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7414	45p	74137	90p
7416	25p	74138	100p
7417	25p	74141	50p
7420	12p	74142	180p
7421	20p	74143	270p
		74144	270p
7422	15p	74145	55p
7423	20p	74147	100p
7425	20p	74148	90p
7426	22p	74150	65p
7427	22p	74151	45p
7428	25p	74153	45p
7430	12p	74154	70p
7432	20p	74155	45p
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7440	12p	74161	55p
7441	45p	74162	55p
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7450	12p	74174	60p
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7453	12p	74176	50p
7454	12p	74177	50p
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7472	20p	74181	130p
7473	25p	74182	50p
7474	25p	74184	120p
7475	25p	74185	100p
7476	25p	74188	320p
7480	40p	74190	70p
7481	85p	74191	70p
7482	75p	74192	60p
7483	75p	74193	60p
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4016	30p	4070	12p
4017	50p	4071	12p
4018	55p	4072	12p
4019	40p	4081	12p
4020	50p	4082	12p
4022	50p	4093	70p
4023	12p	4510	60p
4024	40p	4511	70p
4025	12p	4516	65p
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10/10	7p	220/50	22p
10/16	7p	330/25	17p
10/25	7p	330/35	18p
10/50	7p	330/50	20p
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22/16	7p	470/35	20p
22/25	7p	470/50	24p
22/35	7p	1000/16	27p
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FABULOUS PROFESSIONAL DISCO SYSTEM

F.A.L. De Luxe PROFESSIONAL CONSOLE (Powered) Carr. etc. £15

Slide Fade Controls. Autofade with Music Overide on both mic. and jingle inputs. Headphone pre-fade monitor with 5 Push-button selector. Illuminated V.U. meters. Illuminated rocker switches. LED cue indicators. Tape or Jingle inputs, unity gain. Mic. channel with Bass & Treble. Slave outlet.

Treble Control (Music Channel)
Treble Control (Mic. Channel)
Bass Control (Music Channel)
Bass Control (Mic. Channel)
Output into line (Slave)
Autofade Recovery
Microphone Input.
Tape/Jingle. 1/P

£399

SAVE £100

DEPOSIT £28·88 and 38 weekly payments of £9.74 (Total £399)

TURNTABLES: Garrard 125SB Belt-drive with Low-Mass 'S' arm and Magnetic Cartridge.
POWER: 120 watts continuous RMS into 4 ohms
DECK LIGHTS: Fully adjustable flexi-beams over each turntable with independent switching.
CABINET: Solidly made to withstand the rigours of transporting. Covered in heavy duty leather cloth type material in attractive colour combinations Corner cap protectors Recessed carrying handles.

List £320.76

INTEREST FREE CREDIT on this system only

ALL THREE UNITS PRODUCED BY BRITAINS LARGEST MAKERS OF DISCO EQUIPMENT

PAIR MATCHING FULL RANGE De Luxe 80w LOUDSPEAKERS

Each inc. Pair of Powerful 12" Bass units (with aluminium centre domes), and High Frequency Horn unit to extend frequency range to above 17 kHz. Normally £89·95 ea.

Make your own Console with these DISCO MODULES

CONTROL UNIT (mains powered) Vol. (Left) Vol. (Right) Tape input and volume control. Bass, Treble, ON/OFF switch for each Table. **£25·00** Carr. £1

MONITOR UNIT With H/Phone Socket and Vol. Control Carr Free **£7·95**

FADER UNIT Carr Free **£7·95**

100w OUTPUT UNIT Mains powered Carr. £1·50 **£29·95**

FANTASTIC SPEAKER OFFER

TWIN 12" SPEAKER CABINET PLUS PAIR 12" SPEAKERS

of Robust vibration-proof construction. Fitted protective corner pieces, Removable Vynair covered front with silver effect trim. Sunken jack socket with escutcheon at the rear.
Pair 12" 20w speakers for wiring in series and front mounting in above supplied to complete a 40 watt unit for lead guitar or P.A.

While stocks last Three items

£19·95 Carr. £2·50

TITAN GROUP/DISCO SPKRS

	Value	RSC Price
T12/45R 12" 45w	£15·00	£12·95
T12/60R 12" 60w	£22·50	£14·95
T12/100 12" 100w	£36·00	£25·95
T15/60 15" 60w	£26·00	£17·95
T15/70 15" 70w	£28·00	£19·95
T15/100 15" 100w	£41·00	£29·95
T18/100 18" 100w	£51·00	£39·95

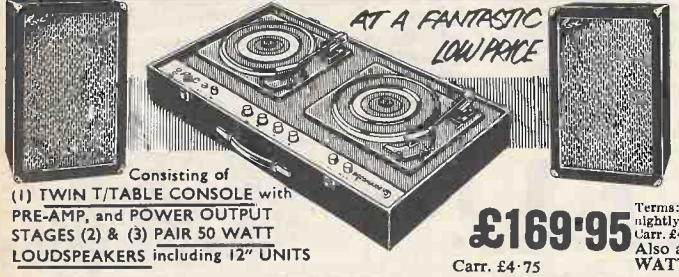
Rating RMS Imp 8-15 ohms

Carr. £1·20, under £18, over this add 6p per £1.

CABINETS FOR ABOVE Heavy duty, finished in black Vynide with Vynair fronts, protective corner pieces, various sizes cut-outs. TE1 1 × 12" £11·95. TE2 2 × 12" £16·95. Deposit Terms orders over £20.

RSC 100 WATT DISCO SYSTEM

ALL RSC PRICES INCLUDE VAT



Consisting of
(1) TWIN T/TABLE CONSOLE with PRE-AMP, and POWER OUTPUT STAGES (2) & (3) PAIR 50 WATT LOUDSPEAKERS including 12" UNITS

★ DISCOMAJOR POWER DISCO CONSOLE with integral Power Amplifier.
★ TWIN FULL SIZE BSR turntables with cueing device.
★ CARTRIDGES with Diamond Styli.
★ 3 SEPARATE VOLUME CONTROLS for each turntable and Mic.
CONSOLE COMPLETE WITH LID. FULL HEADPHONE MONITORING FACILITIES

£169·95 Carr. £4·75

Terms: Deposit £30·00 and 18 fortnightly pymts. £9·80 (Total £206·40). Carr. £4·00.
Also available 200 WATT SYSTEM **£199·95**

50 WATT AMPLIFIER SACRIFICE

Limited stocks of **TITAN TA/50A** to be cleared to make way for a re-styled model.

Solid state, 3 sep. controlled inputs plus Master control. Bass. Treble & Presence Controls. Vynide covered cab. with corner protectives. Value £60. Terms: Dep. £7·95 & 8 monthly payments £4·72 (Total £45·71). Matching Cabinets 1 × 12" £29·95, 2 12" £49·95 Carr. £1 **£39·95**

New Branches at ★LEEDS, ★LIVERPOOL & ★WOLVERHAMPTON

RSC

BARCLAYCARD VISA

Barclaycard & Access PHONE ORDERS quoting CARD NUMBER accepted

MAIL ORDERS & EXPORT ENQUIRIES TO:— AUDIO HOUSE, HENCONNER LANE, LEEDS, 18. Tel: 0532 577631.
MAIL ORDERS MUST NOT BE SENT TO SHOPS

TERMS C.W.O. or C.O.D. No. C.O.D. under £3. POSTAGE 60p PER ORDER OR AS QUOTED. Phone or Write for FREE CATALOGUE.

OPEN ALL DAY SATS (5 Day Week) Prices correct at 11.12.78 E. & O.E. All items subject to availability

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CARLISLE 8 English Street (Closed Thurs.). Tel. 38744
COVENTRY 17 Shelton Sq., The Precinct. (Closed Thurs.) Tel. 25983
DERBY 97 St. Peter's Street (Closed Wed.) Tel. 41361
DEWSBURY 9/11 Kingsway (Closed Tues.) Tel. 468058
DONCASTER 3 Queensgate, Waterdale Centre. (Closed Thurs). Tel. 63069
EDINBURGH 101 Lothian Rd. (Closed Wed.) Tel. 229 9501
GLASGOW 326 Argyle St. (Closed Tues.). Tel. 041-248 4158
HULL 7 Whitefriargate (Closed Thurs.). Tel. 20505
LEICESTER 32 High Street (Closed Thurs.). Tel. 56420
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★**LEEDS** 16-18 County (Mecca) Arcade, Briggate (Closed Wed.). Tel. 449609
★**LIVERPOOL** 35 Dawson Way, St. John's Precinct (Closed Wed.). Tel. 708 9380
★**MANCHESTER** 60A Oldham Street (Closed Wed.). Tel. 236 2778
MIDDLESBROUGH 103 Linthorpe Rd. (Cl. Wed.) Tel. 247096
★**NEWCASTLE UPON TYNE** 59 Grainger St. (Closed Wed.). Tel. 21469
NOTTINGHAM 19/19A Market Street (Closed Thurs.). Tel. 48068
SHEFFIELD 13 Exchange Street (Castle Mkt. Blds.) (Closed Thurs.). Tel. 20718
★**WOLVERHAMPTON** 6 Wulfrun Way (Closed Thurs.). Tel. 26612

★**MUSICAL INSTRUMENTS & ACCESSORIES** in stock at these branches

ROOM THERMOSTAT

Famous Satchwell, elegant design. Intended for wall mounting. Will switch up to 20 amps at mains voltage, covers the range 0.30 C. Special snip this month **£3·25.**

ROD THERMOSTAT—£3·00.

WINDSCREEN WIPER CONTROL

Vary speed of your wiper to suit conditions. All parts and instructions to make **£3·75.**

MICRO SWITCH BARGAINS

Rated at 5 amps 250V. Ideal to make a switch panel for a calculator and for dozens of other applications. Parcel of 10 (two types) for **£1·25.**

RADIO STETHOSCOPE

Easiest way to fault find, traces. signal from aerial to speaker, when signal stops you've found the fault. Use it on, Radio, TV, amplifier, anything. Kit comprises transistors and parts including probe tube and twin stetho-set **£3·95.**

MULTISPEED MOTORS

Six speeds are available 500, 800 and 1,000 r.p.m. and 7,000, 9,000 and 11,000 r.p.m. Shaft is ⅛ in. diameter and approximately 1 in. long. 230/240V. Its speed may be further controlled with the use of our Thyristor controller. Very powerful and useful motor size approx. 2 in. dia. × 5 in. long. Price **£2.**

12V MINIATURE RELAY

dc operated with two sets of change over contacts. The unique feature of this relay is its heavy lead out wires; these provide adequate support and therefore the relay needs no fixing; on the other hand there is a fixing bolt protruding through one side so if you wish you can fix the relay and use its very strong lead outs to secure circuit componants—an expensive relay; but we are offering it for only **87p** each. Don't miss this exceptional bargain!

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, £6.**

MAINS RELAYS

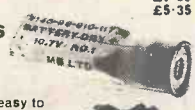
With triple 10 amp changeover contacts—operating coil wound for 230V a.c. Chassis mounting one screw fixing. Price **£1·25**

BURGLAR ALARM ITEMS

(Circuit free on application)

Trigger mats 24" × 18"	£2·45
13" × 10"	£1·95
Relay 24 volt	95p
9-12 volt	95p
Alarm Bell 24 volt	£7·50
9-12 volt	£2·25
Mains	on application
Reset, Switch, ordinary	45p
Secret type with key	95p
Wire—100 metres	£1·50
24v Power unit mains operated	£5·35

MERCURY BATTERIES



Bank of 7 Mercury cells type 625 which are approx. ¾in. diameter by ½in. thick in plastic tube giving a total of 10·7V.

Being in a plastic tube it is very easy to break up the battery into separate cells and use these for radio control and similar equipment. Carton of 25 batteries **£1·60.**

PP3/PP9 REPLACEMENT

Japanese made in plastic container with leads size 2in. × 1¼in. × 1¼in., this is ideal to power a calculator or radio. It has a full wave rectifier and smoothed output of 9V suitable for loading of up to 100mA. **£2·53.**

SWITCH TRIGGER MATS

So thin is undetectable under carpet but will switch on with slightest pressure. For burglar alarms, shop doors, etc. 24in. × 18in. **£2·50.** 13in. × 10in. **£1·95.**

MAINS TRANSISTOR PACK

Designed to operate transistor sets and amplifiers. Adjustable output 6v., 9v., 12 volts for up to 500mA (class B working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9 and others. Kit comprises: mains transformer, rectifier, smoothing and load resistor, condensers and instructions. Real snip at only **£1·95.**

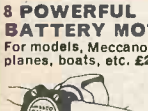
DRILL CONTROLLER

Electronically changes speed from approximately 10 revs to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. **£3·45**

Made up model £1·00 extra

8 POWERFUL BATTERY MOTORS

For models, Meccanos, drills, remote control planes, boats, etc. **£2.**



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.**

SHORTWAVE CRYSTAL SET

Although this uses no battery it gives really amazing results. You will receive an amazing assortment of stations over the 10, 25, 29, 31 metre bands. Kit contains chassis front panel and all the parts **£1·94**—crystal earphone **55p** including VAT and postage.

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 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.

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. 3¾ in. long, 1 in. wide and 1⅜ in. deep **75p.**

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.**

25A ELECTRIC PROGRAMMER

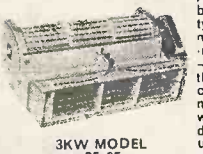
Learn in your sleep. Have radio playing and kettle boiling as you wake—switch on lights to ward off intruders—have a warm house to come home to. All these and many other things you can do if you invest in an electrical programmer Clock by famous maker with 15 amp on/off switch. Switch-on time can be set anywhere to stay on up to 6 hours independent 60 minute memory jogger. A beautiful unit. **£3·50.**

MULLARD AUDIO AMPLIFIERS

All in module form, each ready built complete with heat sinks and connection tags, data supplied Model 1153 500mW, power, output **£1·69**

Model 1172—10 watts power output **£3·94**
Model 1172 1W. power output **£2·25**
Model EP9000 4 watt power output **£2·90**
EP 9001 twin channel or stereo pre-amp **£2 90**

TANGENTIAL HEATER UNIT

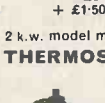


A most efficient and quiet running blower-heater by Solatron—same type as is fitted to many famous name heaters—Comprises mains induction motor—long turbo fan—split 2 kw heating element and thermostatic safety trip—simply connect to the mains for immediate heat—mount in a simple wooden or metal case or mount direct onto base of say kitchen unit—price **£4·95** post **£1·50** control switch to give 2kw. 1kw, cold blow or off available 60p extra.

3KW MODEL
£5·95
+ £1·50 P & P

2 k.w. model made in metal case with control switch **£12·00**

THERMOSTATS



Refrigeration as illustrated with 36" capillary **£1·62.**
Limpet Stat must be mounted in close contact calibrated 90°-190°F 15 amp contacts **£1·62.**
Appliance Stat fix like a volume control—15 amp contact 30°-80°F **85p.**
ditto but for high temps **£1·25.**
Over Stat—with Serson and capillary **85p**
Wall Mounting by Satchwell **£3·00**
Boiler Stat. with control 20°-80°C **£2·16**

SOUND TO LIGHT UNIT

Add colour or white light to your amplifier. Will operate 1, 2 or 3 lamps (maximum 450W). Unit in box all ready to work. **£9·95.**

MINI-MULTI TESTER

Amazing, deluxe pocket size precision moving coil instrument jewelled bearings—1000 opv—mirrored scale.
11 instant ranges measure:—
DC volts 10, 50, 250, 1000
AC volts 10, 50, 250, 1000
DC amps 0-1 mA and 0-100 mA
Continuity and resistance 0-150K ohms.
Complete with insulated probes, leads, battery, circuit diagram and instructions.

Unbelievable value only **£6·50 + 50p** post and insurance.
FREE Amps ranges kit enable you to read DC current from 0-10 amps. directly on the 0-10 scale. It's free if you purchase quickly but if you already own a mini tester and would like one send **£1·50p.**

TERMS: Cash with order—but orders under **£6** must add **50p** to offset packing, etc.

BULK ENQUIRIES INVITED. PHONE: 01-688 1833.

J. BULL (ELECTRICAL) LTD

(Dept. P.W.), 103 TAMWORTH RD., CROYDON CR9 1SG

IT'S FREE

Our monthly Advance Advertising Bargains List gives details of bargains arriving or just arrived—often bargains which sell out before our advertisement can appear—it's an interesting list and it's free—just send S.A.E. Below are a few of the Bargains still available from previous lines.

Telephone Ringing Mains Unit Rather novel unit as it not only reduces mains to 50 volts but also reduces the mains frequency to 25 Hz, this frequency gives correct ringing note for GPO bells. These units were made for the GPO so obviously are first class. Completely enclosed and safe to mount on the wall or stand on a shelf. Price **£3·20.**

Telephone Extension Bells in bakelite wall box. these will save you missing calls when you are out in the garden or shed, etc. Price **£3·16.**

Variable Mains Supply A bench mounting unit which contains an isolation transformer for safety and a 2 amp variac for adaptability. With this you will be able to get continuously variable mains supply from zero to full voltage at 2 amps. A real time saving device, price only **£20·75.**

Answering Machines still available as last month's newsletter but supplies are going down rapidly and this may well be your last chance to acquire one of these.

A very large purchase this month enables us to offer a range of radio items. You will find the prices well below average:

Cassette Recorder/Player Japanese or Hong Kong made, these have all the normal facilities record, playback, fast rewind, etc., also sockets for stop/start, microphone, earphone and lead for mains as these operate from mains or HP1 batteries. **£12·50.**

Six Transistor Pocket Radios Medium wave only but with Radio 2 and Radio 4 changing places, Medium wave is all the average listener will want in the future. These little radios would make a lovely gift for a child. Modern design and in popular colours, please state preferred colour and give an alternative, price only **£1·50.**

AM/FM Radios There's no doubt that FM does give better reproduction in good areas so a more adult member of the family will be pleased with one of these. The ones we have are in leatherette cases and are battery/mains radios having the mains unit built in and are complete with mains plug. These cover medium wave and VHF with optional AFC. Price **£6·75.**

8 Track to Cassette Adaptors Cartridges are going out of popularity, cassettes on the other hand are being made in increasing numbers and cover practically every field of sound entertainment. Cassettes can be played in 8 track if you have an adaptor. We offer these adaptors complete in carrying case and the price is only **£8·50.**

Soft Toy Radios Not necessarily only for the younger members of the family as these are soft and cute and have universal appeal. Dolls, poodles, elephants and rabbits each with zip compartment at the bottom where the radio fits. Medium wave only, working from PP3 batteries. When ordering please state preference and if possible give an alternative. **£4·50.**

5 Band Portable. A very impressive radio in black imitation crocodile case, size approx. 12in. wide, 7in. high and 4in. deep. This has metal embellished carrying handle and a pullout chrome plated FM aerial, covers the following bands AM 535 to 1605 kHz. FM 88 to 108 MHz weather band 162.5 MHz and it has a logging scale. This battery/mains radio has the built in mains unit also serves as a charger if you use rechargeable batteries. The mains lead with plug tucks away in its own compartment, another feature is a dial indicator which shows state of batteries. A real snip at **£10·50.**

Car Battery Power Unit made for Rank Radio. This unit has been designed to operate 6V battery powered equipment from a 12V car battery, it provides a reliable source of stabilised voltage and gives protection to your equipment in case of accidental reversal of connections also against excessive car battery voltage should this occur. The unit is very robust and virtually everlasting if used sensibly. It uses a negative earth circuit but it will operate in a positive earth car providing the instument being played is not connected to the car chassis. A real bargain at **£2·20.**

Extension Speaker Cabinets A new delivery of these enables us to bring down the price quite a lot. We can now supply the smaller ones (11in. x 8in. x 4½in. approx.) at **£1·95.** Post £1·00 and we have a larger one with a silver finish size approximately 12¼in. x 9in. x 5½in. Price of this is **£1·69,** post £1·50. If you can call and collect these cabinets you can save yourself the quite considerable postage and you only have to buy a few to get a discount as well. The quantity discount for these is a speacial rate of 25% if you buy four or more. Note these cabinets are very good quality (made for Rank Audio Systems) the grill material is Dacron.

Slide Switch Bargain Double pole changeover standard size with good length of connecting wire soldered to each tag—10 for **£1·38.**

Six Digit Counter Mains operated, 1 pulse moves counter through one digit, not resettable but all you have to do is to make note of the numbers before the start of each count. Real bargain at **80p**

Be Prepared For possible blackouts and interruptions in electricity supply this winter! Have some emergency lighting nearby. We still have the fluorescent outfits for operating 12in tubes from 12V car battery and the price is still the same **£3·95** plus 50p post complete with a 21in tube.

Stereo Car Speakers usual type in neat compact enclosures for the rear shelf of the car. 8 ohms 5 Watt **£5·50** per pair.

Bleepers 6/12V battery or transformer operated, ideal for using in many alarm circuits but particularly for car and motor cycle alarms. These give a loud shrill note. American made by Delta Alarms. Price **£1·08** + 8p. Large quantities available.

Most Useful Timer Up to 12 on/offs per 24 hours is what you can get from the Venner time switch if you fit our adaptor. The shortest on/or off time is one hour but you can use any combinations of on/off to make up the 24 hours. An obvious use for this is to control immersion heaters. These are real current consumers and even though the thermostats are working properly, economies can be quite considerable if a time switch is used. Our Venners are all capable of 20 amp switching. There are of course many other applications for the time switch, which you will remember in its basic form follows the sun switching on at dusk and off at dawn. Price **£3·24** plus 50p post for switch with adaptor, extra for plastic case **£1·08** or metal case **£2·16** + 16p.

Safe Soilstat For growers who use soil heating on benches, economies can be made by using a thermostat but if mains voltage equipment is used then the thermostat must be enclosed in a waterproof and earthable container. We can now supply this price **£3·78** + 28p. This container will accept the normal immersion heater type thermostat but for soil heating you want one which covers 50 deg. farenheit and upwards, we can supply these at **£3·20.**

Motorised Light Flasher We can offer two motorised units both capable of 2 000W of light. Our ½ second flasher changes every ½ second and the 2 second flasher changes every 2 seconds. Either type **£6·40.**

Frightening Fuel Bills could lose some of their sting if you fit double glazing but even if the fuel bill does not come down much you will have a more comfortable home less draughts, etc. Double glazing frames, movable in the Spring, can be quite easily made using rigid PVC sheetings. We have this, it is as clear as glass and virtually as everlasting. It is easy to fit as you can cut it, bend it, nail it, etc. A recent purchase enables us to offer this at well below current price. It is 600mm (23½in wide) and available in any length (it rolls up like lino). Price 15p per sq ft. Minimum order 20 sq ft for **£1·05** post 50p orders over £6·00 post free, longer lengths price negotiable.

RADIO EXCHANGE LIMITED

NEW ELECTRONIC MASTER KIT

With special V.H.F. Tuner Module to construct. A completely Solderless Electronic Construction Kit, with ready drilled Bakelite Panels, Nuts, Bolts, Wood Screws, etc. Also in the kit: Transistors, Capacitors, Resistors, Pots, Switches, Wire, Sleeving, Knobs, Dials, 5" × 3" Loudspeaker and Speaker Case, Crystal Earpiece, etc. Also ready wound Coils and Ferrite Rod Aerial. These are the Projects you can build with the components supplied with the kit, together with comprehensive Instruction Manual Pictorial and Circuit Diagrams.

Projects:
V.H.F. Tuner Module ★ A.M. Tuner Module ★ M.W. L.W. Diode Radio ★ Six Transistor V.H.F. Earpiece Radio ★ One Transistor M.W. L.W. Radio ★ Two Transistor Metronome with variable beat control ★ Three Transistor and Diode Radio M.W. L.W. ★ Four Transistor Push Pull Amplifier ★ Eight Transistor V.H.F. Loudspeaker Receiver ★ Variable A.F. Oscillator ★ Jiffy MultiTester ★ Four Transistor and Diode M.W. L.W. Radio ★ A.F. R.F. Signal Injector ★ Five Transistor Push Pull Amplifier ★ Sensitive Hearing Aid Amplifier ★ Three Transistor and Diode Short Wave Radio ★ Signal Tracer ★ Three Transistor Push Pull Amplifier ★ One Transistor Class A Output Stage to drive Loudspeaker ★ Sensitive Transistor Pre-Amp ★ Transistor Tester ★ Sensitive Three Transistor Regenerative Radio ★ Four Transistor M.W. L.W. and Diode Tuner ★ Five Transistor M.W. L.W. Trawler Band Regenerative Radio ★ Five Transistor V.H.F. Tuner ★ Three Transistor Code Practice Oscillator ★ Five Transistor Regenerative Short Wave Radio ★ Four Transistor and two Diodes M.W. L.W. Loudspeaker Radio ★ Seven Transistor M.W. L.W. Radio with Loudspeaker Push Pull output ★ One Transistor Home Broadcaster.

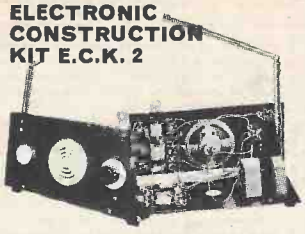
£14·99 + P & P £1·10

V.H.F. AIR CONVERTER KIT

Build this converter kit and receive the aircraft band by placing it by the side of a radio tuned to medium wave or the VHF band and operating as shown in the instructions supplied free with all parts.
Uses a retractable chrome-plated telescopic aerial, gain control, V.H.F. tuning capacitor, transistor, etc. Size 5½"×1½"×3½". All parts including case and plans.

£4·95 + P & P and Ins. 60p

ELECTRONIC CONSTRUCTION KIT E.C.K. 2



Self Contained Multi-Band V.H.F. Receiver Kit.
8 transistors and 3 diodes. Push pull output. 3 in. loudspeaker, gain control, 7 section chrome-plated telescopic aerial, V.H.F. tuning capacitor, resistors, capacitors, transistors, etc. Will receive T.V. sound, public service band, aircraft, V.H.F. local stations, etc. Operates from a 9 volt P.P.7 battery (not supplied with kit).
Complete kit of parts

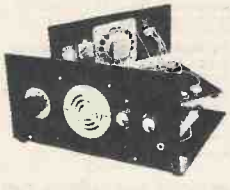
£7·95 + P & P and Ins. 90p

NEW MODEL R.K.1.

MultiBand A.M. Receiver. M.W.L.W. Trawler Band and Three Short Wave Bands. Seven Transistors and Four Diodes. Push Pull Output stage. 5" × 3" Loudspeaker. Internal Ferrite Rod Aerial. Kit includes all parts to build it up including Carrying Strap, Rubber Feet and ready-drilled Panels. Comprehensive Instruction Manual for stage by stage construction. Uses P.P.9 Nine Volt Battery.

£8·99 + P & P 90p

EDU KIT JUNIOR



Completely Solderless Electronic Construction Kit. Build these projects without Soldering Iron or Solder

- ★ Crystal Radio Medium Wave Coverage—No Battery necessary
- ★ One Transistor Radio
- ★ 2 Transistor Regenerative Radio
- ★ 3 Transistor Earpiece Radio Medium Wave Coverage
- ★ 4 Transistor Medium Wave Loudspeaker Radio
- ★ Electronic Noise Generator
- ★ Electronic Metronome
- ★ 4 Transistor Push/Pull Amplifier

All parts including Loudspeaker, Earpiece, M.W. Ferrite Road Aerial, Capacitors, Resistors, Transistors, etc. Complete kit of parts including construction plans.

£6·95 + P & P and Ins. 90p

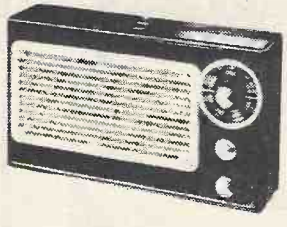
NEW ROAMER TEN MODEL R.K.3.

Multiband V.H.F. and A.M. Receiver. 13 Transistors and Six Diodes. Quality 6" × 3" Loudspeaker
With Multiband V.H.F. section covering Mobiles, Aircraft, T.V. Sound, Public Service Band, Local V.H.F. Stations, etc. and Multiband A.M. section with Airspaced Tuning Capacitor for easier and accurate tuning, covering M.W.1, M.W.2, L.W. Three Short Wave Bands S.W.1, S.W.2, S.W.3 and Trawler Band. Built-in Ferrite Rod Aerial for Medium Wave, Long Wave and Trawler Band, etc., Chrome-plated 7 section Telescopic Aerial, angled and rotatable for peak Short Wave and V.H.F. reception. Push-Pull output using 600mW Transistors. Gain. Wave-Change and Tone Controls. Plus two Slider Switches. Powered by P.P.9—9 volt Battery.

Complete kit of parts including carrying strap. Building Instructions and operating Manuals.

£14·79 + P & P £1·10

E.V.6 PLUS ONE



Build this exciting new design. Now with 7 Transistors and 4 diodes. MW/LW. Powered by 9V battery. Ferrite rod aerial, tuning condenser, volume control, and now with 3in. loudspeaker. Attractive case with red speaker grille. Size 9in. x 5¼in. x 2¾in. approx. All parts including Case and Plans.
Total Building Costs:

£6·95 + P & P and Ins. 90p

EDU-KIT MAJOR

Completely solderless Electronic Construction Kit. Build fifteen projects including:—
● Signal Injector ● Transistor Tester NPN-PNP ● 7 Transistor Loudspeaker Radio MW/LW ● 5 Transistor Short Wave Radio.

Components include:
● 24 Resistors ● 21 Capacitors ● 10 Transistors ● 5" × 3" Loudspeaker ● Earpiece ● Mica Baseboard ● 3 12-way Connectors ● 2 Volume Controls ● 2 Slider Switches ● 1 Tuning Condenser ● 3 Knobs ● Ready Wound MW/LW/SW Coils ● Ferrite Rod ● 6½ yards of wire ● 1 yard of sleeving, etc. Complete kit of parts including construction plans.
Total building costs:

£9·99 + P & P and Ins. £1·10

RADIO CONSTRUCTION KIT Q7

A compact small radio kit covering Medium Wave and Long Wave bands. Rugged Micanite construction and simple square design allows for easy carrying and positioning. Ideal for the Garage, Workroom, Kitchen, etc., has seven Transistors and four Diodes, quality Loudspeaker, ready wound Ferrite Rod Aerial and Carrying Strap. Size 4⅞" × 4⅜" × 4⅜". All parts and plans excluding 9v PP7 Battery.

£6·25 + P & P and Ins. 75p

POCKET FIVE

NOW WITH 2¾" LOUDSPEAKER
3 Tuneable wavebands. M.W., L.W., and Trawler Band, 7 stages, 5 transistors and 2 diodes, supersensitive ferrite rod aerial, attractive black and gold case. Size 5½" × 1⅛" × 3¼" approx. All Parts including Case and Plans.

Total Building Costs

£4·95 + P & P and Ins. 80p

All prices include VAT

To: RADIO EXCHANGE LTD
61A High Street, Bedford MK40 1SA **Tel.: 0234 52367**

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Production of the new catalogue has been held up for a few weeks - since we have just been appointed as distributors for two of the most exciting ranges of radio components products yet : The Micrometals range of iron dust torroids cores and formers, and the OKI range of VLSI for digital frequency displays for receivers. We apologize for any inconvenience, but these two ranges are really worth the wait, and include some products you will find hard to believe, like the MSM5523 IC, an IC with less than ten external components that gives AM frequency readout to 1kHz from LW to 39.999MHz, FM frequency readout in 100kHz steps - (all usual IF offsets programmable by diodes), a 24 hour format clock with 12 hour display, independent on and off timers, time signals on the hours, stopwatch facility and a sleep timer. This costs £14 with its timebase crystal, and makes all that has gone before an expensive and time wasting excercise. Rather like the way the Intersil ICM7216 has revolutionized the instrument counter market. (See the OSTS ad.) And those of you familiar with Amidon and IG dust torroids, favoured in many new RF designs, will be pleased to know Ambit will be stocking a broad range of the Micrometals types for applications from EMI filters to RF PA stages.

OKI frequency counter ICs: details in cat2

MSM5523	for CA LEDs with RHDP such as FND507	£14 inc xtal
MSM5525	for 3½ digit LCD AM/FM with direct segment drive. no clock or timers	£11 inc xtal

Other types for fluorescent displays etc OA

Other new semiconductor additions:

KB4437	pilot cancel mpx decoder	4.35
KB4438	muting stereo preamp	2.22
HA1370	supercedes TDA2020	2.99
TDA1090	HiFi AM/FM	3.35
TDA1220	low cost AM/FM	1.45

PRICES DOWN ON VMOS: as expected, this new technology in power transistors is getting cheaper. 120v comp pairs /100W for £10.00

Price reduction on CA3189E ....now £2.20

New varicaps: to add to the biggest range.....

KV1211 2:9v bias to tune MW, like the KV1210, but a double diode £1.75

New pilot tone filters from TOKO.....

208BLR series, individual per channel with a 26/38kHz version for pilot cancel decoder applications. Flat to 15kHz £0.90

New crystal filter for amateur NBFM.....

TOYO 10M4B1 with over 90dB adjacent ch. rejection for 2m NBFM. 10.7MHz £14

New ceramic IF filters for 455kHz.....

CFM455H 6kHz/6dB, 15kHz max./60dB - ideal for MC3357 etc. £10

A brief summary of some of our range of ICs:

TDA1062/1.95; TDA1083/1.95; HA1197/£1.40 CA3123E/£1.40; TBA651/£1.81; CA3089/1.94 HA1137/£2.20; MC1310/£2.20; HA1196/£3.95 KB4424/£2.75; KB4423/£2.53;SD6000/£3.75 KB4412/£2.55; KB4413/£2.75; KB4417/£2.55 MC1495L/£6.86*; MC1496P/£1.25 LM381N/£1.81; LM1303/£0.99; ULN2283B/ £1.00; LM380N/£1; TBA810AS/£1.09 TCA940E/£1.80; TDA2002/£1.95; ICL8038CC/£4.50*; NE566/£2.50*; NE567/ £2.50*; NE5608/£3.50; NE561B/£3.50; NE562B/£3.50*; NE565A/£2.50*

SEE THE OSTS ADVERT FOR CMOS/TTL REGULATORS, OPTO DISPLAYS , and other types of linear devices.

Some transistors for RF specifically:

BF256LB/0.34; 40822/0.43*; 40823/0.51 * 40673/0.55* ; BF900/961/0.80*; BF960/1.60* BF224/0.22; BF274/0.18; BF195/0.18; BF240/0.22; BF241/0.22; BF362/0.70; BF479/0.86; BF679S/0.70; BFY90/0.90*

PIN and other Varicap diodes:

BA102/0.30; BA121/0.30; ITT210/0.30 BB104B/0.40; MVAM2/£1.48; MVAM115/ £1.05; MVAM125/1.05; KV1210/£2.75 BA479/0.35; TDA1061/0.95; BA182/0.21

METER MADE low cost panel meters : 3 x 930 series with blanks and dry transfer sheet of scales and ledgends for £12.5 *

TERMS etc: CWO please, VAT on Ambit Items is generally 12½%, except where marked (*). Catalogue part 1:45p, part 2 50p all inclusive. Postage 25p per order, carriage on tuner kits £3. Phone Brentwood (0277) 216029/227050 9am-7pm. Callers welcome inc. Saturdays .

At last, DIY HiFi which looks as if it isn't.

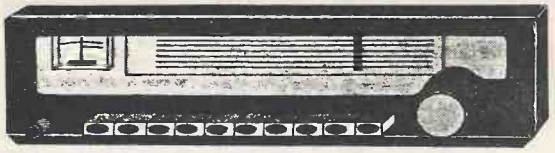
That's not to say it doesn't look like HiFi - just that it doesn't look like the usual sort of thing you have come to associate with DIY HiFi. The Mk3 outstrips and outperforms all British made HiFi tuners, and most imported ones too. Certainly at the price, there isn't one near it. But more than that, it looks superb . A small pic here would be an insult, so send an SAE for details on the kit that looks as if isn't. It's something else.....

- ★ Exceptionally high performance - exceptionally straightforward assembly
- ★ Baseboard and plug-in construction. Future circuit developments will readily plug in, to keep the MkIII at the forefront of technical achievement
- ★ Various options and module line-ups possible to enable an installment approach to the system

and now previewing the matching 60W/channel VMOS amplifier:

- ★ Matching both the style and design concepts of the MkIII HiFi FM tuner
- ★ Hitachi VMOS power fets - characterized especially for HiFi applications
- ★ Power output readily multiplied by the addition of further MOSFETs
- ★ VU meters on the preamp - not simply dancing according to vol level
- ★ Backed with the usual Ambit expertise and technical capacity in audio

The PW Dorchester-LW,MW,SW,& FM stereo tuner



In much the same way as we have swept away the 'old technology' in frequency/timer counters - with the OKI and Intersil single IC counters, we now offer a single IC "All Band" radio tuner. Don't confuse this one chip radio with things like the ZN414 - for this is a genuine superhet receiver with a mechanical AM IF filter, and ceramic IF filters for FM. The AM section employs a balanced input mixer section, covering all broadcast bands - plus a BFO and MOSFET product decetor for SSB/CW - though at this price, the tuner is not intended as a "communications receiver" - although we know of many lesser designs that make that claim. The AM sensitivity is nevertheless better than 5uV, and FM sensitivity is 1.2uV for 30dB S/N. As a multiband broadcast superhet receiver, it is a unique constructor project that fulfills the requests we very frequently get for a general coverage circuit that isn't over complicated. The set has CA3089E FM performance, with mute etc., and a PLL stereo decoder with full pilot tone filtering.

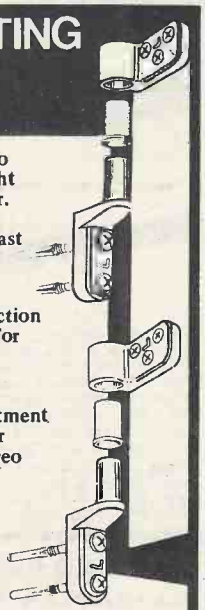
The tuner board - with "on board" PCB mounted switching, all components etc : £33.00
The case/cabinet with PSU, meter and mechanics etc £25.00
An SAE for full details please. See the feature article in Practical Wireless (Dec/Jan)

2 Gresham Road, Brentwood, Essex.

FF1 WALL MOUNTING KIT FOR HI-FI SPEAKERS

Fidelity Fastenings FF1 is a precision made, vibration damped wall fastening for Hi-Fi and Stereo Speakers of up to 50lbs weight each. Almost undetectable when fitted, the FF1 allows easy adjustment of speaker angle, and the rubber mounting ensures that they do not move accidentally. Speakers can also be quickly and easily lifted off for dusting, cleaning and redecorating.
Available from all good Audio, Hi-Fi and electrical shops at

- ★Holds up to 50lbs weight per speaker.
- ★Precision cast mounting brackets.
- ★Rubber friction mounting for complete stability.
- ★Easy adjustment of angle for precise stereo image.



£6.49 in case of difficulty, direct from the manufacturer at £6.89 inc P & P

THE NUMBER BEHIND MOST LEADING MAKES OF HI-FI SPEAKER SYSTEMS.

PRECISION AUDIO PRODUCTS FROM

Fidelity Fastenings

The Ridgeway, Iver, Buckinghamshire
Tel: (0753) 654222

SINCLAIR PRODUCTS microvision tv £90. PDM35 £27·25. mains adaptor £3·24. case £3·25. DM235 £48·30. rechargeable battery units £8. adaptor/charger £3·70. case £8·50. cambridge prog calculator £13·13. prog library £3·45. mains adaptor £3·20. enterprise prog calculator £21·95. DM350, DM450 p.o.a.

COMPONENTS send sae for full list. 1 lb FeCl £1·05. dalo pen 73p. 60 sq ins pcb 55p. laminate cutter 75p. small drill 20p. zn414 £1·05. pcb and extra parts for radio £3·85. case £1. 1N4148 1·4p. 1N4002 2·9p. 723 29p. 741 15p. NE555 23p. bc182b, bc183b, bc184b, bc212b, bc213b, bc214c 4·5p. plastic equivs bc107, bc109 4·8p. ¼W 5% E12 resistors 10R to 10M 1p, 0·8p for 50+ of one value. 16v electrolytics ·5/1/2/5/10/22mf 5p, 100mf 6p, 1000mf 10p. polyesters 250v ·015, ·068, ·1mf 1½p. ceramics 50v E6 22pf to 47n 2p. polystyrenes 63v E12 10pf to 10n 3p. zeners 400mW E24 2v7 to 33v 7p.

TV GAMES send sae for data. AY–3–8500 + kit £8·95. AY–3–8600 + kit £12·50. tank battles chip £6·90, kit £7·05. stunt cycle chip £6·90, kit £5·60. rifle kit £4·95.

TRANSFORMERS 6–0–6v 100ma 74p, 1½a £2·35. 6·3v 1½a £1·89. 9–0–9v 75ma 74p, 1a £2, 2a £2·60. 12–0–12v 100ma 90p, 1a £2·49.

IC AUDIO AMPS with pcb JC12 6W £1·60. JC20 10W £2·95. JC40 20W £2·95.

BATTERY ELIMINATORS 3-way type 6/7½/9v 300ma £2·95. 100ma radio type with press-studs 9v £3·35, 9+9v £4·50. stabilized type 3/6/7½/9v 400ma £6·40. 12v car convertors 3/4½/6/7½/9v 800ma £2·50.

BATTERY ELIMINATOR KITS send sae for data. 100ma radio types with press-studs 4½v £1·40, 6v £1·40, 9v £1·40, 4½+4½v £1·80, 6+6v £1·80, 9+9v £1·80. stabilized 8-way types 3/4½/6/7½/9/12/15/18v 100ma £2·80, 1Amp £6·40. stablilzed power kits 2–18v 100ma £3·60, 2–30v 1A £6·95. 2–30v 2a £10·95. 12v car convertor 6/7½/9v 1a £1·35.

T-DEC AND CSC BREADBOARDS s-dec £3·17, t-dec £4·02, u-dec £4·40, u-decb £6·73.16 dil adaptor £2·14. exp300 £6·21, exp350 £3·40. exp650 £3·89. exp4b £2·48.

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Mk2 covers 550Khz 30Mhz **£25·00**
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MAINS TESTER SCREWDRIVERS 100 to 500V. Standard size **50p**. Large **70p**.
RADIO PLIERS 5¾" **£1·80**. 6¾" **£2·00**, SMALL SIDE CUTTERS (with wire holding device) **£4·50**.
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TAP AND DIE SETS (18 piece) contain 1 each of 0, 2, 4, 6, 8, BA SIZES in Dies, Plug Taps, Taper Taps + American type tap wrench, T type tap wr'ch, Die Holder. **£12·50**.

LARGE ELECTROLYTIC PACKS. Contain range of large electrolytic capacitors, low and high voltage types, over 40 pieces, **£3·00** per pack (+12½% VAT).

Slider Switches. 2 pole make and break (or can be used as 1 pole change-over by linking the two centre pins), 4 for **50p**.

DUE TO A CHANGE OF SUPPLIER, OUR STOCK ALUMINIUM BOXES AND VINYL COVERED EQUIPMENT CASES WILL BE AS FOLLOWS

Aluminium boxes with lids

AL1	3" × 2" × 1"	60p
AL2	4" × 3" × 1½"	70p
AL3	4" × 3" × 2"	80p
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AL5	6" × 4" × 3"	£1·25
AL6	8" × 6" × 2"	£1·50
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Vinyl Equipment Cases
Blue Vinyl covered steel tops with plain aluminium lower sections.

BC0	5" × 2½" × 2½"	£1·00
BC1	6" × 4½" × 2"	£2·00
BC2	6" × 4" × 3½"	£2·25
BC3	8" × 5½" × 2½"	£2·50
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BC7	12" × 6½" × 5"	£3·25

MAINS TRANSFORMERS. Type 15/300 240V Input. 15V at 300mA output. **£1·50** each.
MAINS TRANSFORMERS. Type 45/100, 240, 220, 110, 0V input. 45V at 100mA output, **£1·50** each.

PLEASE ADD 8% VAT UNLESS OTHERWISE STATED

CELESTION 8" × 5" **ELIPTICAL SPEAKERS**, 20 ohm, 3 watts rated, **£1·50** each + 12½% VAT.

IC AUDIO AMP PCB. Output 2 watts into 3 ohm speaker, 12V DC supply, size approx. 5⅝" × 1½" × 1" high, with intergal heatsink, complete with circuits, **£2·00** each.

NICAD CONVERTER PCB. (Low power inverter). Size approx. 4" × 1¾" × 1" high, 12V DC supply, 60V DC output, through pot on pcb, for charging Nicads, etc. (ideal for charging portable batteries from mobile supply). Only needs one BFY50/51/52 or similar transistor, which can be mounted direct on the pcb pins on board, fitted with a star-type heatsink (Not Supplied). **£2·00** each.

THE NEW EAGLE INTERNATIONAL CATALOGUE IS AVAILABLE ON REQUEST containing Audio, In-car, and test equipment, etc.

DECIMAL KEYBOARDS, pressure sensitive type, when pressed contacts go from O/C to approx. 25 ohms. Switches only, no encoders. Size approx. 3" × 3", with large square touch plates. 0—9+Clear, A, B, Dual Watch, and spare. Few only, **£2·00** while stocks last.

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SEMICONDUCTORS
BSX20 (VHF Osc/Mult). 3 for **50p**.
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BFY51 Transistors. 4 for **60p**.
BCY72 Transistors. 4 for **50p**.
PNP audio type TO5 Transistors, 12 for **25p**
BF152 (UHF amp/mixer). 3 for **50p**.
2N3819 Fet., 3 for **60p**.
BC148 NPN SILICON, 4 for **50p**.
BC158 PNP SILICON, 4 for **50p**.
BAY 31 Signal Diodes, 10 for **35p**.
IN4148 (IN914) 10 for **25p**.
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SCRs 400V at 3A, stud type, 2 for **£1·00**.
TIP2955 Silicon PNP power transistor. 60V at 15A, 90 Watts. Flat pack type. 2 for **£1·50**.
GERMANIUM DIODES, approx 30 for **30p**.

741CG op amps by RCA, 4 for £1.

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SPECIAL OFFER FOR COMPUTER BUILDERS, ETC.
19 way ribbon cable, decimal coded, 4 metres for **£1·25**
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VIDICON SCAN COILS (Transistor type, but no data) complete with vidicon base **£6·50** each. Brand New.

IC TEST CLIPS, clip over IC while still soldered to pcb or in socket. Gold-plated pins, ideal for experimenters or service engineers. 28 pin DIL **£1·75**, 40 pin DIL **£2·00**. Or save by buying one of each for **£3·50**.

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PLASTIC PROJECT BOXES with screw on lids (in black ABS) with brass inserts.

Type NB1	approx 3½" × 2½" × 1½"	45p	each
Type NB2	approx 4" × 3" × 1½"	55p	each
Type NB3	approx 4½" × 3½" × 1½"	65p	each
Type NB4	approx 8½" × 5½" × 3½"	£1·50.	

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BNC Plugs, new **50p** each.
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SO239 Sockets (PTFE), brand new (4-hole fixing type). **60p** each.

SOLDER SUCKERS (Plunger type). Standard Model. **£5·50**. Skirted Model **£6**. Spare Nozzles **80p** each.

