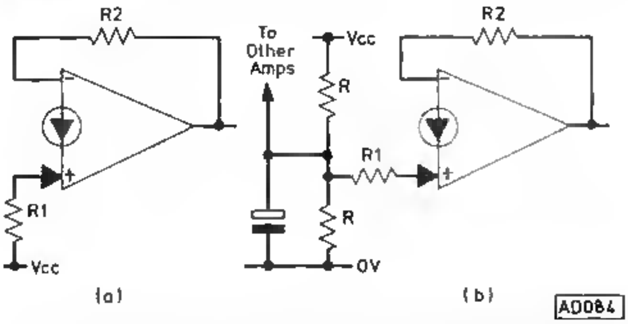


Fig. 4: Modification to provide better smoothing.

Practical Circuits

Having considered the biasing arrangements peculiar to the Norton amplifier, we are now in a position to consider some practical circuits. In most cases a marked similarity to circuits using conventional op-amps will be noticed. The main difference is the more frequent need for d.c. blocking capacitors between stages, apart from the additional biasing circuitry.

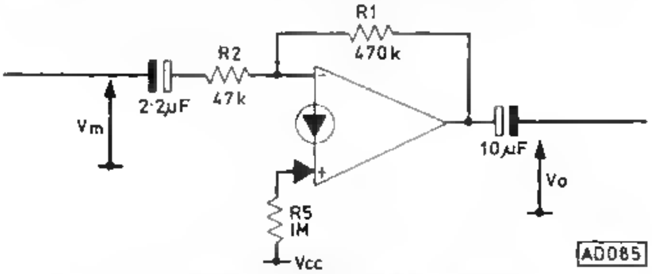


Fig. 5: Simple inverting amplifier.

Inverting Amplifier

The simplest inverting amplifier circuit is shown in Fig. 5. The voltage gain, as with the more conventional circuit, is R1/R2, or 10 with the values shown; the input impedance is equal to R2, or 47k here. The design procedure is to choose R1 and R2 to give the required gain and input impedance, and then make R3 approximately equal to twice R1. The d.c. blocking capacitors should be large enough to pass the lowest frequencies needed.

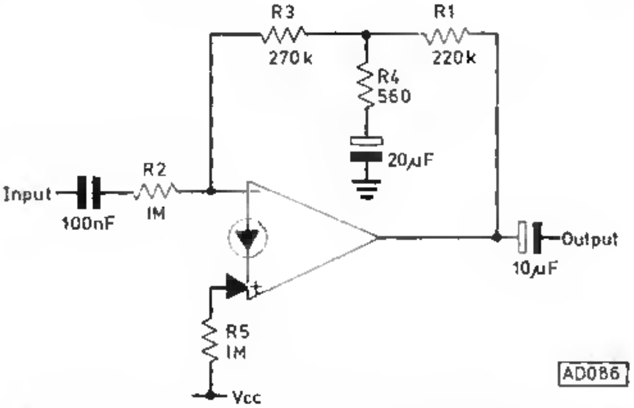


Fig. 6: Additional circuitry to raise input impedance.

A disadvantage of this circuit is that it is not possible to have high gain and high input impedance simultaneously, since R1 must be low enough to pass at least 10µA into the inverting input. With a 12-15v supply, this sets an upper limit of about 560k on R1. The problem can be overcome by using the circuit of Fig. 6, albeit at the expense of extra complexity. The d.c. bias is now provided via R1 and R3 in series, so R2 should be equal to twice their sum. No d.c. passes through R4, due to the blocking capacitor. A.C. signals, however, are attenuated first in the potential divider of R1 and R4, then passed to the inverting input as negative feedback via R3. Then, provided R3 does not load the potential divider (i.e. R3>R4), the voltage gain of the circuit is given by:

$$A_v = \frac{R1 + R4}{R4} \cdot \frac{R3}{R2}$$

and to satisfy the biasing conditions, R1 + R3<560k (with 12V supply). The values shown in the circuit should give a gain of around 105, which is about the maximum obtainable when used as an audio pre-amplifier.

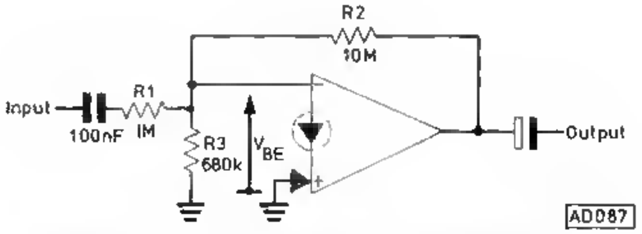


Fig. 7: Simplification avoiding the use of the "current mirror."

A third possibility eliminates the current mirror and its associated bias current. The only bias current needed then is the actual inverting input current (I_1 in Fig. 1a), which is typically 30µA. The circuit is shown in **Fig. 7**. Initially the values of R1 and R2 are chosen to give the desired values of gain and input impedance. R3 is then chosen to give the required output voltage V_0, using the relation:

$$V_0 = V_{BE}\left(1 + \frac{R2}{R3}\right)$$

where V_{BE} is the voltage at the inverting input, typically 0·5V. The main disadvantage of this circuit is that the output voltage depends on V_{BE}, which, being due to a semiconductor junction, is extremely temperature dependent. Output voltage drift will only be a problem, however, when large output voltage swings are envisaged.

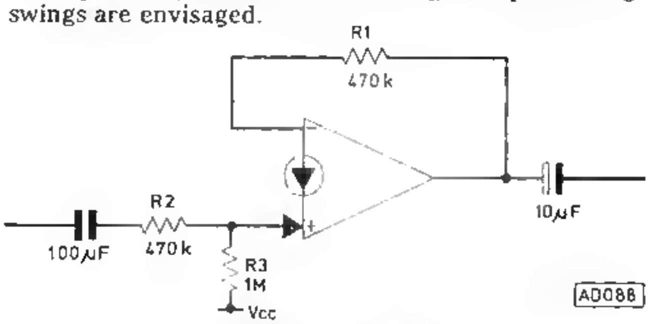


Fig. 8: Unity gain buffer circuit.

Non-Inverting Amplifier

The Norton amplifier is not really recommended for use as a non-inverting amplifier, since accurate determination of the gain is not possible, due mainly to variations in the current mirror circuitry. Motorola state that the voltage gain of a non-inverting amplifier may vary by up to 20% from the calculated value. However the circuit of a unity gain buffer amplifier is given in **Fig. 8** for completeness. One advantage of the non-inverting configuration is that the bandwidth of the amplifier depends only on the value of the feedback resistor R1, since the input resistor R2 is outside the feedback loop. In calculating the gain it is necessary to include the small signal resistance R_s of the current mirror input, which is given by $26{,}000/I_3$. (I_3 is the non-inverting input current, in µA.) The voltage gain then becomes:

$$A_v = \frac{R1}{R2 + Rs}$$

This equation assumes that the gain of the current mirror is exactly unity—in fact it may vary between 0·8 and 1·16, which accounts for much of the uncertainty in the gain. As an example, with R1 = 470k, bandwidth will be over 200kHz for gains up to 100.

Oscillators

The Norton amplifier is not particularly suited to oscillator configurations. The only sinewave oscillator given in the application notes uses all four amplifiers on the chip, as well as considerably more discrete components than the very common Wien Bridge circuit used with conventional op-amps or individual transistors. With square wave oscillators the main limitation is the low slew rate of about 0·5V/μs. Thus with a supply of 15V, the rise-time will be of the order 30μs, which is too slow for most applications.

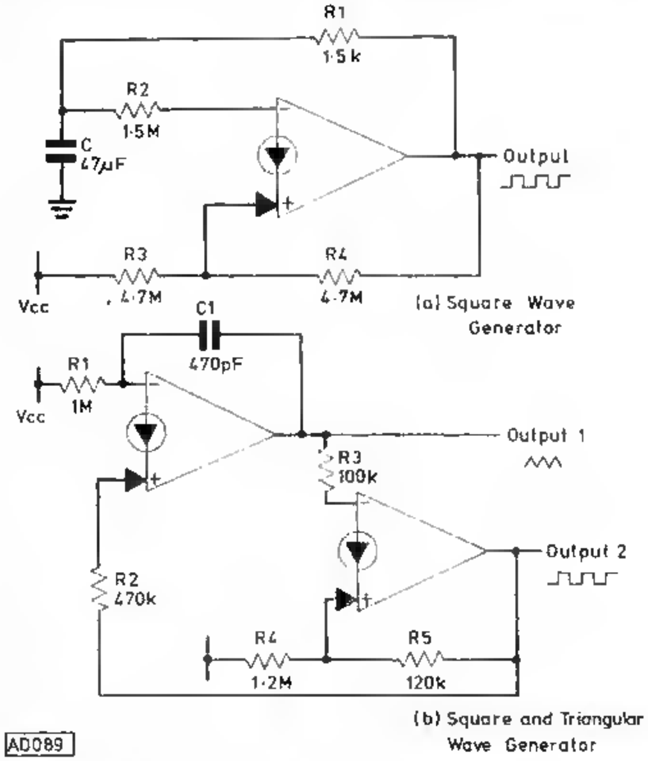


Fig. 9: Typical op. amp oscillators.

Two examp..s, based on the well-established op-amp circuits, are given in **Fig. 9**. The first is a square-wave oscillator, which will oscillate at about 1kHz with the values given. The output frequency is given by $0{\cdot}6/CR_1$ approximately, and the output has good symmetry. The second circuit is the well-known triangular and square wave generator, and is an example of a circuit utilising the properties of the current mirror (in the integrator section) to give a circuit as simple as its op-amp counterpart. The values shown give a period for the waveforms of about 0·9ms. The timing depends on R1 and C1, and to obtain good output symmetry R2 should be half R1.

Various other oscillator circuits are possible—the most interesting is a complete phase-locked loop with linear voltage controlled oscillator, using only three of the amplifiers. However such circuits are not given here since they tend to need designs suited to the particular application.

Voltage Regulators

Some very simple voltage regulators are possible using the Norton amplifier. The simplest is shown in **Fig. 10**, and makes use of the fact that the input potential of the amplifier remains substantially constant with variations in input current. The output voltage is then $V_Z + V_{BE}$, at currents of up to 1A. Bias current for the Zener is provided by resistor R—the

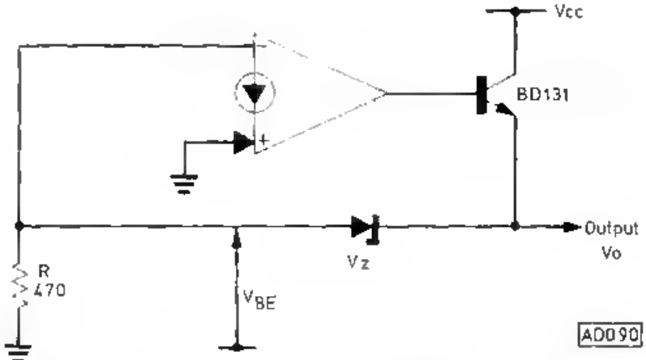


Fig. 10: A simple voltage regulator using a Norton Amplifier.

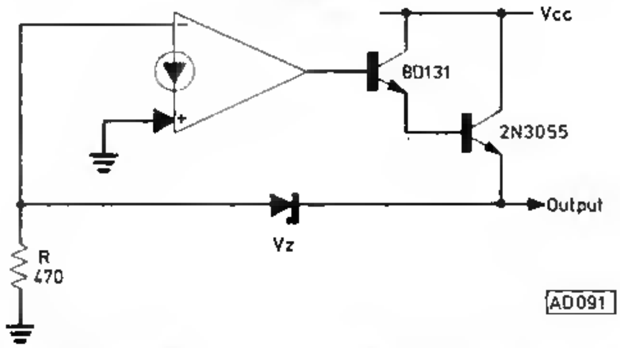


Fig. 11: Increasing current capability with an external transistor.

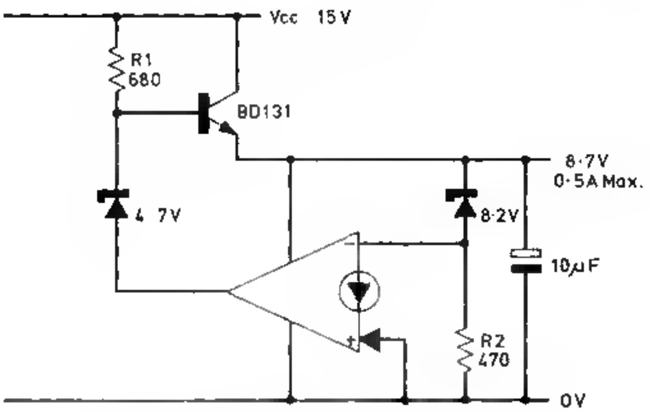


Fig. 12: Self-regulation circuit.

value of 470Ω specified will provide a bias of about 1mA. An additional transistor could be connected as in **Fig. 11** to increase the current capability—outputs of up to 10A are then possible, provided the transistors will dissipate the power. An extension of this idea uses the voltage regulating circuit to regulate the supply to the amplifier chip itself—this is shown in **Fig. 12.**

Conclusions

It is unlikely that the Norton amplifier will ever be used extensively in mains-powered equipment, since in this situation it is relatively simple to provide a split power supply and use conventional op-amps, with their simpler design and generally lower component count. The most likely application is where the power supply is battery derived, in particular in cars and portable radios. The circuits described here give some of the more common applications—with a little ingenuity the Norton amplifier can be made to extend the range of a conventional operational amplifier. ●

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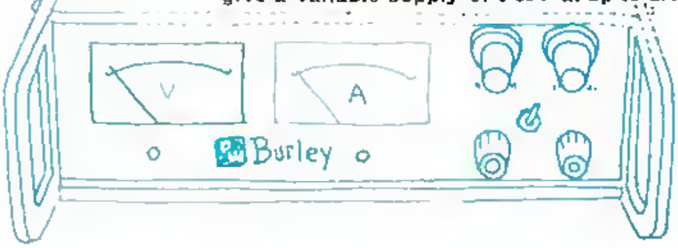
also:

the PW 'Sarum' Q Meter

Eliminate the frustration associated with trial and error coil winding by building this useful piece of test equipment. As well as enabling you to measure the Q of your coils the 1MHz to 30MHz r.f. signal is available at the front panel for other uses

& the PW 'Burley' Simple Stabilised Power Supply

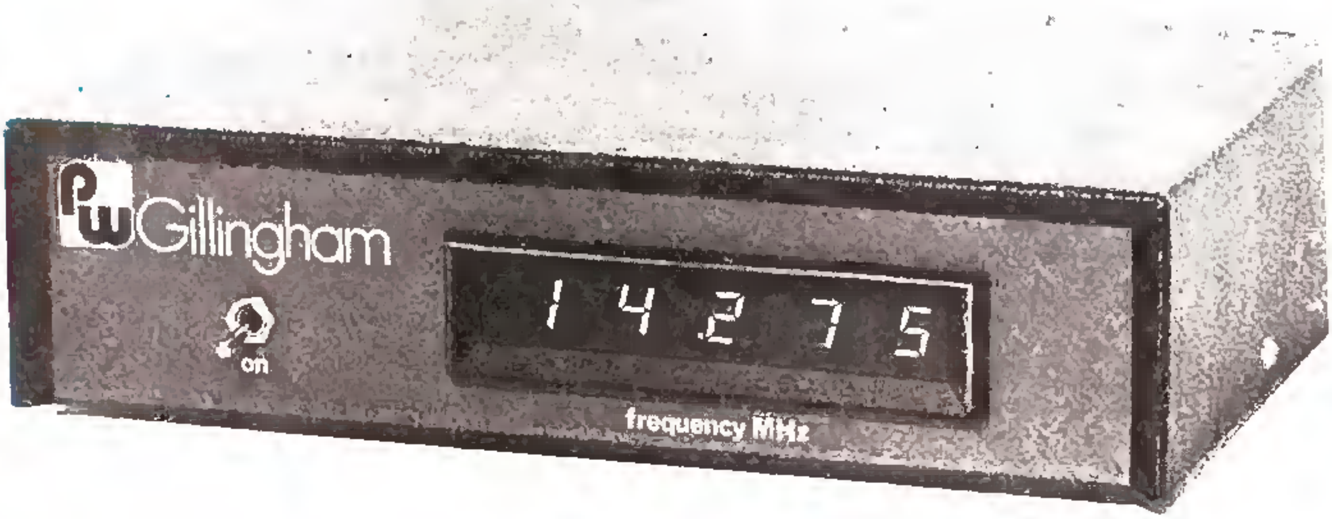
This is a simple but effective unit which utilises a recently introduced current/voltage regulator chip—the L200. This chip is virtually indestructible in normal use, and the complete design will give a variable supply of 0-30V at up to 2A



'ZL SPECIAL' 2m AERIAL

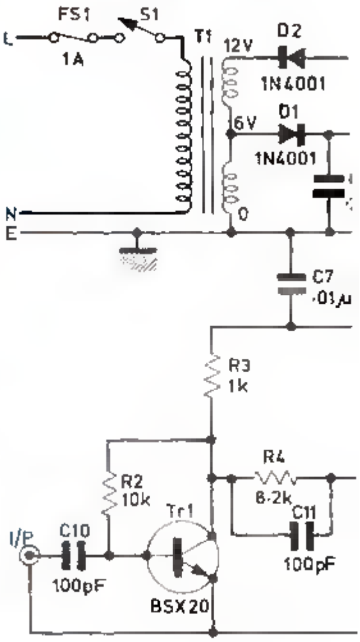
With a gain of 13dB (a forward gain of 6dB over a dipole), this 12-element end-fire array offers excellent results for users of the 2 metre band. Full constructional details are provided along with the relevant assessment methods

the PW 'Gillingham



SHORT-WAVE RECEIVER FREQUENCY READOUT

★ D.S.COUTTS



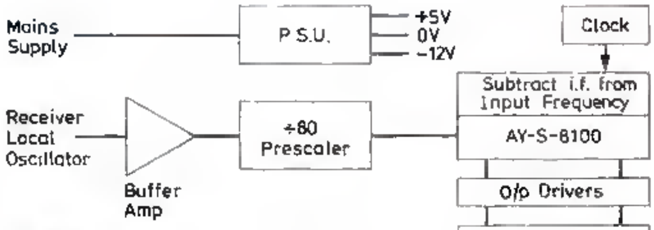
COVER PROJECT

There are many simple "communications" type of receivers in the hands of s.w.l.s which are single conversion types using an i.f. of 460 or 455kHz. These receivers are doing an excellent job, but how often have you wished for a digital readout of the frequency you are tuned to, instead of relying on the pointer and string method used?

The General Instrument AY-5-8100 m.o.s. integrated circuit gives you this readout on a 5 digit l.e.d. display, to an accuracy of ±5kHz, up to 29·95MHz. This allows you to find a net reasonably quickly if you know the frequency being used.

The AY-5-8100 was specifically designed for use in radio receivers. It accepts the receiver local oscillator frequency after suitable prescaling (÷80 on s.w. range), subtracts the i.f. frequency from it, and outputs the frequency the receiver is tuned to the l.e.d. display, via suitable drivers. The receiver local oscillator must therefore be at a higher frequency than the receiver frequency and the short wave receiver i.f. must be 460kHz (or 455kHz with link changes on the p.c.b.). Many of the cheaper receivers around fall into this category.

★ An Engineer with General Instrument Microelectronics, Glenrothes



AD187

The unit has been designed as a free standing unit to be connected to the required receiver via coaxial cable. This allows you to multiplex the unit to more than one receiver and to use it for experimental work on home-brew receivers.

The unit should only be used on receivers which are isolated from the mains, i.e., using a double wound mains transformer.

A block diagram of the unit is shown in Fig. 1. A simple power supply provides the necessary voltage of +5V and −12V. The receiver local oscillator is buffered by a 2-stage amplifier and fed to the ÷80 prescaler and then into the AY-5-8100 i.c. A 1·28MHz clock is also fed into the i.c. for system timing. The segment and digit outputs are fed via transistors to the display.

To consider the circuit in more detail refer to the circuit diagram Fig. 2. The two 6 volt windings of transformer T1 are connected in series to give 6V and 12V to feed the unit.

