EVERYDAY ELECTRONICS

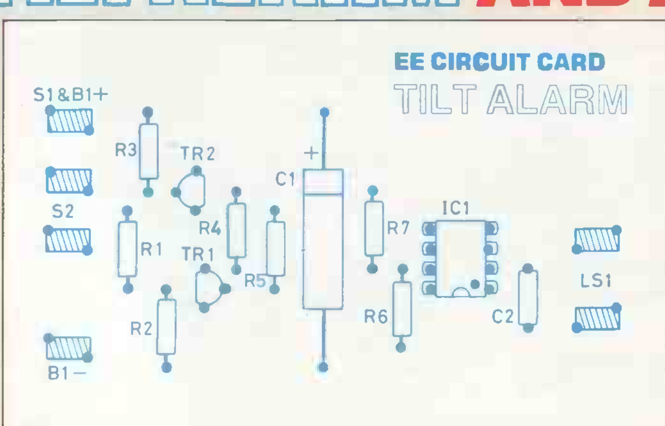
JANUARY 1989

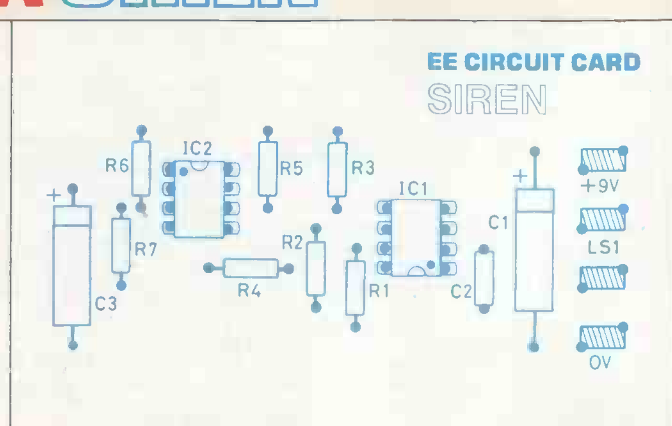
INCORPORATING ELECTRONICS MONTHLY

£1.30

CLASS ONE SOUND DM20 HI FI AMPLIFIER

FREE CIRCUIT CARDS TO BUILD A TILT ALARM AND A SIREN





The Magazine for Electronic & Computer Projects

No. 1 LIST BAKERS DOZEN PACKS

All packs are £1 each, if you order 12 then you are entitled to another free. Please state which one you want. Note the figure on the extreme left of the pack ref number and the next figure is the quantity of items in the pack, finally a short description.

BD2	5	13A spurs provide a fused outlet to a ring main where devices such as a clock must not be switched off.
BD7	4	In flex switches with neon on/off lights, saves leaving things switched on.
BD9	2	6V 1A mains transformers upright mounting with fixed clamps.
BD11	1	6½in speaker cabinet ideal for extensions, takes our speaker. Ref BD137.
BD13	12	30 watt reed switches, it's surprising what you can make with these—burglar alarms, secret switches, relay, etc., etc.
BD22	2	25 watt loudspeaker two unit crossovers.
BD29	1	B.O.A.C. stereo unit is wonderful value.
BD30	2	Nicad constant current chargers adapt to charge almost any nicad battery.
BD32	2	Humidity switches, as the air becomes damper the membrane stretches and operates a microswitch.
BD34	48	2 meter length of connecting wire all colour coded.
BD42	5	13A rocker switch three tags so on/off, or change over with centre off.
BD45	1	24hr time switch, ex-Electricity Board, automatically adjust for lengthening and shortening day. original cost £40 each.
BD49	10	Neon valves, with series resistor, these make good night lights.
BD56	1	Mini uniselector, one use is for an electric jigsaw puzzle, we give circuit diagram for this. One pulse into motor, moves switch through one pole.
BD59	2	Flat solenoids—you could make your multi-tester read AC amps with this.
BD67	1	Suck or blow operated pressure switch, or it can be operated by any low pressure variation such as water level in water tanks.
BD91	1	Mains operated motors with gearbox. Final speed 16 rpm, 2 watt rated.
BD103A	1	6V 750mA power supply, nicely cased with mains input and 6V output leads.
BD120	2	Stripper boards, each contains a 400V 2A bridge rectifier and 14 other diodes and rectifiers as well as dozens of condensers, etc.
BD122	10m	Twin screened flex with white pvc cover.
BD128	10	Very fine drills for pcb boards etc. Normal cost about 80p each.
BD132	2	Plastic boxes approx 3in cube with square hole through top so ideal for interrupted beam switch.
BD134	10	Motors for model aeroplanes, spin to start so needs no switch.
BD139	6	Microphone inserts—magnetic 400 ohm also act as speakers.
BD148	4	Reed relay kits, you get 16 reed switches and 4 coil sets with notes on making c/o relays and other gadgets.
BD149	6	Safety cover for 13A sockets—prevent those inquisitive little fingers getting nasty shocks.
BD180	6	Neon indicators in panel mounting holders with lens.
BD193	6	5 amp 3 pin flush mounting sockets make a low cost disco panel.
BD196	1	in flex simmerstat—keeps your soldering iron etc. always at the ready.
BD199	1	Mains solenoid, very powerful, has 1in pull or could push if modified.
BD201	8	Keyboard switches—made for computers but have many other applications.
BD210	4	Transistors type 2N3055, probably the most useful power transistor.
BD211	1	Electric clock, mains operated, put this in a box and you need never be late.
BD221	5	12V alarms, make a noise about as loud as a car horn. Slightly soiled but OK.
BD242	2	6in x 4in speakers, 4 ohm made from Radiomobile so very good quality.
BD252	1	Panostat, controls output of boiling ring from simmer up boil.
BD259	50	Leads with push-on ¼in tags—a must for hook-ups—mains connections etc.
BD263	2	Oblong push switches for bell or chimes, these can mains up to 5 amps so could be foot switch if fitted into pattress.
BD268	1	Mini 1 watt amp for record player. Will also change speed of record player motor.
BD283	3	Mild steel boxes approx 3in x 3in x 1in deep—standard electrical.
BD293	50	Mixed silicon diodes.
BD305	1	Tubular dynamic mic with optional table rest.

Most other packs still available and you can choose any as your free one.

VERY POWERFUL 12 VOLT MOTORS—⅓rd HORSEPOWER Made to drive the Sinclair C5 electric car but adaptable to power a go-kart, a mower, a rail car, model railway, etc. Brand new. Price £15.00 plus £2.00 postage. Our ref. 158.

OVER 400 GIFTS YOU CAN CHOOSE FROM

There is a total of over 400 packs in our Baker's Dozen range and you become entitled to a free gift with each dozen packs.
A classified list of these packs and our latest "News Letter" will be enclosed with your goods, and you will automatically receive our next news letter.

ATARI 65XE COMPUTER At 64K this is most powerful and suitable for home and business. Brand new, complete with PSU, TV lead, owner's manual and six games. Can be yours for only £45 plus £3 insured delivery.

DATA RECORDERS ACORN for Acorn Electron, etc., reference number ALF03, with TV lead, manual and PSU. Brand new. Price £10 plus £1.50 post. Order ref 10P44.

ATARI XC12 for all their home computers. With leads and handbook. Brand new. Price £10 plus £2 post. Order ref 10P53.

JOYSTICK FOR ATARI OR COMMODORE for all Atari and Commodore 64 and Vic20. New. Price £5. Order ref 5P126.

EXTRA SPECIAL OFFER We will supply the Atari 65XE, data recorder XC12, joystick and six games for £57.50 plus £4 insured delivery.

SUB-MIN TOGGLE SWITCH Body size 8mm x 4mm x 7mm SBDT with chrome dolly fixing nuts. 4 for £1. Order Ref. BD649.

VENNER TIME SWITCH. Mains operated with 20 amp switch, one on and off per 24 hrs. repeats daily automatically correcting for the lengthening or shortening day. An expensive time switch but you can have it for only £2.95 without case, metal case—£2.95, adaptor kit tc convert this into a normal 24hr. time switch but with the added advantage of up to 12 on/offs per 24hrs. This makes an ideal controller for the immersion heater. Price of the adaptor kit is £2.30.

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

RE-CHARGEABLE NICADS 'D' SIZE
These are tagged for easy joining together but tags, being spot welded, are easy to remove. Virtually unused, tested and guaranteed. £2.00 ref 2P141 or 6 wired together for £10.00 ref 10P47.

RECORD PLAYER DECK BRS, 12volt operated, belt driven with an 11in turntable, stereo cartridge. It will play 7in-10in or 12in individually at either 45rpm or 33rmp. Fitted speed selector and pick-up cueing lever. Price £12 plus £3 postage. Order ref 12P4.

2.5kw TANGENTIAL BLOW HEATER has an approximate width of 3in. (plus motor), elements made up of two 1.2kw sections so with switch available you can have 2.5kw, 1.2kw or cold blow. Over-heat cutout eliminates fire risk should fan stop or air flow be impeded. Fan blades are metal. Price £5 plus £2.50 post. Our ref 5P62. Switch 50p.

ALBA TWIN CASSETTE RECORDER AND PLAYER WITH STEREO RADIO This is a mains/battery portable made to sell, we understand, at about £50 but the ones we have are line rejects. They are brand new still in the manufacturers' boxes but have a slight defect associated with the cassette section. The radio and amplifier section, both mono and stereo, is perfectly OK. If you are handy at mending things then this should be for you. Price £20 or two for £38 plus £3 insured post, either package. Our ref 20P7 or 2 x 20P7.

LASER TUBE

Made by Philips Electrical. New and unused. This is helium-neon and has a typical power rating of 1.6mW. It emits random polarised light and is completely safe provided you do not look directly into the beam when eye damage could result. DON'T MISS THIS SPECIAL BARGAIN! Price £29.95 plus £3 insured delivery.

POWER SUPPLY FOR PHILIPS LASER is now available in kit form, Price £15 plus £2 postage, or made-up ready-to-use at £20 plus £2.50 postage. Our ref 13P1 for the kit and 18P1 for the made-up version.

PAPST AXIAL FAN—MANUFACTURERS REF NO. TYP4580N.
This is mains operated. 15 watt rating and in a metal frame with metal blades so OK in high temperatures. Body size approx. 4¾" square x 1⅝" thick. £6.00 each, plus £1.00 postage. Our ref 6P6.

VERY POWERFUL MAGNETS Although only less than 1" long and not much thicker than a pencil these are very difficult to pull apart. Could be used to operate embedded reed switches, etc. Price 50p each, 2 for £1.00. Ref BD642.

ORGAN MASTER is a three octave musical keyboard. It is beautifully made, has gold plated contacts and is complete with ribbon cable and edge connector. Brand new, only £12 plus £3 postage. Order ref. 12P5.

MUSIC FROM YOUR SPECTRUM 128 We offer the Organ Master three octave keyboard, complete with leads and the interface which plugs into your 128. You can then compose, play, record, store, etc., your own music. Price £19 plus £3 special packing and postage. Order ref. 19P1.

20A DOUBLE POLE RELAY WITH 12V COIL complete with mounting brackets. made by the Japanese Omron Company. Price £2 each. Our Ref. 2P173A.

TORROIDAL MAINS TRANSFORMER with twin outputs. 6.3V 2A and 12V 600mA, so ideal for FDD power supply. Price £5. Our Ref. 5P122.

DOUBLE MICRO CASSETTE DECK made by the Japanese ABS company. This takes two micro cassettes and is complete with motors solenoids to select the deck to use and record and playback heads Price £10. Our Rel. 10P49.

QUICK FIX MAINS CONNECTOR A must for your workshop. Saves putting on plugs as you just push the wires under the spring clips. Automatically off when lid is up. Price £7.50. Our Ref. 7P5/1.

BT HANDSET with curly lead terminating with flat BT plug. Colour cream. Price £5. Our Ref. 5P123.

J & N BULL ELECTRICAL
Dept. E.E., 250 PORTLAND ROAD, HOVE, BRIGHTON, SUSSEX BN3 5QT

MAIL ORDER TERMS: Cash, PO or cheque with order. Orders under £20 add £1.50 service charge. Monthly account orders accepted from schools and public companies. Access and B/card orders accepted.
Brighton (0273) 734648 or 203500

POPULAR ITEMS
Some of the many items described in our current list which you will receive if you request it

3½in FDD CHINON 80 track 500k. Shugart compatible interface. Standard connections, interchangeable with most other 3½in and 5¼in drives. Brand new. £28.50 plus £3 insured post.

CASE NOW AVAILABLE FOR THE CHINON F353 This is the 80 track, single sided one which we have been selling at £28.50. The case is sheet metal, finished in hammer-beige with ample ventilation and rubber feet. Overall size 4¼in x 7in x 1½in approx. Designed to take the ribbon cable and 3 core power lead. Price £8. Our ref 8P21.

3in FDD HITACHI HFD305SXA Shugart compatible interface. 500k on 3in disc. Recommended for many Amstrads but interchangeable with most drives. £29.50 plus £3 insured post.

FDD CASE AND POWER SUPPLY KIT for the 3in or 3½in. £11.00. Ref 11P2 for the Chinon, 11P3 for the Hitachi.

9in MONITOR made for ICL, uses Phillips black and white tube. Brand new and complete but uncased. £16.00 plus £5.00 post.

ACORN COMPUTER DATA RECORDER REF ALF03 Made for the Electron or BBC computers but suitable for most others. Complete with mains adaptor, leads and handbook. £10.00. Ref 10P44.

POWERFUL IONISER Uses mains transformer. Generates approx. 10 times more ions than the normal diode/cap ladder circuits. Complete kit £11.50 plus £3.00 post.

FREE POWER! Can be yours if you use our solar cells—sturdily made modules with new system bubble magnifiers to concentrate the light and so eliminate the need for actual sunshine—they work just as well in bright light. Voltage input is .45—you join in series to get desired voltage—and in parallel for more amps. **Module A** gives 100mA, Price £1, Our ref. BD631. **Module C** gives 400mA, Price £2, Our ref. 2P199. **Module D** gives 700mA, Price £3, Our ref. 3P42.

SOLAR POWERED NI-CAD CHARGER 4 Ni-Cad batteries AA (HP7) charged in eight hours or two in only 4 hours. It is a complete, boxed ready to use unit. Price £6. Our ref. 6P3.

50V 20A TRANSFORMER 'C' Core construction so quite easy to adapt for other outputs—tapped mains input. Only £25 but very heavy so please add £5 if not collecting. Order Ref. 25P4.

SWITCH AC LOADS WITH YOUR COMPUTER This is easy and reliable if you use our solid state relay. This has no moving parts, has high input resistance and acts as a noise barrier and provides 4kW isolation between logic terminals. The turn-on voltage is not critical, anything between 3 and 30V, internal resistance is about 1K ohm. AC loads up to 10A can be switched. Price is £2 each. Ref. 2P183.

METAL PROJECT BOX Ideal size for battery charger, power supply, etc.; sprayed grey, size 8in x 4¼in x 4in high, ends are louvred for ventilation other sides are flat and undrilled. Price £2. Order ref. 2P191.

BIG SMOOTHING CAPACITOR. Sprague powerlytic 39,000uF at 50V. £3. Our ref. 3P41.

4-CORE FLEX CABLE. Cores separately insulated and grey PVC covered overall. Each copper core size 7/0.2mm. Ideal for long telephone runs or similar applications even at mains voltage. 20 metres £2. Our ref.2P196 or 100 metres coil £8. Order ref. 8P19.

6-CORE FLEX CABLE. Description same as the 4-core above. Price 15 metres for £2. Our ref. 2P197 or 100 metres £9. Our ref. 9P1.

TWIN GANG TUNING CAPACITOR. Each section is .0005uF with trimmers and good length ¼in spindle. Old but unuse3d and in very good condition. **£1 each.** Our ref. BD630

13A PLUGS Pins sleeved for extra safety, parcel of 5 for £2. Order ref. 2P185.

13A ADAPTERS Takes 2 13A plugs, packet of 3 for £2. Order ref. 2P187.

20V-0-20V Mains transformers 2½ amp (100 watt) loading, tapped primary. 200-245 upright mountings £4. Order ref. 4P24.

BURGLAR ALARM BELL—6" gong OK for outside use if protected from rain. 12V battery operated. Price £8. Ref. 8P2.

24 HOUR TIME SWITCH—16A changeover contacts, up to 6 on/offs per day. Nicely cased, intebnded for wall mounting. Price £8. Ref. 8P6.

CAPACITOR BARGAIN—axial ended, 4700µF at 25V. Jap made, normally 50p each, you get 4 for £1. Our ref. 613.

PIEZO ELECTRIC FAN—An unusual fan, more like the one used by Madame Butterfly than the conventional type, it does not rotate. The air movement is caused by two vibrating arms. It is American made, mains operated, very economical and causes no interference, so is ideal for computer and instrument cooling. Price is only £1 each. Ref. BD598.

SPRING LOADED TEST PRODS—Heavy duty, made by the famous Bulgin company. very good quality. Price 4 for £1. Ref. BD597.

ASTEC P.S.U.—Switch mode type. Input set for +230V. Output 3.5 amps at +5V, 1.5 amps at +12V, and 3 amps at +5V. Should be OK for floppy disc drives. Regular price £30. Our price only £10. Ref. 10T34. Brand new and unused.

APPLIANCE THERMOSTATS—Spindle adjust type suitable for convector heaters or similar. Price 2 for £1. Ref. BD582.

3-CORE FLEX BARGAIN No. 1—Core size 5mm so ideal for long extension leads carrying up to 5 amps or short leads up to 10 amps. 15mm for £2. ref. 2P189.

3-CORE FLEX BARGAIN No. 2—Core size 1.25mm so suitable for long extension leads carrying up to 13 amps, or short leads up to 25A. 10m for £2. Ref. 2P190.

ALPHA-NUMERIC KEYBOARD—This keyboard has 73 keys giving trouble free life and no contact bounce. The keys are arranged in two groups, the main area is a QWERTY array and on the right is a 15 key number pad, board size is approx. 13" x 4"—brand new but offered at only a fraction of its cost, namely £3, plus £1 post. Ref. 3P27.

WIRE BARGAIN—500 metres 0.7mm solid copper tinned and p.v.c. covered. Only £3 plus £1 post. Ref. 3P31—that's well under 1p per metre, and this wire is ideal for push on connections.

INTERRUPTED BEAM KIT—This kit enables you to make a switch that will trigger when a steady beam of infra-red or ordinary light is broken. Main components—relay, photo transistor, resistors and caps, etc. Circuit diagram but no case. Price £2. Ref. 2P15.

1/8th HORSEPOWER 12 VOLT MOTOR Made by Smiths, the body length of this is approximately 3in, the diameter 3in and the spindle 5/16th of an inch diameter. It has a centre flange for fixing or can be fixed from the end by means of 2 nuts. A very powerful little motor which revs at 3,000rpm. We have a large quantity of them so if you have any projects in mind then you could rely on supplies for at least two years. Price £6. Our ref 6p1, discount for quantities of 10 or more.

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EVERYDAY ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

ABC

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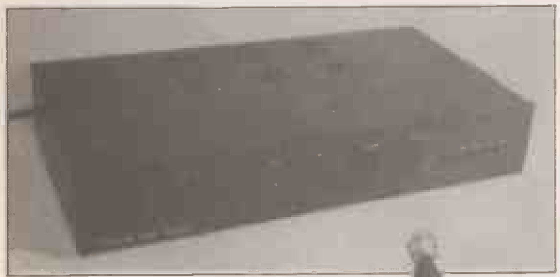
PROJECTS . . . THEORY . . . NEWS . . .
COMMENT . . . POPULAR FEATURES . . .



Seasonal Greetings To All Our Readers

Projects

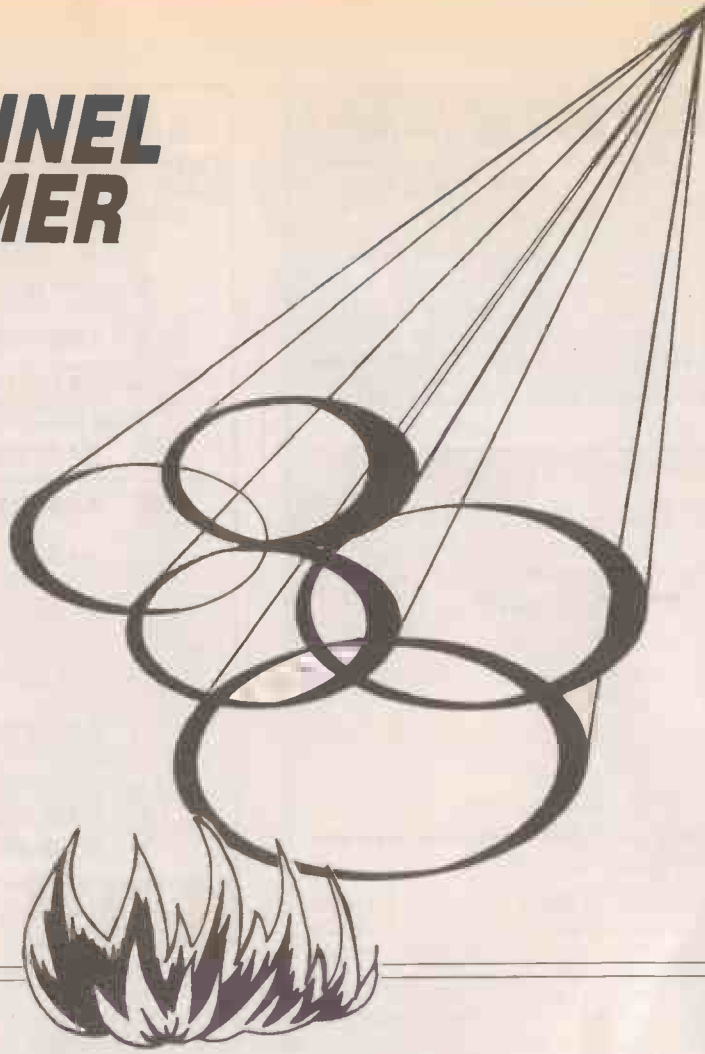
Series

Features

Our February '89 issue will be published on Friday, 6 January 1989. See page 3 for details.

NEXT MONTH

FOUR CHANNEL LIGHT DIMMER



This is a project for constructors who like to experiment, which should include all readers of E.E.! It enables up to four 0-1V d.c. inputs to control 240V a.c. mains lamps from zero to full brilliance, up to 100 watts per channel. As it may be used with all kinds of driving circuitry, safety is a prime consideration and the inputs are totally isolated from the "live" sections through "opto-isolator" chips.

Two seperate interfaces will be described in subsequent issues, these are for a Four Channel Auto-fader and a Four Channel Sound-to-Light unit. Thus a very versatile lighting system can be built up.

FIRE ALARM

Lives and property can be saved by fitting an effective fire alarm system. However, commercially available systems are expensive and very few people think the risk of fire in their house warrants such a large expenditure. There have been quite a few fire alarm projects in electronics magazines over the years, but nearly all depend on using expensive and hard to obtain gas sensors. The alarm to be described uses a simple, cheap and novel method of fire detection, is extremely versatile in that as many detectors as required can be fitted, and will give enough warning to perhaps avoid another tragedy.

SIMPLE PSU

For any electronics amateur a small versatile power supply is probably one of the first items that he or she will consider building. Such a supply should offer a number of outputs so that the unit can be used for both digital and analogue experiments. The p.s.u. to be described provides +and−5V, plus an adjustable 2.5V to 20V dual tracking supply.

EVERYDAY ELECTRONICS

FEBRUARY '89 ISSUE ON SALE JANUARY 6

MAGENTA ELECTRONICS Ltd

PROJECT KITS

Magenta supply Full Kits: Including PCB's (or Stripboard), Hardware, Components, and Cases (unless stated). Please state Kit Reference Number, Kit Title, and Price, when ordering.
REPRINTS: If you do not have the issue of E.E. which includes the project, you will need to order the instruction reprint as an extra: 80p each. Reprints are also available separately–Send £1 in stamps.

REF NO.	KIT-TITLE	PRICE
803	REACTION TIMER Dec. 88	£29.98
802	PHASOR (Light Controller) Dec 88	£25.61
801	DOWNBEAT METRONOME Dec 88	£17.57
800	SPECTRUM EPROM PROGRAMMER Dec 88	£26.97
797	MICRO ALARM Nov 88	£8.81
796	SEASHELL SYNTHESISER Nov 88	£24.99
795	I.R. OBJECT COUNTER Nov 88	£29.63
794	REAR SCREEN ONE-SHOT Nov 88	£11.92
793	DOORBELL DELAY Nov 88	£10.28
792	SOLDERING IRON TEMPERATURE	
	CONTROLLER Oct 88	£9.50
790	EPROM ERASER Oct 88	£24.95
791	BREAKING GLASS ALARM Sept 88	£17.51
789	AMSTRAD PIO Sept 88	£19.98
788	TIME SWITCH Aug 88	£17.61
787	SPIKEATER July 88	£3.99
786	UNIVERSAL NICAD CHARGER July 88	£6.99
785	ISOLINK July 88	£24.51
784	VIDEO WIPER July 88	£33.59
783	HEADLIGHT REMINDER June 88	£7.99
782	DOOR SENTINEL May 88	£12.81
781	SUPER SOUND EFFECTS GENERATOR May 88	£12.99
780	CABLE & PIPE LOCATOR April 88	£15.35
779	STEREO NOISE GATE April 88	£26.98
778	INDUCTIVE PROXIMITY DET. April 88	£8.63
777	LOW FUEL ALERT April 88	£6.43
772	SEMICONDUCTOR TESTER Mar 88	£23.51
776	LIE DETECTOR Mar 88	£11.80
775	ENVELOPE SHAPER Mar 88	£14.99
774	SOS ALERT Mar 88	£9.36
769	VARIABLE 25V-2A BENCH	
	POWER SUPPLY Feb 88	£49.73
	CAR LAMP CHECKING SYST. Feb 88	£7.10
770	GAME TIMER Feb 88	£14.32
765	QUIZMASTER Jan 88	£18.96
767	TRANSISTOR CURVE TRACER (BBC)	£14.98
763	AUDIO SIGNAL GENERATOR Dec 87	£13.64
764	DUAL MAINS LIGHTS FLASHER Dec 87	£20.98
739	ACCENTED BEAT METRONOME Nov 87	£20.95
740	ACOUSTIC PROBE Nov 87	
	(less bolt & probe)	£16.26
741	BBC SIDEWAYS RAM/ROM Nov 87	£27.53
744	VIDEO CONTROLLER Oct 87	£29.14
745	TRANSTEST Oct 87	£9.70
734	AUTOMATIC PORCH LIGHT Oct 87	£17.17
735	CARAVAN FRIDGE ALERT Oct 87	£5.44
736	STATIC MONITOR Oct 87	£8.66
723	ELECTRONIC MULTIMETER Sept 87	£46.96
729	NOISE GATE Sept 87	£23.25
728	PERSONAL STEREO AMP Sept 87	£14.31
730	BURST-FIRE MAINS CONTROLLER Sept 87	£13.57
724	SUPER SOUND ADAPTOR Aug 87	£38.39
718	3 BAND 1.6-30MHz RADIO Aug 87	£26.53
719	BUCCANEER I.B. METAL DETECTOR inc. coils	
	and case, less handle and hardware July 87	£26.45
720	DIGITAL COUNTER/FREQ METER (10MHz)	
	inc.case July 87	£67.07
721	MONOMIX July 87	£21.00
722	FERMOSTAT July87	£12.14
711	VISUAL GUITAR TUNER Jun 87	£22.99
715	MINI DISCO LIGHT Jun 87	£12.59
709	WINDSCREEN WASHER WARNING May 87	£5.12
708	FRIDGE ALARM May 87	£9.88
707	EQUALIZER (IONISER) May 87	£15.53
705	BULB LIFE EXTENDER April 87 (less case)	£5.24
703	EXP. SPEECH RECOGNITION April 87	£20.98
700	ACTIVE I/R BURGLAR ALARM Mar 87	£35.65
581	VIDEO GUARD Feb 87	£8g39
583	CAR VOLTAGE MONITOR Feb 87	£12.58
584	SPECTRUM SPEECH SYNTH. (no ca|Feb 87	£20.92
578	SPECTRUM I/O PORT less case. Feb 87	£9.44
579	STEPPING MOTOR BOOSTER (for above)Feb 87	£5.45
	STEPPING MOTOR MD200 Feb 87	£16.00
575	HANDS-OFF INTERCOM (per station)	
	inc. caseJan 87	£10.49
569	CAR ALARM Dec 86	£12.47
564	CAR FLASHER WARNING Nov 86	£9.37
563	200MHz DIG. FREQUENCY METER Nov 86	£62.98
562	10 WATT AUDIO AMPLIFIER Oct 86	£36.70
561	LIGHT RIDER LAPEL BADGE Oct 86	£10.20
560	LIGHT RIDER DISCO VERSION	£19.62
559	LIGHT RIDER 16 LED VERSION	£13.64
558	SCRATCH BLANKER Sept 86	£55.83
556	INFRA-RED BEAM ALARM Sept 86	£28.35
555	FREEZER FAILURE ALARM Sept 86	£15.50
554	CAR TIMER Sept 86	£8.72

REF NO.	KIT-TITLE	PRICE
553	BATTERY TESTER Aug 86	£7.19
544	TILT ALARM July 86	£7.82
547	SQUEEKIE CONTINUITY TESTER July 86	£3.52
540	PERCUSSION SYNTH June 86	£30.43
542	PERSONAL RADIO June 86	£11.53
543	WATCHDOG June 86	£8.24
529	MINI STROBE May 86	£13.86
528	PA AMPLIFIER May 86	£26.95
523	STEREO REVERB Apr 86	£26.44
524	VERSATILE PSU Apr 86	£24.69
526	FREELOADER Apr 86	£8.48
513	BBC MIDI INTERFACE Mar 86	£27.94
514	INTERVAL TIMER Mar 86	£18.87
515	STEREO HI-FI PRE-AMP	£49.19
512	MAINS TESTER & FUSE FINDER Mar 86	£8.82
503	FUNCTION GENERATOR Feb 86	£24.84
504	POWER SUPPLY FOR ABOVE	£7.62
497	MUSICAL DOOR BELL Jan 86	£18.72
493	DIGITAL CAPACITANCE METER Dec 85	£41.55
481	SOLDERING IRON CONTROLLER Oct 85	£5.47
473	R.I.A.A. PRE-AMP Sept 85	£16.74
464	STEPPER MOTOR INTERFACE FOR THE BBC	
	COMPUTER less case Aug 85	£11.68
	1035 STEPPER MOTOR EXTRA	£14.50
	OPTIONAL POWER SUPPLY PARTS	£5.14
461	CONTINUITY TESTER July 85	£6.20
459	AMSTRAD USER PORT July 85	£17.67
455	ELECTRONIC DOORBELL June 85	£7.56
453	GRAPHIC EQUALISER June 85	£26.94
444	INSULATION TESTER Apr 85	£19.58
432	GAMES TIMER Jan 85	£9.11
430	SPECTRUM AMPLIFIER Jan 85	£6.91
417	DOOR CHIME Dec 84	£18.78
392	BBC MICRO AUDIO STORAGE SCOPE	
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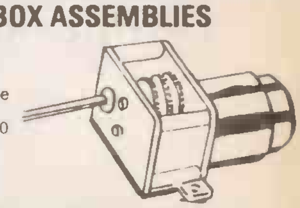

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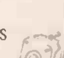

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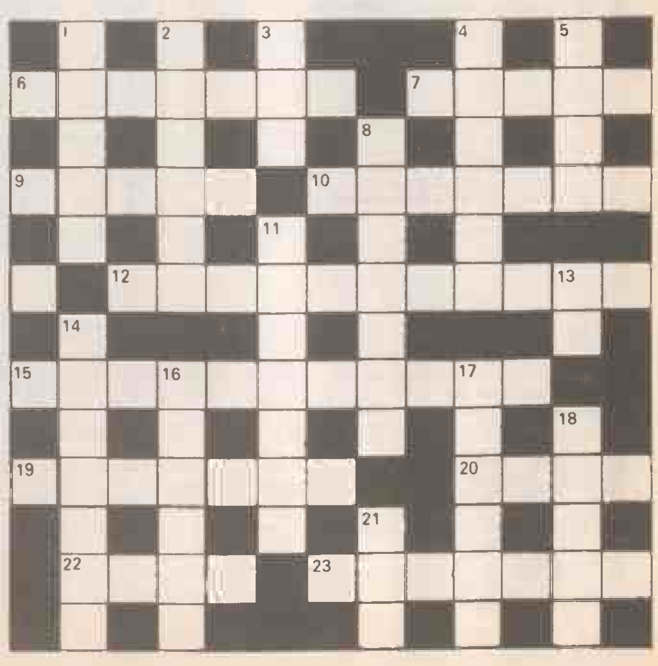
CLUES ACROSS

6 This increases the voltage three-fold (7)
7 Line output sometimes tuned to this harmonic (5)
9 The combining of two files (5)
10 These bars were cured in Germany (7)
12 This circuit removes the carrier (11)
15 Mode of operation for a f.e.t. (11)
19 This sometimes runs away (7)
20 A binary code where only one bit changes at any time (4)
22 Prolonged test (4)
23 The total current in a transistor (7)

CLUES DOWN

1 This colour is equivalent to 59 per cent of peak white (5)
2 High point of a satellite (6)
3 Basic unit in measuring a change in level (3)
4 In short, this carries colour information (6)
5 Branching type of obtaining information (4)
8 No atmosphere in these places? (7)
11 A teletext command to hide (7)
13 and 21 Unit that performs mathematical functions (2,3)
14 Current and voltage are this in a resistive load (2,5)
16 High reluctance space (3,3)
17 To reverse the sign of a numerical quantity (6)
18 Single crystal that is used as a substrate (6)
21 See **13**.

For fun only—answers on page 31



EVERYDAY ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

The Magazine for Electronic & Computer Projects

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BUMPER

A BUMPER issue this month with eight more pages than average issues, just right to keep you busy over the festive season. It seems appropriate at this time to thank all our readers and advertisers for your support over the last year—the staff of *EE* wish you all the very best for 1989.

Even though we have added more pages we are still struggling to get everything in and we have had to split the City and Guilds course and keep the letters from assessment centres until next month. Some centres are still contacting us, so if you have a connection with a centre that is taking outside candidates for 726/301 please drop us a line and we will try and publish it next month.

HI-FI

Another hi-fi amplifier design hits the streets with this issue and we are sure the *Class One Amplifier* will be very popular. This high quality amplifier really does produce an excellent sound for just under £100 in kit form. However, for those whose pockets are not quite so deep we have another stereo design at the testing stage which will cost around £35—you can actually get 30w per channel for that price—so watch out for it in a couple of months.

SUBSCRIPTION PRICES

Sad to say that we are only a couple of months away from a cover price increase—unfortunately costs keep rising (paper in particular seems to go up about three times a year at present). With this in mind our subsription price will rise to £15.70 for U.K. readers and £19 for overseas readers (£36 by airmail) from 1st January, 1989. So if you are quick you can get your next 12 copies for less than the present cover price (and save over £2 on the year's issues), see below for subscription details and act now!

We believe *EE* will still represent the best value for money of any of the monthly electronics hobbyist publications and, thanks to you, *EE* is the U.K.'s best selling magazine in this market.

Mike Kenward

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The law relating to this subject varies from country to country; overseas readers should check local laws.

Constructional Project

PASS-THE-PARCEL

T. R. de VAUX-BALBIRNIE

Electronic variations on this popular children's game.

THE festive party game of "Pass-the-Parcel" has entertained children for generations. In this electronic version, children sit in a circle and pass the parcel from one to another. After some unpredictable time, it buzzes loudly — the child holding it is then "out" and withdraws from the game. Play resumes until only the winner remains.

In the alternative mode, the parcel is activated by vibration. Thus, any child failing to pass it with the greatest of care will activate it. This guarantees a breathing space where harassed parents can relax before resuming the more strenuous activities.

The circuit may be switched to operate by time alone, vibration alone or both modes together. Although strictly a children's game, Pass-the-Parcel can be the source of great amusement at adults' parties, especially after a few Christmas drinks.

CIRCUIT DESCRIPTION

The complete circuit for Pass-the-Parcel is shown in Fig. 1. One half of the dual timer, IC1a, in conjunction with IC2, forms a pseudo-random time generator. This is so called because the times are not really random — they keep repeating but no excited child, or adult, will notice.

When the circuit is switched on using S3, IC1a produces a slow stream of pulses from its output (pin 5). The repetition rate depends on the values of preset VR1, resistor R1 and capacitor C1—VR1 forms the adjustment for this.

These pulses have a large "mark" and a small "space", see Fig. 2a. Transistor TR1 inverts these (a space becomes a mark and vice-versa) so pulses shown in Fig. 2b are obtained at the collector. These pulses are applied to IC2 clock input (pin 14).