NEW MARKSMAN RANGE OF SOLDERING IRONS.
S140D 40W 240V **£4·50**.
S125DK 25W 240V + bits etc., **KIT £5·30**.
BENCH STAND with spring and sponge for Marksman Irons **£2·70**.
Spare bits MT9 (for 15W) **60p**. MT5 (for 25W **50p**, MT10 (for 40W) **55p**.
ALL PRICES + 8% VAT.

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Temperature controlled Iron and PSU. **£30+** VAT (**£2·40**).
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EXPERT. Built-in-spotlight illuminates work. Pistol grip with fingertip trigger. High efficiency copper soldering tip.
EXPERT SOLDER GUN 8100D £12·00.
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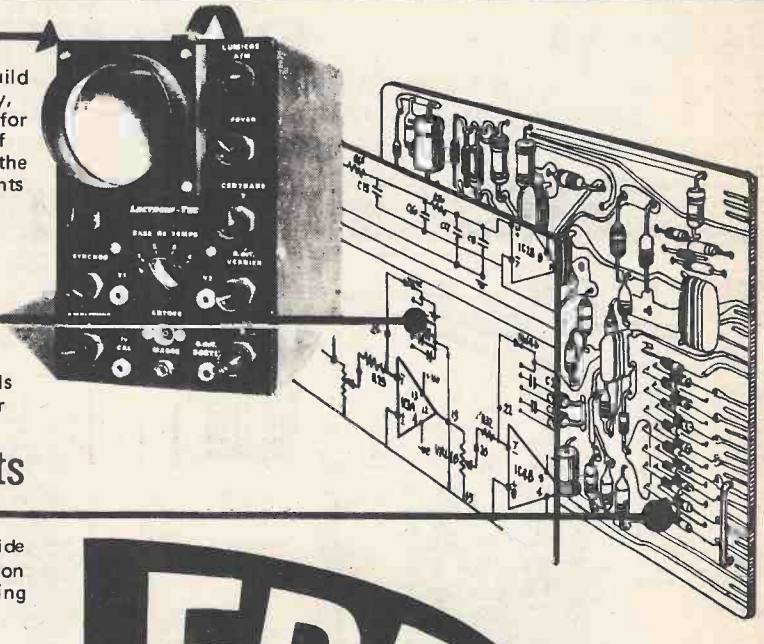

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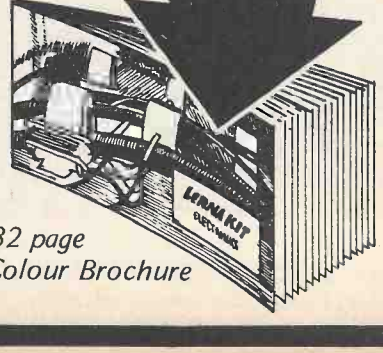

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DL92	0·75*	ECH83	1·25	EL86†	0·75*	PCC84†	0·50*	PL802	3·46	UF80†	0·50*	6AM4	2·30*	6C4†	0·55*	6R7	1·80	12BA6	0·65*	811A†	3·80
DL94	1·20*	ECH84†	0·85*	EL91	4·35*	PCC88	0·65*	PY33	1·10	UF85†	0·65*	6AM5	3·85*	6CB6A†	0·55*	6SA7	1·45	12BE6	1·60*	812A	8·35
DL96	1·10*	ECL80†	0·60*	EL95†	0·80*	PCC89†	1·05*	PY81	0·92	UF89†	0·55*	6AM6†	0·70*	6CD6GA	4·90*	6SC7	1·50	12BH7†	0·65*	813†	10·00
DY86/7†	0·55*	ECL82†	0·60*	EL360	2·75*	PCC189†	1·00*	PY82	0·80	UL41	1·60	6AN5	2·50*	6CG7	1·72*	6SF7	1·60	12BY7†	0·80*	833A	30·00
DY802	0·80*	ECL83	1·50*	EM80	1·10*	PCF80	0·96*	PY83	0·70*	UL84†	0·85*	6AN8A†	0·70*	6CH6	4·42*	6SH7	1·50	12E1	7·10	866A	8·85
E88CC†	1·00	ECL86†	0·85*	EM81	1·00*	PCF82†	0·50*	PY88†	1·16*	UM80	1·00*	6AQ5†	0·85*	6CL6†	0·75*	6SJ7	1·60	30C15	1·56*	872A	13·75
EABC80	0·55*	ECL800	7·00*	EM84	1·00*			PY500A†	1·60*	UY41†	0·75*	6AR5	0·70*	6CW4	7·24*	6SK7	1·30	30C17	1·56*	931A	12·24
EAC91	0·50	EF37A†	2·50*	EM85	1·25*	PCF86†	0·75*	PY800/81†		UY85†	0·65*	6AS6†	0·80*	6D2†	0·40*	6SL7GT†		30C18	1·44*	2050	2·80
EAF42	1·25*	EF39†	1·60*	EM87	1·50*	PCF87†	1·10*		0·92*	1B3GT†	0·65*	6AS7G†	1·50*	6DK6	2·49*		0·70*	30F5	1·60*	5642	5·26*
EAF801	1·75*	EF40	1·15*	EN91†	2·24*	PCF200†	1·15*	PY801	0·92*	1R5†	0·55*	6AT6†	0·75*	6DQ6B	1·90*	6SN7GT†		30FL1/2	1·12*	5654	3·61*
EB41	2·00*	EF41	1·20*	EY51†	0·75*	PCF201†	1·10*	QQV02-6	9·90	1S5†	0·40*	6AU5GT	4·28*	6EA8	2·21*		0·70*	30FL12	1·72*	5651	1·80*
EB91†	0·40*	EF42	2·00*	EY86†	0·50*	PCF801†	0·60*	QQV03-10†		1T4†	0·40*	6AU6†	0·55*	6EB8	2·12*	6SQ7	1·30	30FL14	1·44*	5670	2·86*
EBC33	1·75*	EF50†	0·60*	EZ40	1·25*	PCF802†	0·88*		2·00	2AS15	10·00	6AV5GT	3·74*	6EW6	1·50	6SR7	1·50	30L1	0·84*	5814A	2·60*
EBC41	1·25*	EF80†	0·50*	EZ80†	0·50*	PCF805	1·44*	QQV03-20A†		2D21†	0·80	6AV6†	0·75*	6F6	1·75	6SS7	1·80	30L15	1·72*	6080†	6·85*
EBC81	1·10*	EF83	1·75*	EZ81†	0·50*	PCF808	1·44*		10·50*	3A5	1·35	6AW8A†	1·00	6F23	1·60*	6U5G	2·00*	30L17	1·72*	6146A	5·12
EBC90	0·75*	EF85†	0·50*	EZ90†	0·60*	PCL82†	0·80*	QQV06-40A†		3CX100A5		6AX5GT	3·10*	6F28	1·16*	6U8†	0·55*	30P4	0·92*	61468	5·58
EBF80	0·50*	EF86†	0·60*	GZ32	1·25	PCL83†	0·92*		13·00*		20·00	6B7	0·75	6H2N	1·05	6U8A†	0·55*	30P19	1·12*	6159	6·00
EBF83	1·25*	EF89	1·60	GZ33	4·00*	PCL84†	0·75*	R17	1·65	3S4†	0·75*	6B8	0·75	6H3N	1·05	6V6GT†	0·65*	30PL1	1·32*	6442	15·00
EBF89†	0·45*	EF91†	0·70*	GZ34†	1·52*	PCL85†	0·98*	R19	1·00	3V4†	1·00*	6BA6†	0·50*	6H6	1·50	6X4†	0·60*	30PL13	1·72*	6973	3·52*
EBL31	2·50*	EF92†	0·75*	GZ37	3·00*	PCL86†	0·85*	R20	1·44	4CX250B	17·50	6BA7	5·12*	6J4†	1·20*	6X5GT†	0·60*	30PL14	1·68*	7586	11·38*
ECC40	1·25*	EF98	1·25*	KT61	1·75*	PCL805/85†		U18-20	2·50*	5R4GY†	1·10*	6BA8A	3·75	6J6†	0·55*	7B7	1·70	30PL15	1·72*	7587	19·60*
ECC81†	0·50*	EF183†	0·70*	KTW62	1·75*	PD500	3·60*	U25	1·16*	5U4G	1·52*	6BC4	3·71	6J7	2·00	7C5	1·75*	35W4	0·60*	7868	3·94*
ECC82†	0·47*	EF184†	0·70*	KTW63	1·75*	PFL200	1·12*	U26	1·44*	5U4GB	2·26*	6BE6†	0·48*	6K4N	1·25	7C6	1·25*	50C5	0·70*	8068	5·50
						PL36†	1·12*	UABC80†	0·58*	5V4G†	0·65*	6BH6†	1·20*	6K6GT	1·30	7H7	2·00	85A2	1·50	8136	2·44*
								UAF42	1·25	5Y3GT	0·85*	6BJ6†	1·20*	6K7	1·50	7R7	1·50*	90AG	7·96		
										5Z3	1·50*	GBK4	4·21*	6K8	1·75	7S7	2·25*	90AV	7·96		

INTEGRATED CIRCUITS

7400	0·16	7412	0·26	7432	0·30	7454	0·18	7491	0·80	74118	1·00	74144	2·50	74173	1·40	74196	1·20	TBA530	1·98*	TBA920	2·90
7401	0·16	7413	0·32	7433	0·36	7460	0·18	7492	0·60	74119	1·50	74145	0·90	74174	1·50	74197	1·10	TBA540Q	2·30*	TBA9200	2·99
7402	0·16	7416	0·32	7437	0·32	7470	0·35	7493	0·60	74120	0·83	74147	2·00	74175	0·90	74198	2·25	TBA990Q	2·99*		
7403	0·16	7417	0·32	7438	0·32	7472	0·33	7494	0·80	74121	0·40	74148	1·75	74176	1·20	74199	2·25	TBA550Q	3·22*	TCA270Q	2·99*
7404	0·17	7420	0·17	7440	0·18	7473	0·36	7495	0·72	74122	0·60	74150	1·60	74178	1·25	76013N	1·75*	LM309K	1·50	TCA760A	1·38*
7405	0·16	7422	0·20	7441AN	0·85	7474	0·40	7496	0·80	74123	1·00	74151	0·85	74179	1·25	TAA570	2·30*	TBA560CQ	3·22*	**DIL**	
7406	0·40	7423	0·32	7442	0·72	7475	0·54	7497	3·00	74125	0·55	74154	1·75	74180	1·15	TAA630S	3·50*	TBA673	2·19*	**Sockets**	
7407	0·40	7425	0·30	7447AN	0·90	7475	0·40	74100	1·50	74126	0·55	74155	0·85	74190	1·50	TAA700	3·91*	TBA700	1·52*		
7408	0·20	7427	0·30	7450	0·18	7483	0·90	74107	0·45	74128	0·60	74156	0·85	74191	1·50	TBA480Q	1·84*	TBA720Q	2·30*	8 PIN	0·15
7409	0·20	7428	0·43	7451	0·18	7484	1·00	74109	0·70	74132	0·70	74157	0·75	74192	1·35	TBA520Q	2·30*	TBA750Q	2·07*	14 PIN	0·15
7410	0·16	7430	0·17	7453	0·18	7485	0·35	74110	0·50	74136	0·55	74159	2·10	74193	1·35			TBA800	1·20	16 PIN	0·17
7490	0·52							74111	0·86	74141	0·80	74170	2·30	74194	1·25						
								74116	1·75	74142	2·30	74172	4·40	74195	1·00						
										74143	2·50								

BASES

B7G unskirted	0·15
B7G skirted	0·30
B9A unskirted	0·15
B9A skirted	0·30
NUVISTOR	0·55
Int Octal	0·20
Loctal	0·55
8 pin DIL	0·15
14 pin DIL	0·15
16 pin DIL	0·17
Valve screening cans all sizes	0·30

CRT'S

1CP31	31·00	5ADP1	35·00	VCR517B*	6·00
2AP1*	8·50	5BP1*	10·00	VCR517C*	6·00
2BP1*	9·00	5CP1*	5·00		
3BP1	8·00	5CP1A	40·00	Tube Bases	0·75
3DP1*	5·00	5FP15A	15·00	*⇒Surplus	
3EG1*	7·00	5UP7	14·00	VAT 8%	
3FP7	6·00	DG7-5	25·00		
3GP1	6·00	DG7-32	36·00		
3JP1*	8·00	DH3-91	31·00		
3JP2*	8·00	DH7-11	68·00		
3JP7*	10·00	VCR97*	5·00		
3KP1*	15·00	VCR138*	10·00		
3RP1*	35·00	VCR138A*	12·50		
		VCR139A*	8·00		
		VCR517A*	10·00		

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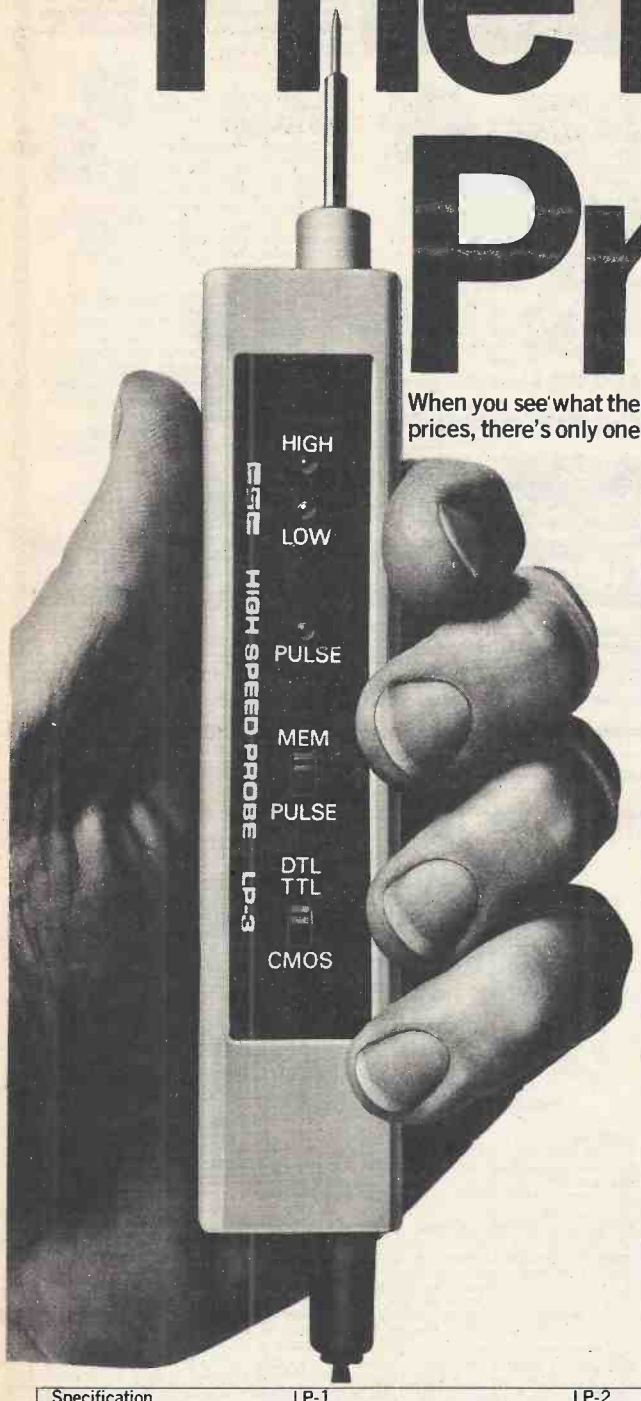
The Logic Probes



When you see what these new CSC logic probes can do, in such a small size, and at such small prices, there's only one word for it:—

Amazing!

LP-1 Unit Price £31.00 · Post & Package £1.50 · VAT £2.60 · **Total £35.10.**
Clip the leads to the power supply of the circuit under test, touch the probe tip to any pin, pad or component and you're in business. The 'HIGH' and 'LOW' LEDs show logic states 1 or 0, if neither come on you've got open circuit, tri-state, signal out of tolerance (or no power!).
The 'PULSE' LED flashes once for any pulse 50n sec or longer, and flashes regularly at 3Hz for high frequency trains. Then, while 'PULSE' is flashing, 'HIGH' will come on alone to show duty-cycles over 85%, 'LOW' alone to show less than 15%, and with both on together duty-cycles can be estimated between 15% and 85% by relative brightness.
In the MEMORY mode, the leading edge (positive- or negative-going) of any pulse will latch a flip-flop on and keep the PULSE LED lit as long as power is applied to the probe. You can catch events that are hard to see even with a high quality scope!
LP-1 is switch-selectable for DTL/TTL and HTL/CMOS circuits.

LP-2 Unit Price £18.00 · Post & Package £1.25 · VAT £1.54 · **Total £20.79.**
Economy version of LP-1, with the same HTL/CMOS and DTL/TTL capability. 'HIGH' or 'LOW' LEDs function as in LP-1, 'PULSE' catches pulses as short as 300nsec and shows pulse trains as 10Hz blink. When pulsing, 'HIGH' comes on to show duty-cycles above 70%, 'LOW' shows below 30%, both on together show between 30% and 70%. 300,000 Ohm input impedance protects your circuit under test, and the low price brings the advantages of our quick, easy LOGIC PROBE technique to anyone interested in logic circuitry.

LP-3 Unit Price £49.00 · Post & Package £1.50 · VAT £4.04 · **Total £54.54.**
Super-high speed version, captures pulses as short as 10nsec, and monitors pulse trains as rapid as 50MHz. That's better performance than many oscilloscopes! And no bulky instruments, no set-up time. At frequencies up to 1.5MHz you can estimate duty-cycles by the High/Low relative intensity, as with LP-1. DTL/TTL and HTL/CMOS are switch-selectable, of course, plus 'MEM' memory mode to latch on to any pulse, pulse train or passing transient.
LP-3 is the ideal trouble-shooter for your fastest logic circuits, and like all CSC probes is well-designed, handy and easy to use, robust, reliable and individually tested before it leaves the factory.

And the new pulser DP-1 Unit Price £51.00 · Post & Package £1.50 · VAT £4.20 · **Total £56.70.**
The Digital Pulser: another new idea from CSC. The DP-1 registers the polarity of any pin, pad or component and then, when you touch the 'PULSE' button, delivers a single no-bounce pulse to swing the logic state the other way. Or if you hold the button down for more than a second, the DP-1 shoots out pulse after pulse at 100Hz. The single LED blinks for each single pulse, or glows during a pulse train. If your circuit is a very fast one, you can open the clock line and take it through its function step by step, at single pulse rate or at 100 per second. Clever! And a very reasonable price.

How to order. Telephone 0799-21682 and give us your Access, Barclaycard or American Express number, and your order will be in the post that night. Or, write your order, enclosing cheque or postal order, or stating credit card number and expiry date. (Don't post the card!). Alternatively, ask for our latest catalogue, showing all CSC products for the engineer and the home hobbyist.
(Prices are for UK only. For Europe add 10%, outside Europe add 12½% to total prices).

Specification	LP-1	LP-2	LP-3	DP-1
Input Impedance	100,000Ω	300,000Ω	500,000Ω	Output Tri State
Minimum Detectable Pulse	50ns	300ns	10ns	Autopolarity Pulse Sensing
Max. Input Signal (Freq.)	10 MHz	1.5 MHz	50 MHz	Sink and Source 100 ma
Pulse Detector (LED)	High Speed Train or Single Event	High Speed Train or Single Event	High Speed Train or Single Event	Pulse Train: 100pps
Pulse Memory	Pulse or Level Transition Detected and Stored	None	Pulse or Level Transition Detected and Stored	LED indicator flashes in Single Pulse. Stays lit on Pulse Train

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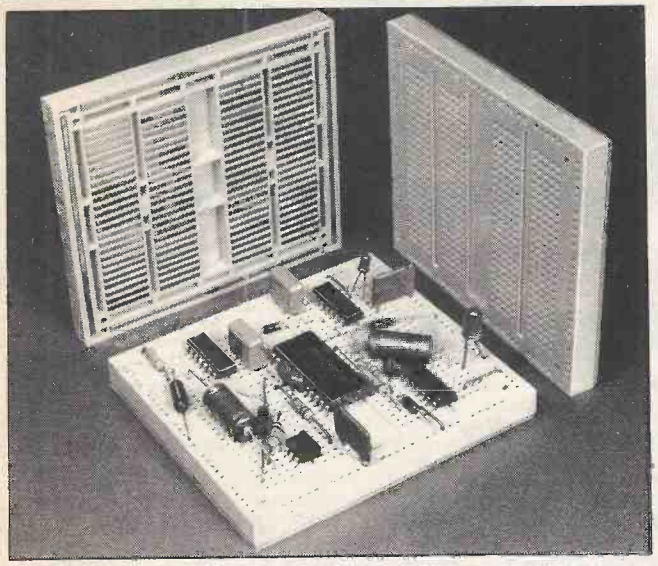
ANNOUNCING

THE NEW EUROBREADBOARD



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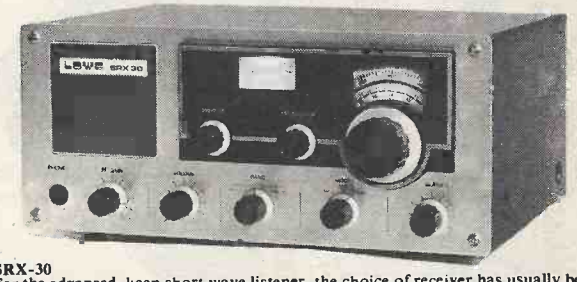

SRX-30
For the advanced, keen short wave listener, the choice of receiver has usually been between cheap and nasty or very good but very expensive equipment. We think that the SRX-30 will provide that listener with excellent performance at a reasonable cost and is the answer to this eternal problem.

The SRX-30 provides AM, CW, USB and LSB reception on all frequencies from 500 kHz to 30MHz. All right, so does your Sooper Blooper Mk. 3 but you can't set the Sooper Blooper dial to the frequency you want and be sure that it's correct! The SRX-30 tuning system is so simple to operate. You have a dial reading in MHz from 0-29 and a main tuning dial reading 0-1000 kHz. So—if you know that Radio Slobovia is broadcasting on 10.295 MHz, you set the MHz dial to 10, the kHz dial to 295 and there you are. The MHz dial setting is not critical, as stability is guaranteed by a triple mixing drift cancelling system, thereby overcoming another problem in your Sooper Blooper Mk. 3: drift.

A further drawback to cheap receivers is massive image interference on the higher frequencies due to the use of a low IF, typically 455 kHz. The cure for this problem is the use of a high IF and the SRX-30 employs a first IF of around 40 MHz—so goodbye to first IF images. You could of course find the same system as this in the Racal RA17 series receivers; after all, the SRX-30 has copied the basic idea from this very receiver. The big drawback to the RA17 (apart from the price !!) is that unless you have the muscles of a prize fighter, lifting the RA17 may send you for a holiday at Hernia Bay (staying at the Truss House?).

To summarize, the SRX-30 covers 500 kHz to 30 MHz with excellent dial readout and reset accuracy; it has all mode (AM, CW, SSB) reception and is equally at home in broadcast or amateur bands: it has all the facilities of a top class communications receiver, RF gain, fine tuning, selectable sidebands, built in loudspeaker, operation from ac mains or 12v. Dc, rugged construction and super styling and all at an attractive price—£175 inc. VAT. Carr £3.

See it soon at your nearest stockist, you will be agreeably impressed.

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SPECIFICATIONS

AMPLIFIER	**Nominal**
Power Output:	2 × 25 watts RMS.
Distortion:	THD @ 2 × 20 watts 0·7%
Frequency Range:	@—1·5dB 30Hz-15KHz
Tone Control Range:	
VC-20dB	18dB
Basic Electrical centre	@ 100Hz-14dB
Treble Electrical centre	@ 10KHz+8dB —14dB
Loudness Control:	
VC30dB	@ 100Hz+14dB @ 10KHz+11dB
Filters:	
VC30dB	@ 10KHz—6dB
Controls:	5 rotary: volume, balance, bass, treble tuning.
Switches:	9 push button: phono, tape, radio, aux. input, mono/stereo, loudness, filter, speaker switching, separate mains switch.
Meters:	2 signal strength: FM tuning
Sockets:	Headphones: 5 pin DIN Aux: AM aerial (ext) FM aerial (coaxial): 4 × 2 pin DIN L/S

Intermediate Frequency:	
AM	475KHz
FM	10·7KHz
Aerial input:	
AM (internal)	Ferrite Rod
AM (external)	2 pin DIN
FM (external)	Co-axial 75 ohm unbalanced!
AGC:	
For 6dB audio change	46dB
IF Bandwidth @ max sensitivity	± 1·5KHz @ 6dB
RF Sensitivity: @ 20dB S/N Ratio	
200KHz	1500μV/m
600KHz	500μV/m
1400KHz	200μV/m
FM:	
RF Sensitivity @ 26dB S/N (mono) 88MHz	2·5μV
100MHz	
@ 46dB S/N (mono)	16μV
@ 46dB S/N (stereo)	125μV
Distortion: @ Decoder O/P	0·9%
Frequency Response: @ ± 1·5dB	30Hz-15KHz
Stereo Separation:	40dB
Audio Filter	Flat to 55KHz 50dB@ 130KHz

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Stereo power amp 25w rms P/channel	£7·50
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Selector Board 8 way	£3·99
Complete chassis massive 22 Inches	£8·50

TU020

A Hi Fi tuner amplifier

This unit can be built from our modules or as a complete kit. Input for mag cartridge, tape record/playback, MW/LW/VHF stereo, tuner. Uses the same R F Board as does the Wimborne with birdie filters, multiplex filter, varicap tuning on MW and LW.
Items from the Wimborne numbers 2 and 3 can be used for different performance specifications.

SPECIFICATIONS

Power output 25 Watts RMS per channel (both channels driven)
Total harmonic distortion 0·05%
Bass 100 Hz ± 12 dB
Treble 10 KHz ± 12 dB
Frequency response ± 1·5 dB 30 Hz—20 KHz
FM sensitivity 1·0μV for 26 dB S/N ratio
IF rejection 60 dB image rejection 60 dB
Stereo separation 40 dB
AM sensitivity 200μV at 1600 KHz 20 dB S/N ratio.

Fully wired modules, Preamplifier,	£6·99
Power amplifier	£9·50
RF Board	£33·95
Power supply unit	£3·99
Transfomer	£4·50
Magnetic PU amp	£2·99
Hardware kit	£7·99

PLEASE ADD £1 for postage and packaging for each item except the mag PU amp which is 30p.

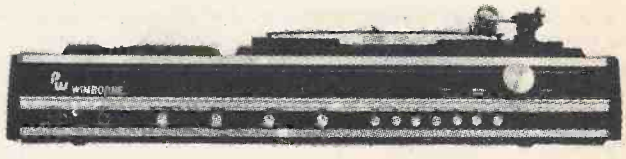
AU10

A Radio Record Player Kit which has everything you need to make a first class three band STEREO unit. Can be assembled in modular form or from scratch. A professional finish is guaranteed.

SPECIFICATIONS

Amplifier	
Output	2 × 10W RMS, both channels driven
Distortion:	1% ± 2 × 5 watts
Controls:	Four rotary 1. OFF/ON/VOLUME 2. Balance 3. Treble 4. Bass
Tone Control Range:	Bass @ 100 Hz ±9dB Treble @ 10 kHz ±9dB
Outputs:	2 × 2-pin DIN for 8 ohm loudspeakers 1 switched stereo headphone socket 1 5-pin DIN Aux. Tape in/out socket
Stereo Performance:	Frequency response @ ± 1·5dB 30 Hz—15kHz Separation 40dB Audio Filter—flat to 55 kHz—50dB @ 130 kHz
Controls:	7 Push Button: Phono, Tape, Mono, FM, MW, LW, AFC 1 Rotary: Tuning
Radio Tuner	
Waveband Coverage:	Medium Wave 525—1620 kHz Long Wave 155—280 kHz FM VHF 88—108 kHz

Price Hardware Kit	8·90	RF Board	21·95
Amplifier & Pots	8·75	Record Deck	13·95
PSU & Transformer	3·99	Dust cover	6·00



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4 Stereo cassette module, with CRO2 switching, low noise devices, ALC tape counter, excellent specification, incredible price **£24·95.**
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6 Magnetic PU Amp with LM387 or discrete (BC 149). Both **£2·99** each.
7 Wooden Plinth plus base board **£9·95.**
8 Perspex dust cover plus hinges **£6·50.**
9 Mains transformer **£2·99.**

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7401	£0·09	7428	£0·25	7473	£0·22	74110	£0·35	74166	£0·75
7402	£0·09	7430	£0·08	7474	£0·22	74111	£0·55	74167	£2·00
7403	£0·09	7432	£0·20	7475	£0·27	74118	£0·75	74174	£0·60
7404	£0·09	7433	£0·28	7476	£0·22	74119	£1·10	74175	£0·60
7405	£0·09	7437	£0·20	7480	£0·40	74121	£0·22	74176	£0·55
7406	£0·22	7438	£0·20	7481	£0·80	74122	£0·35	74177	£0·55
7407	£0·22	7440	£0·10	7482	£0·65	74123	£0·38	74180	£0·80
7408	£0·12	7441	£0·45	7483	£0·55	74136	£0·50	74181	£1·25
7409	£0·12	7442	£0·38	7484	£0·82	74141	£0·50	74182	£0·55
7410	£0·09	7443	£0·68	7485	£0·65	74145	£0·54	74184	£1·00
7411	£0·15	7444	£0·68	7486	£0·22	74150	£0·65	74190	£0·68
7412	£0·14	7445	£0·64	7489	£1·60	74151	£0·45	74191	£0·68
7413	£0·22	7446	£0·60	7490	£0·30	74153	£0·45	74192	£0·65
7414	£0·45	7447	£0·45	7491	£0·60	74154	£0·80	74193	£0·60
7416	£0·22	7448	£0·52	7492	£0·32	74155	£0·48	74194	£0·55
7417	£0·22	7450	£0·09	7493	£0·28	74156	£0·48	74195	£0·55
7420	£0·09	7451	£0·09	7494	£0·70	74157	£0·48	74196	£0·60
7421	£0·19	7452	£0·09	7495	£0·45	74160	£0·55	74197	£0·58
7422	£0·15	7453	£0·09	7496	£0·48	74161	£0·60	74198	£1·00
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7425	£0·18	7460	£0·09	74104	£0·35	74163	£0·60	74279	£1·00
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CD4006	£0·80	CD4020	£0·80	CD4040	£0·78	CD4070	£0·15
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16194	6 x 47 K	LIN Single	40p*
S27	6 x 100 K	LIN Single	40p*
S28	6 x 100 K	LOG Single	40p*
S29	6 x 500 K	LOG Single	40p*
S32	6 x 50 K	LIN Single	40p*

Slider 60mm TRAVEL

S30	6 x 2·5 K	LOG Single	40p*
S34	4 x 5 K	LOG Dual	40p*
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S37	4 x 4·3 MEG	LOG Dual	40p*
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S96	6 x 500 K	LIN Single	40p*
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S134	2 x Magnets suitable for reed switches	£0·10
S135	·1 Veroboard pak 2 pcs 45sq. ins. approx.	£0·80
S136	·15 Veroboard pak 2 pcs 60sq. ins. approx.	£1·10
16199	·1 Veroboard pak 30sq. ins. approx.	£0·50
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£4·50* + £1·00 p. & p.

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£3·50* + £0·86 p. & p.

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STA 15 15 watts per channel amplifier kit Consists: 2 x AL60: 1 x PA100: 1 x SPM80: 1 x 2034: transformer: 2 x coupling capacitors. **£37·70** inc. VAT. 85p P&P.

STA25 25 watts per channel amplifier kit Consists: 2 x AL60: 1 x PA100: 1 x SPM120/45 – 1 x 2040: transformer: 1 x reservoir capacitor: 2 x coupling capacitors. **£41·45** inc. VAT. £1·16 P&P.

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AC128	16p	BC182	*9p	BF197	*12p	TIP41A	34p	2N2218	15p
AC128K	24p	BC182L	*9p	BF200	25p	TIP41B	35p	2N2218A	18p
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AC188	16p	BC212	*10p	BFY52	12p	TIP2955	65p	2N2222	15p
AC188K	26p	BC212L	*10p			TIP3055	42p	2N2222A	16p
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BC107	6p	BC251	*10p	OC44	12p	ZTX301	*7p	2N2905A	15p
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Our Role

OBVIOUSLY, with a title like *Practical Wireless,* our main aim in life must be to impart practical information—working designs, with instructions on building and using them. We don't see that as the whole story, though. We think we're here to educate you too, and this side of things takes many forms.

First there is the item which is straight theory, though often incorporating practical hints such as the *Introduction to Logic* series which concludes in this issue. This sort of article is intended to help you to understand text-books or manufacturer's data sheets, which often assume a fairly advanced level of knowledge and tend to be somewhat obscure in their treatment, or simply to keep you up to date with developments.

A second type of article is typified by the *"FM Receivers—Devices and Circuits* series, and by its predecessor on a.m. receivers. These present outline circuits and explain how they work, but do not give constructional information. Their intention is to provide a basis for further experimentation by interested readers.

Of course, the constructional articles also have quite a big teaching role, too, either in "learning by doing" or "learning by reading". This last category is particularly important, as some part of a circuit will often trigger off an idea for another project in someone's mind, or will provide a solution to a design problem that has been bugging them. And it is the reason that we sometimes publish articles which will, we think, only have direct appeal to a limited number of readers, but where the principles involved are of wider interest. The *Videowriter* project published in *PW* in 1976 was rather in this category, though as it turned out, it was built in quite large numbers and used in applications which we never foresaw.

As already hinted at above, we want to help you to understand text-books etc., and part of that understanding is the ability to take in the various abbreviations and symbols used. This is part of the reason for our decision to change, over the next few issues, to a new but now widely-adopted convention for quoting component values on circuit diagrams. This involves using the unit multiplier instead of the decimal point, so that for example 4·7kΩ becomes 4k7, and 2·2μF becomes 2μ2. The decimal point, being just a small dot on the paper, is so easily missed, and this new method is intended to overcome the problem. Note also that the unit, which is obvious anyway, has been dropped, thus saving space on congested circuit diagrams. More details will be given in our next issue, for the benefit of those unfamiliar with the scheme.

PW PERSONALITY

Alan Martin—News & Production Editor

Following technical college, Alan began his working life as a draughtsman. His first contact with *PW* was as a technical artist in the latter days of F. J. Camm—the founder. After a spell in the technical publications dept. of a large electronics firm, Alan started his own company, specialising in the preparation of technical literature. He joined the staff of *PW* in 1973.

Having lived in West London for most of his life the move to Poole proved quite an upheaval for himself, wife and two daughters. However, the move has been a great success and the family have settled very happily in Christchurch.

Alan's interests include darts, swimming, the countryside and lately gardening, mainly the labouring aspect!

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

New Battery

Chloride Silent Power Ltd. has received a £1·9 million grant from the Government to support the continued development of a revolutionary new battery in which Britain has a world lead.

This is the sodium sulphur battery, which has been under development by Chloride Silent Power, at its Runcorn research establishment, since the formation of the company—jointly owned by the Electricity Council and the Chloride Group—in 1974.

With at least three times the energy of the lead acid batteries now used in battery-operated vehicles, the new battery would give road vehicles a range of well over 100 miles compared with the 60-mile range of the present advanced Silent Karrier vehicles.

Among the many advantages of this new battery is that it uses two materials which are relatively cheap and plentiful throughout the world—sodium and sulphur. Demand for this battery will accordingly not affect supply or cost of these raw materials.

The £1·9 million grant is from the Department of Industry, under the Science and Technology Act 1965, from funds being made available under the Government's new Product and Process Development Scheme.

To date, £2·6 million has been spent by Chloride Silent Power Ltd. on sodium sulphur development, and the DOI grant is a contribution towards further development expenditure over the next four years, including the building of a pilot manufacturing plant. *Chloride Group Ltd., 52 Grosvenor Gardens, London SW1W 0AU. Tel: 01-730 0866.*

New Catalogues

Greenweld Electronics, the wholesale/retail suppliers of electronic components and equipment, have recently published their new 64 page catalogue. Also provided is an order form and reply paid envelope, five 10p discount vouchers and a bargain list. The catalogue costs 30p plus 15p P&P and is obtainable from: *Greenweld Electronics, 443 Millbrook Road, Southampton SO1 0HX. Tel: (0703) 772501.*

Crellon Electronics announce the publication of their largest stock list ever. This 30 page edition covers over 8000 different items and is available free of charge from: *Crellon Electronics, 380 Bath Road, Slough, Berkshire. Tel: (06286) 4300.*

Electronic Brokers' latest catalogue is the largest the company has ever produced, with 86 pages devoted to second user electronic test equipment, computers and peripherals, plus new electronic products. Copies of the catalogue are available, free, to bona fide companies writing in on their letter heads. For private individuals, the charge is £1, and overseas enquiries £2—to cover P&P. From: *Electronic Brokers Ltd., 49/53 Pancras Road, London NW1 2QB. Tel: 01-837 7781.*

Heathkit have their latest 40 page catalogue ready, containing scores of electronic kits dealing with radios, digital clocks, test instruments, metal locators, car tune-up systems—and a new range of personal computers. Also available is their 16 page computer brochure. Both the catalogue and brochure are obtainable for 20p each, from: *Heath (Gloucester) Ltd., Dept. PW, Bristol Road, Gloucester GL2 6EE. Tel: (0452) 29451.*

Club news

Ormskirk Amateur Radio Club will be holding their A.G.M. on Wednesday 17 January 1979. The club meets on Wednesday evenings at members' homes; often there is a talk-in on 145.000MHz at about 2000 GMT. New members are very welcome. For further details contact: *Peter J. Kay G4GCB, Hon. Sec. OARC, 24 Laurel Avenue, Burscough, Ormskirk, Lancs. Tel: Burscough 89 2416.*

Verulam Amateur Radio Club will be holding the 1979 G3PAO Memorial Lecture in the Ex Civil Defence Hall, Chequers Street Car Park, St Albans, Herts on Thursday 25 January at 7.30 for 8.00 pm. This event is held in memory of their former Chairman and Founder Member, George Slaughter, who passed away in 1977. The lecture entitled "EME Transmissions" will be delivered by Peter Blair G3LTF, and will be illustrated with slides and tape recordings. Interested parties are welcome to attend. Further details from: *Hon. Sec. G4DUS QTHR. Tel: Rickmansworth 77616.*

Microprocessor Courses

Bleasdale Computer Systems in conjunction with Texas Instruments Ltd. is expanding its existing range of Microprocessor courses to cover the TI9900 family of microprocessors and TI990 microcomputers.

The courses are run by consultants who are actively involved in designing and building m.p.u. based systems. They are designed to give the participants in-depth practical experience in designing and building such systems. To achieve this, Bleasdale has designed and developed a range of Input/Output devices which can readily interface with microprocessors.

Currently available there is a one-week course for people with little or no previous microprocessor experience entitled "The Fundamentals of the 9900". Also a 2-week workshop entitled "Designing Systems with 9900", which is an advanced workshop for people with knowledge of microprocessors and their operation. For further information contact: *Bleasdale Computer Systems Ltd., 7 Church Path, Merton Park, London SW19. Tel: 01-540 8611.*

Sound and Video 79

Arrangements for Sound and Video 79, the North West's Audio, Hi-Fi and Video exhibition are now well under way and more exhibitors than last year have agreed to participate.

The exhibition will be held for the 3rd year at the Excelsior Hotel, Manchester Airport from Thursday, 18 January until Sunday, 21 January and entrance will be free. For further information: *R. J. Taylor, Advertising & Promotions Manager, Hardman Radio Ltd., Head Office & Accounts, 26 Exchange Street East, Liverpool L2 3PH. Tel: 051-236 2828.*

RAE Reprint

A reprint of the complete series—So You Want to Pass the RAE?—including details of the new examination format being introduced this year, is now available.

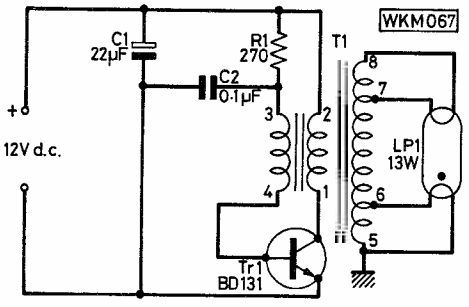
Order your copy by completing and returning the coupon on page 71.

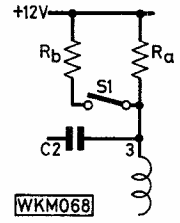
12V FLUORESCENT LIGHT

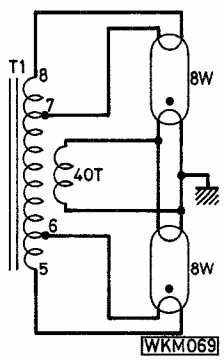
Low-voltage fluorescent lamp fittings have many applications. For boats and caravans, where often the only power supply is an accumulator, they form a permanent light source. For emergency or other intermittent use, the scope is even wider: in the home, when power failures or cuts occur; in the car, for breakdowns and punctures; when camping.

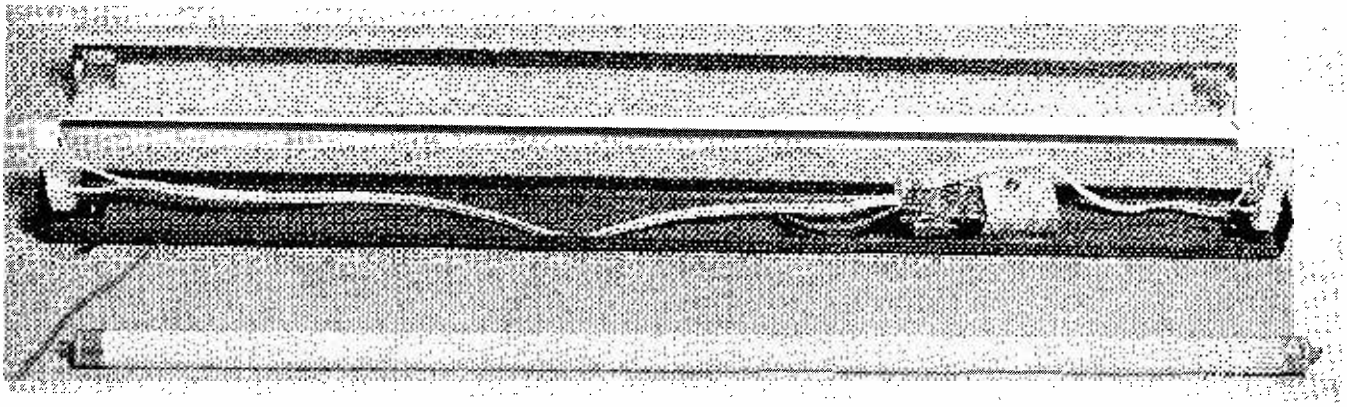
A 13 watt, 21 inch tube will provide a very useful level of lighting for a consumption of about 1 ampere from a 12 volt battery, when driven via a suitable invertor circuit such as that shown in Fig. 1. Transistor Tr1 operates as a blocking oscillator, with feedback from the primary winding (1–2) to the secondary winding (3–4) of transformer T1 applied to its base. Resistor R1 sets the base current for Tr1, with C2 providing decoupling to ensure maximum feedback efficiency.

The pulses at Tr1 collector are also coupled to T1 tertiary winding (5–6–7–8) which is connected to the fluorescent tube LP1. At switch-on, all power will be directed to the tube heaters. When operating temperature is reached the high voltage present across the secondary of the transformer will cause rapid striking of the tube and the heaters will be extinguished. Operation in this manner prevents the tube "blackening" at the ends. When the tube has struck, this voltage drops to a much lower value due to the load then imposed on T1.









Interior view of the complete unit

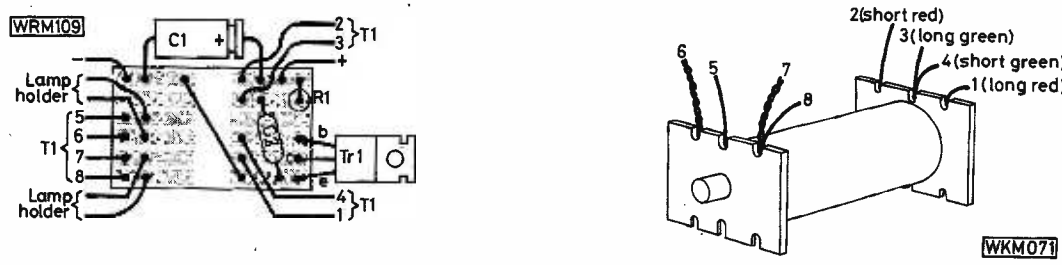


Fig. 4: Board layout and transformer terminations

Assembly of board, transformer and heatsink

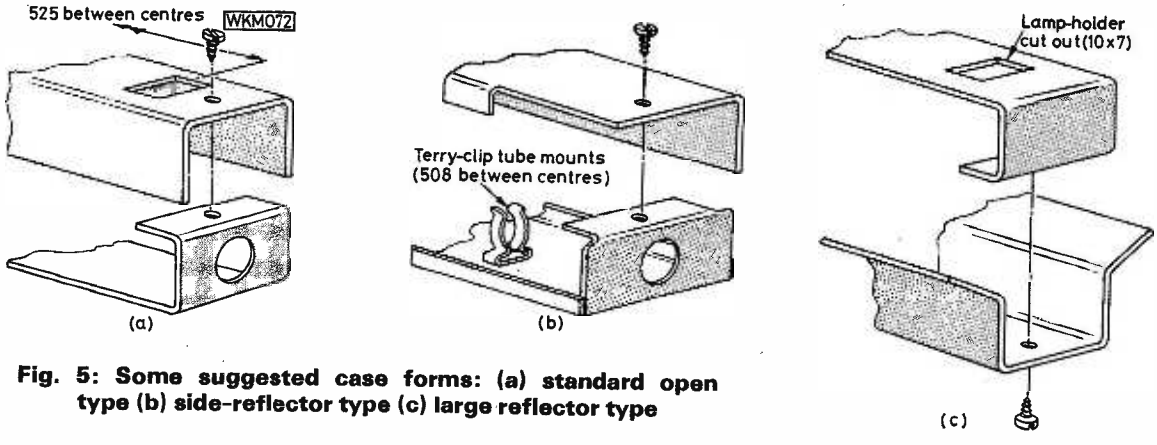


Fig. 5: Some suggested case forms: (a) standard open type (b) side-reflector type (c) large reflector type

Components

The type of transistor used in this circuit is not too critical and any h.f. *npn* power transistor can be used. Some types (for instance the 2N3055) will tend to self-destruct if run off-load. In this case, a cure is to connect an 82V Zener diode between the emitter and collector of Tr1 (cathode to collector). With transistor types other than that specified, it may be necessary to alter the values of R1 and C2 for optimum working.

The transformer is of a special design for use with this invertor circuit, and it is not practicable for the home constructor to wind a component to meet the required tolerances.