Components D1, C1, C2, IC5 and C3 provide a stabilised +5 volts for the unit and D2, C4, C5, R1, C6 and D3 provide the −12 volts. The input is fed to the 2 stage amplifier formed by Tr1 and Tr2 and the output of Tr2 is fed to the buffer, IC1c.

The output of IC1c feeds IC2, (a÷8) and this in turn feeds IC3 (a÷10). IC3 output, pin 12 is either connected directly to pin 27 of IC4 by linking A to B on the p.c.b. (455kHz i.f.) or A is linked to C on the p.c.b. and D is linked to B (460kHz i.f.). IC1a and b provides the 1·28MHz crystal controlled clock to the 8100. Pin 26 of IC4 outputs a 12ms positive pulse to reset the prescaler every 20ms and this is buffered by IC1e and f.

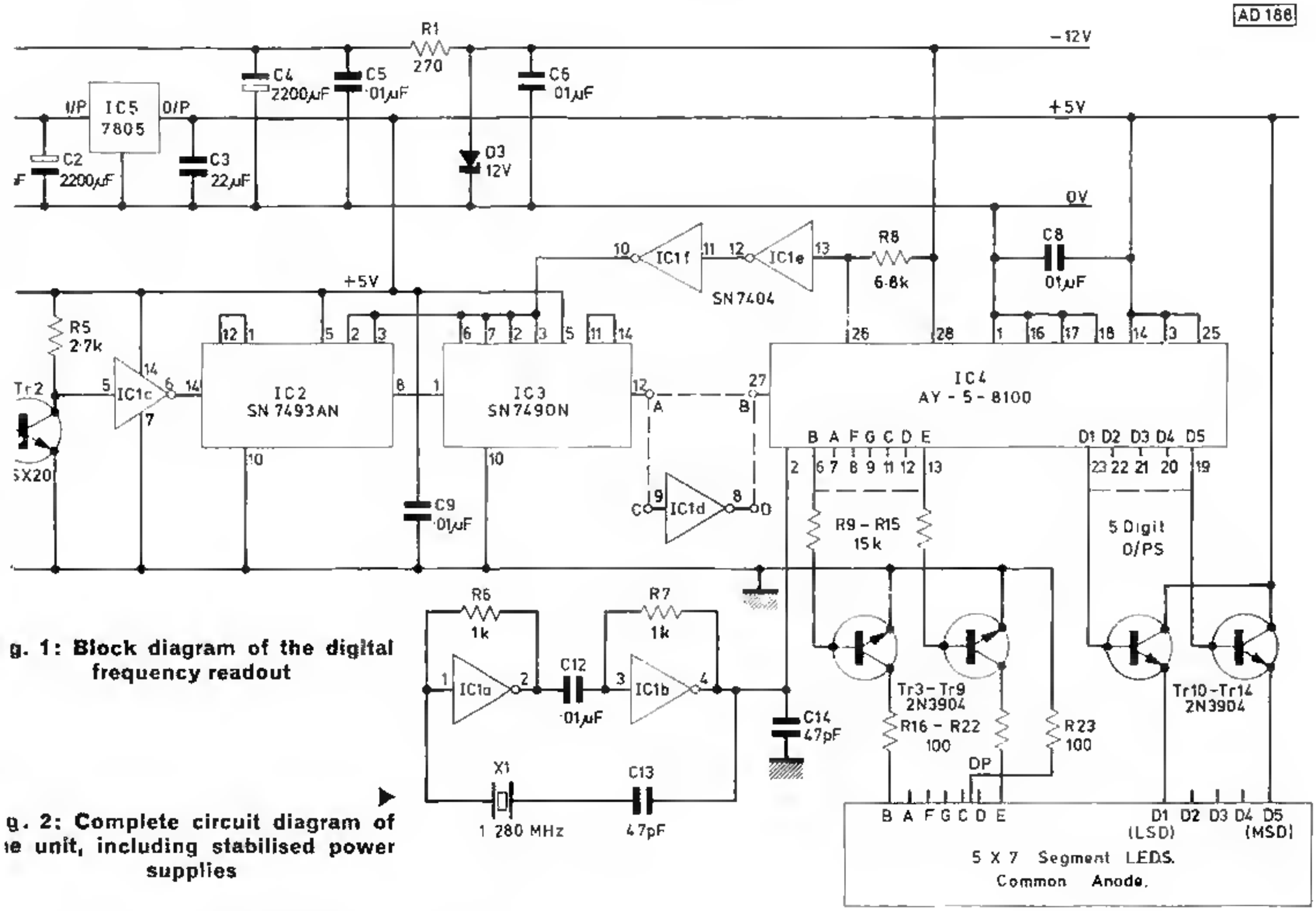
Pins 6-9 and 11-13 of the 8100 output the signals to drive the l.e.d. segments via the transistors Tr3-Tr9. Resistors R16-22 and R23 limit the current through the l.e.d.s. Pins 19-23 output the positive going multiplex signals to drive the digits D1-D5 with D1 as the least significant digit (l.s.d.).

As the digit outputs have limited drive capability emitter followers, Tr10-14 are used to increase the drive. Five common anode 7-segment l.e.ds are used for the display. The l.s.d. only displays a 0 or a 5, giving the ±5kHz accuracy.

Construction

The case is 2-piece all metal case approx. 200mm wide by 50mm high by 125mm deep. Commence construction by drilling the case as shown in Fig. 5 and carefully cut the rectangular slot for the display. Spray the front panel and put the case on one side to dry and await lettering.

Assemble the main p.c.b. using the component layout in Fig. 4 and parts list as a guide. It is advisable to use a socket for the AY-5-8100 and to fit this i.c. after the board has been completed and checked for correct assembly.



g. 1: Block diagram of the digital frequency readout

g. 2: Complete circuit diagram of ıe unit, including stabilised power supplies

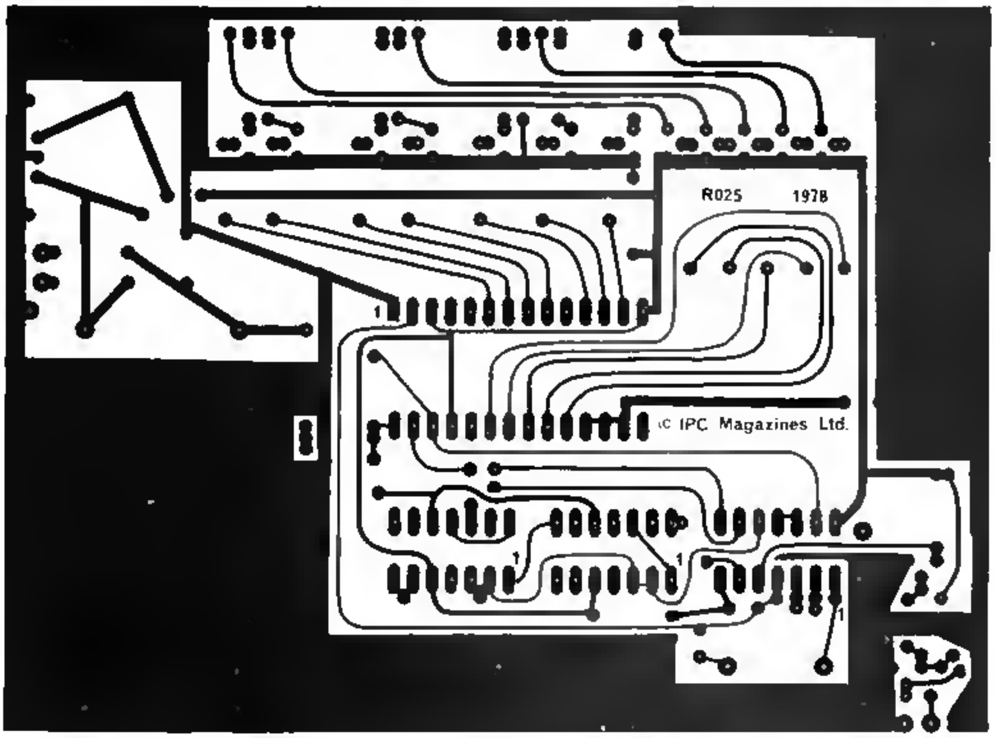


Fig. 3: Full size print pattern of the main p.c.b.

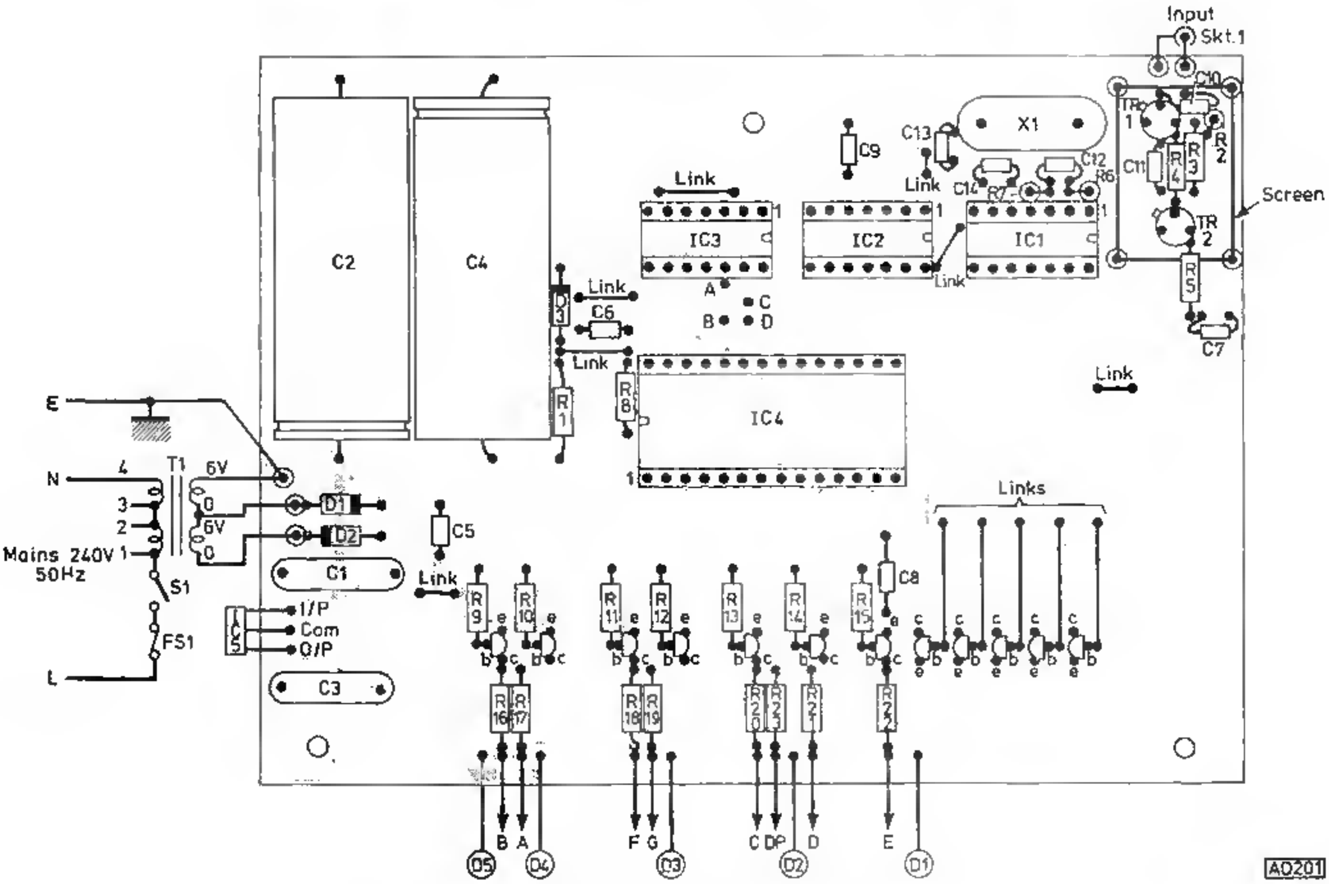


Fig. 4: Component layout and external connection details of the main printed circuit board

★ components

Resistors

¼ W 5%

100Ω	8	R16, 17, 18, 19, 20, 21, 22, 23
270Ω	1	R1
1kΩ	3	R3, 6, 7,
2·7kΩ	1	R5
6·8kΩ	1	R8
8·2kΩ	1	R4
10kΩ	1	R2
15kΩ	7	R9, 10, 11, 12, 13, 14, 15

Capacitors

Plate Ceramic

47pF	2	C13, 14
100pF	2	C10, 11
0·01μF	6	C5, 6, 7, 8, 9, 12

Polyester

0·22μF	2	C1, 3

Electrolytic

2200μF 25V	2	C2, 4

Semiconductors

Diodes

1N4001	2	D1, 2
BZY88C12	1	D3

Transistors

BSX20	2	Tr1, 2
2N3904	12	Tr3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14

Integrated Circuits

SN7474	1	IC1
SN7490N	1	IC3
SN7493AN	1	IC2
AY-5-8100	1	IC4
7805	1	IC5

Displays

RS 586-532	5	(7 segment l.e.d. green common anode:) (alternative red display RS 586-526.)

Miscellaneous

1·280 MHz crystal (McKnight)
Printed circuit boards (2 in set)
Transformer RS 207-194 0-6V, 0-6V (1)
Case Marshall's RB2
Mains on-off switch
Fuseholder
Coaxial socket
Display filter cut from RS 586-677 for green display or RS 586-548 for red display. Optional bezel for display (replaces display p.c.b. and filter) RS 587-002.

A logical building sequence is:

1. Fit all resistors and socket for IC4.
2. Fit all capacitors (note polarities of C2 and C4).
3. Fit wire links.
4. Link A to B or A to C and D to B on the p.c.b. depending on the i.f. used. (A to B=455kHz i.f.)
5. Fit Veropins where indicated on Fig. 4.
6. Fit diodes, transistors and IC5 (7805) taking care to orient them correctly.
7. Fit crystal.
8. Fit IC1, 2 and 3 observing correct orientation.
9. Check board very carefully for solder bridges between tracks and for proper orientation of semiconductors.

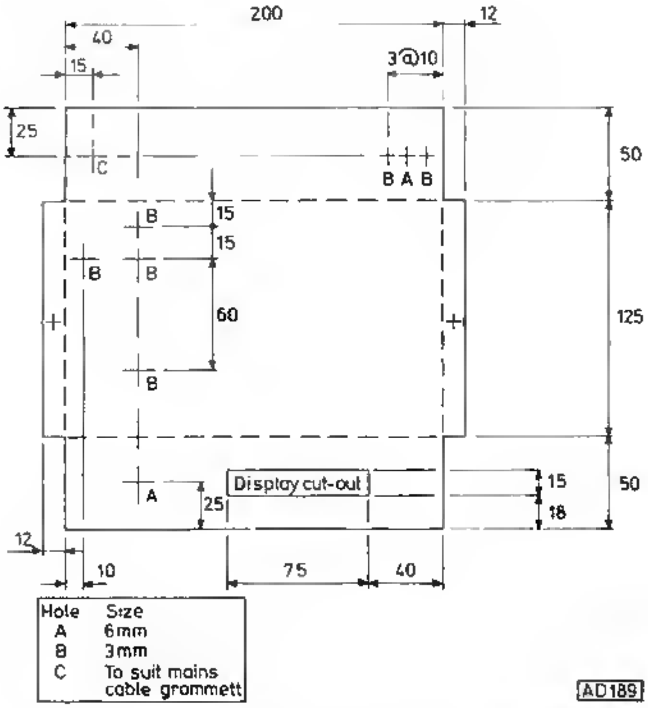
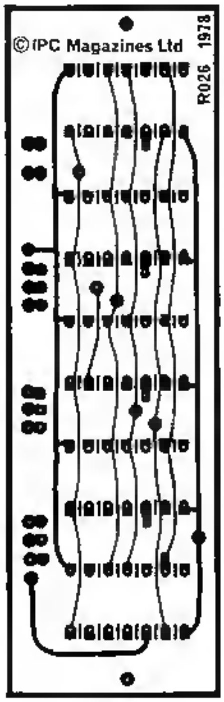


Fig. 5: Drilling details for the case



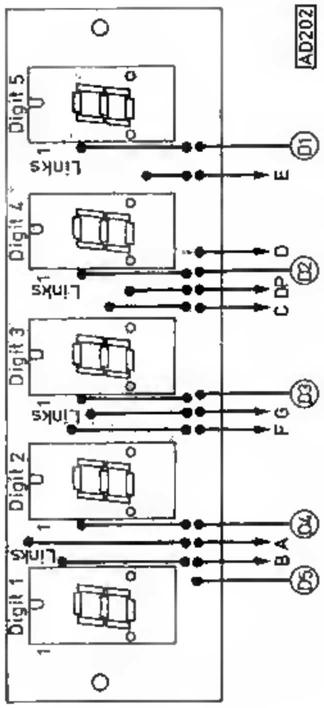


Fig. 6 (left) and Fig. 7 (right): Full size print pattern and component layout for the display p.c.b.

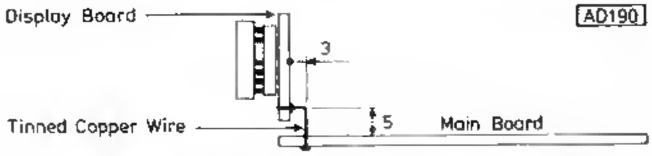


Fig. 8: Connecting together the main and display boards

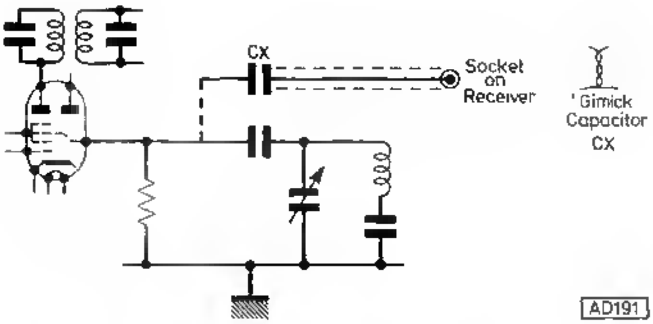


Fig. 9: Signal take-off from a valved receiver local oscillator

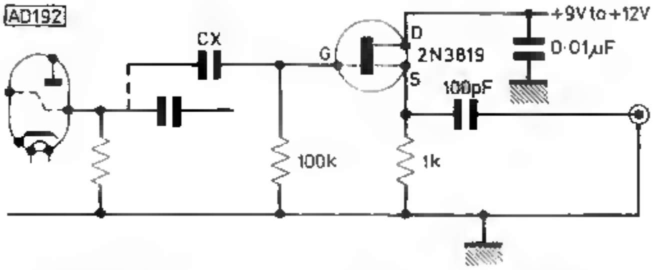


Fig. 10: Adding f.e.t. isolation to the circuit of Fig. 9

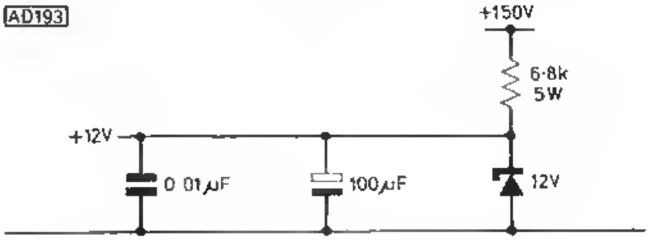


Fig. 11: Deriving a stabilised 12V supply from a 150V h.t. line

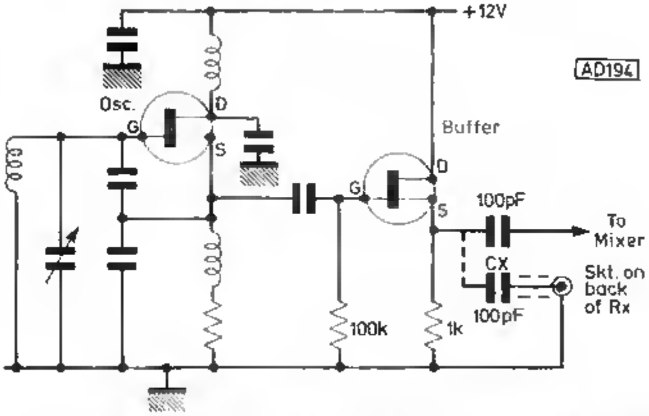


Fig. 12: Tapping the signal from a low-impedance source requires a higher value for CX