IC2 has ten outputs and with the arrival of each pulse, these go high in turn. However, not all ten outputs are connected — the four used ones are outputs 1, 2, 5 and 7 (pins 2, 4, 1 and 6 respectively).

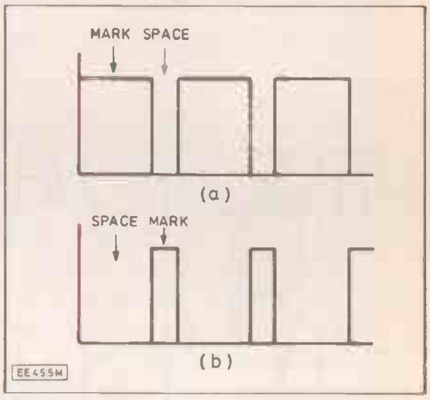
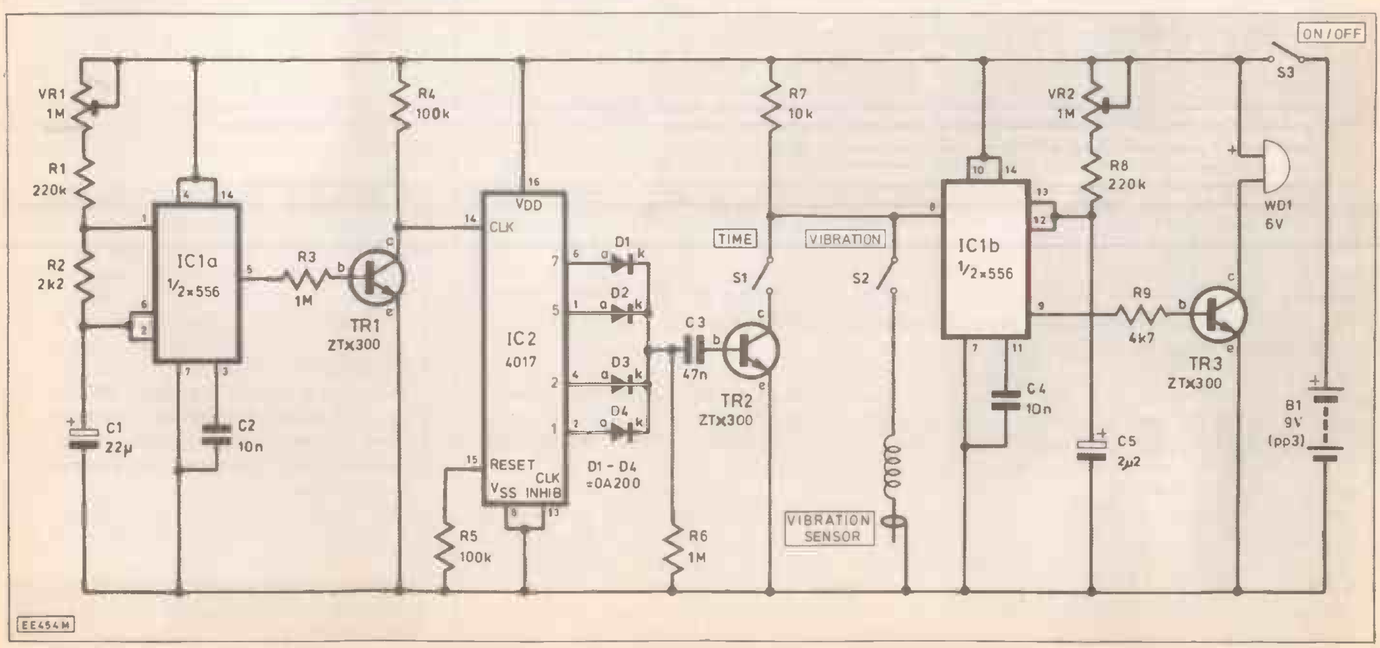


Fig. 2. Output pulses from the timer IC1a (pin 5) and (b) after inversion by TR1.

On switching on, output 0 will be high with the i.c. in the reset condition. Assuming a pulse rate of one every 10 seconds, output 1 will go high after 10 seconds, out-

Fig. 1. Complete circuit diagram for the Pass-the-Parcel game



put 2 after a further 10 seconds, output 5 after a further 30 seconds (since outputs 3 and 4 are missed out) and output 7 after a further 20 seconds. Output 1 will then go high again after a further 40 seconds (since outputs 8, 9, 0 and 1 are missed out).

Diodes D1 to D4 direct a pulse from any high output, via capacitor C3 to transistor TR2 base. This gives a momentary low pulse at the collector which triggers IC1b (S1 disables this section if required). IC1b is connected as a monostable having a time period of one second approximately. This time depends on the values of preset VR2, resistor R8 and capacitor C5. Preset VR2 can vary the operating time between 0.5 and 2 seconds approximately.

When IC1b is triggered, its output (pin 9) goes high and supplies base current to transistor TR3. This, in turn, operates the audible warning device, WD1 in its collector circuit.

With switch S2 set to the vibration mode and when the "parcel" is moved sufficiently, the sensor contacts close momentarily and IC1b is triggered direct. Switches S1 and S2 can be switched on together if desired so that the circuit triggers in either situation. Note that IC1a and IC1b form two independent sections of the same i.c.

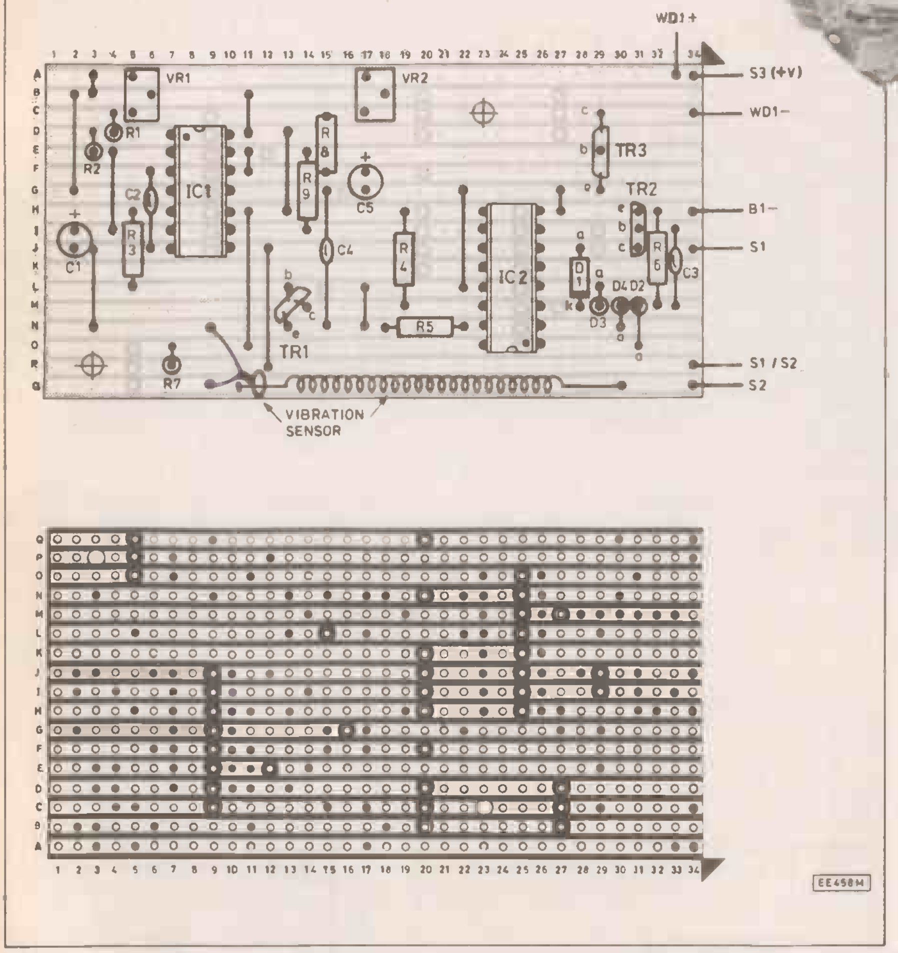


Fig. 3. Stripboard component layout and details of breaks required in the underside copper tracks.

CONSTRUCTION

Construction is based on the Veroboard layout shown in Fig. 3. This is made from a piece of 0.1in. matrix stripboard, size 17 strips × 34 holes.

Begin construction by drilling the mounting holes, making the track breaks and inter-strip links as indicated. Follow with the soldered on-board components including the i.c. sockets but do not insert the i.c.'s themselves until construction is complete. Take care over the polarities of diodes, D1 to D4 and electrolytic capacitors, C1 and C5.

Shop Talk

see page 18

Resistors

R1,R8	220k (2 off)
R2	2k2
R3,R6	1M (2 off)
R4,R5	100k (2 off)
R7	10k
R9	4k7

All 0.25W 5% carbon

Potentioneters

VR1,VR2	1M sub-min. presets, vertical (2 off)

Capacitors

C1	22μ p.c.b. elec. 16V
C2,C4	10n disc ceramic (2 off)
C3	47n disc ceramic
C5	2μ2 p.c.b. elec. 16V

Semiconductors

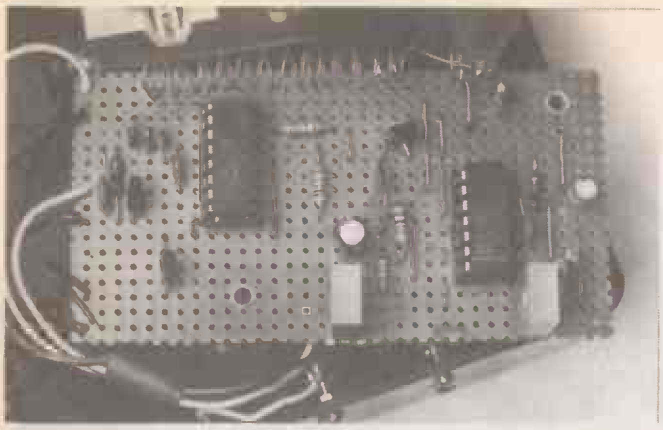
D1-D4	OA200 signal diode (4 off)
TR1,TR2, TR3	ZTX300 *npn* silicon (3 off)
IC1	556 dual timer
IC2	4017 decade counter

Miscellaneous

S1,S2,S3	s.p.d.t. sub-min slide switch (3 off)
WD1	6V 35mA high intensity buzzer

Plastic case, size 119mm × 99mm×44mm (external); strip-board, 0.1in. matrix 17 strips ×34 holes; 14-pin d.i.l. socket; 16-pin d.i.l. socket; B1 9V PP3 battery and connector; connecting wire, solder; wire for vibration sensor — see text.

Approx. cost Guidance only **£9**



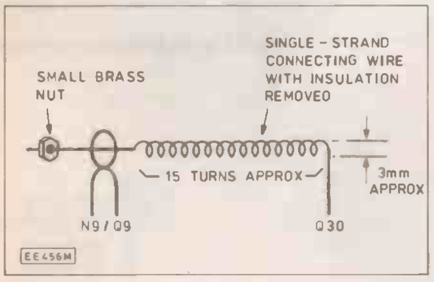


Photo B. (above) Completed circuit board showing the mounting of the vibration sensor.

Fig. 4 (left). Winding and construction details for the vibration sensor.

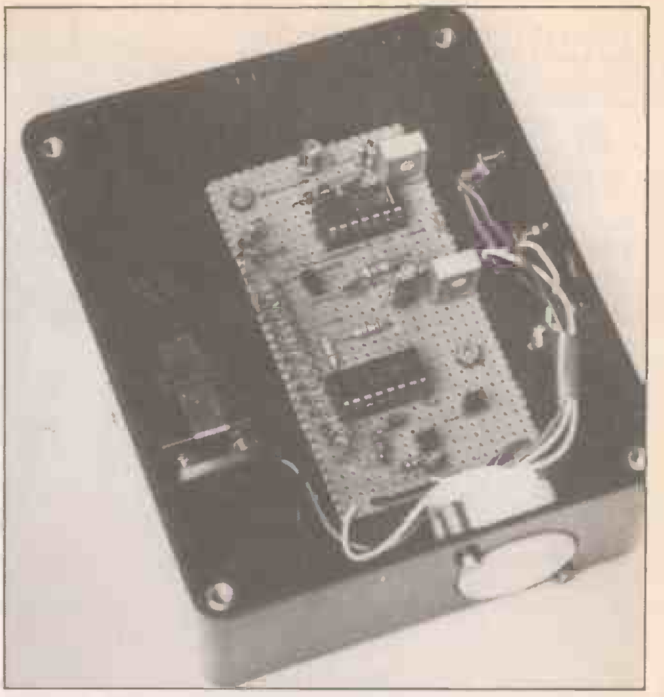


Photo C. The completed "parcel" showing mounting of buzzer and slide switches.

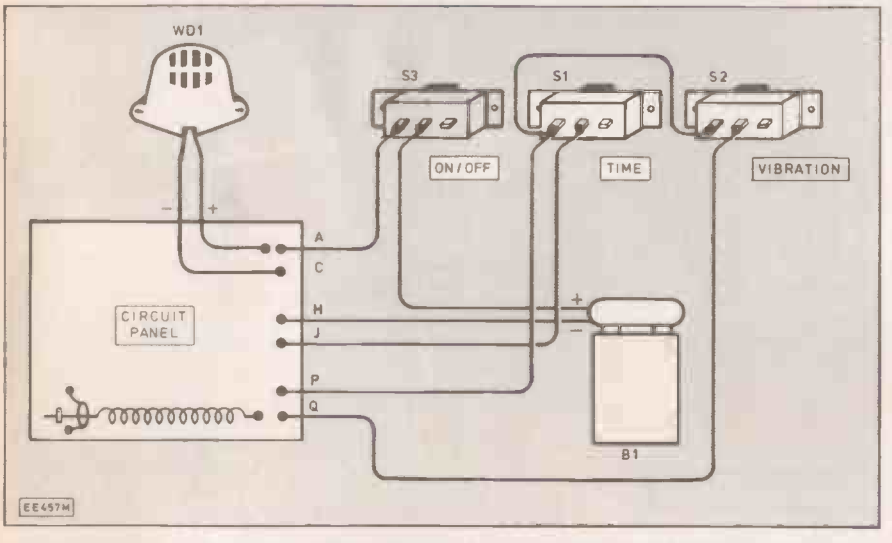


Fig. 5. Interwiring from the slide switches, buzzer and battery to the component circuit board.

VIBRATION SENSOR

Details for the construction of the vibration sensor are shown in Fig. 4. The sensor consists of two parts made from single-strand connecting wire with the plastic insulation removed. The first part is a spiral about 3mm in diameter. This may be made by wrapping approximately 15 turns of wire around a 3mm twist drill. 5mm of wire at each end should be left straight and a small brass nut soldered to one end as shown. The second part is a loop approximately 3mm in diameter.

These parts are soldered to the circuit panel in the positions indicated. The end of the spiral should normally rest in the centre of the loop without touching it.

If the circuit panel is shaken slightly, the two parts should be heard to touch momentarily. Careful adjustment will allow this to happen reliably and with the required degree of sensitivity.

Complete construction of the circuit panel by soldering 10cm pieces of light-duty stranded connecting wire to strips *A*, *J*, *P* and *Q* along the right-hand edge. Connect the buzzer (observing polarity) and negative battery connector wire.

Finally, insert the i.c.s into their holders — note that IC2 is "upside down". Since IC2 is a C-MOS device, it can be damaged by static electricity. To avoid this, remove it from its special packing and insert it into its holder without touching the pins.

INTERWIRING

The box specified in the parts list is larger than is really necessary to house the circuit and battery. This is to make the parcel a reasonable size.

Make holes in the case for the switches and buzzer. Mount these components so that they lie level with the face of the box — use spacers if necessary. Drill holes in the base of the box for mounting the circuit board and bolt it in position. Referring to Fig. 5, complete all interwiring shortening any wires as necessary. Leave presets VR1 and VR2 adjusted to approximately mid-track position.

TESTING

Connect the battery and secure it to the base of the box using an adhesive fixing pad. Switch S1 (Time) on and S2 (Vibration) off. Switch on the supply at S3. The buzzer will probably give a bleep. After a short time it should bleep again and follow the pseudo-random pattern described earlier.

If all is well, preset VR1 may be adjusted to give convenient operating times. Adjust preset VR2 as necessary to give the reequired bleep time. Clockwise rotation of VR1 and VR2 as viewed from the left-hand side of the circuit panel shortens the times.

Next, swith S1 off and S2 on. Each time the box is shaken, the buzzer should sound. If it does this unreliably, clean the parts of the sensor wires where they touch.

It only remains to wrap and decorate the "parcel". Note that the buzzer will probably give sufficient sound through any thin wrapping paper — if not, cut a small opening. To allow access to the switches, a flap may be cut in the paper and a little "Pritt Stick" applied to secure it. It may then be peeled back when the switches need to be used.

Have a ripping time now!! □

Constructional Project

MONKEY/ HUNTER GAME

JOHN LEWIS

Have fun without hurting any wildlife with this simple shooting game. Can you beat the leaping monkey?

A HUNTER sees a monkey in a jungle tree. He fires after carefully taking aim by lining up the barrel of his gun. The monkey sees the flash of light from the gun and, with incredibly fast reactions, he releases his hold on the tree. Does the bullet miss him or has he been too clever for his own good?

This is a problem which can be resolved by the use of an electronic game. The player should also gain some insight into the physics of the parabolic flight path of a bullet.

CIRCUIT DESCRIPTION

The full circuit diagram for the Monkey and Hunter Game is shown in Fig. 1. When the gun is reset, the phototransistor TR1 of the reflective optoswitch will receive no light so its collector will be at a logic "1" (high). This signal then passes through two Schmitt inverters in IC1 to turn on transistor TR2. Current flows through the solenoid making it magnetic so the target can be attached to it.

Firing the gun brings a piece of aluminium foil in front of the reflective optoswitch (D2/TR1), changing the collector of phototransistor TR1 to logic "0" (low). The Schmitt inverters speed up the voltage transition and TR2 is turned off. The solenoid current rapidly reduces to zero and the target is released.

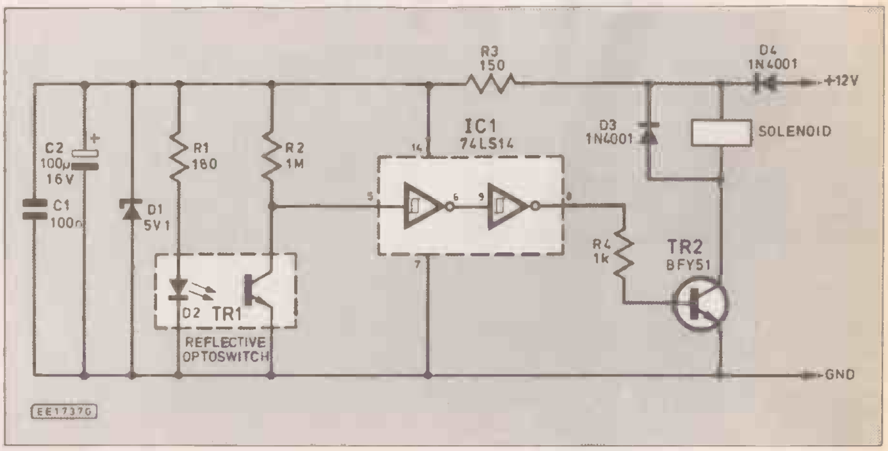


Fig. 1. Circuit diagram of the control unit for the Monkey and Hunter game.

Diode D3 protects transistor TR2 from damage caused by the very large reverse voltage across the solenoid as the magnetic field collapses. Diode D4 protects the circuit components in the event of accidental power supply reversal. Zener diode D1, capacitors C1 and C2 provide a smooth 5V supply for IC1.

CONSTRUCTION

The circuit may be constructed on a small printed circuit board, the component layout and full size foil master pattern for which is shown in Fig. 2. It would also be possible to use stripboard as an alternative. The printed circuit board is available through the *EE PCB Service*, code EE634.

The resistors should be mounted first on the board followed by the capacitors and diodes. Take care to observe the correct

COMPONENTS

Resistors
R1 180
R2 1M
R3 150
R4 1k
All 0.5W 10% carbon

Capacitors
C1 100n disc ceramic
C2 100μ radial elec. (pcb) 16V

Semiconductors
D1 5V1 Zener diode, BZY88 series
D3, D4 1N4001 diodes (2 off)
TR1/D2 min. reflective opto switch RS 501-606 or similar
TR2 BFY51 *npn* silicon
IC1 74LS14 Hex Schmitt inverter

Miscellaneous
Printed circuit board available from *EE PCB Service*, code EE634; 12V small solenoid see text; plastic case, 120mm x 80mm x 35mm; power supply, 12V 300mA d.c. unregulated; 14-pin d.i.l. socket; 3.5mm jack socket; 4mm plugs and sockets (2 off); solder; sleeving and connecting wire.

Approx. cost Guidance only **£15** *excl. gun*

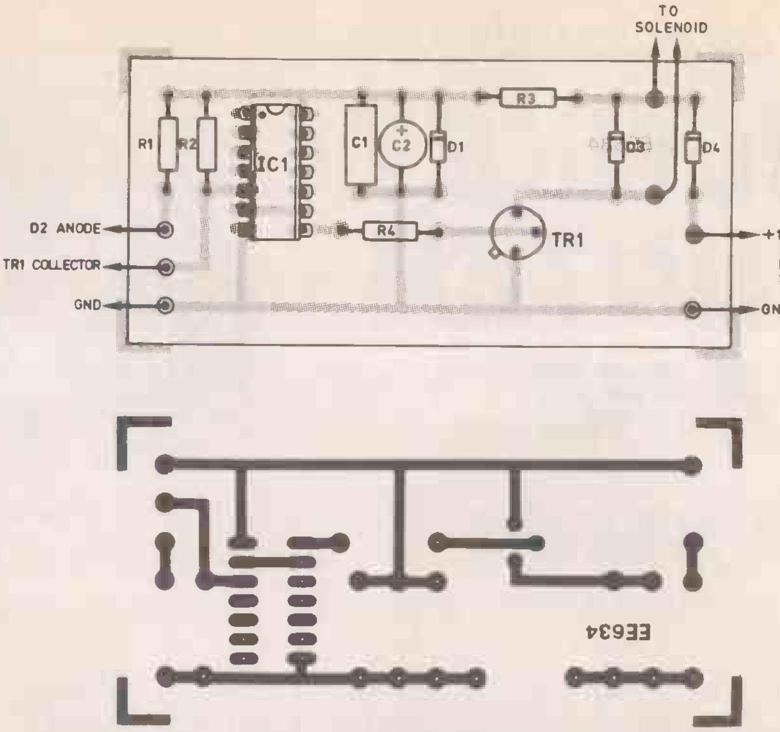


Fig. 2. P.C.B. for the Monkey and Hunter game.

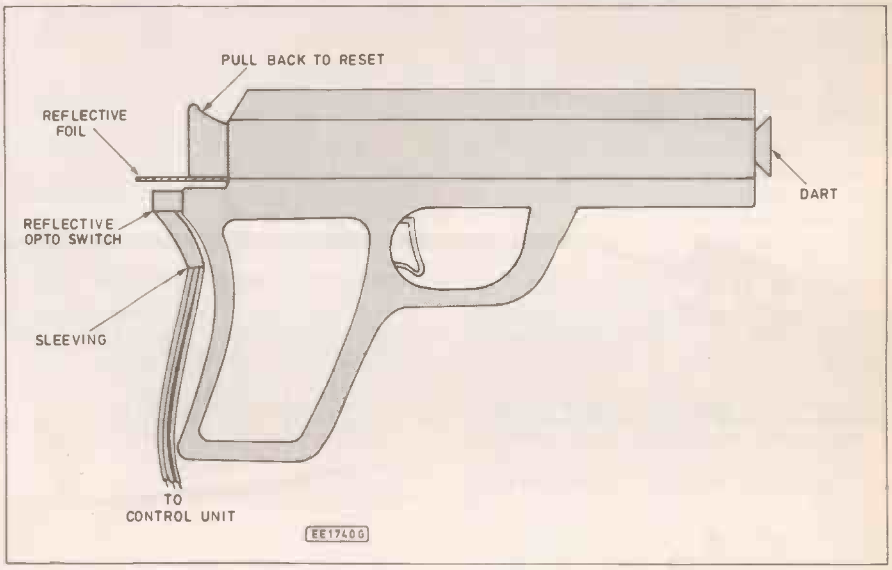


Fig. 3. Mounting the opto-switch on the gun.

polarity when mounting these components. Using a 14 pin d.i.l. socket for IC1 is also a sensible precaution.

COMPONENTS

The solenoid used in the prototype was obtained from J & N Bull Electrical and with a supply voltage of 12V this took a current of 100mA. A dab of epoxy resin is sufficient to retain the central plunger in the solenoid coil.

The "target" may be made from a piece of stiff board from a cardboard box. A steel nail inserted in the top enables the target to be held by the solenoid.

The size of the target depends on how accurate you feel you may be (15cm×20cm is a reasonable size to start with). The nail size may need some adjustment, depending on the weight of the target. If the target refuses to fall off due to residual magnetisation, a few layers of tape over the top of the nail should solve this problem.

The dart gun used in the prototype was a "Soft-Shoot" gun which is easily and cheaply obtained from toy shops. The reflective optoswitch can be held onto the gun handle by cable ties, elastic bands or tape. A piece of foil stuck on the firing mechanism is placed so that it only covers the reflective optoswitch when the gun has been fired (Fig. 3).

The maximum current taken by this circuit with the specified solenoid is about 150mA. This is rather large for batteries so a mains adaptor was used for the pro-

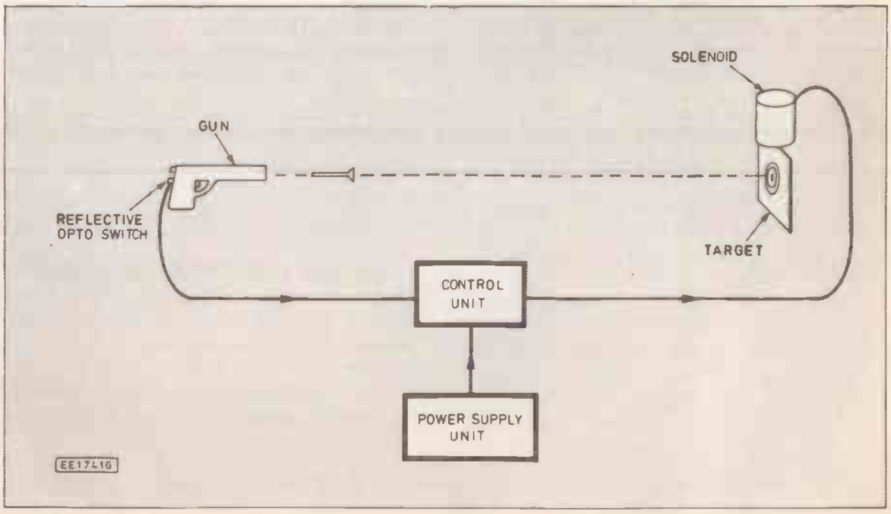


Fig. 4. General set-up of the game.

totype. An unregulated 12V 300mA mains adaptor proved ideal, or alternatively any other suitable 12V supply could be used. Fig. 4 shows the general layout while Fig. 5 details the interwiring in the main unit.

SETTING UP

The solenoid should be fixed at a suitable height so that the target can be attached to it. A doorway may be used and the solenoid fixed with masking tape to avoid damage to the paint.

It is possible to fire horizontally or indeed any angle above the horizontal and achieve a good chance of a hit. The maximum target distance should not be more than about five metres. □

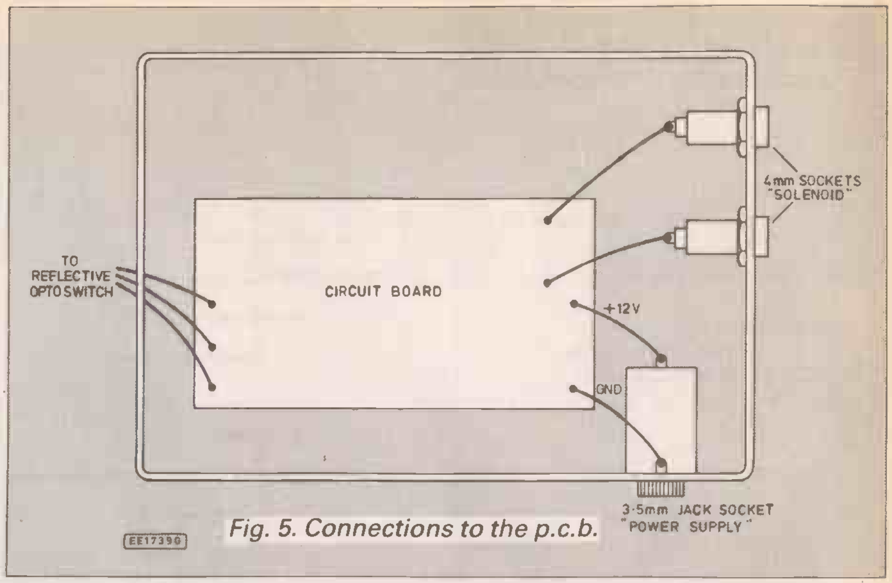
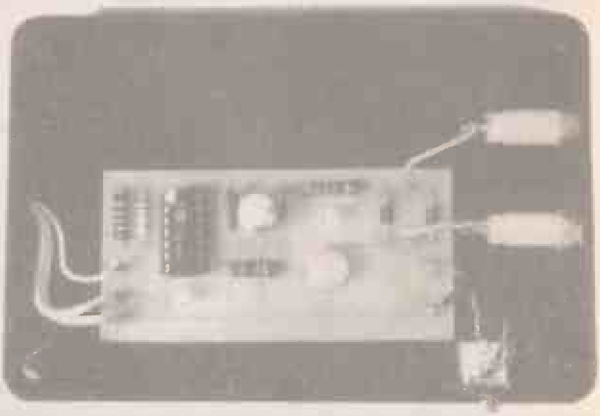
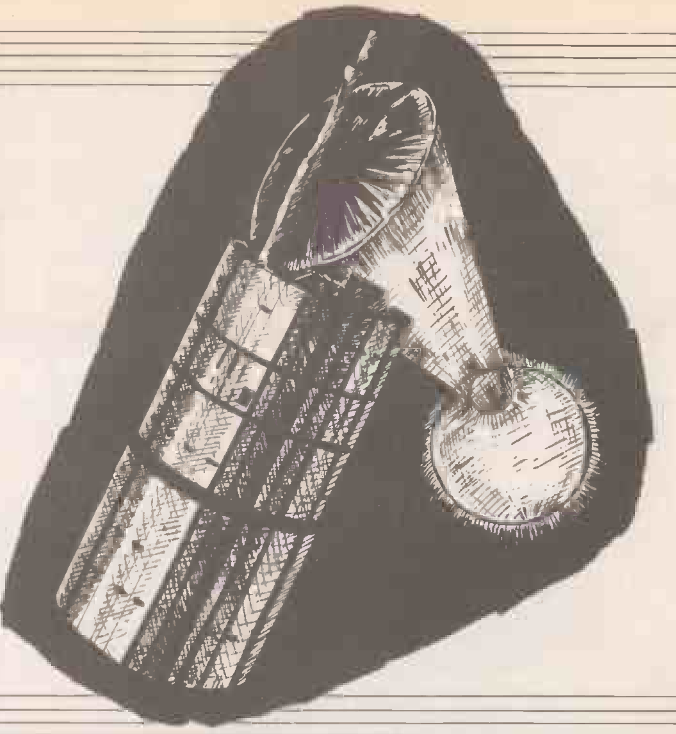


Fig. 5. Connections to the p.c.b.





SATELLITE TV

IAN GRAHAM

*In the next few months, small receiving dishes will begin to sprout on walls and roofs all over Europe to collect television programmes from space. **Ian Graham** reports on the technical progress and commercial competition in this new market-place.*

When plans for satellite television were discussed in the 1970s, broadcasters envisaged a network of satellites using a single television system throughout Europe. This single system would replace the variety of PAL and SECAM systems in use now.

The dream has turned into a nightmare. France and Germany rejected the new transmission system and went their own way with a simpler version of the same system. Most of the receiver manufacturers also favour this version, but the programme makers do not. While the arguments drag on, the satellite launch dates draw ever nearer. The first satellite, a privately owned spacecraft called Astra, is scheduled for launch on December 9th '88, with the second satellite, operated by the British company, British Satellite Broadcasting (BSB), due for launch next Summer.

Rupert Murdoch, managing director of News International, and Amstrad chairman Alan Sugar at their joint news conference in London in June '88. Murdoch's Sky Television plans to broadcast four television channels and a radio channel from the Astra satellite from New Year 1989. Amstrad will make dish antennae and receivers to retail at £199.

The first transmission system to be recommended by the European Broadcasting Union (ERBU) in 1977 for direct-to-home television broadcasting by satellite was developed by Britain's Independent Broadcasting Authority (IBA). C-MAC, as it was called, offered much better picture and sound quality than existing systems and some exciting potential for future improvements. In 1982 the Home Office announced that satellites broadcasting television into Britain by satellite would have to use C-MAC.

CHIP-SETS

Programmes would be beamed directly to viewers' homes and received by a small dish antenna. As all the satellites broadcasting to European countries were to use the same transmission system, a single type of receiver could be used anywhere in Europe—a very attractive prospect for receiver manufacturers. That doesn't mean that all the satellite receivers made by every manufacturer would be identical to each other in every respect all over Europe. It does, however, mean that receivers would be based on the same set of chips. Such a high degree of 'component commonality' would significantly reduce the cost of the chips because of the greater quantities that could be manufactured.

Then the rot set in. France and Germany rejected C-MAC because its digital signals were transmitted at such a high data rate that the older French and German cable television distribution networks could not cope with them. In many cases, their cabling was laid before high speed digital communications began and it was never intended to carry such signals.

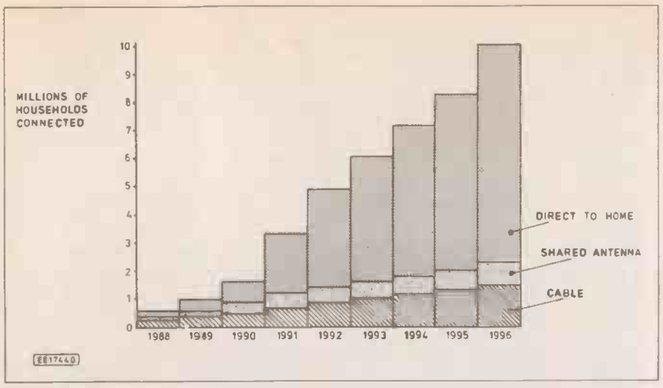


Fig. 1. Predictions of the size and growth rate of the satellite television viewing audience in the early 1990s vary enormously. Astra's operator, SES, includes this rosy view of the future, prepared by independent market researchers, in its promotional material for business customers.

In 1987 the Home Office relented and announced that broadcasters serving British viewers could use a development of C-MAC, called D-MAC, which reduced the data rate to half that of C-MAC. France and Germany went further. They adopted a system called D2-MAC. It would perhaps be more accurate to call it D½-MAC, because it halves the data rate of D-MAC again.

Whilst C-MAC and D-MAC provide eight hi-fi sound tracks with each television channel, D2-MAC is only capable of providing four hi-fi sound tracks or eight "lo-fi" sound tracks. The extra tracks can carry stereo sound in different languages, stereo radio services and even computer-generated information services such as teletext.

Most of Europe's receiver manufacturers started designing D2-MAC receivers. Britain seemed to be out in the cold, resisting growing support for D2-MAC. Then at the beginning of 1988 the programme makers, the television companies which plan to use the new satellites, entered the debate. Like the British authorities, they supported the better quality D-MAC as a vehicle for their programmes.

As if the situation was not confusing enough already, in June '88 newspaper tycoon Rupert Murdoch announced plans to begin broadcasting four television channels and a 24-hour stereo music radio channel to individual homes by satellite from Spring 1989 using yet another transmission system—PAL! Opting for the system already in use in the UK enables Murdoch to avoid the MAC debate altogether and have receiving equipment (made at budget prices) available before the MAC-based equipment is ready.

MULTI-STANDARD RECEIVERS

The answer to the MAC problem will probably be to make receivers which can handle PAL, D-MAC and D2-MAC signals. But of course, these "multi-standard" receivers will inevitably be more expensive than single standard MAC receivers or PAL receivers. The first multi-MAC chips should reach receiver manufacturers this month.

MAC supporters dismiss Murdoch's PAL satellite system as obsolete from the day it begins. But Murdoch will probably be broadcasting before the others and will capture the first of the new satellite television audience. And that's bound to influence the appeal of the MAC services that follow.