Dry Battery Operation

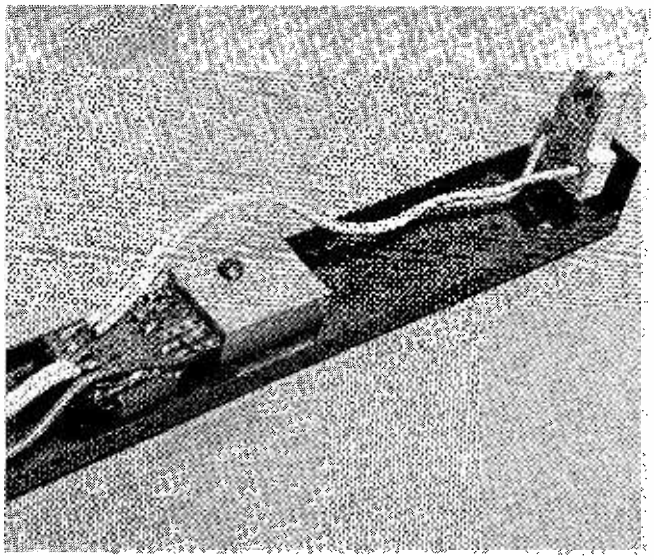
For operation from dry batteries, say two 6V hand-lamp batteries in series, the load of 1A is rather heavy, and in this application, the consumption can be reduced somewhat by increasing the value of R1. The light output will, of course, be reduced also, but a more serious drawback is a possible reluctance of the tube to strike. The easiest way to overcome this is to fit a "Start/Run" switch, which will provide increased bias current to Tr1 to get the circuit going. A suggested arrangement is shown in Fig. 2, where R_A is of the value required to give the desired running current, and R_B is switched in parallel with it for starting, by closing switch S1. The value of R_B should be chosen so that in parallel with R_A it provides a resistance of about 270Ω.

From the point of view of the mechanical design of a portable lantern powered from dry batteries, it is probably more convenient to use a shorter fluorescent tube. This may be done without loss of light output by using two 8 watt tubes. These should be connected as shown in Fig. 3, with the centre pair of heaters powered from an additional winding of about 40 turns of 34 s.w.g. enamelled wire wound on the outside of T1.

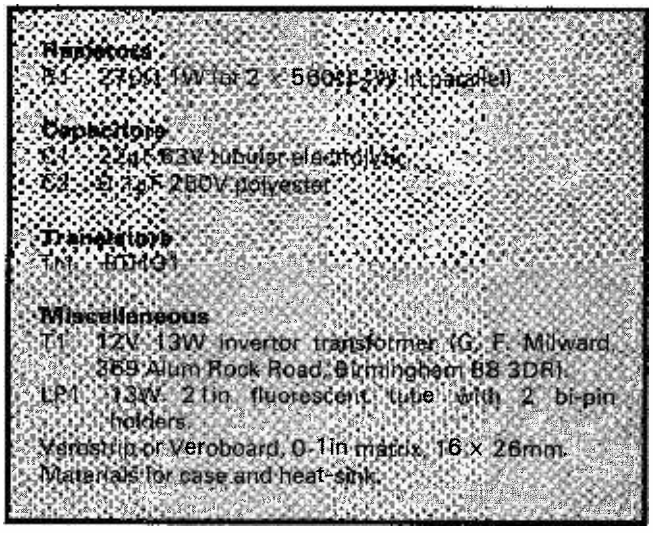
Construction

The circuit is so simple that a printed circuit board is hardly justified. Instead, the components are mounted on a small piece of Verostrip or Veroboard. A suitable layout is shown in Fig. 4. The transformer and board may be held together by means of a double-sided sticky pad. Take care not to break the transformer leads, as these are fragile, particularly on the tertiary winding. The transistor heat-sink can be secured and insulated from the case with another double-sided sticky pad.

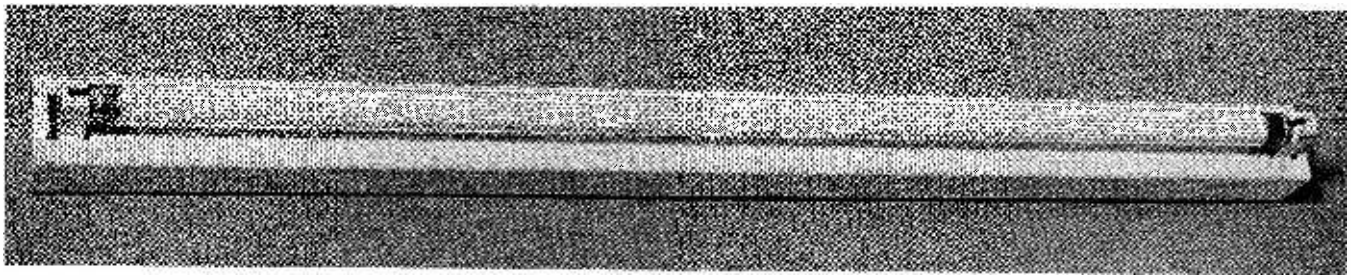
The exact form of the case metalwork will depend to a large extent on what metalworking facilities are available to the constructor. The only critical dimension is the spacing of the two lampholders. Some suggested designs are shown in Fig. 5.



★ components



To ensure reliable starting, one end of the tube must be connected to one side of the 12V supply and/or the lamp case. This is achieved in the layout of Fig. 4 by the circuit board mounting screw. If the lamp is to be used in a vehicle on which the positive supply line is connected to vehicle chassis, then care must be taken that no connection exists between the 12V negative supply line and the lamp case. In the two-tube version, this "earthing" connection should be made to one side of the centre pair of heaters, as shown in Fig. 3. ●



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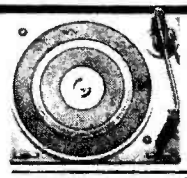

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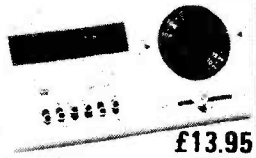

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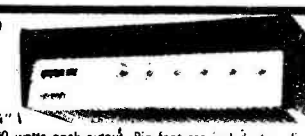

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DIGITAL AUDIO AMPLIFICATION

Gordon J. KING

Almost all audio and hi-fi amplifiers employ a push-pull output stage biased either to class A or quasi-class B (which is rather like class AB), so that the analogue input signal swings over a fairly linear part of the transfer characteristic. To combat residual non-linearity and hence to reduce the distortion a liberal amount of negative feedback is commonly used, and with quasi-class B designs, which are currently the most common, the output transistors are biased for a small quiescent current to avoid transfer characteristic discontinuity at the centre, low-level point where the characteristics of the two output transistors join. Power amplifiers of this kind are well known and it is not here intended to dwell on their design.

A less well-known technique converts the analogue input signal to a digital format which is used merely to switch the push-pull output transistors on and off. The digital format is a pulse train derived from a stable squarewave generator, and the width of the pulses is caused to vary in direct sympathy with the audio information carried by the analogue signal, which is the usual output from a gramophone pickup, tape deck, radio tuner, etc.

The analogue signal is reconstituted for driving the loudspeaker by passing the encoded pulse chain through a low-pass filter which, while greatly attenuating the relatively high-frequency pulses, yields an output which is proportional to the average value of the pulse chain at any instant. Because the squarewave pulse chain is effectively modulated by the analogue signal, the system is generally referred to as pulse width modulation, or p.w.m. for short.

It is not new from the technical point of view, for amplifiers adopting the principle were referred to way back in 1947[1], well before the days of fast-switching transistors, and more recently in 1960 in terms of a practical design[2]. Since then one or two commercial amplifiers have appeared for a short time, later to be taken off the market as the result of various shortcomings, not the least of which being a high level of radiation of the harmonics of the squarewave switching signals. Audio amplifiers are designated class A, class B and class AB, and since class C refers to r.f. amplification, the next class in line was class D, so in the early days the first p.w.m. amplifiers were designated class D.

It is of interest to note that the Dynaharmony range of amplifiers by Japanese Hitachi have been designated class E in the US. This is because they employ an auxiliary output amplifier which automatically switches to a higher voltage supply on high amplitude signals as a means of combating bad distortion on the peaks, which other amplifiers of similar main-amplifier power may well clip; also, of course, because the letter "E" was the next in line! This range of amplifiers is also referred to as class "G" (mainly in the UK), but there is no connection with class D.

Principle of PWM

With the advent of fast-switching power transistors and more sophisticated circuit techniques there has been a revival of interest in p.w.m. amplifiers, and one or two excellent designs, including the recent Sony TA-N88[3], are on the market. The time is now ripe to explore the basic principle of class D operation, to see whether there are advantages (or, indeed, disadvantages) with respect to ordinary analogue power amplification, and to investigate some of the performance parameters of a commercial design.

An impression of the make-up of a p.w.m. amplifier is given by the elementary block diagram in Fig. 1. Here the switching devices are *p*- and *n*-channel V-type junction f.e.t.s (a complementary pair) which are switched on and off by the driver stage feeding the gates.

There are various ways in which the pulse chain can be modulated by the analogue signal, such as by a Miller integrator (an arrangement similar to this being found in the Sony TA-N88) or by a "comparator" stage, shown in the diagram by the block labelled Modulator.

The pulse chain starts life as a high-frequency sinewave, and is then changed to a square or triangle wave, depending on the nature of the modulation, after which it is buffered before being applied to the modulating system. A transformer feedback type of oscillator may be used, though, from the point of view of subsequent filtering, there can be merit in using a crystal-controlled oscillator. One design[4], in fact, employs a television subcarrier reference crystal which runs at 4·433618MHz, which is followed by a divide-by-ten TTL stage to yield a frequency of 443kHz. The Sony TA-N88 amplifier employs a transformer-coupled oscillator running at 500kHz.

Clearly, the switching rate must be much higher than the highest audio frequency. The higher the frequency the better, since this makes it easier to achieve high attenuation of residual ripple signal at the loudspeaker terminals. However, there are constraints related to the switching speed of the output devices and the losses involved if the switching rate is too high. With contemporary power transistors a fundamental switching rate of about 500kHz, corresponding to 2μs, seems appropriate. This also satisfies the requirement for an upper-frequency response extending to around 50kHz before the analogue output is unduly affected by the low-pass filter action. Moreover, if negative feedback is taken after the low-pass filter, as shown in the diagram, the phase shift of the filter at the frequency of unity gain must not be so large as to incite instability. The use of a high switching rate also helps in this respect. When the pulse chain is derived from a very stable oscillator, such as a crystal-controlled oscillator, very high-*Q* filtering can be employed for ripple rejection which, of course, is not possible if the oscillator is likely to drift slightly in frequency.

With the Miller integrator type of modulator, the tops of the pulses widen and the spaces between them shorten as the amplitude of the analogue signal increases and, conversely, as the amplitude of the signal falls so the tops of the pulses shorten and the spaces between them widen. Analogue signal is continuously changing in amplitude as the information carried by the signal changes, so this is encoded in terms of the pulse chain continuously changing in effective mark/space ratio. Information on the frequency components (rise-time, etc.) of the analogue signal is encoded in terms of rate-of-change of the mark/space ratio

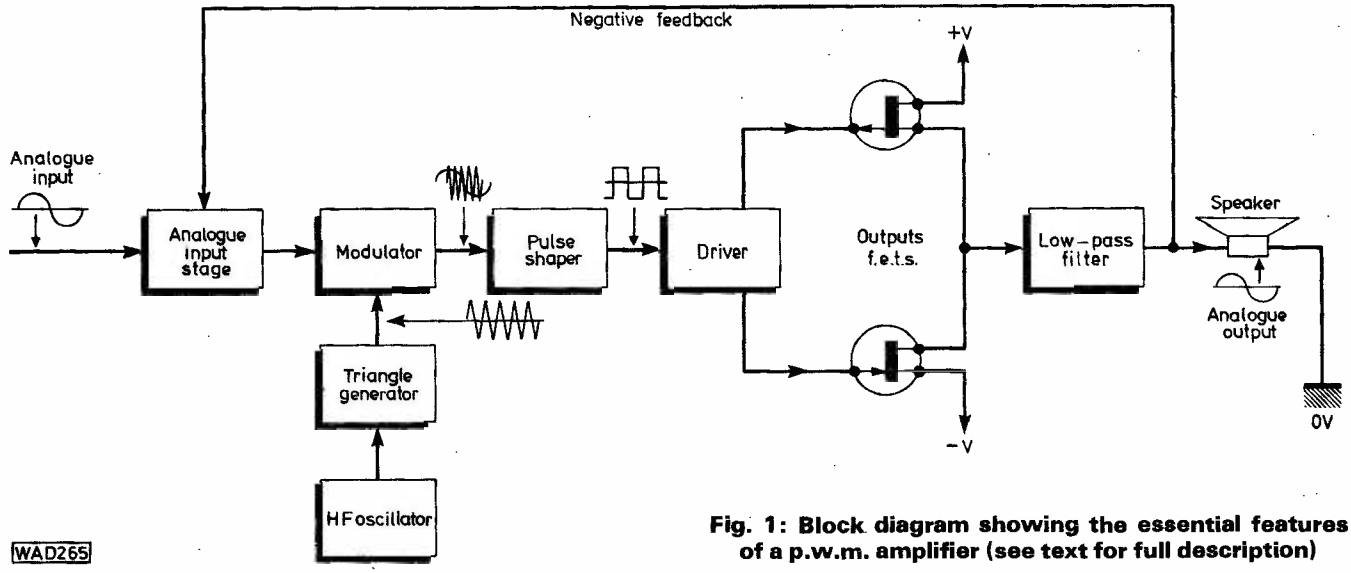

Fig. 1: Block diagram showing the essential features of a p.w.m. amplifier (see text for full description)

of the pulse chain. When there is no analogue input the pulse chain assumes a steady-state 50:50 mark/space ratio, which means that the tops of the pulses and the spaces between them are equal.

The Sony p.w.m. amplifier uses a dual-f.e.t. in differential configuration which, with current regulators and a bipolar stage, forms an integrator to which are applied the analogue and squarewave signals. It works by subtracting the inputs from the output, and has a bandwidth from d.c. to several megahertz. This is followed by a comparator composed of an i.c. containing three differential amplifiers, and its job is to produce the modulated pulse chain for switching the output devices via a driver amplifier. The configuration ensures that the rise-time of the pulse formation is less than 20ns.

Another method of modulation[4], which is that shown in Fig. 1, works in the manner shown in Fig. 2. As already noted, the analogue and pulse information, the latter first converted to a triangular wave format, are fed to the two input ports of the comparator or modulator. A simple sinewave analogue signal is shown in the diagram for the sake of rendering the description more apparent. In a practical situation, of course, the analogue signal would be continuously changing in amplitude and rate in accordance with the audio information. To ensure a faithful conversion to digital, and hence to minimise the amount of false information on the reconstituted analogue signal, a primary requirement is for the triangle wave to be very linear.

The diagram reveals that the output pulse chain encoding is a function of the amplitude of the analogue input

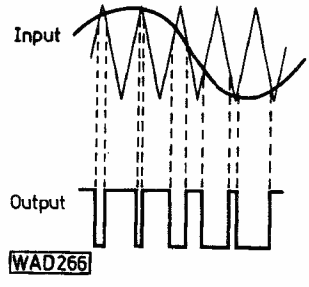

Fig. 2: Showing one method of encoding a pulse chain with information carried by an analogue signal

at any instant resulting from the corresponding changes in "slicing" level with respect to the constant-rate triangle wave input. The implication here is that the triangle wave rate is about four and a half times greater than the frequency of the analogue signal. Thus, if the triangle wave repetition rate were, say, 500kHz, then the analogue signal being encoded would have a frequency of around 111kHz. At lower analogue frequencies, of course, there would be many more triangle wave cycles per analogue cycle.

To avoid the former happening, the frequency of the analogue signal fed to the modulator for encoding is deliberately restricted by low-pass filtering. The audio spectrum is generally regarded as extending from 20Hz to 20kHz, and an amplifier with a small-signal response, at least, of less than this would certainly not be regarded as "hi-fi" by the devotees. However, having said that, it is of interest to note that even a high-quality stereo f.m. transmission carries little or no information below about 30Hz, while at the upper end of the spectrum the output is swiftly attenuated above about 15kHz or, perhaps, a trifle higher owing to the demands of pilot tone filtering.

Well-recorded gramophone records played with a top-flight pickup system fail to extend noticeably above the f.m. audio spectrum. Output below 50Hz is tamed by the specified low-frequency 3180μs time-constant of the RIAA equalisation, while the more recent IEC requirement calls for further filtering at 20Hz, corresponding to a time-constant of 7957μs. It is thus unlikely whether the equivalent **rise-time** of most of the best programme material fed into a hi-fi amplifier is quicker than about 15μs.

Nevertheless, to avoid this rise-time being further slowed down by rise-time limitations of the amplifier to which the programme material is fed, it is generally considered that the amplifier's small-signal frequency response at the −3dB points should extend to about 40kHz, corresponding to a rise-time of just under 9μs. Some amplifiers boast a small-signal rise-time of less than 2μs, corresponding to an upper-frequency response around 200kHz. It is my judgement that this is totally unnecessary and can detract from, rather than enhance, the reproduction.

It is not unreasonable, therefore, to filter the analogue signal before it is applied to the modulator so that the small-signal response is down to −3dB at 40kHz or, perhaps, a little higher (say, 50kHz). The p.w.m. amplifier design in Ref. 4 specifies a Bessel input filter for control-

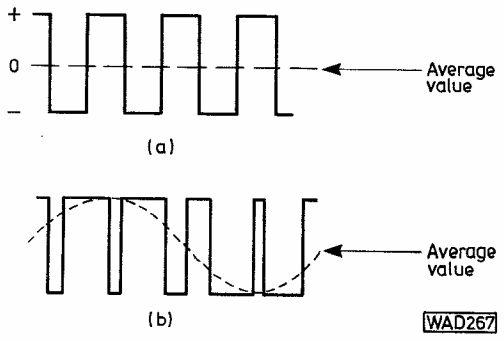

Fig. 3: The analogue of the pulse chain is represented by the average value of the pulse chain, which is shown at (a) with respect to 50:50 mark/space ratio (zero analogue) and at (b) when the pulse chain is encoded with sinewave signal, as produced by the process shown in Fig. 2

ling the input signal rise-time. As with any hi-fi amplifier, the design should aim for the widest open-loop bandwidth of the **power amplifier** section to prevent the effects of so-called transient intermodulation distortion (t.i.d.) which, to some extent, establishes the small-signal upper-frequency response of the analogue signal at the modulator input. To avoid phase distortion at infra-bass frequencies it is now common practice to employ direct coupling throughout the power amplifier system; this presents no problem.

Digital-to-Analogue Conversion

Referring to Fig. 1, the encoded pulse chain is fed to the output f.e.t.s merely to switch them on and off. In Fig. 3 a pulse chain of 50:50 mark/space ratio is shown at (a). Since this chain is perfectly symmetrical its average value is equal to half the peak-to-peak value which is zero. This is the condition when there is no analogue signal input.

Since this chain is fed to the loudspeaker through the low-pass output filter the current flowing through the loudspeaker is zero (the symmetrical switching of the complementary output f.e.t.s also ensures that this is the case). The filter, of course, greatly attenuates the switching component, and when the pulse chain is encoded the average value corresponds to the analogue input signal, as shown at (b) in Fig. 3, which is the pulse chain resulting from the sinewave modulation in Fig. 2. The result is that current corresponding to the analogue signal flows through the loudspeaker, along with a little switching residual, as shown in Fig. 4.

With a suitably high switching rate and well-designed filtering the switching residual is generally much lower than that implied by Fig. 4. The design aim is for a rejection ratio of 100dB which, referred to 100W output into 8 ohms, corresponds to a residual as small as 283μV; but not all commercial designs appear yet to be meeting this aim. The design in Ref. 4, aided by the crystal-controlled switching rate source, is one which has, at least, achieved the aim.

Although a higher level of ripple appears not to affect the reproduction (since it is well outside the response capability of the loudspeaker and up in the r.f. realm), it can cause medium-frequency radio interference owing to radiation from the amplifier direct and from the loudspeaker cables. This was one of the major problems with early p.w.m. amplifier designs. Some produced more than 1V of ripple signal, which is well above the requirements of international standards.

Advantages and Disadvantages of PWM

What are the advantages of p.w.m.? Probably the main advantage is high efficiency, which means that powerful amplifiers can be made in small size without undue overheating. With "linear" amplification the power transistors are not working very efficiently because a relatively high average power is dissipated by them. The maximum efficiency of push-pull class A working is only 50%. The efficiency is improved by class B, it working out to 78·5% excluding the driving and pre-amplifiers, of course[5].

Because the output transistors of p.w.m. remain either bottomed or cut-off for most of the time the efficiency is very high. Maximum theoretical efficiency is 100% (output power the same as the input power). In a practical design an efficiency of up to 90% is realisable. The loss stems mainly from the saturation voltage and the peak current in the "on" state. If it is assumed that these are respectively 1V and 6A, then the power dissipated by the transistors would be a mere 6W, while the peak power into an 8Ω load would be 288W. Other small losses result from transient switching dissipation.

The Sony TA-N88 p.w.m. power amplifier will deliver 2 × 160W average power into 8Ω loads yet its size is only about half that of a 2 × 100W quasi-class B amplifier. In comparison with a class A amplifier of similar power yield, the Sony has a power-to-weight ratio advantage of four or five times!

A quasi-class B amplifier is inherently a very non-linear animal in open-loop mode, which means that a high degree of negative feedback needs to be applied to bring its performance up to an acceptable hi-fi standard. Sadly, negative feedback is not a cure for all amplifier troubles and, contrary to some opinion, there are times when an increase in feedback can actually impair the performance.

On the other hand, a class A amplifier behaves much more linearly in open-loop mode, which means that it requires less feedback for a given fidelity. This is undoubtedly one of the reasons why class A power amplification has been favoured by devotees over the years. When a lot of power is required for driving very inefficient loudspeakers in large rooms, for example, then the major disadvantage of this type of amplifier is the abysmal power-to-weight ratio—very large and massive heat sinks being required by the output transistors along with large transformers to yield the high standing power.

A well-designed p.w.m. amplifier is endowed with virtually the same open-loop linearity as a class A amplifier yet it possesses a far more acceptable power-to-weight ratio. Hence, a p.w.m. amplifier calls for a relatively small amount of negative feedback merely to improve upon an already good intrinsic linearity rather than to correct for the shortcomings of some quasi-class B designs, which is the hallmark of favourable auditioning.

The greatest disadvantage is really related to the switching signal and the probability of this being radiated

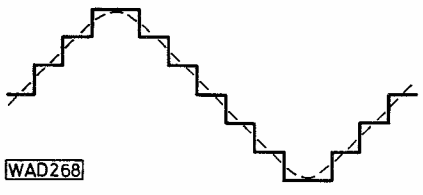

Fig. 4: Reconstituted analogue signal at the output carrying residual switching signal. In practice, the level of the residual is well below that implied by the waveform

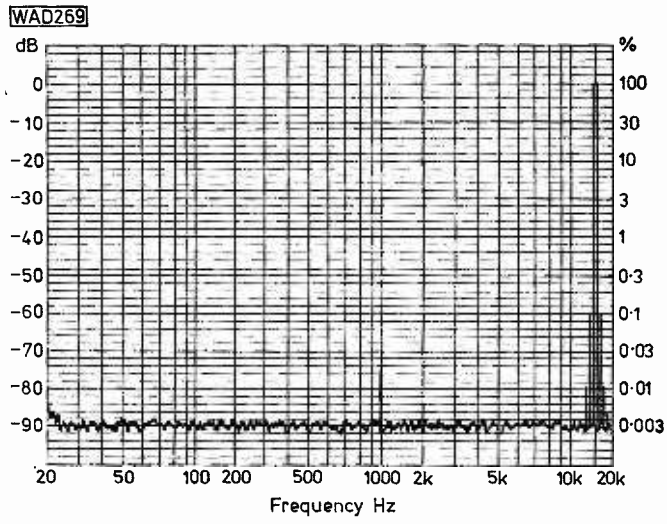

Fig. 5: CCIF intermodulation distortion produced by the Sony TA-N88 p.w.m. amplifier when delivering 38V peak composite signal across a load corresponding to a "difficult" loudspeaker of about 5 ohms modulus of impedance and 60 degrees phase-angle

if it is not suppressed properly. Most of the earlier problems have been resolved by the advent of new solid-state devices, including fast-switching i.c.s and power transistors.

Non-linearity arises when the pulse chain varies in amplitude or width from causes which are not directly related to the analogue modulation process. When this happens harmonic and intermodulation components and products appear across the output load, but by the use of suitably fast switching devices allied with competent design these aberrations are minimised. Normal feedback is possible from the analogue output to the analogue input, as shown in Fig. 1.

In some designs the feedback voltage is obtained prior to the output low-pass filter, as in the Sony, and with others the voltage is picked up after the filter, as in Fig. 1. The latter would appear to have merit, provided the filter does not cause phase shift likely to evoke instability, because it keeps the source impedance low and hence the damping factor high.

Limiting and Protection

Input overload can result in the loss of switching pulses at the extremes of modulation, accompanied by a severe rise in distortion and an increase in r.f. emission. To avoid this, most p.w.m. amplifiers are equipped with a "soft limiting" circuit in series with the analogue input signal. In the Sony, for example, this consists of a high-speed f.e.t. attenuator whose gate is connected to current sensors in the output stage. When the current threshold is exceeded the attenuator is activated so that the level of analogue signal reaching the modulator is reduced.

Thermal and short-circuit protection circuit are also included. These operate a relay whose contacts are in series with the loudspeaker, so that in the event of an output short-circuit under heavy drive or an abnormal rise in temperature the contacts open and disconnect the load. The relay is also connected to an energising delay circuit so that the contacts close after the power supply has fully stabilised. This avoids the switch-on "thump" from the loudspeaker when the power switch is turned on.

Auditioning

How do p.w.m. amplifiers compare in reproduction with more conventional class A and quasi-class B designs? Of the p.w.m. amplifiers that we have auditioned we have found the sound quality to be very close to that expected from a well-designed class A transistor or valve amplifier.

Lab Performance

As already noted, the Sony TA-N88 produced a full 160+160W into 8Ω loads to the threshold of heavy distortion rise (just prior to the peak clipping point) at any frequency, at least, within 20Hz to 20kHz. Second harmonic distortion at 1kHz and with both channels delivering 160W was −70dB, corresponding to about 0·03%. Odd-order and higher-order distortion was negligible, being equal to or below the residual of the switching signal at the output.

At 10kHz and the same two-channel power the distortion was, as would be expected, higher, corresponding to about 0·25% second harmonic, which predominated. The third harmonic was about 64dB down, corresponding to about 0·063%.

At lesser output power all distortion components shrank towards the level of the switching signal residual, which measured about 100mV r.m.s. across the output of one channel (less across the other). Although rather on the high side, the reproduction was not affected, but radio interference could just be detected on medium frequencies when a receiver with a ferrite rod aerial was placed a short distance away from the amplifier (a really tough test!).

The spectrogram in Fig. 5 shows the measured CCIF intermodulation distortion with 38V peak of composite two-tone signal across an impedance load corresponding to a "difficult" loudspeaker. There was a rise in amplitude of the IM products with increasing output voltage.

The amplifier required just under 1·5V r.m.s. for full drive; stereo separation was as high as 88dB, and residual mains ripple below 90dB. The damping factor was not too good, being 28 at 40Hz and 2·3 at 20kHz. This could possibly be improved by taking the feedback from the output side of the low-pass filter. Small-signal bandwidth was from d.c. to almost 90kHz (−3dB), after which the roll-off rate was 12dB/octave, corresponding to about 4μs, which we regarded as unnecessarily fast.

The amplifier is equipped with two pairs of complementary junction V-f.e.t.s in parallel. These devices or MOSFET power devices are ideally suitable for p.w.m. amplifiers, as also are fast-switching power bipolar transistors. However, with the inevitable price reduction of the V-f.e.t. species of power transistors, such as the Hitachi V-MOSFET, we are almost certain to experience a revival of the p.w.m. amplifier, especially when the pundits fully realise just how fine such an amplifier can audition. ●

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Follow-up to PW Wide range CAPACITANCE METER

Ian HICKMAN

Requests from readers for an even wider capacitance measurement range set the author thinking and here is the result—an add-on unit which enables the Wide Range Capacitance Meter (PW Sept '76 issue) to measure capacitors up to 30 millifarads, i.e. 30 000µF. Modifications to build the extra ranges into the original capacitance meter were hardly practical and this add-on unit involves only minimal changes, namely the addition of two 2mm sockets to the front panel.

To avoid possible confusion, component references for the extender follow on from those of the original capacitance meter.

Circuit Description

Fig. 2 shows the circuit diagram of the extender. It works on the same principle as described in the original article. The capacitance under test shunts a voltage waveform generator of known source impedance. The lowest impedance available in the original circuit was about 220Ω, limiting the measurement range to 10µF or 30µF with the function switch at x3. The extender unit takes the test waveform (at 220Ω source impedance) via an extra socket on the front panel of the meter and feeds it to a 220Ω attenuator chain; the extra loading of this chain attenuates the test waveform by 6dB. The chain is tapped at points where, looking in, one 'sees' a 22Ω source resistance (x10 socket) and a 2·2Ω source resistance (x100 socket). The latter point represents a further 40dB of attenuation of the test waveform and IC1 provides 46dB of gain, so producing the same voltage at its output as would have appeared at the red C_x terminal originally. The op. amp. output has a d.c. blocking capacitor whose reactance at the frequency of the test waveform is very low, and by setting the range switch to 10–100pF, the f.e.t. Tr5 is biassed via R22 but 'sees' a.c. signals only from the op. amp. Clearly, a 100µF capacitor connected to the x10 terminal, or 1000µF at the x100 terminal, will produce the same attenuation (in dB) of the test waveform as 10µF connected to the original meter (on the 1–10µF range).

Push button S3 reduces the source resistance at the x100 socket from 2·2Ω to 0·22Ω and raises the gain from the op. amp. to 66dB (x2000) to compensate. This provides a x1000 range, at reduced accuracy. This is because of the reduced bandwidth of the op. amp. when supplying the extra 20dB of gain. In particular, the x1000 range should only be used in conjunction with the x3 range of the function switch, as on x3 the test waveform frequency is reduced by a factor of 3. Even so, R46 has been set at 430kΩ instead of the theoretical 390kΩ. The latter value should be used if you use a high-speed op. amp. such as the LM318 instead of a 741. If using a 741, it should be a full spec. device from a reputable source—not a 'reject' or 'fall out'!

Note that no polarising voltage is applied to the capacitor under test, thus avoiding the inconvenience of a 6 seconds time constant for charging when measuring 30 000µF! The amplitude of the test wave form applied to the capacitor under test is so small that the absence of a polarising voltage is of no consequence.

Construction

The author used a diecast box and though only just deep enough internally, this fits neatly in front of the capacitance meter leaving the controls unobstructed. Any similar sized box would do, but metal is preferable to plastic. The box is connected to the black C_x terminal, i.e. the case of the capacitance meter. Two additional connectors are required on the capacitance meter, one to make the 12V supply available to the extender and one to supply the test waveform. These were added one either side of the existing C_x terminals.

This unit is an add-on extender for the Wide Range Capacitance Meter described in Practical Wireless September 1976. It is presented for the benefit of those readers who have already built the main instrument. We regret that the issue in which the meter originally appeared is no longer available.

The circuitry of the extender was made up on a piece of 0·1 inch pitch Veroboard as shown in the component layout drawing Fig. 1 and mounted on the three 4mm sockets and S3 along one edge of the board, the other edge being supported by a long 6BA bolt fastened to the back of the front panel with Araldite.

Resistors R41 and R42 may be wound using Eureka wire: 126mm of 36 s.w.g. gives 1·98Ω and 124mm of 24 s.w.g. gives 0·22Ω. This allows 2·5mm each end for soldering. Alternatives are to use 3·9Ω, 4·7Ω and 27Ω in parallel for R41 and a 0·22Ω ½W metal film resistor for R42.

On completion of the extender, check that it will not short the stabilised supply of the Capacitance Meter, connect up and switch the Meter to x1 and 10–100µF. Check that the voltage at the junction of R45 and C13 is about 6V. The meter should read off-scale to the right. Connect a 20µF capacitor between the x10 terminal and common and check that the meter reads in the region of 20µF (i.e., 2 on the upper scale). Note that the tolerance on electrolytics is typically −20 + 50%, so precision cannot be expected!

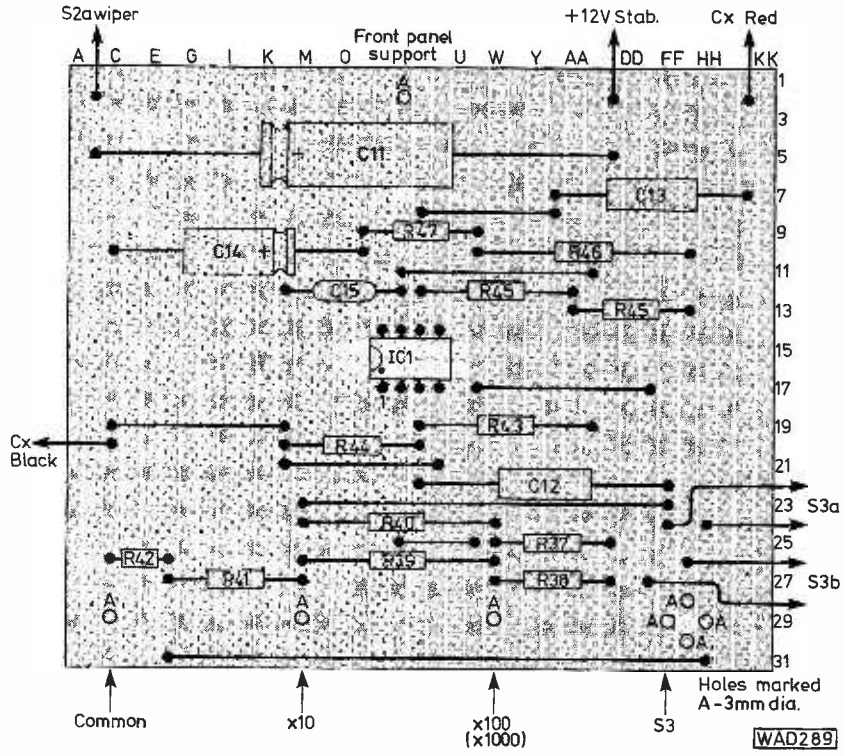


Fig. 1: The component layout of the add-on millifarad extender unit. 0·1 inch pitch Veroboard is used. The 741 op. amp. i.c. is shown as an 8 pin d.i.l. package but the alternative 14 pin d.i.l. package can also be used on the same board layout

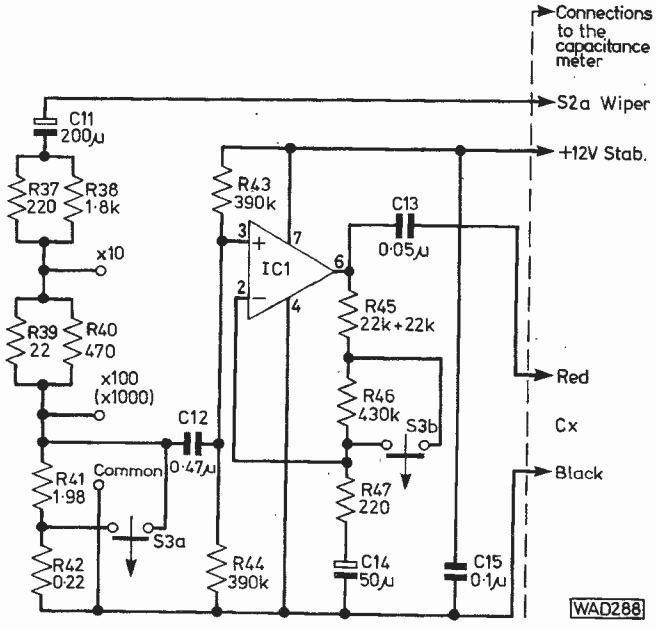


Fig. 2: The circuit diagram of the extender unit

★ components

Resistors

2% ½W metal oxide or thick film

22Ω	1	R39
220Ω	2	R37, 47
22kΩ	2	R45a, b
430kΩ	1	R46

5% ½W

470Ω	1	R40
1·8kΩ	1	R38
390kΩ	2	R43, 44

see text for R41 and R42

Capacitors

Disc ceramic

0·1µF	1	C15

Polyester		*Electrolytic*				
0·04µF	1	C13	47µF	10V	1	C14
0·47µF	1	C12	220µF	10V	1	C11

Semiconductors

Integrated Circuits

741	1	IC1

Miscellaneous

2 pole min. push button switch (RS 337-942) (1).
Diecast box 114 x 89 x 55mm approx. (1).
Veroboard 0·1 inch pitch 36 tracks x 32 holes.
2mm sockets (5).

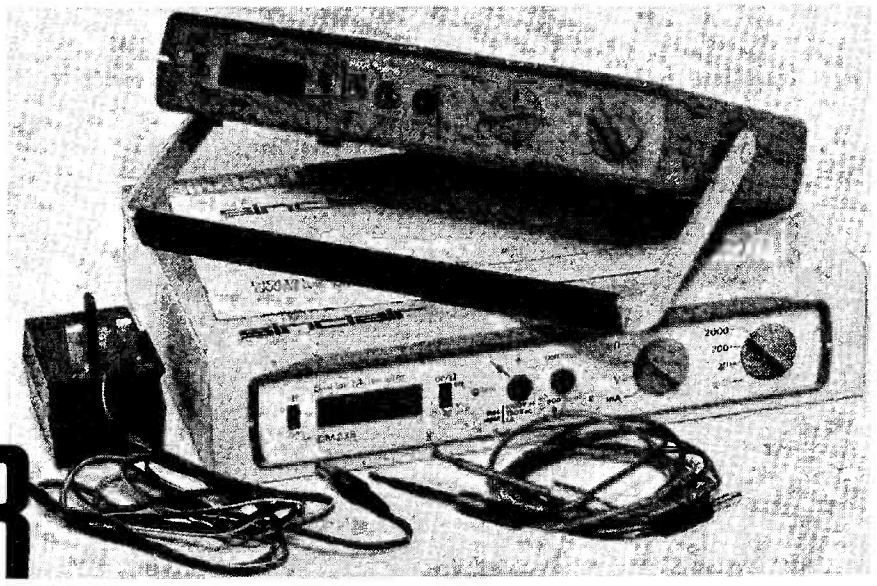
Use

Following the above checks, the unit is ready for use, as there is no calibration to carry out. Capacitors in the range 10–100µF can be measured by connecting between 'common' and 'x10', whilst capacitors between 100µF and 1000µF (3000µF with the function switch at x3) are connected between 'common' and 'x100'. These terminals are also used for measuring capacitors between 3000µF and 30 000µF, with press button S3 depressed and the function switch at x3. As the reactance of 30 000µF at the test frequency is only tens of milliohms, good quality plugs and crocodile clips with short stout leads should be used for connecting the capacitance under test to the extender. ●

SPECIAL PRODUCT REPORT

sinclair

DM235 DIGITAL MULTIMETER



Every person who claims to be actively interested in wireless or electronics needs some form of multi-test meter. If you are richer than most then this will probably be the ubiquitous Avo Model 8, for long regarded as the Rolls Royce of conventional multimeters. For the not quite so well off a lower priced oriental meter will suffice, some of them having a bewildering array of ranges—my own one even tests transistors.

The digital multimeter, or d.m.m. for short, is relatively new to the amateur scene mainly because of its very high initial cost for an instrument with a limited number of ranges.

Recently, however, several such instruments have been launched by manufacturers obviously aimed at the amateur segment of the market. The Sinclair DM235 is such an instrument and forms the subject of this test report.

A $3\frac{1}{2}$ digit, six function multimeter, the DM235 is both a bench-top and a fully portable unit. The carrying handle is arranged to act as a leg to tilt the case for easier reading of the display. With a set of dry batteries in the rear mounted compartment the instrument can be carried very easily with the front uppermost. The test leads fit neatly into a space behind the battery compartment panel when not in use. If you intend to carry the meter around a lot then an ever-ready carrying case is available as an extra. In use the DM235 proved to be simple to operate and the display was easily read with the unit on the bench top. Range selection is by two rotary switches, one of which acts as a function selector and other determines the full scale reading. A slide switch selects d.c./Ω or a.c. readings and a second slide switch controls the power to the unit.

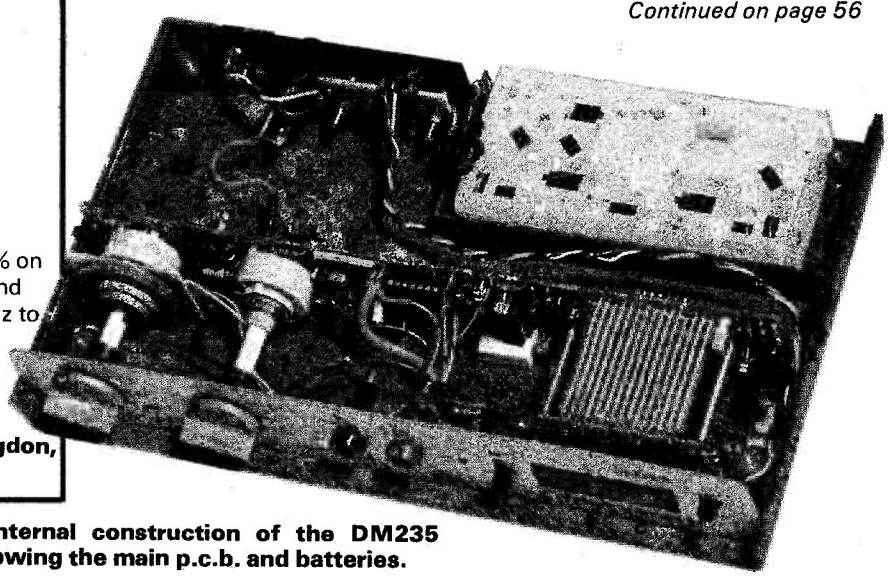
The test leads provided are the usual type with a banana plug at one end and a spring-loaded hook-grip at the other end. I found these to be more of a nuisance than useful. They never seemed to grip properly when I tried to hook them over a test point but when finally in position they seemed reluctant to let go. Also they proved difficult to use as a probe as the wire hook tends to get hidden inside the plastic end. The wander plugs fitted tightly into the two sockets provided on the front panel.

Continued on page 56

★ specifications

Voltage:	1mV to 1kV d.c. 1mV to 750V a.c.
Current:	1μA to 1A d.c. 1μA to 1A a.c.
Resistance:	1Ω to 20MΩ
Diode test:	0·1μA to 1mA
Input impedance:	10MΩ
Basic accuracy:	0·5% on 2V range; 1% on all other d.c. ranges and resistance; 1·5% 30Hz to 10kHz a.c. ranges
Size:	254 x 147 x 41mm
Weight:	682gm

Sinclair Radionics Ltd., St. Ives, Huntingdon, Cambs. PE17 4HJ.



The internal construction of the DM235 showing the main p.c.b. and batteries.

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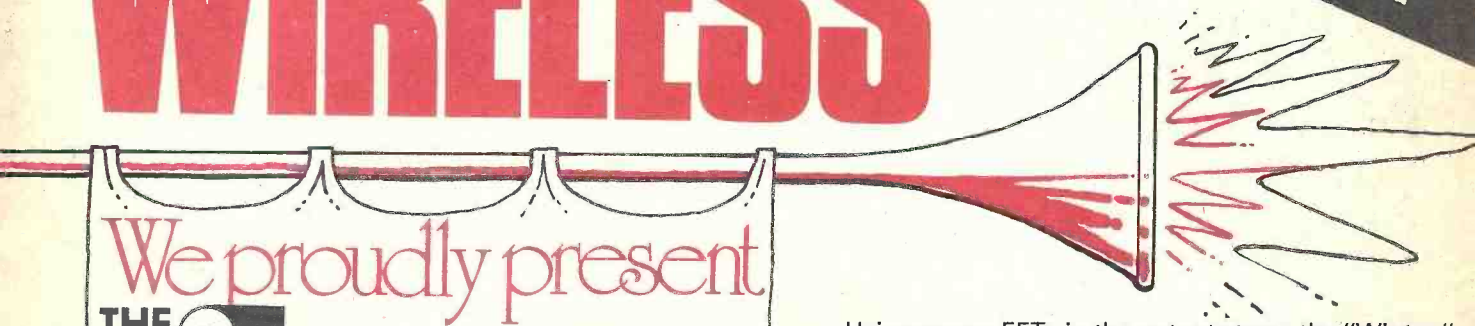

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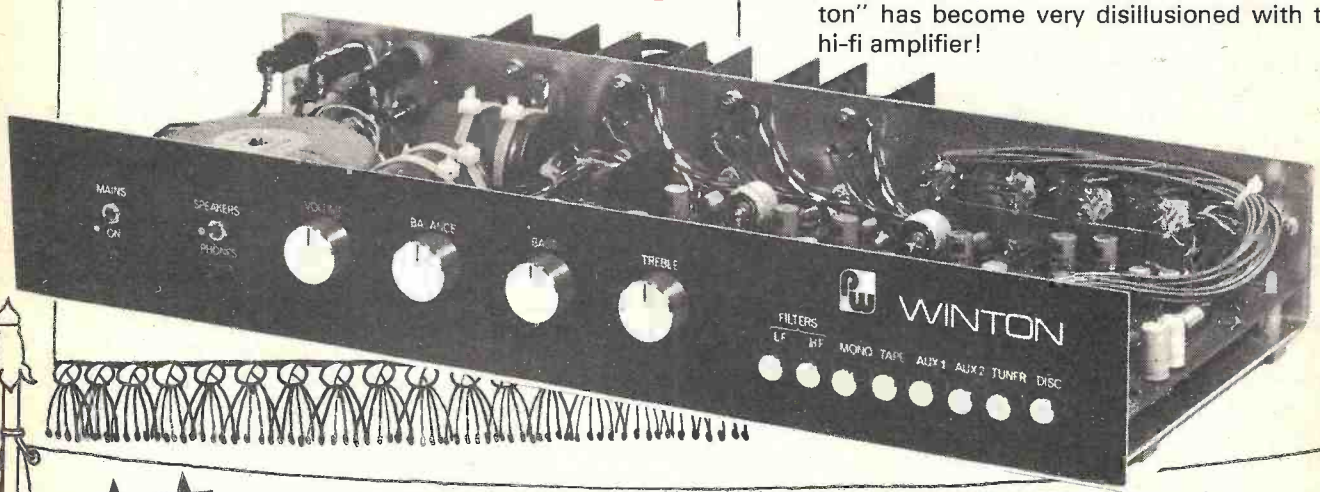

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F.M. RECEIVERS

DEVICES & CIRCUITS

PART 2

M. J. DARBY

In the first part of this feature we saw that the front-end unit of a receiver provides a 10·7MHz intermediate frequency output signal. The i.f. stages must amplify, filter and limit this signal before it is demodulated. Current trends are strongly towards the use of one or two integrated circuits in the i.f. stages rather than the use of discrete components, whilst ceramic filters are generally employed rather than inductance-capacitance tuned circuits, since they provide the required selectivity without the necessity for alignment.

In most designs a single quadrature-tuned circuit is employed in the demodulator circuit and this must be aligned so that it resonates at 10·7MHz. A few years ago Signetics produced an integrated circuit phase-locked loop, the NE563, which required no tuned circuits in the i.f. or demodulator stages, but this device is no longer available. Nevertheless, when using a commercially manufactured front-end unit, the alignment of the receiver is very simple—only the demodulator circuit need be adjusted. The position is very different to the alignment of the many tuned circuits in the older valve type of receiver where any slight mis-alignment of the band-pass tuned circuits or of the ratio detector circuit could result in considerably greater distortion.