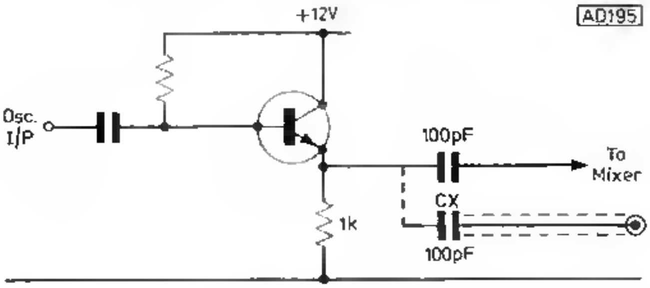


Fig. 13: Some receivers incorporate an isolating emitter follower

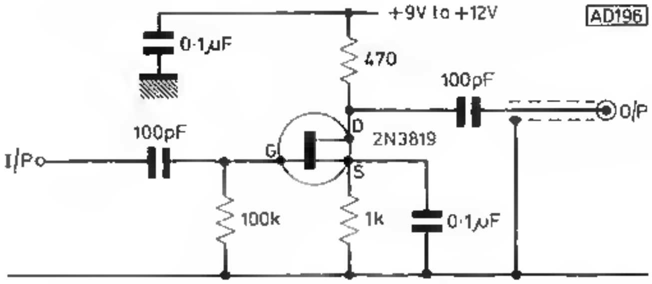


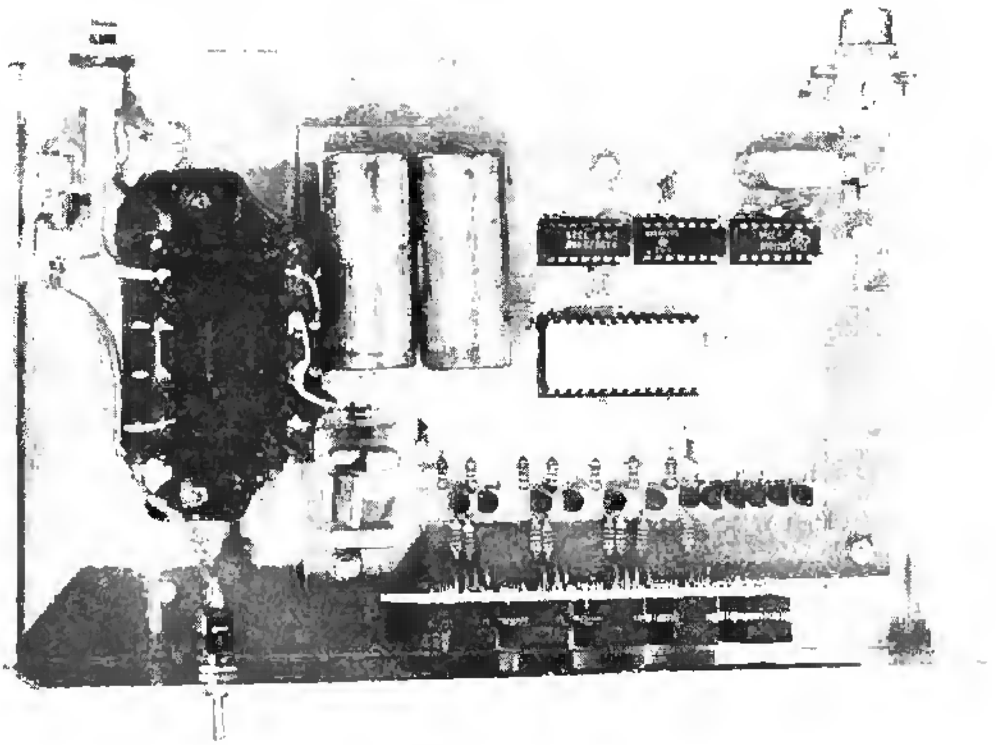
Fig. 14: If the receiver local oscillator output is too small, this simple amplifier will raise it to the 50-100mV necessary to drive the "Gillingham"

10. Lay the main board to one side and start assembly of display board (Fig. 7).
11. Fit the eleven wire links to the display board.
12. Fit the 7-segment l.e.ds to the display board noting that pin 1 is at the top left, looking from the front.
13. Check for any shorts between tracks on the display board.
14. When you are satisfied that both boards are correct fit 13 lengths of tinned copper wire through the holes at the bottom of the display board. Solder the wires to the board. Bend them down at right angles and fit the boards together as in Fig. 8, trimming off any surplus wire protruding through the holes.
15. Fit a small tinplate screen round the input amplifier. Take the completed p.c.b. assembly and lay it in the case, line the display up horizontally with the slot in the front panel and mark through the three fixing holes on the p.c.b. Drill 6BA clearance holes in the case. Mount the p.c.b. assembly in the case using 6BA bolts through the holes and adding 6BA nuts to pack the board up until the display lines up with the front panel slot. Fit a piece of filter material behind the slot and make up a small "picture frame" bezel to finish off the slot. As an alternative to the p.c.b. mounted display an R.S. Components bezel assembly (587-002) can be used with hard wiring instead of the p.c.b. Fit the mains transformer T1, fuse holder FS1 and mains on/off switch S1 to the case. Also fit a coaxial socket in the rear of the case for the input. Wire the unit up as shown in Fig. 4.

TABLE 1.

PIN CONNECTIONS OF AY-5-8100

1	OV (Gnd)	15	No connection
2	1·28 MHz clock input	16	OV
3	+5V	17	OV
4	No connection	18	OV
5	No connection	19	Digit 5 output (m.s.d.)
6	Seg. B output	20	Digit 4 output
7	Seg. A output	21	Digit 3 output
8	Seg. F output	22	Digit 2 output
9	Seg. G output	23	Digit 1 output (l.s.d.)
10	No connection	24	No connection
11	Seg. C output	25	+5V
12	Seg. D output	26	Prescaler reset output
13	Seg. E output	27	Counter input
14	VSS + 5V	28	VDD—12V



An internal view of the completed unit

Testing

Testing the unit is fairly straightforward, but remember that it runs off the mains and requires a little more respect than battery powered equipment. Switch the unit on and check that the voltage across C3 is +5V and the voltage across D3 is −12V. If the voltages are correct and you have an oscilloscope available monitor IC1 pin 4 for the 1·28MHz clock. Switch off the unit, fit IC4 into its socket and power up again. The display should light up. IC4 pin 26 should now be outputting 12ms positive puls·s every 20ms, and these pulses should appear at IC2 pins 2 and 3 and IC3 pins 2, 3, 6 and 7.

To check that the unit is counting you can temporarily connect a wire from IC1 pin 2 to the amplifier input. This provides us with a signal which we can trace through the unit. Monitoring it at IC1 pins 5 and 6 we should have a continuous 1·28MHz signal. At IC2 pin 8 we will have 8ms bursts of (1·28÷8)MHz (i.e. 160kHz) every 20ms and at IC3 pin 12 we will have 8ms bursts of (1·28÷80)MHz (i.e. 16kHz), which should also appear at IC4 pin 27. At this time the display should read around 820kHz.

If this checks out the unit is functioning and we can consider interfacing it to our receiver, using one of the methods indicated in Figs. 9 to 14.

If the unit is not functioning and we have +5V and −12V available then check that −12V appears at IC4 pin 28. If this is so check that +5V is appearing at IC1 pin 14, IC2 pin 5, IC3 pin 5 and IC4 pins 3, 14 and 25, and also at Tr10 collector. If you suspect the crystal oscillator is not running you can listen for it on your receiver around 1·28MHz and harmonics of this frequency. Trouble with the display may be caused by shorts between the tracks on either of the boards causing extra segments to light up. ●

PRINTED CIRCUIT BOARDS SERVICE FOR *PW* PROJECTS

It has now been decided, commencing with our issue dated September 1978, to enlarge the facilities for the supply of p.c.b.s to readers by authorising additional suppliers. It is hoped that readers may benefit from being able to purchase boards as part of component kits, thereby reducing the number of separate orders for a project.

For some time, most p.c.b.s published in *Practical Wireless* have been available exclusively from Reader's PCB Services Ltd., P.O. Box 11, Worksop, Notts, who will continue to be a supplier and to whom we would wish to say thank you for helping us to get the service started.

Applications for permission to reproduce boards for resale must be made to the editor in writing.

PRODUCTION LINES

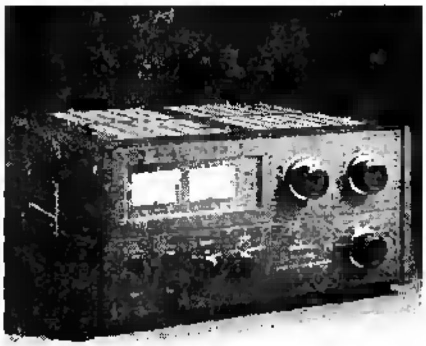
alan martin

Safe cutting

The new OK SAF 01 safety shears, which can handle hard or soft wires up to 1mm diameter, incorporate an adjustable clip to hold wire firmly after it has been cut. This prevents the hazard of clippings flying into the eyes or dropping into the workpiece.

A spring loaded scissors action ensures a clean cut, and the shears' handles have a bright orange padded covering which not only makes them comfortable during prolonged use but also enables them to be found easily on a cluttered workbench.

Priced at £2·58 which includes VAT and P&P, the SAF 01 shears are available from *OK Machine & Tool (UK) Ltd., 48 The Avenue, Southampton SO1 2SY. Tel: 0703 38966/7.*



POWer

At last an h.f. afterburner to complement the fine Trio range of transmitters and tranceivers.

The TR922 grounded-grid linear amplifier packs quite a punch from two husky Eimac 3-500Z tubes in class AB2, delivering a mighty 2kW p.e.p.—1kW c.w. or r.t.t.y. for 80W excitation.

Covering all bands 160m–10m the amplifier matches other Trio equipment in both performance and appearance and must certainly appeal to those already using transmitters of this manufacture barefoot.

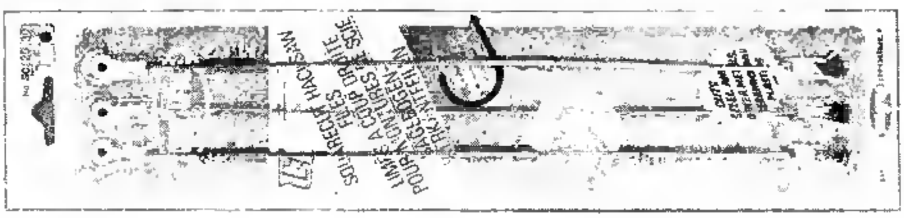
The price is £763 at the time of going to press and further details can be obtained from the importers, *Lowe Electronics Ltd., 119 Cavendish Road, Matlock, Derbyshire. Tel. 0629-2817/2340.*

Hacksaw?

Recently introduced from Abrafile, Squarecut Hacksaw Files. Designed for the rapid cutting of a wide range of materials including tool steel.

When fitted into a hacksaw frame and tightened in the usual manner, these files can be used for straight cuts, internal and external slots and to follow limited profiles; in ferrous and non-ferrous metals (including stainless steel), ceramic tiles and plastics. These files will outlast and out-perform the well-known Abrafile tension files, but they do not have peripheral teeth nor can they be used for more intricate shapes and profiles; they are not suitable for wood.

Supplied in three widths and two lengths, each card contains one of each of the three different width files (1·5, 1·8 and 2·5mm). Card SC25 contains 250mm (10") long files and costs £1·24, and SC30 300mm (12") long costs £1·46. Available from, *Abrasive Tools Ltd., Abrium Works, Colne Road, Twickenham TW2 6QE. Tel: 01-894 1273.*



Safe time

Trying to read the time from one's watch whilst driving can be a dangerous operation, especially at night. So, why not install a car clock? W.K.F. Electronics can supply the 'Harvard', an inexpensive 12V electronic car clock with digital display.

The clock utilises a low power consumption circuit and a quartz crystal oscillator, with a claimed accuracy of ±0·5 seconds per day.

Displaying hours and minutes on a dark blue display with brightness control, the display extinguishes when the car ignition is switched off, whilst of course the clock continues to operate.

Designed with a swivel mounting bracket the clock can be fitted either above or below the dashboard.

Priced at only £12·50 plus 50p P&P, the 'Harvard' is available as an optional 12 hour or 24 hour version and comes complete with supply leads, connectors and inline fuse. *W.K.F. Electronics, Welbeck Street, Whitwell, Worksop, Notts. Tel: 0909720 695.*

ECONOMICAL VMOS POWER DEVICES

J. B. DANCE

Vertical MOS (VMOS) power field effect transistors have been produced by Siliconix of Swansea for more than two years. The first VMOS devices were encapsulated in TO-3 or TO-39 hermetically sealed metal packages, but more recently similar devices in plastic packages have been marketed by the same manufacturer at about one quarter of the price. They can be used in many simple circuits and are equally suitable for use by both the amateur experimenter and by the professional engineer.

A VMOS power device incorporates the high input impedance of a field effect transistor and yet it can control a moderately high current. The devices under discussion have a maximum continuous current rating of 2A and voltage ratings from 40V to 80V. They can be used for audio or radio frequency amplification, as fast switches, etc.

VMOS Structure

The structure of the VMOS power device shown in Fig. 1 may be contrasted with that of the conventional f.e.t. shown in Fig. 2. In the VMOS device of Fig. 1 the current flows vertically through the structure from the drain to the source and this allows a much higher power dissipation than is possible in the ordinary f.e.t. structure of Fig. 2 in which the current flows horizontally along the layers at the top surface of the silicon.

An interesting feature of the VMOS devices is the V-shaped groove shown in Fig. 1 which produces two vertical channel regions bringing the advantage of a high current density.

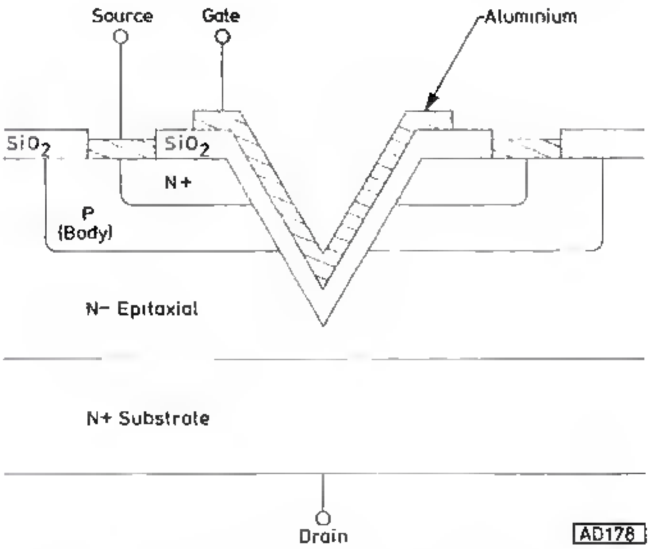


Fig. 1: General physical structure of a VMOS device

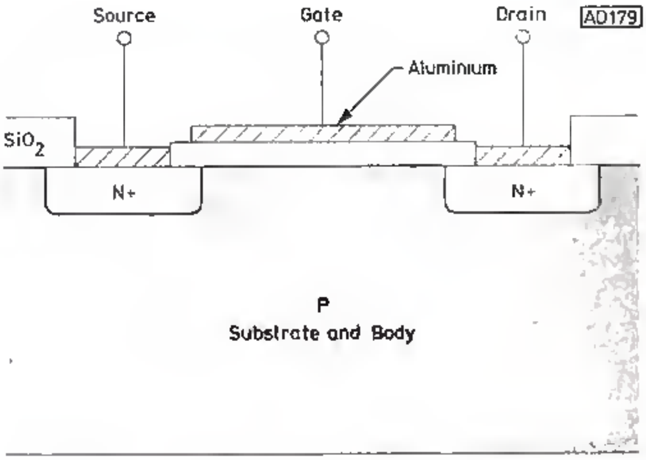


Fig. 2: The physical structure of a conventional f.e.t.

Package

The plastic encapsulated VMOS devices are supplied in the type of package shown in Fig. 3. The device has the same electrodes as a conventional f.e.t., namely source, gate and drain; the metal tab at the back of the device is internally connected to the drain electrode. The internal circuit of a VMOS device is shown in Fig. 3; it can be seen that a Zener diode is connected between the gate and source electrodes. This protects the thin layers of silicon dioxide against the accumulation of any stray electrostatic charges which could produce a voltage great enough to puncture the thin layer. The Zener diode will break down when the voltage across it exceeds 15V positive with respect to the source electrode, causing the charge to leak away. Nevertheless, it is wise to take reasonable precautions when using VMOS devices; in particular, soldering irons should be well earthed. These devices should be kept in metal foil when not in use. The current into the gate should not exceed

2mA and the reverse current out of the gate should not exceed 100mA.

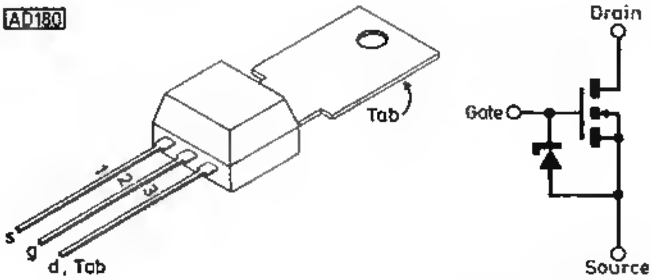


Fig. 3: Package, pin connections, and internal circuit of a VMOS device

Types

The main difference between the three types of VMOS device under discussion is the maximum voltage which can be safely applied to the drain relative to either of the other two electrodes. These voltages are shown in Table 1 together with the drain-source saturation voltage which is slightly higher for the highest voltage device.

Table 1: Differences between the three basic devices

Device type	Max. drain voltage	Maximum drain-source saturation voltage at V_{GS} = 10V and I_D = 1A
VN46AF	40V	3V
VN66AF	60V	3V
VN88AF	80V	4V

The maximum dissipation in the device itself without any heat sink is 2W for temperatures up to 25°C, whereas the device can dissipate 12·5W at a case temperature of 25°C or 6W at a case temperature of 90°C as shown in Fig. 4.

Advantages

VMOS devices have a very high input impedance and can provide an extremely high current gain of the order of a million or more. Another advantage over conventional bipolar transistors is the very short switching time of typically 2ns (maximum 5ns). This can be achieved because they are majority carrier devices in which only electrons contribute to the current flow. Their speed is not limited by minority carrier storage time effects found in bipolar transistors enabling them to be used in high efficiency voltage converters operating with a very small internal dissipation.

Conventional transistors are subject to a phenomenon known as "secondary breakdown" due to local temperature rises; VMOS devices do not suffer from this effect, since any local increase in temperature produces a fall of current in that region owing to the negative temperature coefficient. This also prevents the possibility of thermal runaway.

Applications

VMOS devices are very useful in the control of a device requiring an appreciable current using a high impedance signal source. For example, the circuit of Fig. 5 shows an oscillator using two gates of a CMOS 4011 quad NAND gate device; when the input of the left hand NAND gate goes high, the circuit oscillates at a frequency of around 2kHz. The output from the gate can supply a square wave of about 5V amplitude, but only a small current. However, this output can be employed to switch the VN46AF device which can control enough current to produce a loud noise in the loudspeaker. Thus when the input goes 'high' (a few volts positive with respect to ground), the circuit emits the alarm sound from the loudspeaker.