In future, MAC has the flexibility for further developments such as wide screen television (shaped like a cinema screen) and high definition television, which will far outstrip the performance of any PAL system. A 30-company consortium has been formed to design and manufacture high definition television equipment, from the studio right through to the domestic TV set by 1992. And they are actually ahead of schedule. Even the less sophisticated D2-MAC system will deliver better quality pictures and sound than PAL. But that may not matter in the short term if Murdoch's PAL system is up and running first.

Within a few days of Murdoch's announcement, his sparring partner Robert Maxwell also announced his intention to start a satellite television service. And a few eyebrows were raised when the Home Office and Department of Trade & Industry revealed that they were discussing with BSB, the BBC and the IBA the possibility of broadcasting Channel Four and BBC2 from BSB's satellite. Although both channels would continue to be available "terrestrially" for a few years, their aim was to cease terrestrial transmissions to make room for more local or national television services. The broadcasters raised serious doubts about the plan and it was dropped in July. But that hasn't stopped the government going ahead with plans to radically reorganise broadcasting in the UK.

SCRAMBLED PROGRAMMES

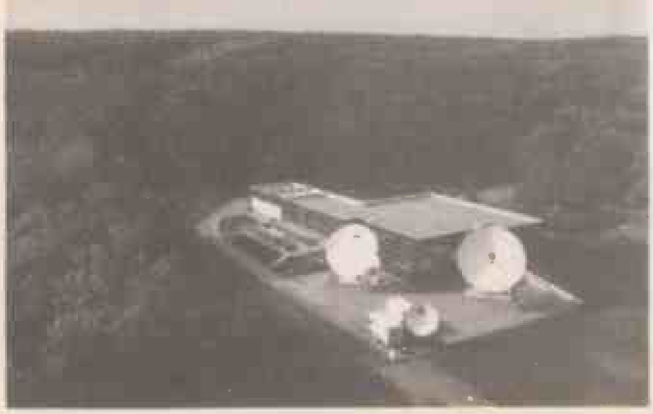
When all the satellites are launched and the programmes begin to rain down on us from space, we won't be able to tune into them all quite as easily as we do now with existing "terrestrial" services. Some of the satellite channels will be scrambled and a descrambler will be necessary to watch them.

The channels which opt for scrambling will principally be those without any income from advertising. They will depend on subscriptions paid by viewers. And only viewers who keep paying the subscriptions will be issued with a descrambler. One of Murdoch's four channels (Sky-Movie, the movie channel) will be scrambled. The other three will be supported by advertising.

The advertisers are very enthusiastic about the opportunity to advertise Europe-wide on Murdoch's satellite network, Sky Television, because Sky will charge them 25 per cent less than they pay now to the independent television channels. W. H. Smith Television has also announced its intention to offer a 25 per cent discount to advertisers buying time on its Lifestyle and Screensport channels on Astra. Lifestyle, a women's interest channel will include a Europe-wide TV shopping service operated by Kaleidoscope/Scotcade. Both channels will be funded by a combination of advertising and subscription. Interestingly, Smith's will begin transmitting in PAL, but as soon as D-MAC receivers are available (towards the end of 1989), it will change over to D-MAC.

The first satellite to beam programmes directly to British homes will be Astra. It will offer 16 television channels, although not all of them will have English soundtracks or subtitles. However, most of the channels will show programmes and movies made in Britain and the United States, so in practice most will be in English. Rupert Murdoch's Sky Television has signed a 10-year lease to broadcast from Astra.

Astra's satellite control centre, embedded in a forest at Betzdorf, approximately 30 miles from Bonn in West Germany.

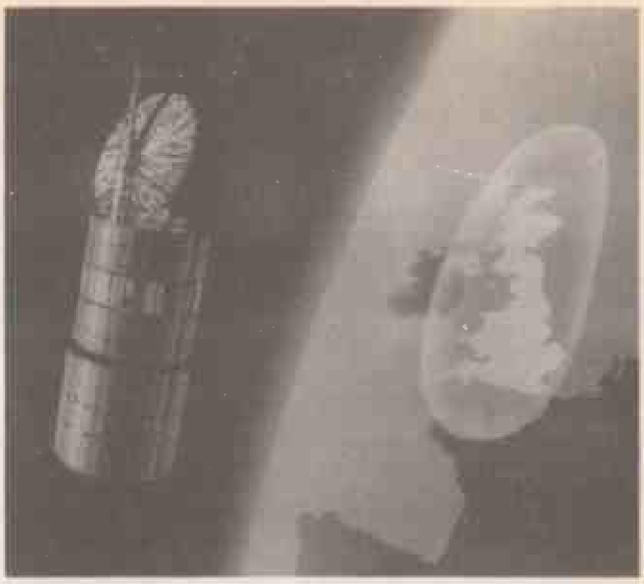


The Astra satellite itself, undergoing final inspection. Following the successful first flight of the Ariane 4 launch rocket on June 14th, Astra is now scheduled for launch on December 9th.

Astra is a medium power satellite broadcasting to all European countries. In comparison, BSB's higher-power satellite will broadcast four channels to the UK only. As it broadcasts at higher power levels, its broadcasts can be received by a smaller dish antenna (around one foot in diameter) than is necessary for Astra.

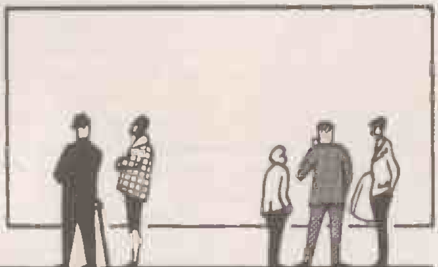
1989 promises to be a year of keen competion between the various satellite operators, the television companies using the satellites and the equipment manufacturers. Astra receivers, costing between £200 and £400 for PAL models and identifiable from their "Astra Compatible" stickers, are now being advertised and will be in the shops from January onwards. D-MAC receivers should begin to appear in the shops from the middle of 1989 onwards. They are expected to cost from £300 upwards.

The only thing one can predict with any certainty about this new high risk business is that 1989 will go down in history as the year that direct-to-home satellite television finally came to Britain and lit the blue touch-paper on a new era of international home entertainment. □



This artist's impression shows the Hughes HS 376 satellite due to be launched by a McDonnell-Douglas Delta rocket on August 10th 1989. Then, operated by British Satellite Broadcasting, it will compete directly with Astra for UK viewers.

SHOP TALK



BY DAVID BARRINGTON

Catalogue Received

We have just received the 1988/89 winter edition of the Cirkit Constructors' catalogue and its 184 pages are crammed with many new lines.

Featured for the first time amongst its 3,000 plus product lines are several new scanning receivers, offering an extended frequency range and increased channels. Also new are a 2m transceiver of all-British design, an eight-channel logic probe, a 2.4GHz frequency counter and the latest Loadstar r.f. and a.f. signal generator with l.e.d. frequency readout.

Once again it carries discount vouchers for use with prepaid orders and, by popular demand, there is another easy-to-enter competition. First prize is a Loadstar signal generator, second and third prizes an Easiwire prototyping kit. The catalogue costs £1.30 and is available from large newsagents or direct from Cirkit Distribution.

Class One Sound Amplifier

Without compromising its performance, the *Class One Sound Amplifier* has been budgeted to sell as a complete kit for under £100. This has been achieved by **Audiokits** bulk purchasing certain items and passing the savings on.

Because of the size and closeness of some of the copper tracking, we feel that for readers to attempt to make their own printed circuit board could lead to all sorts of problems. We, therefore, recommend that constructors purchase a board from Audiokits. This will cost £12.50 plus p&p.

For full details of all component kits and various options contact: **Audiokits, Dept EE, 6 Mill Close, Borrowash, Derby, PE7 3GU.**

Spectrum Parallel Printer Interface

The parallel input/output interface controller chip Z80A-PIO is now a commonly stocked, low cost item amongst most advertisers wares and should not cause any buying problems. This device should be priced around the £2 to £3 mark.

The D-socket and plug, Centronics plug and the double-sided edge connector are stocked by most of our components advertisers. Some of them also supply connecting cable and plug sets for various micros, including ones suitable for the Spectrum.

The small plastics case used in the prototype *Spectrum Parallel Printer Interface* was purchased from **Maplin,** order code WY03D (ABS Box 2002). However, practically any small plastics case could be used provided particular care is used in positioning the edge connector so that it protrudes through the case lid a minimum of 15mm to allow easy connection to the computer.

Monkey/Hunter Game

We have only been able to locate one source of supply for the "diffuse scan opto-switch sensor" called for in the *Monkey/Hunter Game* and this is from **Electromail (☎0536 204555).** This device, designated 301-606, is usually used for detecting beginning and end of tape sensors and for batch counters.

The small 12V solenoid used in the designer's model was originally obtained from **J & N Bull Electrical (☎0273 734648)** and measures approximately 40mm×12mm×12mm. Other 12V solenoids should work in this circuit, although they have not been tried.

Unregulated a.c. to d.c. mains adaptors are listed in most components catalogues and it should not prove too difficult to locate a suitable unit. The 300mA adaptor from **Maplin** (code XX09K) was used with the prototype game and is switchable from 3V to 12V, in six ranges.

The choice of plastic "toy" gun is, of course, left to individual choice, but it should have a "pull-back" plunger to load the gun so that the reflective foil can be mounted on the plunger. The opto-switch device can be held in position by a couple of cable-ties fixed around the gun butt.

The small printed circuit board for the game is available from the *EE PCB Service*, code EE634 (see page 67).

Tilt Alarm and Siren

Looking through components catalogues, quite a number list mercury switches suitable for the "Easiwire" *Tilt Alarm* and should not cause purchasing problems. The BICC-Vero Easiwire kit is also stocked by many of our advertisers. In fact, Greenweld are making a special offer to readers who purchase the wiring kit from them.

We cannot foresee any component buying difficulties for the *Siren* project. The circuit cards for these two projects are attached to the front cover of this issue.

Christmas Tree Lights Controller

We were more than surprised at the total cost for constructing the *Christmas Tree Lights Controller—On Spec project*—and rechecked our figures three times in disbelief. However, the bulk of this figure was made up by the two driver i.c.s, which cost £6.50 each, mains transformer and the various connectors.

The only source we have found for the UCN5801A chip is **Maplin** code QY77J. The rest of the components should be readily available.

We do not expect any component buying problems for readers undertaking the *Pass-The-Parcel* project.

FOR YOUR ENTERTAINMENT

BY BARRY FOX

Dirty Fight at the IBC

Broadcasters from all round the world converged on Brighton in September for the International Broadcasting Convention. Many of them hoped to get a clearer picture of the battle to set a new world standard for making and transmitting programmes in high definition TV.

But the Europeans and Japanese, each with a different system, fought such a dirty and muddled fight that most delegates will have left Brighton even more confused than when they arrived.

Europe's proposal, a Eureka project, was displayed in a pavilion built on the beach. This only held 40 and French company Thomson was in charge of allocating seats. Instead of giving out tickets they used a clumsy computer list system which had would-be participants wasting time in queues.

At the press demonstration I attended,the Eureka presenter forgot his script, got in a frightful muddle as equipment went wrong all round him and refused to have an organised question and answer session. Instead we were herded into a side room to mill around looking for someone who looked as if they might be able to answer our specific questions.

I came away with questions unanswered and the hope that Thomson of France will be kept well away from all future Eureka presentations.

Badwill Balance

As if to balance the badwill, Sony organised a press conference for the Japanese system. It involved a series of demonstrations interrupted by a long sit down meal miles out of town at Sussex University. In all the Japanese pantomime soaked five hours out of a busy day. As a result I missed a string of appointments, and—by what surely cannot have been coincidence—those who attended also missed an afternoon seminar in the main exhibition at which Japanese technology came under fire from European engineers.

The technical issues on HDTV are complex, but these are the basics.

Most of Europe currently uses the PAL (Phase Alternate Line) colour TV system. France and the Eastern bloc use SECAM (Sequence a Memoire). Both systems rely on 625 horizontal scanning lines to display 50 pictures a second.

From next year, Europe will use an improved 625/50 system called MAC (multiplex analogue components) for direct broadcasting by satellite.

The US and Japan use the NTSC (National Television Systems Committee), with only 525 lines but 60 pictures a second. When an attempt is made to convert from 60Hz to 50Hz standard, moving objects look blurred or judder on a large screen.

Film/Video

Many TV programmes are now made on 35mm film because the picture quality is better than currently available video and conversion is easier from film to TV.

But the electronics industry wants to replace film with a high definition video system which records over 1000 picture lines to give much clearer pictures. Broadcasters would like eventually to transmit pictures in HD format. Because there is no video projector which can produce pictures on a cinema screen as large and bright as a 35mm film projector, the cinema industry would need to transfer HDTV pictures onto 35mm film for projection in cinemas.

Thirty European companies, led by Bosch, Philips and Thomson, have been collaborating since October 1986 on the Eureka HDTV project (EU 95). There are now 29 Japanese companies working on HDTV, led by state broadcasting station NHK who began work 20 years ago and was soon after joined by Sony. They claim that their system, Hi Vision, is not only best but ready to buy.

Japan has also developed a compression system called MUSE (Multiple Sub-Nyquist Sampling Encoding) which squeezes the 1125/60 signal into a single satellite TV channel. But MUSE is not compatible with NTSC, PAL or MAC.

Europe's HDTV system builds on MAC technology to display 1250 line pictures. HD MAC is compatible with PAL.

For five years CBS lobbied the US Government and broadcast industry to adopt Japan's Hi Vision. In July 1987 the Federal Communications Commission started with a clean slate and open mind to study all possible options for advanced television systems, or ATV.

FCC Findings

On September 1 the FCC issued its first findings. The Commission did not specifically recommend any technology, but laid down guidelines which put Hi Vision out of court.

The FCC says that existing broadcast TV networks will be licenced to implement Advanced TV. Most important, whatever ATV system is adopted, it must be compatible with existing TV sets, and thus make none of them obsolete. Because the new Advanced Compatible or ACTV systems will deliver wide screen pictures with twice the normal number of scanning lines, they will need more television bandwidth. The FCC says this will have to be found in the existing v.h.f. and u.h.f. TV bands.

TV stations will have to continue broadcasting conventional signals on existing frequencies, so that people with existing sets will carry on watching as if nothing had happened.

One idea is for the TV station to broadcast an extra signal on a different frequency which an ATV set will receive and mix with the conventional signal, to improve picture quality.

The extra signal may be on a frequency next door to the existing frequency. Or it may be in some quite different part of the spectrum.

The extra signal may be of equal bandwidth to a conventional TV signal (6MHz in the US) or it may be of half bandwidth.

Alternatively a TV station may simultaneously broadcast each programme in two quite different formats, one of conventional type for the benefit of existing receivers and another in ATV format which only ATV sets can receive.

The FCC is inviting broadcasters to comment on which option they prefer. Philips claims that it has a version of HD MAC which is compatible with NTSC.

Production

European broadcasters have also rejected Hi Vision as a transmission standard. So at Brighton the Japanese changed tack and offered Hi Vision as a production standard for TV and film studios. But the Eureka team argues that Hi Vision is not fully compatible with any European system.

Eureka HD-MAC uses 1250 lines to give wide screen pictures. Picture rate is 50 Hz, but this can be artificially doubled in the receiver to give a flickerless 100Hz display.

Most important, Eureka system uses a clever technique called Digitally Assisted TV (developed by the BBC) to offer full compatibility between normal and high definition reception. Programmes are made in 1250 line format, but transmitted in 625 line format. Anyone with a conventional MAC receiver will see normal MAC pictures. Buried in the MAC picture signal there is a digital code, like teletext, which helps a high definition MAC receiver display 1250 line pictures.

It does this by taking the information from two full pictures, (four fields), and adding together all the detail which is available from motionless parts of the picture. Moving parts of the picture are left alone. Because the human eye sees detail most clearly on stationary parts of a picture, it does not matter that moving parts are of slightly lower definition. Or, at least, that's the theory.

The DATV signal gives the receiver all the necessary instructions for this picture processing, so the receiver need not be too expensive.

The Japanese system Hi Vision uses 1125 picture lines at 60Hz. When pictures are seen in this format they are very impressive. The Achilles heel of Hi Vision, which the Japanese worked hard at Brighton to conceal, is that problems arise when 1125/60 signals have to be converted to 625/50 TV systems for transmission in Europe or to 24 pictures per second film used for cinema projection.

Often, there is a disturbing smear on motion. This was clearly evident on a cinema film of pop group Genesis, converted from Hi Vision and being shown in Brighton.

The only demonstration of conversion from Hi Vision to European 625/50 TV at Brighton was on a small monitor connected to four cases of electronics, each the size of a large fridge/freezer.

Although the Eureka system offers Europe well nigh perfect compatibilty right through the chain, from studio production to domestic reception, the hardware is not yet ready to buy.

FUTURE TELEVISION

By GEORGE HYLTON

TELEVISION can now be as good as film. This was strikingly demonstrated at the 1988 International Broadcasting Convention at Brighton. There, professional engineers (the IBC isn't a public show) could see, projected on large, cinema-style screens, TV pictures without visible lines, with crisp detail, accurate colours and no interference. In one demonstration the TV signals were originated at Brighton but relayed by a satellite in space. In another, signals from London were sent to Brighton over a fibre optic cable link.

HDTV

This was high definition television, HDTV. It was very impressive. From the user's point of view, there are some questions. When can we get it? Not yet. In Europe, HDTV will be relayed by the DBS satellite due to go up in 1992, though some signals may be available in 1989. How much will it cost? When you ask that question you get lots of answers, all different. Since none of the bits of equipment required has yet gone into large scale production any price estimate is no more than a guess.

You will need a receiving dish and converter for the 12GHz satellite signals. You'll need a receiver capable of displaying the pictures to advantage, which means a big screen and high quality electronics. You'll need a good audio system, since HDTV sound will be high quality stereo. One American cost estimate was 3500 US dollars. But on top of this you may have to pay for what you watch: many HDTV proposals are for a form of pay TV, with the signals scrambled so that the non-paying viewer can't watch the programmes.

Whatever it costs, it will cost plenty.

WHICH SYSTEM?

There are two perfectly good HDTV systems available. One, developed by a group whose main member is Sony, transmits 60 fields per second and 1125 lines per field. The other, sponsored by a European consortium called Eureka 95, uses a field frequency of 50 and a line number of, ultimately, 1250, though in the early phases only 625 lines will be used. (To get true HDTV pictures the full 1250 lines are necessary but 625 line HDTV is still quite good.)

These two systems are not compatible with one another. The "Sony" (1125/60) system is well developed. The Eureka (1250/50) was a late starter but is catching up fast. The Sony system cannot be received on existing receivers, even with an adapter. The Eureka system is designed to be partially compatible with existing European receivers. Partially, because, even with an adapter, an existing set won't see the full "wide screen" picture, but only the central part—a bit like the present situation when a wide screen film is televised. (See *For Your Entertainment* for more about these two systems).

EUREKA 95 and the MAC FAMILY

Here in Western Europe the choice has in effect been made. We shall go for a step by step programme which will end up with 1250/50 HDTV—if the money doesn't run out first. There are several variants of the European transmission system but they all use what are called Multiplexed Analogue Components (MAS). The "components" are the parts of the picture signal: two colour-difference components and one luminance component.

In MAC systems the luminance and colour information are kept separate by transmitting first colour then luminance. In other words, the multiplexing is done in time, not in frequency. One important MAC system, D-MAC/Packet, developed by the Independent Broadcasting Authority in Britain, transmits three multiplexed signals (Fig. 1). During the one line period of 64μs there is, first, a short burst of high-speed data (the "packet"); second, the colour-difference information; and third, the luminance information. For satellite links all these signals are frequency-modulated on the microwave carrier.

The advantage of separating luminance and chrominance is that the receiver doesn't have the chance of mistaking one for the other. This can happen on today's PAL televisions: this is why, when someone is wearing a shirt striped black and white it appears as a shimmering coloured image. To do justice to a MAC signal, the receiver ought to have separate internal channels for the various components.

The data burst has enough capacity for eight high quality sound channels as well as other coded information. This is useful for international telecasts where sound may take the form of spoken words in different languages.

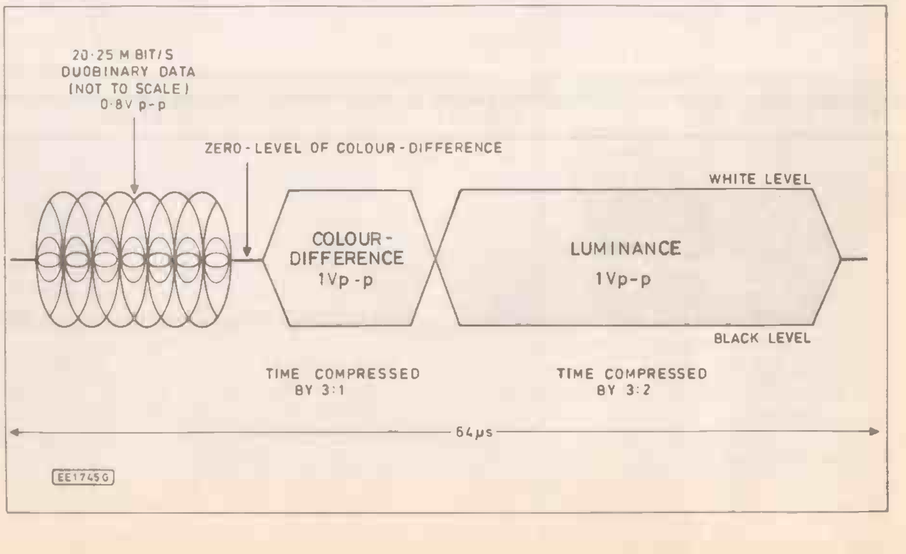
A GAMBLE?

Eureka is putting forward its own system, rather than joining forces with Sony. The Americans have been leaning towards Sony, but haven't made their minds up, and there was a paper at IBC on a rival 60-field system designed to be compatible with existing U.S. television.

Whatever system is chosen will involve somebody in a commercial gamble. Will it come off? In a recent survey people in Britain were asked if they would buy satellite dishes at £350, to receive extra TV channels. Only 7 per cent said they would. Note that this survey implied "free" TV, where programmes are paid for by advertisers, not by charges to viewers. If the question had been: Will you buy a new set of receiving equipment, costing £1000, and then pay for what you watch? would even 7 per cent have said "Yes"?

While all this heady talk of HDTV via satellites has been going on, there has been another proposal. This is to broadcast extra channels on short-range microwave links, using aerials on high buildings. Up to 20 extra channels could be made available. The equipment required at the receiving end would be relatively modest. This sort of TV exists already in the USA. Perhaps it should be taken seriously elsewhere.

Fig. 1. Video signal for one line of a 625 line D-MAC television picture. A burst of data (enlarged here for clarity is followed by colour information then luminance information. The data signal incorporates high quality sound channels. The picture signals are compressed in time before transmission and expanded back to the correct length at the receiving end.



City and Guilds

Certificate Course

Introducing DIGITAL ELECTRONICS

Part 4: Measurement and Testing

By Michael J. Cockcroft
Training Manager, Peterborough ITeC

This series of twelve articles has been designed as a complete course for the City and Guilds Introductory Digital Electronics syllabus (726 301). Full details on registering for C&G assessment, details of assessment centres, and information on the course in general were given in a booklet provided free with the October issue.

THIS month we expand on some of the principles introduced in Part 1 and fulfil the following City and Guilds objectives:

2.1 Test Instruments and Aids

2.1.1 Perform initial adjustments (including range selection and zero where appropriate) of both analogue and digital multimeters.

2.1.2 Perform initial adjustments (including focus, brightness, attenuator and timebase setting) of a simple single or double beam oscilloscope.

2.1.3 Adjust a sine/square wave signal generator to produce a waveform of given frequency and amplitude.

2.1.4. Adjust a pulse generator to produce waveform of given repetition frequency, pulse amplitude and pulse width.

2.1.5 Connect a logic probe to an appropriate supply and observe the indications produced when the probe tip is connected to a variable voltage d.c. source.

2.2 Measurement

2.2.1 Measure low voltage d.c. and a.c. voltages using both analogue and digital multimeters

2.2.2 Use a continuity tester to test specified components such as switches, fuses, cables connectors and p.c.b. tracks.

2.2.3 Measure the value of any given resistor using both analogue and digital multimeters.

2.2.4 Measure low voltage d.c. (of either polarity) using an oscilloscope.

2.2.5 Display the waveform of a low voltage a.c. supply making appropriate use of the trigger selection, trigger level, shift and attenuator controls.

2.2.6 Measure the peak to peak voltage of a low voltage a.c. supply using an oscilloscope.

2.2.7 Measure the periodic time of a low voltage a.c. supply using an oscilloscope.

2.2.8 Calculate the frequency of an a.c. supply when given its periodic time.

2.3 Power Supplies

2.3.1 State essential requirements of d.c. supplies for use with digital circuits.

2.3.2 Adjust and use a power, supply or select a suitable battery, for the operation of a different circuit. (Appendix M)

2.4 Logic Testing

2.4.1 Measure supply rail voltages in typical TTL and CMOS logic arrangements using multimeters (both digital and analogue types) and oscilloscopes.

2.4.2 Measure signal voltage levels in typical TTL and CMOS logic arrangements using multimeters (both digital and analogue types) and oscilloscopes.

2.4.3 Determine logic levels in typical TTL and CMOS logic arrangements using a logic probe.

2.4.4 Observe the effects of pulsing states (of various repetition frequencies and mark to space ratios) on the displays produced by both digital and analogue multimeters.

2.4.5 Observe the effects of pulsing states (of various repetition frequencies and mark to space ratios) on the indications produced by typical logic probes.

2.4.6 Observe the effects of pulsing states (of various repetition frequencies and mark to space ratios) on the display produced on an oscilloscope (using both a.c. and d.c. coupling).

2.4.7 Define pulse repetition frequency, pulse width, pulse duration, mark-to-space ratio, and duty cycle of a pulse waveform.
2.4.8 Determine the pulse width and pulse duration of given pulse waveforms.

In the first article of the series we introduced, among other things, electronic signals and voltage sources. We described electronic signals as either analogue or digital, depending on how any messages may be interpreted from a particular waveform; and we used a heat generated voltage source as an example power supply. Now we look deeper into power supplies and waveforms in order to gain a deeper understanding of how circuits are energised and how electronic signals are used, generated, and measured.

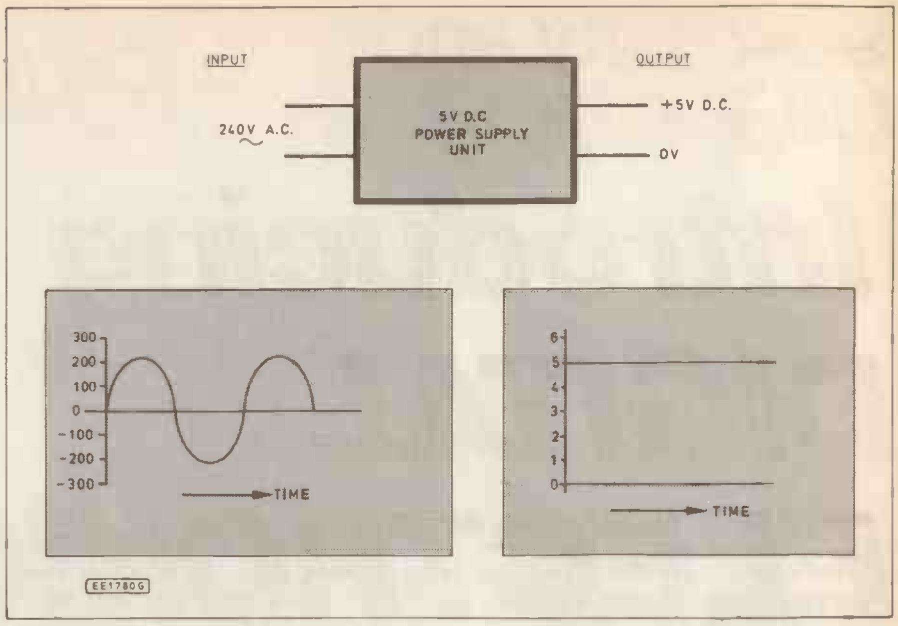


Fig. 4.2. A mains derived d.c. power supply operation.

Power Supplies

Power supplies of electric circuits fall into one of two general categories: they are either **alternating current** (a.c.) or **direct current** (d.c.). The mains supply in people's homes is an example of an a.c. source of electricity (i.e. 240 volts a.c.) and batteries are d.c. sources (e.g. 9 volts d.c.).

When we speak of voltages in terms of *alternating* or *direct* current, we are referring to *sources* of voltage, and whether a voltage source is a.c. or d.c. depends on the method by which the voltage is generated. A d.c. voltage is generated by creating a steady flow of electrons in one direction around a circuit as explained in Part 1 and shown here in Fig. 4.1a. An a.c. voltage is generated by creating a current flow first in one direction around the circuit and then in the other direction in a continuous cycle, alternating the direction at regular intervals; Fig. 4.1b shows that a.c. current flows in a clockwise direction for some of the time and an anti-clockwise direction for some of the time.

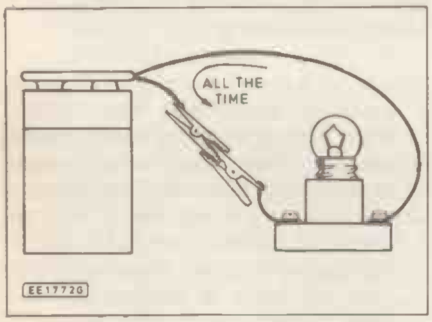


Fig. 4.1a. A battery operated bulb.

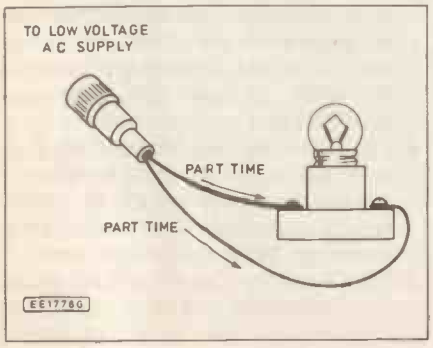


Fig. 4.1b. Bulb operated by an a.c. supply.

Almost all electronic circuits require d.c. power supplies and, since batteries always discharge (run down) after a time, they are not suitable for most applications; therefore, unless the system is a portable one, it will more than likely need to be powered by the mains. We are not concerned about how power supplies work until a later article, but we do need to know something about them at this time in order to satisfy a couple of the above objectives and, perhaps, to save on batteries for our experiments.

Power Requirements

The power supply requirements of electronic circuits vary (even between digital circuits) but, in general, if they are derived from the mains they need to be **regulated**. This means that the d.c. voltage level must be maintained at all times: typically, the supply voltage reduces with increasing load current, regulation is the name given to the electronic process of maintaining voltage with increasing load. A power supply which exhibits minimum voltage reduction for maximum load current is said to be "well regulated" or is described as having the right degree of **stabilisation.** Digital electronic circuits, in particular, require this property of their power supplies.

The amount of voltage required for proper operation of the circuit will always be stated on the circuit diagram. The function of a mains derived d.c. power supply (see Fig. 4.2) is to convert the 240 volts a.c. at its input to an appropriate d.c. voltage (usually of a much lower value—less than 30 volts for most electronic equipment). The figure includes graphs of voltage against time at both input and output to show the difference between a.c. and d.c. voltage. These graphs show that 240 volts a.c. is only at 240 volts for very short periods every so often; however, 5 volts d.c. is always 5 volts. The graph of a voltage against time is called the **waveform** and the a.c. mains waveform is called a **sine wave.**

Waveforms

The graph of a waveform describes the waveform precisely. The sinewave is made up of repeating cycles, a single cycle is expressed as the **period** (or periodic time) of the wave and, as can be seen from Fig. 4.3, is the time taken to rise from zero volts, through all values of positive voltage, back through zero again, and through all negative values, to zero a third time.

The maximum positive voltage shown in the waveform is called the positive peak and the maximum negative voltage is the negative peak.

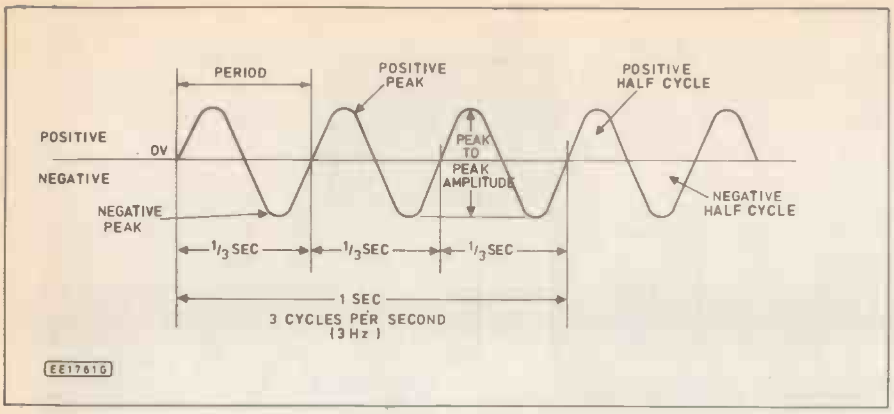


Fig. 4.3. Definitions of a sinewave.

We usually refer to the voltage level of a signal waveform as its **amplitude**. The peak to peak amplitude of a sine wave is twice that of the peak amplitude.

The **frequency** of the wave is the number of repeating cycles in one second. We know that the period of the wave is the time taken for one cycle to occur, so mathematically:

$$\frac{1}{\text{period}} = \text{frequency and} \frac{1}{\text{frequency}} = \text{period}$$

For the waveform of Fig. 4.3 the frequency is three cycles per second or, since the standard unit of frequency is the Hertz (Hz), 3Hz. As the frequency of the wave is known from the diagram we can calculate the periodic time:

$$\frac{1}{3} = 0.33 \text{ seconds}$$

Similarly, if only the periodic time was known, the frequency would be found as follows:

$$\frac{1}{0.33} = 3\text{Hz}$$

The a.c. generators at power stations produce sine waves of dimensions (frequency, amplitude etc.) that you will calculate as an exercise later.

The sine wave is an important signal in electronics and it is often necessary to be able to generate such waveforms (of much smaller dimensions than the mains signal, of course).

Generating Waveforms

The sine wave is only one of a number of waveforms, some other basic waveforms are depicted in Fig. 4.4. Signal generators, or **function generators** are used to produce waveforms for test (and other) purposes. A function generator is shown in Fig. 4.5; in general, these instruments can produce sine, square, and triangle waves (depending on the function selector switch) to any frequency within a range. Fig. 4.6 shows the similarity between these three waveforms with respect to periodic time.

Setting up an output signal on the function generator requires the use of an **oscilloscope**; therefore, we will defer any discussion with regard to this until we know how to use the oscilloscope.

The generation of rectangular waveforms requires an intrument called a **pulse generator** (Fig. 4.7); this is a square wave generator with controls to vary the pulse width within the desired frequency. When dealing with square and rectangular waveforms we are concerned with the relationship between the pulse width and period as shown in Fig. 4.8, we call this the **mark/space ratio** which is exactly what it says:

$$\frac{\text{mark}}{\text{space}} = \text{mark/space ratio}$$

Compare the 3Hz function generator output of Fig. 4.9a to the pulse generator output of the same frequency in Fig. 4.9b; although square waves can be produced from the pulse generator, rectangular waves cannot be generated by the function generator. The difference between the two waveforms is in the mark/space ratio. Another way of representing this difference is by the waveforms **duty cycle** which is the relationship between the pulse width and the period of the wave expressed as a percentage:

$$\frac{\text{pulse}}{\text{period}} \times 100 = \text{duty cycle}$$

We will return to the pulse generator as part of an exercise later.

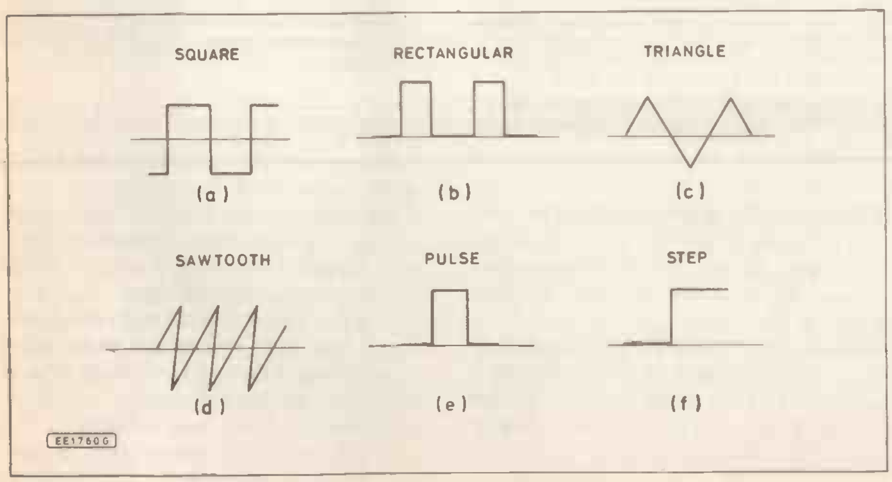


Fig. 4.4. Various types of waveforms.