Available Devices

There are quite a number of integrated circuits available which include all the devices required for the i.f. amplifier/limiter and demodulator stages of an f.m. receiver. The decoder required for stereo reception is always a separate circuit, normally a phase-locked loop i.c., but some amplifier/limiter/demodulator devices incorporate an audio amplifier. Many of the devices designed for use as amplifier/limiter/demodulators in the sound section of television receivers are suitable for use in f.m. radio receivers. A selection of typical amplifier/limiter/demodulator devices is shown in Table 1. These devices are suitable for the f.m. section only of receivers which cover both the f.m. and a.m. bands. However, some details will be given later of devices which can be used in both parts of an a.m./f.m. receiver.

Sensitivity

It is quite reasonable to feed the output from a high gain front-end unit through a single ceramic filter into a high gain i.f. device (such as the 3089) for local station reception, but in a situation using a relatively insensitive device, such as the μA2136 or the LM2111, it is almost essential to employ an interfacing amplifier in order to obtain adequate gain, reasonable a.m. rejection, etc. The amplifier used may employ one or two discrete transistors, but an integrated circuit amplifier is often much more convenient.

The sensitivity of the devices shown in Table 1 is expressed as a value which is known as "the input limiting voltage at the −3dB point" or sometimes as the "limiting sensitivity" or the "input limiting threshold", any of these terms being used in various data sheets. Let us consider what this definition means. If the input signal level to a device is relatively high, the amplitude of the output signal will be unaffected by any reasonable variations of the input signal, since the output amplitude is controlled only by the limiter circuit. As the input voltage falls, a point is eventually reached at which the input to the limiter is inadequate for it to operate correctly and the output amplitude must then fall. When this fall is equal to −3dB, the input signal level to the device is known as the "input limiting voltage at the −3dB point" or one of the other terms mentioned. The lower the value of the input limiting voltage, the more sensitive the device.

It can be seen from Table 1 that the input limiting voltage ranges from about 12μV up to about 450μV.

The main difference in the internal circuits of such devices is the use of a more sensitive amplifier-limiter with more amplifying stages in the more sensitive devices. Although it must be remembered that the more sensitive devices are likely to become unstable if the circuit layout is unsuitable, all of the devices should be stable if used in a reasonable circuit layout with the input well away from the output. The input to a sensitive device should not consist of a length of copper strip on a board, but rather a miniature coaxial lead or at least a short wire.

Facilities

Another important factor to be considered when choosing an amplifier/limiter/demodulator device is the range of facilities provided by each of the integrated circuits concerned. The 3089 device, the TDA1200 and the CA3189E offer a very wide range of facilities, including a.g.c. output, a.f.c. output, muting of noise when tuning between stations and generally a very high performance for high quality equipment. A few devices, such as the LM1808, are available with an incorporated audio amplifier and this can be useful when space is at a premium.

Gain Block

Before we consider typical amplifier/limiter/demodulator circuits, we will look at an integrated circuit gain block which will provide ample gain between the front-end unit of the receiver and any of the devices shown in Table 1.

The circuit of this 10·7MHz amplifier is shown in Fig. 7. A Fairchild μA753 integrated circuit (in a plastic 8 pin dual-in-line package) is very convenient for use in this type of circuit for a number of reasons. There is a choice of a

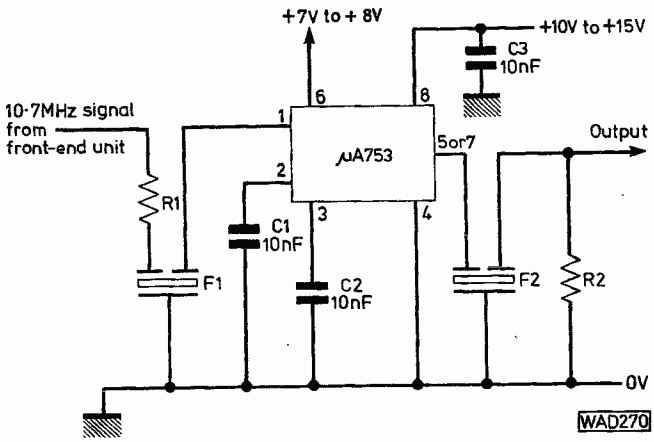


Fig. 7: A simple μA753 10·7MHz amplifier with ceramic filters

gain of about 34dB if the output is taken from pin 7 or a higher gain of about 50dB if the output is taken from pin 5. Another feature of the μA753 is that its input and output impedance have been chosen to match those of the ceramic filters normally used in the input and output circuits.

It is important that the filters (marked F1 and F2 in Fig. 7) should be reasonably closely matched with the circuit impedances. The 10·7MHz filters now available from Toko, Vernitron and Murata have been designed to operate with their inputs and outputs connected to circuits of 330Ω impedance; if the "in" and "out" impedance is far from this value, the band-pass characteristics of the filters will be impaired.

The input impedance of F1 can be matched by making the value of R1 equal to 330Ω minus the output impedance of the front-end. Similarly the value of R2 is selected so that this resistor, in parallel with any load which the circuit feeds, forms the required 330Ω value across the output of F2. The values of these resistors are not at all critical and R1 can often be 270Ω whilst R2 may be about 390Ω.

Ceramic filters are marked with a colour code to indicate the approximate resonant frequency. It is vitally important that the two filters used in the Fig. 7 circuit should both have the same colour coding or they will not match one another accurately enough in frequency; they must also come from the same manufacturer. Two such filters provide almost the ideal band-pass characteristic with a rejection of around 100dB at frequencies 0·2MHz or more from the resonant frequency. However, it is possible to omit F2 and to couple pin 5 or pin 7 through a small capacitor (perhaps 1nF) directly to the input of an amplifier/limiter/demodulator device. The rejection of unwanted frequencies will then be of the order of 55dB—which is adequate for many locations.

The μA753 provides a stabilised output of +7·8V from pin 6. This is ideal for use as a power supply to certain front-end units (such as the Mullard LP1186), but some of the Toko front-end units require a higher voltage supply which can be conveniently obtained using a Zener diode. The maximum current which can be taken from pin 6 of the μA753 is about 10mA.

The μA753 has been designed to operate over a wide temperature range, namely −40°C to +85°C, at almost constant gain. Naturally care must be taken to ensure that the leads to the decoupling capacitors C1, C2 and C3 in Fig. 7 are kept as short as possible.

There are few other similar gain blocks available. The Fairchild μA3076 (available from Arrow Electronics Ltd.) provides a relatively high gain (around 80dB) for use with a demodulator of moderate sensitivity.

Amplifier/Limiter/Demodulators

The output from the circuit of Fig. 7 may be fed into one of the amplifier/limiter/demodulator devices listed in Table 1. We will now consider some typical applications circuits using some of these devices. Although the principles of operation of each type of device are the same, the individual features of the devices (and therefore practical circuits) differ considerably. A common feature is that they all require a phase shifting "quadrature" tuned circuit.

The μA2136

The Fairchild μA2136 is a relatively simple device with moderate gain, three stage input amplifier/limiter, a quadrature demodulator circuit, an audio output amplifier, an internal voltage regulator and other circuitry. The connections of this device are shown in Fig. 8; it is available in a standard 14 pin dual-in-line case from Arrow Electronics Ltd., Coptfold Road, Brentwood, CM14 4BN at a price of about £2.

The basic circuit for a limiter/demodulator using a device such as the μA2136 is shown in block form in Fig. 9, whilst a full typical circuit is shown in Fig. 10. The input from the amplifier which follows the front-end may be coupled through C1 to L2 and hence into the limiter of the μA2136 device. Although inductor coupling is used in this circuit, other types of input coupling can be employed, such as in the examples used with other circuits in this article. It is important to note, however, that the maximum resistance between pins 4 and 6 is about 300Ω; in Fig. 10, this resistance is that of the winding L2 which is very low.

The output of the limiter is fed to the quadrature detector and appears at pin 10; after attenuation by a factor of about seven times, it also appears at pin 9. The quadrature tuned circuit is connected between pins 2 and 12, R1 damping the resonance of the circuit. The value chosen for R1 is a compromise between obtaining a relatively high audio output voltage and obtaining the lowest possible distortion at the output.

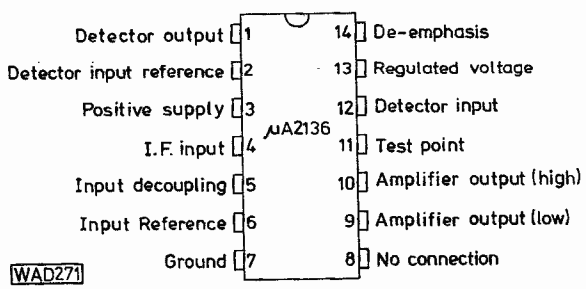


Fig. 8: The μA2136 connections

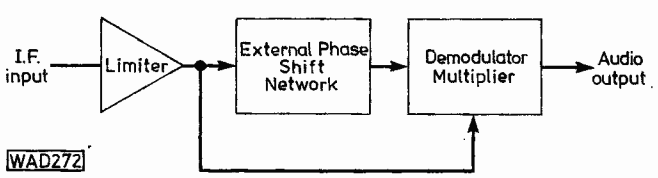
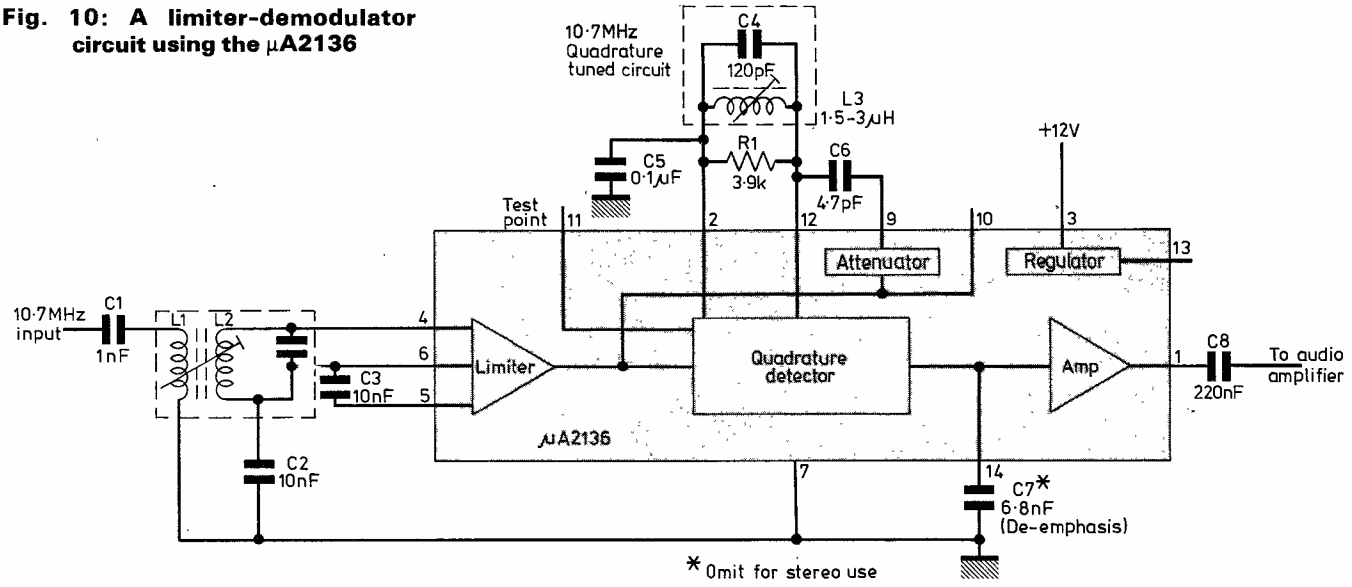


Fig. 9: Basic circuit in block form for a limiter and f.m. demodulator

Fig. 10: A limiter-demodulator circuit using the μA2136



The output from the quadrature circuit is amplified and fed to pin 1. A de-emphasis capacitor should be connected from pin 14 to ground, the internal resistance of the device at pin 14 providing the required resistive component of the de-emphasis network.

The regulated voltage appears at pin 13, but this voltage is also used to power the input limiter and the quadrature detector; the internal connections are not shown in Fig. 10 in order to keep the circuit as simple as possible. No external connection need be made to pin 13.

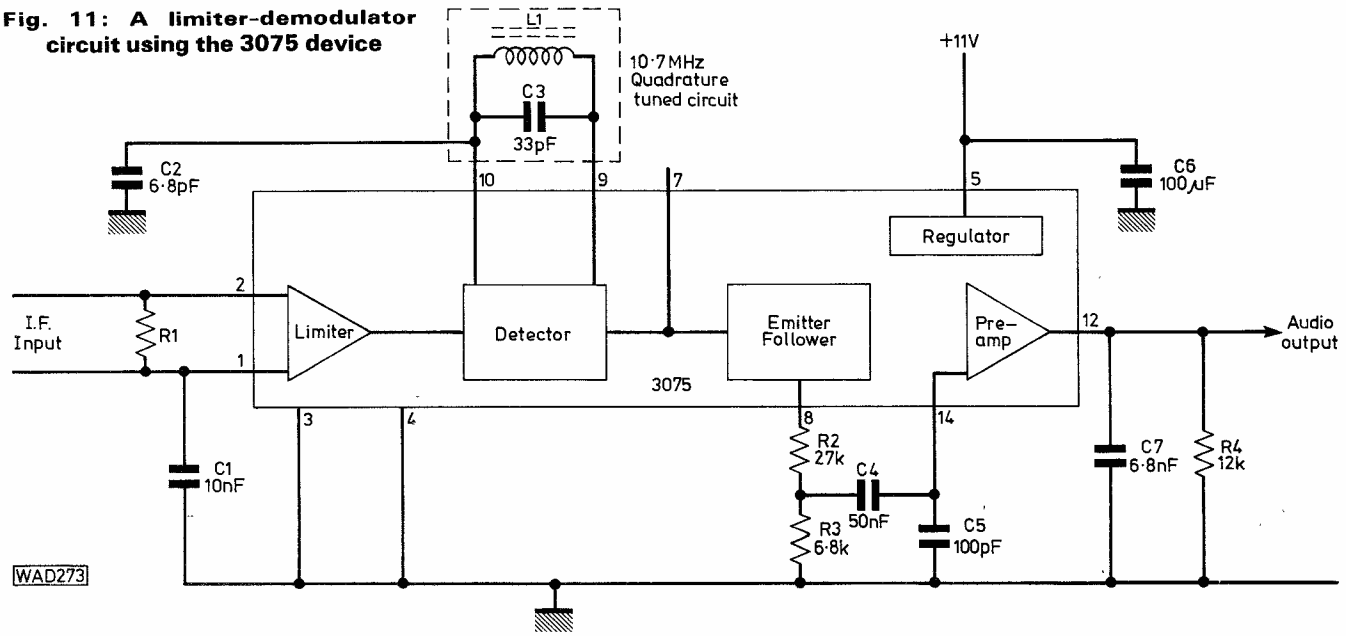
It may be noted that the μA2136 device is an improved version of the earlier ULN2111 14 pin dual-in-line device. The Sprague ULN2111 has no internal voltage regulator and the positive supply of about 12V must be connected directly to pin 13 instead of to pin 3. Otherwise, the connections are the same. Further similar devices are the ULN2111A (Sprague), the CA2111AE and its quad-in-line version the CA2111AQ (RCA) and the MC1357 (Motorola). The μA2136 is a direct equivalent of the Sprague ULN2136.

The 3075

The Fairchild μA3075 (available from Arrow Electronics Ltd.), the National Semiconductor LM3075 and the RCA CA3075 are somewhat similar devices to the μA2136, but an audio pre-amplifier is incorporated on the same chip as the i.f. circuitry. These are 14 pin dual-in-line plastic devices.

A typical 3075 circuit is shown in Fig 11. The i.f. input circuit may be similar to that of Fig. 10 or one of the other circuits, but the effective resistance between pins 1 and 2 must be fairly small so that pin 2 is correctly biased from pin 1. The 3-stage limiter has a gain of about 60dB and feeds a quadrature detector, the output from which feeds an emitter-follower before being coupled to the input of an audio pre-amplifier at pin 14. The output from the pre-amplifier stage is fed to pin 12. The capacitor C7 of Fig. 11 is for de-emphasis and should be omitted from a stereo circuit. The audio pre-amplifier provides a gain of about 21dB, but there is a loss in the coupling network between the emitter follower and the pre-amplifier.

Fig. 11: A limiter-demodulator circuit using the 3075 device



TBA 120 series

The TBA120 device was developed for television sound circuits and contains a six stage limiter, but the more sensitive TBA120S with an eight stage limiter is normally preferred for f.m. receiver applications (available from Chromasonic Electronics, 56 Fortis Green Road, N10 3HN). The TBA120T is similar to the TBA120S, but has an 820Ω input resistor to match it to the 5·5MHz ceramic filters used in television receivers; the TBA120U is another device in this series designed to be used with L/C tuned circuits. These devices are manufactured by Siemens, AEG-Telefunken, etc.

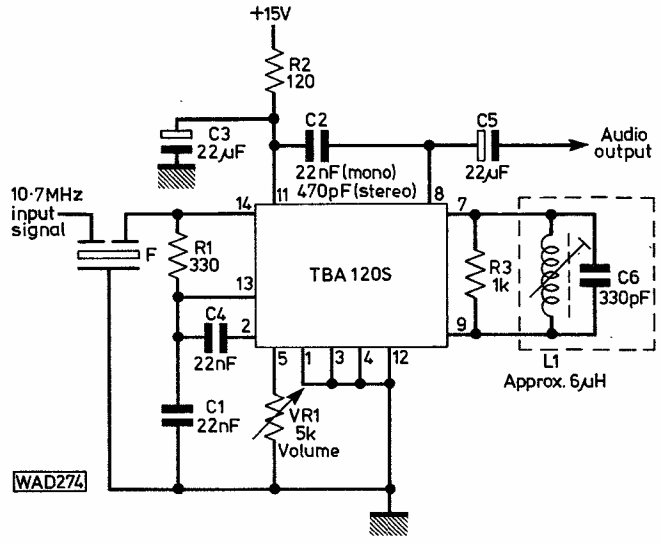


Fig. 12: A limiter-demodulator using the TBA120S device with an electronic volume control

A typical TBA120S amplifier/limiter/demodulator circuit is shown in Fig. 12. A particular feature of all the TBA120 series of devices is an electronic attenuator in the circuit shown. VR1 will provide a variation of about 70dB in volume and since only d.c. levels are involved the volume control leads need not be screened—this is another feature of the TBA120 and the LM1808 devices.

The filter F in Fig. 12 may well be the output filter F2 of the circuit of Fig. 7. L1 and C4 form the normal quadrature circuit of the demodulator.

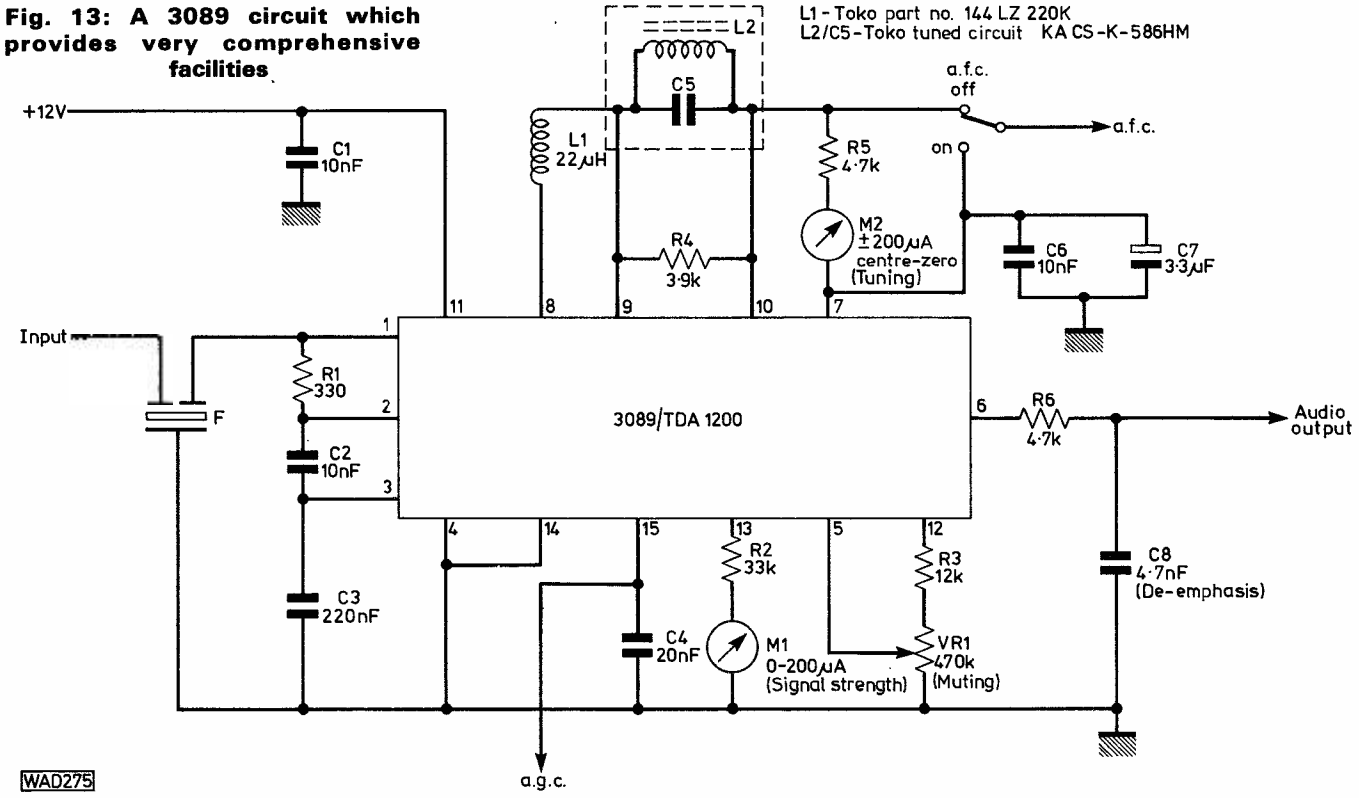
The 3089

The 3089 type of device (equivalent to the TDA1200) is probably the best known of all limiter/demodulator integrated circuits for 10·7MHz f.m. i.f. use; it is an "industry standard" type available from many manufacturers and provides a wide range of facilities for use in high quality equipment. It has been included in many circuit designs which have appeared in this magazine. It is a sensitive device with a 12µV limiting sensitivity.

A 3089 circuit is shown in Fig. 13. The input to pin 1 is obtained from the 10·7MHz ceramic filter F (which may be the output filter F2 of Fig. 7). Inside the device the signal passes through three cascaded amplifier/limiter circuits and hence to the quadrature detector circuit. This part of the circuit requires a 22µH choke (L1 in Fig. 13), but a miniature Toko component is available for this application. The Toko Company also produces a KACS-K-586HM 10·7MHz tuned circuit in a miniature can which has been especially designed for use as the quadrature detector tuned circuit with 3089 devices.

The output impedance of the 3089 device at pin 6 is about 5kΩ, so when the value of the series resistor R6 is added to this, the total of nearly 10kΩ produces the required 50µs de-emphasis time-constant with C8. The capacitor C8 should be omitted in stereo circuits.

Fig. 13: A 3089 circuit which provides very comprehensive facilities



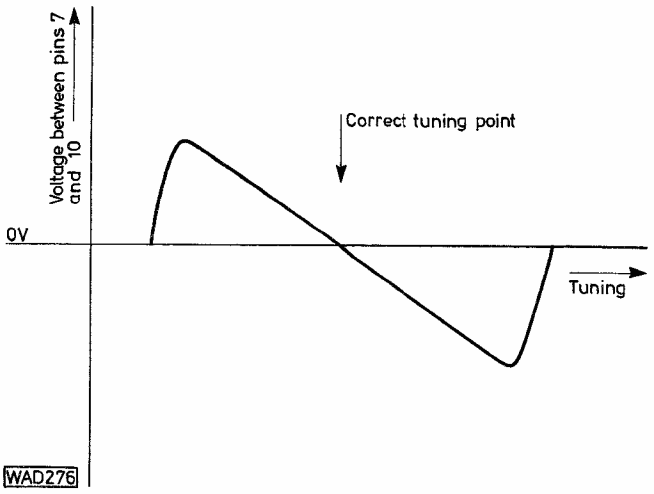


Fig. 14: Variation of the 3089 pin 7 potential with tuning

The meter M1 provides an indication of the signal strength of the i.f. signal at pin 1 of the device. The potential at pin 13 of the device increases approximately as the logarithm of the signal strength and the meter reading increases in proportion to this voltage. The logarithm scale has been chosen so that a very wide range of signal strengths can be accommodated and shown on the meter. In practice, the circuit can indicate any input signal level between about 5μV and 100mV by means of M1.

Each of the three cascaded amplifier/limiter circuits in the input of the device has a signal level detector associated with it. The combined outputs of these signal level detectors control the deflection of the signal strength meter. The first level detection circuit also provides the a.g.c. control signal from pin 15 which may be fed to the front-end unit.

The centre-reading meter M2 can be used as a tuning meter. When tuning towards the centre frequency of the signal, the meter needle is deflected to one side, but as tuning becomes closer to that of the signal, the meter needle returns through the centre position (when tuning should be exact) and is displaced to the other side. This variation of the potential at pin 7 with the tuning is shown in Fig. 14.

All the phase quadrature circuits discussed in this article must be aligned before use by adjusting the position of the core of the phase quadrature coil, whilst the extra input coil used in Fig. 10 must also be aligned. The alignment is greatly facilitated by the use of the meters shown in Fig. 13. When L2-C5 is correctly tuned, the meter M2 will show almost a symmetrical response when tuning through the signal (see Fig. 14) with optimum results when the receiver is tuned to the centre point of the curve.

The use of the meters in the Fig. 13 circuit is optional and some readers may wish to construct the circuit so that a meter is used only during the alignment of the receiver, since the incorporation of a meter permanently into a circuit does increase the cost of the receiver. The full scale reading of M1 and of M2 is not at all critical, as the values of the series resistors R2 and R5 can be adjusted to obtain suitable deflections with the meters available. However, the full scale deflection should not exceed a few mA or the device operation may be affected.

When tuning an f.m. receiver, a considerable amount of unpleasant random noise ("hiss") is formed when tuned to

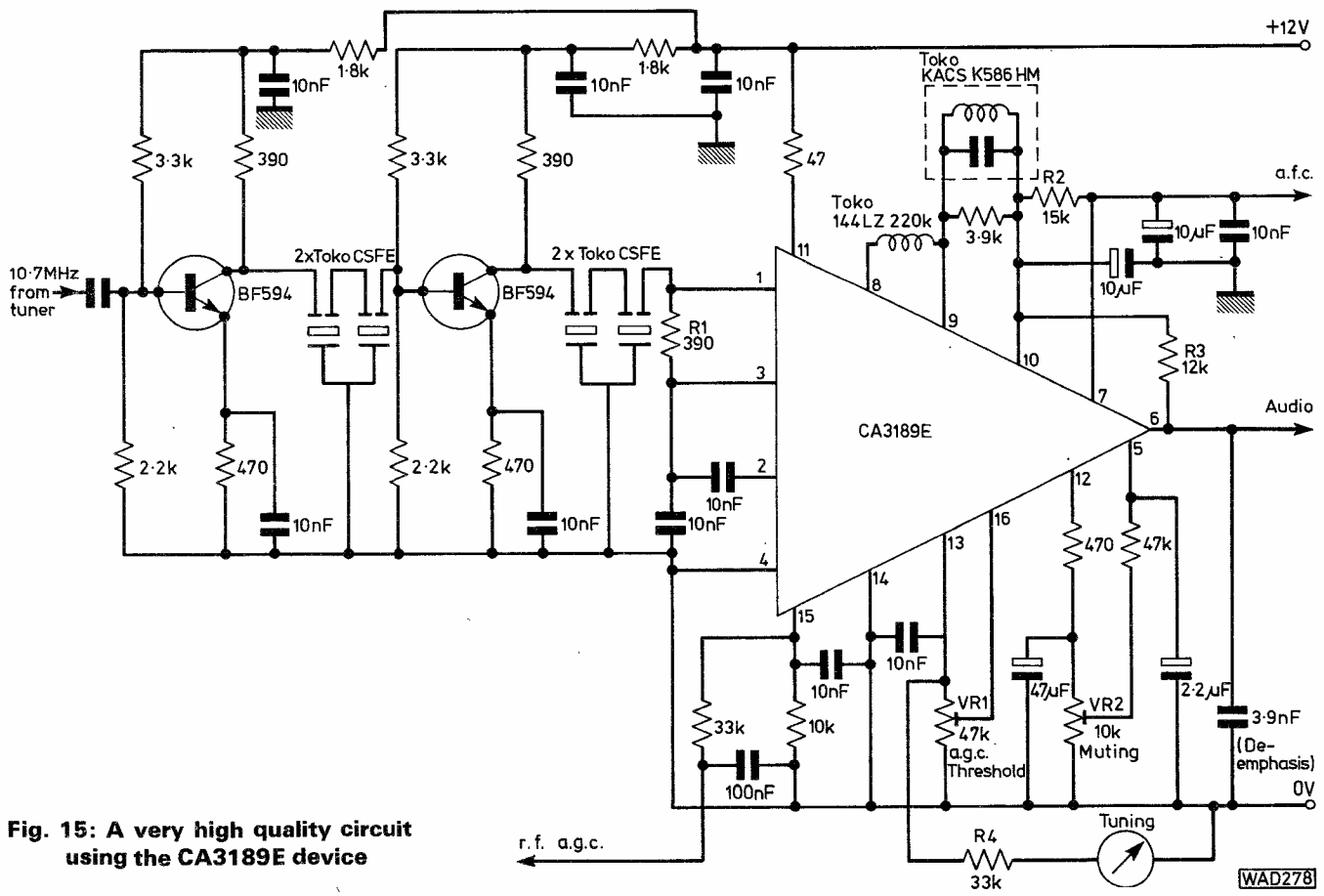


Fig. 15: A very high quality circuit using the CA3189E device

Device	Package	Sensitivity (Input voltage at −3dB point)	Supply Voltage	Supply Current (in mA at 12V)	AM Rejection (dB)	Total Harmonic Distortion	AFC Output	AGC Output	Muting	On-chip Audio Pre-amp	Electronic Volume Control range (dB)	Remarks
µA2136	14 pin d.i.l.	450µV (max. 800µV)	12V (20V max.)	17 (max. 22)	40	1% (max. 3%)	—	—	None	—	—	—
3075	14 pin d.i.l.	250µV (max. 600µV)	12V (max. 18V)	17 (max. 28)	50 (min. 40)	1% (max. 2%)	—	—	None	Yes	—	—
3089 or TDA1200	16 pin d.i.l.	12µV (max. 25µV)	12V (max. 16V)	23 (max. 30)	55 (min. 45)	0·5% (max. 1%)	yes	yes	Noise only	—	—	Industry standard type
CA3198E	16 pin d.i.l.	12µV (max. 25µV)	12V (max. 16V)	14 (max. 18)	55 (min. 45)	0·5% (max. 1%)	yes	yes	Noise and deviation	—	—	used in high quality receivers
TBA120	14 pin d.i.l.	80µV	12V (max. 14V)	14 (max. 20)	60 (min. 50)	—	—	—	none	—	60	designed for television sound
TBA120S	14 pin d.i.l.	50µV (max. 100µV)	12V (max. 18V)	14 (max. 20)	68	0·2%	—	—	none	single transistor available	85 (min. 70)	Internal transistor and Zener diode
LM1808	18 pin d.i.l.	200µV (max. 400µV)	18V (max. 26V)	11 (i.f. only)	min. 40	1·2% (max. 2%)	—	—	none	2W power amplifier	75	On-chip power amplifier with protection
2111A	14 pin d.i.l.	300µV	12V (max. 15V)	17 (max. 22)	40	0·3%	—	—	none	—	—	—

Parameters may vary from one manufacturer to another—consult data sheets

Devices suitable for use as 10·7MHz Limiter/Demodulators

frequencies between the incoming required signals. The 3089 device incorporates a circuit which is able to mute or silence the receiver when no signal is being received. A muting signal is obtained from a level detector connected to the quadrature circuit which feeds a steady output voltage to pin 12, this voltage varying according to whether an input signal or only noise is being received.

A fraction of the voltage from pin 12 is tapped off by VR1 and fed to pin 5, the muting input. The voltage fed into pin 5 can mute the audio pre-amplifier inside the 3089 so that no audio output is obtained whilst tuning between input signals.

The total harmonic distortion at the output of the 3089 device is about 0·3%, this being lower than that of most other similar devices. This distortion level is mainly a function of the phase linearity characteristic of the quadrature tuned circuit. A considerable reduction in the distortion level can be obtained by employing two tuned circuits instead of one between pins 9 and 10, but the alignment is then far more difficult and suitable test equipment is required to set up the double tuned circuit correctly. However, it is possible to reduce the total harmonic distortion at the output to a level of less than 0·1%.

The CA3189E

The RCA device type CA3189E is a recent development of the 3089 type of device. Like the 3089, it is encapsulated in a 16 pin dual-in-line package and the connections to the two devices are almost identical (except for pin 16), but the external circuits which must be used with the two devices are somewhat different. The CA3189E is the latest device for use in equipment of the highest quality.

The bandwidth of the CA3189E circuit has been restricted to about 15MHz (as opposed to the 25MHz of the 3089 type devices); this not only improves the noise level by reducing the amount of "in-band" noise generated by two signals outside the pass band, but also renders the circuit layout less critical and improves stability.

Unlike the 3089, the CA3189E includes an adjustable delay for the a.g.c. system; this means that the signal level at which the a.g.c. voltage commences to reduce the gain of the device is adjustable. Improvements in the design of the CA3189E internal circuit have resulted in the signal-to-noise ratio being increased to over 70dB. Another feature unique to the CA3189E is the inclusion of a "deviation" muting circuit in addition to the normal noise muting circuit used in the 3089 devices. This deviation muting circuit results in the muting of the "thump" noise when turning rapidly through a fairly powerful signal.

A typical CA3189E circuit is shown in Fig. 15. The limiting sensitivity of the CA3189E is about the same as that of the 3089 device and a similar input circuit can be employed. However, Fig. 15 shows a different type of input circuit using two BF594 npn transistors and a total of four Toko CSFE ceramic 10·7MHz filters which provide a band-pass characteristic which enables a signal-to-noise ratio of about 40dB to be obtained at an input signal level of onlu 3µV.

It is possible to omit one of the BF594 amplifier stages and two of the ceramic filters; the input signal is then fed directly (through a capacitor) to the base of the second BF594 transistor. In this simpler circuit the signal-to-noise ratio is appreciably lower, being rather over 20dB at the same input signal level of 3µV.

The similarity between the CA3189E and 3089 circuits can be seen from Figs. 15 and 13. An important difference between the two is the use of an external audio load resistor 12kΩ between pins 6 and 10 in the CA3189E circuit, whereas the load resistor is fabricated on the

continued on page 71

HOTLINES

A REVIEW OF RECENT DEVELOPMENTS

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

MPU bank cards

A popular cheque scheme on the Continent is one in which the owner's photograph is printed on each cheque. This gives a useful security "cheque"! The Continental bankers have again been looking at services to customers and on French electronics company has warmed to this theme by proposing to stick a microprocessor into everyone's bank credit card.

Cards in current use can store only a limited amount of information in magnetic stripes. The proposal is that, by using a microprocessor, every transaction could be recorded and the holders bank balance could be updated at each transaction.

While all this "with-it, latest, state-of-the-art" approach might be applauded by electronics pundits, I keep hearing about electronic accounting systems charging people idiotic amounts, like the £8 million gas bill etc. The Ginsberg abbacus rules—OK?

What is an 1154?

Say 1154 to most Lisle Street electronics buffs and they will draw you a picture of an enormous ex-RAF transmitter, complete with coloured knobs and a couple of PT15 directly heated valves in the p.a. stage.

Contrast this nostalgic collossus with the new i.c. that incorporates its own 4MHz oscillator. The chip uses silicon gate techniques (not to mention a touch of c.m.o.s.) and sips only a dainty 6μA at 1·55V. It is aimed at the watch market and deliveries are now rumoured to be rife.

Meter magic

So now I've heard it all, Magic Meters—well, they appear to be magic to me. A new range of analogue panel meters just out on the British market look all very smart in their black edged cases and large white dials with black lettering. The scale reads 0–150A (on the one I'm looking at). But if I want it to read 0–15kV, I can simply unplug one scale, and insert another. And the readings are guaranteed to be accurate to Class 1·5 accuracy. There's virtually dozens of scales; another reads 0–1 000kW.

The nice thing about these meters is that they are dustproof, the scales have a positive "click" insert mechanism, and you can change scales without taking the meter to pieces or, indeed meddling with anything else on the instrument.

The range of scales available is truly enormous, ranging from milliamps to Megavolts. These meters are intended for the professional who should look for the IMO J Series instruments.

Confucius—II dit

Someone in History is always having his magic phrase "Damned clever these Chinese" repeated. Alas, to bring it up to date we must substitute French. An electronics company in Toulouse has been watching the growing market in home computing and business computing. Now, it is to launch its X1 system which is based on the Motorola 6800. The X1 offers 8K of memory, two minifloppy discs, keyboard, and 12in display monitor all for around £2 000 The display can handle 24 rows of 80 characters. Strong rumours persist that a basic version wil be made available for around £500.

The murky depths revealed

Television cameras on the seabed are all very well—until there's turbulence, or the water gets murky, then they're blind and virtually useless.

A British company has come up with a solution—use an ultrasonic TV camera. While the possibility has been argued about since the late 1930's, it is only now that a practical solution has been achieved. In use, an array of ultrasonic transducers fire forward to "illuminate" the screen at ultrasonic frequencies.

The reflections are focused onto a special converter tube. A half-wavelength piece of quartz is embedded in the faceplate of the converter tube and it is this that accepts the ultrasonic echoes and translates them into a voltage pattern. The new unit is said to operate at depths down to 30 metres, but can be used down to 300 metres with an added pressure window.

The TV scan details are 12½ frames/second 201 lines/frame. Using a frequency of 2MHz it is claimed to see clearly through several metres of very murky water.

While underwater enthusiasts celebrate, doubtless Hams will wonder about further QRM at the high end of Topband!

Hothouse transducers

If you're interested in checking relative humidity, then you might be pleased to hear about a special relative humidity transducer that has recently appeared on the American market. It measures only 41 x 22 x 1·6mm and the humidity is sensed by an electrically conductive surface. It can monitor from 0% to 100% relative humidity over the temperature range −60°F to +200°F. Useful, perhaps, for electronics gardeners or budding sauna enthusiasts.

Optical disc store

In previous Ginsberg writings I mentioned that video discs were a reality and that many manufacturers were producing these. It now seems that these discs will have another application—for storage in computers. A European company has produced an optical disc memory system that looks very promising. One, single 12 inch double sided disc can store the equivalent of half a million pages of typewritten matter. This is considerably more than magnetic discs. The mean access time to any address anywhere on the disc is 250ms.

Self checking

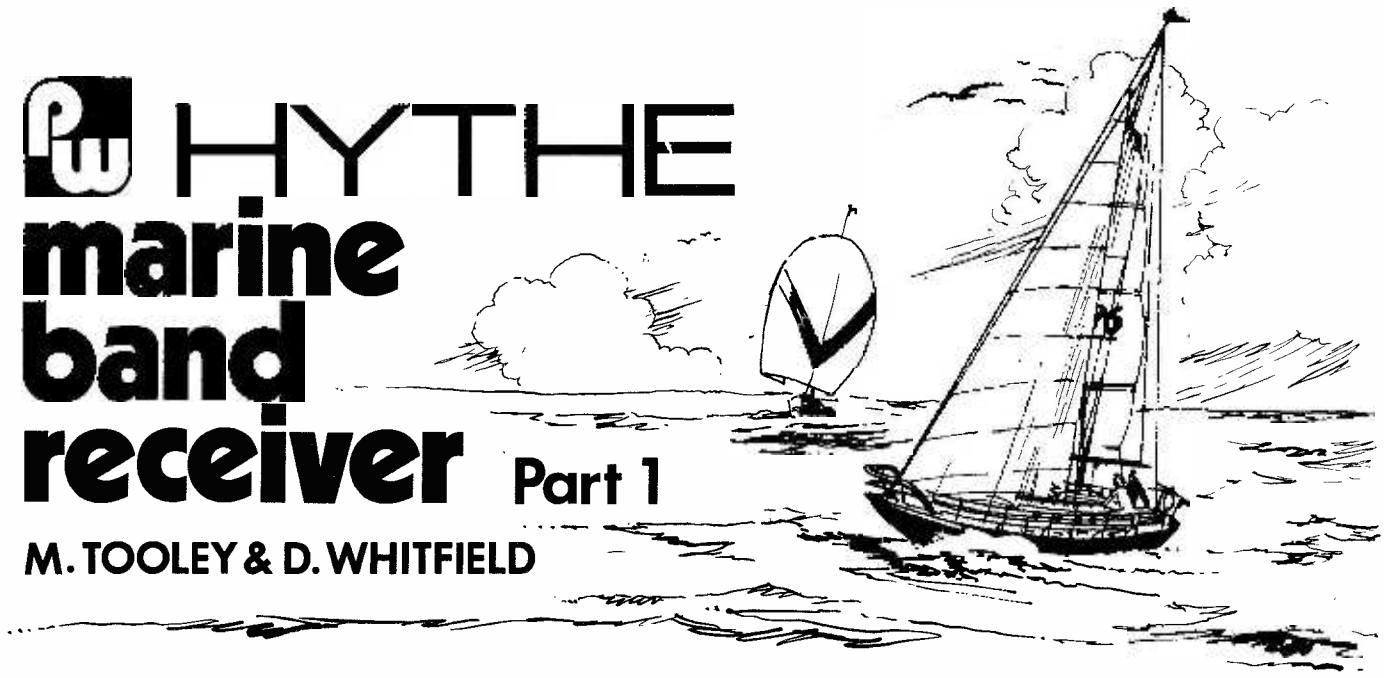
When using computers and computer systems it is not unusual to find a thing called "self-diagnostic". This is where the computer (or system) fires signals around its own circuitry to check that all its circuits are functioning correctly. This usually happens in those fractions of a second that the system isn't being used.

The latest digital multimeter to arrive on the market does the same thing. It will self-check itself and, if it does find something it shouldn't, it will isolate the fault to one of the five basic boards. It will also function as a d.m.m. to an accuracy of better than ±2 p.p.m. of reading, and 1 p.p.m. of full scale (6½ digits). Input impedance of this truly magnificent beast is 1 000MΩ and the input is also fully protected against overloads to 1kV. And the price!

Ginsberg

PW HYTHE marine band receiver Part 1

M. TOOLEY & D. WHITFIELD



This modern receiver design offers very good performance at low cost, is easy to build and uses readily available components. The receiver provides for the reception of a.m., c.w. and s.s.b. signals. The construction of the receiver unit makes use of a single printed circuit board and the alignment procedure is simplified by the use of a pre-tuned ceramic i.f. filter. The resulting performance is more than adequate to satisfy the needs of the discerning short wave listener or medium wave DXer.

Although the basic receiver design is for a frequency coverage of 1·5 to 3·5 MHz, coil winding details are also given for alternative frequency bands in the range 1 to 12 MHz. Only two coils need to be wound by constructors and, to further simplify this task, they each make use of only a single tuned winding.

The multi-mode capability and the 2 MHz tuning range of the receiver also makes it ideally suited for use as a 'tuneable i.f.' in conjunction with a front-end convertor for the v.h.f. aircraft or amateur bands.

The receiver utilises the National Semiconductor LM373N i.f. amplifier. This versatile device, designed specifically for communications subsystems, provides all the necessary facilities for a complete multi-mode i.f. amplifier and detector. The LM373N is a 14-pin dual-in-line integrated circuit which comprises a gain-controlled i.f. preamplifier, main i.f. amplifier, f.m./c.w./s.s.b. product detector, a.m. peak detector and an a.g.c. system.

The product detector operates in an unbalanced mode for a.m. reception and functions as an amplifier followed by an envelope detector. For f.m. reception, the product detector is supplied with a signal which is in phase quadrature with the original i.f. signal (i.e. 90° out of phase). The product detector inputs for s.s.b. operation are the i.f. signal and the b.f.o. output. The audio output is then derived before the envelope detector. The envelope detector then acts as an audio frequency peak detector and the output of this stage is used for a.g.c. purposes.

Circuit Description

An overall block diagram of the receiver is shown in Fig. 1. It is a conventional single-conversion superhet which makes use of five transistor stages and two integrated circuits. The circuit diagram is shown in Fig. 2.

For this external view, the receiver has been fitted with satin-finish aluminium knobs, contrasting the black front panel

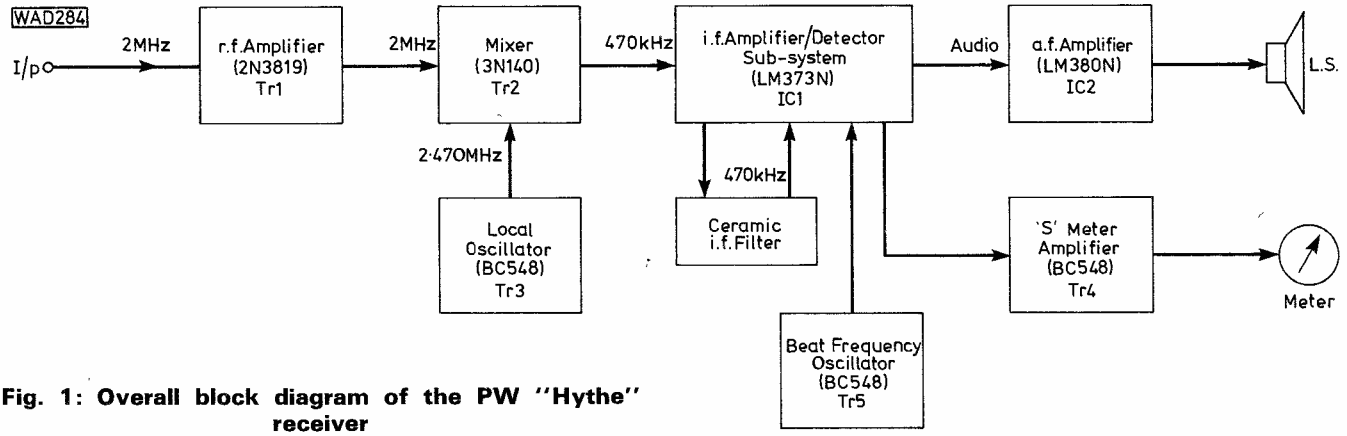


Fig. 1: Overall block diagram of the PW "Hythe" receiver

Amplification at r.f. is provided by a junction gate field effect transistor, Tr1, operating in common gate configuration. This stage exhibits a low input impedance, ideal for matching long wire aerials, and a high output impedance, which is necessary to reduce the loading on the r.f. tuned circuit, L1 and VC1.