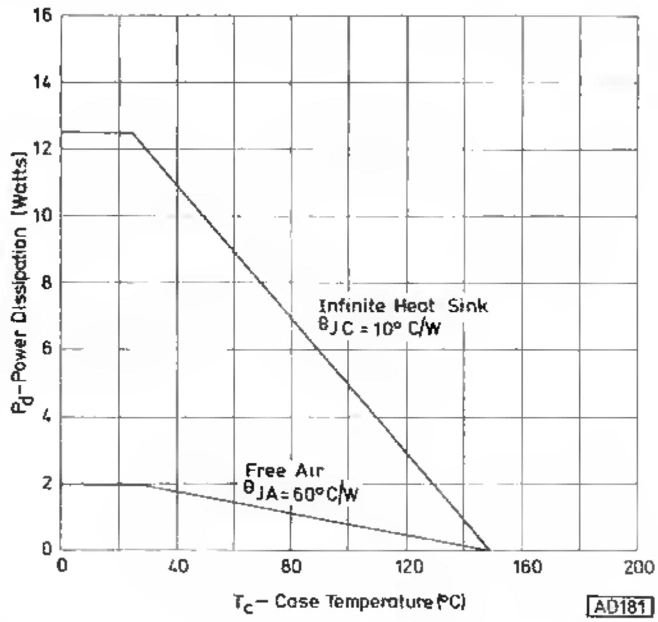


Fig. 4: Power dissipation in relation to case temperature

The frequency of the alarm signal can be set by choosing suitable values of R1 and C1. The VN46AF device imposes a negligible load on the CMOS output circuit and does not affect its waveform.

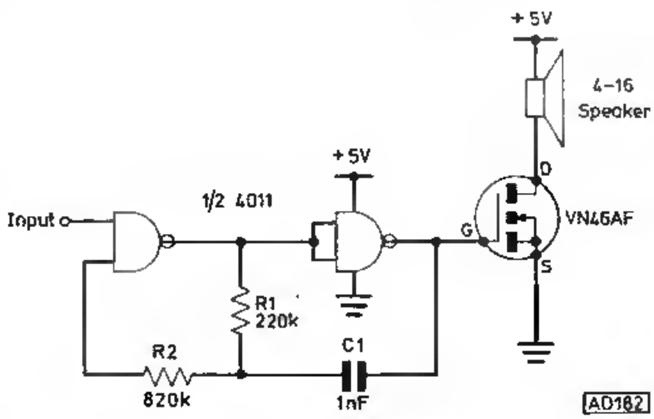


Fig. 5: A circuit which uses a VMOS device as a "slave" current driver. The impedance of the speaker should read "4-16Ω"

The high switching speeds of VMOS devices render them suitable for switching laser diodes. The type of circuit shown in Fig. 6 may be used, the values of R1 and R2 being chosen according to the bias and pulse currents required by the laser diode.

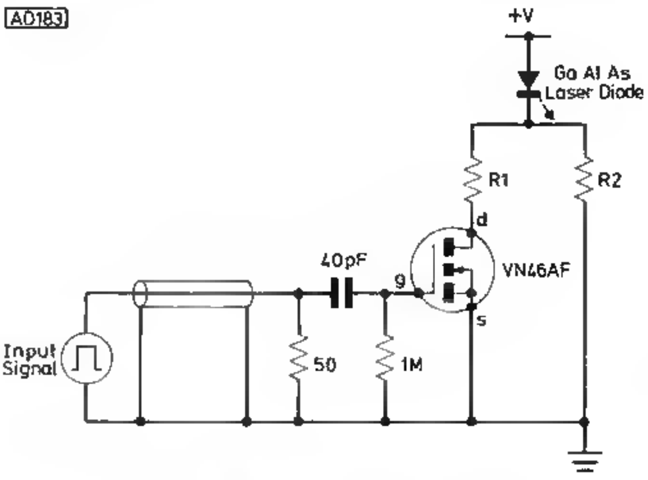


Fig. 6: A laser switching circuit

VMOS devices can be employed in voltage converters which enable a steady input voltage to be converted into a steady output voltage of another value. A typical basic circuit using a pair of VMOS devices is shown in Fig. 7, but the transformer design would depend on the input and output voltages concerned and on the power output level required. High efficiencies can be obtained with this type of circuit, since the rapid switching of the VMOS devices ensures that they spend little time in the intermediate voltage state where power is wasted.

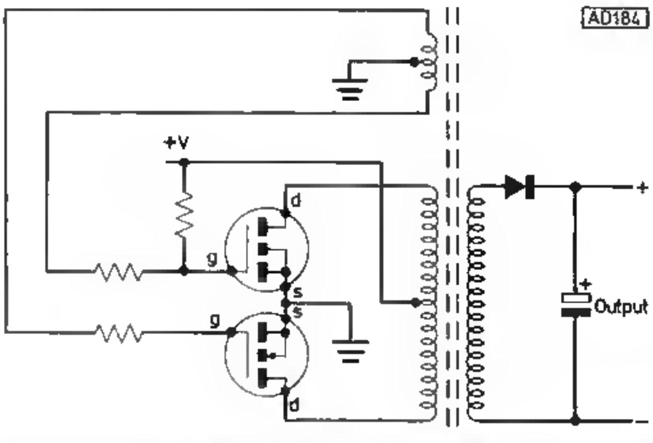


Fig. 7: Two VMOS devices used as a steady voltage converter

It would be possible to use a VMOS device to control the brightness of a tungsten filament lamp by merely varying its gate voltage; however, this would result in much power being wasted in the device when the light output of the lamp is fairly low. A pulse-width-modulation lamp dimming circuit is shown in Fig. 8. The 4011 gates act as a square wave oscillator with a duty cycle which varies according to the setting of VR1. The VN46AF is either fully conducting or completely switched off at all times except during the very rapid switching transients, so little power is wasted. The brightness of the lamp can be controlled and one of the inputs of the left hand gate used as an ON/OFF switch.

Amplifiers

VMOS devices form excellent low distortion amplifying devices, since their characteristics are very linear at drain currents exceeding about 400mA. Simple VMOS device amplifiers such as that shown in Fig. 9 can have a response which is almost level to frequencies up to 10MHz.

High quality amplifiers and a transmitter/receiver for the 144MHz amateur band have also been produced using similar VMOS devices.

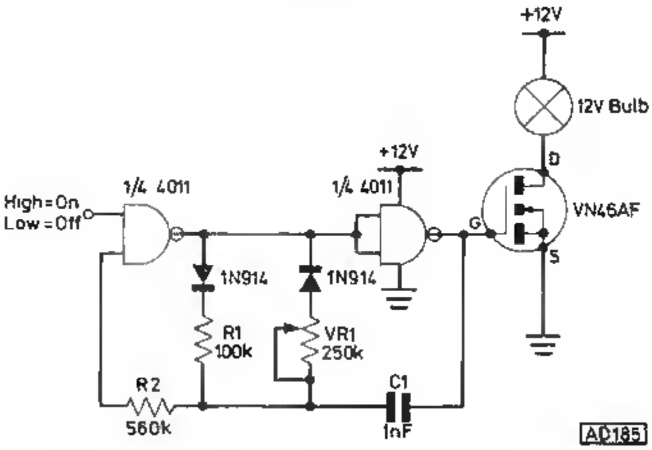


Fig. 8: A lamp dimming circuit which is economical in terms of power consumption. VR1 controls the duty cycle

Conclusions

VMOS devices have many advantages over conventional bipolar power transistors, including much higher current and power gain (better by a factor of about 10,000), faster switching, no secondary breakdown or thermal runaway and the ability to operate with several devices connected in parallel.

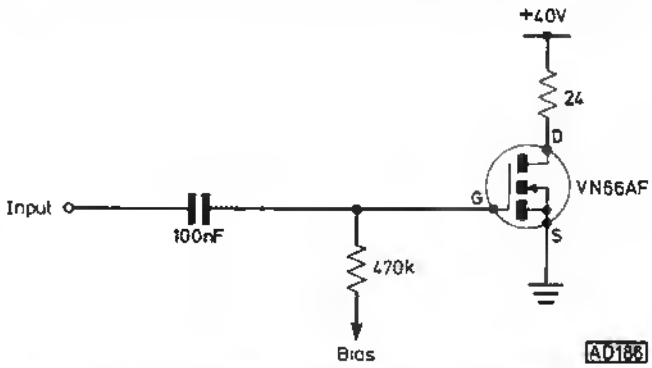


Fig. 9: A high impedance broadband amplifier circuit

Plastic packaged VMOS devices are available from Arrow Electronics Ltd., Leader House, Coptfold Rd., Brentwood, Essex CM14 4BN. The price of the VN46AF is £1·36, the VN66AF is £1·43 and the VN88AF is £1·58 including VAT, but 25p must be added to orders under £5 to cover packing and postage. ●

A.M. RECEIVERS
DEVICES & CIRCUITS
PART 2

M. J. DARBY

Last month we discussed simple tuned radio frequency receivers using the ZN414 device, but we now turn our attention to the more complex superheterodyne receivers which are able to provide much better selectivity and also higher gain over a wider frequency range.

Basic Circuit

The basic circuit of a typical superheterodyne receiver is shown in Fig. 12. The incoming signal from the aerial (which may be a ferrite rod) is coupled into an optional radio frequency stage which amplifies the signal at the same frequency as that at which it is transmitted. The signal is then coupled through another tuned circuit to a mixer stage.

If the radio frequency stage is omitted, the signal from the aerial is fed directly to T2 and the mixer stage. A high frequency oscillation is generated in this stage (or in a separate oscillator stage) and the incoming signal is "mixed" with this locally generated oscillation. The resultant output signal from the mixer-oscillator stage contains not only the input signal frequency and the oscillator frequency, but also the sum and difference of these two frequencies.

The transformer at the output of the mixer-oscillator stage, T3, is normally resonant at the difference frequency so that other frequencies are greatly attenuated. This required different frequency is known as the intermediate frequency (i.f.) and remains constant as the tuning varies; in most a.m. receivers the i.f. is in the range 455kHz to 475kHz, but other frequencies such as 1·6MHz are sometimes used.

The output from the i.f. stage is fed into a second pair of coupled tuned circuits resonating at the intermediate frequency, T4, so that good selectivity can be obtained. In many modern receivers T3 is replaced by a ceramic or a mechanical filter to obtain still better selectivity. The output is demodulated by the diode D1 and the resulting audio signal is fed to a power amplifier which in turn drives a loudspeaker.

Advantages

The advantage of using the superheterodyne type of circuit is that the transformers T3 and T4 always operate at the same frequency and need not therefore be retuned each time the station being received is changed. It is thus possible to add further tuned circuits if required, and special types of filter.

In the circuit of Fig. 12, the capacitors C1, C2 and C3 are ganged together so that the transformers T1 and T2 are resonant at a frequency close to the wanted signal, whilst C3 controls the oscillator frequency. The so-called padder capacitor C_p and the value of the inductance L used for the oscillator coil are chosen so that the difference between the resonant frequency of T1 (or T2) and the oscillator frequency remains almost constant as one tunes through the band using the ganged capacitor. The three tuned circuits are said to "track" with one another.

The tracking cannot be made exact at more than about three points on the tuning scale. The selectivity of the four tuned circuits in T3 and T4 is much greater than that of the two tuned circuits in T1 and T2, and it is this which determines the frequency being received. A small variation of the oscillator circuit tuning will produce a large effect on the tuning of the receiver, whereas a small variation of the tuning of either T1 or T2 will only produce a small change in the gain of the circuit.

The disadvantages of the superheterodyne receiver, apart from its complexity relative to a t.r.f. receiver, are the generation of spurious frequencies which can

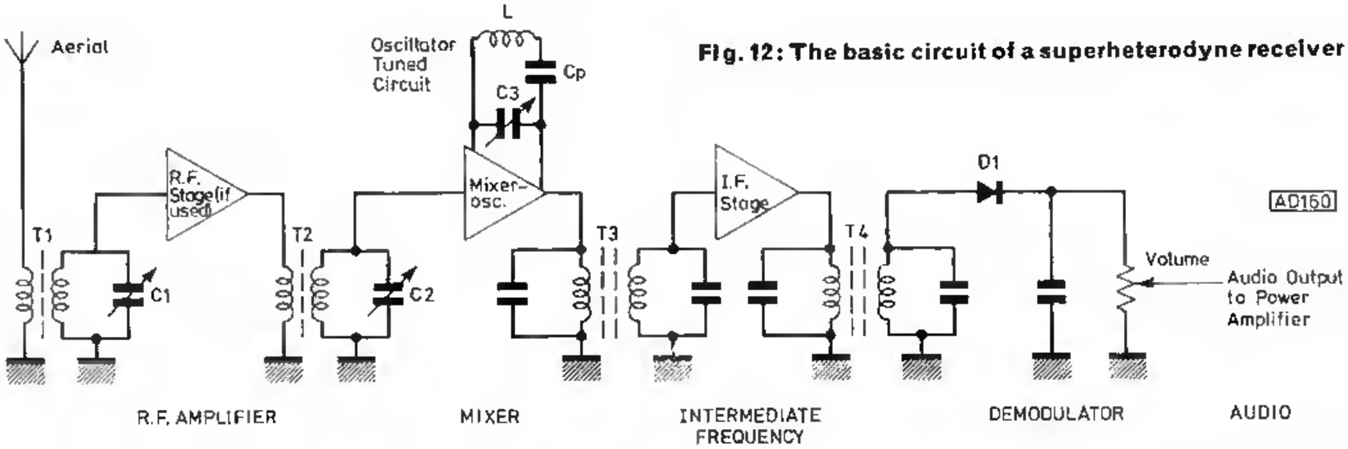


Fig. 12: The basic circuit of a superheterodyne receiver

result in "whistles" in the output, plus the problems of aligning the receiver after construction so that the radio frequency and oscillator circuits track correctly.

One has to accept these disadvantages if one wishes to receive distant signals. One cannot increase the selectivity of a t.r.f. receiver by an adequate amount by using more and more tuned circuits at the incoming radio frequency, since the number of sections in a ganged capacitor which can be practically useful is limited. Tuned circuits using a ganged capacitor cannot be designed for optimum selectivity, whereas the tuned circuits of T3 and T4, which operate at a relatively low and constant frequency, can be designed so that they give optimum selectivity at that frequency. In addition, the use of a constant frequency makes the use of ceramic or mechanical filters possible.

The performance of t.r.f. receivers leaves much to be desired when one attempts to use them at high frequencies of, perhaps 30MHz, since the relatively low value inductances required to tune the circuits results in a low gain and poor selectivity

A.M. Devices

A number of integrated circuits are readily available from advertisers which contain all of the semiconductor elements required for the radio section of an a.m. receiver for use at frequencies of up to at least 30MHz. Some of them include a provision for a radio frequency input stage, whereas others do not. Although such devices contain many of the components required for the radio section of a receiver, all of the tuned circuits are separate components external to the integrated circuit used. A few a.m. superhet integrated circuits are now becoming available with a low power audio amplifier integrated onto the chip.

One of the best known a.m. devices has become an "industry standard" type and is available from National Semiconductor as the LM1820, from RCA as their CA3123E, from Fairchild as the μA720, from Signetics as their NE546 and also as the HA1197, etc. Another somewhat similar device with an r.f. amplifier stage on the chip is the SGS-ATES TBA651 which provides a very good performance. The Siemens devices are their TCA440 for use at signal frequencies of up to 50MHz and the TDA1046 for use at up to 30MHz.

A number of manufacturers are introducing devices for use in a.m./f.m receivers. Apart from the semiconductor devices required for the radio section of the a.m. receiver, these also include the i.f. amplifier and demodulator for the f.m. section of the receiver. Examples of such a.m./f.m. devices include the Fairchild μA721, whilst other a.m./f.m. devices such as the SGS-ATES TDA1220 and TDA1230 and the Siemens TBA460 include an audio pre-amplifier on the chip. The Mullard TBA700 a.m./f.m. device incorporates a 1W audio amplifier. The circuits in which a.m./f.m. devices are used are relatively complex, since one has both the a.m. and the f.m. receiver circuits, so these devices will not be discussed further. However, some constructors may find the new Telefunken TDA1083 and the equivalent Sprague ULN2204 a.m./f.m. device with a 0·8W output attractive (available from Ambit International).

Some of the earlier a.m. devices (such as the Mullard TAD100 and the RCA CA3088) are still available from retailers, but we will confine our attention to the more recent devices.

6V Superhet

The circuit of a simple 6V superheterodyne receiver is shown in Fig. 13. This employs the LM1820 device which has provision for a radio frequency amplifier before the mixer stage, but the radio frequency amplifier is not used in the simple circuit shown. A two-gang capacitor can therefore be used in this circuit for tuning.

The aerial T1 is normally a ferrite rod type, the secondary winding consisting of a few turns of wire connected between the mixer input at pin 1 and the supply voltage at the lower end of R1. The oscillator operates at a frequency determined by the inductance of T2 and the value of the oscillator section of the ganged capacitor C1. The difference frequency appearing at the mixer output at pin 14 is selected by T3 and fed into pins 11 and 12. These pins are connected to what is normally used as the radio frequency amplifier stage, but in this circuit is used as an additional intermediate frequency amplifier.

The output signal from this stage appears at pin 13 and is coupled to the input of the intermediate frequency amplifier at pin 7. The output from this stage appears at pin 6 and feeds a transformer T5 also resonant at the intermediate frequency. Part of the signal from pin 6 is fed through C3 to the automatic gain control circuit incorporated in the LM1820 device.

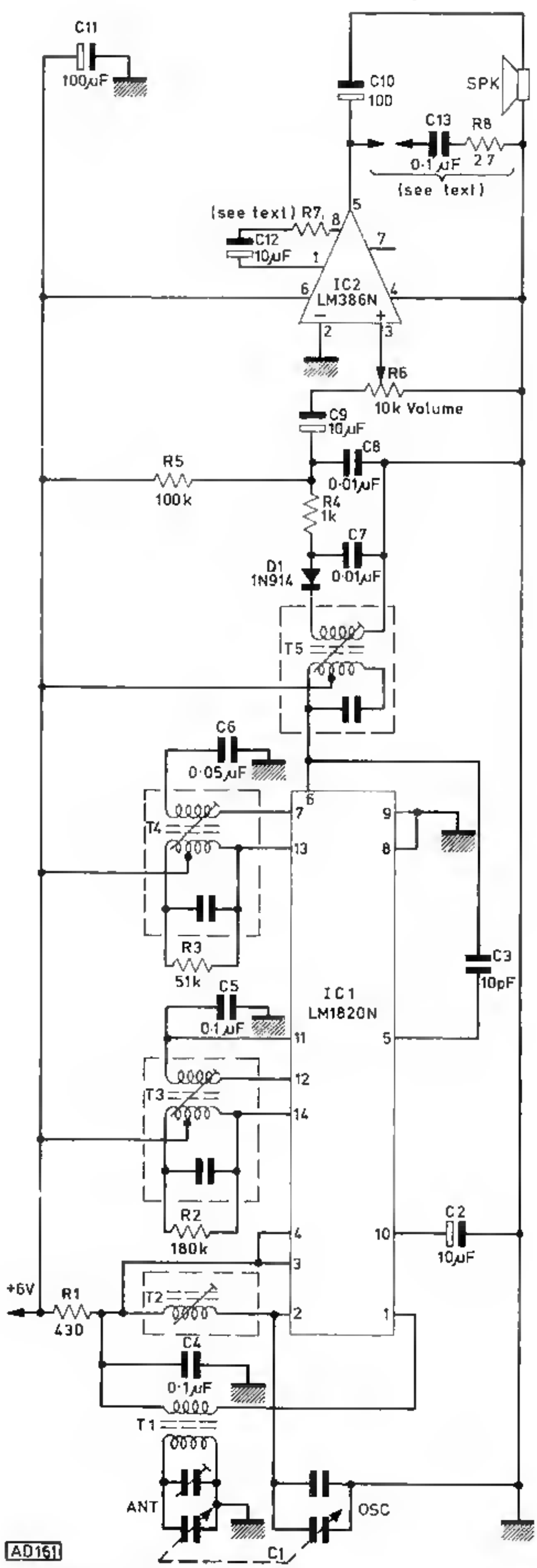
The signal from T5 is also fed into the demodulator diode D1 which is connected to the i.f. filter components R4, C7 and C8. The resulting audio signal is coupled through C9 to the volume control.

A simple LM386 audio amplifier stage is used in Fig. 13. The gain of the audio stage is set by the value of R7. If R7 is completely omitted together with C12, the voltage gain will be 20 times, whereas if R7 is zero (C12 being connected directly between pins 1 and 8 of the LM386), the voltage gain will be 200 times. Values of R7 intermediate between these values of infinity and zero will produce intermediate values of gain, for example if R7 is 168 ohms, the gain of the audio stage is about 100 times.