The Way Ahead

We now come to an important stage in the development of our subject. Up to now, in this article and in the three previous parts of the series, we have done a lot of learning and a small amount of doing. The way forward now is to prepare for the kind of work that is superior to all other kinds of learning—practical work.

From now onwards you are going to be observing those invisible quantities of voltage, current, resistance etc., examining every detail of those waveforms, constructing the electronic systems, and experimenting with every facet of what you have learned to date.

But it is *you* who must do it, *we* set the scene but **you are responsible for what you learn and what you ultimately get out of this course.** If you are looking for a career in electronics it is in your own interest to broaden your experience by constructing not just those projects which are a part of the course, but other published projects. Don't just answer the questions we set, ask your own questions and devise your own experiments according to what *you* need to know.

We do not expect you to buy all the instruments and equipment needed for the practical work, this is where your local college or ITeC comes in, give them a ring and ask if they provide an open learning service with regard to the use of equipment. ITeCs often do. (Peterborough ITeC cer-

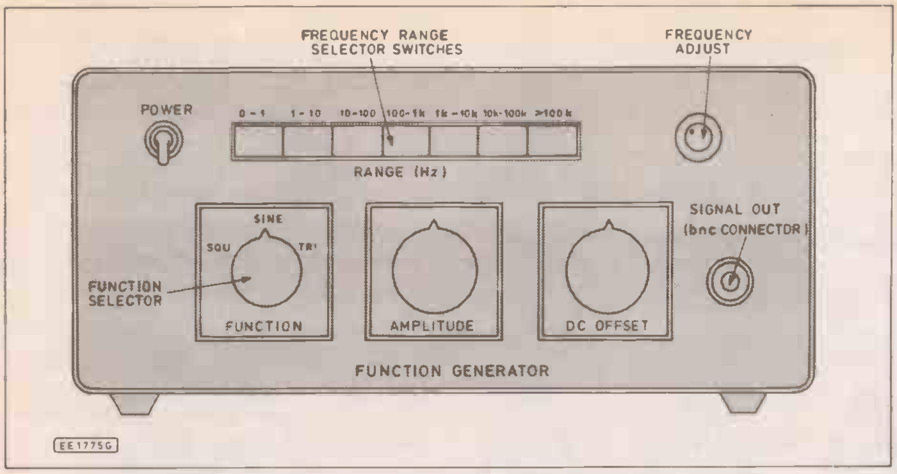


Fig. 4.5. A typical function generator.

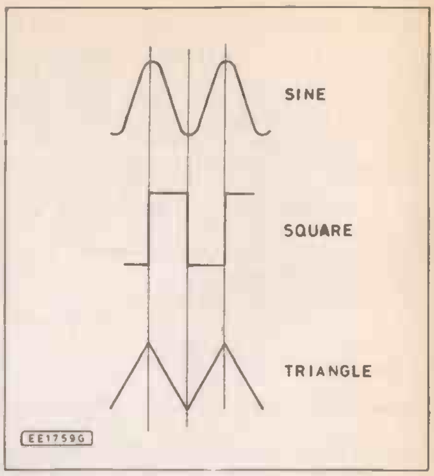


Fig. 4.6. Similarity between the output waveforms of a function generator.

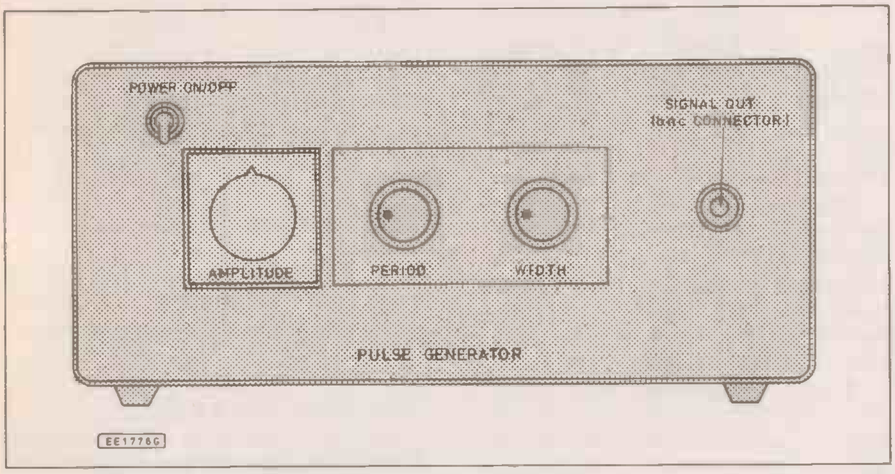


Fig. 4.7. A typical pulse generator.

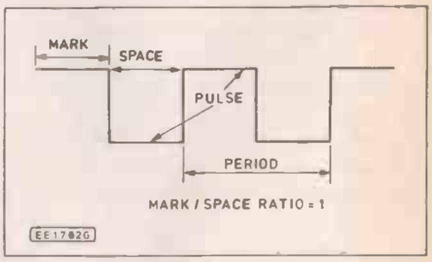


Fig. 4.8. Relationship between pulse width and period.

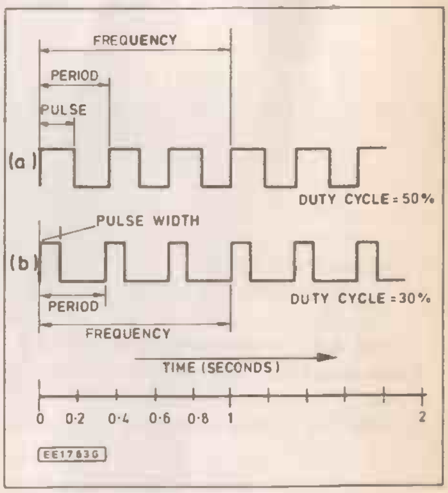


Fig. 4.9. Comparison of squarewave and pulse waveforms of the same frequency.

tainly does) and the charges are usually very reasonable, providing you realise that the electronics tutor is not at your disposal if you have only hired use of the equipment; just remember to ask for the instruction manual for the equipment you will be using. You will almost certainly be charged by the hour, so make sure you are perfectly clear as to what you want to do beforehand.

Electronic Measurement

In testing an electronic system or subsystem for correct operation we need to know what electrons are doing at various points of interest within the circuit. Since we cannot see electrons we need measuring instruments to provide this information. The following measuring instruments are of particular interest to us in this course:

(a) Meters (analogue and digital)
(b) The Oscilloscope
(c) The Logic Probe.

A VERY IMPORTANT SAFETY NOTE

Before making any measurements, read the operators manual for the equipment you are using. Always observe and obey *all* safety precautions for the particular equipment you are working on.

Here are some additional general rules for your attention:

1. Avoid working on any exposed wiring or terminals which exceed 50 volts (at this early stage of your development, *buy* a safe power supply unit for your experiments, rather than constructing one yourself).
2. Ensure correct wiring of "live", "neutral", and "earth" conductors in the mains plug of the equipment you are using.
3. Ensure all equipment is correctly fused and mains plugs and leads are in good condition (i.e. not cracked or broken).
4. Learn the introductory set of safety signs from Appendix 1 of the City and Guilds Resource Document (reproduced in Table 4.1).

Meters

Even at the most rudimentary level of circuit test we need to be able to determine:

(a) How many electrons exist, at a given time, between two points in a circuit; *this is measuring voltage.*
(b) How many electrons are flowing past a certain point in a circuit at a given time; *this is measuring current.*
(c) How much opposition to the flow of electrons has a particular substance (or component); *this is measuring the components resistance.*

TABLE 4.1
Introductory Set Safety Signs

Four types of safety signs are recognised in the Safety Sign Regulations 1980. Examples of each type are given below:

PROHIBITION SIGNS

White background. Red circular band and cross bar. Black symbol detail.

no smoking	smoking and naked flames prohibited	do not extinguish with water	not drinking water

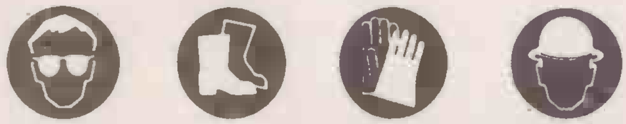
WARNING SIGNS

Yellow background. Black triangular band and symbol detail.

caution, toxic hazard	caution, corrosive hazard	caution, risk of electric shock	caution, risk of fire

MANDATORY SIGNS

Blue background, White symbol.



eye protection must be worn	foot protection must be worn	hand protection must be worn	head protection must be worn

SAFE CONDITION SIGNS

Green background White symbol detail.

Direction	First Aid

Details of Safety Signs are given in BS 5378 "Safety signs and colours" Part 1 "Specification for colour and design." A selection of the signs are given in PD 7307 "Graphical symbols for use in schools and colleges."

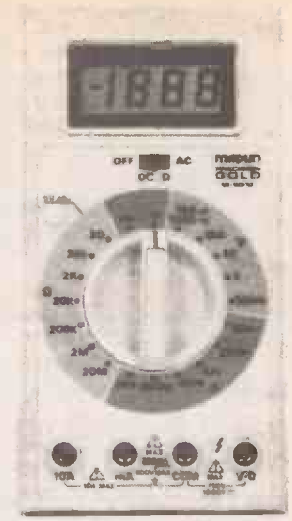


Fig. 4.10b. A digital multimeter.

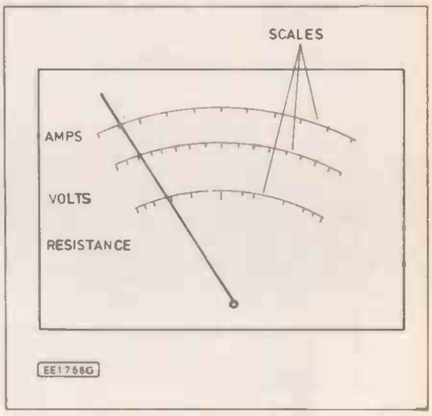


Fig. 4.11a. The scale of an analogue multimeter (scale markings have been separated for clarity).

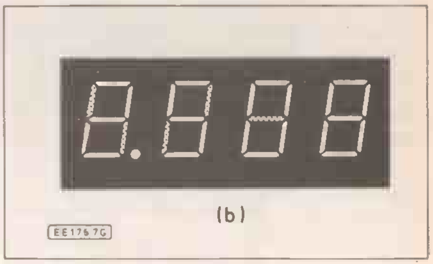


Fig. 4.11b. A digital multimeter display.

Meters are the instruments used for measuring voltage, current, and resistance. Voltmeters are used for measuring voltage, ammeters are used for measuring current, and ohmmeters are used for measuring resistance. It is common, these days, to buy a single instrument which serves as a substitute for all three of these meters; this is a **multimeter** — a combination voltmeter, ammeter, and ohmmeter.

There are two types of multimeter in general use: the "analogue multimeter" (Fig. 4.10a) and the "digital multimeter" (Fig. 4.10b). The analogue meter indicates a value by moving a needle to a position on a graduated scale (Fig. 4.11a), and the digital meter displays the value directly as a number as shown in Fig 4.11b. The meter's display, whether analogue or digital, can only be interpreted with respect to its range setting on the front panel of the meter (Fig. 4.12).

Multimeters vary in appearance from manufacturer to manufacturer, the range settings and the

Fig. 4.10a. An analogue multimeter.

markings on analogue meter scales are usually quite different; however, it is not difficult to work out how to interpret the displayed reading just by examining the front panel settings and graduations on the scales. Consider, for example, how the voltage scale markings in Fig. 4.13a correspond to the range

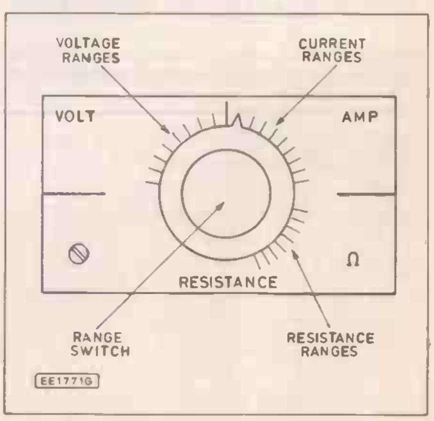


Fig. 4.12. A typical multimeter range switch.

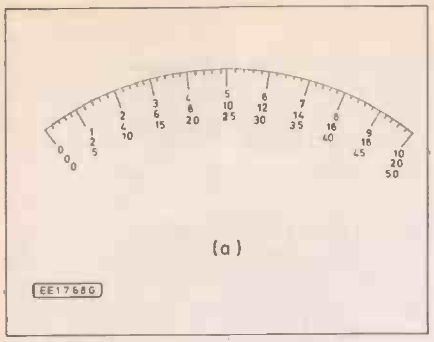


Fig. 4.13a. Voltage scale markings.

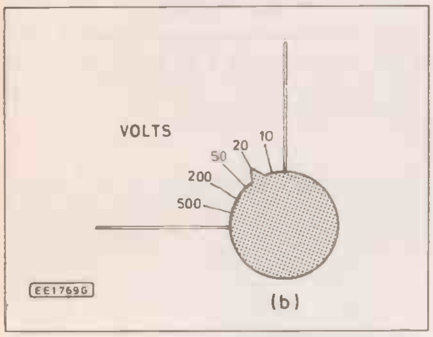


Fig. 4.13b. Range switch setting.

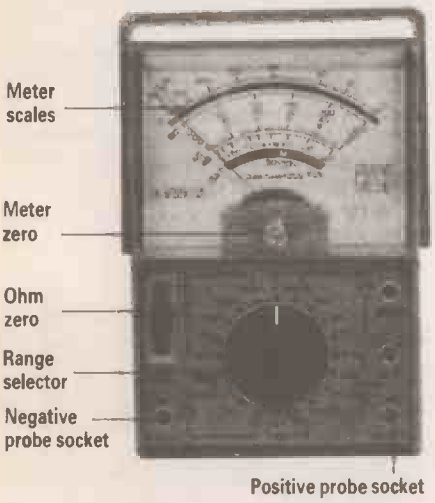


Fig. 4.14. A typical multimeter.

switch setting in Fig. 4.13b. Although there are five voltage ranges and only three scales, it is obvious that the 0-200 and 0-500 volt ranges share the 0-20 and 0-50 scales respectively (when taking readings in these last two ranges, a nought is added to the marked value).

A typical multimeter is depicted in Fig. 4.14 although your own meter (or the one you will be using) will be different, it will contain most, if not all, of the labelled parts in this diagram. The following discussion makes reference to all of these parts and you will need to study the operators manual of your own meter to compare the differences.

Measuring Voltage

Care must be taken that any voltage to be measured is lower than the maximum value for which the meter is designed, otherwise the meter may be damaged.

When measuring voltage, the measurement is always taken "across" the two points of interest; for example, the voltage across the bulb in our ubiquitous diagram (Fig. 4.15) would be measured by touching the meter probes to the two terminals of the bulb holder.

Before actually taking the measurement, though, we need to ask ourselves a few questions in order to make the proper meter settings; are we measuring a.c. or d.c. voltage?, to what voltage range should the meter be set?, to which side of the bulb should the red meter probe be touched?

A.C. or D.C.

If an attempt is made to measure d.c. voltage on an a.c. range an incorrect measurement will be displayed; therefore, it is important to know the type of voltage source supplying the current. We know that batteries supply d.c. and, a.c. is supplied by the mains. Bench power supply units often deliver both a.c. and d.c., depending on switch settings.

A d.c. voltage source has both a negative and a positive terminal. The polarity of a voltage source is usually indicated in some way at its terminals (for example, marking the positive terminal with the symbol "+"and the negative terminal with the symbol "−").

The meter may have an "AC-DC Switch" which must be set according to the type of voltage being measured. The meter must be set to the correct function (a.c. or d.c. voltage, a.c. or d.c. current, or resistance) and range within that function.

Selecting a Range

The most accurate reading on an analogue meter is obtainable by selecting a range for which the part of the circuit being measured causes the needle to point as near to the far end of the scale (full-scale deflection) as possible. The quickest and safest (to the meter) way to do this is by trial and error: Starting from the highest possible voltage range, take the first measurement; if the needle does not move, or is a long way short of full scale, select the next range down and try again . . . and so on until a reading can be taken from near the end of the scale (or at least centre scale).

If, at any time during this procedure, the needle deflects beyond full scale deflection (past the end of the scale), quickly remove the probe from the circuit.

Polarity

In a d.c. circuit the polarity at the terminals of a device (such as the bulb in the figure) is the same as the supply source. The bulb terminal with the red lead connected to it, in the figure, is therefore positive.

The terminals of a multimeter are also coloured or otherwise marked to indicate polarity. The polarity of the multimeter terminals must match the polarity of the part of the circuit being measured (only on the d.c. ranges — a.c. alternates between positive and negative and, therefore, is not polarised). If you fail to observe this rule when you are using an analogue meter, the needle will move opposite to its normal direction and the meter may be damaged.

As an exercise, measure the voltage across the bulb in our torch circuit. Make sure the AC-DC Switch is on DC, and select the range as directed above. Fig. 4.16 shows how to connect the meter probes for correct polarity.

Measuring Current

The diagram of Fig. 4.17 shows how to connect a meter to a circuit

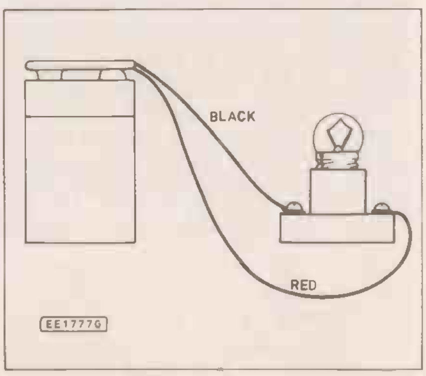


Fig. 4.15. That diagram again!

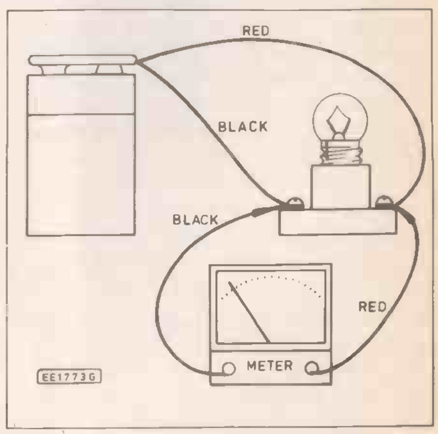


Fig. 4.16. Measuring d.c. voltage.

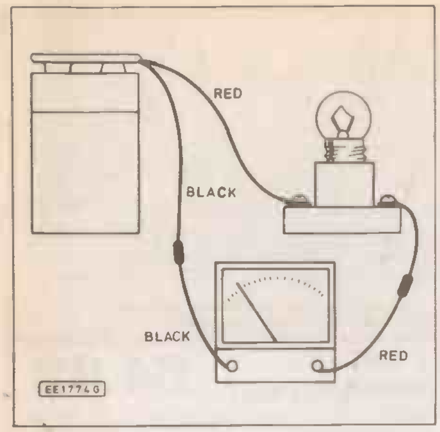


Fig. 4.17. Mesuring d.c. current.

for measuring the amount of current flowing. Notice that the circuit needs to be broken to allow the meter to become part of the circuit so that current can flow through it.

The meter must be set to an appropriate current range (select the range by moving slowly down the ranges as you did for voltage) and it is important to ensure that you are on the correct a.c. or d.c. setting.

Polarity is also important when measuring d.c. current; the positive meter probe should be connected to the more positive side of the break in the circuit. Electrons flow from negative to positive, so they should enter the negative terminal of the meter and leave its positive terminal.

As an exercise, measure the current flowing in our torch circuit. Make sure the AC-DC Switch is on DC, and select the range as directed above. Fig. 4.17 shows how to connect the meter probes for correct polarity.

Measuring Resistance

Resistance is a physical property of all meterials and is the materials ability to resist the flow of electrons through itself. A good conductor of electricity has a small or low resistance, and a poor conductor has a high resistance. We give thorough treatment to electrical resistance in Part 7; for now, we deal with how to measure it.

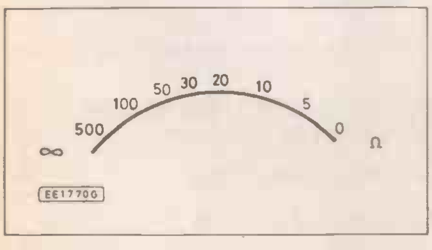


Fig. 4.18. Resistance range marking.

A typical ohms scale is shown in Fig. 4.18, it ranges between zero ohms (the perfect conductor) and infinity (this would be the perfect insulator if such a thing existed — there are no perfect conductors or perfect insulators).

When measuring resistance we can ignore the AC-DC Switch and any regard of polarity, once a resistance range has been selected the meter is ready to measure; however, before accurate measurements can be made, the ohmmeter part of the multimeter needs to be calibrated.

Calibrating the Ohms Range

The ohms range of an analogue meter must be "zeroed" before any accurate measurement can be made. The calibration procedure is similar for all meters; steps two and three that follow are not always required:

1. Set the range switch to X1.
2. Check the needle at rest, it should be positioned exactly on the infinity line — if your meter has a mirror built into the display, position your eyes over the meter in such a way that you cannot see the needle's reflection in the mirror (this ensures that you are oriented for accurate interpretation of the meter — it eliminates what is known as the paralax error).
3. If the needle is sitting either side of the line, it can be adjusted using a small screwdriver on an adjust screw, either on the meter face or the back of the meter.
4. Touch together the tips of the two meter probe leads so that the needle deflects to the right hand side of the scale. If the needle does not sit directly over the ohms zero, adjust the ZERO-OHM control (see Fig. 4.14) until it does (this is called "zeroing the Ohm's range").

Now, if you look at the Ohm's scale, you will see that the number 20 is about half way along the scale; therefore, an 18 ohm resistor should deflect the needle approximately half way. Connect the red meter probe to one leg of an 18 ohm resistor and the black probe to the other leg. Does it read about 18 ohms? — it may not be exactly this because the resistor has a tolerance, also, the meter is not 100 per cent accurate.

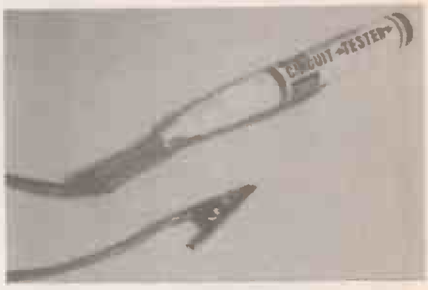
Using the same resistor, change the rotary switch to position ×10 and observe the reading. It should read about 1.8 ohms. Since you are on the ×10 range you must multiply your reading by 10 to give the correct reading.

Now measure the 180 ohm resistor on the ×10 range, the 1.8 kilohm resistor on the ×100 range, and the 18 kilohm resistor on the ×1000 range. The needle should remain at about the centre of the scale for all readings.

Continuity Testing

A multimeter on the Ohm's range can be useful as a continuity tester. Continuity testers are used for testing fuses, cables, and wires for open circuit. We will be using the torch assembly (Fig. 4.1) as a continuity tester.

The photo below shows a commercially available continuity tester which simply "bleeps" to indicate continuity between the two probes. This instrument can only be used for testing fuses, wires and other conductors for open or closed circuits.



Reading Digital Meters

Digital multimeters are easier to use since it is not necessary to interpret a given reading from a graduated scale. The position of the decimal point, however, must be carefully observed and the reading interpreted according to the range setting.

It would be worthwhile for you to repeat the above exercise (using the 18 ohm, 180 ohm, 1.8k, and 18k resistors), this time using a digital meter.

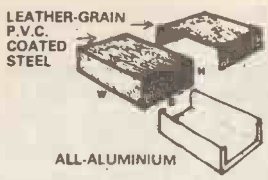
After you have measured all these resistors, and experimented with all the settings on the ohms range, there is nothing left to say about reading digital meters except, perhaps, to remind you that the same decimal point manipulation applies to all ranges. For example, on a 200mA d.c. range the result is displayed in milli-amps and would require moving the decimal point three places to the left for a reading expressed in amperes.

Answers to Part 3, page 32.

NOTE Unfortunately, this part has turned out much longer than anticipated, and rather than cut back the material we have held over "The Oscilloscope" and "Logic Probes" to next month, together with the Exercises and Questions.(We also hope to fit in Prototyping and Circuit Assembly to keep to our published timetable).

We are also still receiving letters from Assessment Centers and will publish a couple of pages of them next month.

EQUIPMENT CASES



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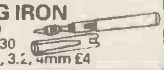

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•••Sinewave Generation•••

IN EARLIER articles in this series we have discussed the use of the timer/counters in the BBC computer to provide logic level output signals of certain durations and frequencies. While the ability to produce logic output signals over a wide range of frequencies is undoubtedly a useful one, such a signal is of limited value for audio frequency testing.

Much audio checking, such as frequency response measurements, requires a reasonably pure sinewave signal. You have to bear in mind here that the squarewave output from timer 1 of the BBC computer's user port does not just contain the fundamental frequency. It also contains strong harmonics (multiples of the fundamental frequency). To be precise, it is the odd order harmonics that are present (3, 5, 7, etc. times the fundamental frequency). Having a test signal which contains strong components over a wide range of frequencies would clearly compromise the accuracy of frequency response tests.

Switched Capacitors

Although the squarewave output from the user port may be unsuitable for much audio testing, this signal can be processed to give a more suitable signal, or it can act as the control signal for a sinewave generator. This second method is the one we will consider first. Basically what this involves is using the output from the user port as the clock signal for a digital sinewave generator.

The clock frequency of the circuit is at some multiple of the output frequency. For example, assume that the output frequency from the user port is at 100kHz and that the ratio of the clock frequency to the output frequency is 100 to 1. Obviously a sinewave signal at 1kHz will be produced by the circuit. By altering the clock frequency the output frequency can be varied over wide limits.

Unfortunately, the timers of the BBC computer tend to give good resolution at low frequencies and relatively coarse resolution at high frequencies. By effectively dividing the output frequency by a substantial factor a digital sinewave generator exacerbates the problem. High frequencies cannot be obtained at all. Despite this limitation, it is a system that can provide some useful results when applied to the BBC computer.

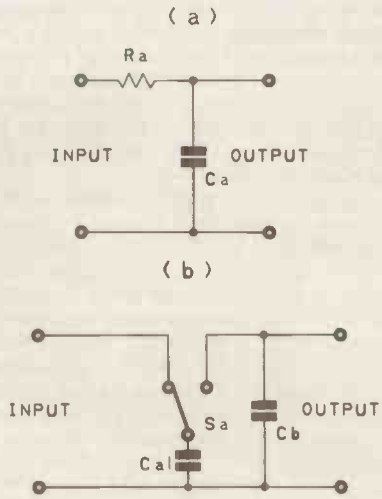

Fig. 2. The switched capacitor filter (b) is equivalent to a standard R-C lowpass filter (a).

The circuit diagram for a simple digital sinewave generator that is suitable for operation with the BBC range of computers is shown in Fig. 1. It is based on the MF10CN switched capacitor filter. Actually there are two twin pole filters in the MF10CN, but in this application only one section of the device is utilized.

R-C Lowpass Filter

A switched capacitor filter operates in a manner which has similarities to an ordinary R-C lowpass filter. Fig. 2 shows the circuit for a conventional R-C lowpass filter together with its switched capacitor equivalent. In the R-C version the filtering is obtained due to the resistor limiting the rate at which the capacitor can be charged or discharged by the input signal. At very low input frequencies slow charge and discharge rates are adequate to let the output faithfully track the input signal. At very high frequencies there may well be no significant output signal at all. The cutoff frequency of the filter is governed by the resistor and capacitor values, and it is inversely proportional to both of these.

In the switched capacitor version the resistor has been replaced by a small capacitor (C_a)and an electronic switch. The switch is controlled by a clock signal, and repeatedly goes to and fro at a rate which is controlled by this clock signal. As it does so, it charges up C_a across the input, and then discharges it into C_b at the output. It therefore provides a signal transfer from the input to the output, and in this respect it is analogous to the resistor of the R-C filter. It is also comparable in that it only provides a limited signal transfer.

The important point here is that C_a has a very low value in relation to that of C_b. Consequently, any large change in the input signal's level require several transfers via C_a in order to give a similar change in the output signal's level. In other words, with the input frequency well below the clock frequency the signal passes through the circuit with minimal losses, but as the input frequency begins to get close to the clock frequency there are severe losses through the circuit. This gives the required correlation between clock frequency and cutoff frequency.

Digital Sinewaves

Although a basic switched capacitor filter only provides lowpass filtering, some additional circuitry can convert this to any of the standard types of filtering. The MF10CN includes two switched capacitor

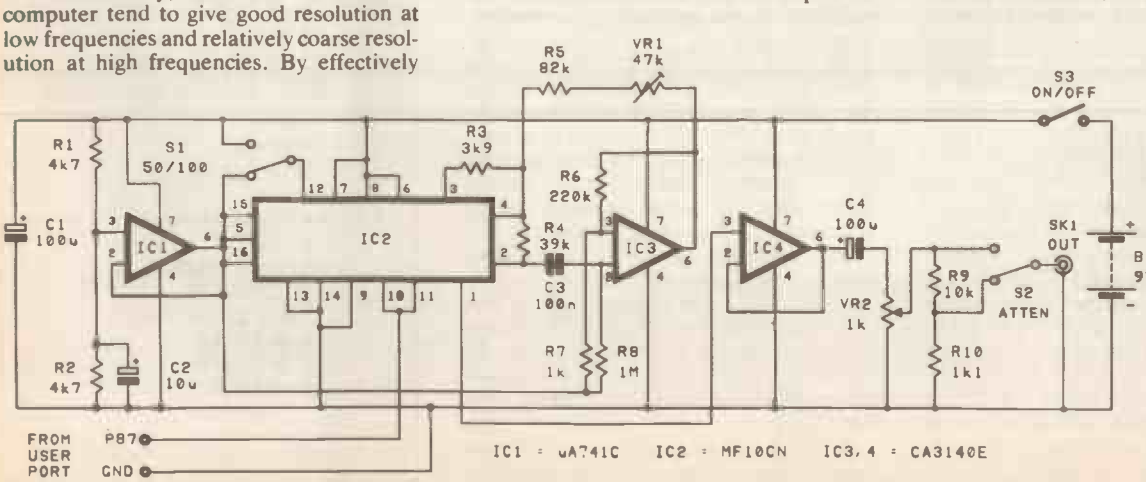

Fig. 1. The Digital Sinewave Generator

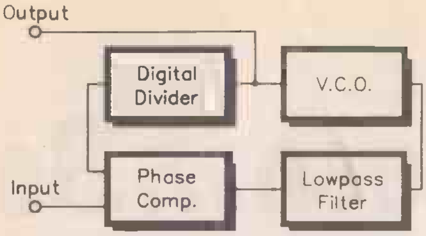

Fig. 3. The system used for harmonic locking.

filters in each section, plus the circuitry needed to provide any of the standard types of filtering. In this case the MF10CN provides a form of bandpass filtering with feedback provided via a trigger circuit based on IC3. The circuit therefore oscillates at the centre frequency of the filter.

Variable Resistor VR1 is used to control the feedback level and is given any setting that gives a good sinewave output signal. Good results are obtained with an output level of about one volt r.m.s. (2.8 volts peak to peak). Although many sinewave oscillators need gain stabilisation in order to give consistent results over a wide frequency range, this circuit works well without any automatic feedback level control circuit. IC4 is an output buffer amplifier, and this feeds into variable attenuator VR2. This in turn feeds into a simple switched attenuator that can provide 20dB of attenuation (i.e. reduce the output level by a factor of ten). Accurately setting low output levels using VR2 is easier if S2 is set for 20dB of attenuation.

Digitized

The MF10CN can have a clock to filter frequency ratio of either 50 to 1 with pin 12 taken to the positive supply rail, or 100 to 1 if it is taken to the mid-supply level. The desired ratio is selected using S1. Where possible it is better to use the higher ratio as this gives a higher quality output signal. The output is a form of digitized signal, and it is a stepped waveform.

With a ratio of 50 to 1 the steps are clearly visible if the output signal is displayed on an oscilloscope. With a 100 to 1 ratio they are barely discernable, and the output signal sound noticeably purer. In fact with a 100 to 1 ratio the purity of the output signal is at least as good as many other types of sinewave generator circuit, and with either ratio it is perfectly adequate for all but the most specialised of frequency response tests.

Power for the circuit is obtained from a 9 volt battery, with the mid-supply bias level being provided by a simple supply splitter based on IC1. It would probably be possible to modify the unit to operate on the plus and minus 5V outputs of the BBC micro's power port, or the +12V output could be dropped down to the required level of 9 to 10 volts. However, I have not tried either of these methods in practice.

Testing

In order to test the unit you must set up timer 1 in the free running mode, and with its output directed to line PB7 of the user port. Various values are then written to the high and low bytes of timer 1 in order to ensure that the oscillator operates properly over a wide frequency range. An oscilloscope, crystal earphone, signal tracer, etc. can be used to monitor the output of the signal generator circuit. This simple test circuit sets up timer 1 in the appropriate manner and allows you to input values that are sent to the low and high bytes of its counter.

```
10 REM AF GENERATOR TEST PROG
20 ?&FE6B = 192
30 INPUT "LOW BYTE" L
40 ?&FE66 = L
50 INPUT "HIGH BYTE" H
60 ?&FE65 = H
70 GOTO 30
```

I will not go into great detail about the 6522 v.i.a.'s timers here as they were covered in the BEEB Micro article to be found in the March 1987 issue of *Everyday Electronics*. I will describe the basic way in which timer 1 operates in this mode of operation as it is essential to understand this in order to be able to set the required output frequency. The basic action is for the system clock to be divided by the value in the timer 1 counter. The two values sent to the counter of timer 1 together form a 16 bit number. Multiplying the high byte by 256 and adding it to the low byte gives the overall division rate.

Things are not quite as simple as this, because the 2MHz clock signal is reduced from 2MHz to 1MHz before reaching the 6522 v.i.a. Also, it takes two clock cycles for each reload of the counters. A further factor to take into account is that PB7 is toggled at the end of each count. Therefore, two counts are needed per output cycle. What this means in practice is that the minimum division rate (i.e. both bytes at zero) is 8, giving a maximum output frequency of 250kHz. The length of one cycle (in microseconds) is 2× (N+2), where "N" is the value written to the counter. Dividing 1 by this figure gives the output frequency in MHz. Use 1,000 or 1,000,000 instead of 1 in order to obtain an answer in kHz and Hz respectively.

As a simple example, with a value of 3 written to the counter, adding 2 to this figure and doubling it gives an answer of 10μs (3+2=5, 5×2=10). Dividing 1,000 by 10μs gives an output frequency of 100kHz. Remember that this is the clock frequency which must be divided by 50 or 100 (depending on the setting of S1) in order to obtain the output frequency of the sinewave generator circuit.

Harmonic Locking

A maximum clock frequency of 250kHz is a bit limiting in that it permits a maximum operating frequency from the sinewave oscillator of just 5kHz. This falls some way short of the 20kHz upper limit of the audio spectrum. Also, if the output from PB7 is required as a digital test signal, 250kHz might limit its usefulness.

There is a method of obtaining increased maximum frequency, and this is to use harmonic locking. Fig. 3 shows the arrangement used to provide harmonic locking which is a form of frequency multiplication. If we ignore the digital divider for the moment, the other three stages form what is just a standard phase loop. This keeps the v.c.o. (voltage controlled oscillator) locked onto the same frequency as the input signal, and in-phase with it.

The important stage is the phase comparator which, after smoothing by the lowpass filter, produces an output voltage that is proportional to the phase and frequency difference betwen its two input signals. Its output is used to control one v.c.o., and there is a standard negative feedback loop here.

If the input frequency increases, this produces a higher output voltage from the phase comparator, and the v.c.o. goes higher in frequency. However, it only goes high enough in frequency to balance the two input frequencies at the phase comparator. A higher frequency would produce an opposite imbalance, the output voltage of the phase comparator would reduce, and so would the v.c.o.'s operating frequency.

With the digital divider circuit included in the system it still operates in much the same way as before. However, to compensate for the reduction in frequency through the divider the v.c.o. must operate at a higher frequency in order to maintain the balance. For example, with a divide by ten circuit the v.c.o. would go to ten times the input frequency in order to match the two input frequencies at the phase comparator. In theory, the v.c.o. can be locked onto any multiple of the input frequency by using a divider circuit having the appropriate division rate.

The output frequency range from PB7 of the BBC computer is from about 7.6Hz to 250kHz. With the aid of harmonic locking and frequency multiplication by a factor of 10, this could be changed to a range of 76Hz to 2.5MHz, which is more suitable for some applications. In the case of the sinewave generator circuit this would give a frequency range of approximately 0.76Hz to around 30kHz. The upper limit would be governed by the MF10CN's parameters rather than the maximum available clock frequency. Resolution at high frequencies would still not be particularly good, but would be adequate for many purposes.