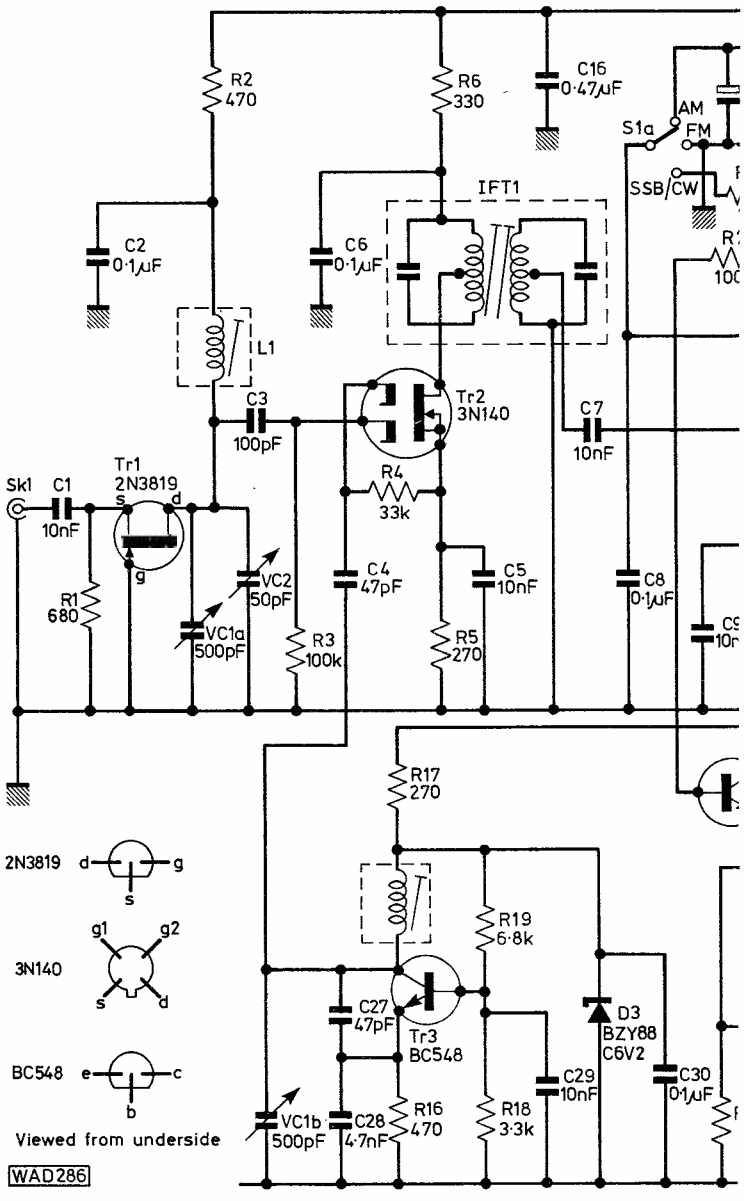
A dual gate field effect device, Tr2, is used in the mixer stage. The signal from Tr1 is applied to gate 1 and the

★ specification

Frequency Coverage: 1·5 to 3·5MHz
Modes of Operation: AM, FM, CW and SSB
Intermediate Frequency: 455kHz (nominal)
Sensitivity: 1·5µV RMS typical for 10dB S+N/N ratio measured at 2·5MHz (30% modulation at 400Hz)
Selectivity: 5·6kHz at −3dB points
11·9kHz at −20dB points
AF Power Output: 500mW maximum into 8Ω loudspeaker at 1kHz
AF Response: 130Hz to 3·6kHz at −6dB
Image Channel Rejection: Greater than 20dB at 2MHz. This figure is considerably improved with the aid of an aerial tuning unit or preselector
IF Rejection: Greater than 55dB at 2·5MHz
AGC Range: AM; less than 3dB change in audio output for 40dB change in input. Measured at 2·5MHz, 30% modulation
BFO Tuning Range: 2kHz centred on 455kHz (nominal)
Input Impedance: 600Ω (nominal)
Output Impedance: 8Ω to 15Ω (nominal)

Table of component changes for alternative frequency coverage

Frequency coverage	L1		L2		C28
	Turns	SWG	Turns	SWG	
1·0–2·5MHz	140	34	105	34	4·7nF
2·5–6·0MHz	50	30	50	30	1nF
5·0–12·0MHz	40	30	38	30	470pF



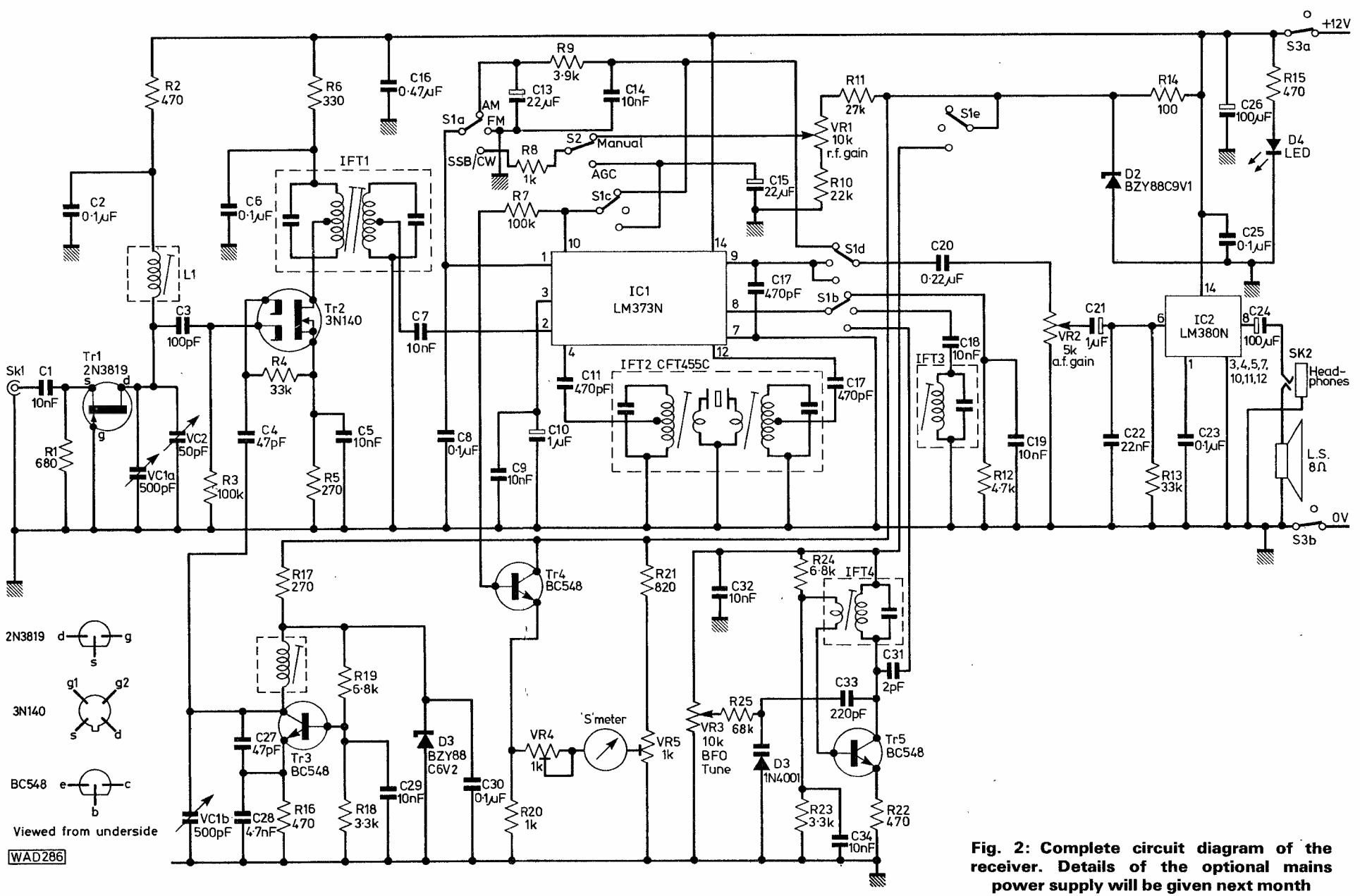


Fig. 2: Complete circuit diagram of the receiver. Details of the optional mains power supply will be given next month

Practical Wireless, February 1979

local oscillator signal to gate 2. This type of mixer offers very good performance, providing considerable conversion gain and minimising the loading on the r.f. amplifier and local oscillator tuned circuits. The drain load of Tr2 is a double-tuned i.f. transformer, used to select the desired intermediate frequency signal.

The local oscillator stage is somewhat unconventional in design. A bipolar transistor, Tr3, is connected in common base configuration in a modified form of Colpitts oscillator. This arrangement provides an almost constant output level over a very wide tuning range, with the added advantage of requiring only a simple untapped inductor. The power supply to the oscillator is stabilised by a Zener diode, D1.

The i.f. amplifier and detector functions are provided by IC1. A ceramic filter is used to define the overall selectivity of the receiver. The LM373N is ideally suited for filters of this type having medium level input and output impedances.

External switching is used to select the different modes of operation. This switching is important, not only to select the appropriate signal paths, but also to ensure that the correct a.g.c. characteristics are provided.

As the LM373N uses only a relatively small a.g.c. voltage swing compared with a conventional i.f. amplifier, it is necessary to provide additional d.c. amplification in order to drive the signal strength meter. The current amplifier, Tr4, operates as an emitter follower which has a high input impedance in order to minimise the loading effect on the a.g.c. line. Pre-set potentiometers, VR4 and VR5, are respectively used to allow calibration and balancing of the 'S' meter.

The beat frequency oscillator (b.f.o.) stage uses a transistor, Tr5, operating as a conventional common emitter, tuned-collector oscillator. The emitter load, however, is left un-bypassed in order to improve the purity of the output waveform. The operating frequency of the b.f.o. is pre-adjusted by the core setting of IFT4. Fine frequency adjustment is achieved by means of a conventional silicon diode D3, connected as a "varicap"—i.e., to a variable reverse bias potential derived from a potentiometer across the supply. The b.f.o., a.g.c. amplifier and local oscillator

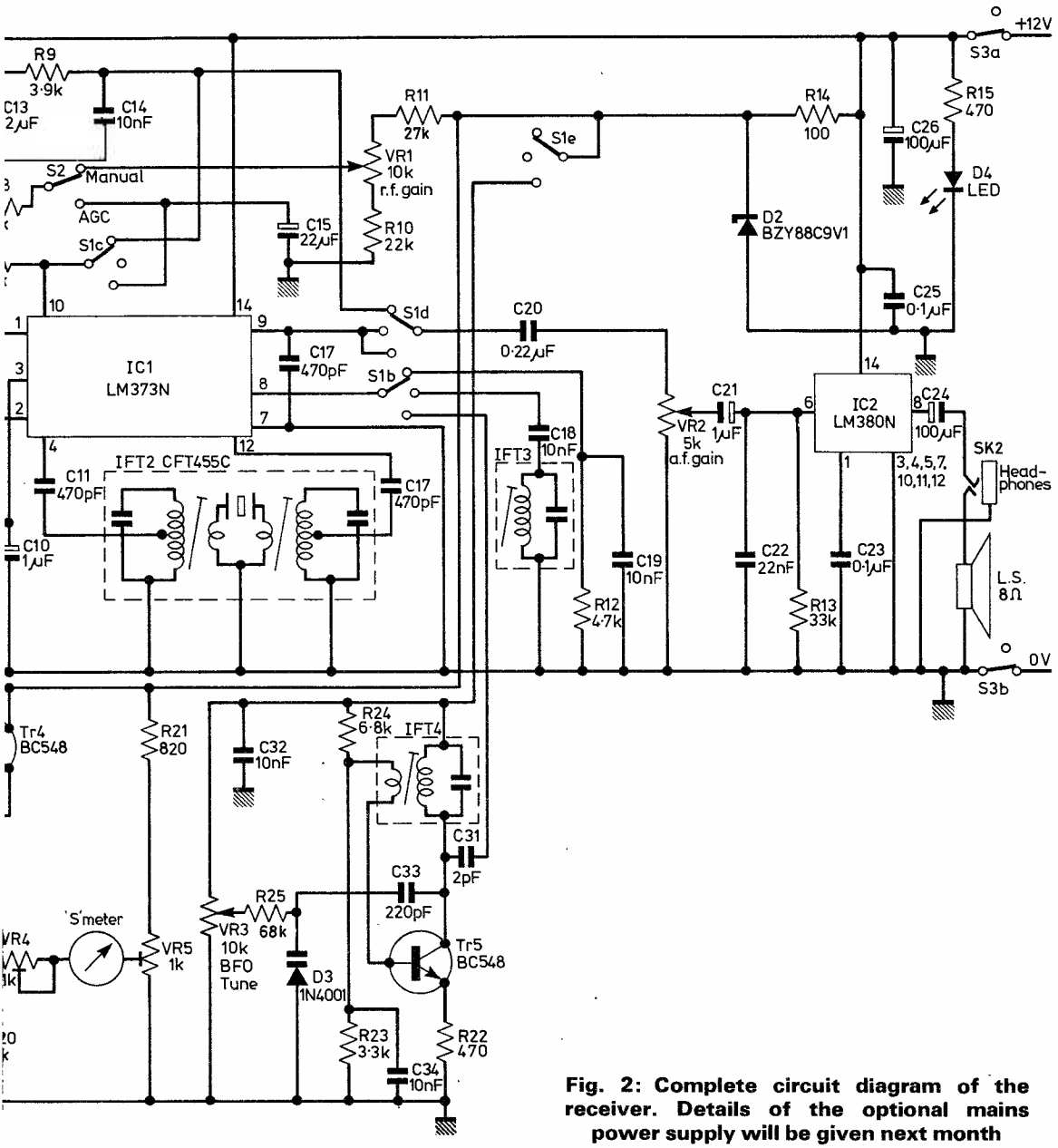


Fig. 2: Complete circuit diagram of the receiver. Details of the optional mains power supply will be given next month

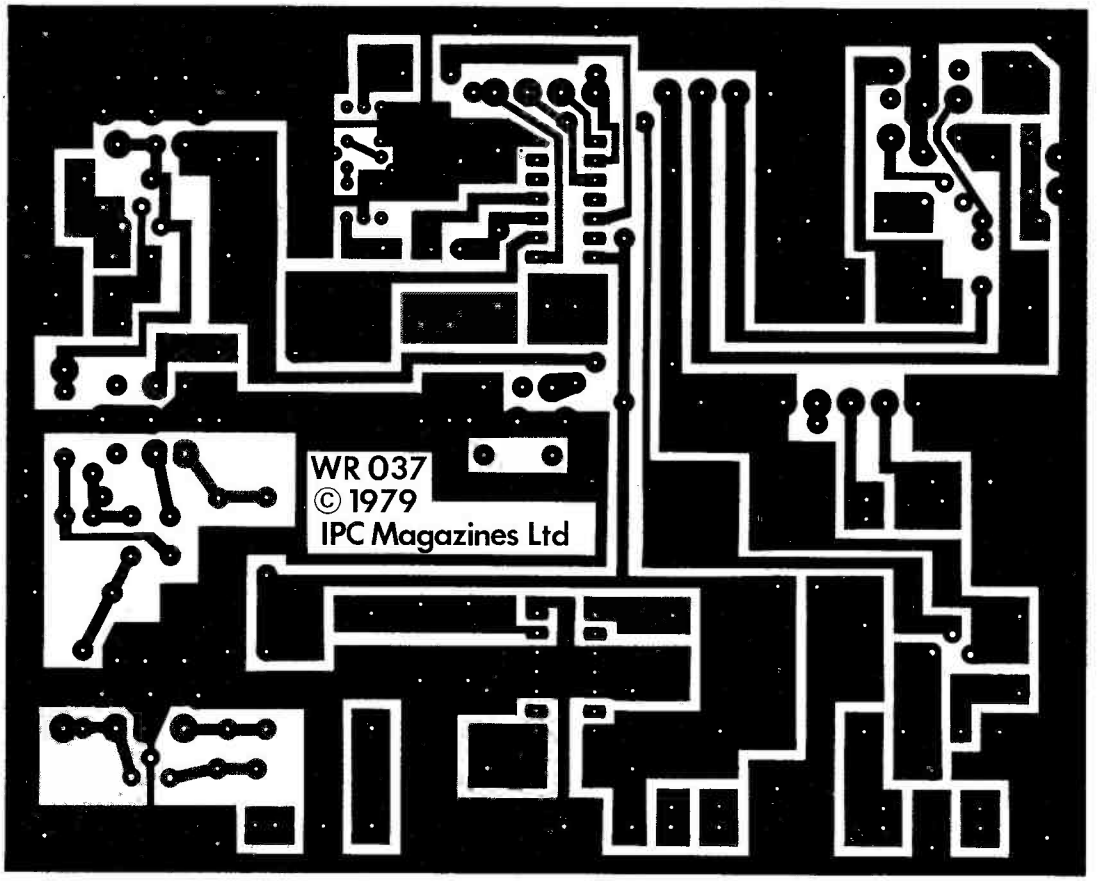
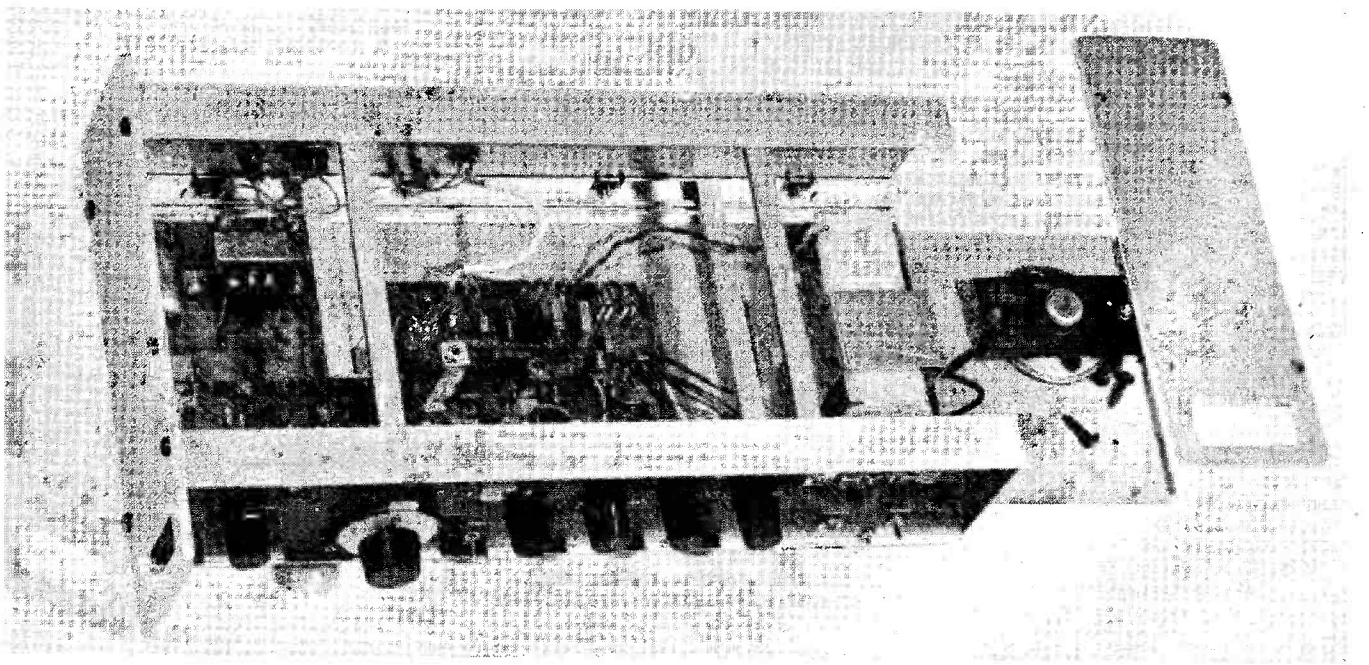


Fig. 3: Printed circuit board track pattern, shown full size



Internal view of the PW "Hythe". Access to the internal battery pack is by removing the right-hand end of the case. The case specified is also suitable for mounting in a standard 19 inch rack cabinet

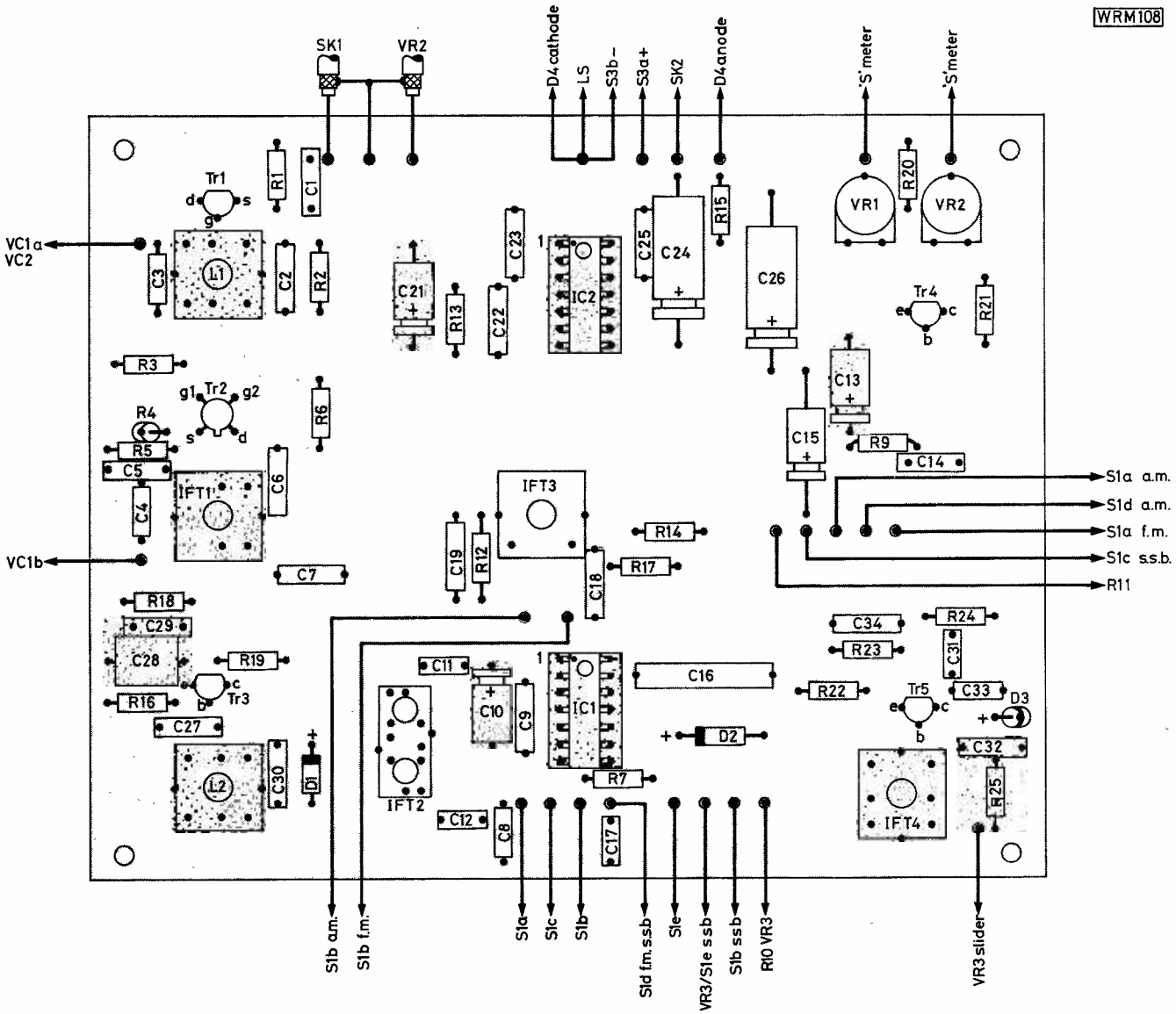


Fig. 4: Component location and external connections for the receiver printed circuit board

stages are all powered from a nominal 9V stabilised supply provided by D2.

Audio amplification of the detected signal is provided by IC2. This is a conventional arrangement using an LM380N. Little comment is needed, save to mention that this arrangement provides an adequate power output, with a fixed voltage gain of around 50, and uses an absolute minimum of external components.

Construction

The majority of components are located on the p.c.b. with controls and switches mounted on the front panel. After completing the assembly of the p.c.b. a careful visual check should be carried out in order to ensure that all components have been soldered correctly into place and that no dry joints or inadvertent short circuits exist. It is essential that the p.c.b. should be thoroughly checked at this stage since it is difficult to remove it for inspection once it has been wired to the front panel components. Push-fit terminal pins may be inserted into the p.c.b. to readily facilitate connections to the rest of the circuit. The p.c.b. is secured above the base of the chassis close to the front panel by means of four short stand-off pillars. The wiring from the main p.c.b. to the front panel, and par-

★ components

Resistors

all ¼W 10% carbon

100Ω	1	R14
270Ω	2	R5, 17
330Ω	1	R6
470Ω	4	R2, 15, 16, 22
680Ω	1	R1
820Ω	1	R21
1kΩ	2	R8, 20
3·3kΩ	2	R18, 23
3·9kΩ	1	R9
4·7kΩ	1	R12
6·8kΩ	2	R19, 24
22kΩ	1	R10
27kΩ	1	R11
33kΩ	2	R4, 13
68kΩ	1	R25
100kΩ	2	R3, 7

Miscellaneous

S1 miniature Maka-switch, two 4p 3w wafers and spacers, S2 s.p.d.t. miniature toggle switch, S3 d.p.d.t. miniature toggle switch. IFT1 Denco IFT18, IFT2, IFT3 Denco IFT13, VC1 dual gang 500pF (365pF if reduced frequency coverage acceptable). VC2 50pF variable. Ceramic filter CFT455C (6kHz bandwidth) Ambit International. Coil formers 4·8mm dia × 27mm in length 2 off, base plates, cans and dust cores to suit. 8Ω speaker (2½in dia), moving coil meter (see text), 50mm vernier drive, terminal pins, stand-off pillars, round BNC socket, countersunk 4BA screws, 15mm long (min.) 3 off, 4BA clearance spacers 12½mm long (min.) 3 off, standard jack, battery holders (optional), West Hyde "Brightcase" BC2121, front panel (D. J. Pattle).

Potentiometers

all carbon track

1kΩ lin	2	VR4, 5
5kΩ log	1	VR2
10kΩ lin	2	VR1, 3

Capacitors

Silvered mica

2pF	1	C31

Polystyrene

47pF	2	C4, 27
100pF	1	C3
220pF	1	C33
470pF	3	C11, 12, 17

Polyester min dipped

4·7nF	1	C28
10nF	10	C1, 5, 7, 9, 14, 18, 19, 29, 32, 34
22nF	1	C22
0·1µF	6	C2, 6, 8, 23, 25, 30
0·22µF	1	C20
0·47µF	1	C16

Electrolytics 63V tubular

1µF	2	C10, 21
22µF	2	C13, 15
100µF	2	C24, 26

Semiconductors

LM373N	1	IC1
LM380N	1	IC2
2N3819	1	Tr1
3N140	1	Tr2
BC548	3	Tr3, 4, 5
BZY88 C6V2	1	D1
BZY88 C9V1	1	D2
1N4001	1	D3
TIL 209	1	D4

ticularly that associated with the tuning capacitor VC1, should be as short and direct as possible, and wiring from the board to the volume control, and from the aerial socket to the board, should employ short lengths of screened cable. Some care is needed here in order to ensure that the control spindle of VC1 is correctly aligned to the shaft of the drive. If this alignment is not correct, undue wear may be placed on the vernier drive mechanism and also the tuning may be found to be somewhat erratic.

Inductors L1 and L2 consist respectively of 120 turns and 80 turns of 32 s.w.g. enamelled copper wire wound in two layers on a 4·8 mm diameter former fitted with a base, screening can, and dust core. In each case, care should be taken to ensure that the terminal pins of the base align correctly with the p.c.b. connections. After completing the winding of the coils, they should be liberally coated with a polystyrene impregnant in order to hold the windings in place. The screening can is then fitted and the entire assembly is located and soldered to the p.c.b. If an alternative frequency coverage is required, coil winding details are provided in the table shown. The moving coil meter used in the prototype was a miniature edgewise tuning indicator of approximately 200µA full-scale deflection. The receiver will, however, operate satisfactorily with moving coil meters having anything between 100µA and 1mA full-scale deflection and, if desired, constructors may choose to use a properly calibrated 'S' meter. In the authors' experience, however, the calibration of such meters in all but the most expensive of receivers has been found to be somewhat arbitrary and, for most purposes, a conventional linear meter scale will be found to be quite satisfactory.

The second part of this article will deal with the two optional items involved—the power supply, and an aerial matching unit, the latter providing an improvement both in image rejection and impedance matching. Details will also be given for setting up and operation of the receiver generally.

PRODUCTION LINES

alan martin

If you please

Would readers kindly mention "Production Lines", when applying to manufacturers or suppliers featured on this page.

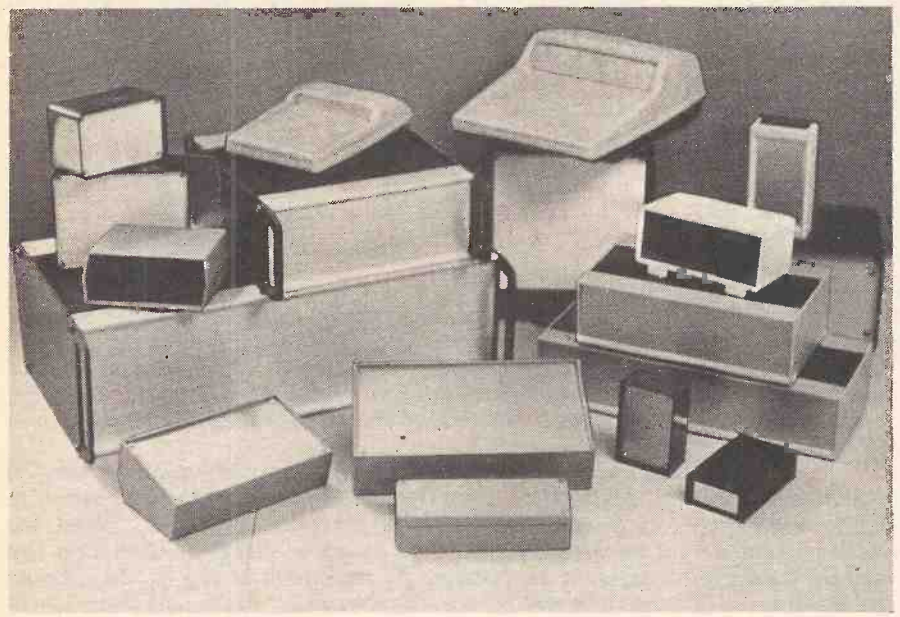
Cases Galore

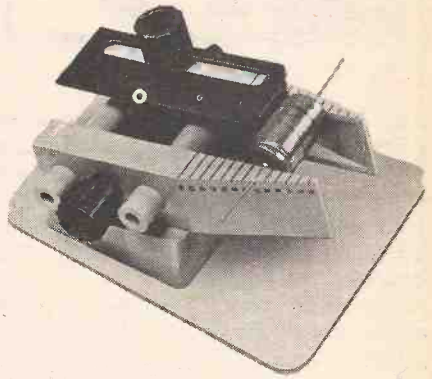
West Hyde Developments, the Aylesbury based electronic hardware suppliers, inform me, that they can supply from stock a case to house virtually all projects likely to appear in journals such as *Practical Wireless.* The photograph shows a selection of the various families of cases available, however, the combination of sizes multiply this selection enormously.

West Hyde can also offer a full range of accessories such as knobs, handles, switches, indicators and tools.

With the aid of a computer, designed to complement West Hyde's accounting system, they are able to provide a speedy turnround of orders.

To obtain their latest, free catalogue and price list, applications should be sent to: *West Hyde Developments Ltd., Unit 9, Park Street Industrial Estate, Aylesbury, Bucks HP20 1ET. Tel: (0296) 20341/4.*





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With the home constructor demanding a highly professional standard of finish to his projects, a useful tool has been introduced by Litesold.

The Opsec component lead bending tool is designed for simple and accurate preforming of component leads prior to insertion into the p.c.b.

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Manufactured in Deroton, a tough, high impact plastic and with the base fitted with non-slip feet, which may be drilled through and the unit screwed securely to the bench, the Opsec tool costs £4.99 plus 8% VAT and 15p P&P. *Light Soldering Developments Ltd., 97/99 Gloucester Road, Croydon, Surrey CRO 2DN. Tel: 01-689 0574.*

Drill stand

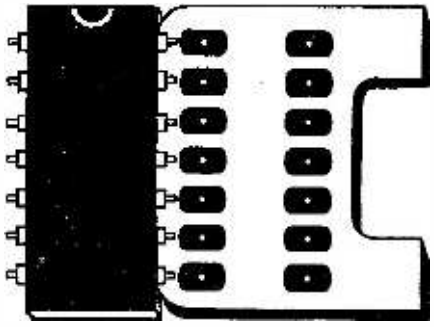
Recently introduced by Mega Electronics Ltd., a new low-cost p.c.b. drill stand designed for use with conventional hand-held p.c.b. drill units.

Designated the Photolab PLST-12A, the drill stand is constructed with a strong base of machined cast iron supporting precision steel guides by means of which the standard 12V drill is raised and lowered.

Important features are its combined simplicity and accuracy, and the fact that it will accept both the Mega and other proprietary drills of 34mm body diameter. Additionally, the same basic drill stand is available to special order from Mega, capable of accepting drills between 20mm and 41mm diameter, at marginal extra cost.

Printed circuit boards of up to 254 × 228mm (10 × 9in.) overall will be accepted by the drill stand.

The Photolab drill stand is priced at £16.50 which includes VAT, and is available from: *Mega Electronics Ltd., 9 Radwinter Road, Saffron Walden, Essex CB10 1EP. Tel: 0799 21918.*



OF THE MONTH 73

Brian DANCE M.Sc

NATIONAL LM391N-60 AUDIO DRIVER

The design of high quality audio power amplifiers is quite complex, and poorly constructed circuits may develop distortion or even burn out if used in a warm room. To avoid the problems associated with the construction of a complete amplifier using discrete semiconductor devices, a complete audio hybrid module or integrated circuit power amplifier can be used.

However, another approach involves the use of an audio power driver i.c. which contains most of the circuitry required for the early stages of the amplifier, but which is not itself designed to supply high power levels. This device will provide signals which can be used to drive external power transistors feeding the load.

Unfortunately very few audio power driver devices have been manufactured, but recently the new LM391N-60 has become available to the home constructor. This is a 16 pin dual-in-line device with the connections shown in Fig. 1 which can be used to construct audio power amplifiers producing only about 0·01% total harmonic distortion. It has the advantage that it is internally protected against output faults causing excessive current flow. In addition, it is protected against thermal overloading, and also protects the external power transistors.

A typical LM391N-60 amplifier which will deliver up to 20W into an 8Ω loudspeaker or up to 30W into a 4Ω loudspeaker when operated from suitable power supplies is shown in Fig. 2. Pin 8 of the LM391N-60 can deliver an output current of up to 5mA to the base of the BD345 driver transistor Tr1; this latter device amplifies the current before it is again amplified by the BD346 power transistor, Tr2. Pin 8 is a current source, but pin 5 accepts current and is therefore known as a current sink. The current is withdrawn from the base of the BD344 transistor Tr3 into pin 5; Tr3 drives the BD347 power transistor Tr4.

The positive half cycles of the waveform are handled by the BD346 power device, the current passing through R9, L1 and the loudspeaker to ground, but during negative half cycles current flows from ground through the speaker, L1, and R10, to the BD347 and hence to the negative supply line. This is a normal type of Class B operation in which each output transistor conducts alternately.

Circuit Details

The audio input signal is coupled by C1 to pin 1 of the device, R1 being the ground return resistor. The values of these components must not be too low or the bass response will be reduced. The amplifier input impedance is approximately equal to R1, but if this resistor has a very high value, board layout problems may occur when designing for stability. In addition, the use of a very high value for R1 may result in a high offset voltage at the output.

Negative feedback is taken from the output through R4 to pin 2. The gain at audio frequencies is equal to (1 + R4/R2) or about 20 (26dB) with the component values shown. However, the value of R2 can be altered (within reasonable limits) to obtain various values of gain. The input voltage required for full output power is about 630mV with the values shown. The value of R4 should be approximately equal to R1 for minimum offset voltage.

Capacitor C2 prevents the flow of a steady direct current in the feedback circuit so that there is 100% negative feedback at zero frequency; this reduces the gain of the circuit to unity at zero frequency with the result that any small input offset voltage is not amplified to produce a large output offset. Such an output offset would not only reduce the output voltage swing in one direction (and hence limit the maximum output power), but would also drive a steady current through the loudspeaker so that the loudspeaker coil would be displaced in its magnet gap or perhaps even burnt out. The value of C2 should be adequate to prevent the attenuation of bass frequencies.

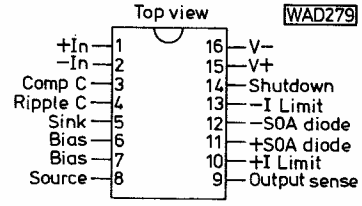


Fig. 1

The 5pF capacitor C4 is for frequency compensation (as in an operational amplifier) and sets the high frequency gain-bandwidth product. This component is required for high frequency stability. Capacitor C3 connected to pin 4 improves the rejection of mid-band and high frequencies (see Fig. 3) and if used should have a value equal to that of C4.

The potentiometer VR1 between pins 6 and 7 sets the bias for the external transistor output stages. Too little bias will result in excessive crossover distortion, whilst too much will result in an excessive power consumption and possible overheating. In the circuit of Fig. 2, VR1 should be adjusted for a quiescent current in the output devices of about 15mA, since this is just a little more than is required for minimum crossover distortion (as shown in Fig. 4). Crossover distortion is best detected at high frequencies and at low signal amplitude. The component C5 is a bias by-pass capacitor which reduces high frequency distortion and improves the transient response.

The components L1 and R14 connected in parallel may be made as a single item by wrapping about 25 turns of 19 s.w.g. wire around a 10Ω 2 watt resistor and soldering the ends of the wire to the resistor leads. It is possible to omit these two components completely with some loads, but the inductance L1 greatly improves the stability of the circuit with a capacitive load. Almost all the load current flows through the wire of the inductance (except at very high frequencies) rather than through the resistor R14. The value of this inductance is not at all critical, 2 to 12μH being suitable, but the wire used for L1 must be able to carry the

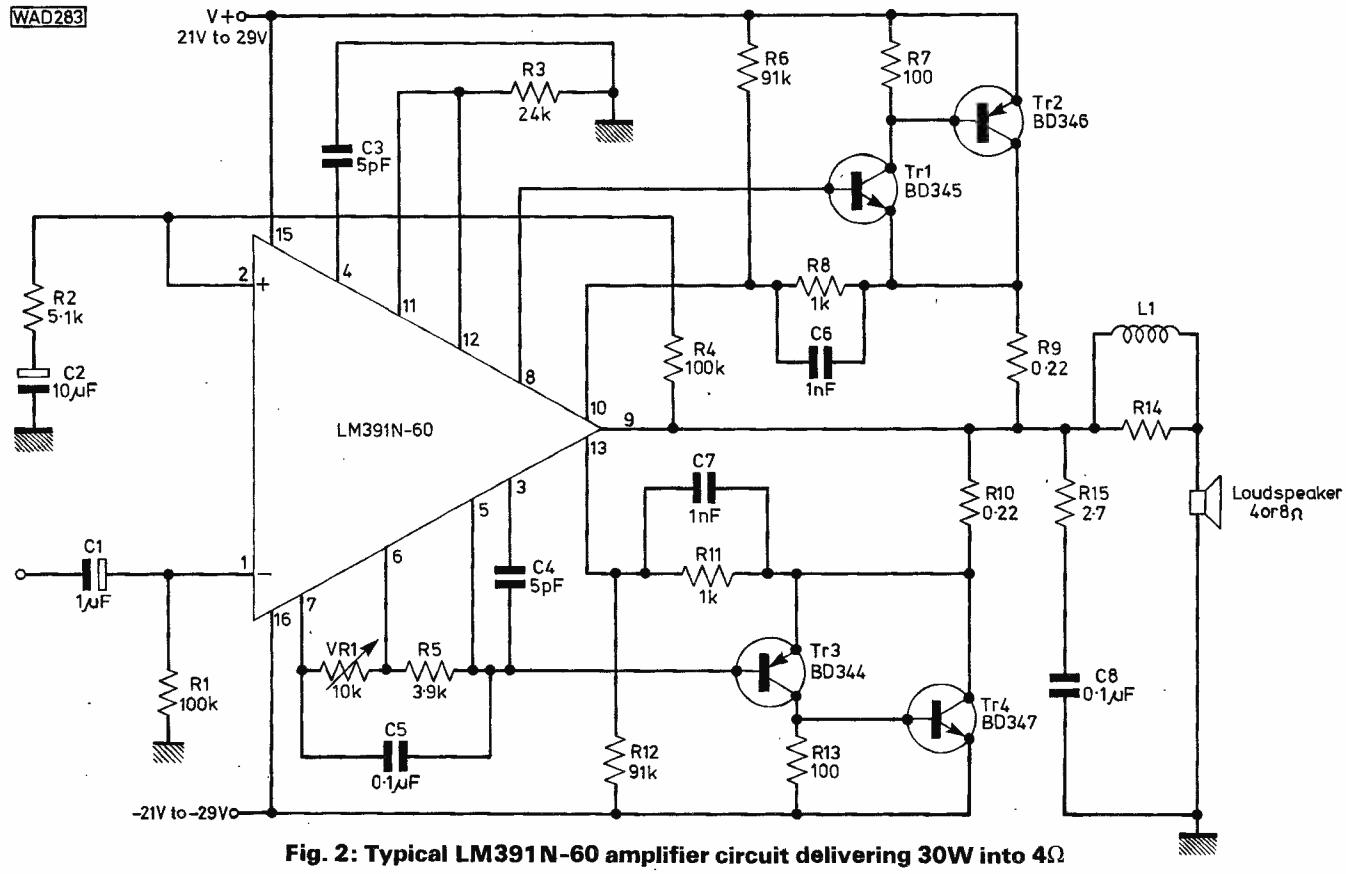


Fig. 2: Typical LM391N-60 amplifier circuit delivering 30W into 4Ω

peak current required by the loudspeaker.

The components R15 and C8 form the normal Zobel network which improves the stability at very high frequencies with certain types of load. Although the circuit may possibly operate satisfactorily without these two components, it is wise to include them rather than risk having trouble with the finished amplifier.

The resistors R9 and R10 are the emitter stabilising resistors for the power output transistors Tr2 and Tr4 respectively. They can easily be wound from a short length of resistance wire (possibly around a resistor of higher value), but the resistance wire used must be able to carry the peak current passed by the transistors. R9 and R10 stabilise the ouput stage quiescent current against variations of temperature.

The resistors R7 and R13 are bleed resistors which remove the charge stored in the base of the output transistors and thereby speed up the operation of these components.

Protection Circuit

If an excessive current passes through R9, the voltage drop across this resistor will be passed to pin 10 of the LM391N-60. The internal circuit of the device will then cause the current drive to pin 8 to be reduced so that the current passing through R9 is limited to a safe value. Similarly, a high current through R10 results in an increased voltage being applied to pin 13; this results in a reduction of the pin 5 current so that the current in Tr4 is limited to a safe value.

The limiting action of this protective circuit commences when the voltage between pins 10 and 9 or between pins 9 and 13 exceeds about 0·65V. When the component values shown are used, this means the output current in each transistor is limited to a few amps.

The safe operating area (s.o.a.) protective diodes connected in the pin 11 and pin 12 circuits are not used in the relatively simple circuit of Fig. 2 and neither is the device shutdown facility of pin 14. However, a thermal switch may be fitted to one of the ouput device heat sinks so that this switch closes when the temperature rises above a certain level and connects pin 14 directly to ground. A current of less than 0·5mA in the pin 14 circuit is adequate to shut the device down.

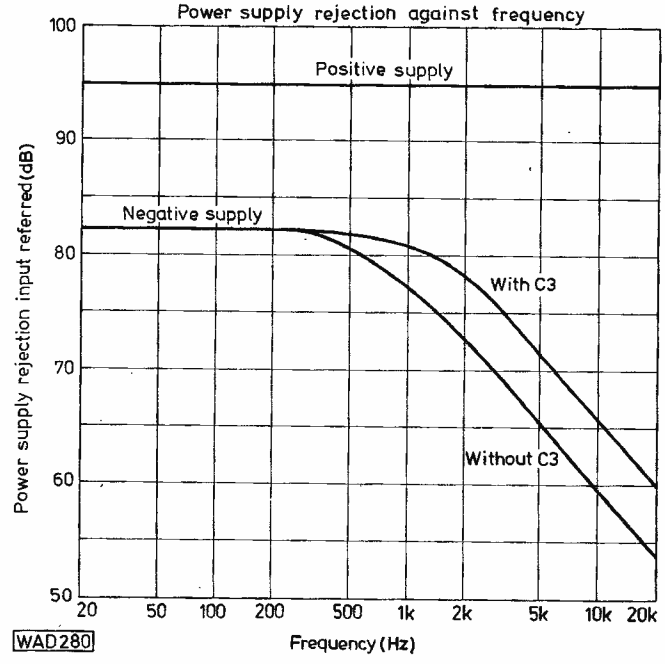


Fig. 3

Power Supply

The maximum power supply voltage which can be safely applied to the LM391N-60 is ±30V. However, it is wise to keep the applied voltage appreciably below this value so as to provide a margin of safety to allow for any normal increases in the mains supply voltage producing a higher supply line voltage. An upper limit of 27V is suggested unless stabilised supplies are employed. If the power supply voltage is low, the maximum output power may be reduced. The LM391N-60 draws a quiescent current of about 3mA (maximum 10mA for any device of this type).

The output voltage of a typical LM391N-60 can swing to within 5V of the potential of either of the supply lines. When using a supply of ±21V, the maximum output voltage swing will therefore be about ±16V. The current in a 4Ω load will be 16 ÷ 4 = 4A peak, whilst the peak power will be 16 × 4 = 64W. In Europe amplifiers are rated according to the maximum mean power they can deliver; the mean power is one half of the peak power in the case of a sine wave, so the peak power could be about 32W provided the current limiting circuit does not limit at a current under 4A.

When employing an 8Ω loudspeaker with ±21V power supplies, the peak current is 16 ÷ 8 = 2A and the peak power 16 × 2 = 32W. Thus the maximum mean power is about 16W. A little more power can be obtained with an 8Ω load if the power supply voltage is increased to about ±23V.

The LM391N-60 provides excellent rejection of noise and hum present on the power supply lines. The amplitude of any such noise and hum signals at the output of the device is typically 31 600 times (or 90dB) less than their amplitude on the power supply lines; the typical variation of the rejection with frequency is shown in Fig. 3. The minimum rejection figure for any LM391N-60 is 70dB or 3160 times.

The noise generated by the LM391N-60 is only 3μV referred to the input.