The components C13 and R8 may be required to suppress high frequency instability in the audio amplifier stage, but should not be needed if the loudspeaker has an impedance of more than about 40 ohms. These components form the so-called Zobel network which compensates for the inductance of some loudspeakers and reduces the variation of loading on the amplifier with frequency.

In small radio receivers of this type a miniature loudspeaker is often employed for convenience, but it must be stressed that one cannot expect to obtain good reproduction unless one employs a speaker and a speaker enclosure which are of a reasonable size. This applies to all radio receivers; miniature speakers just cannot reproduce a good audio signal with good bass notes.

For simplicity no waveband switching is shown in the circuit of Fig. 13. However, arrangements may be made to switch the transformer T1 and the oscillator inductance T2 to provide the wavebands required. Obviously a better aerial than a ferrite rod will be required for the reception of very distant stations.



C1: 2-Section Gang Capacitor. Oscillator Section = 60pF Antenna Section = 130pF Max.

The R.F. Stage

A similar circuit employing a radio frequency stage before the mixer involves the use of a three-gang tuning capacitor and three coils for each waveband instead of two. What advantages does this bring?

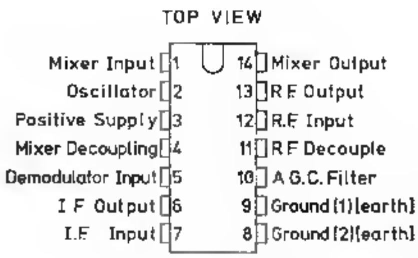
One advantage of the use of a radio frequency stage is a lower noise level when receiving signals at high frequencies. The conversion gain of a mixer stage is considerably less than the gain of a radio frequency amplifier and hence the noise added to the signal by a mixer stage is greater than the noise added by an amplifier stage. If one has an amplifier before the mixer, the signal is brought up to such a level that the noise added by the mixer is less noticeable in the larger signal voltage. At long, medium and the lower short wave frequencies, however, the amount of noise entering the receiver from a good aerial is so great that the mixer noise is relatively insignificant, so one does not usually bother to include a radio frequency stage unless one wishes to receive relatively high frequency signals.

A further advantage of the use of a radio frequency stage is the greater rejection of signals at the "image" frequency which can interfere with reception of the wanted signal. Image rejection is also important only at the relatively high short wave frequencies. In order to understand the term "image" frequency, let us consider the case of a receiver tuned to a signal at 1000kHz with an oscillator circuit operating at 1455kHz so that the intermediate (difference) frequency is 455kHz. If a signal at 1910kHz is also present at the mixer input, this will mix with the 1455kHz local oscillator frequency to form a spurious difference signal at the 455kHz intermediate frequency which interferes with the wanted signal. If a radio frequency stage is used, the additional tuned circuit will attenuate the unwanted 1910kHz signal before it reaches the mixer and therefore the interference will be minimised. No amount of extra selectivity in the intermediate frequency stages will affect image interference; the additional selectivity is required before the mixer.

TBA651 Receiver

A receiver with an r.f. stage can be made using the LM1420, μA720, NE546 or CA3123E devices, but as we have already considered the use of one of these 14 pin dual-in-line integrated circuits in the receiver shown in Fig. 13, we will now discuss a receiver using the TBA651 device which also incorporates a radio frequency stage.

A circuit using the TBA651 is shown in Fig. 14; no audio amplifier is included in this circuit, but the audio output can be fed into any standard type of



LM1820/μA720/CA3123/NE546 Connections

Fig. 13: A receiver using the LM1820 device with a simple LM386 audio stage

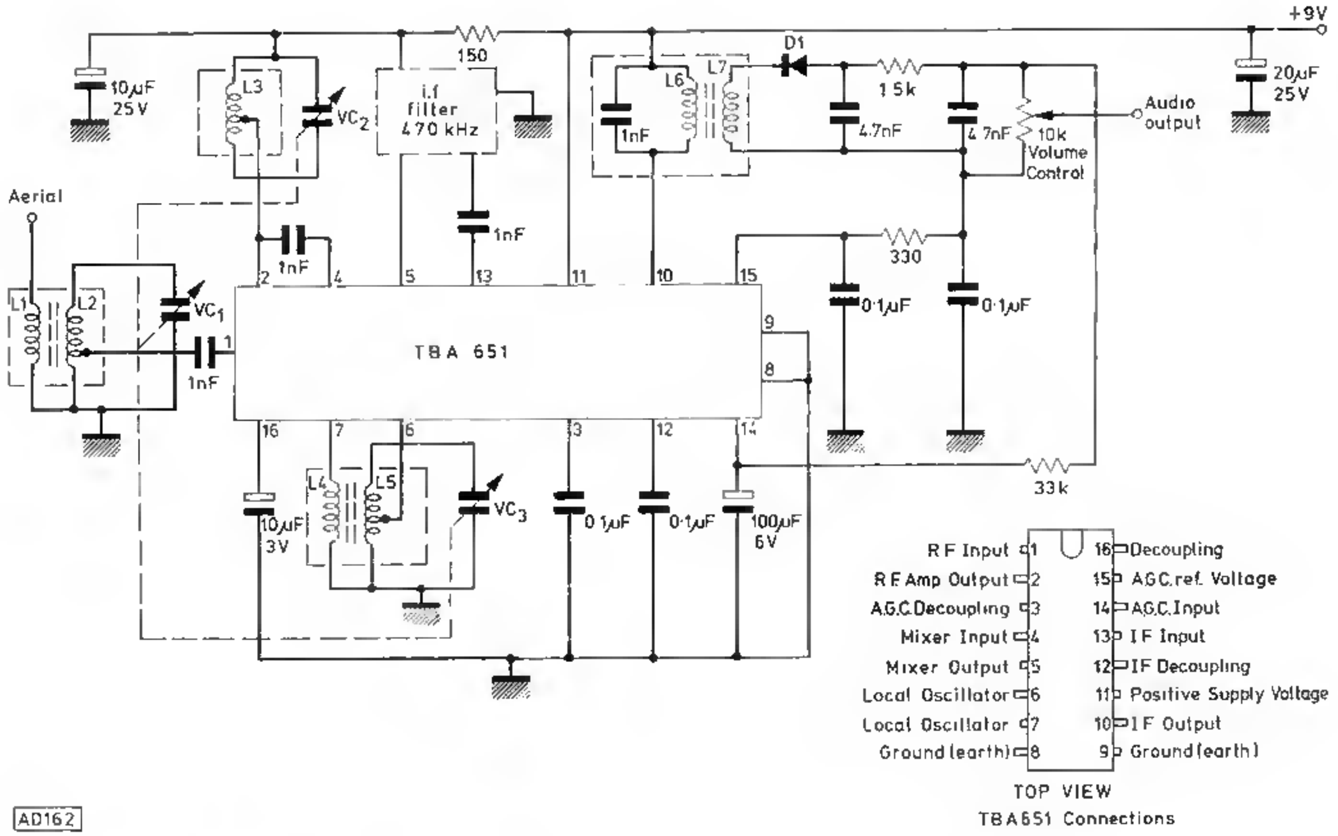


Fig. 14: A TBA651 receiver (no audio amplifier is shown)

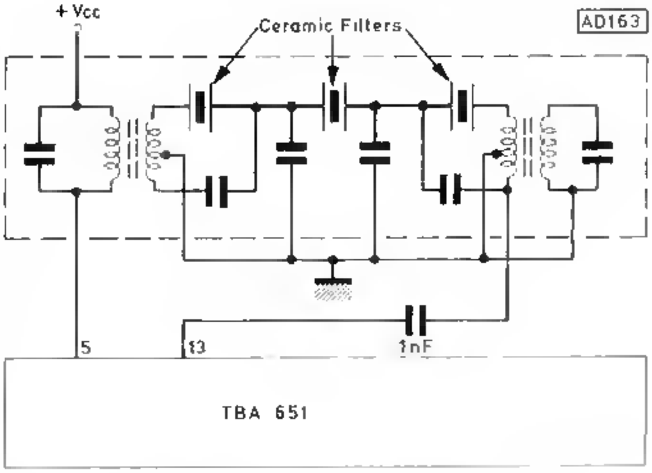


Fig. 15: The selectivity of the circuit of Fig. 14 may be greatly improved if a suitable ceramic filter is employed between pins 5 and 13 of the TBA651

audio amplifier circuit. The TBA651 is a quad-in-line device with the connections shown, quad-in-line devices having alternate pins bent so that their tips are at different distances from the body of the device.

In the circuit of Fig. 14, the radio frequency signal from the aerial is coupled to the amplifier input at pin 1. The signal at the input frequency appears in amplified form at pin 2, further selectivity being added by the parallel tuned circuit L3—VC2. The oscillator tuned circuit consists of L5—VC3, the three sections of the tuning capacitor (VC1, VC2 and VC3) being ganged together.

The output from the mixer stage at pin 5 is fed to an intermediate frequency filter. This may consist of an intermediate frequency transformer, a simple ceramic filter with suitable coupling or a more complex ceramic filter of the type indicated in Fig. 15. The selectivity (and hence the performance of the whole receiver) is mainly determined by the type of filter used between the mixer output at pin 5 and the input to the intermediate frequency amplifier at pin 13. This filter must be included before the amplifier, or unwanted signals may overload the amplifier.

The output from the intermediate frequency amplifier at pin 10 is fed to the transformer containing L6 and L7, the L6 circuit resonating at the intermediate frequency. The diode D1 and the following filter components demodulate the signal and provide the required audio output.

An a.g.c. reference voltage from pin 15 is mixed with the voltage obtained by demodulating the signal and the resulting voltage is fed through a 33 kilohm resistor to the a.g.c. input at pin 14 so that it can be used to keep the gain fairly constant.

Noise

The TBA651 employs a high gain, low noise radio frequency amplifier and this enables an excellent overall noise performance to be obtained. This noise performance is conveniently shown by the type of graph of Fig. 16. The lower curve shows the noise output when no signal is present at the input, whereas the upper curve shows the output with a signal modulated to a depth of 30 per cent with a 1kHz tone. The carrier test frequency is 1·6MHz.

It can be seen that the signal output is about 26dB above the noise under these conditions when the input voltage is only 10μV, whilst an input signal of only 1μV produces a 6dB signal-to-noise ratio.

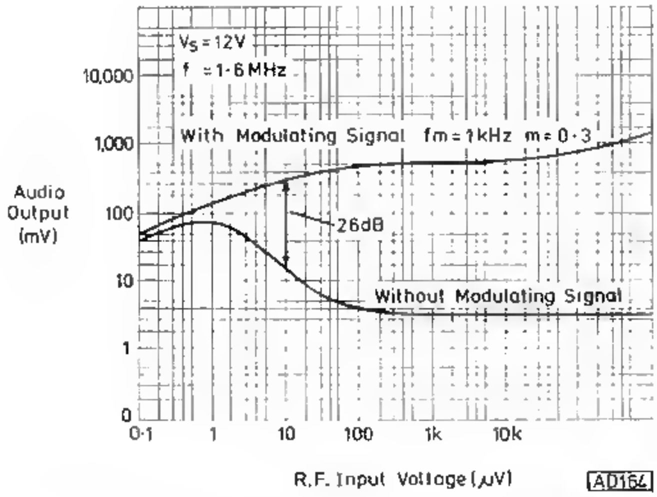


Fig. 16: The typical noise performance of the TBA 651 device. The lower curve shows the output noise level without any input signal

The a.g.c. control range of the TBA651 is some 120dB, this being made up of about 50dB for the first stage and 70dB for the mixer stage. A variation in the input signal level of 80dB can be made to produce a change of less than 10dB in the output level. The a.g.c. voltage is applied to the first stage only when the input voltage exceeds 100μV so as to obtain optimum signal to noise ratio. The TBA651 will operate at supply voltages in the range 4·5V to 18V, the current required being of the order of 12mA.

The TCA440

The Siemens TCA440 is another high performance a.m. superhet device. It uses a multiplicative mixer so that few harmonic mixing products and therefore few "whistles" are formed.

A typical TCA440 circuit for medium wave use is shown in Fig. 17. The aerial input to L1 is coupled to the signal frequency amplifier at pins 1 and 2, but this signal frequency amplifier output is internally connected directly to the mixer stage without the use of any external tuned circuit. The oscillator tuned circuit is connected to pins 4 and 5.

An output from the mixer stage appears at pin 16, is coupled from the tuned circuit containing L6 to L7 and hence D1 which rectifies the signal and provides a.g.c. The other mixer output at pin 15 passes through the transformer containing L9 and L10 and hence to the SF 455D ceramic filter element. It then passes into pin 12, is further amplified and appears at pin 7. The audio signal is obtained from D2, the demodulator diode, whilst an a.g.c. signal is fed back into pin 9 for controlling the gain of the final amplifier stage.

When a 1MHz signal modulated to a depth of 30 per cent with a 1kHz tone is fed to the TCA440 circuit, input levels of 1μV, 7μV and 1mV will produce signal-to-noise ratios of about 6dB, 26dB and 58dB respectively.

The tuning meter, if used, may have a full scale deflection of 100μA, in which case it should have a resistance of about 1500 ohms, but a 500μA meter with an internal resistance of about 300 ohms may also be used.

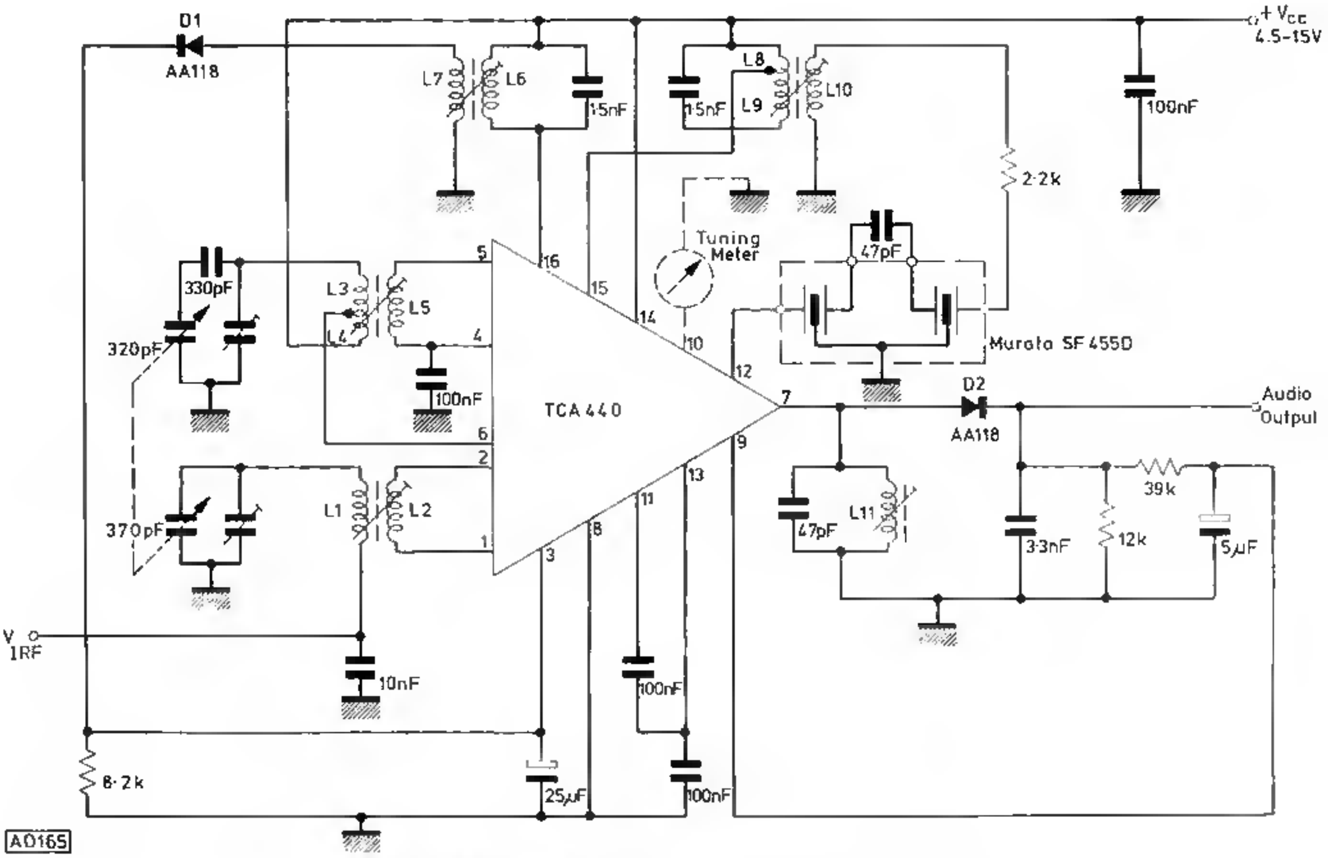


Fig. 17: A TCA440 circuit for use as a medium wave receiver

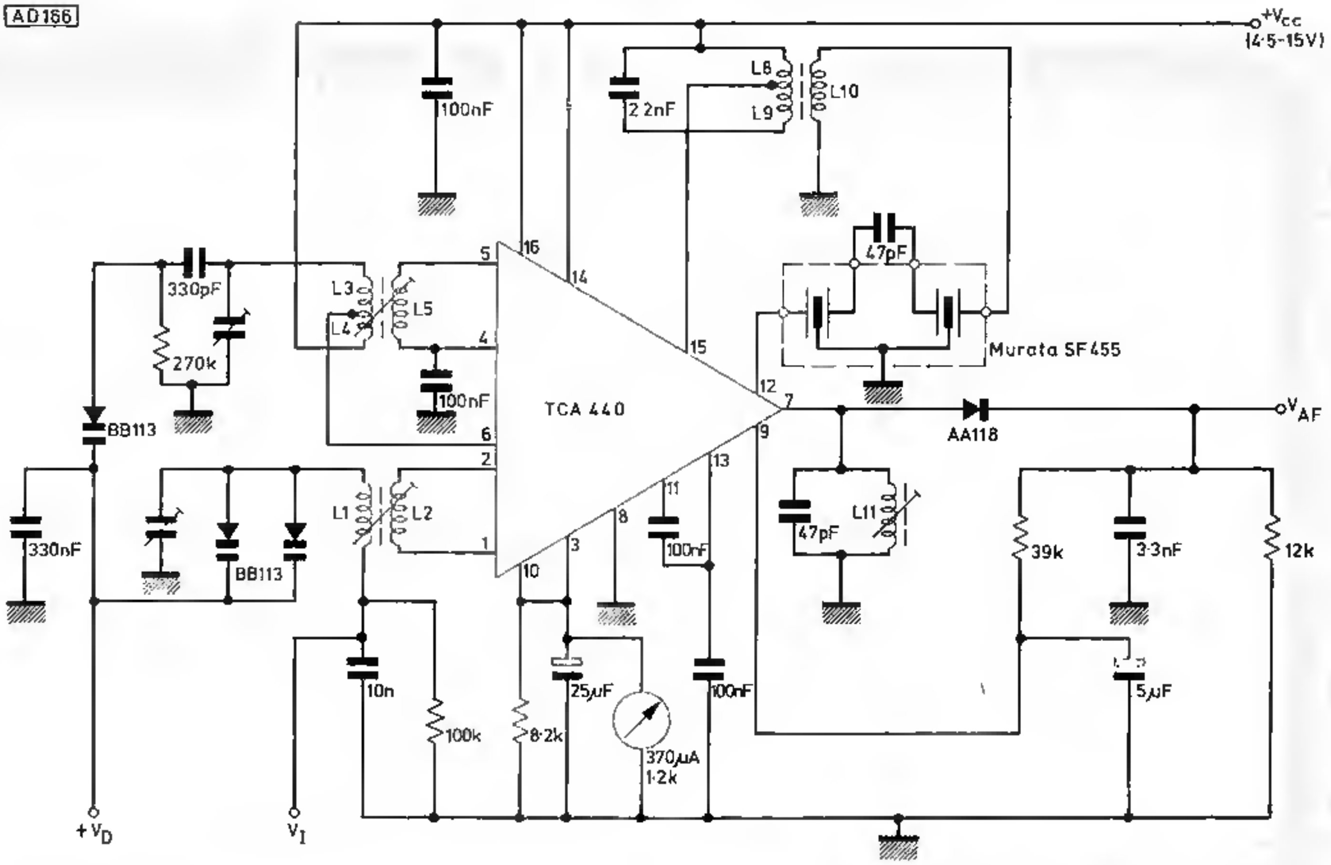


Fig. 18: A TCA440 circuit for medium wave use in which tuning is performed by varying the voltage $+V_D$ applied to the BB113 varicap diodes

Varicap Diodes

Another circuit using the TCA440 for medium wave reception is shown in Fig. 18, but instead of a ganged tuning capacitor, semiconductor "varicap" diodes are employed. Tuning is carried out by varying the voltage applied to the terminal marked $+V_D$. In a typical case, a tuning voltage of +8·5V will result in the receiver being tuned to a frequency of 800kHz, whilst increasing the tuning voltage to +30V will change the tuning point to the uppermost part of the medium wave band at about 1620kHz.