This is fine in theory, but in practice it is difficult to obtain harmonic locking over a suitably wide frequency range. However, as we shall see in the next BEEB Micro article, it can be done, and using quite simple circuitry.

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CHARGING Ni-Cads

By Ivor Abelson B.Sc.

Some Necessary Precautions

THE recent article on a Ni-Cad charger by Costas Calamvokis (August 1988) gives only basic information on charge rates. Some further data is of importance if best results and proper life is to be obtained from cells and in particular, the PP3 size battery.

Ni-Cads are made in two types. Larger sizes use sintered electrodes and can stand substantial overcharging. Button cells and batteries made from them, which includes the PP3 size, use solid electrodes to save space, and have no real capability to withstand overcharging.

Charge Rate

It seems correct to say that a charge rate based on a 16 hour time is safe for permanent charging, if and ONLY IF, the cell is kept cool. In a practical situation, heat will build up, especially in one-piece chargers where heat from the mains transformer will worsen the position. As the leakage current in a sintered plate cell is high, self discharge in a month is not unusual, many users will wish to keep the cells on permanent charge, transferring them into the instrument to be powered just prior to use. One remedy is to have a switch giving normal charge rate and a "standby" rate of say 0.5mA. A simpler step is to halve the 12 to 14 hour charge rate. In most applications using standby charging, a 24 hour charge time is not excessive.

In the case of solid plate cells, the self discharge rate is slow, the charge being held for perhaps a year, a performance not as good as with non-rechargeable alkaline-manganese cells which should have a shelf life of three years, but is nevertheless a very useful span. The very serious problem is that the 12 to 14 hour charge rate means exactly this, that a fully discharged solid plate cell or battery must be charged for *no more* than 14 hours! Anything longer is destructive.

The safe continuous charge current is about a tenth of the 12 to 14 hour current, with a typical PP3 it is 1.1mA. So we are looking at a full working week charging time!

One way out of this is to ensure the solid plate Ni-Cad is fully discharged and then use a timer to switch off after 14 hours, not very convenient and quite costly. The better solution is to buy extra Ni-Cads so one or more can remain on charge at the safe continuous rate. The low self discharge rate makes it feasible to leave such Ni-Cads in the instrument.

The author has five small instruments powered by PP3 types, a frequency counter, an audio generator (featured in EE), a sound level meter, a miniature vacuum cleaner and a pocket radio, and keeps two PP3's permanently on a charge of 1.1mA. This proves a very practical approach. A less busy user might transfer his PP3 Ni-Cad between charger and equipment as required.

Duty Cycle

With larger cells it is worth considering the duty cycle. A frequently used personal tape player would be given a change of Ni-Cads each day so a 12 to 14 hour charge rate is safe. This would not be the case with a shaver where depending on the beard, a monthly change is typical. So it is best to charge at the 24 hour rate then.

For some applications it may be best to change from sintered plate cells to button cells. A doctor friend found a piece of medical equipment of very little use as when the time came to measure with it, the cells had self discharged.

The obvious step was to use alkaline-manganes cells but due to the economy policy at his place of work, this was frowned on. The use of solid plate button cells, with the charger altered to give the continuous charge rate, solved the problem. □

*The author is honorary technical advisor to the *Charity "Music for the Blind and Disabled", based in south-East Essex. the charity would be pleased to hear from anybody able to play an instrument or with sound equipment who would be prepared to help the group in its work. Youngsters who use school-provided instruments are welcome as the charity has numerous donated instruments from cellos to mouth organs.*

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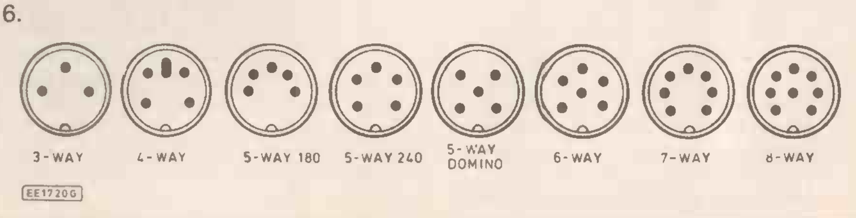

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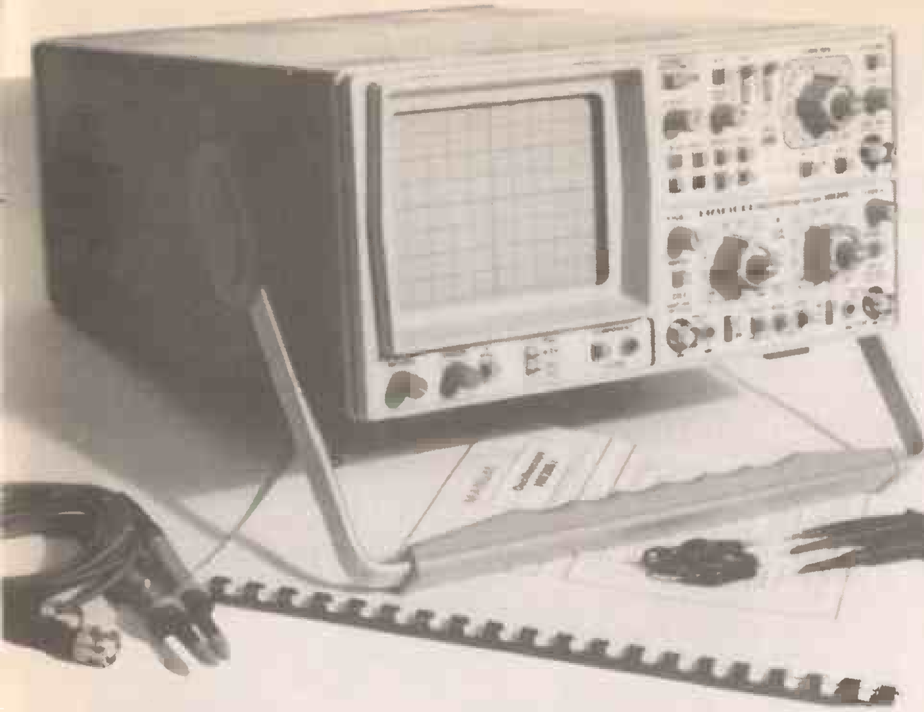

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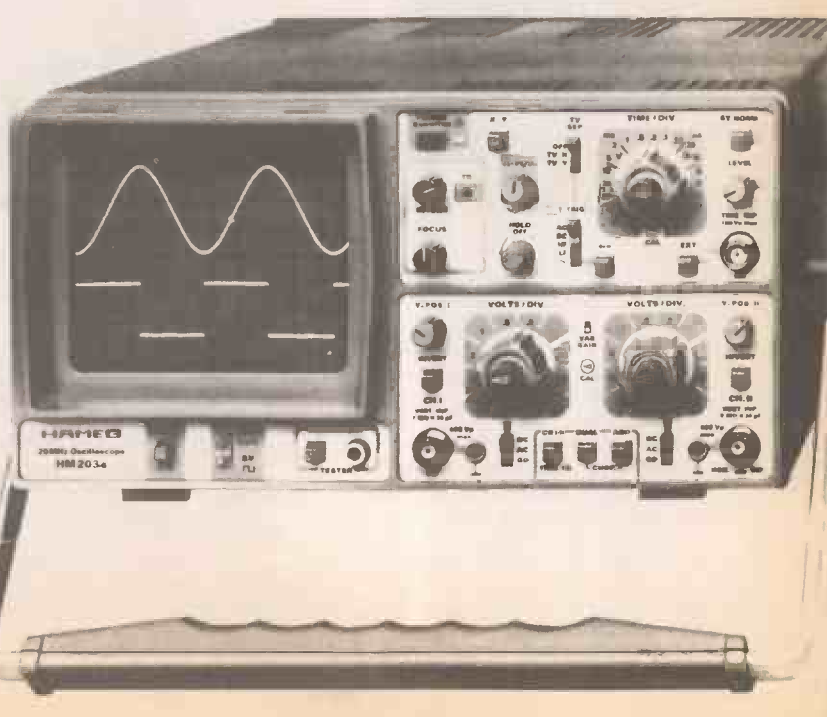

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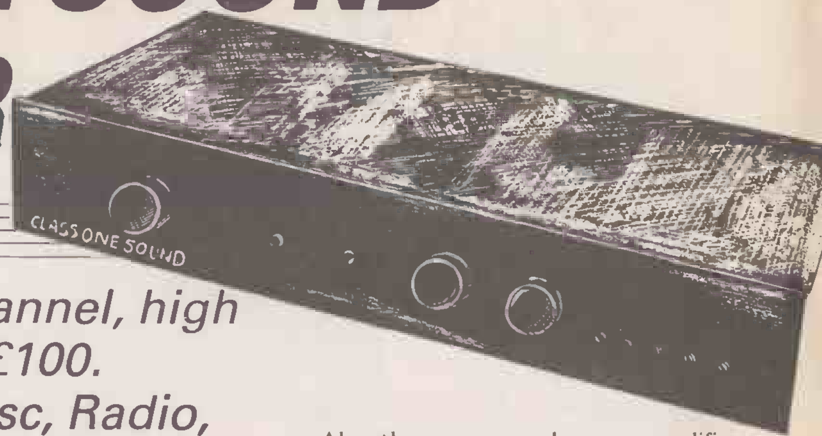
Constructional Project

CLASS ONE SOUND AMPLIFIER



GRAHAM NALTY

A single board, 20W per channel, high quality amplifier for under £100. Inputs for Disc, Compact Disc, Radio, Video and Tape.

AUDIO amplifiers are among the most popular constructional projects featured in electronics magazines. This is rightly so as audio amplifiers are not only interesting projects to build, but also have a long useful working life when completed. Not only do you learn from building it and enjoy the satisfaction from completing it, but you own a very useful product which has cost you much less than you would pay to buy a ready made equivalent. In the case of the DM20 Class One Sound Amplifier, the standard of construction you can achieve without the use of specialist tools is equal to the very best manufactured amplifiers.

The DM20 (Dual Mono 20W) has been designed as a very special project. It is not simply another amplifier project, but designed to be the best that could be produced using today's technology, in terms of value for money, sound quality, presentation and the education value of construction and testing.

VALUE FOR MONEY

The DM20 has been budgeted to sell as a complete kit for under £100. Though this budget is tight, this has been achieved by passing on savings from bulk buying of components, without compromise on sound quality or presentation.

SOUND QUALITY

The DM20 has several features which improve its sound quality over amplifiers which the reader might consider comparable.

1. Oversize mains transformer, rated at twice the full power output of both channels together.
2. Separate transformer windings, rectifiers and reservoir capacitors for left and right channel for improved stereo performance.
3. Separate rectifiers and reservoir capacitors for low and high current parts of power amplifier and for preamplifier.
4. Large heatsink for low temperature generated distortion as well as reliable operation.
5. T0220 driver transistors for low temperature generated distortion.
6. Cascode circuitry in drive stage of power amplifier for greater linearity and improved high frequency performance.
7. Special two-transistor input stage for improved sound quality (see later explanation).
8. Power amplifier negative feedback a.c. path taken outside the output capacitor.
9. High quality metal film resistors and plastic film capacitors used extensively.
10. Two stages of power supply filtering for preamp.
11. Special disc circuit designed for good power supply ripple rejection.
12. High quality silver plated switches used for signal switching.

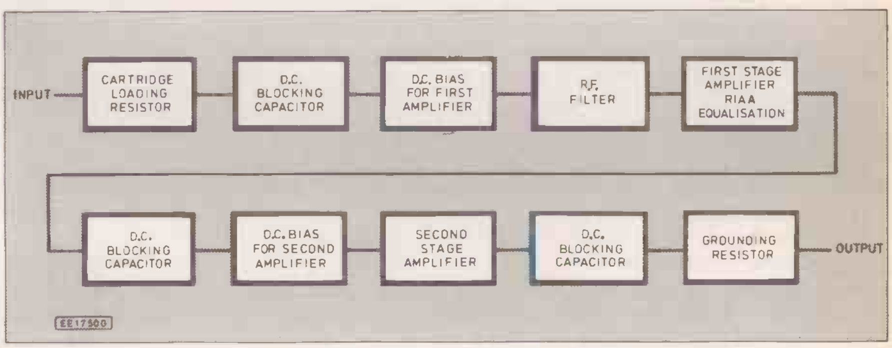


Fig. 1. Block diagram for the preamplifier stages.

PRESENTATION

Presentation is an important part of selling an amplifier. It is not good enough to offer high quality electronic design in a dull box. Good styling will attract the attention of potential buyers and, if backed up by good performance and the required features, will win the sale. After buying the owner will feel privileged to possess the product, show it off to friends, and boast about it at the pub.

The DM20 has been developed so that the hardware can be used for a manufactured version, with or without minor cosmetic changes, competing with the very best available.

EDUCATIONAL VALUE

The DM20 provides excellent opportunities for electronics teaching. The most attractive feature is the high motivation of students to complete it so they can use it. Also the preamp and power amplifier stages have different levels of complexity and can be used on their own for students at different levels.

Students wishing to gain experience of making printed circuits boards will find the preamp section easy for making their own layout whilst a single channel of the power amplifier will provide a more exacting challenge for experienced students. (If there is a demand Audiokits can supply printed circuit boards separately for the preamp only or for one channel of the power amp.)

A major problem for educational establishments is the cost of purchasing components for a project. With this in mind arrangements have been made for special bulk prices for items such as the heatsinks, printed circuit boards and input sockets purchased in quantity. Further savings can be made by using 5 per cent carbon resistors in place of metal film resistors, and electrolytic capacitors in place of polyester capacitors (provided the correct polarity is observed, but not C3, C4, C103, C104) and substituting the switch system for one four pole two way rotary plus a toggle for tape monitor.

Single winding transformers can be used provided one lead is connected to both fused input lines and the other is connected to both non-fused lines. Such measures will reduce the sonic performance of the amplifier but the amplifier will still work. Note: test voltages may be different to those measured using a transformer with separate windings.

The use of separate power supplies for each stage makes testing of the amplifier a more logical process and enhances its value as a training exercise.

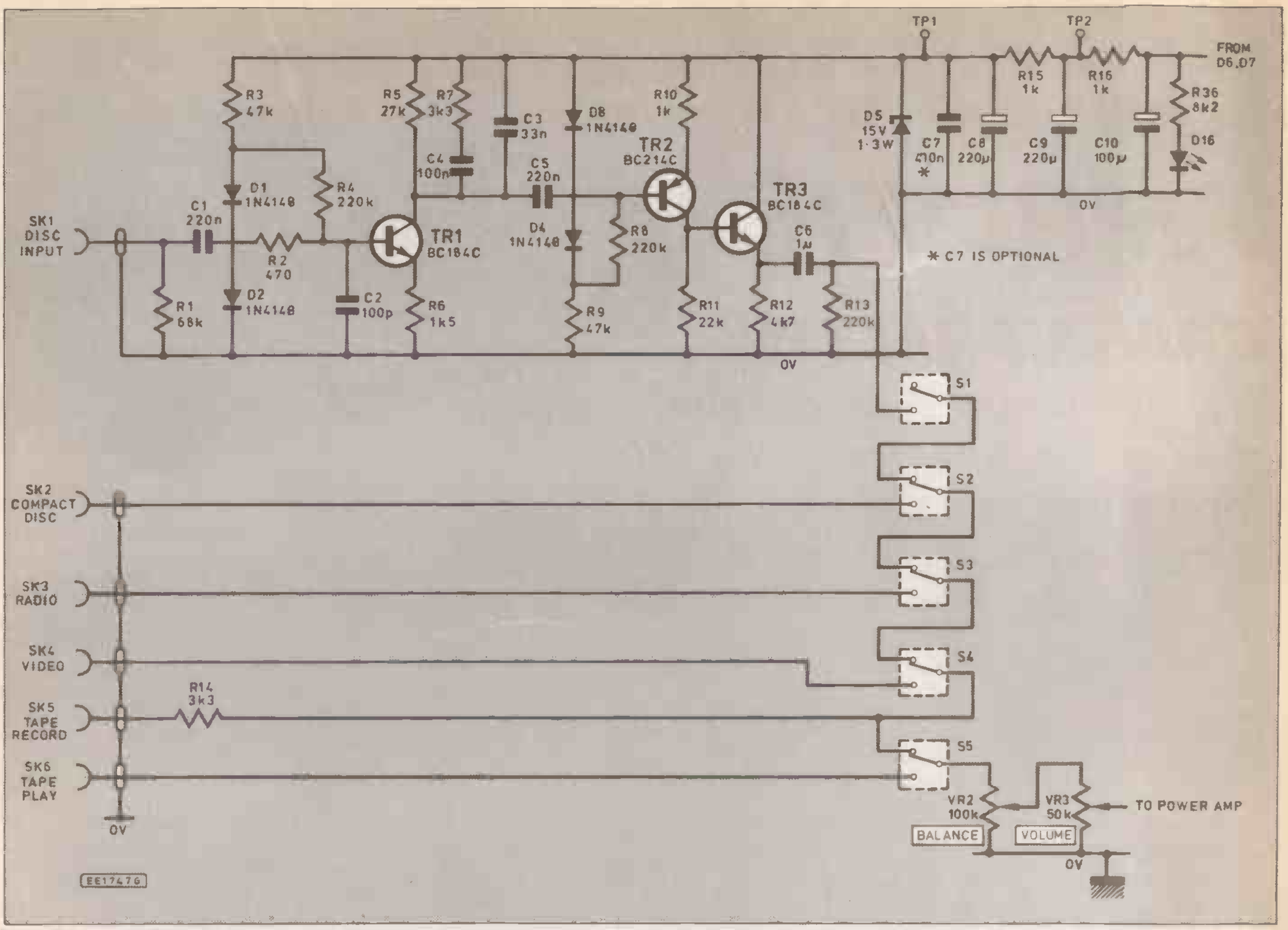


Fig. 2. Full circuit diagram for the preamplifier stages showing inputs for disc, CD, radio, video and tape.

CIRCUIT DESIGN

The circuit uses standard components which are easily obtainable. Many readers might be expected to see the latest audio integrated circuits but there are several good reasons why discrete components are used. Firstly the use of integrated circuits would require more complex power supplies. Secondly building the amplifier with integrated circuits would make the project less useful for educational and training purposes. Thirdly I see no reason why the use of integrated circuits could improve the sound quality.

Tone controls are not included in this design. If any readers wish to add tone controls, the tone control circuit used in the *Apex Preamp* (EE March and April 1987) is ideally suited.

PREAMP

The preamplifier is a simple but very effective circuit. Its operation is very easy to understand and it contains three stages;

Stage 1: common emitter amplifier using *npn* transistor.

Stage 2: common emitter amplifier using *pnp* transistor.

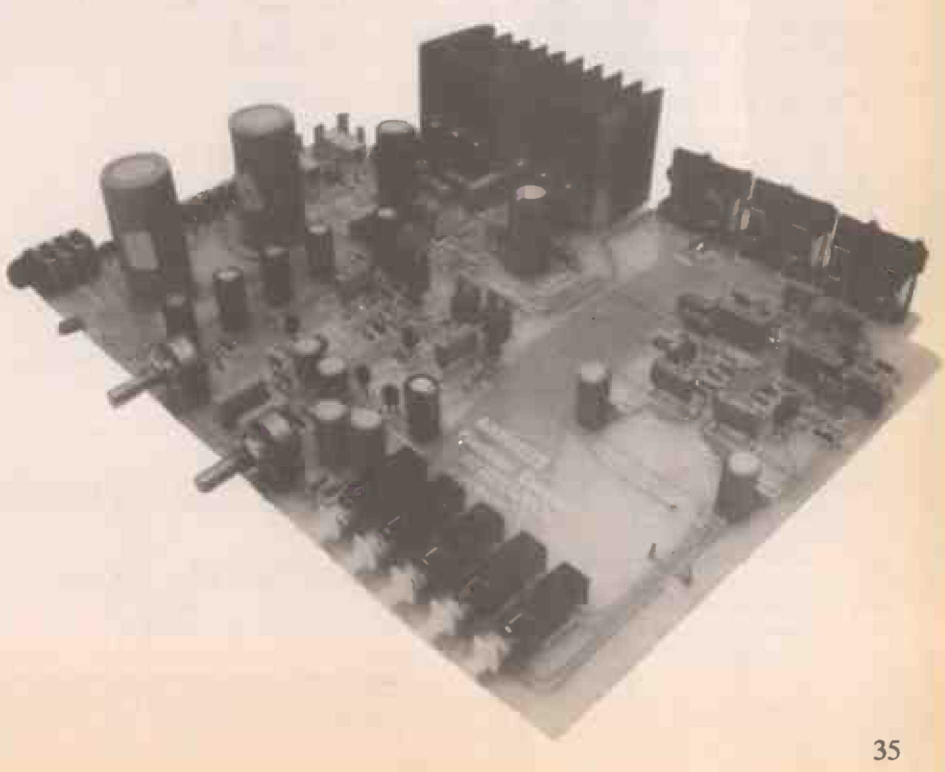
Stage 3: emitter follower.

All other components are included to enable these three stages to work effectively and a full block diagram is shown in Fig. 1. The preamplifier circuit diagram is shown in Fig. 2.

1. Cartridge loading resistor R1. This has two functions. The first is to set the d.c. potential of the input side of C1 to ground so that no large transients are generated when a cartridge is connected and the second is to provide the required resistive load to the cartridge to enable the cartridge to perform at its best. The frequency response of the cartridge will vary with varying load resistance.

2. D.C. blocking capacitor C1. This allows all audio frequency signals to pass, but blocks d.c. This is necessary because the circuit requires different voltages between the input and the base of TR1.

3. D.C. bias circuit D1, D2, R3, R4. Transistor TR1 requires a d.c. voltage of around 0.8V to 1.0V to work properly.



Diodes D1 and D2 are conducting with a current taken from the supply via R3. This gives a voltage close to 1.2V at the anode of D1. Current flows via R4 to the base of TR1. The product of TR1 base current ×R4 gives a voltage of around 0.3V to set the base of TR1 at around 0.9V.

4. Radio frequency filter R2, C2. This prevents any radio frequency signals which see the leads from the cartridge as an aerial being demodulated by TR1.

5. First amplifier stage TR1, R5, R6, R7, C3, C4. The d.c. current through TR1 is determined by the d.c. voltage at the base. The base emitter junction will have a volts drop of 0.6V and so the voltage across R6 will be around 0.3V. As the transistor has a high gain, the d.c. current through R5 will be the same as through R6. A low frequency a.c. signal at the base of TR1 will be amplified by the ratio R5/R6, but as the frequency of the signal increases the gain will decrease, due to the effects of C3 and C4/R7. This frequency selective circuit provides equalisation for records which are recorded at higher levels at high frequencies to reduce the overall noise.

6. D.C. blocking capacitor C5 enables d.c. potentials to be different at either side whilst allowing all audio frequency signals to pass.

7. D.C. bias D3, D4, R8, R9. Operates as in paragraph 3 above but is referenced to the supply.

8. Second amplifier TR2, R10, R11. Operates as TR1 but in reverse polarity and constant gain at all frequencies.

9. Emitter follower TR3, R12. This reduces the output impedance of the circuit. If this were omitted and a tape deck were connected at the output the gain of the circuit would be considerably reduced by the effect of the tape input impedance in parallel with R11.

10. D.C. blocking capacitor C6 prevents the d.c. at TR3 emitter reaching the output.

11. D.C. grounding resistor R13 holds the output at zero d.c. voltage.

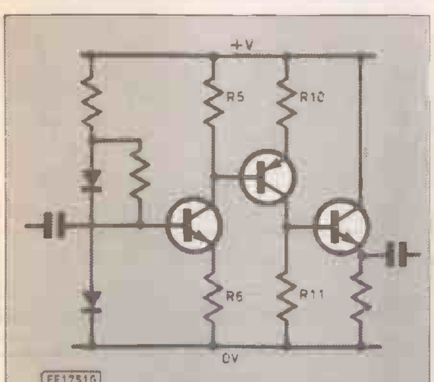


Fig. 3. Basic amplifier circuit.

POWER AMPLIFIER

To the newcomer the power amplifier may look rather complex. It is quite simple but has a number of features added to make it work exactly as we require it. If we look at the circuit of Fig. 3, we see a circuit that looks like the preamp, but omits the frequency selective network on TR1 collector and the d.c. blocking capacitor between

COMPONENTS

Shop Talk
See page 18

Resistors

R1, R101	68k (2 off)
R2, R102	470 (2 off)
R3, R9, R24, R103, R104, R124	47k (6 off)
R4, R9, R13, R104, R108, R113	220k (6 off)
R5, R19, R105, R119	27k (4 off)
R6, R106	1k5 (2 off)
R7, R14, R107, R114	3k3 (4 off)
R10, R15, R16, R17, R21, R110, R115, R116, R117, R121	1k (10 off)
R11, R20, R30, R111, R120, R130	22k (6 off)
R12, R112	4k7 (2 off)
R18, R118	100k (2 off)
R22, R122	1M (2 off)
R23, R123	100 (2 off)
R25, R125	22 (2 off)
R26, R31, R126, R131	220 (4 off)
R27, R28, R127, R128	1 1W metal oxide (4 off)
R29, R129	10 (2 off)
R32, R132	680 1W (2 off)
R33, R133	330 (2 off)
R34, R134	22k carbon (2 off)
R35, R135	47 5W W/W (2 off)
R36	8k2 carbon

Metal film unless otherwise stated

Potentiometers

VR1, VR101	1k carbon preset (2 off)
VR2, VR102	100k MN (balance) (ALPS 16mm)
VR3, VR103	50k log.stereo (ALPS 16mm)

Capacitors

C1, C5, C101, C105	220n polyester 10/15mm pitch (4 off)
C2, C102	100p Polystyrene (2 off)
C3, C103	33n 5% polyester 10/15mm pitch (2 off)
C4, C104	100n 5% polyester 10/15mm pitch (2 off)
C6, C14, C106, C114	1μ polyester 15mm pitch (4 off)
C7, C107	470n optional bypass (2 off)
C8, C9, C108, C109	220μ elect. 35V 5mm pitch (4 off)
C10, C19, C21, C110, C119, C121	100μ elect. 63V 5mm pitch (6 off)
C11, C22, C111, C122	470n polyester 15mm pitch (4 off)
C12, C112	220p polystyrene (2 off)
C13, C113	47μ elect. 63V (2 off)
C15, C115	10p polystyrene (2 off)
C16, C116	100n polycarbonate 10mm pitch (2 off)
C17, C117	1000μ elect. 40V 7.5mm pitch (2 off)
C18, C20, C118, C120	470n optional bypass (4 off)
C23, C123	100μ elect. 63V elect. optional bypass (2 off)
C24, C124	3300μ elect. 63V Type PX, 10mm pitch (2 off)

Approx. cost
Guidance Only **£99.50**

Semiconductors

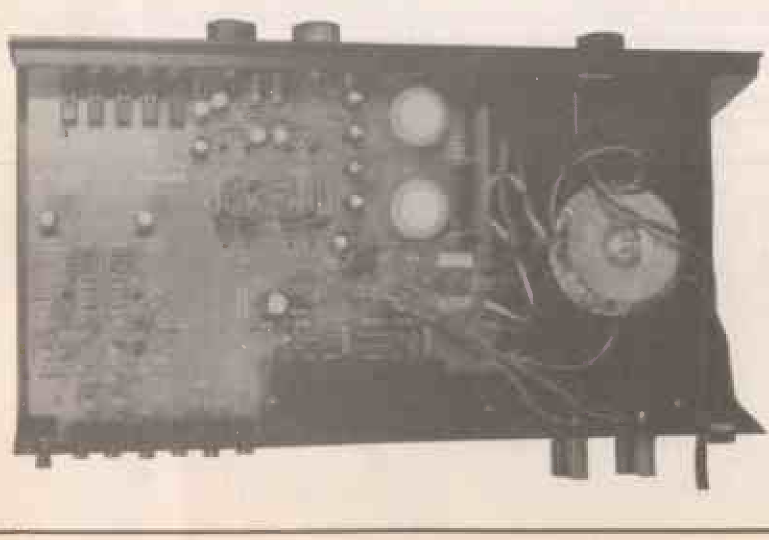
D1 to D4, D8, D9, D101 to D104, D108, D109	1N4148 (12 off)
D5, D105	15V Zener 1.3W (2 off)
D6, D7, D10, D11, D106, D107, D110, D111	1N4002 (8 off)
D12 to D15, D112 to D115	1N5401 (8 off)
D16	red l.e.d.
TR1, TR3, TR9, TR101, TR103, TR109	BC184C (6 off)
TR2, TR6, TR102, TR106	BC214C (4 off)
TR4, TR104	BC307C (2 off)
TR5, TR105	BC547C (2 off)
TR7, TR107	BD244C (TIP42A) (2 off)
TR8, TR10, TR108, TR110	BD243C (TIP41A) (4 off)
TR11, TR111	TIP121 (2 off)
TR12, TR112	TIP126 (2 off)

Miscellaneous

SK1 to SK6, SK101 to SK106	Quad phono sockets — p.c.b. mounting (3 off)
S1 to S5, S101 to S105	2-pole changeover silver plated pushbuttons (5 off)
S6	rotary double pole mains switch with insulating cover
SK7, SK107	4mm socket terminals (2 off red, 2 off black)
SK8, SK108	stereo headphone socket, p.c.b. mounting
FS1, FS101	5A, 20mm fused with p.c.b. mounting clips (2 off)
FS2	panel mounting screw type fuse-holder with insulating cover and 2.5A fuse
T1	mains transformer, toroidal type 80VA, low mechanical noise 0-35V, 0-35V secondaries.

Hardware (mounted on p.c.b.)
P.C.B. (available from Audiokits); p.c.b. pins (11 off); ¼ inch male blade connectors, p.c.b. mounting (8 off); 6BA × ¼ inch bolts (8 off); 6BA × ⅜ inch bolts (8 off); 6BA washers (6 off); 6BA washers, insulating type (2 off); TO220 mounting kits, bushes and insulators (6 off); heat sink (available from Audiokits; threaded pillars 6BA × ¾ inch (4 off); tinned copper wire for links.

Hardware (case and fixings)
Case with printed front panel and fixing screws (available from Audiokits); moulded feet (4 off); 2BA × ⅜ inch bolt and nut; 6BA × ¼ inch bolt and nut; 6BA solder tag (2 off); control knobs (3 off); screws for phono sockets (3 off); ¼ inch blade connectors, female (8 off); grommet for mains cable; "p" type cable clamp for mains cable; 4BA × ⅜ inch bolt and nut; 4BA washer (2 off).



the two transistors. The gain of the circuit can be calculated;

$$\text{Gain} = \frac{-R5}{R6} \times \frac{-R11}{R10} = \frac{R5,R11}{R6,R10} \qquad (1)$$

Now look at Fig. 4. Negative feedback is applied to the input via R_F. If the current fed back via R_F is much greater than the current through TR1, the voltage at the emitter of TR1 can be approximated at R6/(R6+R_F) times the output voltage. If the open loop gain defined by equation (1) is much greater than (R6+R_F)/R6 then we have a negative feedback amplifier which has the advantage of less harmonic distortion and a wider frequency response than the circuit without feedback. The theory of negative feedback is an important part of any basic electronics course and can be covered far better in relation to op. amp theory so I do not wish to go into it here.

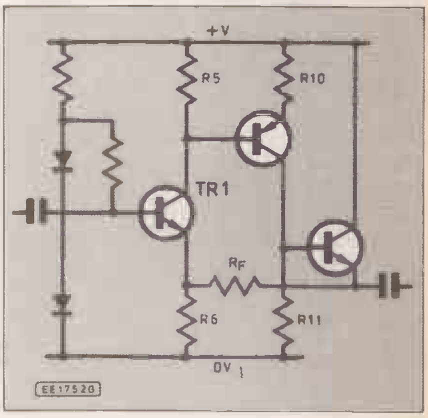
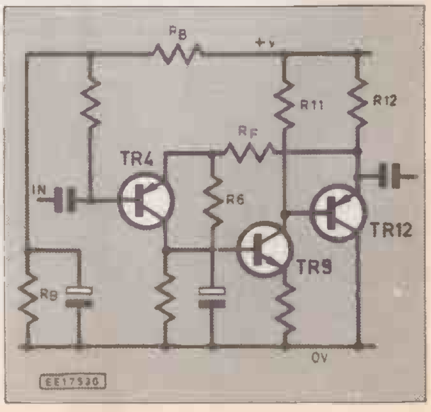


Fig.4. Applying negative feedback via resistor R_F.

Comparing Fig. 4 with Fig. 5, you will notice that Fig. 5 has a number of changes;

1. The circuit has been inverted by changing the *pnp* and *npn* transistors around.
2. As the circuit is now looking more like the power amplifier, we have changed the names of some components to refer to their equivalent number in the power amp circuit.
3. The base of the input transistor has a d.c. bias equal to half the supply voltage. At the same time we have put a d.c. blocking capacitor to ground in series with R6. This makes the audio frequency gain equal to (R_F+R6)/R6 but reduces the d.c. gain to

Fig. 5. Switching the pnp *and* npn *transistors of Fig. 4 around.*



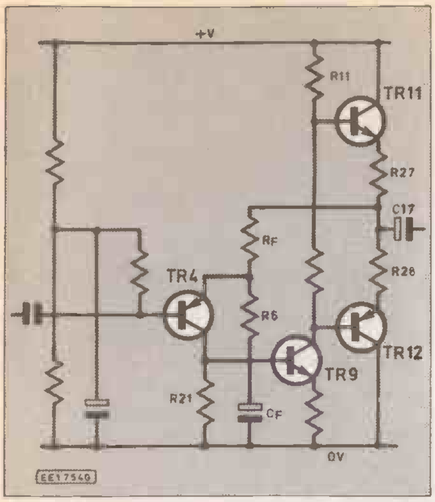


Fig. 6. Adding a complementary output stage (TR11, TR12).

×1. In other words it sets the d.c. voltage of the emitters of TR4 and TR12 at approximately the same, the difference being $R_F \times I_c$ (of TR4).

4. To maintain current supply to TR12, R12 has been re-instated.

In Fig. 6, emitter follower TR12 and R12 have been replaced by a complementary output stage comprising TR11 and TR12. The current that passes through the output stage is determined by the voltage difference between the bases of these transistors and the value of R27 and R28.

The change in negative feedback is shown in Fig. 7. Whilst the circuit of Fig. 6 works well there are a number of unacceptable compromises. Firstly the same d.c. current through TR4 collector flows through R_F and R21. Now we would like to increase the current through R21 because this will increase the slew rate (the fastest change of voltage with time, which is related to the highest frequency that can be reproduced) of the amplifier. But this will give a large d.c. voltage drop across R_F, which will reduce the maximum output voltage. Secondly, we have two electrolytic capacitors C_F and C17 in the signal path. As electrolytic capacitors are known to distort sound quality, we would really like to eliminate them or reduce their effects.

The circuit of Fig. 7 achieves all these objectives, and tests with a completed amplifier show that the sound quality is considerably improved. The addition of TR5 enables the current through R21 to be increased. At the same time the current through R22 is greatly reduced by a factor of the H_{fe} of TR5. This enables R22 to be increased. R30 and R31 provide a fraction of the output after C17 to be fed back to the input so that distortions of the signal caused by pasage through C17 can be corrected. As this signal is at zero d.c. voltage a blocking capacitor C14 is used. The value of this capacitor can be made as low as 1μF as a result of increasing the value of R22. The low frequency response limit (−3db) of the amplifier is calculated at the frequency at which the impedance of 1μF equals the impedance of (R22 × R31)/(R30 +R31). This is equal to 16Hz.