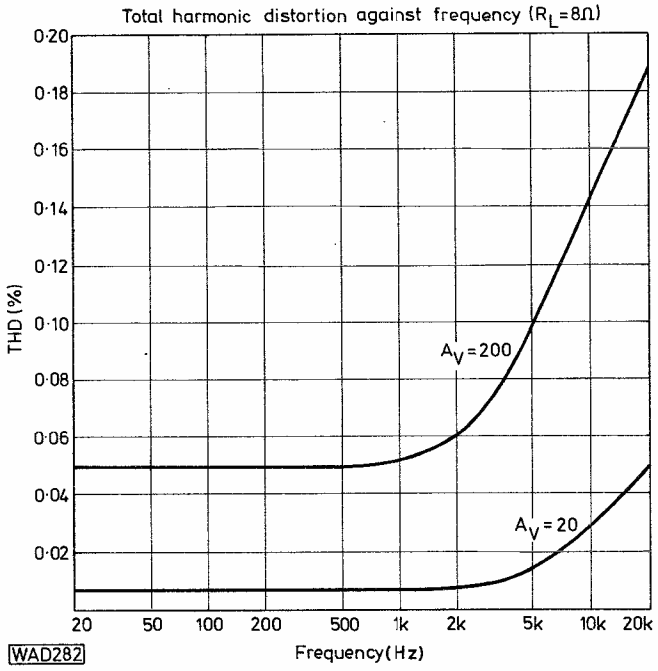


Fig. 4: Above

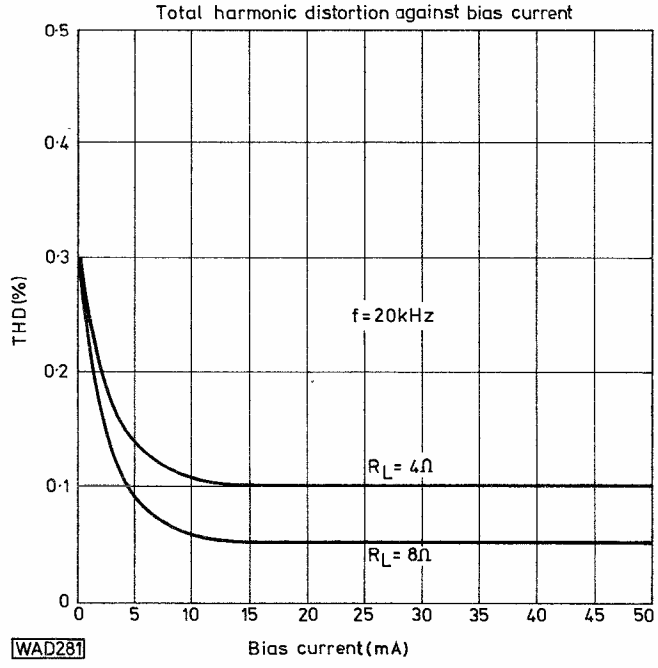


Fig. 5: Below

Performance

The total harmonic distortion in a LM391N-60 circuit is about 0·01% at 1kHz when the circuit gain is 20, but it increases with frequency as shown in Fig. 4. The distortion is also higher in circuits employing higher gain, since the amount of negative feedback is smaller. Typical values of the total harmonic distortion at two values of gain are shown in Fig. 5. The intermodulation distortion has been measured as 0·01% for signals of 60Hz and 7kHz simultaneously present.

External transistors

Various types of complementary output transistor (Tr2 and Tr4 in Fig. 2) may be used with various types of driver device (Tr1 and Tr3). The transistors used must have a V_{CEO} breakdown voltage rating which is not less than the total voltage applied across the circuit (namely the sum of the positive and negative supply voltages). The maximum current at the LM391N-60 outputs is 5mA. The gain of the driver transistor multiplied by the gain of the output stage must be adequate to bring up this 5mA current to a value which is great enough to drive the loudspeaker at the required power level.

The complementary driver transistors in the circuit shown have a gain of 40 at 200mA collector current. Thus they can bring the 5mA output up to the 200mA level. The output transistors have a minimum gain of 30 at a current of 4A, so this is adequate for the purpose. The driver transistors should have a much higher transition frequency (f_T) than the output transistors to prevent instability.

It is recommended by the device manufacturers that the output transistors of the Fig. 2 circuit should each be mounted on a heatsink of thermal resistance not more than 4·8°C/W or alternatively both could be mounted on the same heat sink which should not have a higher thermal resistance than 2·4°C/W. No heat sinks are required for the driver transistors. These heat sinks are not designed to cope with long duration short circuiting of the output to ground.

The LM391N-60 can be used together with external transistors in high fidelity amplifiers which are reasonably simple to construct. The device is available from Arrow Electronics Ltd., Coptfold Road, Brentwood, Essex, CM14 4BN. ●

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Plain board (less connector)	**09-1040-J**	**90p**
DIP board (less connector)	**10-1041-J**	**£3.60**
Connector, plug, 31 way	**17-0267-H**	**98p**
Connector, socket, 31 way	**17-0268-C**	**£1.07**
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Introduction to LOGIC ~ 7

S. A. MONEY

Having examined the various types of logic element and some typical applications it may now be interesting to look at some of the more recent developments in digital integrated circuits and see how they might affect amateur projects in the future.

Probably one of the more significant advances in the technology of integrated circuits in recent years has been the development of Large Scale Integrated (LSI) circuits in which there might be a thousand or more gates, or flip-flops, on a single silicon chip. This has been made possible by using larger chips, maybe 4mm square, and better photographic and etching techniques allowing more components to be packed into the chip. These complex chips make it possible to build a complete logic system into a single i.c. package. Even more complex devices, having tens of thousands of gates on a chip, known as Very Large Scale Integrated (VLSI) circuits are now being developed which promise to reduce complete computer systems to little more than a handful of i.c. chips.

MOS Logic

Most of the LSI logic devices currently being built use MOSFETs to form the logic elements. Unlike CMOS logic, which uses both *p*- and *n*-channel devices, the MOS logic in LSI chips uses either all *p*-channel or all *n*-channel type transistors.

The earliest LSI chips used *p*-channel transistors and this type of logic is generally referred to as PMOS logic. Power supplies for PMOS devices are negative and often there are two or three different voltages required to produce the correct bias conditions. Typical devices might use supply lines of −5V and −12V although some circuits may need as much as −20V for the supply rail. Because the logic signals are of different amplitude and opposite polarity there can be problems in interfacing PMOS logic with normal TTL and CMOS circuits. Discrete transistor circuits are normally used to match the PMOS outputs to TTL inputs and vice-versa.

Production of LSI circuits using *n*-channel transistors was initially more difficult than that of PMOS devices, but, once the fabrication problems has been overcome, these new NMOS devices, as they came to be called, were found to be better than their PMOS counterparts.

Initially NMOS devices, like the PMOS types, used two or three positive power supply rails but in many of the new NMOS circuits the bias supplies are derived inside the chip so that only a single supply voltage is required. One big advantage of NMOS circuits is that they can easily match up with TTL or CMOS logic and in many cases direct connection between the two types of logic is possible. Most NMOS logic circuits are faster in operation than PMOS equivalents.

A typical NAND gate in NMOS logic would have a circuit arranged as shown in Fig. 77(a) whilst a NOR gate would be as shown in Fig. 77(b). As with CMOS the input impedance of PMOS or NMOS circuits is very high so static electricity can be a problem. Most modern LSI chips will have protection diodes built in to minimise the possibility of damage due to static. Nevertheless it is wise to handle all MOS LSI type devices with the same care as CMOS, and they should be stored with all device pins shorted together by aluminium foil or conductive plastic foam.

Semiconductor Memories

Among the earliest applications of LSI techniques was the production of semiconductor memory systems for use

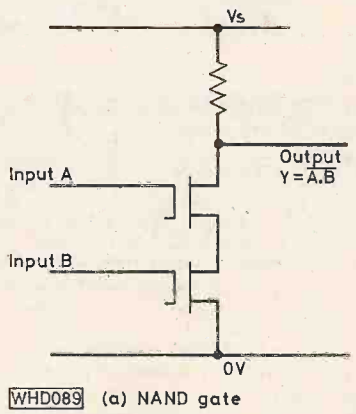


Fig. 77 (a): Typical MOS LSI NAND gate

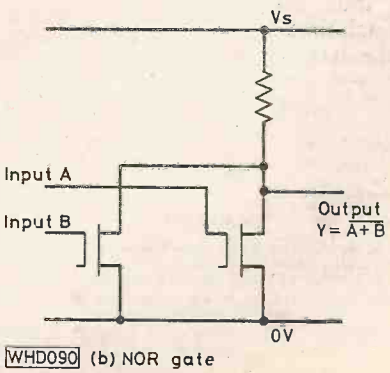


Fig. 77 (b): Typical MOS LSI NOR gate

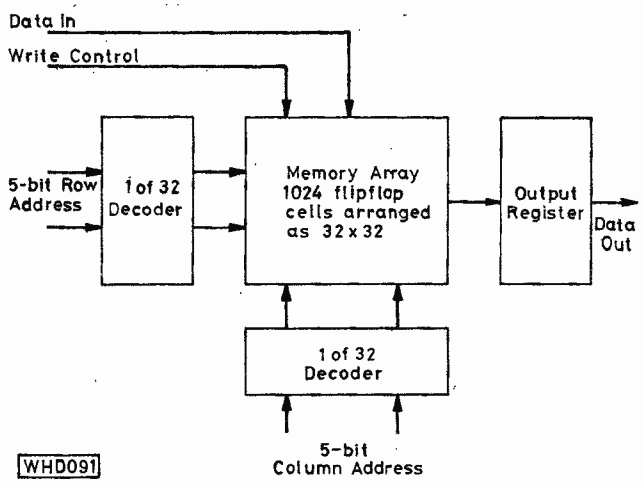


Fig. 78: Organistion of a typical 1024-bit (1K) memory

with small computers. Prior to the mid-1970s virtually all of the digital computer systems used ferrite cores as memory cells. These small ferrite ring cores were magnetised one way to represent a logic *1* state and the magnetisation polarity was reversed to represent a *0* state. A vast array of these tiny magnetic cores would be used to store the states of perhaps thousands of bits of data. Complex addressing logic had to be used to select a particular core in the array, to read its state or to write in new data. Because the windings often consisted of only one turn quite large current pulses were needed to magnetise the cores, so power supplies tended to be rather large.

A semiconductor memory can readily be produced by using a flip-flop for each memory cell. Using LSI techniques it is possible to build 1 000 or more such cells on a single chip and with MOS logic the power requirements will be relatively small.

To simplify the addressing logic the array of flip-flop cells in an MOS memory would be arranged as, say, 32 rows and 32 columns, and the general arrangement of the chip would be as shown in Fig. 78. To select a particular memory cell a 32-way decoder is used to select one row of flip-flops. Next a second decoder is used to select one of the 32 columns and hence will select one flip-flop in the chosen row. The input and output circuits of this selected flip-flop will now be routed to the input and output pins of the chip. When a clock pulse (called the Write input) is applied, the selected flip-flop will take up the state of the data input line thus allowing data to be written into the memory. Each time a flip-flop is selected, its output will be routed to the data output line of the memory chip allowing the data to be read out.

In a typical memory device, such as the 2102, there might be 1024 cells arranged as a 32 × 32 array. Such a chip would be called a 1K memory. Note the convention by which the "binary thousand" (1024) is denoted by a capital K. Thus a 4K memory would hold 4 × 1024 = 4096 bits, a 16K memory would hold 16 384 bits and so on. The address decoders would each be 32-way devices and would be controlled by a pair of 5-bit binary codes, giving a total of 10 pins allocated to address signals for the memory. Apart from the address and power supply there will also be data input and output and a Read/Write control signal to be accommodated. Some chips also have a Chip Enable (CE) line and provide a tri-state output signal. The connections for a 2102 memory are shown in Fig. 79.

Larger memory devices use capacitors as the storage device and the *0* or *1* state is determined by whether the capacitor is discharged or charged. A typical memory cell of this type is shown in Fig. 80.

One problem with capacitor-type memories is that, due to leakage paths on the chip, the charge on the capacitor is slowly leaked away and memory would be lost unless the cell could be topped up. In fact this process of "refreshing" the state of the memory cell is achieved by regularly reading the state of the cell and rewriting this state back into it. This refresh process needs to be carried out at about 2ms intervals and for this reason such memories are called dynamic memories, whereas the normal flip-flop types are referred to as static memories.

In a dynamic memory the capacitors used for storage of data are very small and in a typical chip there may be as many as 16 384 cells together with the addressing logic. Newer types with 65 536 cells are already starting to appear. Static memories, with their more complex cell structure, tend to be less dense and may have perhaps 4096 cells, although here too larger devices are being developed.

Digital Calculators

Until a few years ago most engineers used slide rules or mathematical tables to carry out their calculations. Today they almost invariably use an electronic calculator and even the housewife shopping at the local supermarket may be found using a pocket electronic calculator to check prices.

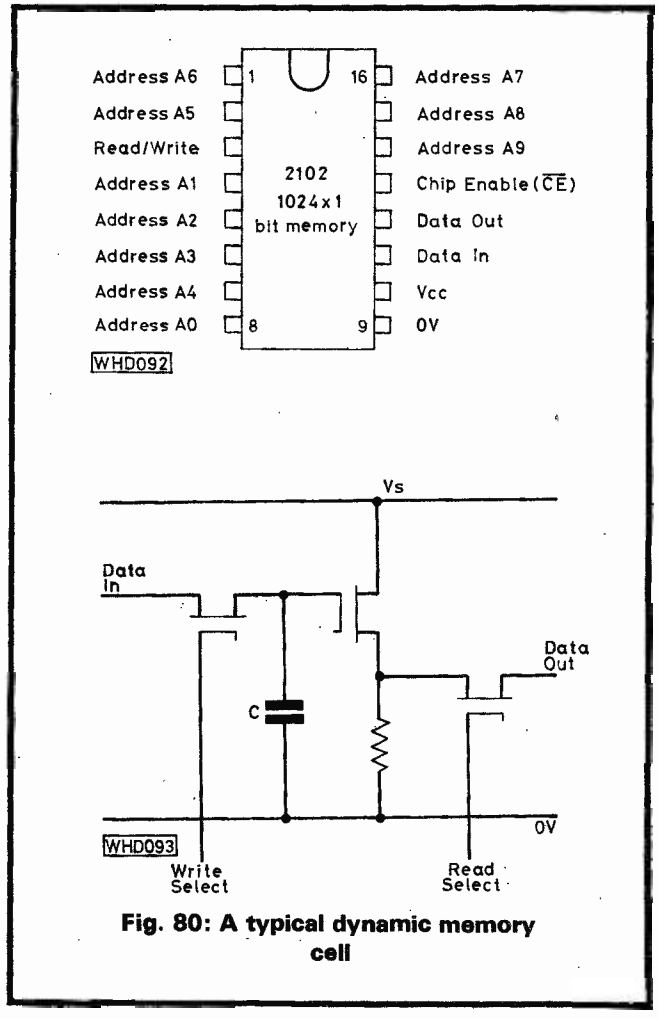


Fig. 80: A typical dynamic memory cell

Prior to 1971 calculators were desk-top machines which were either mechanical or used a vast array of SSI devices. The complex logic of these machines was however an ideal application for the new LSI techniques. In 1971 MOSTEK were to produce the first calculator chip which could add, subtract, multiply and divide numbers. The LSI revolution had begun.

Early calculator chips used PMOS logic and needed a number of extra circuits around them to drive the displays and communicate with the keyboard but despite this it was possible to build a complete four-function calculator unit into a case that would fit into a coat pocket and run from a set of batteries.

The basic logic scheme inside a typical calculator is shown in Fig. 81. At the heart of the device is the ALU (arithmetic and logic unit). This is a complex logic array which can add or subtract two numbers and perform one or two simple tests on the result. For convenience the numbers are represented in the BCD format and the ALU deals with them four bits (one BCD digit) at a time. For multiplication and division a sequence of successive additions or subtractions is carried out in much the same way as if the sum were being worked out on paper.

Apart from the ALU there are flip-flop registers which will hold the two numbers to be operated upon and the result of the operation. An 8- or 10-digit l.e.d. or l.c.d. seven-segment display is provided to present the numbers in visible form. To minimise the number of pins needed on the calculator, chip display is multiplexed with the digits flashing up in sequence at a sufficiently high rate to produce a flicker-free display. A further complex section of logic controls the activities of the ALU, registers, keyboard and display to produce the desired results.

Suppose we are going to add two numbers. At the start the control logic connects the keyboard and display to the "A" register, and as numbers are keyed in their 4-bit data patterns are shifted into this register one digit at a time. The display will show the contents as the number is fed in. When the "+" function key is pressed, a flip-flop is set to select the addition process whilst the keyboard and display are switched to the "B" register where the second number will be stored. When the second number has been entered and the "=" key is pressed, the numbers from the "A" and "B" registers are routed to the inputs of the ALU which adds them together, and the result from the ALU is fed to the display. Digits are switched in sequence by the control logic and any carry bits from one decade are added in as the next decade is dealt with.

In the case of multiplication and division, a sequence of add or subtract operations is carried out in the ALU as the control logic works its way through a preset sequence of commands. These commands switch the operation of the ALU and control the transfer of numbers between it and the other registers. A similar complex sequence of operations is used in some modern calculators to work out trigonometric and other mathematic functions. Sometimes additional registers will be included to allow intermediate results of a complex calculation to be stored temporarily.

LSI in Television

Another application of LSI devices which has come into prominence in the past year or two has been the TV game. In the early 1970s TV based games, such as Pong (or TV tennis), began to make their appearance in the amusement arcades. In these early games conventional logic devices were used, but soon GI introduced an LSI chip which could provide a choice of several different games such as tennis, hockey and squash. Recently much more sophisticated games such as tank battle, which would have needed hundreds of TTL devices, have been introduced.

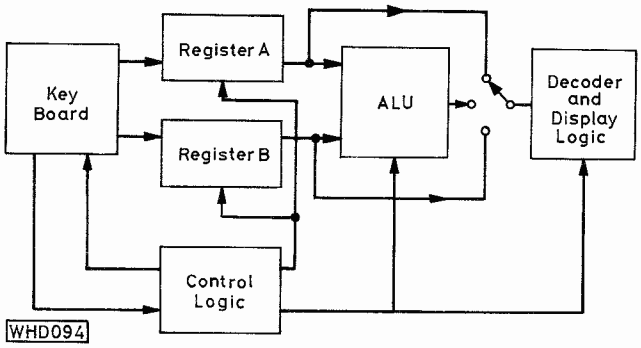


Fig. 81: Block diagram of a digital calculator

The games chip itself has to generate a complete video signal for the game display including sync pulses and in some cases colour signals. Sound effects, such as the ball striking the bat, are generated as bursts of pulses by the games chip. Apart from producing the display the chip must control the motion of bats, balls, etc., and also detect scoring moves and keep the score for both players. Further logic is needed to display the score on the screen and to control the selection of the various games.

External controls for bats, tanks, etc., are normally potentiometers which alter the timing of delay circuits in the chip and hence alter the position of objects on the TV screen. Sometimes the speed of movement may be controlled in a similar way as in the stunt rider and racing car games.

Another recent application of LSI devices in television has been in building decoder systems for the Ceefax and Oracle teletext transmissions now being broadcast by the BBC and ITV.

In teletext decoders the logic must select out the data signals from the television picture signal and decode them. A particular page of text, selected by the viewer, must then be detected and removed from the incoming data stream. The selected page of text is stored as a set of binary data words in a memory and data from this memory is regularly read out and converted into video signals to produce a text display on the screen in place of the programme picture. Using conventional logic such a decoder system might require about a hundred TTL devices whereas by using LSI it is possible to reduce this to perhaps six to ten chips which will fit conveniently on to a small card mounted in the back of the television receiver.

Universal Logic Chips

One of the problems facing the manufacturer of LSI chips is to decide what to put into them. As the logic gets more complex the number of options also increases as each user will want his own favourite features. Unfortunately it costs a lot of money to design an LSI chip and unless it can be made in thousands or even millions it will not be economic to produce it.

One solution to this problem adopted by the chip makers was to build a standard chip which contained a large array of identical gates and to tailor the devices to the user's requirements by interconnecting the gates as required during the final stages of making the device. Thus only the final interconnection pattern needed to be designed for each new application and the overall cost of a new device could be kept down.

Another approach was to make the circuit on the chip more versatile so that it might satisfy a number of varied applications. The limit here is in the number of pins that can be used on the chip package and typically a 40-pin

d.i.l. is about the biggest practical container for normal use.

Intel faced this basic problem when they were making calculator chips for various designs of calculator unit. It occurred to their engineers, however, that basically all of the systems were the same but the control sequence used in each calculator was different. Since most logic systems can be broken down into a sequence of separate logic operations, a universal logic chip might now be produced where the set of commands to the ALU and control logic was fed in from an external memory. Now the basic calculator or logic operation chip could be standard and mass produced, whilst its action could be tailored to suit the user's needs by supplying the appropriate sequence of instructions from some external memory device. The basic idea of the microprocessor has been born and Intel's 4004 device became the world's first microprocessor chip which could handle 4-bit data words and process them in any way the user desired.

Microprocessors

Recently, microprocessors have been very much in the news and in some circles have taken on the aura of being a kind of magical device which can solve all of our problems. In practice, as we shall see, the microprocessor is nothing more than a very versatile logic element that will respond to a set of external commands to perform a wide variety of logic functions. In essence the device works in virtually the same way as the central processing unit of any digital computer system.

Internally a microprocessor will be arranged more or less as shown in Fig. 82. It consists basically of some control logic, an ALU and a set of registers which connect to two external data bus systems. At any time the signal interconnections between the internal circuits are set up by the control logic in response to the external commands, and the internal circuits can communicate with one another via an internal data bus system. Outside the chip an 8-bit-wide data bus is used to carry data to and from the processor chip. A second bus, usually 16 bits wide, carries address signals from the processor which define the particular external circuit that is to talk to the 8-bit data bus. Usually most of the external circuits are memory arrays and the address bus will select the particular memory location where the desired data is to be found or sent to.

The ALU is perhaps the heart of the processor since it can add or subtract numbers, carry out AND, OR, INVERT and EXCLUSIVE OR logic operations or act as a counter or shift register. This is the versatile logic element. The control logic decodes the command instructions fed in from the external memory and sets up the appropriate operation in the ALU and the interconnections between the registers.

The Accumulator register is used to take data from the external data bus and process it via the ALU, after which the result is held in the Accumulator. A second register, called the Program Counter, keeps track of the memory address where the next instruction is to be found. The Program Counter also controls the transfer of instructions from the data bus into the instruction register, from whence they pass to the control logic for decoding and execution.

An Address register is used to hold the current memory address for any data or instructions that are to be passed from the data bus into or out of the processor. Two other registers may also affect this address signal. One is the Index register which allows the processor to modify the memory address during program execution whilst the Stack Pointer register is used to hold the address of a special area of memory used as a scratchpad by the processor as it executes the program. Finally there is usually a Status register which provides information on the state of play within the processor device. This register can for instance indicate if the result of the last arithmetic operation was zero or negative.

Microcomputers

A microprocessor chip by itself is totally useless, apart from its value as an objet d'art or collectors item. To produce a working system it needs the addition of some memory to hold program and data information and also there must be input-output circuits to allow the device to talk to the outside world. A typical microcomputer system might be as shown in Fig. 83.

To make the system work, a set of program instructions must be written into the memory system and the program counter register is then loaded with the address of the first instruction of the sequence. Each instruction may consist of from one to three 8-bit data words. The first word is always an Operation code which will tell the processor what to do. The second and third words convey the address in the memory where any data needed is to be found or stored. As each of the instructions is executed the Program counter register is updated automatically so that

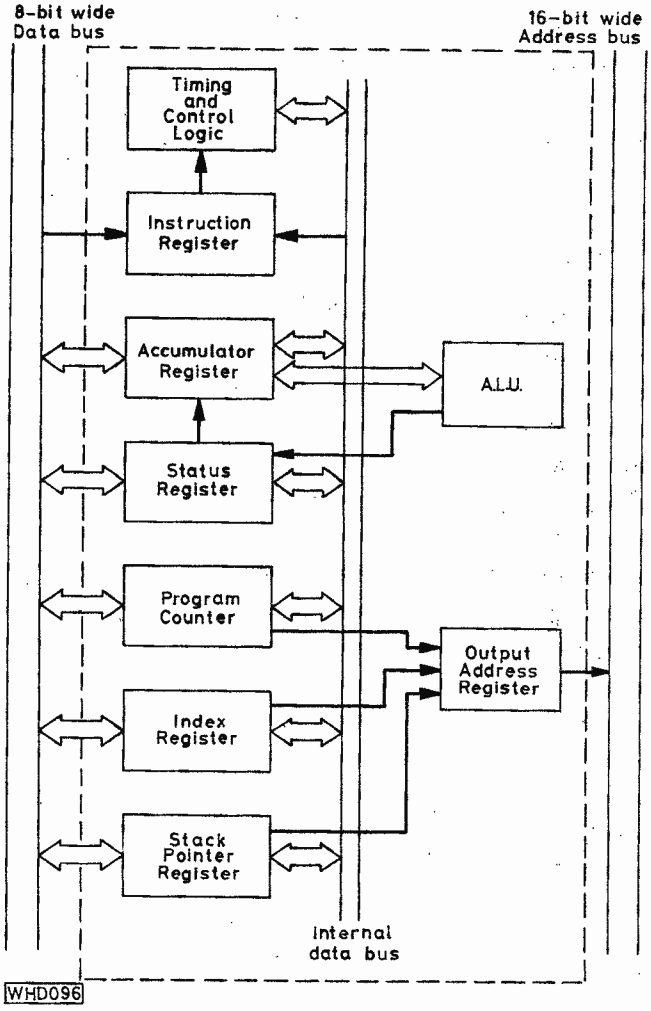


Fig. 82: Block diagram of a simple microprocessor chip

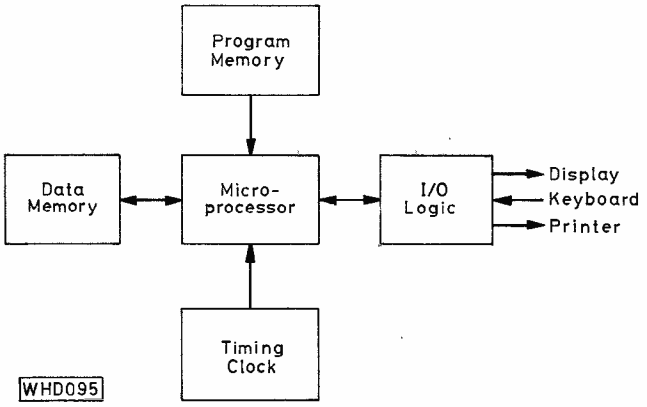


Fig. 83: Block diagram of a typical microcomputer system

it now contains the address in memory where the next instruction to be executed is to be found.

Programming

Perhaps the most important part in designing a system using microprocessors is the process or writing the program of instructions, or software as it is called in computing circles.

Actual instruction codes stored in the memory are just 8-bit binary numbers which represent instruction codes and addresses. Programming in this machine code is difficult and definitely not recommended. To overcome this problem a new language called Assembler code is normally used for writing the programs for a microprocessor. Here each operation code is given a mnemonic name such as ADD, SUB or LDA (Load the Accumulator) and the memory addresses can be given names, such as TEMP, SPEED or SUM.

Suppose we want to add two numbers together. The set of instructions might be;

```
LDA N01     (Load N01 into accumulator)
ADD N02     (ADD N02 to accumulator)
STA SUM     (Store the result in SUM)
```

When the complete program has been written in this mnemonic language it must next be translated into the 8-bit binary words of the machine code before it can be loaded into the microcomputer's memory system for execution. The translation is carried out by a complex program called an Assembler. This translation process may be carried out on a similar microcomputer system or on a full-size digital computer system. Once the machine code data has been generated it may be put on to a cassette tape or written into a Read Only Memory. In the small microcomputer system the program is either loaded from cassette tape into a normal read/write memory or read directly from the programmed ROM in order to make the microprocessor carry out its required operations.

Where the microprocessor is being used as a calculator or computer it is convenient to use a higher level language than the Assembly code. Typical of these are the FORTRAN and BASIC languages used on larger digital computers. In this case our simple addition program is reduced to the statement:

$$C = A + B$$

where A and B are the two numbers and C is the answer. These high level languages also need to be translated. In the case of BASIC this is done by using an interpreter-type program to translate each instruction as it is executed, but FORTRAN is translated to machine code in much the same way as the Assembly code.

Where do we go from Here?

In this series the basic principles of logic have been discussed and some of the applications of these devices to amateur electronic projects have been touched upon. It is to be hoped that the reader will now be in a position to understand how a logic system works and perhaps to follow the descriptions of logic operation in books and articles, though it must be admitted that some books on logic tend to be a bit obscure.

How will microprocessors and LSI affect our projects? It is certain that microprocessors are here to stay and that they will feature in the more advanced amateur projects such as RTTY systems, Morse decoders, control systems and various types of electronic games.

LSI devices are already making themselves felt in the field of amateur electronics. It is now possible to buy a single LSI chip which, with a suitable display, makes a very nice digital voltmeter. The counter and control logic for a digital frequency meter can now be reduced to a handful of LSI chips whilst text displays can readily be produced on the domestic TV screen using a few LSI devices.

Small logic circuits and discrete transistors will not disappear however, and still have their uses in the simpler applications. It's foolish to use a microprocessor when a few simple gates will do the job, unless of course the microprocessor is already in the system somewhere. It's always a good idea to look at the simple approach first before a microprocessor or LSI chip is considered. The problems are all out there waiting to be solved so why not see if you can put those logic chips in the junk box to some good use? ●

SPECIAL PRODUCT REPORT—DM235

continued from page 32

The readout is a full $3\frac{1}{2}$ digit l.e.d. display with 8mm high red digits reading up to ± 1999. The digits are bright and well formed giving a good angle of view.

The instrument is well built with most of the components on one main printed circuit board. The two halves of the plastics case are held together by several screws. The display board is mounted onto the main board.

For use in the lab it would make sense to use the a.c. mains adaptor which is built into a 13A plug. This small unit was a shade tight fitting into a standard mains socket but otherwise was satisfactory, and should repay its cost by saving on dry batteries. Rechargeable batteries are also available and can be recharged from the mains adaptor while the instrument is being used.

The advantages of a d.m.m. over the conventional analogue type is the unambiguous readings given by the digitial display. Even with a mirror scale such as provided by the Avo 8 type of instrument it is difficult to obtain an accurate reading and almost impossible if you cannot stand right over the scale. The d.m.m. eliminates any parallax error as well as any misreading of ranges or scales. Against this, however, is the comparatively slow scanning rate of the DM235. It can be a little disconcerting for the newcomer to digital meters to have to wait for three or four changes of the display before the true reading is shown. With an analogue meter the reading is instantaneous. Also, if you are used to using your conventional meter to indicate maximum or minimum voltages, such as when tuning a circuit, then the digital readout will be no real substitute, as it is difficult to interpret trends.

However, taken all round the DM235 represents good value for the enthusiast and should prove to be a useful addition to his workshop test equipment.

Dick Ganderton

PRODUCTION LINES

alan martin

High power batteries

A new heavy-duty battery has been added to the range of transistor and high-power types from the Vidor division of Crompton Parkinson Ltd., a Hawker Siddeley company.

The new Vidor battery, which is known as the VT3C, is identical in size to the "small" transistor type currently available. It has been designed for use in portable electronic and electrical equipment and is particularly suitable for heavy-duty applications where sustained high power is required.

Typical applications for the VT3C include calculators, TV games, toys, remote TV programme selectors and small battery-powered domestic appliances.

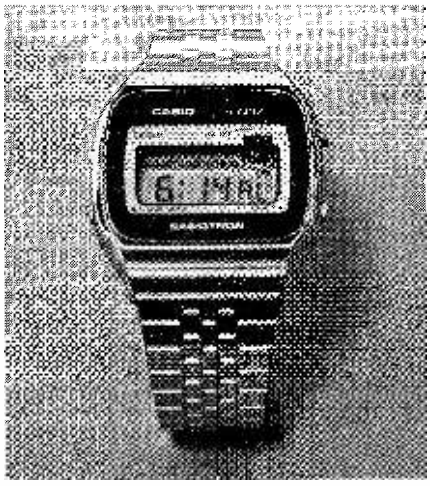
The new VT3C complements the recently introduced HP7C calculator battery. *Crompton Parkinson Ltd., 50/52 Marefair, Northampton NN1 1NY. Tel: (0604) 30201.*

Alarm watch

If you feel like treating yourself to a really nice present, the Casio Alarm watch (25CS–14B) should fit the bill.

Presented with a superb stainless steel case and strap, the watch displays in the normal time mode—hours, minutes, seconds, a.m./p.m. and day, with a claimed accuracy of ±10 seconds per month.

The calender mode displays day, date, month, year and is pre-programmed until the year 2009.



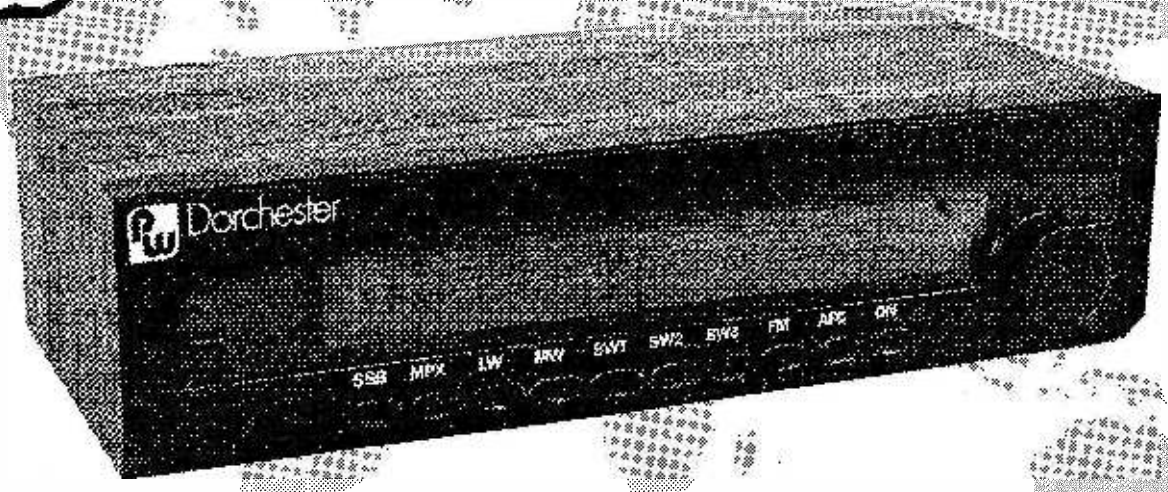
Also the watch features an alarm facility with a rather piercing voice.

Powered by one silver oxide battery (type UCC393) with an operating life of approx. 15 months, calculated on the basis of 5 pushes of the light button per day for 1 second duration each, and the alarm running for 60 seconds.

The recommended retail price is £74.95, but Tempus offer the watch at a discounted price of £59.95 which includes VAT. *Tempus, Dept. PW, 19/21 Fitzroy Street, Cambridge CB1 1EH. Tel: 0223 312866.*

Dorchester

PART 3



ALL-BAND TUNER

W.S.POEL

This part deals with the extensions and accessories that you may wish to consider in connection with the "Dorchester" tunerboard, some of which are likely to be methods of housing, powering and tuning the receiver, in a manner which will not disgrace your sitting room.

The case housing the Author's unit was modified from parts used for a commercial design which is no longer produced. In this way, a professional standard of presentation, with a neatly sculptured front panel and proven mechanics were available instead of the usual combination of folded aluminium and Dymo tape.

The basic mechanical layout of the prototype is given in Fig. 11: subsequent versions had the chassis deepened slightly to accommodate the tuner with a little more ease. An extension shaft is required which is fitted to the tuning capacitor spindle and held rigid by means of a bush mounted on a bracket.

The tested tuner board—remember not to expect a completely un-tried unit to work first time, no matter how carefully you may have constructed it—is fitted to the base plate by means of pillars mounted in the bottom of the chassis. The Author prefers spacers which are designed for use with self-tapping screws so that the pillars are fixed down independently of the tuner board. The approach whereby the bolt is simultaneously passed through a pillar and fixed through the p.c.b. is usually frustrating and tedious to perform.

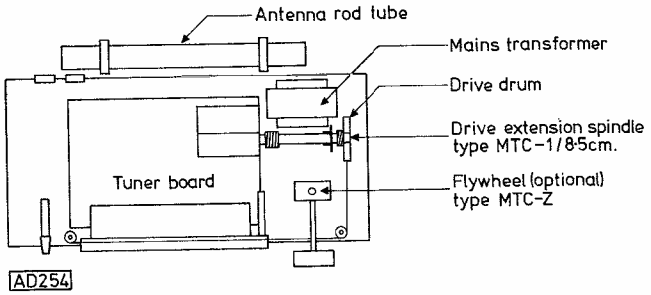


Fig. 11: Mechanical layout of the tuner

Tuner Power Supply

This unit (Fig. 12) is simply a mains transformer, followed by a rectifier and three-terminal voltage regulator from the 7812 series, or the SGS TDA1412. Radio frequency interference from this type of regulator needs to be suppressed with additional filtering circuitry, so note the extra decoupling.

The current-handling capacity of the power supply needs to be about 150mA—but in the prototype, a degree of headroom has been left, so that the illumination of the meter and tuning scale may be included. Before you consider attaching any sort of audio power amplification to the tuner supply, make absolutely certain that there is sufficient reserve to prevent the voltage from falling below the minimum at which regulation takes place.

Where a steel chassis is used, it is desirable to mount the ferrite rod antenna on the back panel (outside) or the efficiency will be greatly impaired. There are various methods employed in commercial designs, the most elegant of which is to mount the rod in a non-ferrous tube on some form of infinitely-adjustable pivot so that the angle may be adjusted to the user's requirements. A long wire antenna coupled to the rod tends to reduce directional effects and can be the conveyor of problems arising from one of the many thousands of sources of r.f.i. This design makes a simple approach, using proprietary parts and tubing—since it seems the more intricate mechanical arrangements are exclusively customised to individual manufacturers' specifications.

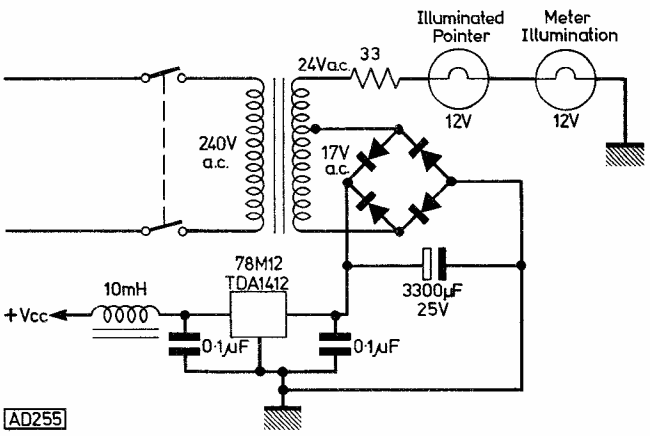
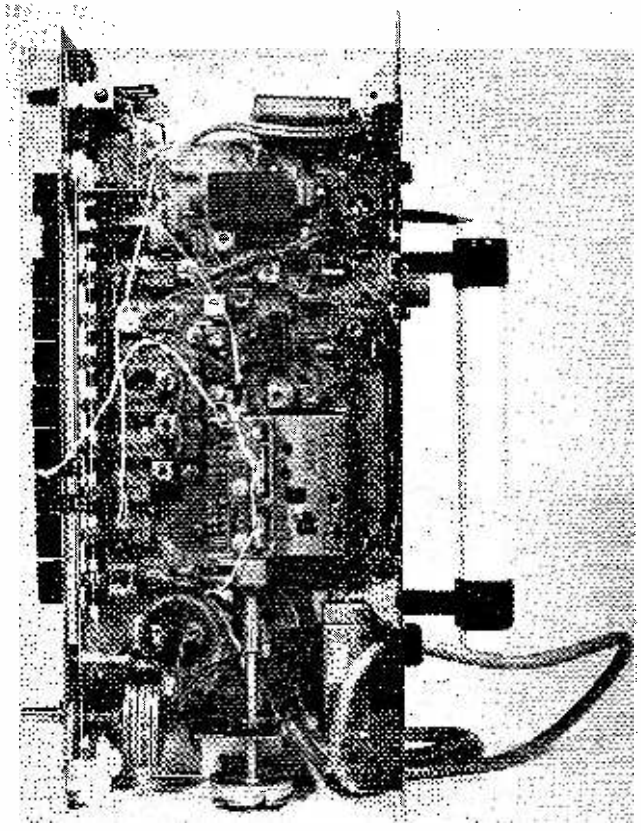


Fig. 12: Power supply arrangements

In stretching the wiring feeding the ferrite rod, the possibility of extraneous pickup on the coupling leads has been greatly increased, so this wiring must be tightly wound and kept to an absolute minimum. It is not feasible to use fully screened connections of this length, since their additional capacitance would restrict the necessary bandwidth.

Remember to secure the coils on the rod when you have adjusted them. This should be carried out whilst the rod is in place at the rear of the chassis, since the presence of adjacent metal will tend to modify the aerial tuning characteristics somewhat.



A view of the completed unit prior to the outer case being fitted

Coverage and Sensitivity

In the Author's prototype, SW3 was restricted to a maximum of approximately 22MHz. In this way, the main broadcast bands are given a bit more spread on the dial. No modification of the circuit is necessary, since the adjustment is simply carried out using the trimming adjustments of capacitors and tuning slugs.

A preselector is frequently suggested for use in conjunction with receivers that are to be fed with nondescript antenna arrangements and have broad coverage—and before considering a suitable design here, it is very important to bear in mind that gain and h.f. receivers are not necessarily the best of companions. Certainly everyone likes to think their set can resolve s.s.b. below 1µV, but then, there isn't much point if the set overloads when another station a few kilohertz away flattens the whole thing with a 1mV input!

The basic tuner has excellent sensitivity for a unit of this type—a broadcast transmission receiver, first and foremost. An antenna of some twenty feet in length proved to be more than adequate, so before getting carried away with antennae it must be borne in mind that some selectivity in the tuner is called for, to limit cross-modulation of the mixer by strong adjacent channels.

The average casual listener usually has a length of wire for an antenna, and as far as receiving is concerned, this can be turned into a beautifully affective and versatile arrangement with a simple pi-network tuner. Various designs have been featured over the years (Fig. 13 shows two examples) and so we will not go into too much detail here. By switching coil taps at various positions along an inductor, almost any piece of wire can be tuned to resonance at h.f. Wires that are much shorter than a wavelength tend to exhibit a high impedance—and the pi-network is one of the best ways of matching.

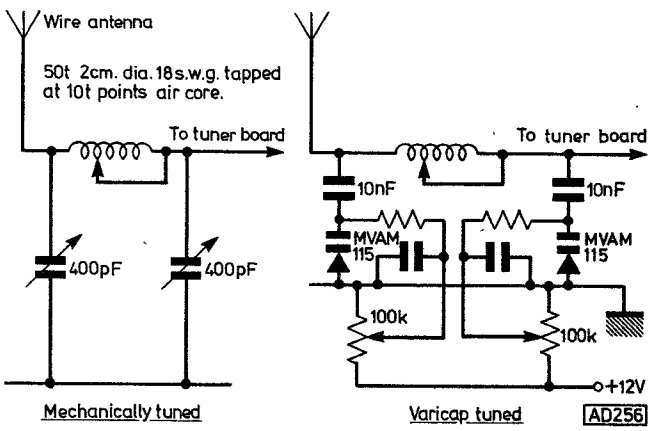


Fig. 13: Typical pi-network aerial tuning arrangements with (left) ganged variable capacitor and (right) varicap diodes

If you still want more gain with your tuner, then the circuit of Fig. 14 is suitable, but remember that the gain control is not merely an adornment, but a necessity—since the preselector may be used as a tuned attenuator when things get out of hand simply by backing-off the gain control.

If you are a keen s.w.l. then a digital frequency-readout is a virtual must these days. The recently-published PW design will readily suit this receiver. Take the oscillator from pin 20 of the i.c.—or by f.e.t. buffering from the oscillator section of the tuning capacitor.

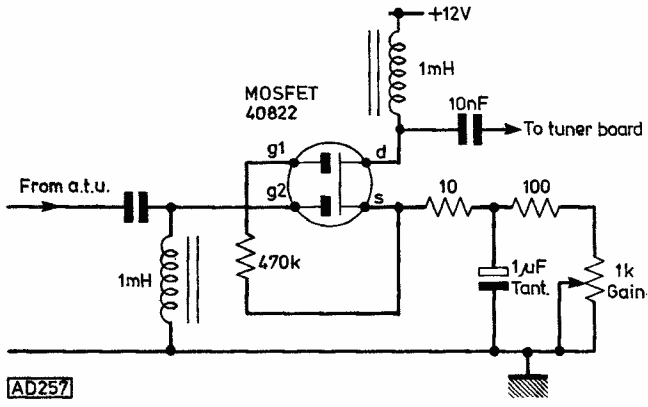


Fig. 14: R.F. pre-amplifier

Audio

Some readers may wish to include audio amplification within the tuner—and the many i.c.s that exist to fulfil this requirement scarcely need additional comment here. However, there is one point to watch, and that is the almost universal tendency of such amplifiers to exhibit h.f. oscillation at their output. Remember to decouple the power supply carefully—and feed the loudspeaker/headphones using screened audio cable, taking care to follow manufacturers' recommendations concerning Zobel networks, ferrite bead suppressors, etc. The high gain of the tuner makes it susceptible even to quite low levels of spurious radiation that most applications could quite easily ignore.

The question of using the tuner in a portable configuration was briefly discussed in the first part of this article. The main i.c. consumes a fair amount of current for this application—especially in the a.m., mode; but in f.m. the consumption reaches around 23mA, with another 12mA for the tunerhead. This is not necessarily unreasonable by modern standards, and indeed, many of the larger portables have a much higher consumption.

Thus the unit makes the basis of a very fine portable. The really superfluous part of the circuit would then be the stereo decoder, for however desirable the idea of a stereo portable may seem, it is usually a wasteful extravagance. In units incorporating mains/external 12V options, the decoder arrangement should be locked out when the internal batteries are used. All scale lighting functions should be wired so that they only illuminate on the operation of biased switch or pushbutton.

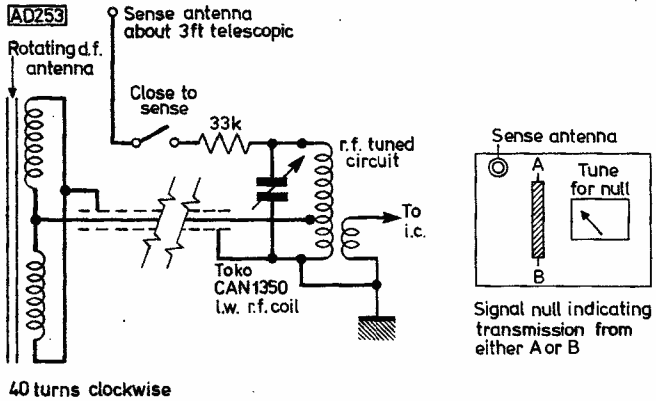
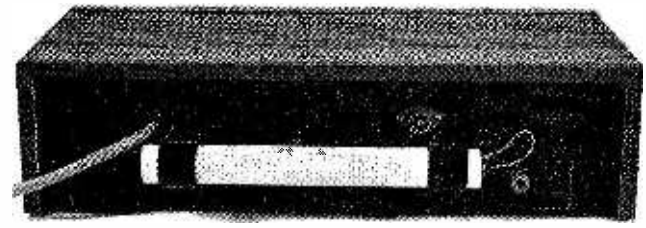


Fig. 15: Typical arrangements when direction-finding facilities are to be incorporated

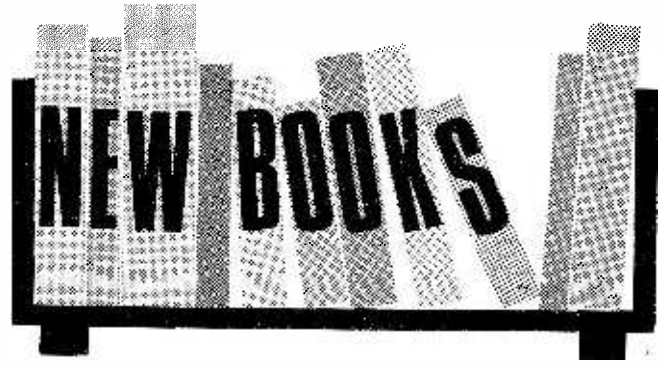


A rear view of the Dorchester showing the ferrite rod aerial and other connections

The question of direction-finding has recently been raised, and since the nautical and aero transmissions are located in the only section omitted from the standard broadcast range of 175kHz to 30MHz (250–400kHz approx.) one of the s.w. bands has to be sacrificed if the facility is to be accommodated. This will probably be SW3 and oscillator coil is changed for a 632µH DF band type. The antenna coil is also changed, and a second ferrite rod antenna for the DF band fitted—or, as an alternative, the "loopstick" arrangement used to permit sensing of the rod position relative to the transmission (Fig. 15).