The tuning voltage is applied to the BB113 triple a.m. tuning diode. Two of the three diodes are used in the radio frequency aerial circuit, whilst the third diode is used in the oscillator circuit where the required capacitance is considerably smaller.

The supply from which the tuning voltage for the BB113 diodes is obtained must be regulated. The use of a low current integrated circuit voltage regulator is convenient for this purpose, since it will stabilise the tuning voltage against drift with temperature or against mains voltage changes and will also reduce the mains frequency ripple to the very low level required for the supply to the tuning diodes. Tuning is carried out by using a ten-turn potentiometer to tap off the required tuning voltage $+V_D$ from the stabilised supply voltage.

Conclusion

We have looked at a variety of integrated circuit a.m. receivers; although these have not been discussed in any great detail, it should be clear that an excellent performance can be obtained at frequencies of up to at least 30MHz (corresponding to a wavelength of 10m).

PW WIMBORNE
continued from page 34

Precautions Against Hum

As with the majority of audio amplifiers, care must be taken in the physical layout to avoid high levels of hum, especially where earthing at various points on the chassis is concerned. The emphasis placed upon "input earth" and "speaker earth" in the circuit diagram is no idle instruction; it is essential to take external earthing to only one of these points in order to prevent the creation of circulating currents ("hum loops"), and a consequent high residual hum level.

With the same aim in view, caution in the layout of current carrying conductors such as mains transformer secondary cables will help to prevent hum by routing them well away from sensitive points on the audio pre-amplifier layout.

One very important point is that the mains transformer itself can, by virtue of its high field intensity, radiate hum to the amplifier sections. This is especially true of the cassette unit, where the replay head will be very sensitive in this respect. As a result, it should not be permanently sited until after the cassette unit has been installed, at which point it should be swung in different directions while the cassette unit is switched to "play", noting the best position for minimum hum.

Succeeding instalments will cover the remaining circuit elements, which includes the r.f. board and tuner unit, along with the two optional magnetic cartridge pre-amplifiers, and notes on installation of the cassette unit.

Landsat System scans the earth

The third Landsat satellite was launched from the US Western Test Range on March 5, 1978. It joins an earlier Landsat craft to scan the entire earth every nine days from an altitude of 500 miles. The satellites detect variations in sunlight patterns reflected from objects on the earth and even from subterranean materials such as mineral deposits and water.

Information thus provided is transmitted to earth stations and converted into photographic prints and tapes which can provide solutions to many problems in food, minerals and other critical resources. It has been estimated that the Landsat craft will save thousands of millions of dollars annually and cut the cost of obtaining data about environmental resources by a factor of about 20 times.

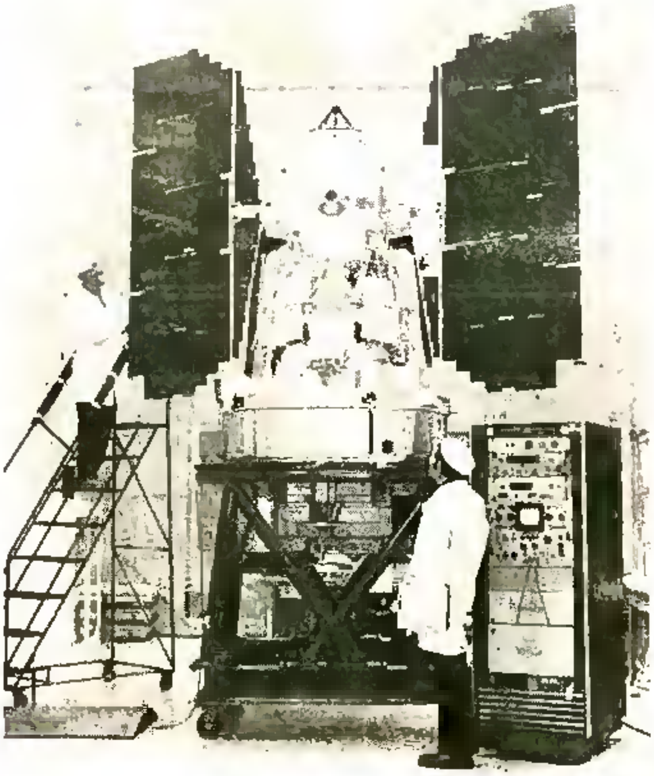
The imaging systems aboard Landsat-3 (weight 940 kg) are improved versions of the multi-spectral scanner subsystem and return-beam vidicon units employed in the two earlier Landsat craft. The developments in these infra-red sensors allow the detection of temperature differences in vegetation, bodies of water and urban areas, during either the day or night.

The Landsat craft have provided over half a million electronic images of the earth to over one hundred nations and are said to have affected more people than any other space programme. Information contained in the Landsat images is vital to the intelligent management of our natural resources.

Although the prime contractor for the construction of each of the three Landsat craft was the US General Electric Company, the work required ground support equipment for the launch operations, satellite tracking and data-collection receiving site apparatus for NASA tracking and data stations. The initial ground data system at the NASA Goddard Space Flight Centre, Greenbelt, Maryland, USA decodes the Landsat data to the required form for distribution to the various user agencies.

Landsat-1 was launched in July 1972 and was operating successfully when its transmitters were turned off in January 1978 in preparation for the launching of Landsat-3. Both Landsat-2 (launched in January 1975) and Landsat-3 will continue to provide data in the coming years, but plans are well advanced for the launch of a Landsat-D craft in the early 1980's. The new spacecraft will provide more and better data at a faster rate; in addition, major improvements have been made to the ground data-handling system.

Although the Landsat programme was initially experimental, undertaken to ascertain the feasibility of the remote sensing of earth resources from space, more and more demands for information obtained by the spacecraft are being received from an increasing number of users. The Landsat observations have been employed as a vitally important part of the information required to estimate food crop yield, to aid oil and mineral exploration, to measure water quantity and quality, to make inventories of forests and to monitor land use. Indeed, the number of purposes for which the information is being used is growing at a rapid rate. ●



The third Landsat spacecraft during its final checking at the General Electric Space Division Laboratory, Valley Ford, Pennsylvania.

AERIAL TUNER

F.G. RAYER G3OGR

This tuner can be used with end-fed or balanced feeder systems, either for reception or transmission. When used with a receiver, a substantial improvement in signal strength is obtainable. For transmission, it allows the usual pi-tank to be matched to end-fed, Zepp, and other aerials.

Construction

L1 is wound with 20 s.w.g. tinned copper wire, and L2 is of well-insulated wire, on top of L1, as in Fig. 2. The former is 89mm x 44mm and 34 turns are used in all. Taps are equally spaced at six turns, two turns, four turns, and five turns from the centre tap. They are made by passing short lengths of 16 s.w.g. wire into holes in the former, and securely soldering these to the winding turns as required. Nine 6BA bolts with tags, mounted on a piece of paxolin about 102mm x 102mm (as in Fig. 2), support the coil. Below these taps fit three bolts for A, B and C. A to B is three turns, and B to C has four turns, so that three, four, or seven turns may be selected. Two further bolts are for E, E, Fig. 2.

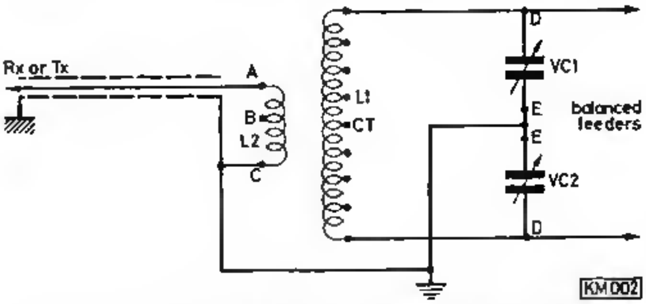


Fig. 1: The circuit diagram of the aerial tuner

Provided plenty of taps are available, other coils may be suitable.

Methods of Coupling

It is possible to find a suitable coupling method by trial only, especially for reception alone. Fig. 3 will help clarify some of the more usual configurations.

"A" is a pi-coupler, and adjustment of the capacitors allows a wide range of impedances to be matched, either to load the transmitter correctly, or to give best reception.

"B" is a popular method for high impedance aerials. With a transmitter, a co-axial lead is generally used, with outer conductor to the chassis. This, shown at "B" may be fitted for any circuit.

"C" employs the link for coupling. For low frequencies, the two capacitors may be put in parallel as shown, and this is useful if they are not of very large value.

"D" is a somewhat similar arrangement to using a centre-tapped coil and having the capacitors in series in this way is most appropriate for a high frequency band.

"E" shows the aerial tapped down, which is useful with parallel tuning when aerial loading prevents proper tuning with "B".

"B", "C" and "D" are appropriate for high impedance. "E" suits many intermediate lengths. "F" is for low impedance (quarter wave) with one capacitor used for series tuning.

Parallel tuning of balanced feeders is shown in Fig. 1. This is satisfactory when the feeder termination is high impedance. For low impedance feeders, "G" in Fig. 3 is necessary. The best balanced system is a tuned doublet. The top is divided into equal lengths, and the twin feeders are spaced about 102mm by spreaders. High impedance feed is expected if one-half the top, plus the feeder, equals a half-wave or multiple of half-waves. Should one-half the top plus feeder be a quarter wave or odd multiple, low-impedance coupling "G" is anticipated.

★ components

VC1 and VC2 350pF Jackson 5021/2 or similar. Ceramic or paxolin former, 100 × 100mm. Aluminium base 165 × 100 × 9mm, aluminium panel 203 × 152mm, Case 203 × 152 × 152mm. Tinned copper and insulated wire.

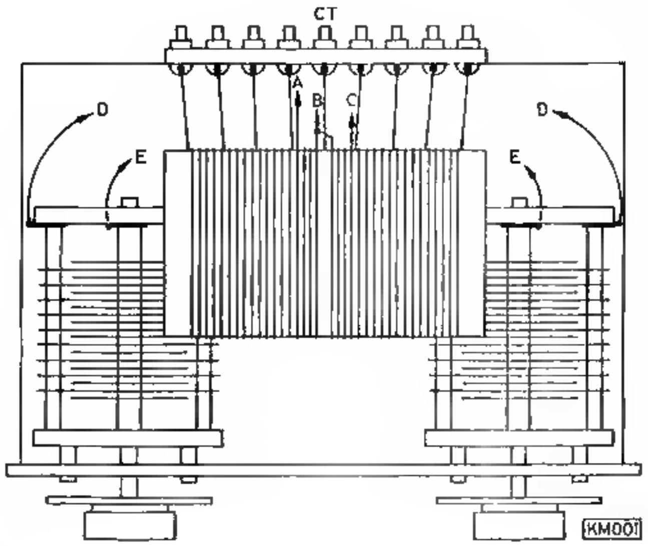
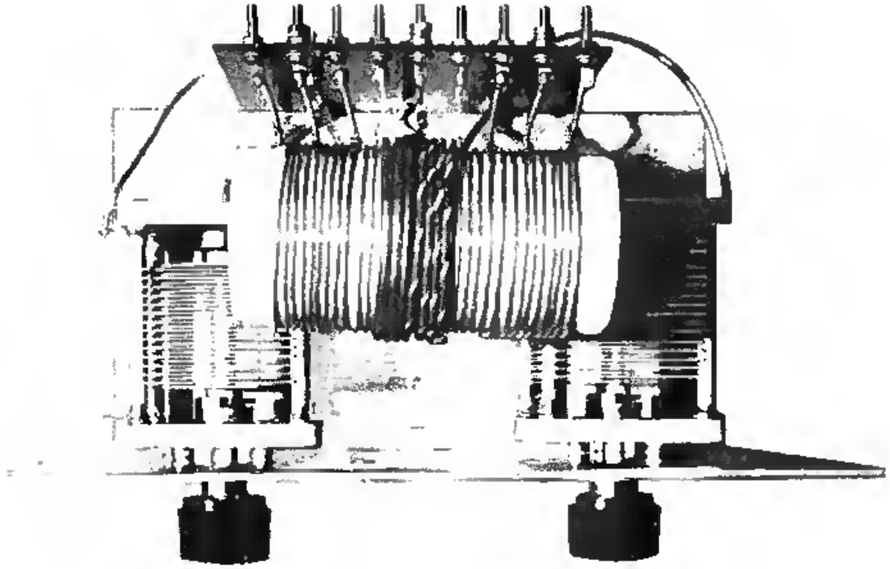


Fig. 2: General layout, showing connections to screw terminals



A view of the unit showing L2 (p.v.c. covered wire) wound *over* L1

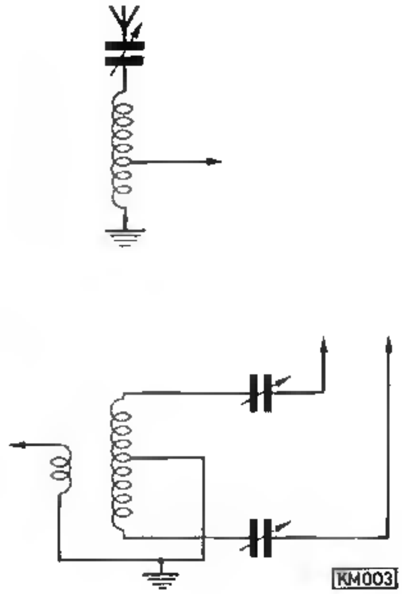


Fig. 5: Coupling circuits F (upper) and G (lower); details of all coupling circuits are given in the text

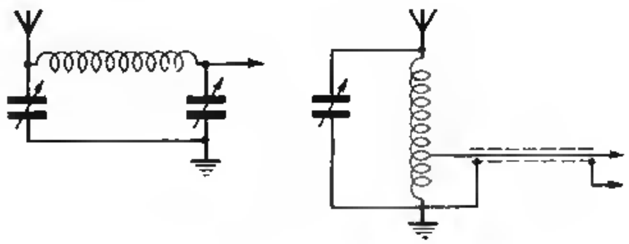


Fig. 3: Coupling circuits A and B

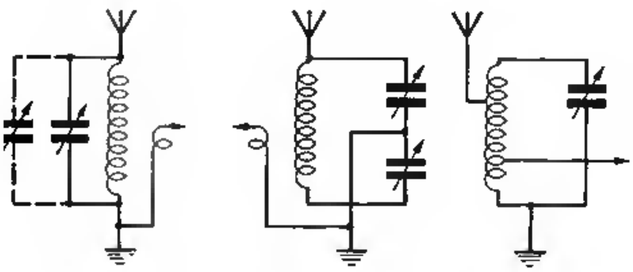


Fig. 4: Coupling circuits C to E

Frequency

Circuits showing the whole of L1 in use, above, are for the 80m band. For higher frequencies, fewer turns are used. With "A" short out unwanted turns. Circuits such as "B", "C", "E" and "F" are used at higher frequencies by moving the aerial and capacitor connections down the coil.

With balanced circuits, Fig. 1, "D" and "G" in Fig. 3, move taps in equally from each end.

There is sufficient latitude to allow tuning up for reception on 25m, 31m and other broadcast bands, if required.

Reception

For reception purposes only, it is an easy matter to try various tappings or circuits, to find which peaks up signals best. This can be done with the aid of the S-meter, selecting a signal not subjected to fading. "B", "E" and "F" will cover most conditions likely to be met with a single wire aerial. The improvement is greatest when the original match with no tuner was poor.

Fig. 1 or "G" will be used with twin tuned feeders (doublet or Zepp) or Fig. 1 with feeders tapped in equally from each end of L1.

Transmission

The points already mentioned apply, plus the fact that for correct operation and loading, suitable matching is essential. Mis-matching may in fact cause damage to the transmitter output stage.

An excellent method of matching is to place a standing wave indicator in the co-axial lead from tuner to transmitter, and adjust the tuner for minimum SWR, with reduced power. An indication of 1·5:1 or lower is normally satisfactory. Adjustment to a very low SWR (virtually 1:1) is generally simplified by placing a variable capacitor in series with the link or tap—e.g., between A and the co-axial inner conductor in Fig. 1. A 500pF component is suitable for h.f. bands, and 2×500pF for 80m, receiver type capacitors having adequate spacing. "A" Fig. 3 does not require this item, and can generally provide virtually 1:1 SWR.

Capacitor settings and tappings used for each band should be noted so that re-tuning is possible with a minimum of trouble. ●

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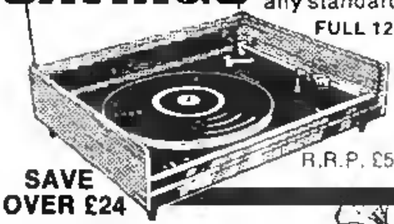

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2m MOSFET CONVERTER

continued from page 25

An internal supply using a PP3 battery could also be utilised if the Zener stabiliser in the oscillator is changed to a 6V8 type and R_{b1} suitably adjusted in value.

The converter would then be completely self-contained and could be used with valve receivers where an internal 12V supply is not normally available.

Coil Winding Details

Coils L1, L2, L3, L6 and L7 are identical, with the exception of a tap at $1\frac{1}{4}$ turns on L1. They are all made using a 6·5mm drill as a winding mandrel.

All coils can be wound using 19 or 20 s.w.g. tinned copper wire and, with the exception of L1, may be constructed from enamelled wire for appearances sake. The turns are separated evenly until the coils are 9mm (0·3 inches) long.

Coil L4 is wound using 30 s.w.g. enamelled copper wire with a total of 17 turns on a 5mm slug-tuned former, which is then fixed to the board with cyano-acrylate adhesive.

Enamelled 30 s.w.g. copper is also used for L5, which is wound with 9 turns on a 5mm slug-tuned former and fixed in the same manner. Both the coils are close-wound, the windings being subsequently waxed to aid stability and to hold in place whilst fitting to the board.

Alignment and Operation

Once the unit has been completed and checked for faults, the battery or other supply may be connected and the current measured. This should be in the order of 20mA at 12V. If all is well the oscillator can now be adjusted with the core of L5, using a wavemeter to sense when oscillation occurs and to tune for maximum output. At this point, the supply should be switched off and on again to ensure that the oscillator re-starts. If it does not, then detune the coil slightly until instantaneous oscillation occurs at switch-on. Once correct, use a wavemeter to tune L6/TC4 to 116MHz and then tune L7/TC5; return to TC4 and peak, then TC5 again to achieve maximum output, as these coils will tend to detune each other.

Plug the converter into the aerial socket of a receiver and tune the set to 29MHz, now adjust L4 for maximum noise at the speaker.

Carefully tune the station receiver from 28 to 30MHz and try to find a signal. If a station is heard or a locally-generated signal is available trimmers TC1, TC2, and TC3 can be peaked for maximum output from the speaker or against a reading on the S-meter (which is usually much more accurate).

The trimmers TC4 and TC5 should now be carefully turned for optimum converter gain.

No further adjustments are required and the unit should give you years of satisfactory operation without the need for any further adjustment if a small drop of wax is melted into the coil cores to ensure rigidity. ●

ON THE AIR

AMATEUR BANDS

by Eric Dowdeswell G4AR

Looking at the spate of reports on 10 and 15m activity it is fairly obvious that most are from readers possessing one of the relatively new types of receiver, such as the FRG-7. This is only to be expected, of course, but it leads me to wonder just how many readers are plodding away with older sets, which may not be very effective at these frequencies, not hearing very much, and frequently switching off, convinced that the bands are dead.