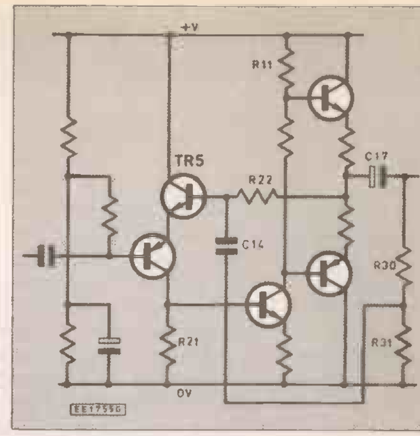


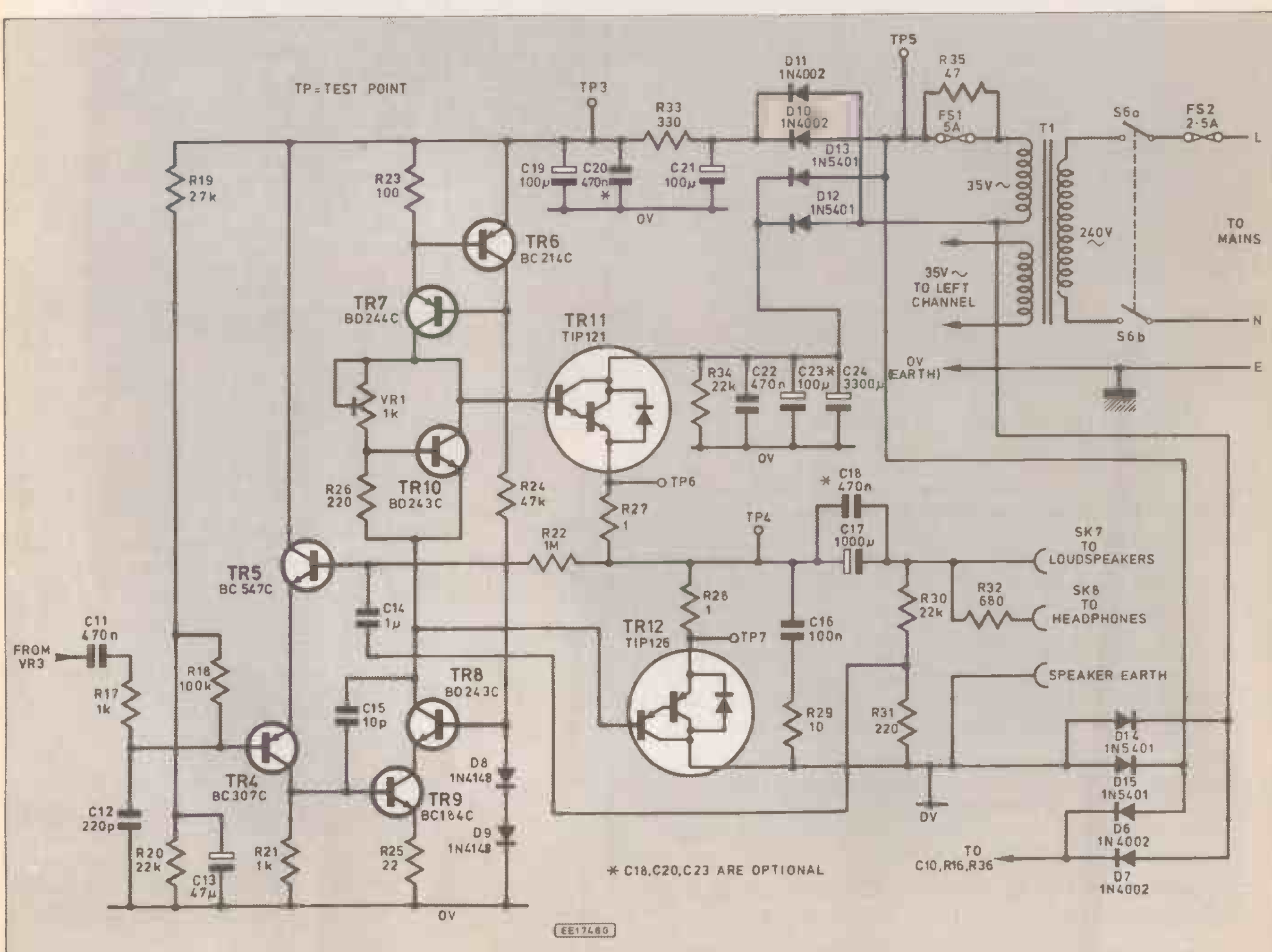
Fig. 7. Improving the distortion factor of Fig. 6.

POWER AMP CIRCUIT

The completed power amplifier circuit is shown in Fig. 8. If we compare this with Fig. 7 we see a number of further changes, which all contribute to the high performance of the circuit.

1. TR8 is added; this has several advantages. The cascode connection improves both the linearity of TR7 and its high frequency performance. By maintaining the collector voltage of TR9 almost constant, we improve the linearity because the gain of the transistor changes by a small amount due to large changes in collector voltage.

Fig. 8. Complete circuit diagram for the power amplifier section.



Also, transistors have capacitative effects between collector and base, and the effect of varying the collector voltage is to apply feedback (see Fig. 9).

In the actual circuit a real capacitor C15 is used to control the high frequency performance in order to maintain stability. Another advantage is that whilst a high gain low power transistor is used for TR9, a high power transistor can be used for TR8, and its gain is not so critical, but the thermal sinking effect of its metal tab reduces temperature generated distortion.

2. A network comprising VR1, R26 and TR10 provides accurate biassing of the output transistors. Mounting TR10 on the heat sink not only improves reliability by reducing the bias voltage when the output transistors get hot, but also improves the sound as a result of lower temperature generated distortion.

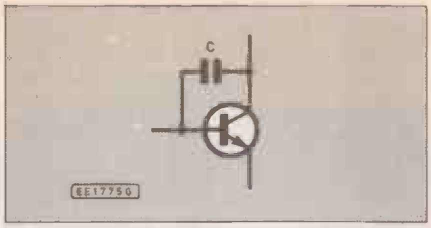


Fig. 9. Adding a capacitor to maintain high frequency performance.

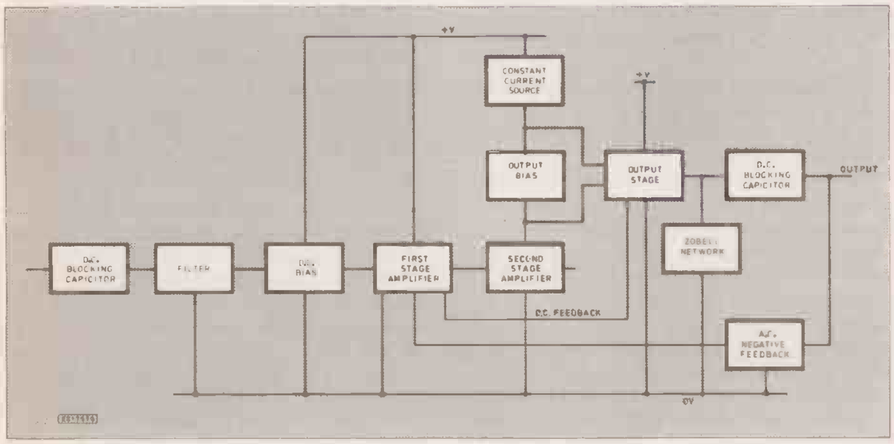
3. R11 is replaced by a constant current circuit TR6, TR7, R23; this has two advantages. Firstly, it provides adequate current to drive the output stage as the output voltage before C17 approaches the supply voltage. Secondly, as the current is constant, it carries far less of the ripple in the a.c. supply into the circuit than a resistor.

4. Darlington transistors are used to provide two stages of gain converting the current of 6mA through TR7, TR8 into several amps available to drive loudspeakers.

5. A Zobell network comprising R29 and C16 is added to improve the stability of the amplifier at high frequencies. Without it the amplifier could turn into a high frequency oscillator under some adverse load conditions.

A block diagram of the power amplifier is shown in Fig. 10. As all the information on how each stage works has been covered, a summary is not required. However, it would prove an excellent teaching exercise to identify each part in each block and describe its function as we did earlier in the preamps.

Fig. 10. Block diagram for the power amplifier.



Next Month: Construction, interwiring and final testing.

Robot Roundup

NIGEL CLARK

FOLLOWING its first appearance at the Craft, Design and Technololgy Show at Birmingham last year the drainpipe kits of Tribotics have been undergoing a facelift. The basic concepts have remained but the range has been redesigned and re-engineered with new gears.

Bob Vidler, one of the directors, said that the earlier versions had been prepared to assess what the response would be like and they had proved expensive to manufacture. The results supported their initial findings that there was a need for something fairly large and strong but inexpensive and the company's backers were prepared to support further improvements being made as well as a redesign to help cut the costs of making the equipment.

At the same time Tribotics has been doing a lot of work in its other main area of supplying automated laboratory equipment and not all the improvements the company hopes to make to the kits have been completed. However, it was able to display some of its products in their new look at the CDT show, again in Birmingham, this year.

BASIC UNITS

As before the basic units include two types of motor, one for driving the hinges to make the joints and the other driving a rotating tube used in items such as the conveyor, and 2½ inch drainpiping which provides the main structural pieces. Vidler said that as a result of the changes the kits were even stronger.

There are now four kits, containing one, two, three or seven motors plus the necessary hinges and other pieces for making a variety of models. These include a four-axis arm, a conveyor and a series of mobile bases. They are controlled by Tribotics own power unit and interface with a range of stackable units which provide the control which is required for the axes, direction, speed and so on.

Software is ready for the BBC series and the IBM PC and is being written for the RML Nimbus.

MOBILES

The mobiles, under the name of Explorer, are designed to carry other items in the range including arms and eventually a camera. The one at the show was radio-controlled. An umbilical cord version is planned. They do not have sensors at the moment, relying on instructions from the host computer, but they are planned.

Readers may remember that two interesting features of the original design were the ingenious gripper and a model which walked. The gripper still uses an inflating balloon to provide the closing grip with an elastic band reopening the three fingers. Although it was not on show at Birmingham, Vidler said that it was still available.

The walking model is still at the same stage as it was last year, awaiting software to ensure that it does not fall over when it moves. Vidler said that it was hoped that with a bit more time available more of the robotic developments could move ahead.

LEGO CONTROL LOGO

Lego's new kits for primary schools, launched on August 1, have been well received, according to Alex Wright, educational advisor for the company's UK section. Called Lego Control Logo they are intended, as with the company's earlier kits for secondary schools, to present an easy way for children to learn about technology, and to provide assistance to teachers.

Unlike the secondary level, which was developed as a bottom-up system, the primary scheme adopts a top-down approach. The younger children learn about how to use the technology before they attempt to understand how it achieves the end results.

At a cost of about £300 the smallest kit, or starter pack, contains a set of parts, including two d.c. motors, two touch sensors and one optosensor, a teacher resource pack to help in the development of class work and an interface for the BBC series. With the parts it is possible to build a simple two motor buggy, a motor vehicle and traffic light and a conveyor.

The pack is based around the Logotron Logo. For those without the necessary chip Lego provides an alternative resource pack including the chip.

Wright said that the set had been 3½ years in development including two years of trials in primary schools throughout the country. The result was that everything that was needed to start teaching the subject was included in the pack and no prior training was needed.

He added that all teachers who had looked at the set had been extremely positive in their reactions. Although aimed at primary schools Lego is also getting inquiries from secondary schools to use the kits with the younger students.

CYBER

A name from the past is getting a facelift courtesy of its new distributor. The Cyber 310 has been on the market for almost as long as the Armdroid to which it was similar in that it used stepper motors with belt and cable drive.

It sold in small quantities at a price of £650 but sales had been falling off and it was expected to be withdrawn as soon as stocks ran out. However when the general manager, Paul Ritson, left to set up his own company, Computervoice, he took the rights for the sale of Cyber products with him. He expected that the voice synthesisers would be the major part of the business but he found that sales of the five axis articulated arm began to grow in the Netherlands. In the last few months Dutch sales have gone above 60.

To consolidate the growth a work cell has been developed including the usual conveyors, rotary tables and vision sensors for sorting objects. The full system, which has software for the IBM PC, sells for about £2,000.

Sales at the moment are almost totally overseas but the standard machine with the original software, which allows it to operate with old favourites such as the TRS 80 and the Jupiter Ace as well as the BBC and IBM, is being offered in the UK for about £450.

At the moment sales are from stock built up by the old Cyber company but Ritson said that when those run out there are plans to begin manufacturing again. There are also plans for an improved and updated version but Ritson gave no dates as to when that might be available.

Tribotics drainpipe robot

TEACH-IN SERIES

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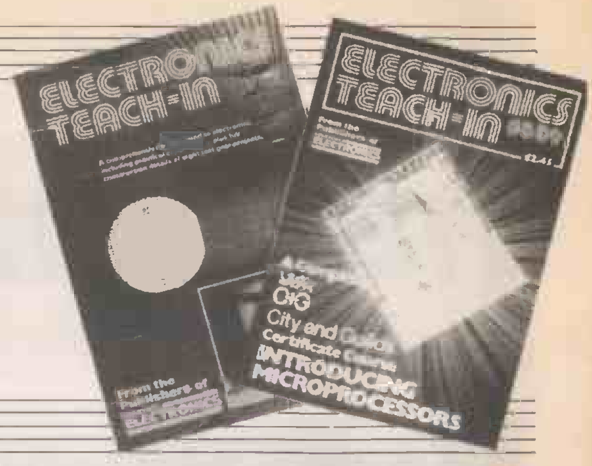

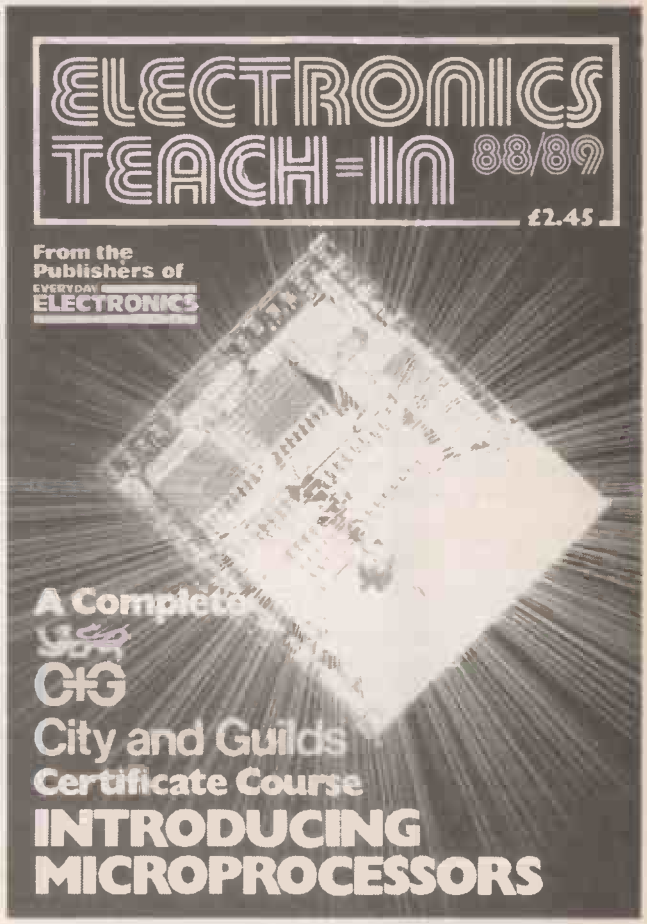

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Circuit Card Project

TILT ALARM

ROBERT PENFOLD

Use your Free Circuit Card and the BICC–Vero Easiwire system to make this inexpensive solderless alarm.

IT IS said that thieves will try to steal anything that is not nailed down. Where nailing down is impossible or inappropriate, this simple stand-alone burglar alarm could be the solution! It has a sensor that detects when the unit is tilted more than a certain amount. In practice simply picking up the device (or whatever it is fitted to) is usually sufficient to trigger the alarm.

An obvious application for a unit of this type is to protect a briefcase or suitcase where it is impractical to keep a close eye on the case all the time. Anyone trying to make off with the case would trigger the alarm and alert you to its impending disappearance. It could also be used with choice household items such as video recorders and hi-fi equipment.

The alarm is not loud enough to alert neighbours in the event of someone stealing goods from unoccupied premises, but it should be effective if someone tried to remove the valuables from downstairs while the occupants were asleep upstairs. Even with the premises unoccupied, the alarm might be sufficient to induce a loss of nerve on the part of the would-be thieves and cause them to run off.

The unit is battery powered, but has a negligible stand-by current consumption that gives an extremely long battery life. In fact the battery lasts for its "shelf" life (generally about 6 to 12 months). The unit can be made quite small if necessary, and despite the diminutive loudspeaker used in the unit it can still produce a very loud and shrill alarm sound. (See the *Siren* project for an even better output!)

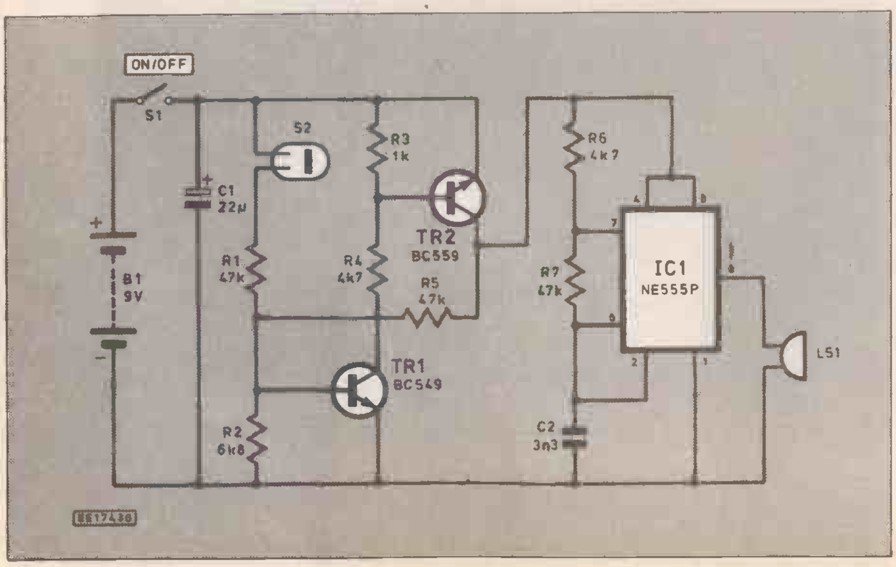
MERCURY SWITCH

A very simple sensor is all that is needed in a device of this nature, and a mercury switch is the usual type. These use the setup outlined in Fig. 1. With the switch (S2) in the upright position the two electrodes are insulated from one another by the non-conductive panel on which they are mounted, and the air gap between them. There is some mercury at the bottom of the case, and at room temperature (or thereabouts) this is a liquid. Mercury is a metal, and as such it is a very good conductor of electricity.

If the switch is steadily rotated, a point will be reached where both of the electrodes are immersed in the mercury. At this point there is a path of conductivity from one to the other through the mercury, and the switch is effectively closed. Any strong movement of the switch will cause the mercury to slop around inside the case and will also effectively close the switch.

It is not essential to use a mercury switch, and it is not too difficult to improvise a tilt switch. Something as basic as a fixed metal plate plus a wire with a metal weight on the end hanging next to it will give much the same result. However, a mercury switch is small, neat, and reliable, and probably represents the best option.

Fig. 1. Circuit diagram for the Tilt Alarm.



COMPONENTS

Shop Talk
see page 18

Resistors

R1,R5,R7	47k (3 off)
R2	6k8
R3	1k
R4,R6	4k7 (2 off)

All 0.25W 5% carbon

Capacitors

C1	22µ axial elect. 10V
C2	3n3 polyester 7.5mm pitch

Semiconductors

IC1	NE555P
TR1	BC549
TR2	BC559

Miscellaneous

B1	9 volt (PP3 size)
S1	s.p.s.t. sub-min toggle
S2	Mercury switch
LS1	PB2720 cased ceramic resonator

Case; battery connector; Free EE Circuit Card or Easiwire board, 8 pin d.i.l. i.c. holder, wire, etc.

Approx. cost Guidance only **£6** inc. case

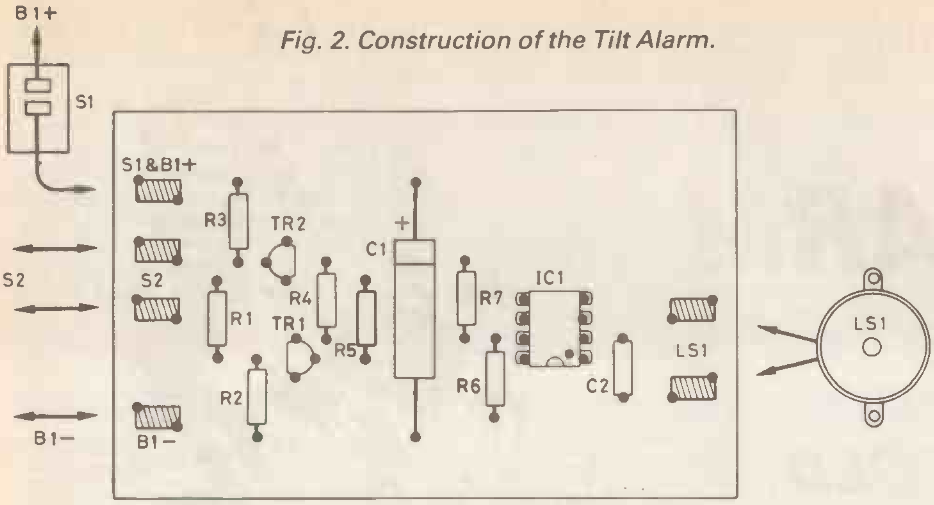
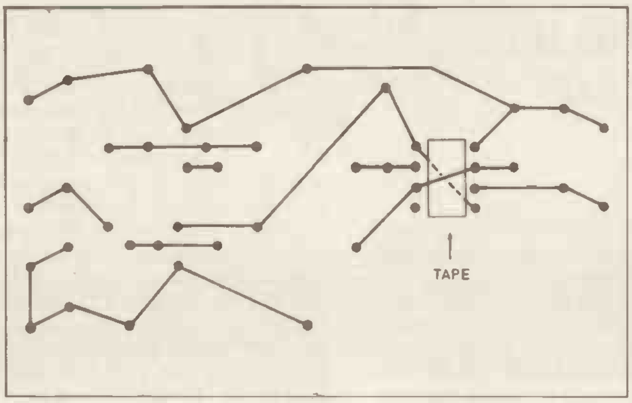


Fig. 2. Construction of the Tilt Alarm.



THE CIRCUIT

Simply wiring an alarm generator of some kind in series with a mercury switch and a battery will not provide satisfactory results. The alarm would only be activated while the mercury switch was closed. It would probably only close briefly and intermittently, giving little output from the alarm. This would also make it too easy for someone to defeat the alarm, as they might soon realise that holding the unit reasonably steadily with a suitable orientation would silence the alarm.

What is needed is a latch circuit that will hold the alarm switched on once a trigger signal from the mercury switch has been received. In this circuit (Fig. 1) the latch is based on TR1 and TR2, while the alarm signal is generated by IC1.

Starting with the latch circuit, TR1 normally receives no input bias current and is switched off. It therefore supplies no significant base current to TR2 which is also cut off. S2 is the mercury switch, and if this should close momentarily, TR1 will be supplied with a small base current via R1. R1 is needed to limit this base current to a safe level. This small input current produces a much larger output current from TR1, which then biases TR2 hard into conduction. TR2 now supplies TR1, with a base current via R5, and this holds both TR1 and TR2 in the on state when S2 opens again.

The only way to reset the circuit back to its original condition is to switch off, wait a second or so, and then switch it on again. The current consumption of the circuit under stand-by conditions is very low because the only currents that flow are the leakage currents through TR1, TR2, and C1. These should all be minuscule, and in practice will probably total less than one microamp.

The alarm signal is generated by a standard 555 astable (oscillator) circuit that receives its power via TR2. Consequently, it is not activated until the unit is triggered by the mercury switch. The operating frequency of the oscillator is quite high at about 3kHz. It is at frequencies of around this figure that LS1 offers optimum efficiency. This component is not a standard moving coil loudspeaker, but is a cased ceramic resonator. Provided it is operated at a suitable frequency, this device offers a very high output level from an input current of just a very few milliamps.

CONSTRUCTION

The *Tilt Alarm* has been designed to be constructed with the BICC Vero Easiwire system using the Free Circuit Card attached to the front of this issue. It could of course be built on plain matrix board if required.

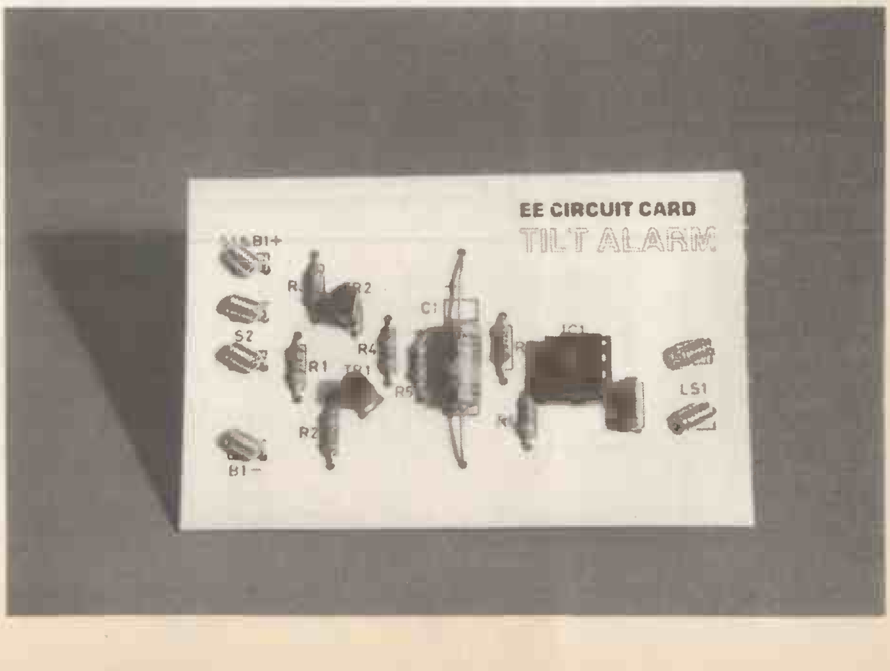
The unit will fit into virtually any small plastic case. LS1 can be mounted on either the front or rear surfaces of the front panel using 8BA or M2 fixings. Mounting it on the rear surface gives the neatest results, but a large mounting hole (about 30 millimetres in diameter) is needed in addition to the two small holes for the fixing screws. With it fitted on the front surface, only a small hole to permit the leadout wires to pass through to the interior of the case is needed in addition to the two fixing holes.

If the mercury switch is small enough it could be mounted on the circuit board. Most types are a bit too large for this, and it will probably be necessary to glue S2 to the inside of the case using a good quality adhesive such as an epoxy resin type.

Refer to Fig. 2 for details of the Circuit Card wiring. Please read the *Using Your Circuit Cards* page before commencing construction. Fitting the components on the board is quite straightforward, but be careful to get the orientations of C1 and the semiconductors correct. There are one or two slightly awkward points to watch when adding the underside wiring. There is a cross-over between IC1's two rows of pins. Put in the first of these wires and then cover it over with a small piece of insulation tape before adding in the second wire.

The wire that carries the negative supply rail must be curved slightly near to the point where it reaches IC1. A piece of Easiwire double-sided backing material or a piece of insulation tape placed over the top of it can be used to hold this wire in place. The negative supply rail cannot be handled using a single wire. The easiest way of tackling this is to first wire up all the points apart from pin 1 of IC1. Then add this short branch in the wiring.

LS1 has flying leads which have their



ends already prepared for connection. There is no difficulty in connecting Easiwire plugs to these and then connecting them to the board. Note that LS1 must not be an ordinary loudspeaker, but must be the proper (cased version) of the PB2720 ceramic resonator.

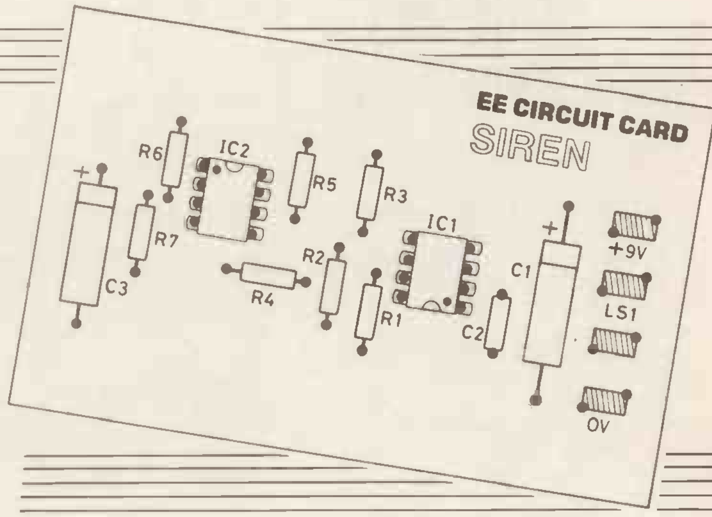
Mercury switches normally have small pins or tags, and the connections to S2 can be made via insulated leads using plugs at the board end and wire-wrap connections to the switch. For some purposes a miniature toggle switch will be adequate for on/off switch S1, but in a lot of situations this would be unsatisfactory. It would make the unit too easily defeated once discovered. Much better security would be provided by a key switch, and in many circumstances a switch of this type would probably justify its much higher cost.

IN USE

With the unit switched on, orientate it so that the alarm is triggered, and then return it to its original orientation to ensure that the alarm keeps operating. Switch off at once and recheck the wiring if the alarm will not trigger, or only does so intermittently.

Obviously a little thought needs to be used when fitting the unit to the object it will protect. In general it should be positioned in such a manner that it is only a few degrees away from the trigger point, so that reliable triggering is obtained if anyone tries to remove the protected object. A little trial and error should soon locate a suitable position and orientation for the unit. □

Circuit Card Project



SIREN

ROBERT PENFOLD

A personal alarm, or a siren output for many other projects—built on your Free Circuit Card.

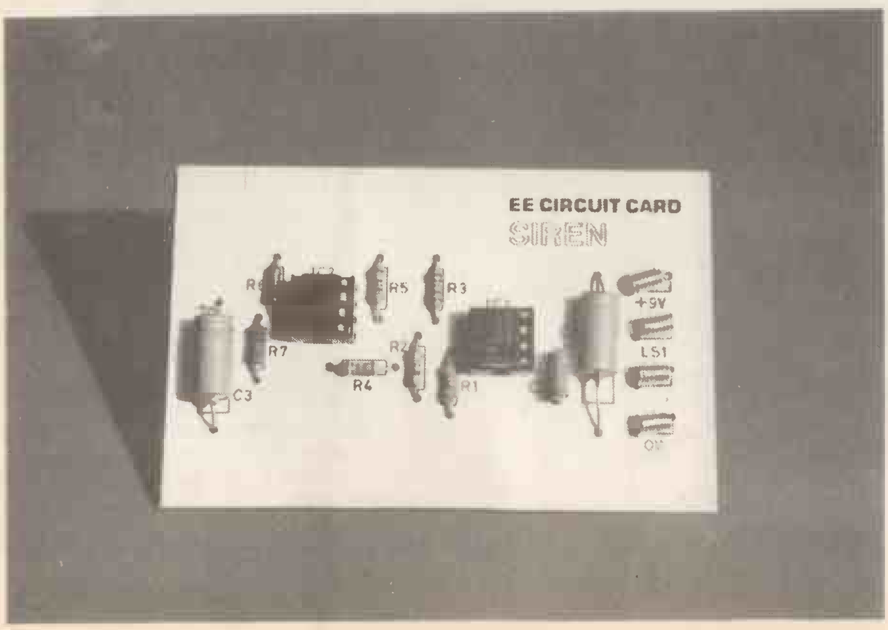
UNTIL not so long ago the standard form of alarm generator was an electric bell. Times change, and while electric bells are still in widespread use, electronic alarm generators seem to be steadily taking over. This design is a simple but effective modulated tone generator for general purpose use. It could, for example, be used as a stand-alone unit in the role of a personal alarm. It can also be used as part of other projects. As an example of this role, it could be used in place of the simple tone generator in the *Tilt Alarm* project described above. With the aid of a simple sensor and driver circuit it could be used as a rain alarm, or in other simple alarm applications.

ALARM TYPES

A basic tone generator is adequate for many alarm applications, but a unit of this type has its limitations. A simple tone signal is easily masked by other sounds, and unless it is very loud it is easily missed. Some form of modulated signal tends to be much more noticeable due to its less monotonous character, and with a suitable form of modulation it is much less easily masked by other sounds.

There are two normal types of modulation, which are a.m. (amplitude modulation) and f.m. (frequency modulation). The former merely involves varying the volume of the signal in some way, and in an alarm application this generally means pulsing the alarm on and off two or three times per second. Frequency modulation involves varying the pitch of the tone generator, and in its most fundamental form this means switching the tone generator between two pitches. Again, the switching rate would normally be a few times per second.

Frequency modulation is probably the more effective type, because a wider range of frequencies are present on the output signal. Any sound must provide a similarly wide spread of frequencies in order to effectively mask the alarm signal. In order to get a good range of frequencies on the output signal it is preferable to have the tone swept up and down in frequency rather than simply switched between two tones. The design featured here is of this type, and it has the tone swept smoothly up and down in frequency at a rate of about two Hertz or so.



THE CIRCUIT

The full circuit diagram of the *Siren* appears in Fig. 1. This is basically just two oscillators, with IC1 generating the tone and IC2 providing the low frequency modulation signal. IC1 is a 555 timer operated in the standard astable (oscillator) configuration.

The values of the timing components give a roughly squarewave output signal at a frequency of about 3kHz. The output signal is fed to loudspeaker LS1, which is

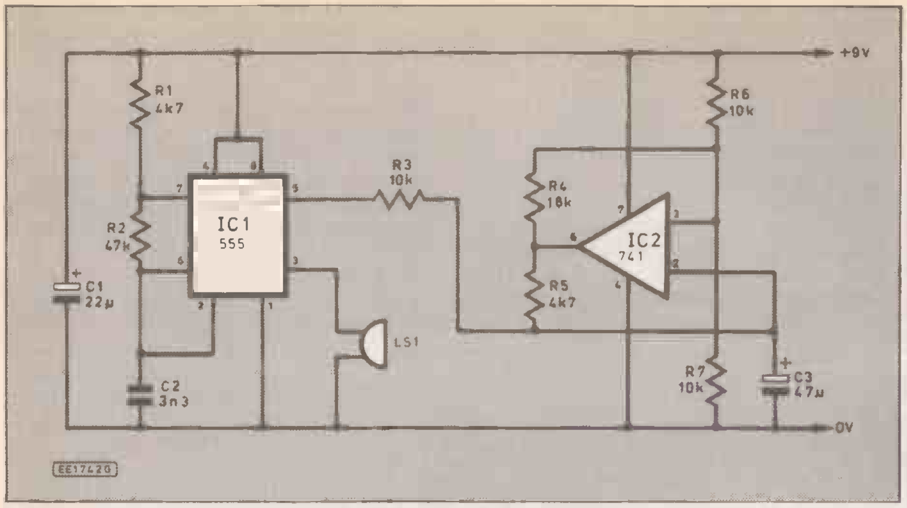


Fig. 1. Circuit diagram of the Siren.

actually a cased ceramic resonator and not an ordinary loudspeaker. It provides very high efficiency and gives a very loud output from the drive signal which is only about eight volts peak to peak at a current of a few milliamps.

IC2 is an operational amplifier connected in a conventional oscillator configuration. Capacitor C3 is repeatedly charged and discharged from the output of IC2 via timing resistor R5. This gives a roughly squarewave signal from the output of IC2, and a non-linear triangular waveform across C3. It is this second signal that is used to modulate IC1, and this gives the smooth sweeping up and down of the output frequency.

THE 555

The modulation signal is coupled to pin 5 of IC1. Normally the timing capacitor of a 555 astable charges to two thirds of the supply voltage, discharges to one third of the supply voltage, and continues in this fashion indefinitely. Pin 5 of the 555 gives access to the circuit that sets the two thirds of the supply voltage threshold level. By pulling this voltage higher it takes timing capacitor C2 longer to charge to the threshold level, and to discharge from this level to one third of the supply voltage. Consequently, the output frequency is reduced.

Pulling the threshold potential lower has the opposite effect, with C2 having less far to charge and discharge. The output frequency therefore increases. As the modulation voltage rises and falls, the output frequency of IC1 therefore falls and rises (respectively).

One advantage of this form of modulation is that it sweeps the tone over the full range of frequencies where the ceramic resonator has good efficiency. The frequency response of the resonator has a lot of peaks and troughs over this range, and using a single output tone there is a risk that it will coincide with a trough and give a relatively low output level. The swept tone will go through these troughs, but it will also go through the peaks where an extremely high output level will be obtained. This ensures a good average output level with strong peaks of high volume.