The tuned circuit for DF is then the l.w. r.f. coil, with the DF rod coupled to the tap.

Work on DF applications is far from finalised as yet, but if sufficient reader-interest is apparent, then further developments will be published at a later date. ●



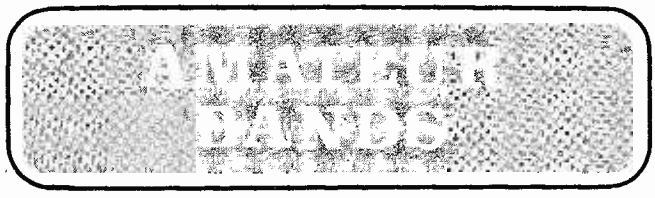
ELECTRONICS—an elementary introduction for beginners
by L. W. Owers
Published by Talbot House Press
Freeland, Oxford OX7 2AP
119 pages. 209 × 149mm. Price £2.95

This book sets out to give a broad introduction to the subject of electronics, providing a background for more advanced study. This is achieved well, starting with the discovery of electric charge and ending with semiconductors.

Moving away from electrostatics into the realm of moving charges and conduction we meet resistors, capacitors and inductors, progressing through valves and the cathode ray tube into semiconductors and the doping of semiconductor materials to form transistors and integrated circuits.

The whole book is well illustrated with some excellent diagrams which are available as 35mm slides for teaching purposes.

KA



by Eric Dowdeswell G4AR

The business of listening on the amateur bands ought to be more than just a matter of entering long lists of stations in the log. After some months it will become apparent that there is a definite pattern to the times at which stations in different parts of the world appear on the various bands.

I have mentioned this before as a means of understanding the mechanics of the propagation of radio signals in connection with the 11-year sunspot cycle. However there is another aspect which should not be overlooked. Since none of us have unlimited time to spare listening or working on the air, it is essential that the time we do have available is well-spent.

The newly-licensed amateur whether a G4 or a G8 is going to waste an awful lot of time if the optimum band or mode is not chosen as a result of experience gained as a listener. The tyro may call CQ for hours without a reply on a dead band or use the wrong mode for a particular part of a band.

On the h.f. bands a note should be kept of prefixes and when they are heard, at what time and which band, to build up a picture over a year or so. If a band is found to be dead then note it and check all bands if possible, whenever sitting down to listen.

For the listener who is able to copy c.w., check the c.w. end of each band as it is strange how often there is activity there when the s.s.b. part is comparatively dead. In contest work the listener and the transmitting amateur can perform much more efficiently by choosing the right band to work on at any given time. In days gone by I would always watch the bands for a couple of weeks before a big international contest just to get the feel of them, noting when the more elusive countries and prefixes were coming in well, band by band.

Then an operating schedule was compiled of bands against time for 24 hours thus giving two "windows" for working a particular DX station in a 48 hour contest, all aimed at reducing unnecessary operating to a minimum. This resulted on one occasion in being able to work 99 countries on c.w. in a weekend contest using all bands from 3·5 to 28MHz.

It will be noted that occasionally signals from the west coast of the US and from VK are audible in the early morning and late afternoon due to short and long path propagation, thus doubling the possible openings for working or copying stations in these areas.

On the Bands

In spite of our most welcome Indian summer the change to winter conditions has gone on apace on the h.f. bands, exemplified by reports from readers such as **Ian Marquis** A9140 of Leigh-on-Sea, Essex, who copied CT2, EA6, EA8, JA, VP2 and 9K2 on 80m s.s.b. Ian's FRG-7 and long wire also found the extremely rare Willis Island in the form of VK9ZM on 20m, in the DX Net on 14 265kHz. 15m revealed another new country in KV4KV/D on Deception Island, plus W0DX/D on c.w. on 10m, part of the same set-up there.

Richard Smith in Porthcawl, S. Wales, has forsaken his old and trusty t.r.f. set for a KW77 and is particularly glad to find it incorporates a crystal calibrator. He plans to put a 2m converter in front to get the feel of the v.h.f. world before he takes his RAE in the not too distant future. Richard found a 5Y3 and 7X2 on 80m so let's hope this is a sign of more good stuff to come from that direction. African activity has always been low on the l.f. bands due to the high level of static experienced there. It's something that has to be experienced to be believed!

SSTV has captured the imagination of **Simon Robinson** in Stocksfield, Northumberland, and now G8POO. Using an MK Electronics monitor he has seen DL, OZ, I, EA and OK stations, using a 10in diagonal c.r.t. The only call of interest on 10m s.s.b. was JW7FD on Bear Island.

Rod Hunt (Darlington) sticks with his t.r.f. rig and to date has logged over 80 countries on it, mainly on 21 and 28MHz. The latter band has come up with DX such as JW7, ZP5, with 21 producing EA0, HP0, ZB2DV (G4EMR on holiday!), ZL1, 3D6 and 9J2. Rod has started his own RAE course and is not neglecting to get some practice in on the key, while a G3 "on the other side of the hill" is giving advice and assistance.

Loft aerials for **Bob Bell** in Blyth, Northumberland, means sloping tubular ones with coils to load to a particular band but due to the awkwardness of the set-up it's all likely to finish up in the garden very soon! Bob found PY0EG on 20m s.s.b. and an early morning session provided VK7, not heard too often, ZL4 and VK5.

Not a very exciting month for **Bill Rendell** of Truro but KG4KG in Guantanamo Bay is a rare bird on 20m s.s.b., with KC6GF a good find. Bill also intends dumping his attic aerials and getting something up outside. **Allan Stevens** is still plugging on with his *PW* direct conversion set plus PR40 preselector and has notched up 81 countries so far including excellent find VR6TC on Pitcairn, a real rarity.

In Oswestry, Salop, 14-year-old **David Wyatt** has moved to the amateur bands with his home-brew 4-transistor superhet plus audio amp and b.f.o. Prefixes like HH and HP and another KG4 aren't bad on 20m but an AR88 is in the pipeline. **John and Steven Goodier** have been struggling over the rig trying to decide on BC or amateur bands and I'm glad to report that the latter has won the day! Reports to follow regularly now, I gather. They've been looking for LU3ZY on South Sandwich but no-one seems to have heard them yet. J and S have an FRG-7 and 30ft wire so it can't be the rig.

With the Clubs

Barking Radio & Electronics Society is on a recruitment drive and meets, wait for it, FOUR nights a week, Monday to Thursday. Morse classes Tuesdays and main club night Thursdays, all at 1930. Stations G3XBF and G8GPK are active on h.f. and v.h.f. but club activity tends to favour v.h.f. at the moment, hopefully to be redressed very soon! So pop along to the Westbury Recreation Centre, Westbury School, Ripple Road, Barking, Essex some time or contact Sec Nick Dowsett G8PUY, 44 St Ann's, Barking, Essex.

Every Tuesday sees the **Bury RS** hard at work at Mosses Centre, Cecil Street at 1930 onwards with RAE classes at nearby College of FE. 9 Jan has G2BTO on TVI and the Amateur, with G4CLF holding forth on the SL600 series of i.c.s on 13 Feb. The subject on 13 March is v.h.f. linear amps with G8NOF covering Orbiting Satellites on 10 April so there's plenty to look forward to at Bury RS. Write to Eric Thirkell G4FQE, 59 Oulder Hill Drive, Rochdale.

It's all go, down with the Wessex AR Group with a proposal to revert to the old title of the Bournemouth ARS, similar to the society that was first formed there in 1922. As an outsider I heartily approve! Don't like changes that cause a group to lose its identity! Meetings are held at the Dolphin Hotel, Holdenhurst Road, Bournemouth at 1930 hours. Friday 19 Jan sees G2YH talking and demonstrating miniature v.h.f. transmitting devices while 2 February is devoted to "Planning and Preparation for HF and VHF Contests". Note new QTH of Sec/Editor Geoff Cole G4EMN 3A Cavendish Road, Bournemouth or ring 20027.

Log Extracts

R. Bell:—20m PY0EG **20m** VK7AZ **15m** JR3IIR

S. & J. Goodier:—20m CE0AE HK0QA (San Andres) KG6SW KJ6BZ VK2AGT (L. Howe Is) VK9ZM (Willis Is) VK9ZR (Mellish Reef) VP2EEK VP2GVI VP5BD VR6TC ZK1CV

D. Wyatt:—80m VO1FG **20m** CT2CB HH2SD HP1XDN KG4EP

A. Stevens:—20m JW7FD (Svalbard) VE8RCS VK7AZ VR6TC WA4YUG/VQ9 (Diego Garcia)

W. Rendell:—20m CT2BQ HR1JAG KC6GF KG4KG VK7AE VP2AW **15m** C5ABK HV3SJ KZ5BA ZB2DV **10m** CT2SH HK4DF

I. Marquis:—80m CT2QN EA8CR JA6BSM VP2SD 9K2IX **20m** PJ8CO VK9ZM VP2VER **15m** EA9EO JW7FD KV4KV/D (Deception Is) TA1DF **10m** EP2SL FG0EID/FS VS6FE W0DX/D (Deception Is) YJ8KM

R. Smith:—80m 5Y3GT 7X2DG **40m** EA8CR **20m** CT3AC S79MC VP8PF **15m** AP2KS **10m** EL2AG

S. Robinson:—SSTV 20m DL6HP OZ2ARD I2II EA2JO OL7VI **10m** JW7FD

R. Hunt:—15m EA0NS HP0ED ZB2DV 3D6BP **10m** JW7FD ZP5AO 9K2DR

All s.s.b. unless indicated otherwise.

MEDIUM WAVE DX

by Charles Molloy G8BUS

This is the time of year to listen to North America on the medium waves. Although reception is possible at any time of year it is in the winter when the nights are long that one can pick up a few local broadcasts from across the Atlantic before going to bed. Listen between 2300 and midnight, as European interference begins to subside for CKVO in Clarenville, Newfoundland on 710kHz, CJYQ in St John's, Newfoundland on 930, WINS in New York City on 1010 and WNEW also in New York on 1130. These are but a few of the many North Americans that can be picked up in the UK when conditions are favourable but be careful. All transatlantic signals are subject to slow fading and it is very easy to pass over quite a strong signal that is temporarily in the minimum of a fading cycle. So tune carefully and slowly. The path is not always open and fadeouts do occur at times so if you are unsuccessful at first then try again a few nights later.

North American Medium Wave Stations

There should be no problem identifying North American DX, for nearly all broadcasts are in English and all, without exception, are issued with callsigns which the stations are obliged to use when they identify themselves. In the United States the callsigns are either of four or three letters which begin with a W or a K. For example, WINS is the call of the station on 1010kHz located in New York while KDKA on 1020 is in Pittsburg. Similarly in Canada where the prefix is C, or V in the case of a few outlets in Newfoundland.

The station separation in North America is 10kHz instead of the 9kHz we have in Europe and each channel is also a multiple of 10kHz which means that the band is divided up into 107 "channels" starting at 540kHz and ending at 1600kHz. It is a lot easier to use kHz instead of metres when dealing with North Americans and receivers in that part of the world are often marked from 54 to 160, i.e., with channels 54 to 160.

North Americans are usually good verifiers, that is of course if you send them an accurate reception report. The time to gather material for the report is just before the hour and the half hour when commercials (jingles),

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 Sogdrs Lane, Southport, PR8 3JG. Reports for both bands **must** be kept separate.

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

weather reports, news items and station identification takes place. The reports themselves should be sent to the chief engineer of the station and the address should include the call letters of the station and the town or city mentioned in the announcement. For example, The Chief Engineer, WNEW Radio, New York City, NY, USA will certainly find the station on 1130kHz.

Loops and Aerials

Although the standard 40in box loop has a single turn for the coupling winding it is worth experimenting a bit to find out what suits your particular receiver best. This point is highlighted by **Harold Emblem** (Mirfield) who tried the effect of using two turns instead of one with a Layfayette HA63 receiver a few years ago. The two turns gave much better results with this receiver. Harold thinks it is worthwhile trying a second turn to see if there is any significant improvement and also the adjustment of the position of the two turns is worthwhile.

Shortwave DXer **J. F. Porter** of Belfast would like to listen to some medium wave DX and he wonders if a ferrite rod aerial could be used as a substitute for a loop. The pick-up of a ferrite rod aerial is really too small for serious DXing. I have played about with ferrite rods (see July 1978 *PW*) and they can be useful for semi-DX but this is really the field for someone who likes experimenting rather than hearing DX. There is nothing wrong with an FRG-7 plus Joystick or 100ft long wire for m.w. DXing and if you want a substitute for a full size loop then try Bob Bell's half size loop (Nov. 1978 *PW*).

Beacons

Although the medium waves are supposed to be used exclusively for broadcasting there are a small number of navigation beacons that operate inside the band at the low frequency end. In answer to **E. C. Adams,** this is probably what you are hearing around 460 metres. Navigation beacons have callsigns which are repeated in Morse and the majority of them operate on the long waves on frequencies between the long and medium wave broadcasting bands. The third harmonics of some of these beacons occasionally appear on the medium waves to cause QRM with broadcasting stations and to mystify the DXer. Sometimes these harmonics can travel a considerable distance, much farther than the fundamental. For a number of years, using several different receivers, I have picked up the call SW (··· ·––) on approx 930kHz while listening to CJON (now CJYQ). There is an SW on 310kHz situated at the Cabo de Santa Marta Grande lighthouse on the north-west coast of Brazil which transmits with a power of 0·5kW (fundamental) and it is interesting to speculate whether it really is the tiny third harmonic of this beacon that we hear as QRM on CJYQ.

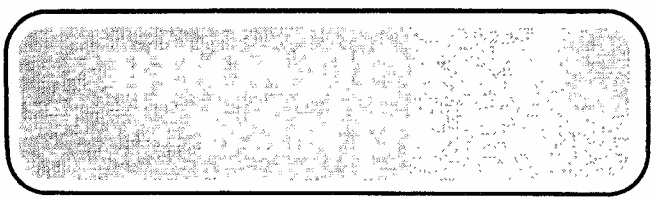
Readers' Letters

A number of interesting loggings of stations in the USSR come from **Bob Bell** in Blyth who uses an FRG-7 receiver and a mini (half-sized) loop. These are Kharkov on 836 (837), Stavropol 881, Arkhangelsk 908, Tallin 1034 (1035), Yoshkar Ola 1061 (1062), Baku on 1295 and an unidentified station on 1525. The frequencies are pre-Geneva Plan and those in brackets are the new ones where known. The station on 1525kHz may in fact be in China even though the language was Russian and there is often jamming to be heard on this unauthorised channel. Bob is willing to supply information and to advise anyone who is genuinely interested in his half-size loop. Letters should go direct to Bob at 5 Byron Avenue, Blyth, Northumberland NE24 5RN with, I would hope, a stamped addressed envelope for a reply.

News of Manx Radio comes from **Douglas Gibb** (Selkirk) who heard their test transmission on 1368kHz last September. This local station is now full-time on the new frequency and the 219 Times gives details of their broadcasts. It is available from Manx Radio, Broadcasting House, Douglas, IOM which is also the address for reception reports. Manx Radio will QSL by return.

Some countries are easier to hear on the medium or long waves than on the short waves and this has been noted by **David Wyatt** of Oswestry who logged Radio Andorra on 710kHz. He received a QSL in three weeks in answer to a report made out in French. On the long waves he picked up Radio Algeria in English on 251kHz at 2025, another country he had not been able to hear. The receiver in use is a 1947 Kolster Brande BR20 and a 90ft long wire. These older domestic sets often perform very well on the medium waves especially when used with a loop. Why not try this before looking for another receiver; it is possible to use low impedance phones in place of the loudspeaker. Be careful though to keep away from the chassis which may be live.

Sweden Calling DXers is now on a second frequency on the medium waves as the transmitter at Gothenburg on 991kHz has been allocated to the foreign service during the evening according to a station announcement. A final item from **Ian Rennison** (Horsham) who has logged Radio Paradise, St Kitts on 1265kHz at 0014, details of receiver, etc., not given.



SHORT-WAVE BROADCASTS

by Charles Molloy G8BUS

The majority of short-wave receivers tune from 6MHz to 18MHz, a range which includes six international broadcast bands. These are the 49 metre band (6MHz), 41m (7MHz), 31m (9MHz), 25m (11MHz), 19m (15MHz) and 16m (18MHz). There are also the 13 metre band (21MHz), the 11m band (26MHz) and the 75m band (4MHz) which are within the range of some receivers. It is traditional to quote a band by its wavelength in metres and the individual station within the band by its frequency in kilohertz (kHz) but there is a trend these days to refer to a band by the frequency in megahertz (MHz) and this is the figure shown in brackets. The 49m band for example can also be referred to as the 6MHz band. The relationship between MHz and kHz is quite simple. 1MHz is the same as 1000kHz. Radio Nederland is on 6020kHz in the 49m band but it may appear on 6·02MHz on some receivers.

Short-wave reception is entirely by means of the sky wave, which is reflected by the ionosphere many miles above the surface of the earth. The sky wave is influenced by the amount of daylight between transmitter and

receiver. The more daylight the higher the frequency that may be used. DX is possible on the highest frequencies during the day and on lower frequencies after dark. Short range reception is on lower frequencies by day and either 75m or the medium waves by night. In general, the frequency in use over any particular path will be higher during the day than after dark. In order to help beginners to find their way about the different bands it might be useful to have a look at each one in turn to see what sort of DX can be found there, starting this month with 25m.

25 Metre band

The 25m band has official limits of 11 700kHz to 11 975kHz, though in practice stations are to be found between 11 600kHz and 12 100kHz. There is something to be heard on 25m at any time of the day or night or during any season of the year and for that reason it is a good place for the newcomer. Last autumn the Radio Japan relay in Sines Portugal could be heard on 11 825kHz from 2200 to 2230, but after sign-off the much weaker Voice of Free China in Taiwan could be heard in English in its place, so always investigate weak signals.

During the day, look for distant broadcasts from Radio Pakistan on 11 640kHz, Radio Australia 11 760 and 11 900, Madagascar 11 730, Bonaire 11 790, Kuwait 12 085. Medium range stations that can be heard are Vatican Radio 11 740, Finland 11 755, Spain 11 815, Austria 11 855, Norway 11 865, Budapest 11 910, Greece 11 925 and Bucharest on 11 940. Latin America appears on 25m during the evening. Look for Radio Guaiba on 11 785, Radio Globo 11 805, Pernambuco on 11 865, all of them being in Brazil, and Radio Habana Cuba on 11 760. Other DX that may be heard at this time are WFYR Family Radio USA on 11 805, ELWA Liberia 11 835, Canary Islands 11 880, Radio Bamako in Mali on 11 960 and Radio Abidjan Ivory Coast on 11 920. Broadcasters on the short waves often move around and some of the frequencies mentioned may change but the list is typical of what a DXer may hope to hear without too much difficulty on the 25m band.

Readers' Letters

Sean Stray of Market Harborough (details of receiver and aerial not mentioned) reports some useful DX heard during his recent half term holiday. Radio Japan is a regular on 21 535kHz in the 13m band between 0800 and 0830. The signal is weak but clear of interference but a curious echo effect was observed, probably the result of propagation along different paths through the ionosphere. Radio Nacional Argentina was logged on 11 715 in the 25m band at 2320 and the address for reception reports is RAE Ayacucho 1556, 1000 Buenos Aires, Argentina. Riyadh in Saudi Arabia was picked up at fair strength at 1930 the address to write to being Ministry of P and T, Riyadh, Saudi Arabia. An unidentified with the call Radio Tinian (not Tirana) was heard on the 25m band at 2145. Has anyone any ideas on this?

A signal like a short burst of machine-gun fire is reported by **T. M. Headley** of Seaford in Sussex who has started listening on the short waves again after an absence of many years. This is over-the-horizon radar which can be heard all over the short waves and was the subject of international complaints to the USSR a year or two ago. A Sanyo RP8700 portable communications receiver which was a present from USA is in use by 13-year-old **Paul Cox** of Twickenham. When used with a 70ft long wire this rig pulled in Delhi on 11 740 at 2125 SIO 544, Radio Kuwait 12 085 at 1940 SIO 544 and Radio Japan on 17 820 at 0715 SIO 344. From Walsall comes another report of reception of R. Japan on 17 820 from **Craig Kelly** who used a t.r.f. receiver and 75ft long wire. Craig asks for identification of a station playing guitar music but he forgot to mention the frequency or band concerned. Requests for identification should contain as much detail as possible including the frequency, date, time and station announcement and the language used.

Tropical Bands

From Blyth in Northumberland comes an interesting log compiled by **Bob Bell** using his FRG-7 and home-made vertical antenna. On the 60m band he heard USSR (unid) on 4775kHz at 0255, Radio Lara Venezuela on 4800 at 0300, Radio Luz y Vida in Ecuador on 4800 at 0405, plus Radio Nacional Canaries on 11 880 in the 25m band at 1400. A Vega 206 plus 20ft outdoor aerial are in use by **Bill Stevenson** who heard Radio Yaounde Cameroon in French on 4850 at 0430 SIO 333, Radio N'Djamena Chad also in French on 4905 at 0430 sign-on SIO 333 and Radio Nigeria in English on 4990 at 0430 SIO 333, all on 60m. Bill has built an r.f. pre-amp for use with his receiver but it does not give good results. The symptoms are of overloading. Bill would be interested to hear from other Vega 206 users. Replies direct to him at 10 Crompton St, Swinton, Lancs.

Reception Reports

A DX Press Release from Radio Finland makes disturbing reading for the DXer. This station has stopped using QSL cards. In their place there will be audience cards with a different card for each month of the year. The new cards will not confirm the date, time or frequency and will therefore only be an acknowledgment of the listener's letter.

The reasons for the change are interesting. Radio Finland gets about 300 reception reports a week and to quote the press release "you could say we were keener to receive programme comments". Of course, if they stop issuing QSLs then they may not get any reports at all and a better policy surely would be to restrict QSLs to reports that are of real value to the station. None-the-less the point of view expressed by Radio Finland is a valid one. A short-wave station transmits a programme for its audience to listen to rather than a signal for DXers to pick up and DXers should bear this in mind when writing to a station. Perhaps if DXers were to include comment on the programme heard and how it compares with other stations, which apparently is what Radio Finland wants, in addition of course to the reception reports, then everyone would be satisfied. The "powers that be" at Radio Sweden, according to a recent broadcast from that station, feel they have few listeners but many DXers for an audience and this might be a prelude to another attempt to cut back the popular Sweden Calling DXers. Radio RSA has reduced its English transmission and cancelled its DX Corner, so abruptly that the editor Gerry Wood did not even have the chance to say goodbye. The future for DXers does not look too good at the moment. On a lighter note. A DXer who recently sent a report to a Middle East country received the reply "Don't you have radio in your country, why you listen to ours?".

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PW2

by Ron Ham BRS15744

What more could we v.h.f. addicts ask for than a new amateur satellite to play with, the 10m band alive with signals from all parts of the world, a tropospheric opening which sent the amateur and broadcast bands haywire, and all between mid-October and 18 November?

The 10 Metre Band

How often the new recruits to amateur radio must have heard the old hands reminiscing about the great 10m openings of the past. Well, hopefully, those good times are here again, but now, thanks to the RSGB, we have the International Beacon Project going well and it is almost a daily occurrence to hear strong signals from the beacons in Bahrain A9XC, Bermuda VP9BA, Cyprus 5B4CY, Florida N4RD and Germany DL0IGI indicating the best DX path to use.

Like many other clubs and individuals throughout the world, the Mid-Sussex Amateur Radio Society entered the CQ World Wide contest on 28/29 October from their club shack in Burgess Hill. During the event the operators, G3JMB, WPO, WYN, ZYE, G4GNX and HHB, worked almost 500 stations and more than half of these were on 10m. Afterwards, G4GNX said that conditions were so good that around 1800 on the 28th they worked 60 Ws in 45 minutes, and at 0730 on the 29th they had 16 contacts with JAs in about 20 minutes. Throughout the contest good signal reports were exchanged with stations all around the world, and **N. Clarke** BRS 34306, Knottingley, Yorks, logged all W call areas within one hour.

While **John Branegan** GM8OXQ, Saline, Fife, N. Clarke and myself kept a daily watch on the IBP signals and found that A9XC was the most consistent, closely followed by 5B4CY, DL0IGI, N4RD and VP9BA. **Graham Lay,** West Chiltington, **Alan Baker** G4GNX, Newhaven and **Ian Rennison,** Horsham, all in Sussex, listened to the world-wide DX on 28MHz. Ian also mentioned the very strong American CB signals he heard in the 27MHz band, especially on 21 October.

Solar Activity

Although the sun has been "quiet" at 136MHz compared with the same period in 1977, a few small bursts of solar radio noise were recorded on 6, 7, 8, 11 and 13 November by John Branegan, **Cmdr Henry Hatfield,** Sevenoaks, **John Smith,** Rudgwick, Sussex and myself and, on 6 and 13 Nov., Henry saw several filaments on the sun's disc with his spectrohelioscope.

Satellites

John Branegan has completed a 6-month survey of 70cm propagation from space, based on the signals from OSCAR-8J and says "Not only is OSCAR-8J affected by propagation disturbances both in, *and way above,* the normal E and F regions, all 70cm satellites are affected. Attenuations of up to 20dB (not due to polarisation rotation) seem to occur regularly in two regions of the world. The most noticeable are the Denmark Strait between Iceland and Greenland (i.e. between us and the magnetic pole) and over the equator in the South Atlantic". So far he cannot correlate these effects with solar disturbances but there is, writes John, "A positive correlation with time of day, the equatorial disturbance being most marked in the evenings".

For about 20 minutes at 1258, on 27 October, John heard the Russian amateur radio satellite, RS-1, come up over North America, heading east, and pass between his QTH and the pole. The satellite appeared again at 1502 and John accessed it on 145·890MHz (Down link 29·370MHz), called CQ and immediately a c.w. station answered, so excited that he sent John's call sign six times and forgot his own! The next pass was at 1708 when John had a good five-minute QSO with G3IOR. On the 28th he had his first transatlantic QSO via the new bird with W2BXA in New Jersey, followed by contacts with DC9II and DC9ZP. During the same orbit 5 GMs were in QSO with European stations and, that afternoon, a delighted GM8PSM made his first contact outside the UK via RS-1.

Microwaves

The two Erns, G8BDJ and G8GKV assisted **Mitch Tribe** G8PMT, Worthing, a newcomer to 10GHz activity, to contact four QRA locator squares on Sunday morning, 12 November. While Mitch set up his equipment, with a 60cm dish aerial, on Chanctonbury Ring, a high spot on the South Downs, G8GKV, accompanied by **Matthew Walton** a keen SWL and student of microwave activity, took his gear to other high spots in squares AK, AL and ZL. G8BDJ made the QSO with Mitch in ZK. Conditions were good and all contacts were 59. During the morning both G8BDJ and G8PMT heard the Isle of Wight beacon, GB3IOW on 3cm, and were later joined by G3JHM to make arrangements for future tests on the band.

Tropospheric

On 18 October, the atmospheric pressure rose rapidly from 30·0in to 30·4in, and with a few fluctuations it remained high until 12 November when it dropped back to 30·1in. This high pressure, coupled with mild and fine weather, frequently upset the v.h.f.s between 27 October and 12 November and as usual, our readers were both active and observant. At 2237 on 27 October, Alan Baker worked G8FRB/P near Derby on 2m s.s.b. and during the evening of the 28th, Belgian stations were working through the Dover repeater GB3KR, R4. While continental broadcast stations were audible in Band II on 28, 29 and 30 October, I frequently received strong pictures from the IBA transmitter at Lichfield, 189MHz, with a dipole aerial. Between 1900 and 2000 on 5 November, **Dermot Cronin** G4GRO, Royal Sovereign Light, heard 2m s.s.b. signals from DM, HG, OE and OK and at 2057 **Ken Smith,** Horsham reported patterns on u.h.f. TV. On the 9th both Ken and Ian Rennison heard continental stations in Band II and Alan Baker heard DL3HB and worked F6EVL on 2m c.w. At 0044 on the 10th, Alan, behind 400ft of chalk had a QSO with G8FUE in Somerset on 2m s.s.b.

Although conditions were generally very good for v.h.f. and u.h.f. DX throughout the 10th, 11th and part of the 12th, some strange things also happened. For instance, during the morning of the 10th, **Brian Houghton** G4BCO, Hastings, worked a station in Luton on f.m. running 1 watt from a hand-held set and **Brian Fenwick** G8BTC, Brighton, was listening to G8BDJ in nearby Southwick on 2m f.m., when suddenly his strong signals were obliterated by a station in Birmingham.

At 0843 on the 10th, I received strong pictures plus co-channel interference from Lichfield, and with patterning

on some u.h.f. TV channels I was not surprised when I heard signals from the 70cm beacons at Emley Moor GB3EM and Sutton Coldfield GB3SUT, using only a dipole aerial. Around 1800 **John Keegan,** Steyning, Sussex saw German TV signals, complete with adverts in Band V. Later the same evening, **Peter Beer,** near Saffron Walden, Essex, using a loft aerial, received pictures from French u.h.f. television.

Mitch Tribe was delighted with his achievements on the 10th because, using his Multi-800D rig from his stationary car, he worked several PD0 (Dutch Novices' call sign) on 2m f.m. and at 1300 G4GNX/M, situated on Beachy Head, worked PA0 and DJ via the Brugge repeater ON0VW, R2. Between 2145 and 2230 Ian Rennison received Belgian, Dutch and French stations in Band II, using a dipole aerial into his AIWA 5080 stereo system. At 0054 on the 11th, **John Cooper** G8NGO, Cowfold, heard an OZ on 2m s.s.b., and periodically between 0900 and 1400 both Ian Rennison and myself received pictures from a Dutch station on Channel E4.

Amateur Co-operation

While in contact with PA0OOM at 0036 on the 11th, G4GNX learnt that the Dutch station had been trying for two years to work a station in QRA square ZK, so he called G8NGO who lives in ZK who was very soon in touch. Later, PA0OOM told G4GNX that he was going QRT, a very happy man.

During the opening, several amateurs and u.h.f. televiewers complained about total loss of signals and a good example was a local QSO in Hastings between G3JSF and G8PUW on 2m, only about three miles apart, who suddenly completely lost contact with each other. More fading was reported by **Guy Stanbury,** Chelmsford, who became aware of the disturbance when he saw patterning on Band V pictures on the 10th, and from about 1900 received f.m. signals, some in full stereo, from stations in West Germany and the Low Countries. Throughout the evening he noticed that signals would appear for a while and then fade away, and very soon the space would be taken by another. Guy also remarked about the extensive fluctuations in signal strengths and writes "I am sure you will agree that this type of opening is as fascinating when it deteriorates as when it starts".

New VHF Repeater

The first QSO through the Brighton repeater GB3SR, which commenced operation on R3 at 1900 on 15 October, was between G8ETL/M, Brighton, and G3WPO, Worthing, who was using a home-brew, hand-held transceiver. The Sussex Repeater Group, who are responsible for the station, are delighted with its initial performance despite the fact that they are using temporary filters.

From our Overseas readers

Congratulations to **Anthony Mann,** Applecross, Western Australia, who sent us the exciting report that he had received Ch.B1 BBC TV sound, 41·5MHz, down-under, on 13, 14, 16 and 19 October, the vision, 45 MHz, on the 13th and Ch.F2 French sound, 41·25MHz, on the 16th. Anthony also received strong f.m. signals from the Korean Broadcasting Service, 44·3 and 44·9MHz, on each of these days and Russian signals on 41, 42 and 43MHz on the 19th. Also on the 19th he heard signals from Japanese amateurs on 52MHz, and Chinese and Malaysian TV signals on Channels R1 and E3 respectively.

"You might realise that any v.h.f. from the north is DX long before it arrives" writes **Ian Roberts,** Pretoria, South Africa, who also says that 19 October was remarkable because he was receiving Ch. R1 vision at 0900 and the Cyprus beacon, 50·5MHz, just above the noise. Also on the 19th, Ian heard the second harmonic of the French (Issoudum, 500kW) programme at 43·16MHz S5, while the fundamental at 21·58MHz was S9.

Oddleiv Tungland, Trondheim, Norway, is now licensed as LA3GW and is operating from LA1K, the club station of the students in Trondheim. Oddleiv is also interested in DX TV, and in recent years has received signals from about 10 European countries using a dipole aerial in Band I.

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

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

SPECIFICATIONS:
INPUTS. Magnetic Pick-up 3mV; Ceramic Pick-up 30mV; Tuner 100mV; Microphone 10mV; Auxiliary 3-100mV; input impedance 47kΩ at 1kHz.
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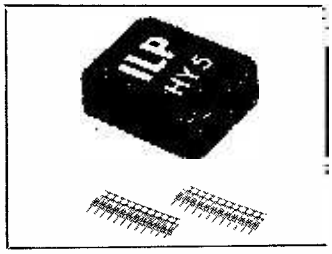

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APPLICATIONS: Updating audio equipment—Guitar practice amplifier—Test amplifier—audio oscillator.

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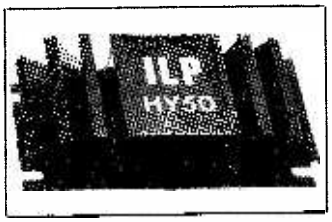
OUTPUT POWER 15W R.M.S. into 8Ω: DISTORTION 0·1% at 1·5W.
INPUT SENSITIVITY 500mV. FREQUENCY RESPONSE 10Hz-16kHz—3dB.
SUPPLY VOLTAGE ± 18V.

Price £6·27 + 78p VAT P&P free.



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

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

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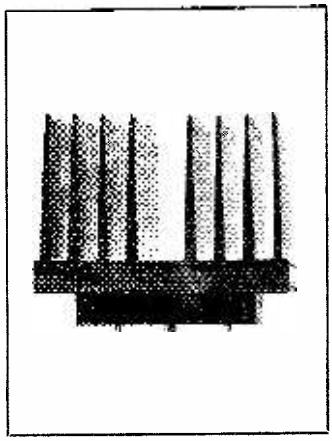
FEATURES: Very low distortion—Integral heatsink—Load line protection—Thermal protection—Five connections—No external components

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.



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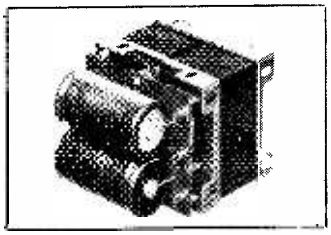
FEATURES: Thermal shutdown—Very low distortion—Load line protection—No external components.

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.



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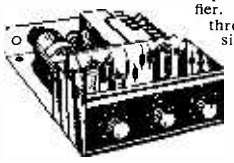

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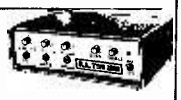

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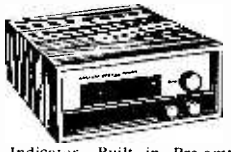

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7416	27p	74125	55p
7417	27p	74126	60p
7420	17p	74128	75p
7421	40p	74132	75p
7422	22p	74136	75p
7423	34p	74141	70p
7425	30p	74142	200p
7426	40p	74145	90p
7427	34p	74147	190p
7428	36p	74148	150p
7430	17p	74150	100p
7432	30p	74151A	70p
7433	40p	74153	70p
7437	35p	74154	100p
7438	35p	74155	90p
7440	17p	74156	90p
7441	70p	74157	70p
7442A	60p	74159	190p
7443	112p	74160	100p
7444	112p	74161	100p
7445	100p	74162	100p
7446A	93p	74163	100p
7447A	70p	74164	120p
7448	80p	74165	130p
7450	17p	74166	140p
7451	17p	74167	200p
7453	17p	74170	240p
7454	17p	74172	720p
7460	17p	74173	120p
7470	36p	74174	93p
7472	30p	74175	85p
7473	34p	74176	90p
7474	30p	74177	90p
7475	36p	74178	160p
7476	35p	74180	93p
7480	58p	74181	200p
7481	100p	74182	90p
7482	84p	74184A	150p
7483A	90p	74185	150p
7484	100p	74186	700p
7485	110p	74190	100p
7486	34p	74191	100p
7489	210p	84192	100p
7490A	33p	74193	100p
7491	80p	74194	100p
7492A	46p	74195	95p
7493A	33p	74196	95p
7494	84p	74197	80p
7495A	70p	74198	150p
7496	65p	74199	150p

74221	160p		
74251	140p		
74259	250p		
74265	90p		
74278	290p		
74279	140p		
74283	190p		
74284	400p		
74285	400p		
74290	150p		
74293	150p		
74294	200p		
74298	200p		
74365	150p		
74366	150p		
74367	150p		
74368	150p		
74390	200p		
74393	200p		
74490	225p		
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74LS00	18p		
74LS02	18p		
74LS04	20p		
74LS08	22p		
74LS10	20p		
74LS13	38p		
74LS14	100p		
74LS20	22p		
74LS22	28p		
74LS27	38p		
74LS30	22p		
74LS47	90p		
74LS55	30p		
74LS73	50p		
74LS74	60p		
74LS75	50p		
74LS83	110p		
74LS85	100p		
74LS86	40p		
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74LS93	60p		
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74LS112	100p		
74LS123	75p		
74LS132	900p		
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74LS138	60p		
74LS139	60p		
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74LS153	60p		
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74LS161	100p		
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74LS163	100p		
74LS164	120p		
74LS165	80p		
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74LS174	110p		
74LS175	110p		
74LS181	320p		
74LS190	100p		
74LS191	100p		

74LS192	140p	74C157	250p
74LS193	140p	74C160	155p
74LS195	140p	74C161	155p
74LS196	120p	74C162	155p
74LS221	100p	74C163	155p
74LS240	175p	74C164	120p
74LS241	175p	74C173	120p
74LS242	175p	74C174	160p
74LS243	175p	74C175	210p
74LS245	175p	74C192	150p
74LS251	200p	74C193	150p
74LS257	120p	74C194	220p
74LS259	175p	74C195	110p
74LS298	240p	74C221	175p
74LS373	200p	**4000 SERIES**	
74LS374	195p	4000	15p
81LS95	120p	4001	17p
81LS96	160p	4002	17p
81LS97	120p	4006	95p
81LS98	160p	4007	18p
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9301	160p	4009	40p
9302	175p	4010	50p
9308	316p	4011	17p
9310	275p	4012	18p
9311	275p	4013	50p
9312	160p	4014	84p
9314	165p	4015	84p
9316	225p	4016	45p
9322	150p	4017	80p
9368	200p	4018	89p
9370	200p	4019	45p
9374	200p	4020	100p
9601	100p	4021	110p
9602	175p	4022	100p
9603	60p	4023	22p
INTERFACE I.C.s		4024	56p
MC1488	100p	4025	20p
MC1489	100p	4026	130p
75107	160p	4027	50p
75182	230p	4028	84p
75450	120p	4029	100p
75451/2	72p	4030	55p
75491/2	96p	4031	200p
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74C00	25p	4034	200p
74C02	25p	4035	110p
74C04	27p	4040	100p
74C08	27p	4041	80p
74C10	27p	4042	80p
74C14	90p	4043	90p
74C20	27p	4044	90p
74C30	27p	4046	110p
74C32	36p	4047	100p
74C42	110p	4048	55p
74C48	250p	4049	32p
74C73	75p	4050	49p
74C74	70p	4051	80p
74C85	200p	4052	80p
74C86	65p	4053	80p
74C90	95p	4055	125p
74C95	130p	4056	135p
74C107	125p	4059	600p
74C150	250p	4060	115p
74C151	260p	4063	120p
		4066	55p

LINEAR I.C.s

*AY1-0212	600p		
*AY1-1313	668p		
*AY1-5050	212p		
*AY5-1315	800p		
*AY5-1317	636p		
*AY5-1320	320p		
*CA5019	80p		
*CA5046	70p		
*CA3048	225p		
CA3080E	72p		
*CA3089E	225p		
*CA3090AQ	375p		
CA3130S	100p		
CA3140E	70p		
CA3160E	75p		
FX200	750p		
ICL7106	925p		
ICL8038	340p		
LM301A	36p		
LM311	190p		
LM318	200p		
LM324	70p		
LM339	90p		
LM348	95p		
*LM377	175p		
*LM380	75p		
*LM381AN	150p		
*LM389N	140p		
LM709	36p		
LM710	50p		
LM733	100p		
LM741	29p		
LM747	70p		
LM748	35p		
LM3800	70p		
LM3911	130p		
LM4136	120p		
*MC1310P	150p		
MC1458	55p		
MC1495	400p		
*MC1496	100p		
*MC3340	120p		
*MC3360	120p		
*MFC4000B	120p		
MK50398	750p		
NE531	130p		
*NE540	200p		
NE543K	225p		
NE555	25p		
NE556	70p		
NE561B	425p		
NE562B	425p		
NE565	130p		
NE566	155p		
NE567	175p		
RC4151	400p		
*SN76003N	175p		
*SN76013N	140p		
*SN76013ND	120p		
*SN76023N	140p		
*SN76023ND	120p		
*SN76033N	175p		
*SP8515	750p		
*TBA641B11	225p		
*TBA800	90p		
*TBA810	100p		
*TBA820	90p		
*TCA940	175p		
*TDA1022	600p		
XR2206	400p		
XR2207	400p		
*XR2216	675p		
XR-240	400p		
*ZN414	90p		
ZN424E	135p		
ZN425E	400p		
ZN1034E	200p		
95H90	800p		

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Fixed Plastic TO-220

1A	+ve		1A	—ve	
5V	7805	90p	5V	7905	100p
12V	7812	90p	12V	7912	100p
15V	7815	90p	15V	7915	100p
18V	7818	90p	18V	7918	100p
24V	7824	90p	24V	7924	100p

100mA	TO-92		100mA	TO-92	
5V	78L05	35p	5V	79L05	80p
12V	78L12	35p	12V	79L12	80p
15V	78L15	35p	15V	79L15	80p

OTHER REGULATORS

LM309K	135p	TBA625B	120p
LM317T	200p	TL430	65p
LM323K	625p	78HO5KC	675p
LM723	37p	78MGT2C	135p

OPTO-ELECTRONICS

2N5777	45p	ORP12	90p
OCP71	130p	ORP60	90p
ORP61	90p	TIL78	70p

TRANSISTORS

AC127/8	20p	BFY51/2	22p	TIP41C	78p	2N3866	90p
AD149	70p	BFY56	33p	TIP42A	70p	*2N3903/4	18p
AD161/2	45p	BFY90	90p	TIP42C	82p	*2N3905/6	20p
BC107/8	11p	BLY83	700p	TIP2955	78p	*2N4036	65p
BC109	11p	BRY39	45p	TIP3055	70p	*2N4058/9	12p
*BC147/8	9p	BSX19/20	20p	*TIS43	34p	*2N4060	12p
*BC149	10p	*BU105	190p	*TIS93	30p	*2N4061/2	18p
*BC157/8	10p	*BU108	250p	*ZTX108	12p	*2N4123/4	22p
*BC159	11p	*BU205	220p	*ZTX300	13p	*2N4125/6	22p
*BC169C	12p	*BU208	240p	*ZTX500	15p	*2N4289	20p
*BC172	12p	*BU406	145p	*ZTX502	18p	*2N4401/3	27p
BC177/8	17p	MJ481	175p	*ZTX504	30p	2N4427	90p
BC179	18p	MJ491	200p	2N457A	250p	*2N4871	60p
*BC182/3	10p	MJ2501	225p	2N696	35p	*2N5087	27p
*BC184	11p	MJ2955	100p	2N697	25p	*2N5089	27p
BC187	30p	MJ3001	225p	2N706A	20p	*2N5172	27p
*BC212/3	11p	*MJE340	65p	2N708A	20p	2N5179	27p
*BC214	12p	MJE2955	100p	2N918	45p	2N5191	83p
BC461	36p	MJE3055	78p	2N930	18p	2N5194	90p
BC477/8	30p	*MPF102	45p	2N1131/2	20p	*2N5245	40p
*BC516/7	50p	*MPF103/4	40p	2N1613	25p	*2N5296	55p
*BC547B	16p	*MPF105/6	40p	2N1711	25p	*2N5401	50p
*BC549C	18p	*MPSA06	30p	2N2102	60p	*2N5457/8	40p
*BC557B	16p	*MPSA12	50p	2N2160	120p	*2N5459	40p
*BC559C	18p	*MPSA56	32p	2N2219A	20p	*2N5460	40p
BCY70	18p	*MPSU06	63p	2N2222A	20p	*2N5485	44p
BCY71/2	22p	*MPSU56	78p	2N2369A	16p	*2N6027	48p
BD131/2	50p	OC28	130p	2N2484	30p	2N6247	190p
BDY56	200p	OC35	130p	2N2646	50p	2N6254	130p
BF200	32p	*R2008B	200p	2N2904/5	25p	2N6292	65p
*BF244B	35p	*R2010B	200p	2N2906A	24p	2N128	120p
*BF256B	70p	*TIP29A	40p	2N2907A	30p	3N140	100p
BF257/8	32p	*TIP29C	55p	*2N2926	9p	3N201	110p
BF259	36p	*TIP30A	48p	2N3053	20p	3N204	100p
*BFR39	30p	*TIP30C	60p	2N3054	65p	40290	250p
*BFR40	30p	TIP31A	58p	2N3055	48p	40360	48p
*BFR41	30p	TIP31C	62p	2N3442	140p	40361/2	45p
*BFR79	30p	TIP32A	68p	2N3553	240p	40364	120p
*BFR80	30p	TIP32C	82p	*2N3565	30p	40408	70p
*BFR81	30p	TIP33A	90p	*2N3643/4	48p	40409	65p
BFR29	30p	TIP33C	114p	*2N3702/3	12p	40410	65p
BFX30	34p	TIP34A	115p	*2N3704/5	12p	40411	300p
BFX84/5	30p	TIP34C	160p	*2N3706/7	12p	40594	97p
BFX86/7	30p	TIP35A	225p	*2N3708/9	12p	40595	105p
BFX38	30p	TIP35C	290p	2N3773	300p	40603	58p
BFW10	90p	TIP36A	270p	*2N3819	25p	40673	90p
BFY50	22p	TIP36C	340p	*2N3820	50p	40841	90p
		TIP41A	65p	2N3823	70p	40871/2	90p

DIODES

*BY127	12p
*OA47	9p
*OA81	15p
*OA85	15p
*OA90	9p
*OA91	9p
*OA95	9p
*OA200	9p
*OA202	10p
*1N914	4p
*1N916	7p
*1N4148	4p
1N4001/2	5p
1N4003/4	6p
1N4005	6p
1N4006/7	7p
1N5401/3	14p
1N5404/7	19p
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1 W	15p
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*1A 400V	30p
*2A 50V	30p
*2A 100V	35p
*2A 400V	45p
*3A 200V	60p
*3A 600V	72p
*4A 100V	95p
*4A 400V	100p
6A 50V	90p
6A 100V	100p
6A 400V	120p
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25A 400V	400p

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silicon chip of the 3089 device. The use of an external load resistor in the CA3189E enables any noise at pin 10 to be decoupled by a 10μF capacitor to ground; in addition, the value of the load resistor can be selected as desired so as to vary the audio output level, which increases with the value of the load resistor. The value of the de-emphasis capacitor from the output to ground must be chosen according to the value of the load resistor used so that the produce of the values of these two components is about 50μs.