If you have such a set, don't scrap it but build yourself a converter from some published design. The set is probably quite effective at, say, 3·5 to 5·5MHz, with a good dial, so the converter is used to change signals on the 10 and 15m bands (28 to 29·7MHz and 21 to 21·4MHz) to a frequency within the range of the main receiver, which is used as a tuneable i.f. stage. The simple r.f. tuned circuits can be arranged to cover both bands without any switching.

A good line-up for the converter is an r.f. stage, mixer, and crystal oscillator/multiplier. If, for example, a 3·5MHz crystal is chosen, the oscillator output selects the 7th harmonic on 24·5MHz which is fed to the mixer, producing a difference frequency, on 28MHz, of 3·5MHz which is fed to the receiver. The dial calibration of 3·5MHz will now represent 28MHz and by tuning up to, say, 4·5MHz then signals on 29MHz will be heard, and so on, the converter r.f. circuits being peaked appropriately.

In practice a crystal just below 3·5MHz will be chosen or the receiver will be blocked by the fundamental. A frequency of about 3·490MHz should be suitable

If the fifth harmonic of the crystal is chosen, on 17·5MHz, this will mix with 21MHz to produce 3·5MHz again, thus covering the 15m band. The only switching involved is for the correct harmonic, the r.f. tuning covering both bands. There are no variable oscillators involved which means that the overall stability of the set-up is as good as the main receiver.

Crystals over a very wide range of frequencies can be chosen, different ones for each band if you like, and the i.f. tuning range can be other than that suggested. However, the use of 3·5MHz gives automatic fixing of the band edges.

It is essential that the main receiver be well screened and that the converter is connected up with coaxial cable with proper fittings, otherwise signals may leak through at the chosen i.f. The converter should have a switch to change the aerial input direct to the receiver to avoid having to play around with cables. If solid-state, the converter may be powered by a 9V PP3 battery, or possibly from the main receiver.

I used a valved version of such a converter for some years, coupled to a much-modified HRO, and such a combination would be hard to beat. Remember that in a multiband receiver the necessary r.f. switching can only introduce losses at the higher frequencies.

Newcomers to the Column

From East Kilbride, Glasgow comes a letter from **Greg Duffy** who has been listening around the bands for only a few months. He has an FR50B receiver but has been worried about the type of aerial to use, and wants to improve on an indoor wire. I have sent him the *PW* Aerial Chart that was given away in October '72 and I have a few more copies for any other newcomers who have aerial problems. An 8 x 5in SAE would help, please. My other oft-repeated advice was to write to the RSGB for a copy of the *Guide to Amateur Radio* which costs £1·70 inc post and packing. Their address is 35 Doughty Street, London WC1 for those just starting in amateur radio.

I'm going to include **Neil Clarke** of Mexborough, S. Yorks here because although he has written to me before, he has only recently got going with a PCR receiver, although he was after an HRO or AR88. He comments on the very rapid overs that some chaps use so that he is unable to copy the callsigns. This, I'm afraid, is something that only experience, listening on the bands, will sort out, but be patient, Neil.

An appeal from **Steve Donnelly** of 25 Church Street, Adlington, near Chorley, Lancs, who would like to meet others of like interest in his district. He's been using another FR50B for over a year and if anyone wants to call on Steve and "have a go" they are welcome. Thanks, OM. Steve wants to know all the pros and cons of adding accessories to a set. It so happens that an article from me on the very subject is with the Editor now, so let's hope he looks on it kindly!

On the Bands

Dick Smith of Porthcawl (mid-Glam) is still plugging away with his little t.r.f. set, mainly on 20m where he found HP3AB on s.s.b., and A5JO ostensibly in Bhutan, which is just too good to be true! **Bob Bell** (Blyth, Northumberland) reports that about a dozen people have come forward as a result of appeals in this column so it looks as if a local club there will materialise very soon. Any group thinking of starting a club but feeling a bit hesitant about it should write to the RSGB and see if they still have the leaflet which gives a suggested set of rules and general guidance on running a club.

Flat Holme Island was the QTH for the Marconi celebrations and special station GB3FI. **Brian Smith** of Barry, Glam. can see the island from his QTH but was determined to log the station. He found it eventually on 160m! Brian bought himself a typewriter, unfortunately for me, as his letters are now twice as long! He found DX on 80m at this time of year in the shape of ZP5YW, which is pretty good going.

Steve Turner BRS37620 kept away from radio while working on his O-levels but was amply rewarded on his return by catching the Rodriguez Island DX-pedition 3B9DA on 20m s.s.b., using his ex-Army R208 and 50ft wire. He's contemplating recalibrating his set and would like to hear from anyone else who has managed to do this successfully. So fellow R208 users are asked to drop a line to Steve at 9 Wallingford Road, Handforth, Wilmslow, Cheshire.

According to **Ian Marquis** A9140 the band with the sparkle has been 15m where he found VP2MZZ on Montserrat, VR4CF in the Solomons and YB0AB in Indonesia. Talking of VP2, I wonder how many people realise that it counts as nine different countries for DXCC purposes? The first suffix letter denotes the island, as shown with VP2MZZ above, and there are nine principal islands. Another one who is just relaxing after his exams is **Pete Cockerell** of Leigh-on-Sea, Essex. He's asking me when the peak of the current sunspot cycle is likely to be! My guess is as good as anyone's but I'd say around 1981, but there, half the fun of amateur radio is not knowing how conditions are going to turn out! Pete's problem is that he'd like something better than the *PW* Direct Conversion Receiver that has stood him in good stead, but can't decide whether to go on making up odds and ends of projects or to save for a proper set! Go for the set first OM and get some more listening time in. You can go for the bits and pieces later.

In far-distant Truro, Cornwall **Bill Rendell** has added a 15m folded dipole to his "elementary" valved Heathkit AR3 and his log seems to justify the work involved, with FP, KC4, KG4 etc appearing in the log, as part of Bill's quest for island calls. Bill comments on the sunspot wipeout in mid-July when the band was full of DX at 1730 but within a couple of hours all he could hear were G's working each other. He managed to bag GJ for a new one on 15m!

Club News

John Howard G4EVI, publicity officer of the Yeovil ARC G3CMH invites interested readers to two lectures. On September 14th Dud Charman G6CJ gives his famous talk and demo on aerials, and on October 12th the RSGB's Region 17 rep Les Hawkyard G5HD will discuss the World Administrative Radio Conference 1979. Club meetings every Thursday at 1930 in Building 101, Houndstone Camp, Yeovil. A club net operates on Sundays 1030 on 3660kHz.

I always thought that Shirehampton was one of those places mentioned in Crossroads! But now **R. G. Ford** tells me that the Shirehampton ARC meets on Friday evenings at Twyford House, High Street, Shirehampton, Bristol and that a new RAE course starts in September. The club has h.f. and v.h.f. gear plus a programme of lectures and films. Write to Hon. Sec. R. G. Ford, 2 Jersey Avenue, St. Annes, Bristol for details.

Log Extracts

W. Rendell:— 15m C5AAR EA8LD FP0AM HM1II HS1WR J3AH KA6KN KC4AAC (Anvers Is.) KG4FW KZ5ED SV1IW (Crete) TR8AC YB0ACB 9V1TG.

I. Marquis:— 20m FC9UC OH0NA TA1ZB **15m** TU2GM FM7BA VP2MZZ VR4CF 3D6BP YB0AB **10m** 3D6BP 8R1J (c.w.).

S. Turner:— 20m DU1CLR HB0XAA YB1BF/7 3B9DA (Rodriguez Is.).

B. Smith:— 80m ZP5YW **40m** CO2KK TI2RMA TG9IA **15m** HS1WR.

R. Smith:— 20m A5JO CO2FRC HP3AB VP2VEM.

R. Bell:— 15m P29JS CP3AF **10m** LU1NR.

All s.s.b. unless indicated otherwise.

BROADCAST BANDS

MEDIUM WAVE DX

by Charles Molloy G8BUS

During the last war a number of specialist receivers covering the low frequency bands only, were produced and on the face of it, they should be the answer to the medium wave DXers' prayers. Unfortunately there are snags. The majority of these receivers are bulky and heavy. Some are unsightly with jacks and multiway plugs on the front panel, and many were designed to run from unorthodox power sources such as a 24 volt aircraft supply. Reader **M. N. Button** of 101 The Street, Holt, Trowbridge, Wiltshire, has acquired one of those receivers—the ex-USAF DF Receiver type R101A/ARN6 which covers 100kHz to 1750kHz in four bands and he would be very grateful for any information on it. All letters will be answered.

Low Frequency Communications Receivers

A general coverage receiver such as the CR100 or the AR88 must have a reasonably high i.f. in order to provide good image rejection at the h.f. end of its range, but the higher the value of the i.f. then the worse the selectivity becomes so usually a compromise is chosen around 460kHz. If the selectivity is not good enough then a crystal or mechanical i.f. filter has to be provided. A receiver for low frequency use only, can have an i.f. as low as 100kHz which provides excellent selectivity with a minimum of complication while at the same time the image rejection is acceptable. Stability is also easier to achieve and two r.f. stages and three i.f. stages are not uncommon. As

Reports on the various bands are welcome and should be sent direct, by the 15th of the month, to:-

AMATEUR BANDS Eric Dowdeswell G4AR, Silver Firs, Leatherhead Road, Ashtead, Surrey KT21 2TW. Logs by bands, each in alphabetical order.

MEDIUM and SW BANDS Charles Molloy G8BUS, 132 Segars Lane, Southport, PR8 3JG. Reports for both bands must be kept separate.

VHF BANDS Ron Ham BRS15744, Faraday, Greyfriars, Storrington, Sussex RH20 4HE.

I have used three of these receivers at one time or another for medium wave DXing I thought it might be useful to pass on what I know of them.

The Marconi Mercury is by far the best receiver I have used for MW DXing. It first came to my attention when detailed in an article on coastal radio stations in *Practical Electronics* November 1966 edition. At that time the receiver was still in use in these stations. This valved receiver, complete with separate power pack, can be plugged straight into the 240 volt mains and it is ready to use. There is even an internal speaker. The receiver covers 100kHz to 4·0MHz in four bands with an additional band from 15kHz to 40kHz. On the two higher bands, which include the medium waves, it is a double superhet with i.f.s of 4·5MHz and 85kHz. There is a three-position selectivity switch which is adequate and heterodynes can be removed with an external audio notch filter instead of the more usual crystal phasing control. The receiver, although presentable in appearance, is too bulky and heavy for use in domestic surroundings, at any rate in my QTH, and consequently it is temporarily in retirement.

The BC314 is a low frequency version of the well known BC312 and there is also a BC344 which has the same relationship to the BC342. The BC314, which I have used, covers 150kHz to 1500kHz in four bands using an i.f. of 92·5kHz and there are two r.f. stages and two i.f. stages with metal octal valves. The BC314 performs very well on the medium waves. It is heavy but not too bulky but it runs from a 12 volt battery with a consumption of about 5 amps. The one I used was converted to run off 240 volt mains but this is not too easy to do as internal space is limited. The BC344 runs off 110 volt mains.

Older DXers will remember the Medium Wave Command Receiver which at one time was popular as a car radio. The official name is the R24/ARC5 or the BC946. It is compact and light, it has one r.f. and two i.f. stages using metal octal valves and the i.f. is 239kHz. The three i.f. transformers have push-pull rod adjustments for changing selectivity and in the "narrow" position this receiver is excellent for DXing. The frequency range is from 520kHz to 1500kHz in a single band. The tuning scale which rotates, is surprisingly accurate but there is no tuning knob as the receiver was designed for remote control by Bowden cable. It is fairly easy to fit a tuning control. The Command receiver works from 24 volts but the dynamotor can be removed to make space for a mains transformer etc. The heaters are unfortunately wired for 24 volts.

Other l.f. receivers that I know of are the Radio Compass MN26 with the suffix A, C, CA or W for medium wave coverage and the RBM which tunes from 140kHz to 2MHz with an i.f. of 140kHz. Although all of the receivers mentioned here have long since disappeared from the surplus market many are still in private hands and are sometimes on offer in the small ads columns of specialist radio amateur magazines such as *Radio Communications* (RSGB) and the *Short Wave Magazine*. When available, these receivers can usually be obtained for a modest outlay, for apart from the medium wave DXer and perhaps collectors, few people have any use for them.

Crystal Calibrators

"The crystal calibrator you mention presumably applies to your particular set and valves" writes **R. E. Steele** from Swanley, referring to the notes in the June issue about the gear at my QTH. This is not so. A crystal calibrator is connected to a receiver in place of the aerial and one can be used with any receiver, even a crystal set. A 100kHz calibrator generates a 100kHz carrier plus harmonics at 100kHz intervals. Harmonics are multiples of the fundamental, which in this case is 100kHz. This means that there will be 11 such harmonics or markers across the medium waves starting at 600kHz, then 700kHz and so on up to 1600kHz. Although useful, such a calibrator has limitations on the medium waves and a more complicated model with an additional alternative output of 25kHz or 10kHz will be more useful. My calibrator has switched outputs of 100kHz, 50kHz and 10kHz which are used as markers on the medium waves, enabling me to set my receiver onto any of the North American "channels" which are spaced at 10kHz intervals between 540kHz and 1600kHz. A calibrator with a single output of 10kHz would have its own problems as it would then be difficult to identify the individual 10kHz markers from one another. There would be 107 of them across the band.

These remarks apply to the medium and long waves only. A different approach is required for the short waves where the 100kHz markers become difficult to identify on the higher frequencies and an additional marker of 500kHz or 1MHz is then an advantage. For general DXing a calibrator with three outputs is adequate. One output of either 500kHz or 1MHz, a second of 100kHz and a third of either 25kHz or 10kHz, will cover most requirements.

DX

The implementation of the new (Geneva) band plan for the medium and long waves on the 23rd November 1978 will make Asiatic, African and Near East DXing more difficult from the UK. The new plan applies to these areas as well as to Europe! At the moment broadcasts from outside Europe are to be found in some of the gaps between European stations. For example, Kabul in Afghanistan can be found on 1280kHz which lies between Europeans on 1276 and 1285. Under the new plan, Kabul moves to 1278kHz which will be a European channel and this station may then become a rarity. So now is the time to have a look around before the change occurs. Listen as darkness approaches in the gaps between the European channels and refer to an up-to-date list, such as the 1978 *World Radio and TV Handbook* for possible DX. Riyadh in Saudi Arabia is on 587kHz, Kermanshah Iran is on 895kHz, Egypt on 1155, Enugu Nigeria on 1320, Kuwait on 1345, Kirkuk 1360 and Ahwaz 1390 both in Iran and Ban Pachi Thailand on 1580 with sign-on at 2230 GMT.

Pirate Radio Stations

A number of readers, the latest being **Richard Casey** EI9BL, send in logs of Pirate Radio stations. These stations operate outside the ITU regulations and they ought to be illegal in any country that belongs to this international organisation. It is also illegal in the UK to publicise these stations and consequently details of them cannot be included here. In any event, pirates are seldom DX. To the serious DXer they are just an unwelcome addition to a band already overloaded with QRM.

SHORT WAVE BROADCASTS

by Charles Molloy G8BUS

A reference to the MCR1 receiver in this column prompted **John I. Brown** of South Ockenden in Essex to write "I designed the MCR1 early in 1943 and it was produced by Philco in Perivale reaching a rate of 500 per week before Christmas that year. The set was packed in Huntley and Palmer biscuit tins, complete with two dry batteries, an a.c./d.c. power pack for 110-240V, earphones and coil boxes for all bands from 150kHz to 15MHz. The tins were solder sealed and 'delivered' in parachute containers, mainly by Halifax and Stirling bombers." John goes on to say that altogether 30,000 of these receivers were made, the majority being used to provide links to resistance movements in occupied countries. John, who has been a *PW* reader since he was a boy, thinks that many people would regard attempts to modify the MCR1 as vandalism! Strong words, but it does seem rather a pity to muck about with such a famous piece of equipment.

Time Signal Stations

A request for detailed information about the various time signal stations that can be heard on the short waves comes from Findon Vicarage in Wellingborough where the **Revd J. P. Beaumont** thinks this could be helpful to DXers for receiver alignment and calibration checks.

Time signal stations are to be found on 2·5MHz, 5MHz, 10MHz, 15MHz and on a number of other frequencies as well. In the UK, station MSF located at the National Physical Laboratory at Teddington transmits on 2·5, 5·0 and 10MHz, and the 5MHz transmission which is within the 60m broadcast band is a strong signal at my QTH. The "programme" which lasts for 10 minutes is repeated throughout the 24 hours. At 30 seconds before the hour the callsign MSF is sent in Morse code. Then there are second and minute pulses for a period of five minutes and during the following $4\frac{1}{2}$ minutes the station is off the air. As well as providing an accurate time check, MSF also provides an accurate frequency check and the DXer will find it useful for locating 5MHz on his receiver and hence the 60m band. He can use MSF as a frequency standard against which to calibrate equipment such as a wavemeter or crystal calibrator (where an adjustment is provided). MSF is also a good signal on 2·5MHz which marks the upper limit of the 120 metre tropical band. Clock pulses can also be heard from various stations throughout the world on 10MHz (30m) and 15MHz (20m) which lie within the unofficial limits of the 31 metre and 19 metre bands respectively.

Perhaps the most useful and interesting feature of these stations is the guide they give to propagation. Station VNG in Lyndhurst, Australia transmits on 4·5MHz, 7·5MHz and 12MHz, all three transmissions being audible in the UK when propagation is favourable. Others from Taiwan, China, India, Italy, Japan, Argentina, USSR, USA, Hawaii and South Africa are on 5MHz and 10MHz and some of them can be heard in the UK. Identification can be a problem but some information is included in the *World Radio and TV Handbook*. Full details of all known time signal stations, including a breakdown of each programme which in some cases gives a propagation forecast, are contained in a booklet, printed in English called *List of Time Signal Stations*, which has been compiled by a German DXer. It is obtainable from Gerd Klawitter, Ochtrupper Str 38, D-4430, Steinfurt, FRG (West Germany) in return for five International Reply Coupons.

Aerials and Trees

Following the comments in the July issue about using a tree as an anchorage for an aerial in place of a mast, **E. C. Rowland** has written in with some details of his own experiences. He says that if the tree is likely to move a lot then make sure that the pulley is able to move freely and is of as large a diameter as possible. Use stranded wire instead of rope as the latter will absorb moisture and freeze in cold weather. A spring between the end of the rope and the weight is also a help. His first attempt to use a tree was in the early days of wireless when he had a crystal set and the "weight" was an old-fashioned type of cooking pot designed to hang on a hook in a chimney. This rested on the ground when the tree was not in motion. An attempt was made to fit the pulley at the house end of the aerial but this caused problems with the lead-in and the idea was abandoned.

Receivers

Phil Grainger (South Shields) has moved from a Trio 9R59DS to the new Yaesu Musen FRG-7 but he says "I can't say this receiver is that much better than my trusty Trio". Do not expect spectacular results if you swap a good receiver for one that may be better. The law of diminishing returns also applies to receivers and quite a large outlay may bring only a marginal improvement which is not apparent except when listening to a weak or difficult station.

From South Africa regular *PW* reader **Francois Steyn** writes to ask if any reader could help him with some information, including a circuit diagram, about a rather old valve receiver which is marked SAJ Geloso Gruppo No 1988 Micro. Replies direct to 26 Voortrekker St, Villiersdorp, 7170, RSA. When connected to a 150ft inverted "L" aerial via a MOSFET (40673) preselector, this receiver pulled in JJY, the time signal station in Japan on 10MHz at 1640, the CBC Northern Service on 11720 SIO 333 at 2104, FEBC Philippines in English on 15440 at 1430 SIO 433 and SLBC Sri Lanka with a test transmission on 17850 at 1850 SIO 433.