COMPONENTS

Shop Talk see page 18

Resistors

R1,R5	4k7 (2 off)
R2	47k
R3,R6,R7	10k (3 off)
R4	18k

All 0.25 watt 5% carbon

Capacitors

C1	22µ axial elect. 16V
C2	3n3 polyester 7.55mm pitch
C3	47µ axial elect. 10V

Semiconductors

IC1	NE555P
IC2	µA741C

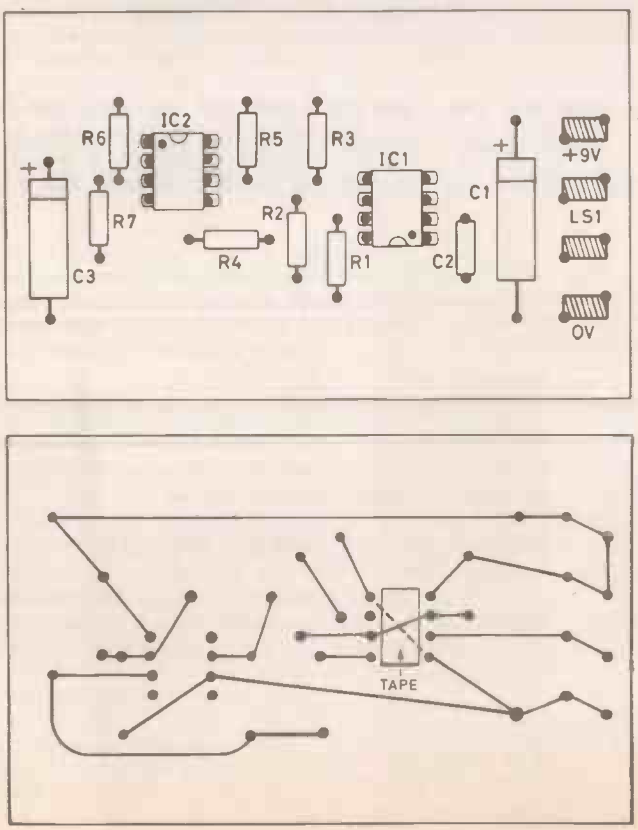
Miscellaneous

LS1	PB2720 ceramic resonator

Case; Free EE Circuit Card or Easiwire board; 8 pin d.i.l. i.c. holder (2 off); wire; etc.

Approx. cost Guidance only **£4.50** *incl. case*

Fig. 2. Construction of the Siren.



CONSTRUCTION

The complete *Siren* has been designed to be built on one of the Free Circuit Cards attached to the front cover of this issue. It could of course be built on plain matrix board if an alternative constructional method is required.

Details of the component layout and the underside wiring of the board are given in Fig. 2. Please read the *Using Your Circuit Cards* page before you begin construction. Make sure that C1 and C3 are fitted to the board with the correct polarity, and note that IC1 and IC2 have the opposite orientations.

The underside wiring is less than totally straightforward, but should not give any real difficulties. There is a cross-over between IC1's two rows of pins, and the first wire must be covered over with a piece of insulation tape before the second wire is added. One curved wire is needed, and the Easiwire double-sided self-adhesive backing material can be used to hold this firmly in place, or it can be covered with a piece of insulation tape which should also do the job quite well. The positive supply rail cannot be added as a single wire. Put in the main wire first, and then add the branch wire that connects to IC1, etc.

The resonator LS1 has flying leads with ready-prepared ends. These are easily fitted with Easiwire plugs and connected to the on-board "sockets". Incidentally, two millimetre plugs are also suitable for use with the Easiwire "sockets". The PB2720 ceramic resonator has provision for screw fixing via two 8BA or M2 screws, but suitable mounting nuts and bolts are not normally supplied with this component.

Although the supply voltage is given as 9 volts, supplies of up to 15 volts are usable, and higher supply voltages give a higher output level from the unit. The current consumption is about 10 milliamps from a 9 volt supply, and a PP3 size battery is adequate to provide this.

IN USE

To test the unit simply connect it to the power source (being careful to get the polarity correct). This should give a loud and quite high pitched warbling type sound. Switch off at once and recheck all the wiring if a suitable sound is not produced.

If the unit is to be used as a personal alarm an s.p.s.t. on/off switch should be added in the positive supply lead. If the unit is used as an alternative alarm for the *Tilt Alarm* project, omit R6, R7, C2, IC1, and LS1 from the *Tilt Alarm*. The negative supply lead of the *Siren* connects to the negative supply of the *Tilt Alarm*, while the positive (+9 volt) lead connects to the collector of TR2 in the *Tilt Alarm*. Easiwire connectors and a couple of insulated leads are suitable for providing the links between the two boards. □

USING YOUR CIRCUIT CARDS

THE CIRCUIT CARDS attached to the front cover of this issue have been specially designed for easy, solderless construction of projects using the BICC-Vero Easiwire system.

HOLE PUNCHING

Carefully remove your Circuit Cards from the cover taking care not to damage them, then cut them in half along the heavy line. Next, using the pointed end of the Easiwire unwrap tool, make holes through the board for the component leads. This is best done by placing the Circuit Card, component side up on a piece of thick cardboard or a pad of scrap paper then push the point through the Circuit Card at all the points marked with a "●".

Once all the holes are made you can use the Circuit Card, as described in the special articles in this issue, to build your projects. If you do not have a BICC-Vero Easiwire kit see the special offer below.

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100/16,100/25 7p; 100/50 12p; 100/100 .... 14p
220/16 8p; 220/25, 220/50 10p; 470/16, 470/25 .... 11p
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DIODES (piv/amps)
75/25mA 1N4148 2p. 800/1A 1N4006 6p. 400/3A 1N5404 14p. 115/15mA OA91 .... 6p
100/1A 1N4002 4p. 1000/1A 1N4007 7p. 60/1.5A S1M1 5p. 100/1A bridge 25p
400/1A 1N 4004 5p. 1250/1A BY127 10p. 30/45mA 30/15A OA47 .... 8p
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Battery snaps fdor PP3 - 6p for PP9 .... 12p
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THE WIDE use of computer printers is bringing the price down so that they are now within the means of most computer users. Often however the salesman has little knowledge of the product and you are left wondering if it's possible to marry the printer to your Spectrum without a degree in computer electronics.

This was my problem when one day I noticed a Smith Corona parallel printer on special offer. The shop assistant hadn't a clue regarding its technical details so I just had to take a chance. Luckily the manual provided enough data on the requirements of the printer to enable the operating system to be designed.

This article describes the simple interface that was produced and lists the software programs to drive it. This combination enables the printer to respond to the LPRINT and LLIST commands, to decode the Spectrum keywords and to work with many of the commercial programs.

It can be used with a Spectrum, a Spectrum plus or a Spectrum 128 plus 2 (in 48K mode). It has been tried with two or three printers and should operate almost any parallel machine.

To assist in overcoming any of the problems that may be encountered, a full description of the functioning and timing of a parallel printer will be given. . . . But before we go any further perhaps I should explain the difference between serial and parallel printer systems.

SERIAL AND PARALLEL SYSTEMS

As most owners will know, every Spectrum character has a numerical code in the range of 0-256. This code which is essentially the same as the international ASCII code used by all printers and data transmission devices, can be represented by one byte (8 binary digits).

These eight bits can either be sent sequentially like the signal to the computer tape recorder, or simultaneously (in parallel). Obviously to send all the eight signals simultaneously requires at least eight lines — and a common return — instead of the two lines for the serial system.

This then is the fundamental difference for although both systems use more than the minimum number of lines the parallel system transmits all the bits at the same time whereas the serial system sends one bit at a time. Both have standards which define the uses of the extra lines and two articles in the June 87 issue of EE dealt very comprehensively with the serial or RS232 system. The standard for the parallel system is known as the Centronics system.

The Centronics system not only defines the uses for the lines and signals but it uses a distinctive plug and socket. This unique socket which immediately identifies a parallel printer has 36 contacts arranged like that of an edge connector mounted in a shell similar to a D-socket.

The plug is usually secured in the socket by two wire clips. Fig. 1 shows the pin layout of the socket and Table 1 lists the lines connected to them.

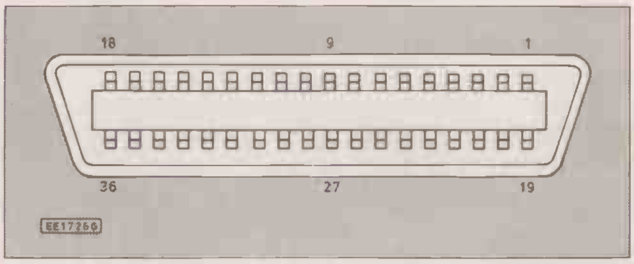


Fig. 1. Pinning arrangement for the printer socket.

Table.1: Centronics Pin-out Information

PIN No	SIGNAL	PIN No	SIGNAL
1	STROBE	19	GND (Return line)
2	DATA LINE 0	20	GND (Return line)
3	DATA LINE 1	21	GND (Return line)
4	DATA LINE 2	22	GND (Return line)
5	DATA LINE 3	23	GND (Return line)
6	DATA LINE 4	24	GND (Return line)
7	DATA LINE 5	25	GND (Return line)
8	DATA LINE 6	26	GND (Return line)
9	DATA LINE 7	27	GND (Return line)
10*	ACKNLG	28	GND (Return line)
11*	BUSY	29	GND (Return line)
12*	PE (Paper empty)	30	GND (Return line)
13*	SLCT (Select output)	31	INIT (Initialise printer)
14	AUTO LINE FEED	32*	ERROR
15	NC	33	GND
16	0 Volts (Signal GND)	34	NC
17	0 Volts (Chassis GND)	35*	(x)
18	NC (or +5 Volts)	36	SLCT IN (Selected inpt)

* These signals are output from printer.
(x) Pull up line from printer through resistor (3.3k).

All the lines are based on TTL levels (0-5 volts) which simplifies this interface design but limits the length of the interconnecting lead to about three meters.

INTERFACE CIRCUIT

The parallel printer interface described here consists of a Z80 PIO assembled in a small plastic box which plugs directly onto the Spectrum edge connector. A 25-way D-socket is provided for the printer lead which has the Centronics connector at the other end.

The circuit diagram for the Spectrum Parallel Printer Interface is shown in Fig. 2, and you can now see why the unit is so simple and cheap. The use of the PIO which nowadays is very reasonably priced, is made possible by the TTL compatability of the system. It has two 8-pin ports and in this circuit the B port is used for the data lines and the A port for the control lines.

Six control lines are shown but you will see later that the program only uses two of them. However, the others may be necessary for some printers and it is probably worthwhile to wire them just in case.

The grounded pins 19-29 may look strange until you study the layout of the Centronics socket pins in Fig. 1. You will see that the data return lines go to pins opposite the data line pins and with a ribbon cable this provides a return (GND) between every data line. This is of special importance if an IDC (Insulation Displacement Connector) is used, as there is a natural sequence of alternate data and GND lines.

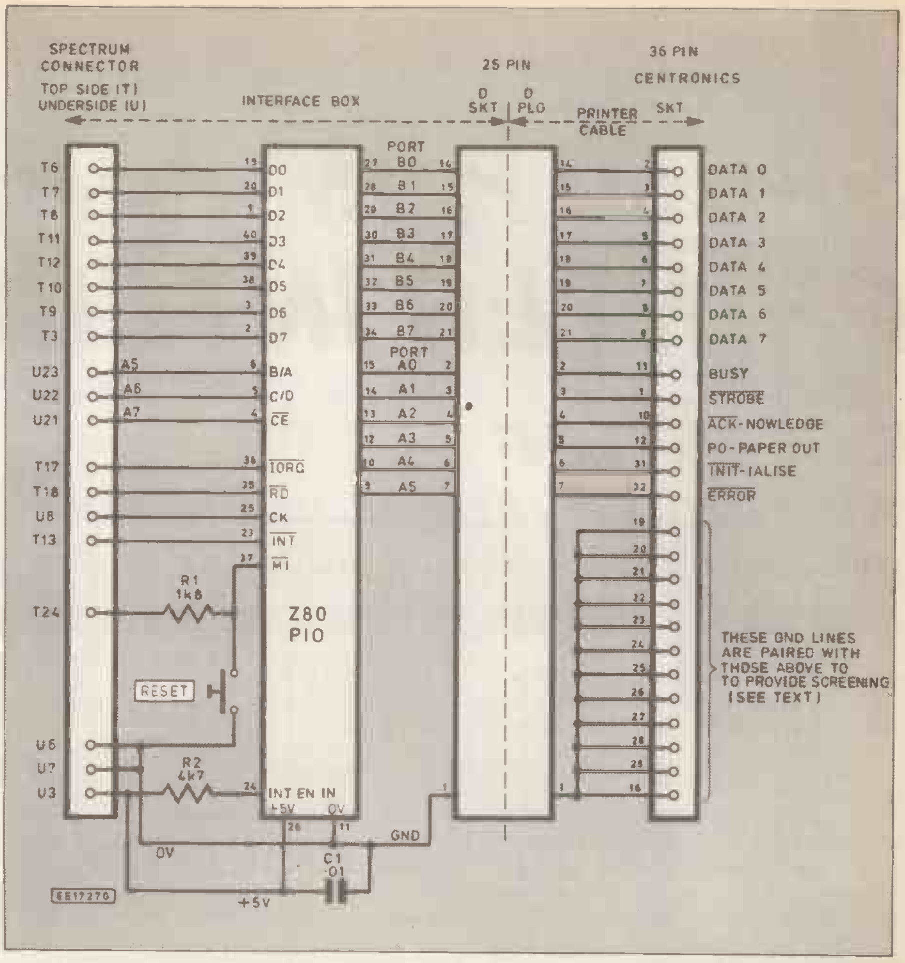


Fig. 2. Complete circuit diagram for the Spectrum Parallel Printer Interface. The circuit should be referred to when wiring up the Spectrum/Printer interconnecting ribbon cable.

CONSTRUCTION

The Interface is built on a pice of Vero board approximately 38 strips by 18 holes. The component layout and details of cuts required in the underside copper strips is shown in Fig. 3.

The unit is designed around the recommended box which assists the support of the Veroboard when fitting or removing the edge connector to the computer. Nevertheless any box can be used providing it doesn't obstruct the computer power plug.

COMPONENTS

Shop Talk see page 18

Resistors
R1 1k8
R2 4k7
All 0.25W 10% carbon

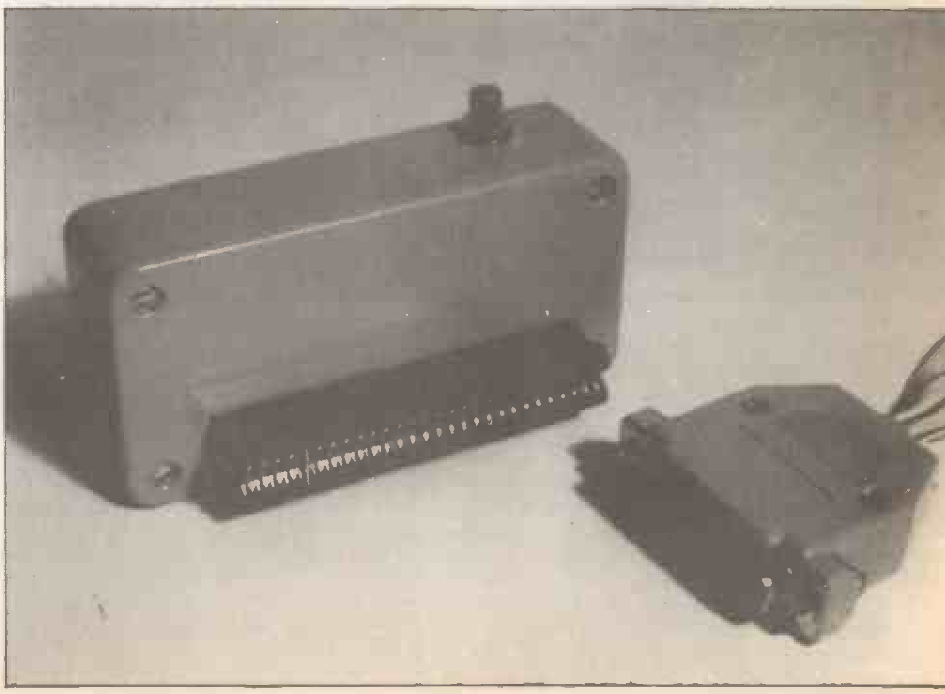
Capacitors
C1 10n

Semiconductors
IC1 Z80A-PIO dual 8-bit parallel input/output interface

Miscellaneous
S1 Push-to-make switch
Plastic box, 100 × 50 × 25mm external size; Veroboard, 0.1in. matrix size 38 strips × 18 holes; Spectrum double-sided edge connector; 40-pin i.c. socket; 25-pin D-socket; Centronics type plug; 25-pin D-plug and cover; 1.5m ribbon cable (stranded); solid and stranded connecting wire; screws and nuts, 6BA (2 off); etc.

Approx. cost Guidance only **£20**

The completed interface showing the Spectrum edge connector and the D-plug which plugs into the rear of the case. When wiring up the Centronics plug, refer to the circuit diagram and Fig. 1/Table 1.



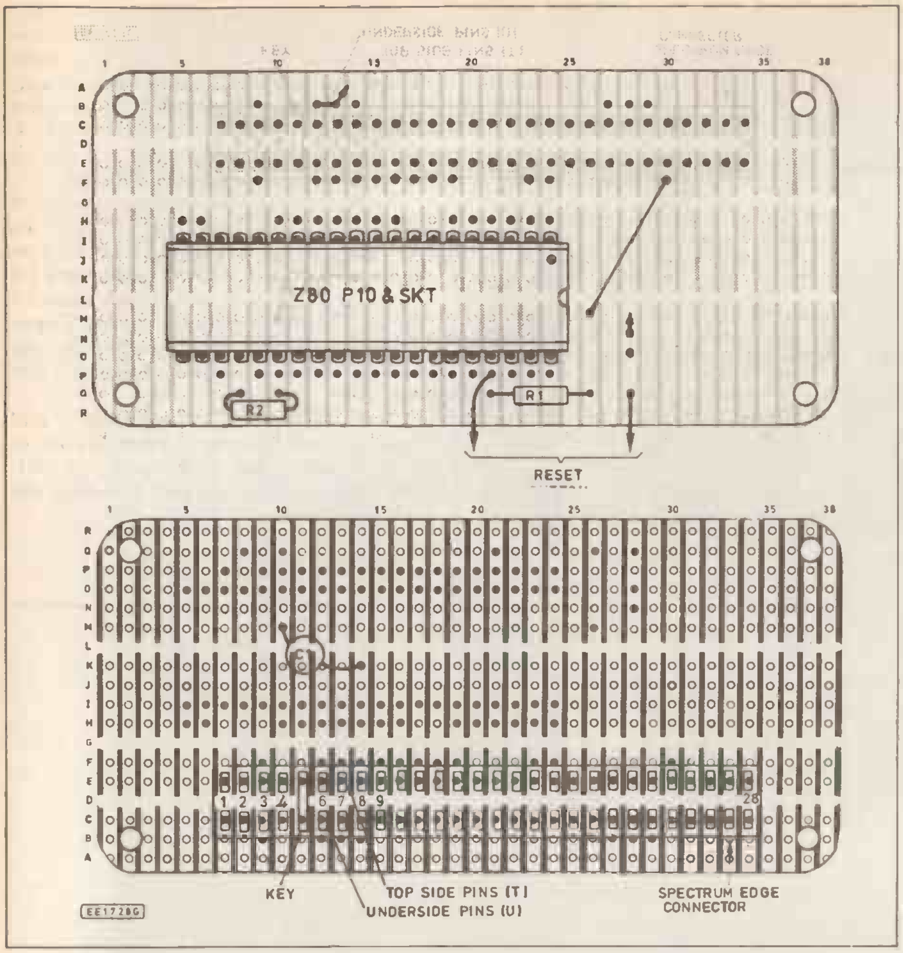


Fig. 3. Component layout and details of breaks required in the copper strips. (The saw cuts through the copper are shown as "white" strips across the board.) The capacitor C1 and Spectrum edge connector are mounted on the track side. Refer to Fig. 2 for wire connections.

First cut the Veroboard to exactly fit inside the box and make the three saw cuts through the copper strips, as shown in Fig. 3. Drill and cut the pillars until the board rests on the top of the serrations on the side walls of the box. The lid will now clamp the circuit board and can be used to mark the screw holes.

The edge connector can be assembled in its correct location and the slot cut in the top to allow it to pass through. Cut the hole for the D-socket and the reset button at the opposite end to the PIO socket to give the maximum clearance for the wires, Fig. 4.

Fit the edge connector and measure the stand-out. It should be a minimum of 15mm beyond the top of the box with the pins resting on the base. If not, it is worthwhile packing them to take the load off the Veroboard when connecting to the computer.

Solder the edge connector, the PIO socket and the other small components and wire the board—refer to Fig. 2 and make sure all connections are made. Wire the D-socket on flexible leads about 40mm long, then if suitable notches are made in the D-socket slot, it can be slid through and screwed on the outside of the box. The unit is now complete except for checking, fitting the PIO and assembling.

Make up the printer lead 1 to 1.5 meters long. If you use ribbon cable connect the first wire, to pin 1 of the Centronics plug, wire two to pin 19 (GND), wire three to pin 2, wire four to pin 20 and so on. At the D-plug end join all the GND leads and connect them to pin 1. (Refer to Fig. 1. when carrying out this operation).

SOFTWARE PROGRAM

Because of the differences between the interface and the Sinclair printer, the ROM

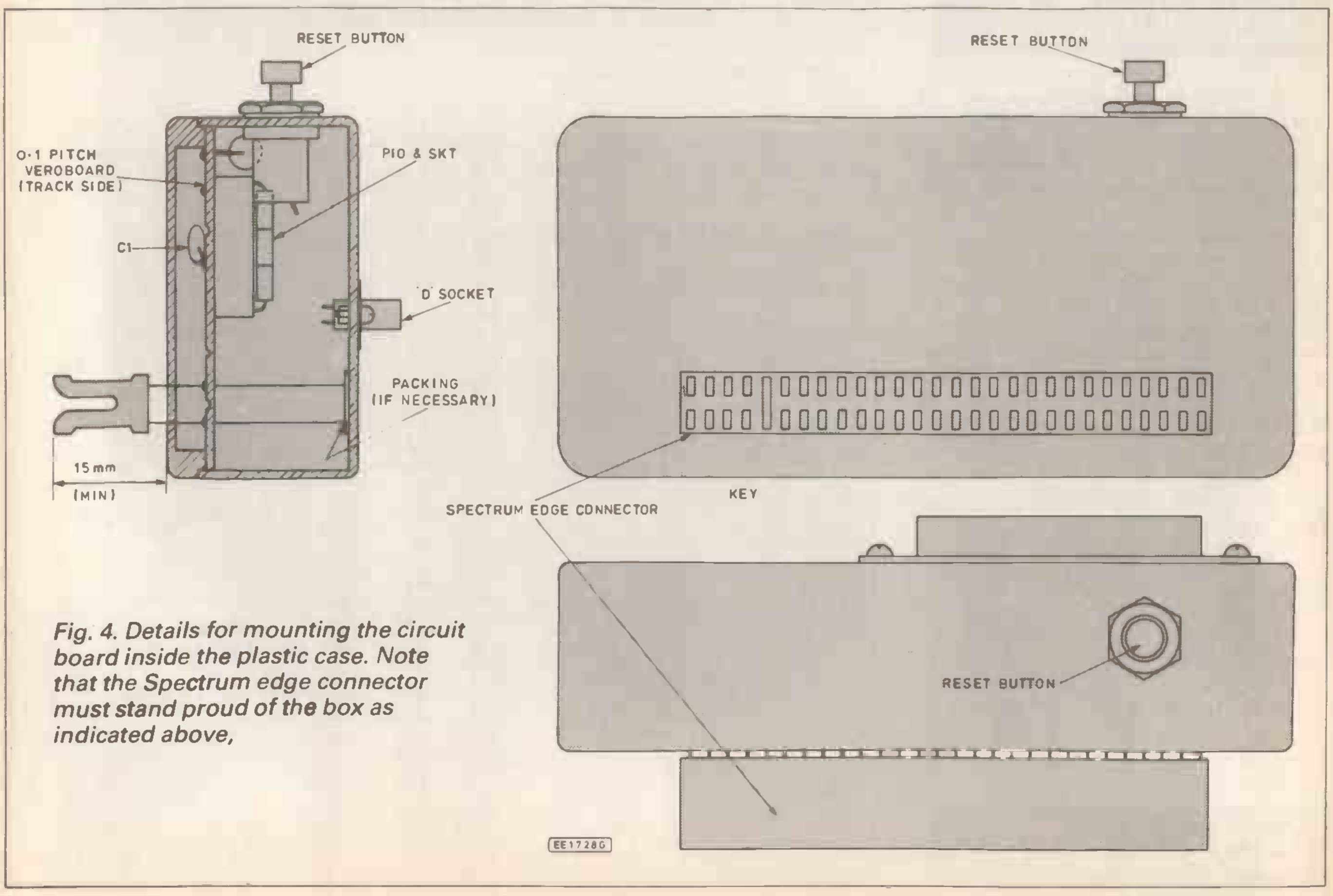


Fig. 4. Details for mounting the circuit board inside the plastic case. Note that the Spectrum edge connector must stand proud of the box as indicated above,

Completed circuit board showing the edge connector "legs" protruding through the board to offer additional support when mounted in the case.

program cannot be used without some modification. The object of this program is to link the various ROM sub-routines together and direct the output code to the interface and the printer.

Those of you who are keen to see how the program works can follow the explanation given with the assembler version of the program. But those who only want a working program will find the BASIC Loading Program in Listing.1 sufficient.

Type it in and RUN it. You will find it's user friendly and will tell you when all bytes are entered, or which line contains an error. When it has run successfully SAVE both it and the machine code it has produced.

The machine code program can be saved with a command such as:—

SAVE "PRNTR PROG" CODE 23296,92

This code is all you need to operate the interface and LPRINT and LLIST can be called once you have initiated the program with the following command:—

RANDOMIZE USR 23296

However, don't use COPY or any program that calls it, or the program will be erased. You must also note that if you are using ZX Interface 1 you must POKE 23300,255 before initialising.

Those conversant with machine code, should use the Assembler Program in Listing.2. Once it has been entered save it in its assembly form to provide a base for future modifications. After assembly the object code should be saved as described above.

HOW THE PROGRAM WORKS

To provide an understanding of the program we shall now go through the assembler version expanding on the notes that are included in the print-out of Listing.2. The code and addresses will usually be in Hex prefaced by '#'.

The program starts by loading the START address (#5B06) into the Spectrum printer channel at address (#5CC5). Then the next eight lines identify the character code which arrives at START in the A register and direct it as appropriate. Carriage Returns are sent to LINEND, codes up to #7E (ASCII) are printed, a space is substituted for any graphic characters and Keywords (Tokens) are returned to the ROM for decoding into individual characters.

Line 130 is the start of the interface operation. First the A register is stored then it is used to set Port A to mode 3. This mode allows any of the port lines to be either output or input and as stated earlier we are only using two control lines (STROBE & BUSY). So #FD, program line 160, sets all lines to input except line 2 (STROBE).

The way this is done becomes obvious if you translate the Hex code #FD to its binary equivalent 11111101. Each bit represents a port line, with the right hand bit for the first line (A0) and the left hand bit the last line. Now if you read 1 for 'I'nput and 0 for 'O'utput you will see how the signal is developed and how to change it if you wish.

Code #3F signals 'All lines Output' and when sent with the code for Port B control (# 7F) it sets all lines of this port to output. This, of course, is the port handling the eight data lines.

Listing 1: LOADING PROGRAM

```
 10 REM Base Printer Program
 20 LET t=0: LET b=0: LET n=0
 30 LET s=23296
 40 READ r
 50 POKE (s+b),r
 60 LET t=t+r: LET b=b+1
 70 IF b<10 THEN  GO TO 40
 80 READ m
 90 IF t<>m THEN  GO TO 130
100 LET t=0: LET n=n+1: LET s=s+b: LET b=0
110 IF n<10 THEN  GO TO 40
120 PRINT AT 10,5;"ALL BYTES ENTERED": STOP
130 PRINT AT 10,10;"DATA ERROR Line ";(200+10*n): STOP
200 DATA 33,6,91,34,197,92,254,13,40,67,827
210 DATA 254,126,56,11,254,164,56,5,214,165,1305
220 DATA 195,16,12,62,32,245,62,255,211,95,1185
230 DATA 62,253,211,95,62,63,211,127,62,2,1148
240 DATA 211,31,205,84,31,210,8,0,219,31,1030
250 DATA 203,71,32,244,241,211,63,175,211,31,1482
260 DATA 62,2,211,31,58,76,91,60,50,76,717
270 DATA 91,254,64,40,2,201,28,62,13,205,960
280 DATA 25,91,62,10,205,25,91,175,50,76,810
290 DATA 91,201,0,0,0,0,0,0,0,0,292
```

Listing 2: ASSEMBLER PROGRAM

```
*HISOFT GENS3M2 ASSEMBLER*
Pass 1 errors: 00

5B00            10          ORG   23296 ;       BASE PRNTR PROG
5B00 21065B     20          LD    HL,START
5B03 22C55C     30          LD    (#5CC5),HL   ;PRINTER CHANNEL
5B06 FE0D       40 START    CP    #0D     ;     CR. (ENTER)
5B08 2843       50          JR    Z,LINEND
5B0A FE7E       60          CP    #7E;          PRINTABLE
5B0C 380B       70          JR    C,PRNTBL
5B0E FEA4       80          CP    #A4;          GRAPHICS
5B10 3805       90          JR    C,SPACE
5B12 D6A5      100          SUB   #A5;          TOKENS
5B14 C3100C    110          JP    #0C10;        ROM
5B17 3E20      120 SPACE    LD    A,#20
5B19 F5        130 PRNTBL   PUSH  AF
5B1A 3EFF      140          LD    A,#FF;        PORT A MODE 3
5B1C D35F      150          OUT   (#5F),A
5B1E 3EFD      160          LD    A,#FD;        ALL IN EXCPT STRB
5B20 D35F      170          OUT   (#5F),A
5B22 3E3F      180          LD    A,#3F;        PORT B OUTPUT
5B24 D37F      190          OUT   (#7F),A
5B26 3E02      200          LD    A,#02;        STROBE OFF
5B28 D31F      210          OUT   (#1F),A
5B2A CD541F    220 RDY      CALL  #1F54     ;   CHK BREAK KEY.
5B2D D20800    230          JP    NC,#0008  ;   RET IF PRESSED.
5B30 DB1F      240          IN    A,(#1F)
5B32 CB47      250          BIT   0,A;          CHECK BUSY LINE
5B34 20F4      260          JR    NZ,RDY
5B36 F1        270          POP   AF
5B37 D33F      280          OUT   (#3F),A;      SEND CHR
5B39 AF        290          XOR   A;  ZERO A
5B3A D31F      300          OUT   (#1F),A;      STROBE ON
5B3C 3E02      310          LD    A,#02
5B3E D31F      320          OUT   (#1F),A;      STROBE OFF
5B40 3A4C5B    330          LD    A,(STORE);    LINE STORE.
5B43 3C        340          INC   A
5B44 324C5B    350          LD    (STORE),A
5B47 FE40      360          CP    #40   ;       LINE LENGTH
5B49 2802      370          JR    Z,LINEND
5B4B C9        380          RET
5B4C 00        390 STORE    DEFB  #00
5B4D 3E0D      400 LINEND   LD    A,#0D     ;   CR.
5B4F CD195B    410          CALL  PRNTBL
5B52 3E0A      420          LD    A,#0A   ;     LF.
5B54 CD195B    430          CALL  PRNTBL
5B57 AF        440          XOR   A         ;   {ZERO
5B58 324C5B    450          LD    (STORE),A;    {LINESTORE.
5B5B C9        460          RET
```

Listing 3: TASSWORD LOADING PROGRAM

Modify Listing 1 loading program as follows:

Change line 30 to read. ***30 LET s= 23376***

Change line 110 to read. ***110 IF n<5 THEN GO TO 40***

Add lines 200 to 240 below and delete lines 250 to 280

```
200 DATA 33,86,91,34,197,92,245,62,255,211,1306
210 DATA 95,62,253,211,95,62,63,211,127,62,1241
220 DATA 2,211,31,205,84,31,210,8,0,219,1001
230 DATA 31,203,71,32,244,241,211,63,175,211,1482
240 DATA 31,62,2,211,31,201,0,0,0,0,538
```

Then RUN the program and SAVE the code.

Listing 4: COPY ASSEMBLER PROGRAM

```
*HISOFT GENS3M2 ASSEMBLER*
Pass 1 errors: 00

5B00                10          ORG   23296
5B00 21065B         20          LD    HL,START
5B03 22C55C         30          LD    (#5CC5),HL ;CURCHL
5B06 FE0D           40 START    CP    #0D
5B08 2007           50          JR    NZ,PR
5B0A 3E0D           60 LFCR     LD    A,#0D
5B0C CD115B         70          CALL  PR
5B0F 3E0A           80          LD    A,#0A
5B11 F5             90 PR       PUSH  AF
5B12 3EFF          100          LD    A,#FF;PORT A MODE 3
5B14 D35F          110          OUT   (#5F),A
5B16 3EFD          120          LD    A,#FD;ALL IN EXCEPT STRB
5B18 D35F          130          OUT   (#5F),A
5B1A 3E3F          140          LD    A,#3F;PORT B OUTPUT
5B1C D37F          150          OUT   (#7F),A
5B1E 3E02          160          LD    A,#02; STROBE OFF
5B20 D31F          170          OUT   (#1F),A
5B22 DB1F          180 RDY      IN    A,(#1F)
5B24 CB47          190          BIT   0,A;CHECK BUSY LINE
5B26 20FA          200          JR    NZ,RDY
5B28 F1            210          POP   AF
5B29 D33F          220          OUT   (#3F),A; SEND CHR
5B2B AF            230          XOR   A;  ZERO A
5B2C D31F          240          OUT   (#1F),A; STROBE ON
5B2E 3E02          250          LD    A,#02
5B30 D31F          260          OUT   (#1F),A; STROBE OFF
5B32 C9            270          RET
5B33 3E1B          280 INIT     LD    A,#1B ;Esc
5B35 CD115B        290          CALL  PR
5B38 3E2A          300          LD    A,#2A ; * (GRAPHICS)
5B3A CD115B        310          CALL  PR
5B3D 3E00          320          LD    A,#0  ;mode
5B3F CD115B        330          CALL  PR
5B42 3E00          340          LD    A,#0  ;Lo No.
5B44 CD115B        350          CALL  PR
5B47 3E01          360          LD    A,#01 ;Hi No- 256.
5B49 CD115B        370          CALL  PR
5B4C C9            380          RET
5B4D 3E1B          390 SPC      LD    A,#1B ;Esc
5B4F CD115B        400          CALL  PR
5B52 3E41          410          LD    A,#41 ;A
5B54 CD115B        420          CALL  PR
5B57 3E01          430 SZ       LD    A,#01 ;1/72 line spacing
5B59 CD115B        440          CALL  PR
5B5C C9            450          RET
5B5D 444F5542      460 TEXT     DEFM  "DOUBLE SIZE? Y/N"
5B6D 3E02          470 DBL      LD    A,#02
5B6F 32585B        480          LD    (#5B58),A ;Line spacing.
5B72 32485B        490          LD    (#5B48),A  ;No pixels.
5B75 3E05          500          LD    A,#05
5B77 323E5B        510          LD    (#5B3E),A  ;Mode.
5B7A 1821          520          JR    CLTXT
5B7C 3E01          530 ST.PRG   LD    A,#01    ;Set Flag for
5B7E 323C5C        540          LD    (#5C3C),A;btm screen.
5B81 0610          550          LD    B,#10
5B83 3A085C        560          LD    A,(#5C08)
5B86 4F            570          LD    C,A
5B87 215D5B        580          LD    HL,TEXT
5B8A 7E            590 TXT      LD    A,(HL)   ;Print
5B8B D7            600          RST   #10      ;Text
5B8C 23            610          INC   HL
5B8D 10FB          620          DJNZ  TXT
5B8F 3A085C        630 CHK      LD    A,(#5C08)
5B92 B9            640          CP    C        ;Check
5B93 28FA          650          JR    Z,CHK    ;keyboard
5B95 FE59          660          CP    #59      ; 'Y'
5B97 28D4          670          JR    Z,DBL
5B99 FE79          680          CP    #79      ; 'y'
5B9B 28D0          690          JR    Z,DBL
5B9D 0602          700 CLTXT    LD    B,#02    ;Delete
5B9F CD440E        710          CALL  #0E44    ; text.
5BA2 CD005B        720 COPY1    CALL  #5B00
5BA5 CD4D5B        730          CALL  SPC
5BA8 CD335B        740          CALL  INIT
5BAB 210040        750          LD    HL,#4000;st display file
5BAE 1E08          760 START0   LD    E,#08 ;No. lines/block.
5BB0 1608          770 START1   LD    D,#08 ;No.lines/char:
5BB2 0E20          780 START2   LD    C,#20 ;No. chars/line.
5BB4 0608          790 LOOP1    LD    B,#08 ;No. pixels/char.
5BB6 E5            800 LOOP2    PUSH  HL
5BB7 D5            810          PUSH  DE
5BB8 C5            820          PUSH  BC
5BB9 56            830          LD    D,(HL)
5BBA AF            840          XOR   A
5BBB CB16          850          RL    (HL) ;LH bit into carry.
5BBD 17            860          RLA   ;Then into A.
5BBE ED4B575B      870          LD    BC,(SZ);Check it
5BC2 CB48          880          BIT   1,B     ;Double size
5BC4 2809          890          JR    Z,PR1   ;is required.
5BC6 72            900          LD    (HL),D ;If so
5BC7 CB16          910          RL    (HL)    ;load another
5BC9 17            920          RLA   ;    bit.
5BCA F5            930          PUSH  AF      ;And print
5BCB CD115B        940          CALL  PR      ;it twice.
5BCE F1            950          POP   AF
5BCF CD115B        960 PR1      CALL  PR
5BD2 C1            970          POP   BC
5BD3 D1            980          POP   DE
5BD4 E1            990          POP   HL
5BD5 10DF         1000          DJNZ  LOOP2 ;x8
5BD7 23           1010          INC   HL
5BD8 0D           1020          DEC   C
5BD9 20D9         1030          JR    NZ,LOOP1 ;x32
5BDB CD0A5B       1040          CALL  LFCR
5BDE CD541F       1050          CALL  #1F54;Break key.
5BE1 D0           1060          RET   NC
5BE2 CD335B       1070          CALL  INIT ;start next line.
5BE5 E5           1080          PUSH  HL
5BE6 01E000       1090          LD    BC,#E0
5BE9 09           1100          ADD   HL,BC ;Next address.
5BEA 15           1110          DEC   D
5BEB 20C5         1120          JR    NZ,START2 ;x8
5BED E1           1130          POP   HL
5BEE E5           1140          PUSH  HL
5BEF 01FF06       1150          LD    BC,#06FF;addr nxt block.
5BF2 37           1160          SCF
5BF3 ED42         1170          SBC   HL,BC ;New address.
5BF5 1D           1180          DEC   E
5BF6 20B8         1190          JR    NZ,START1;End 3 blocks?
5BF8 E1           1200          POP   HL
5BF9 3E58         1210          LD    A,#58
5BFB BC           1220          CP    H     ;or end of display?
5BFC 20B0         1230          JR    NZ,START0
5BFE C9           1240          RET

Pass 2 errors: 00

Table used:    232  from   383
```

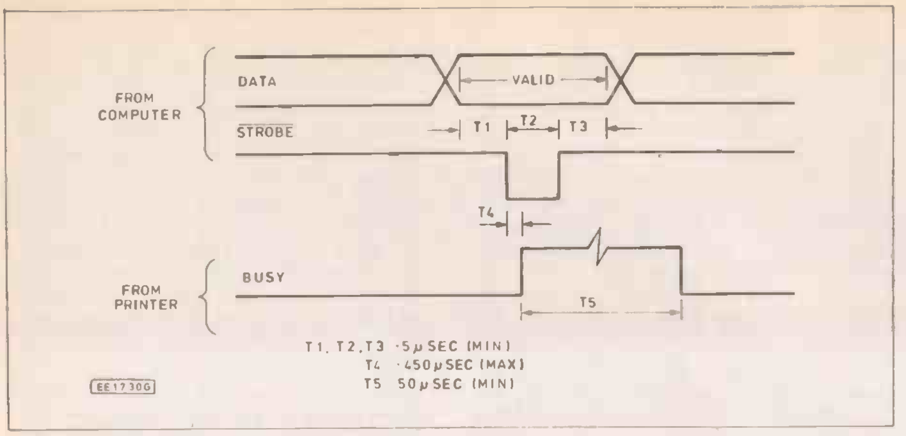


Fig. 5. Printer timing diagram.