There is no connection to pin 16 of the 3089 devices, but in the CA3189E this pin is used to feed the controlling voltage for the a.g.c. threshold into the device. This controlling voltage may be obtained using the voltage at pin 13 as shown in Fig. 15, in which case the onset of a.g.c. action will vary from about 200μV up to 200mV at pin 1 according to the setting of VR1. When the a.g.c. voltage is plotted against the input voltage a curve with an extremely sharp "knee" is obtained, so the onset of a.g.c. action is very rapid. When the a.g.c. voltage from the CA3189E is fed to one of the gate electrodes of a MOSFET in a front-end unit, a range of 40dB in the gain is easily obtained.

FM/AM Devices

The f.m. i.f. devices we have discussed process only an f.m. signal, but many new devices are now coming onto the market which will not only handle the f.m. i.f. signal, but which will also process an a.m. signal. When an f.m. front-end unit is coupled to such a device together with an audio amplifier, all the devices (except possibly one or two diodes or transistors) which are required in a receiver to cover both a.m. and f.m. bands are then available. Devices in this class include the Fairchild μA721, the A.E.G.-Telefunken TDA1083, the Mullard TBA570 and their new TDA5700 and the SGS-Ates TDA1220 device.

One of the problems of using these devices in a home constructed receiver is the complexity of the circuitry around a single integrated circuit. Many constructors therefore prefer to keep the a.m. and f.m. sections of their receivers quite separate. However, in car radio receivers and in small portable receivers where space can be at a premium, these new combined a.m./f.m. devices are very attractive, especially to the receiver manufacturers.

The μA721

The Fairchild μA721 device is encapsulated in a standard 16 pin dual-in-line plastic package (available from Arrow Electronics Ltd.). It contains the semiconductor devices required for the a.m. r.f. stage, oscillator, mixer and i.f. stage together with an f.m. limiter and quadrature demodulator circuit. Although all of this circuitry has been compressed onto a single chip, the total quiescent current required is only some 20mA. The device operates from a supply of about 9V.

The f.m. section input has a limiting sensitivity of about 500μV and provides an audio output signal of about 520mV r.m.s. at a typical total harmonic distortion of some 0·9% (maximum for any μA721 device is 2%). The signal-to-noise ratio is typically 75dB with a minimum value of 60dB. The rejection of a.m. signals is some 46dB (as opposed to about 60dB in the case of the CA3189E).

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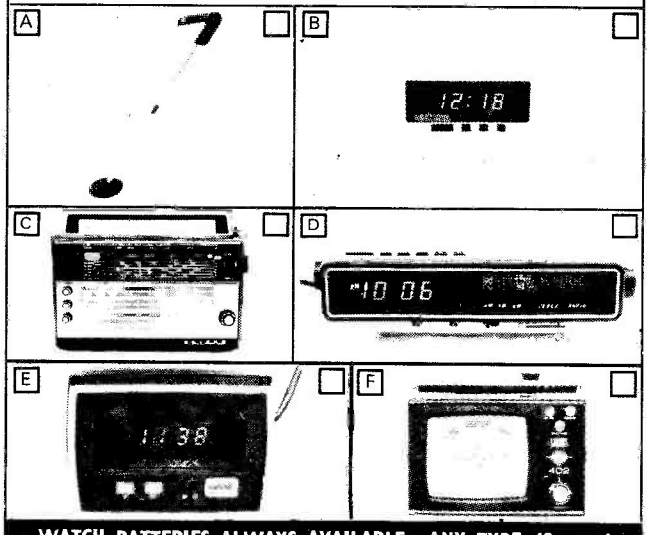

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BC212L	.10	.09	.075
BC213A/B/C	.07	.065	.05
BC214B/C	.07	.065	.05
BC214L	.10	.09	.075
BC300/1/3	.25	.23	.20
BC337	.09	.08	.065
BC441	.29	.27	.22
BC461	.30	.27	.23
BC546/8/9/7	.07	.06	.055
BC550/6/7	.07	.065	.055
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BCY70	.18	.16	.135
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BD132	.40	.37	.31
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BD222	.47	.42	.36
BD223/4	.49	.44	.37
BD239	.32	.29	.24
BD240	.34	.30	.26
BD241	.32	.29	.24
BD242	.37	.33	.28
BD243	.42	.38	.32
BD244	.45	.40	.34
BF257	.26	.23	.20
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TIP29A/B	.35	.32	.27
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TIP32	.35	.32	.27
TIP32A/B	.35	.32	.27
TIP32C	.38	.35	.29
TIP41/A	.51	.46	.39
TIP41C	.57	.52	.44
TIP42/A/B	.53	.48	.40
TIP42C	.57	.52	.44
TIP47	1.45	1.32	1.11
TIP48	1.54	1.39	1.17
TIP110	1.00	.92	.77
TIP111	1.05	.95	.80
TIP112	1.20	1.10	.92
TIP115	1.02	.92	.78
TIP116	1.07	.96	.81
TIP117	1.24	1.13	.95
TIP120	1.03	.93	.78
TIP121	1.05	.95	.80
TIP125	1.02	.92	.78
TIP126	1.07	.96	.81
TIP127	1.24	1.13	.95
TIP2955	.62	.57	.48
TIP3055	.62	.57	.48
2N1132	.26	.23	.20
2N2102	.38	.34	.29
2N2218/A	.24	.21	.18
2N2219/A	.24	.21	.18
2N2221/A	.17	.16	.13
2N2222/A	.15	.14	.12
2N2646	.41	.37	.31
2N2904/5	.24	.21	.18
2N2904A/5A	.25	.22	.19
2N2906/7	.15	.14	.12
2N2907A	.16	.15	.12
2N3053	.23	.20	.17
2N3054	.67	.60	.51
2N3055	.68	.61	.52
2N3232	.83	.76	.64
2N3440	.80	.73	.61
2N3442	1.43	1.30	1.09
2N3703	.08	.07	.06
2N3704/5/6	.09	.08	.065
2N3771	2.06	1.87	1.57
2N3772	2.08	1.89	1.59
2N3773	3.45	3.12	2.63
2N3904/6	.08	.07	.06
2N4036	.26	.23	.20
2N4037	.25	.22	.19
2N5294	.46	.42	.35
2N5296	.40	.37	.31
2N5298	.49	.45	.38
2N5415	1.08	.97	.82
2N5416	1.39	1.26	1.06
2N5490	.58	.52	.44
2N5492	.61	.55	.46
2N5494	.64	.58	.49
2N5496	.66	.59	.50
2N6098	.58	.53	.45

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2N6099	.58	.53	.45
2N6101	.60	.54	.46
40366	.40	.36	.30
40406	.41	.37	.32
40407	.41	.37	.32
40411	.88	.80	.68
40594	1.18	1.06	.90

TTL	1+	25+	100+
7400	.16	.15	.13
7401	.19	.17	.14
7401AN	.21	.19	.16
7402	.16	.15	.13
7403	.19	.17	.14
7404	.16	.15	.13
7405	.20	.18	.15
7408/7	.27	.24	.21
7408	.16	.15	.13
7409	.20	.18	.15
7410	.16	.15	.13
7412	.20	.18	.16
7412AN	.22	.20	.17
7413	.32	.29	.25
7416/7	.24	.22	.19
7420	.16	.15	.13
7422/3	.20	.18	.15
7425/6/7/8	.21	.19	.16
7430	.16	.15	.13
7432	.18	.16	.14
7433	.23	.21	.18
7437/8	.20	.18	.16
7440	.16	.15	.12
7441AN	.74	.67	.56
7442	.28	.25	.21
7443	.44	.40	.33
7444	.45	.40	.34
7445	.21	.19	.16
7446	.50	.45	.38
7447	.40	.36	.30
7448	.50	.45	.38
7450/1/3	.19	.17	.15
7454/60	.19	.17	.15
7470/2	.34	.30	.26
7473/4	.26	.23	.20
7475	.21	.19	.16
7476	.31	.28	.23
7480	.36	.33	.27
7481/2	.57	.52	.44
7483	.31	.28	.23
7484	.45	.40	.34
7485	.47	.42	.36
7486	.20	.18	.15
7489	2.42	2.19	1.85
7490/1	.20	.18	.15
7491AN	.20	.18	.15
7492	.31	.28	.24

TTL	1+	25+	100+
7493	.20	.18	.15
7494	.40	.36	.30
7495	.23	.21	.18
7496	.34	.31	.26
7497	1.02	.94	.79
74100/4	.71	.65	.56
74105	.86	.78	.66
74107/9	.35	.32	.27
74110	.42	.38	.32
74111/16	.27	.25	.21
74118	.89	.81	.68
74119/20	.60	.54	.46
74121	.39	.35	.30
74122	.44	.40	.34
74123/5/6	.42	.38	.32
74128	.45	.40	.34
74132	.60	.55	.46
74136	.24	.22	.18
74137	.25	.23	.19
74141	.24	.22	.18
74142	1.48	1.33	1.13
74145	.36	.33	.27
74147	.71	.65	.55
74148	.74	.67	.57
74150	.45	.40	.34
74151/3	.29	.26	.22
74154	.69	.63	.53
74155	.28	.25	.21
74156	.36	.33	.27
74157	.29	.26	.22
74159	.77	.70	.59
74160/1	.36	.33	.27
74162	.40	.36	.31
74163/4/5	.36	.33	.27
74166	.52	.47	.40
74167	1.26	1.14	.97
74170	1.08	.99	.83
74172	2.07	1.87	1.58
74173	.71	.65	.55
74174	.54	.49	.42
74175	.84	.76	.64
74178/7	.38	.35	.29
74180	.40	.36	.30
74181	.99	.90	.76
74182	.40	.36	.30
74184/5	.94	.85	.72
74188AN	4.08	3.69	3.11
74190/1	.31	.28	.24
74192/3	.36	.33	.28
74194	.50	.45	.38
74195	.27	.24	.21
74196/7	.38	.35	.29
74198	.60	.54	.46
74199	.37	.33	.28
74221	.91	.82	.69
74H00	.28	.26	.22
74H05	.32	.29	.25
74H10/11	.28	.26	.22

TTL	1+	25+	100+
74H20	.28	.26	.22
74S10	.31	.28	.24

CMOS			
4000A	.19	.175	.15
4001A	.19	.175	.15
4011/12A	.19	.175	.15
4013B	.83	.75	.63
4014A	.95	.86	.72
4017A	1.03	.92	.79
4018B	1.18	1.06	.90
4021/22A	1.03	.92	.79
4023A	.19	.18	.15
4024B	.93	.84	.71
4025A	.19	.175	.15
4027B	.45	.40	.34
4028B	.84	.76	.64
4029A	1.20	1.08	.92
4030A	.45	.40	.34
4040A	1.18	1.06	.90
4042B	.86	.78	.66
4043/44B	.80	.73	.61
4049A	.44	.40	.34
4050B	.44	.40	.34
4051B	1.24	1.12	.95
4068/69B	.19	.175	.15
4071B	.19	.175	.15
4098B	1.67	1.51	1.28
4160/1/2	1.04	.94	.80
4175B	1.23	1.11	.94
4194B	1.24	1.12	.94
4409P	6.64	6.00	5.06
4433P	8.73	7.90	6.65
4450P	3.48	3.15	2.65
4501CP	.26	.23	.20
4507A	.44	.40	.34
4508B	.74	.67	.56

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16 pin	.16	.14	.12
18 pin	.22	.195	.165
20 pin	.23	.21	.18
22 pin	.25	.225	.19
24 pin	.26	.235	.20
28 pin	.34	.31	.26
40 pin	.49	.44	.37

Voltage Regs			
7805	.78	.71	.60
7812	.78	.71	.60
7905	.90	.82	.69
7912	.90	.82	.69

Triacs. TO220	1+	25+	100+
2A 100V	.45	.41	.35
2A 200V	.46	.42	.35
2A 400V	.50	.45	.38
6A 100V	.51	.46	.39
6A 200V	.52	.47	.40
6A 400V	.56	.51	.43
10A 100V	.82	.74	.63
10A 200V	.84	.76	.64
10A 400V	.91	.82	.69

Thyristors, TO220			
3A 50V	.37	.34	.28
3A 400V	.41	.37	.31
5A 100V	.37	.34	.28
5A 600V	.50	.45	.38
7A 400V	.56	.51	.43
10A 200V	.62	.56	.48

Bridge Rect			
2A 50V	.38	.35	.29
2A 100V	.42	.38	.32
2A 200V	.47	.42	.36
2A 400V	.59	.54	.45

LEDS			
TIL209	.17	.155	.13
TIL212	.21	.19	.16
TIL216	.21	.19	.16
TIL220	.16	.14	.12
TIL228	.23	.21	.175
TIL234	.23	.21	.175
TIL232	.21	.19	.16

Diodes			
IN914	.03	.016	.013
IN916	.03	.016	.014
IN4001	.045	.04	.035
IN4002	.05	.04	.035
IN4003	.055	.045	.04
IN4004	.055	.05	.04
IN4005	.055	.05	.04
IN4006	.06	.05	.045
IN4007	.065	.055	.05
IN4148	.03	.015	.013
IN4149	.03	.016	.014
BZY88C Series	.07	.055	.047

Linear ICs			
555	.30	.27	.22
709	.42	.38	.32
710	.47	.42	.36
741	.24	.21	.18
747	.40	.37	.31
748	42	.38	.32
CA3130E	.95	.86	.72
CA3130T	1.03	.94	.79

LM301A	.28	.25	.21
MC1310P	1.35	1.22	1.03
NE555	.28	.25	.21
NE556	.51	.46	.39
SN76003	2.20	2.00	1.68
SN76013	1.47	1.33	1.12
SN76023	1.47	1.33	1.12
SN76033	2.20	2.00	1.68
UA709C	.38	.35	.29
UA741CP	.28	.25	.21
UA747C	.68	.61	.52
UA748C	.38	.35	.29
TAA570	2.14	1.94	1.64
TBA120SQ	.91	.82	.69
TBA520Q	2.04	1.85	1.56
TBA530Q	1.79	1.62	1.36
TBA540Q	1.92	1.73	1.46
TBA550Q	2.29	2.08	1.75
TBA560CQ	2.36	2.13	1.80
TBA750Q	1.79	1.62	1.36
TBA800Q	1.79	1.62	1.36
TBA920	2.42	2.19	1.84
TBA920Q	2.42	2.19	1.84
TBA950	2.29	2.08	1.75
TBA990Q	2.04	1.85	1.56
TCA270Q	1.79	1.62	1.36
TCA800	2.82	2.55	2.15

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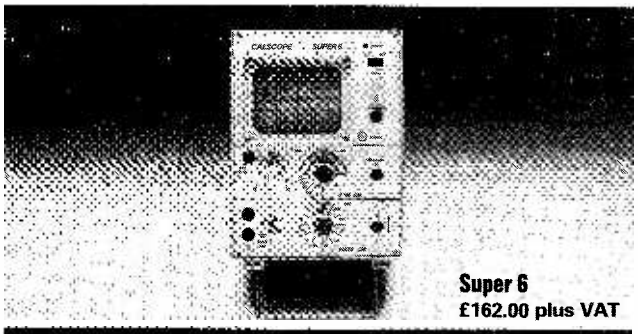

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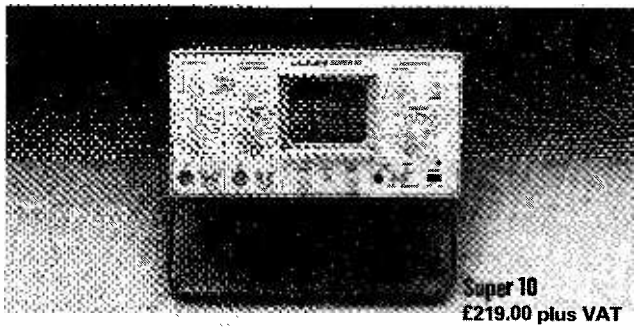

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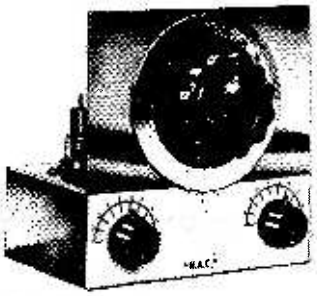

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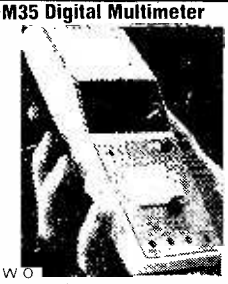

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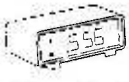

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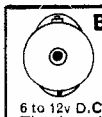

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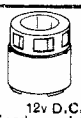

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47	8.00	5.00	3.00	1.80
48	15.00	9.00	6.00	3.30

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14 & 16	4.50	2.25	1.44	.90
20 & 22	5.00	2.85	1.74	1.06
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28 & 30	6.67	3.86	2.35	1.44

Prices include P & P and VAT
SAE brings list of copper & resistance Wires
Dealer Enquiries Invited.

AERIAL BOOSTERS Improve weak VHF Radio and Television reception, price £5·00 S.A.E. for Leaflets. ELECTRONIC MAILORDER LTD., Ramsbottom, Bury, Lancashire BL0 9AG.

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Rechargeable and suitable for 'fast charge' HP7 (AA) **£1·13,** SUB C **£1 47,** HP 11 (C) **£2·15,** HP 2 (D) **£3·27,** PP3 **£4·09** (PP3 not suitable for fast charge), PP3 charger **£5 31.** All above Nickel Cadmium batteries are guaranteed 'EVER READY' full spec, and are supplied complete with solder tags (except PP3). Just in stock—New rechargeable sealed lead acid maintenance free batteries suitable for burglar alarms etc., 1·2 amp hr. 6v. **£4·40** 6 amp hr. 6v **£5·65.**

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111	0·5	0·25	2·20	0·45
213	1·0	0·5	2·64	0·78
71	2	1	3·51	0·78
18	4	2	4·03	0·96
70	6	3	5·35	0·96
108	8	4	7·42	1·14
72	10	5	8·12	1·14
116	?	6	8·99	1·32
17	?	8	10·72	1·32
115	20	10	13·98	2·08
187	30	15	17·05	2·08
226	60	30	36·74	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.

Ref	Amps	£	P & P
102	0·5	3·41	0·78
103	1·0	4·57	0·96
104	2·0	7·16	1·14
105	3·0	8·56	1·32
106	4·0	11·41	1·50
107	6·0	15·06	1·64
118	8·0	20·26	2·08
119	10·0	24·98	OA

MAINS ISOLATING (SCREENED)

Pri 120/240V SEC 120/240V CT

Ref	VA (Watts)	£	P & P
*107	20	4·40	0·79
149	60	6·70	0·96
150	100	7·61	1·14
151	200	11·16	1·50
152	250	13·28	1·84
153	350	16·43	1·84
154	500	20·47	2·15
155	750	29·06	OA
156	1000	37·20	OA
157	1500	51·38	OA
158	2000	81·81	OA
159	3000	86·66	OA

Pri 0-220-240V. Sec 115 or 240V. State volts required.

HIGH VOLTAGE ISOLATOR

Pri 200/220V or 400/440V
Sec 110/120V CT or 200/240CT

Va	Ref	£	P & P
60	243	6·70	1·32
350	247	16·43	1·84
1000	250	37·10	OA
2000	252	61·81	OA

30VOLT 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	5·77	0·96
20	3·0	6·20	1·14
21	4·0	7·99	1·14
51	5·0	9·87	1·32
117	6·0	11·17	1·45
88	8·0	14·95	1·64
89	10·0	17·25	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, or 30V-0-30V.

Ref	Amps	£	P & P
124	0·5	3·88	0·96
126	1·0	5·91	0·96
127	2·0	7·60	1·14
125	3·0	11·00	1·32
123	4·0	12·52	1·84
40	5·0	15·84	1·64
120	6·0	18·06	1·84
121	8·0	25·56	OA
122	10·0	29·55	OA
189	12·0	34·06	OA

AUTO TRANSFORMERS

Ref	VA (Watts)	£	P & P
113	15 0-115-210-240	2·48	0·71
64	75 0-115-210-240	4·01	0·96
4	150 0-115-200-220-240	5·35	0·96
67	500 0-115-200-220-240	10·99	1·64
84	1000 0-115-200-220-240	18·76	2·08
93	1500 0-115-200-220-240	23·36	OA
95	2000 0-115-200-220-240	34·82	OA
73	3000 0-115-200-220-240	59·21	OA
80s	4000 0-10-115-200-220-240	76·86	OA
57s	5000 0-10-115-200-220-240	89·50	OA

CASED AUTO TRANSFORMERS

240V cable in 115V USA flat pin outlet

VA	£	P & P	Ref
15	4·96	0·96	113W
75	7·73	1·14	64W
150	10·01	1·14	4W
200	9·92	1·45	65W
250	10·49	1·45	69W
500	15·17	1·64	67W
750	23·41	1·76	83W
1000	27·88	OA	84W
1500	26·02	OA	93W
2000	49·97	OA	95W

SCREENED MINIATURES

Ref	mA	Volts	£	P&P
238	200	3-0-3	2·57	0·55
212	1A, 1A	0-6, 0-6	2·85	0·78
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	2·77	0·71
208	1A, 1A	0-8-9, 0-8-9	3·53	0·78
236	200, 200	0-15, 0-15	1·99	0·38
214	300, 300	0-20, 0-20	2·80	0·78
221	700 (DC)	20-12-0-12-20	3·41	0·78
206	1A, 1A	0-15-20-0-15-20	4·63	0·96
203	500, 500	0-15-27-0-15-27	3·99	0·96
204	1A, 1A	0-15-27-0-15-27	6·04	0·96
239	50	12-0-12	2·57	0·38

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DC-1000V AC-1000V DC-100mA Res-150kΩ 10000Ω/V Bargain **£6·45.** VAT 8% P & P 62p.

20,000 ohm/V Multimeter, mirror scale. Ranges AC/DC to 1000V DC current to 250mA Resistance to 3 Mohms. 5" × 3½" × 1¼". **£14·36.** VAT 8%. P & P **£1·05.**

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AVO 73	£44·20	20KΩ/VDC2K/VAC
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Pri 120V or 220/240V. Sec 0-36-48 twice to give 36-0-36V 48-0-48V 72V or 92V.

Ref	Price	P & P
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41 × 41mm		82 × 82mm	
0–50μA	£5·50	0–50μA	£6·70
0–500μA	£5·50	0–500μA	£6·70
0–1mA	£5·50	0–1mA	£8·40
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VU Ind. Panel 90mm 250ma £3·36
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65 High Quality Metal Oxide 5% ¼ + ½ W resistors.
150 Mixed Value Capacitors.
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200V	2A	£0·45
400V	4A	£0·85
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250VA ISOLATOR

0-200-220-240V
0-240V centre tap.
250VA **£5·20** P & P 96p Ref. 62.

Aluminium Boxes—with ½" lip lid & screws.

	l	w	h	
B1	5¼	2½	1½	62p
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Ref		Price	PP
171	500 ma	2·09	·45
172	1A	2·96	·78
173	2A	3·59	·78
174	3A	3·75	·86
175	4A	5·73	·96

P.W. Purbeck oscilloscope transformer In stk 250-0-250 6·3V, 12·9V **£6·20** p & p 90p

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BE5 15W matching trans. sec 15Ω suit EL89 **£1·50** p & p 30p

BE6 Pn 0·220V sec 4500V 10ma **£4·50** p & p £1·00

BE7 0-110-120-220V Pn 240V sec 20V 1 amp **£1·50** p & p 30p

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1000pF/350V 8p

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500v: 10 40p; 47 63p; **250v:** 100 65p; **63v:** 0·47, 1·0, 1·5, 2·2, 2·5, 3·3, 4·7, 6·8, 8,10, 15,22, 8p; 47, 32, 50, 11p; 63, 100, 27p; **50V:** 1·0, 7p; 50, 100, 220, 25p; 470, 50p; 1000, 62p; **40V:** 22, 33µF, 7p; 100, 11p; 2200, 3300, 62p; 4700, 64p; **35V:** 10, 33, 7p; 330, 470, 32p; 1000, 49p; **25V:** 10, 22, 47, 6p; 80, 100, 160, 4p; 220, 250, 13p; 470, 640, 25p; 1000, 27p; 1500, 30p; 2200, 41p; 3300, 58p; 4700, 64p; **16V:** 10, 40, 47, 68, 7p; 100, 125, 8p; 220, 330, 14p; 470, 16p; 1000, 1500, 20p; 2200, 34p; **10V:** 100, 6p; 640 12p; 1000, 14p.
TAG-END TYPE: 70V: 2000, 98p; 4700, 121p; **50V:** 10,000 245p; **40V:** 2500, 65p; 3300, 4700, 70p; 15,000, 450p; **25V:** 4700, 48p; 2000, 37p; **40V:** 2000+2000, 95p.

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35V: 0·1µF, 0·22, 0·33, 0·47, 0·68, 1·0, 2·2µF, 3·3, 4·7, 6·8. **25V:** 1·5, 10. **20V:** 1·5µF 13p each. **10V:** 22µF, 33, **6V:** 22µF, 47, 68, **3V:** 100µF 20p each. **10V:** 100µF 30p. **16V:** 47, 100µF 40p

MYLAR FILM CAPACITORS
100V: 0·001, 0·002, 0·005, 0·01µF 6p
0·015, 0·02, 0·03, 0·04, 0·05, 0·056µF 7p
0·1µF, 0·2 9p. **50V:** 0·47µF 11p

CERAMIC CAPACITORS 50V.
Range: 0·5pF to 10nF 3p
15nF, 22nF, 33nF, 47nF, 4p. 100nF 6p

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10pF to 1nF, 8p. 1·5nF to 47nF, 10p.

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Carbon Track, 0·25W Log & 0·5W Linear values
500Ω, 1K & 2K (LIN ONLY) Single 27p
5KΩ–2MΩ single gang 27p
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3·3, 4·7, 6·8, 10, 12, 18, 22, 27, 33, 47, 50, 68, 75, 82, 85, 100, 120, 150, 200, 250 9p each. 300, 330, 360, 390, 600 & 820pF 16p each. 1000, 2200pF 20p each.	S-DEC	325p*
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	U-DEC 'A'	450p*
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Dielectric 100/300pF	140p	0 2 365pF with motion Drive	slow 325p
500pF	165p	00 208/176	285p
6:1 Ball Drive 4511/DAF	115p*	" " with motion drive	slow 325p
Dial Drive 4103 6:1/36:1	650p*	C804–5pF; 10; 15; 25; 50pF	175p*
Drum 54mm	30p*	100, 150pF	215p*
0-1-365pF	245p	'L' 3x310pF	495p
00 2 365pF	275p	00-3x25pF	430p

TRIMMERS mini
2·5–6pF; 3–10pF; 3–30pF; 10–40pF 22p
6–28pF; 65pF; 88pF 30p

COMPRESSION
3–40pF; 10–80pF 22p
28–200pF 33p
100–500pF 45p

AUDIBLE Warning
Buzzers 6V or 12V 65p*

RF CHOKES
1 µF, 4·7, 10, 22, 47, 100, 220, 470, 750, 1mH, 2·5, 5, 10mH 35p

CRYSTALS

100KHz	385p
455KHz	385p
1MHz	323p
1·80MHz	385p
1·6MHz	395p
3·2768MHz	323p
4·0MHz	323p
4·032MHz	323p
4·433619M	135p
5·0MHz	355p
8·083333M	275p
18MHz	395p

TRANSFORMERS* (Mains Prim. 220-240V)
6-0-6V 100mA; 9-0-9V 75mA; 12-0-12V 100mA 95p.
8VA type: 6V-·5A 6V-·5A; 9V-·4A 9V-·4A; 12V-·3A 12V-·3A; 15V ·25A 15V-·25A 195p.
12VA; 4·5V-1·3A 4·5V-1·3A; 6V-12A 6V-1·2A 12V-·5A 12V-·5A; 15V- ·4A 15V-·4A 20V- ·3A 20V-·3A (20p p&p) 220p
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50VA: 6V-4A 6v-4A; 9V-2·5A 9V-2·5A; 12V-2A 12V-2A; 15V-1·5A 15V-1·5A; 20V-1·2A 20V-1·2A; 25V-1A 25V-1A; 30V-·8A 30V-·8A (50p p&p) 350p.
100VA: 12V-4A 12V-4A; 15V-3A 15V-3A; 20V-2·5A 20V-2·5A; 30V-1·5A 30V-1·5A; 40V-1·25A 40V-1·25A; 50V-1A 50V-1A (80p p&p) 650p
(N.B. P&P charge to be added above our normal postal charge.)

DENCO COILS
Dual Purpose 'DP' VALVE TYPE
Ranges: 1–5 Bi. Yl. Rd. Wht. 85p
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'T' type (Transistor Tuning).
Ranges: 1–5 Bi. Yl. Rd. Wht. 92p

B9A Valve Base 25p
RDT2 82p
RFC 5 chokes 91p
RFC 7(19mH) 96p
1FT 13/14/15/16 17 85p
1FT 18/1·6 or 465 99p
TOC1 86p
MW 5FR 82p
MW/LW 5FR 103p

RESISTORS–Erie make 5% carbon
Miniature High Stability, Low Noise

	RANGE	Val.	1–99	100+
0·25W	2·2Ω–4·7M	E24	1·5p	1p
0·5W	2·2Ω–4·7M	E12	2p	1·5p
1W	2·2Ω–10M	E12	5p	4p
2% Metal Film	10Ω–1M	E96	6p	4p
1% 0·5W	51Ω–1M	E24	10p	8p

COMPUTER HARDWARE:–

2101	99p	4047	750p
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2111	175p	74S287	325p
2112–2	295p	74S470	325p
2114	650p	74S475	825p
2708	650p	81LS95	70p
27LO8	995p	81LS96	70p
2716	1650p	81LS97	109p
TMS6011	325p	MC1488	85p
4027	190p	MC1489	90p

LINEAR IC'S

702	75	LM301A*	30	NE571	450
709C 8 pin	35	LM304*	240	RC4136D	120
723* 14 pin	45	LM308T	110	SG3402*	295
741* 8 pin	22	LM311H*	120	SN72710*	43
747C 14 pin	75	LM318H*	205	SN72733*	125
748C 8 pin	38	LM318S*	195	SN76003N	175
753 8 pin	150	LM324A	79	SN76013N	140
810	150	LM339	86	SN76013ND	120
AY-1-0212	580	LM348	95	SN76018*	148
AY-1-1313A	650	LM349	125	SN76023N	148
AY-1-1320	395	LM370*	375	SN76023ND	111
AY-1-5050	180	LM380	85	SN76033N	175
AY-1-5051	145	LM381N	145	SN76115N	215
AY-1-6721/6	185	LM381AN	248	SN76131*	110
AY-3-8500*	390	LM382	125	SN76227N	116
AY-5-1224A*	260	LM732	125	SN76477*	225
AY-5-1230*	450	LM1458*	50	TAA621AX1	228
AY-5-1315	560	LM3900*	60	TAA661A	158
AY-5-1317A	638	LM3909N*	78	TAA960	390
AY-5-3500*	918	LM3911*	125	TAD100	150
AY-5-4007D	650	M282AA*	750	TBA120S	70
AY-5-8100*	735	M253AA*	785	TBA540	215
CA3011*	82	MC1303	88	TBA550Q	330
CA3014*	137	MC1304P	260	TBA641-A12/	
CA3018*	68	MC1310P	149	BX1 or BX11	250
CA3020	178	MC1312PQ	185	TBA651	180
CA3023	178	MC1496L	82	TBA800	98
CA3028A*	80	MC1495	395		
CA3035	240	MC3340P*	128	TBA810S	99
CA3036	110	MC3360P	158	TBA820	70
CA3043	190	MC3401	70	TBA920Q	280
CA3045	140	MEM780	295	TCA965*	120
CA3046	70	MFC4000B	85	TDA1022	575
CA3048	200	MFC6040*	97	TDA2020	320
CA3075	175	MK50362*	850	TLO61C*	76
CA3080E*	70	MK50398*	635	TLO62CP*	125
CA3081	190	MM57160*	620	TLO64CN*	199
CA3089E	210	NE544	185	TLO71*	70
CA3090AQ	375	NE555*	29	TLO71CP*	78
CA3123	200	NE556DB*	60	TLO72CP*	125
CA3130*	85	NE560*	325	TLO74CN*	199
CA3140	70	NE561*	395	TLO84CND*	
ICL7106*	752*	NE562B*	410	TLO81CP*	48
ICL7107*	975	NE564*	425	TLO82CP*	84
ICL8038CC*	335	NE565A*	120	TLO84CP*	130
ICM7205*	1150	NE566*	160	UAA170	198
LD130*	452	NE567V*	170	ZN414	90
LM300H	178	NE570TBA		ZN424E	130
				ZN425E*	410

TTL 74* (TEXAS)

7400	13	7474	27	74153	64	74LS47	90
7401	13	7475	38	74154	96	73	96
7402	14	7476	36	74155	53	74	41
7403	14	7480	48	74156	80	75	49
7404	14	7481	86	74157	67	83	115
7405	18	7482	69	74159	210	90	80
7406	38	7483	72	74160	82	96	116
7407	38	7484	95	74161	92	107	44
7408	17	7485	106	74162	92	132	95
7409	17	7486	31	74163	92	139	85
7410	15	7489	210	74164	105	151	96
7411	20	7490	53	74165	105	153	76
7412	17	7491	75	74166	105	155	96
7413	30	7492	38	74167	198	156	96
7414	51	7493	32	74170	230	157	76
7416	30	7494	78	74172	825	158	96
7417	38	7496	65	74173	170	160	128
7420	16	7498	57	74174	87	161	98
7421	29	7497	180	74175	87	162	138
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7423	27	74104	62	74177	78	164	114
7425	27	74105	62	74180	85	174	106
7426	38	74107	29	74181	165	175	110
7427	27	74109	64	74182	90	181	318
7428	35	74110	54	74184	135	190	140
7430	17	74111	68	74185	135	191	140
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74LS*

74LS00	18	74LS20	18
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CMOS*

4000	15	4001	17
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4012	18	4066	58
4013	42	4067	380
4014	86	4068	22
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4016	45	4070	32
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4018	89	4072	21
4019	48	4073	21
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4022	88	4077	48
4023	20	4078	21
4024	66	4081	20
4025	19	4082	21
4026	180	4085	74
4027	45	4086	73
4028	81	4089	150
4029	99	4093	85
4030	58	4094	190
4031	205	4096	105
4032	100	4097	372
4033	145	4098	110
4034	196	4099	145
4035	111	4160	109
4036	325	4161	108
4037	108	4162	108
4038	108	4163	109
4039	320	4174	110
4040	195	4175	98
4041	80	4194	108
4042	75	4408	720
4043	84	4409	720
4044	88	4410	720
4045	145	4411	1040
4046	128	4412V	1380
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4048	88	4415V	795
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4051	72	4433	1099
4052	73	4435	825
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4063	110	4501	17

4502	120	4585	101
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4536	388		
4538	160		
4539	110		
4541	150		
4543	175		
4549	396		
4553	449		
4554	152		
4556	78		
4557	451		
4558	117		
4559	388		
4560	208		
4561	65		
4562	533		
4566	159		
4568	298		
4569	350		
4572	25		
4580	604		
4581	409		
4585	101		

TRANSISTORS

	p		p		p		p		p		p		p
AC107*	23	BC170	17	BF167	25	MPSA55	24	TIP3055*	60	2N2160*	350
AC117*	35	BC171	11	BF173*	25	MPSA56	24	TIS43	36	2N2217*	48
AC125*	20	BC172	10	BF177*	24	MPSA70	34	TIS44	45	2N2218A*	31
AC126*	20	BC173	12	BF178*	25	MPSU02	58	TIS45	45	2N2219A*	22
AC127*	20	BC177*	17	BF179*	30	MPSU05	48	TIS46	45	2N2220A*	26
AC128*	20	BC178*	17	BF180*	30	MPSU06	54	TIS47	50	2N2221A	23
AC141*	24	BC179*	17	BF181*	30	MPSU52	65	TIS48	50	2N2222A*	20
AC141K*	38	BC182	9	BF182*	30	MPSU55	53	TIS49	50	2N2303*	45
AC142*	24	BC183	9	BF183*	30	MPSU58	56	TIS50	47	2N2368*	21
AC142K*	38	BC184	9	BF184*	30	MPU131*	39	TIS60	45	2N2369A*	15
AC176*	18	BC182L	10	BF194	10	OC23*	150	TIS62	45	2N2483*	28
AC187*	20	BC183L	10	BF195	10	OC25*	120	TIS74	47	2N2484*	30
AC188*	20	BC184L	10	BF196	10	OC26*	150	TIS90	18	2N2646*	48
ACY17	35	BC186	21	BF197	10	OC28*	99	TIS91	22	2N2784	55
ACY18	40	BC187*	28	BF198	18	OC29*	160	ZTX107	11	2N2904*	22
ACY19	40	BC212	9	BF199	18	OC35*	80	ZTX108	11	2N2905A*	20
ACY20	40	BC212L	10	BF200*	32	OC36*	99	ZTX109	11	2N2906*	18
ACY21	35	BC213	9	BF224A	18	OC41*	48	ZTX212	28	2N2907*	20
ACY22	40	BC213L	11	BF244	24	OC42*	32	ZTX300	13	2N2907A*	22
ACY28	40	BC214	9	BF244B	30	OC43*	55	ZTX301	16	2N2926G	10
ACY39	78	BC214K	14	BF256*	50	OC44*	31	ZTX302	18	2N3011*	24
AD149*	70	BC214L	10	BF257*	26	OC45*	20	ZTX303	21	2N3053*	20
AD161*	42	BC307B	14	BF258*	30	OC46*	28	ZTX304	24	2N3054*	49
AD162*	42	BC308	13	BF259*	32	OC70*	19	ZTX311	17	2N3055*	55
AF106	70	BC327	15	BF336	30	OC71*	25	ZTX314	24	2N3108	39
AF114*	25	BC328	12	BF394	22	OC72*	30	ZTX320	30	2N3442*	131
AF115*	25	BC338	12	BF594	40	OC74*	45	ZTX326	40	2N3563	20
AF116*	25	BC441*	30	BF595	38	OC75*	45	ZTX341	20	2N3614*	169
AF117*	25	BC461*	30	BFR39	25	OC76*	36	ZTX500	13	2N3615*	135
AF118*	55	BC477*	25	BFR40	25	OC77*	76	ZTX501	14	2N3663*	24
AF121*	48	BC547	11	BFR41	28	OC79*	76	ZTX502	19	2N3702	10
AF124*	55	BC548	11	BFR79	28	OC81D*	28	ZTX503	15	2N3703	11
AF125*	35	BC549C	13	BFR80	28	OC82D*	48	ZTX504	25	2N3704	10
AF126	55	BC557	13	BFR81	28	OC83*	48	ZTX531	25	2N3705	11
AF127*	35	BC558	12	BFR98	105	OC84*	44	ZTX550	25	2N3706	10
AF139*	55	BC559	20	BFX29*	26	OC122*	48	40250*	85	2N3707	10
AF178*	70	BCY30*	57	BFX84*	24	OC123*	48	40251*	97	2N3708	10
AF180*	70	BCY34*	75	BFX85*	24	OC139*	85	40311*	50	2N3709	10
AF239*	42	BCY39*	80	BFX86*	28	OC140*	85	40313*	125	2N3710	16
AFZ12	126	BCY40*	78	BFX87*	28	OC141*	85	40315*	55	2N3711	10
ASY26*	40	BCY42	48	BFX88*	24	OC170*	40	40316*	85	2N3772*	170
ASY27*	45	BCY43	75	BFY18*	50	OC171*	40	40317*	52	2N3773*	288
ASY50*	95	BCY58	22	BFY50*	20	OC200*	48	40319*	71	2N3819	22
ASY75*	95	BCY59	22	BFY51*	20	OC201*	75	40320*	56	2N3820	32
ASY76*	95	BCY70*	15	BFY52*	20	OC202	85	40323*	60	2N3823*	65
BC107*	9	BCY71*	17	BFY53*	28	OC203*	85	40324*	85	2N3824*	70
BC107B*	10	BCY72*	17	BFY55*	45	OC204*	85	40326*	52	2N3866*	90
BC108*	9	BCY78*	20	BFY64*	40	SJE5039*	95	40327*	62	2N3903	18
BC108B*	12	BCZ10	145	BFY71*	20	TIP29	43	40347*	80	2N3904	18
BC108C*	12	BCZ11	145	BLY83*	649	TIP29A	44	40348*	101	2N3905	18
BC109	9	BD112	95	BSX20*	18	TIP29B	56	40360*	43	2N3906	17
BC109B*	12	BD115*	62	BSX26*	75	TIP29C	60	40361*	45	2N4037*	52
BC109C*	12	BD121*	95	BSX29*	45	TIP30	47	40362*	48	2N4041*	80
BC113	17	BD123*	98	BSX78*	55	TIP30A	47	40406*	65	2N4058*	17
BC114	19	BD124*	115	BSY95A	25	TIP30B	64	40407*	50	2N4061	17
BC115	19	BD131*	38	BU105*	140	TIP30C	65	40408*	75	2N4062	13
BC116	19	BD132*	38	BU205	190	TIP31*	40	40411*	285	2N4064*	120
BC117	15	BD133*	43	BU208	228	TIP31A*	40	40412*	63	2N4069	45
BC118	19	BD135*	36	E421	96	TIP31B*	40	40467*	95	2N4236	145
BC119*	26	BD136*	37	MD8001	158	TIP31C*	65	40594*	80	2N4286	20
BC134	19	BD137*	36	ME1120	25	TIP32*	45	40595*	90	2N4289	20
BC135	20	BD138*	36	ME4102	10	TIP32A*	49	40603*	58	2N4427*	75
BC136	18	BD139*	45	ME6002	14	TIP32B*	70	40636*	125	2N4859	65
BC137	20	BD140*	50	MJ400*	90	TIP32C*	70	40673*	68	2N4922*	55
BC140*	28	BD142*	59	MJ491*	190	TIP33*	80	2N697*	21	2N5135	42
BC142*	25	BD144*	198	MJ2955*	95	TIP33A*	80	2N698*	39	2N5136	42
BC143*	25	BD145*	198	MJE340*	50	TIP33B*	100	2N699*	39	2N5138	29
BC147	7	BD181*	85	MJE370*	55	TIP33C*	105	2N706A*	18	2N5172	24
BC147B	10	BD205*	110	MJE371*	60	TIP34*	85	2N707*	50	2N5179*	80
BC148	7	BD222	80	MJE520*	45	TIP34A*	85	2N708*	19	2N5180*	80
BC148B	10	BD378*	65	MJE521*	65	TIP34B*	110	2N914*	32	2N5191*	65
BC148C	10	BD434	42	MJE2955*	89	TIP34C*	110	2N916*	27	2N5305*	24
BC149	8	BD517*	85	MJE3055*	70	TIP35*	219	2N918*	30	2N5457	32
BC149C	10	BD695A*	75	MPF102	30	TIP35A*	225	2N930*	31	2N5458	32
BC153	14	BD696A*	75	MPF103	38	TIP35B*	240	2N1131*	22	2N5459	32
BC154	14	BDY11	220	MPF104	36	TIP35C*	270	2N1132*	22	2N5485	32
BC157	10	BDY17*	195	MPF105	36	TIP36*	280	2N1303*	50	2N5642*	750
BC158	11	BDY56*	156	MPF106	50	TIP36A*	265	2N1304*	50	2N5777	56
BC159	11	BDY60*	110	MPF107	50	TIP36B*	300	2N1305*	28	2N6027	49
BC160*	27	BDY61*	165	MPS3904	40	TIP36C*	325	2N1306*	35	2N6109	45
BC167A	11	BF115*	22	MPSA05	24	TIP41A*	63	2N1307*	50	3N128	85
BC168C	12	BF154*	23	MPSA06	24	TIP41B*	73	2N1308*	46	3N140	85
BC169C	10	BF161	60	MPSA12	42	TIP42A*	64	2N1613*	23	**Matched Pair**	
						TIP42B*	82	2N1670*	150	10p extra	
						TIP2955*	63	2N1671B*	195		

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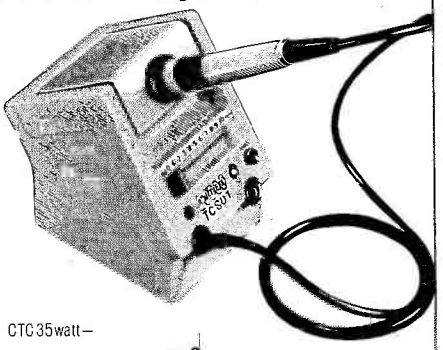
Now heat to any level

between 145°–400°c

(with accuracy of 2%)

Model TCSU1 Soldering Station



CTC 35 watt—

The TCSU1 soldering station with either the XTC 50 watt—24/26 volt soldering iron or the CTC 35 watt—soldering iron for pin point precision and exceptionally fast recovery time. We have put at least twice as much power into irons which are already well known for good recovery time. The temperature control stops them from over-heating; the "fail-safe" electronic circuit provides protection even if the thermocouple fails. TCSU1 soldering station **£38.10**. XTC and CTC irons **£14.85** inclusive of VAT and P.&P.

Model CX - 17 watts

... a miniature iron with the element enclosed first in a ceramic shaft, then in a stainless steel. Virtually leak free. Only 7½" long. Fitted with a 3/32" bit **£4.37** inclusive of VAT and P.&P. Range of 5 other bits available from ⅛" down to 3/64".

Model X25 - 25 watts

A general purpose iron also with a ceramic and steel shaft to give you toughness combined with near-perfect insulation. Fitted with 1/8" bit and priced at **£4.37** inclusive of VAT and P.&P. Range of 4 other bits available.

Model SK3 Kit

Contains both the model CX230 soldering iron and the stand ST3. Priced at £6.21 inclusive of VAT and P.&P. It makes an excellent present for the radio amateur, modelmaker or hobbyist.

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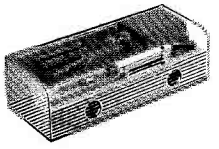

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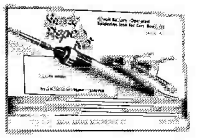

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