DX

The Newport Amateur Radio Society is looking for new members, enquiries should go to **Martin Liezers**, 32 Barrack Hill, Newport, Gwent NPT 5FR. Martin, who looks after the interests of SWLs, uses a Realistic DX160, a home-brew aerial tuner and a large medium wave loop in series with a 200ft long wire. On 60m, DX heard included two Venezuelans, Radio Universo in Barquisimeto on 4880kHz at 2245 and Ecos del Torbes in San Cristobal on 4980 at 2240. Conakry, Guinea on 4910 was also heard at 2305.

Martin is having difficulty identifying Latin Americans and he mentions hearing "Colo Santa Araba" and "Radio Baraba" on 4950kHz approx. This is probably a reference to Santa Barbara del Zulio which is a medium wave station which may well be linked up in a network, such as Radio Rumbos, with a short wave outlet. The Rumbos network has the habit of announcing the names of all its stations, including the towns, which is very confusing for the DXer. Martin asks for the address of Radio Clarin which is AP 205, Zona 2, Sto Domingo, Dominica. **John Dennis Court** of Birmingham reports hearing Radio Clarin on 11700kHz (25m) between 2230 and midnight using an Eddystone EC10 and 10ft outdoor aerial, while thirteen-year-old **David Wyatt** of Oswestry heard Radio Clarin at 2300 in English also on 11700 using a home-brew receiver and 100ft of wire "tangled up" in the loft. From David's penpal in Indonesia comes news of RRI Jakarta on 9710 and 11790 from 0900-0930 and on 11790 from 1100 to 1200.

S. Donnelly suggests that the Radio Ping Pong mentioned in the July issue may be Radio Pyongyang in Korea while David Wyatt asks if anyone has reported recently to Radio Pyongyang. This station sent David a QSL card, a pennant, schedule, letter, set of postcards of Wonsan, a badge, a book about Pyongyang Zoo and two IRCs, as the latter are not valid in North Korea.

by Ron Ham BRS15744

We all know that the v.h.f.s are full of surprises, but, how many of us would have expected to see adverts on Hungarian television, cartoon films from Italy, sport from Poland, hear east-European and Italian broadcast signals dominating Band II, and UK amateurs working their Italian counterparts on 2m with comparative ease. It was all this, in one 3-hour session which set the telephones buzzing among our readers and disrupted the Saturday evening plans in many of our homes.

Sporadic-E

Around 1700 on July 8th, the v.h.f. bands were relatively quiet, but, by 1800 my R216, monitoring Ch. R1, 49·75MHz, was receiving strong television sync pulses which were heralding the start of the biggest sporadic-E disturbance for many years. It was soon obvious that frequencies between 30 and 150MHz were wide open and it was amazing to hear the chaos, as signals from a wide variety of international broadcast transmitters, which share the same frequencies throughout Bands I and II, mixed together.

Between 1810 and 1930, **Ian Rennison**, Horsham, Sussex, using a JVC 3040 UKC, fed by a dipole, received strong pictures from ORF Austria, DDR East Germany, RAI Italy and the USSR. At 1930, **Guy Stanbury**, Chelmsford, counted 37 Italian stations between 87 and 104MHz, as did Ian who writes "I was also monitoring Band II and it was cluttered with Italian f.m. stations, some were so strong that stereo reception was a 'piece of cake' ". I rang **Alan Baker**, G4GNX, Newhaven, Sussex, who demolished his piece of cake and rapidly humped his 2m gear up to his loft shack (it had been out for v.h.f. field day), and was rewarded for his immediate efforts, because between 1849 and 1930 he worked I6WJB, I0HKD, I0JFE on 2m s.s.b. and heard **Mike Hearsey**, G8ATK, Farnham, Surrey, along with several other G stations, in QSO with the Italians. **Clive Atlowe**, Blofield, Norwich, using three Sony stereo receivers, heard many private stations among the multitude of Italians in Band II and **Bob Dewick**, Bradwell-on-Sea, Essex, reckons that this event had been brewing up since early morning because during the day he received strong signals from Italian, Portuguese and Spanish broadcast stations in Band II. While most of us were concentrating on the v.h.f.s, **Harold Goble**, G4FDQ, Lancing, Sussex, used the short skip on 10m to work into GI, ZE and 5N2.

Throughout a similar event during the evening of July 10th, the German beacon, DL0IGI, was very strong and G4GNX had a half-hour QSO with DF2RQ, both on 10m. Guy Stanbury reports that Band II was disturbed early in the evening, and so was 2m, because **Peter Henley**, G8IQO, Eastbourne, Sussex, and **John Matthews**, G3WZT, near Horsham, worked stations in Greece. Later in the evening Alan Baker and **Roy Bannister**, G4GPX, Lancing, worked YU0OM, on 2m s.s.b. and **John Cooper**, G8NGO, Cowfold, Sussex, heard similar signals from I1, HG, and YU with an indoor 4-element Yagi. **Duncan Groves**, Chelmsford, described the opening as being like Pandora's box. . "things appeared everywhere" and William Poel. G8CYK, Brentwood, Essex, heard Yugoslavian stations in Band II with only a piece of wire in the aerial socket of his Ambit International Tuner.

During the morning of the 11th, DL0IGI was pounding in on 10m, TV pictures were coming from Sweden and the USSR on Band I and I counted 48 strong signals from east-European broadcast stations between 65 and 73MHz, some of which were heard by **Harold Brodribb**, St. Leonards-on-Sea, Sussex, using an indoor dipole to a home-brew receiver. Important, but much less severe sporadic-E disturbances occurred on June 19th, when I received good pictures from Finland, Iceland and Sweden, 20th, 22nd, and 29th and July 1st, when Ian Rennison received pictures from Austria, Hungary, Italy, Norway, Spain and the USSR, and July 2nd, 7th, 15th and 16th.

Solar Activity

Radio noise from the "active" sun was recorded at 136/142MHz by **Cmdr Henry Hatfield**, Sevenoaks, Kent, **John Smith**, Rudgwick, Sussex and myself on 18 of the 25 days from June 21st to July 16th, during which time there were two major noise storms, June 24th to 28th and July 9th to 12th, both disturbing the ionosphere and causing radio blackouts on many occasions. On June 26th, **John Branegan**, GM8OXQ, Saline, Fife, heard solar bursts at 29MHz, while Alan Baker received one at 144MHz and, on July 9th and 12th, many of us heard them at 28, 50 and 70MHz.

On July 7th, Henry Hatfield, using his spectroheliscope, saw the first appearance of the giant sunspot which reached the Central Meridian Passage on the 14th. Despite overcast skies, Henry did get a look at it on the 10th and noticed its unusually large penumbra. **Charlie Newton**, G2FKZ, London, tells me that the largest known Xray burst lasting 11 minutes took place on the Sun during the early days of this sunspot, and sent all recording instruments off scale. The thinning cloud during the evening of the 13th enabled **Barry Ainsworth**, **Eric Dowdeswell**, G4AR, Ashtead, Surrey, and **Mike Rowe**, G8JVE, East Preston, Sussex, to see this giant spot with only a filter in front of their eyes. **It is not advisable to look directly at the sun under any circumstances unless as Henry Hatfield says, you have a special and carefully designed filter to protect your eyes.**

Tropospheric Openings

To add to the turmoil the atmospheric pressure rose above 30·0in on July 6th and was still high on the 16th during which time there were several tropospheric openings. At 2218 on the 11th G4GNX worked ON5QW on 2m c.w., on the 13th G8JVE worked DK7KO and 4 French stations on 2m s.s.b., at 0130 on the 14th G8NGO had a QSO with DF1JC, first via the French repeater on R9 and then direct on s.s.b. G4GNX and G8JVE both contacted stations in southern France on the 15th and **Ern Hoare**, G8BDJ, Brighton, heard an OE on 2m.

Microwaves

Ern Downer, G8GKV, Worthing, Sussex and Ern Hoare, G8BDJ installed their 3cm gear at Chanctonbury Ring, a high spot on the South Downs, to compete in the 2nd round of the RSGB 10GHz Cumulative contest on June 25th. Despite the atrocious weather conditions, both Erns worked G3JHM/P, near Petersfield, G3JVL and G8DIC, in Hayling Island, and G3IFF/P on Portsdown Hill, all in Hampshire. During a contact between G8BDJ/P and G3KSU/P, Isle of Wight, a rain storm was seen crossing the path and the signal strength dropped from S9 down into the noise and came up again when the storm cleared the path.

CB Down Under

M. A. Penfold, ZL1TUI, Dunedin, New Zealand, read about the American CB stations being heard in the UK in our April issue, and asks if our readers would periodically listen around 26·5MHz for CB signals from New Zealand. M. A. Penfold also has a CB call, R0575, and would like to know if their 0·5 watt signals ever reach the UK.

OSCAR-8

John Branegan, assisted GM8NXW on the OSCAR stand at the Scottish Mobile Rally on June 10th, and says "I talked OSCAR-8 solidly for five hours, we had about 300 people there and a continuous stream of groups of 4 or 5 asking questions the whole time". At 2213 on July 8th John worked W1CRL, Maine, his first W contact via the satellite's mode-J. At 2317 on the 9th he contacted VE2LI, Montreal on s.s.b. and the VE replied on c.w. Two minutes later he had an s.s.b. QSO with WA3ZHW in Pennsylvania.

Club News

One of the attractions at the Worthing and District Amateur Radio Club's mobile rally held at Whiteways, near Arundel, Sussex, on June 20th was the Radio and Television interference detector van belonging to the Brighton area of the Post Office. The officer in charge, **Bob Taylor**, G8JZZ, demonstrated the vehicle's equipment. More than 150 attended the event which was organised by Barry Ainsworth. The talk-in station on 145MHz, operated by G8GKV worked more than 100 stations.

Bob Taylor G8JZZ beside his Post Office interference detector van

The Mid-Sussex Amateur Radio Society had stations on 4m G3XUP/P, 2m G3ZMS/P (the club call), 70cm G3VQN/P and 23cm G3RXJ/P (the club chairman), during the RSGB VHF NFD on July 8th. They were situated 700ft a.s.l. near Brighton and are very pleased with their results, especially on 23cm where they worked 10 stations in 5 counties using RXJ's home brew transmitter and a Microwave Modules converter.

Readers' Equipment

G8NGO now has a 12ft dish and hopes to use it in the future for moon-bounce on 23cm.

Gordon Goodyer has completed the *Practical Wireless* Audio Filter and is delighted with its performance.

Clive Atlowe, a keen TV/FM DXer has 12 TV receivers installed at his home, nine are fixed channels for sporadic-E and meteor scatter on Bands I, II, and III and the others, Sony 9-306UM, Luxor Colour set, and a German Philips Bellini are for u.h.f. reception. All are fed by a wide variety of aerials and pre-amps.

FRANK LUMAN *by RON HAM*

American-born Frank Luman began seriously DXing on the medium wave band, with a Hallicrafter SX-110, when the family moved from Cumberland, Maryland, to Denver, Colorado. The medium waves interested Frank because he could often hear stations some 3000 miles apart (i.e. KNX, Los Angeles and WNBC, New York), and was kept updated with the news as it happened as well as getting a different perspective on the music that was being played.

When Frank came to study in the UK (Pharmaceutical PhD) his hi-fi system, cassette deck, loudspeakers, stereo receiver and turntable came too. Through using the receiver, a Sherwood S-7100 A, at his present QTH in Glasgow, he fell for v.h.f. DX in a big way and began experimenting with aerials. In 1976, he was told that it was next to impossible to receive transmissions from the new station, Downtown Radio, (Belfast, 96·0MHz) in Glasgow, so, typically Frank, he mounted a Jaybeam FM9s aerial on his AR40 rotator, built an f.e.t. pre-amp and received the station loud and clear. What's more, with a little help from the troposphere, he heard signals from BBC Radio Carlisle, Radio Cleveland, and Metro Radio, along with Radio 4 from Holme Moss, Pontop Pike, and Sandale.

It was Roger Bunney's column, *Long Distance Television* in our sister magazine *Television*, that decided Frank to add DXTV to his radio activities. This meant two more Yagis on the rotator to feed a Hallicrafter S36-A for Band I sound carriers, and an early, dual-standard KB Victor VV-10 for v.h.f. and u.h.f. TV reception.

Frank's regular contributions to my v.h.f. column have shown some of the problems facing a DXer in Scotland and it was his enthusiasm for the subject that moved him to instigate the Scottish VHF and SW DXers Club, which currently meets fortnightly at his home. The members are making plans for a club shack where they can test a variety of aerials and equipment. Already they have an early warning system between them for auroral, meteor shower, sporadic-E and tropospheric events.

Frank Luman gets the most from his radio by coupling his interests in current affairs and music to an urge to receive programmes from stations at almost impossible distances.

AMATEUR SSTV

continued from page 29

One interesting feature of SSTV is that it can be stored on conventional audio recording tape. This is due to the low frequencies employed, which fall well within the 'audio' spectrum. Consequently, a readily available cassette or reel-to-reel recorder can also double as a storage and retrieval system for your SSTV pictures.

Slow to fast-scan converters are available which will display an SSTV picture on a conventional television monitor or receiver; designs by active amateurs such as DL2RZ are already well known. Alphanumeric information and colour transmissions have also been proved possible.

The accepted UK standards for SSTV are given in Table 1, and are the references to which any would-be constructor should work. There is, of course, a variety of commercially produced equipment available for those without the necessary facilities. The typical block diagram for a monitor, for example, is given in Fig. 2, and provides an indication of its complexity.

Table 1

Line Frequency 16·66Hz
Frame Frequency 0·142 (1/7)Hz
Lines per Frame 120 ± 8
Aspect Ratio 1:1
Horizontal Pulse Duration 5ms
Vertical Pulse Duration 30ms
Sub-carrier Frequencies:—
Sync. 1·2kHz
Black 1·5kHz
White 2·3kHz

The normal amateur licence permits the holder to use SSTV and no special dispensations are required, provided the standard requirements are observed. The accepted frequencies on which transmissions are made are 3640kHz, 3740kHz, 7040kHz, 14230kHz, 21350kHz, 28680kHz and 144·230MHz, the bulk of DX traffic being on 14230kHz.

Several publications on this subject are available to those interested and can be obtained from BATC Publications, 64 Showell Lane, Penn, Wolverhampton, Staffordshire.

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71	2	1	3 51	0 78
18	4	2	4 03	0 96
70	6	3	5 35	0 96
108	8	4	6 88	1 14
72	10	5	7 67	1·14
116	12	6	8 99	1 32
17	16	8	10 39	1·32
115	20	10	13 18	2·08
187	30	15	17 05	2·08
226	60	30	26 82	OA

50 VOLT RANGE
Pri 220/240v Sec 0-20-25-33-40-50V Voltages available 5, 7, 8, 10, 13, 15 17, 20, 33, 40 or 20V-0-20V & 25V-0-25V

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103	1 0	4 57	0 86
104	2 0	6·98	1 14
105	3·0	8 45	1 32
106	4 0	10 70	1 50
107	6 0	14·62	1 84
118	8 0	17 05	2 08
119	10 0	21 70	OA

MAINS ISOLATING (SCREENED)
PRIM 120/240 SEC 120/240 CT

Ref	VA (Watts)	£	P & P
*07	20	4·40	0·79
149	60	6 20	0 95
150	100	7 13	1·14
151	200	11·18	1·50
152	250	12 79	1 84
153	350	16 21	1 84
154	500	19 15	2 15
155	750	28 04	OA
156	1000	37 20	OA
157	1500	45 60	OA
158	2000	54·80	OA
159	3000	79·05	OA

*State Volts required 115V or 240V.

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1000	250	41·78	OA
2000	252	84 25	OA

30 VOLT RANGE
Pri 220/240 Sec 0-12-15-20-24-30V Voltages available 3, 4, 5 6, 8, 9, 10, 12, 15, 18, 20, 24, 30V or 12V-0-12V & 15V-0-15V.

Ref	Amps	£	P & P
112	0 5	2 64	0 78
79	1·0	3 57	0 96
3	2·0	5·27	0 98
20	3 0	6 20	1 14
21	4 0	7 44	1·14
51	5·0	8 37	1 32
117	6 0	9 82	1·45
88	8·0	11 73	1·64
89	10·0	13 33	1·84

60 VOLT RANGE
Pri 220/240V Sec 0-24-30-40-48-60V Voltages available 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 or 24V-0-24V, 30V-0-30V

Ref	Amps	£	P & P
124	0 5	3·80	0·96
126	1·0	5 58	0 96
127	2 0	7 60	1 14
125	3 0	10 54	1 32
123	4·0	12 23	1·84
40	5 0	13 85	1 64
120	6 0	15·66	1·84
121	8 0	20·15	OA
122	10 0	24 03	OA
189	12·0	27·13	OA

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67	500	0-115-200-220-240	10 99	1 64
84	1000	0-115-200-220-240	18 78	2 08
93	1500	0-115-200-220-240	23·38	OA
95	2000	0-115-200-220-240	34 82	OA
73	3000	0-115-200-220-240	48 00	OA
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57	5000	0-10-115-200-220-240	77 48	OA

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13	100	9-0-9	2·14	0·38
235	330, 330	0-9, 0-9	1 99	0·38
207	500, 500	0-8-9-, 0-8-9	2·50	0·71
208	1A, 1A	0-8-9, 0-8-9	3 53	0 78
236	200, 200	0-15, 0-15	1 88	0·38
214	300, 300	0-20, 0-20	2 56	0 78
221	700 (DC)	20-12-0-12-20	3 41	0 78
206	1A, 1A	0-15-20-0-15-20	4 83	0·96
203	500, 500	0-15-27-0-15-27	3 89	0·96
204	1A, 1A	0-15-27-0-15-27	5 39	1·96
239	50	12-0-12	1 99	0 38
S112	500	12-15-20-24-30	2 64	0 78

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ELECTROVALUE Buying Guide

Section 1

If you have bought before from Electrovalue, you will know just how large and varied our stocks are. For those who have yet to know, we are publishing a series of five ads. month by month to give up-to-date information and prices on the most important items we carry. These ads. will appear in stepped rotation in five journals—Pr. Wireless, Pr. Electronics, Everyday Electronics, Electronics Today Intntnl. and Elektor, so that the complete series will be available each month. In this way, no matter which journals you read, BY DETACHING AND SAVING THESE PAGES, YOU WILL BUILD UP A VALUABLE AND COMPREHENSIVE MONEY SAVING CATALOGUE.

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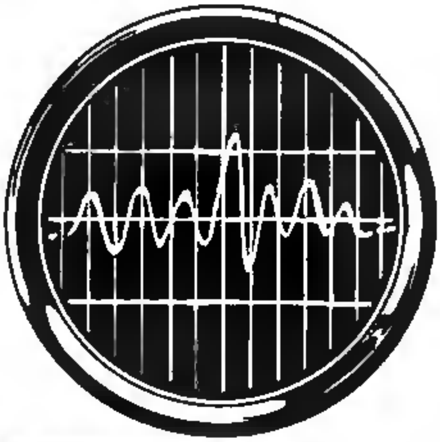

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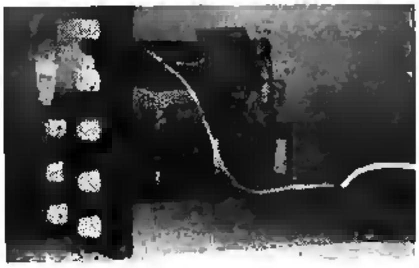

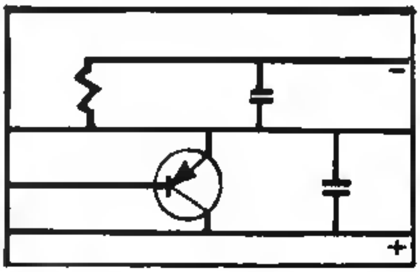

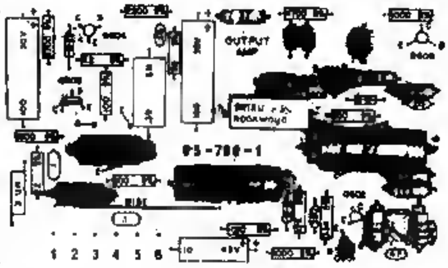

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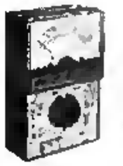

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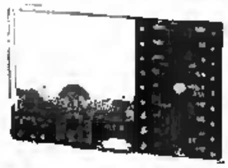

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