The Strobe is switched on or off by sending a 'Data' signal to Port A (# 1F) but as the strobe is active low the Hi #02 (lines 200/210) sets it to OFF.

The program now enters a loop where it continuously monitors the BUSY line and the BREAK key. BUSY is checked by first loading the A port inputs and checking the first bit. If this is a "1" (Hi) then the program loops again until it is zero. The A register is then recovered and the character put on the B port data lines. A Hi — Lo — Hi strobe pulse to signal that the data is valid and an increment of the character count completes the program.

The remaining program lines are associated with starting a new line; either if called by a #OD character or if the number of characters in a line exceeds 64 (#40 line 360). Note that if you change this number by poking 23368 you can set the line length to any value you wish.

PRINTER OPERATION

The printer and interface have a handshake sequence governing the transfer of data. This is best illustrated by reference to the printer timing diagram in Fig 4. If the BUSY line is Lo (not busy) you will remember that the program will place the character to be printed on the data bus (port B) and send a pulse on the STROBE line.

The printer responds by activating the BUSY line until it has accepted the character. If it has to perform a LFCR or if there is a hold up — out of paper or off line — time T5 may be extended but if not, the BUSY clears and the sequence repeats. Thus each character is sent to the printer as fast as it can cope.

There are other signals associated with the sequence and you may find your printer operates slightly differently. You should now however be able to change the program or the lines to suit. Many printers have signal lines which indicate Paper-Out or Error, or which can be used to initialise the printer — set it to a standard typeface, spacing etc — but all these are luxuries which you can add yourself if you wish.

SYSTEM OPERATION

The system has successfully operated every printer which has been connected to it and is at present interfaced with an Epson LX86, Amstrad DMP 2000 and a Fastex 80 printer. Apart from switching off the auto line feed no changes were necessary.

It has also been tried with many commercial programs and here there are some difficulties. If the program sends individual characters to the printer and providing it doesn't use the same adddresses in the Spectrum printer buffer as the program then all is well, but if it uses a screen copy to print out the data then this system as it stands won't work.

However all is not lost, let me list the programs that do work, with and without some small alterations and try to deal with the difficult ones later:

GENS and MONS the assemblers and disassemblers by ***Hisoft*** work very well without any modifications or problems.

VU-FILE also prints correctly although in its original form it only prints 32 characters to the line.

TASWORD TWO by ***Tasman Software*** uses part of the printer buffer and this requires that the program is moved up 80 bytes to start at #5B50. As it doesn't use graphics or Keywords and sends its own LFCR's lines 40 to 120 of the program has also to be deleted.

This is easy for those of you with an assembler, simply load the previous assembly program and make the following changes:

Line 10 change 0RG 23296 to 0RG 23376.
Delete lines 40 to 120 inclusive.
Line 130 change the label PRNTBL to START.
Delete lines 330 to 370 and lines 390 to 460.

For those without assemblers we have listed the modifications to the loading program in Listing.3. In both cases SAVE the machine code program at CODE 23376,46 and initiate by adding this line to the Tasword BASIC program:

261 RANDOMIZE USR 23376

Note that the Microdrive modification is:

POKE 23380,255

COPY ASSEMBLER

Here is a final program which, we hope, will let you use those programs, such as Masterfile, which use the COPY command to produce a print-out. It will also let you make a copy of any picture on the screen. However, it does require some knowledge of your printer's Bit Image (Graphic) Mode and a machine code assembler program.

The program listed in Listing.4 is for a Smith Corona Fastex 80 printer. Before using it you should check to see if the commands in the following areas match those required by your printer.

1. Lines 280 to 370. These send the following bit image control code to the printer:

   ESC * (mode) n1 n2

   Esc * sets the Fastex 80 printer in the bit image mode. This instruction is common to many printers and may therefore be O.K.

   The (mode) number is a density code special to this printer. It is unlikely to apply to any others although some have different characters in place of the "*" for the same purpose.

   The number of bits to be printed is indicated by n1 n2. The total is 256 * n2 + n1. This will probably not need altering.

2. Lines 390 to 440 send ESC A n

   ESC A sets the paper feed to n/72 inch. In the program n is set to 1 for normal size and 2 for double size. Some printers don't have this facility and cannot then use this program.

The program is run with the command:

RANDOMIZE USR 23420

and this must replace COPY in any program making use of it. Masterfile requires this change at line 4010.

Remember that with microdrive you must POKE 23300,255 □

Completed interface with board removed showing wiring to the D-socket. Wiring from board to interconnecting sockets is best carried out by referring to Figs. 1 and 2.

a regular feature for the Spectrum Owner...

by Mike Tooley BA

THIS MONTH we have a seasonal project which takes the form of a Christmas Tree Lights Controller. Before we start, and with the New Year in mind, we begin by considering the past, present and future of the humble Spectrum.

Staying Power!

The superiority of one particular microcomputer over all others must be THE perenniel topic for all computer enthusiasts. Indeed, dedicated computer magazines add fuel to this fire for the obvious reason that their continued existence depends largely upon maintaining a user base for a particular machine.

This is a shame, since it can hardly make for objective journalism. Often, one machine is held up as being better than another by concentrating on points which may be somewhat peripheral. As an example of this, several years ago I remember reading a rather lengthy magazine article which reviewed a number of "state of the art" personal computers.

The author's main point was that the "power" of a microcomputer was largely a function of the microprocessor and could be measured by the size of its instruction set and internal registers. Little mention was made of execution times, clock rates, etc. The system which was being held up as an example of "state of the art" technology was based on the TMS9900, an early 16-bit microproceesor which was developed by Texas Instruments.

The microcomputer in question, the Texas TI99/4, was intended for mass market appeal but unfortunately had a price tag which, when it first appeared, was way beyond the budget of most computer enthusiasts. Shortly afterwards, the Sinclair Spectrum appeared in the high street at a rock-bottom price and you all know the rest of the story!

There is, perhaps, a simple lesson to be learned from this. The features which guarantee "staying power" in the microcomputer scene are not always those which are commensurate with a very advanced technical specification. The attributes of which can be summarised in just a few words: very low-cost; wide availability; and a huge software-base kept alive by a policy of upward compatability as new versions of a machine become available.

Clearly, the Spectrum does have "staying power", a quality which has been sadly lacking where some other machines are concerned. The Spectrum *should* have had some serious competition where a number of other machines are concerned (Memotech, Elan and a host of MSX machines to name but a few). All of these computers are technically superior on a whole host of different counts!

Now, as we enter 1989, it is perhaps worth speculating about the future of the Spectrum. A new Amstrad/Sinclair machine built for the entry-level user (using much the same philosophy as that advocated by Sir Clive when the Spectrum was first announced) will undoubtedly find favour with the masses. This machine will continue where the Spectrum leaves off, introducing computing to a new generation of computer users.

For those who would prefer to upgrade (*and* retain software compatability), Miles Gordon Technology are rumoured to have a super-Spectrum up their sleeves. This machine should also have an assured future but this time it will be favoured by the many tens of thousands of Spectrum users.

Yet again, we seem to be saying "*watch this space—it should be another exciting year for Spectrum owners*"!

CHRISTMAS TREE LIGHTS CONTROLLER

Some time ago, David Whitfield and I wrote a series of articles which was based on a simple microprocessor-based controller. The controller itself was nothing more than a board salvaged from an electronic cash register but it could be (and was!) easily configured with minimal hardware and software for a huge variety of household and industrial control applications.

In order to demonstrate the system at an exhibition, David spent many hours wiring several sets of Christmas tree lights to the controller and, with some simple software, a rather attractive display resulted which entertained family and visitors for many years afterwards. Now, with Christmas almost upon us, an improved Spectrum version of the project seemed irresistible!

Sets of Christmas tree lights for use in the UK often employ 35 individual bulbs wired in series across the 240V a.c. mains supply. Each lamp is usually rated at 7.2V 0.75W and thus requires an operating current of approximately 100mA.

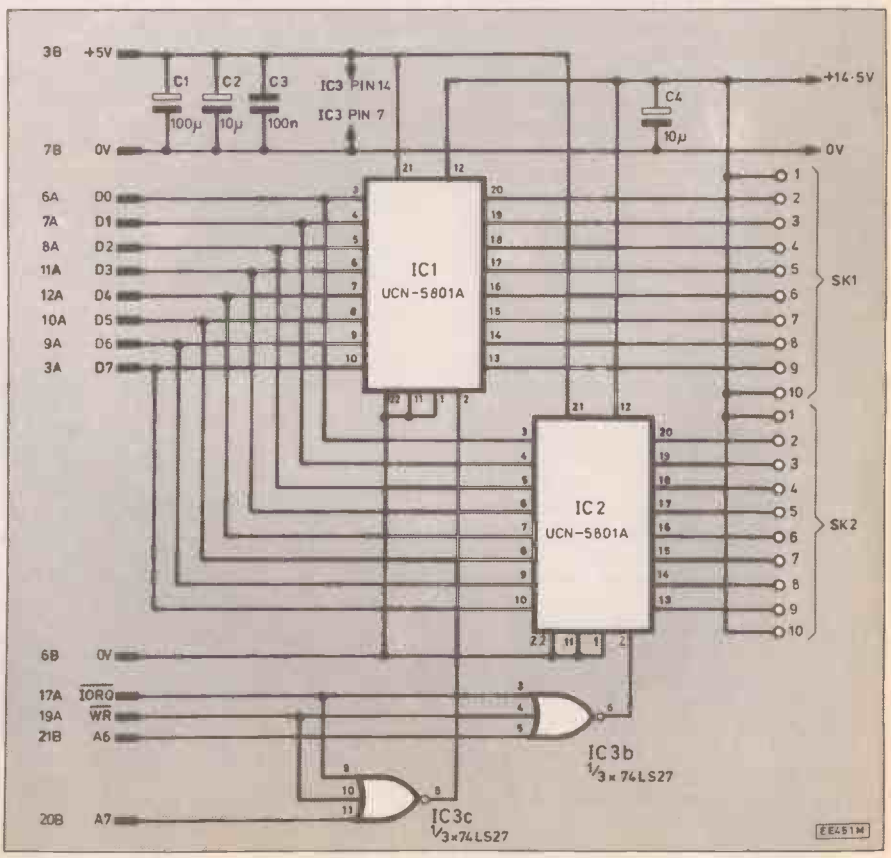
Our Spectrum Christmas tree lights controller has been designed to handle 32 lights wired as 16 separate branches (each comprising two lamps connected in series). Each pair of lamps is individually controlled and thus a wide range of effects can be produced.

The Christmas tree lights controller consists of an interface board (connected to the expansion port at the rear of the Spectrum) and a 14.5V d.c. power supply unit, which provides the necessary power for operating the lamps. The power supply is built into a separate enclosure and it may be easily adapted (by means of a switch fitted) to serve as a general purpose 12V 2A bench power unit.

The circuit of the Christmas Tree Lights Controller Interface is shown in Fig. 1. Two Darlington drivers, IC1 and IC2, are used to provide two byte-wide output ports at sockets SK1 and SK2. IC3c, and IC3b provide address decoding for IC1 and IC2, respectively.

The address decoding ensures that data is latched into IC1 whenever an I/O write operation is carried out to an address in which A7 is low. Similarly, data is latched into IC2 whenever an I/O write operation takes place to an address in which A6 is low.

Fig. 1. Circuit diagram for the Christmas Tree Lights Controller Interface



The single-line address decoding within the Spectrum's ULA requires that the lower five address lines all remain high in order to avoid conflicts when addressing external hardware. Hence we have assigned decimal addresses 127 (binary 01111111) and 191 (binary 10111111) to IC1 and IC2.

IC1 and IC2 each drive eight output lines and each is driven low by its corresponding data bit. Hence, if we wish to activate the two series-connected lamps associated with pin-2 of SK1 (whilst all other lamps remain off), the BASIC command is simply:

OUT 127,BIN 00000001

Similarly, if we should wish to illuminate all of the lamps connected to SK2 (driven by IC2), the required BASIC command is:

OUT 191,BIN 11111111

The circuit diagram for the Christmas tree lights Power Supply is shown in Fig. 2. The power supply employs a conventional transformer (T1) and bridge rectifier (D1-D4) arrangement in conjunction with a current-boosted 12V 1A regulator IC4, the output voltage of which is increased to 14.7V by means of a Zener diode (D5) "pedestal".

lower sides of the 28-way connector). A purpose designed "spot-face" cutter is ideal for this purpose or, if such a tool is not obtainable, a small sharp drill bit may be used.

The remaining components (capacitors and two 10-way connectors) should then be fitted to the board. As usual, the decoupling capacitors (C1 to C4) should be distributed around the board with C2 and C3 being placed close to the positive supply inputs of IC1 and IC2.

Links on the underside of the board should make use of appropriate lengths of miniature insulated wire (of the type normally used for wire wrapping). Readers requiring further information on the connector should refer to March 1985 *On Spec* or send for the "*Update*".

When the stripboard wiring has been completed, the two UCN-5801A output drivers (IC1, IC2) and the 74LS27 (IC3) should be inserted into their respective sockets (taking care to ensure correct orientation of each device).

The layout of the power supply is also not critical, however capacitors C6 and C7 should be wired in close proximity to IC4.

Lights

The modified wiring of the Christmas tree lights is shown in Fig. 3. The lamps are arranged in two groups of 16 and each group is terminated at a 10-way connector which will mate with either SK1 or SK2 (note pins 1 and 10 provide the common 14.5V supply). When wiring the lights, the original lampholders may be used or discarded (in which case the lamps may be soldered directly to the connecting wires).

Constructors may also wish to replace the original wiring (which is designed to handle mains voltages) with thinner, less obtrusive, insulated wire of a suitable colour. Furthermore, when preparing lengths of wire, it is important to allow sufficient to run from the base of the tree to the interface board at the rear of the Spectrum.

Lastly, the interface board should be linked to the power supply using appropriate insulated leads. The interface board wiring should be carefully checked before attempting to connect it to the Spectrum or applying power (***it is very important to note that the Spectrum should ALWAYS be disconnected from its supply before connecting or disconnecting ANY interface module).***

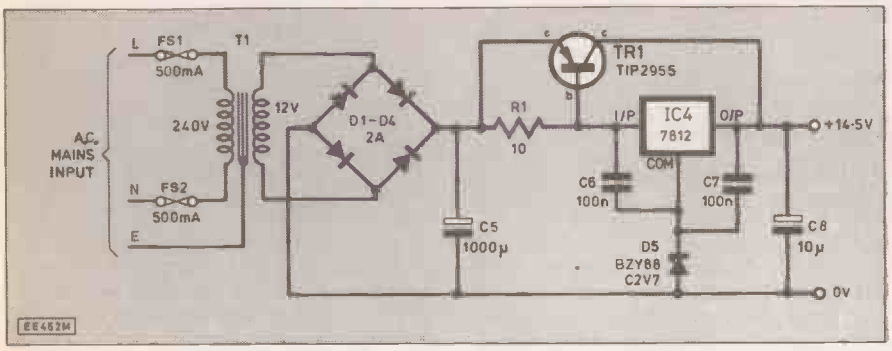


Fig. 2. Suggested power supply circuit diagram

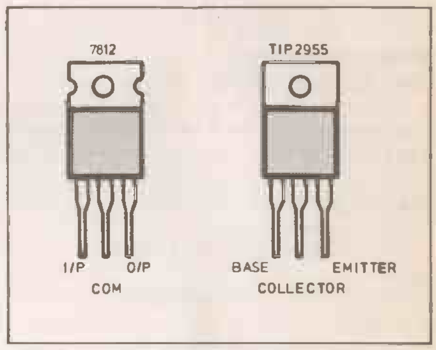


Fig. 4. Pin connections for the 7812 and TIP2955

CONSTRUCTION

The controller is assembled on two small pieces of Veroboard measuring approximately 100mm x 100mm (for the Spectrum interface) and 80mm x 100mm (for the power supply). The precise dimensions of both are unimportant except that the interface board should have a minimum of 28 tracks aligned in the vertical plane in order to accomodate mounting of a 28-way double-sided edge connector. This connector is fitted to the lower edge of the board and will require five holes across the full width of the stripboard so that the board stands vertically when the connector is mated with the Spectrum.

Before soldering any of the interface board components, it is important to allow adequate clearance for the rear overhang of the case. For the Spectrum this gap should correspond to eight rows of holes (20mm approx.) whilst for the Spectrum Plus, 128 and Plus-Two, the gap should be increased to 12 rows of holes (30mm approx.).

Component layout for the interface is generally uncritical though it is well worth carefully planning the layout in advance of mounting the components and i.c. socket. Readers are advised to carry out this exercise on paper first (using, if desired, the layout sheet provided with our "*On Spec Update*").

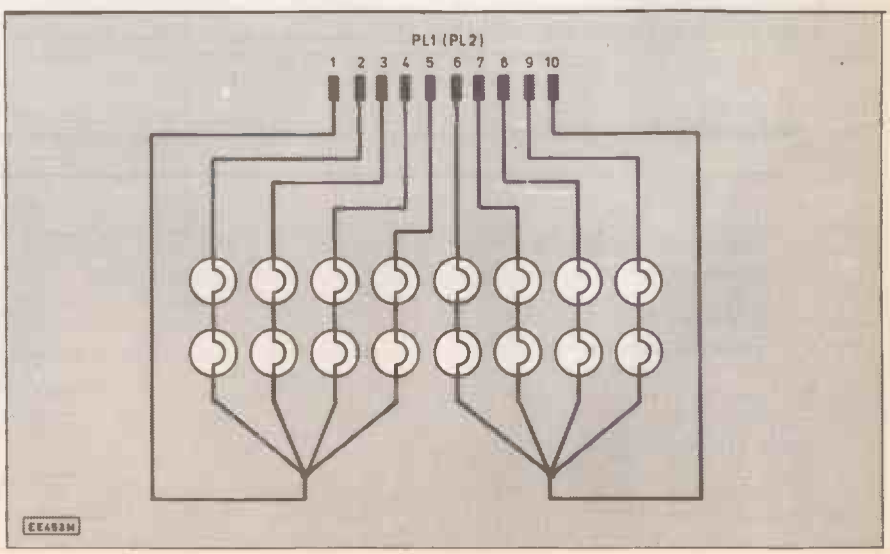
After mounting the i.c. sockets, great care must be taken to ensure that all unwanted tracks are out (including, in particular, those which link the upper and

Transistor TR1 will require a small heatsink and insulating kit and the entire power supply should be mounted inside a *plastic* enclosure.

A few ventilation holes will be required to provide adequate air flow around the transformer, regulator and heatsink. The output of the power supply should be terminated using a pair of colour coded 4mm sockets (red for +ve and black for 0V).

When checking has been completed, the interface board should be connected to the Spectrum, and power should be applied to the lights (via the power supply) and to the Spectrum. If all is well, the normal Spectrum copyright message should appear (none of the Christmas tree lights should be on!). If this is not the case, disconnect both power sources, remove the interface and carefully check again!

Fig. 3. Wiring arrangement for the Christmas tree lights



COMPONENTS

Approx. cost Guidance only **£32**

Shop Talk
See page 18

Resistors

R1	10

0.5W 5% carbon

Capacitors

C1	100μ p.c.b. elec. 25V
C2, C4, C8	10μ p.c.b elec. 25V (3 off)
C3, C6, C7	100n polyester (3 off)
C5	1000μ p.c.b. elec. 25V

Semiconductors

D1-D4	KBPC102 (2A bridge rectifier)
D5	BZY88 C2V7 2.7V 500mW Zener diode
TR1	TIP2955 *pnp* power transistor
IC1, IC2	UCN-5801A latching octal driver (2 off)
IC3	74LS27 triple 3-input NOR gate
IC4	7812 12V 1A regulator

Miscellaneous

T1 20VA mains transformer with 12V sec.; S1 miniature slide switch; 4mm sockets (2 off, 1 black and 1 red); 22-way low-profile DIL sockets (2 off); 14-pin low-profile DIL socket; 10-way p.c. mounting connectors and plugs (2 sets); 20mm fuse holders (2 off); 20mm 500mA quick-blow fuses (2 off); Enclosure for transformer and fuses; TAB power transistor mounting kit (mica insulator and bush); Heatsink (10 deg. C per Watt, or better); Mains connector; 28-way open end double-sided 2.54mm (0.1 in.) pitch edge connector (e.g. Vero part number 838-24826A); 0.1 in. pitch Veroboard, measuring approximately 100mm×100mm for the controller interface circuitry and 80mm×100mm for the power supply.

Programming the Lights Controller

The Christmas Tree Lights Controller can be programmed very easily using a minimum of code written in BASIC. In order to fully illuminate the tree (i.e. all lamps on) the following direct mode commands should be issued:

```
OUT 127,BIN 11111111
```

and

```
OUT 191,BIN 11111111
```

Within a program, one or more loops can be used to provide a series of different light displays. The following subroutines should provide a starting point:

```
100 REM Four at a time
110 LET ×=1
120 OUT 127, ×
130 OUT 191,×
140 LET ×=×*2
150 PAUSE 10
160 IF ×<256THEN GO TO 120
170 RETURN
200 REM Shimmer effect
210 FOR z=1 TO 50
220 OUT 127, 255*RND
225 PAUSE 5
230 OUT 191, 255*RND
235 PAUSE 5
240 NEXT z
250 RETURN
300 REM Alternate flash
310 FOR z=1 TO 20
320 OUT 127, BIN 10101010
330 OUT 191, BIN 10101010
340 OAUSE 10
350 OUT 127, BIN 01010101
360 OUT 191, BIN 01010101
370 PAUSE 10
380 NEXT z
390 RETURN
```

The first few lines of the program need comprise nothing more than a series of subroutine calls contained within an infinite loop. The following shows how:

```
10 REM Christmas lights
20 CLS
30 PRINT "Press BREAK to exit"
40 GOSUB 100
50 GOSUB 200
60 GOSUB 300
70 GO TO 40
```

Next Month: We shall be dealing with a number of points and queries raised by readers. In the meantime, if you would like a copy of our "*On Spec Update*", please drop me a line enclosing a *large* (250mm x300mm) *adequately* stamped addressed envelope. Mike Tooley, Department of Technology, Brooklands Technical College, Heath Road, Weybridge, Surrey. KT13 8TT.

ACTUALLY DOING IT!

by Robert Penfold

THE SUBJECT of soldering is one that has been covered in a previous *Actually Doing It*, but no apologies are made for returning to this topic. Efficient soldering is something that should be mastered by anyone who is going to undertake even the occasional electronic project. Badly soldered joints are almost certainly the biggest cause of newly constructed projects failing to work, and probably account for the vast majority of project failures. Learning to solder proficiently before you start constructing your first project could eliminate a lot of wasted time (and possibly expense) later on.

TOOLS FOR THE JOB

The basic tools and materials are not something that are to be found in the tool chest of the average household. These are something most newcomers to the hobby will have to buy-in specially, and you will need to be careful to obtain suitable items. There are many soldering irons available, but for electronic work a small electric type is the most suitable. An iron with a miniature bit and having a rating of about 15 to 25 watts should be just about right.

There are some quite expensive soldering irons available, including sophisticated temperature controlled types. There is no need to spend a lot of money on a soldering iron, and a relatively cheap model will almost certainly prove to be more than adequate. I have occasionally tried one of these exotic soldering irons, but I always seem to return to one of my faithful old 15W "standard" irons.

Some circuit boards tend to be so intricate that there is some advantage in using a really small bit, such as a one millimetre diameter type. On the other hand, these are not so good for larger joints such as when mounting large components (relays, large capacitors, etc.) on a circuit board, and when making connections to the tags of controls and sockets. You could have two irons — one fitted with a small bit and the other fitted with a slightly larger one.

Apart from the expense involved, it can be awkward to accommodate two irons on the workbench, and most users prefer to use a single iron with a bit of a size that provides a good compromise. One of around two millimetres in diameter should be about right (most irons are supplied complete with a bit of about this size).

IRON STAND

Just as important as the soldering iron is some sort of stand to provide somewhere safe to keep the iron between making sets of joints. It is not too difficult to put together a do-it-yourself soldering iron stand, but the ready-made article is generally quite cheap. It is much better to spend a pound or two on a ready-made stand than to improvise something that could be less than 100 per cent safe.

Most stands have a heavy metal or plastic base section plus a sort of large spring or metal tube into which the iron is placed. This second section of the stand is usually designed to take away excess heat from the iron if it is left unused for some time. This is important as without this heatsinking the life of the bit could be greatly reduced, as could the lifespan of the element (which is usually expensive to replace).

SOLDER

Last, and by no means least, you will need some solder. A 60 per cent tin/40 per cent lead type with cores of flux built-in is the type to use. At one time there were a number of different types of electrical solder available, and some of them were of dubious quality, or not really intended for small electronic work at all. You are unliklely to encounter a 40 per cent tin/60 per cent lead type these days, but if you do, avoid it at all costs. This type of solder sets too slowly, and tends to crack and craze unless the joint can be held very steady while the solder sets.

I remember using one solder that contained so much flux that each joint produced a large amount of smoke and spluttering from the iron. After a number of joints had been completed my hands were literally coated with the flux! The purpose of the flux is to help the molten solder to flow nicely and make good contact with the objects that are being jointed together. Too much flux can be counter-productive in that it can result in leads etc. becoming coated with the flux and being insulated from one another.

Fortunately, modern solders seem to be very good in this respect, and invariably have a suitable amount of a good quality flux. There still seem to be occasional problems when a point in the solder is reached where the mix of flux and metal is not quite right. This will usually be readily apparent due to too much or too little smoke being produced as each joint is made. Proceed with great caution if this occurs as a "dry" joint is quite likely to occur. The best policy is probably to discard the questionable section of solder rather than to risk using it.

Electrical solder is generally either 22 s.w.g. or the much thicker 18 s.w.g. type. For most work on printed circuit boards the thinner type is generally easier to use, but the 18 gauge type is more suitable for larger joints. It is useful to have both types to hand, but if you are only going to buy one or the other, the 22 s.w.g. solder is probably the best choice. If you use the heavier gauge solder when producing intricate circuit boards you run a strong risk of feeding in too much solder and producing solder bridges.

A large reel of solder can cost several pounds, but it is much cheaper buying it this way as opposed to buying lots of small amounts. Perhaps of more importance is that a large reel will last a very long time, and thus avoid the possibility of frequent hold-ups and subsequent frustration due to continually running out of solder at an inopportune time. If you do buy the small packs of solder, always try to keep an extra one in stock for emergency use.

Some soldering equipment. From left to right: two types of desoldering tool, 18 s.w.g. solder, a 17W iron and stand, desolder wick and 22 s.w.g. solder.

Tinning the bit of the iron with solder.

MAKING CONTACT

It is a good idea to spend some time practicing with the iron before trying to use it in earnest on your first project. Basically there are two types of soldered joint in electronics construction; those involving the mounting of components on a printed circuit board, and those that are concerned with soldering leads to the tags of controls, switches, etc.

To try your hand at dealing with printed circuit boards it is a good idea to buy a small piece of stripboard and to solder some wires onto this (22 s.w.g. tinned copper wire is about right). Stripboard is a form of proprietary printed circuit board, and it has a matrix of component holes on a 0.1 inch pitch. On one side of the board there are copper strips running down each row of holes. In normal use the component leads are threaded through the holes, the components are pushed right up against the board, their leadout wires are trimmed short (leaving about three millimetres protruding), and the trimmed leads are then soldered to the copper strips. The latter provide the interconnections between the components.

Soldering wires to a small piece of stripboard is a very cheap way of obtaining invaluable experience. Better still, buy a large piece of stripboard and a "bargain pack" of components, and try fitting some of these components to the board. This may seem a little wasteful, but it will be time and money well spent.

With suitable equipment it is possible to fit a number of components to the board and to then solder them into curcuit en-mass. However, initially it is probably best to take components one at a time. Use proper wire cutters to trim the leadout wires. They are the only tool that will enable you to easily trim the leadout wires just above the surface of the board.

IMPORTANT

The important point to bear in mind when making soldered joints is to apply the iron to the joint first and then feed in the solder. Do not load the bit with solder and then try to transfer it to the joint. By the time the solder reaches the joint most of the flux will have been burnt away, and a "dry" joint is likely to result.

Applying the solder first and the bit second is less disastrous, but still unreliable. A lot of the flux will still burn off before it has a chance to take effect. Also, a better joint is likely to be obtained if it is heated prior to the solder being added. This helps the solder to flow nicely over the joint. However, it only needs to be heated momentarily prior to feeding in the solder.

If you apply the tip of the bit to one side of the joint and feed in the solder from the other side, the solder should flow nicely and produce a neat mountain shaped joint. The surface of the solidified solder should be quite bright and shiny. If the solder is dull looking or the shape of the joint is globular, this would indicate that the quality of the joint is not very good.

If you produce a dubious joint, which is something we all do from time to time, you should clean off the solder and try again. One method of desoldering is to use a solder "wick" (which is actually a sort of thick copper "string" made from very fine wires). This can be used to soak up molten solder from a joint. However, I prefer a suction type desoldering tool which uses a spring and piston mechanism to suck up the molten solder, rather like an air-gun in reverse. These mostly cost just a few pounds, will last many years, and are well worth having right from the start.

If you have problems connecting a component it could be that the trouble is due to its leads being oxidised, or contaminated with grease or dirt. It used to be the standard procedure to clean the leadout wires of components prior to connecting them. Modern production demands more streamlined methods of production, and this has led to better component leads that are less easily contaminated with oxide or dirt. It can still happen though, especially with components that have been left in storage for some time before you finally come along and buy them.

Rubbing the leadouts with fine sandpaper is a good way to get them really clean, or scraping them with the blade of a penknife is also very effective. If a "dry" joint is produced, after clearing away the solder you should always clean the end of the leadout wire before trying again. Even if there was no contamination on the leadout wire originally, there may well be after the unsuccessful attempt to solder it in place.

FIRST STEPS

When the soldering iron is first plugged in it will probably start to produce a certain amount of smoke as it gets hot. Do not worry about this as it is quite normal. This is just dust on the element and (probably) a protective coating on the bit burning off. As soon as the bit starts to get really hot it should be tinned with solder. In other words, place in a small amount of solder onto the tip of the iron.

Try to keep the bit well tinned with solder at all times. This solder helps to make a good thermal contact between the bit and joint so that connections can be completed quickly and efficiently. If the iron is left running but unused for a while it is likely that the solder on the bit will oxidise. Instead of having a fairly bright and shiny surface it will then look relatively dark and will have a far from mirror-finish. If this happens, clean the solder from the bit and re-tin it before trying to make any further joints.

Cleaning the bit is usually accomplished using a sponge incorporated into the soldering iron stand. As this cleaning is done while the bit is hot, the sponge must be kept wet or it will simply melt when the bit is rubbed against it. Simply scraping the bit gently with the blade of a small screwdriver seems to be a simple but effective alternative method of cleaning it.

It is very important to keep the bit as clean as possible. If flux and oxidised solder are allowed to build-up on it there is a much stronger risk of dry joints being produced. If the build-up gets really bad it is quite likely that thermal contact between the bit and the solder will become so bad that it will be virtually impossible to melt the solder! I do not like to admit it, but this has hap-

For practice try making some joints on stripboard.

pened to me once or twice. It is very easy to get so absorbed in putting a project together that you forget about such things as cleaning the bit.

THIRD HAND

After trying one or two soldered joints you will soon come to the conclusion that it is a job which requires three hands. You need one each to hold the printed circuit board, to hold the soldering iron, and to feed in the solder. Most constructors soon sort out their own way around this problem, but here are a few suggestions that might be of help.

One way is to fix the component in place on the board so that you do not need to hold it in place manually. There are printed circuit frames which use a foam material to keep things in place, and which enable a number of components to be dealt with at once. Unfortunately these are not particularly cheap, and are little used by electronic hobbyists.

Some strategically placed Bostik Blue-Tack can work quite well as a temporary fixing while components are soldered in place, and is a very inexpensive solution. If you use a method of this general type, make sure that the components are held right against the board. A gap between the components and the board, even a small one, gives physically weak results. Any pressure on the components tends to pull the copper pads and surrounding tracks away from the board.

The method I generally adopt is to hold the printed circuit board and component in one hand, and the soldering iron in the other. Pull out about 300 millimetres or so of solder from the reel, and leave it sticking out over the edge of the workbench. You can then take the board and iron to the end of the solder, rather than taking the solder and iron to the board. This may sound like an awkward way of doing things, but many people find it quite quick and easy. It is certainly worth giving it a try. A simple frame to hold the board and allow it to be turned over can also be very useful.

HARD-WIRING

Hard-wiring is the term which is often used to describe wiring that is carried by connecting wires rather than copper tracks on a printed circuit board. This is mostly wiring from a printed circuit board to sockets and controls. The wires can be soldered direct to the printed circuit board, but it is more usual (and better) to fit printed circuit pins to the board, and then to connect the wires to these. Normally single-sided pins will suffice. These are fitted from the copper side of the board and the leads are connected to them on the top side of the board.

"Hard-wiring" is perhaps an apt term, as this wiring is generally a little more difficult than soldering components onto a printed circuit board. It is relatively easy to produce a "dry" joint with this type of wiring. In my experience the easiest and most reliable method of making this type of connection is to first tin the bare end of the lead and the pin, tag, or whatever, with a very generous amount of solder.

If there is any difficulty in coating either of them with solder, clean the offending surface and try again. With both halves of the joint well tinned, and the bit of the soldering iron also well tinned, firmly bend the wire around the tag or pin and apply the bit of the iron (and a little extra solder) for a second or two. When the iron has been removed try to keep the joint as steady as possible while the solder solidifies.

Provided both surfaces are properly tinned with solder prior to making the connection, this method should prove to be very easy and totally reliable. Do not be tempted to use the same method when fitting components onto a printed circuit board. It will prove to be difficult and unreliable.

A good way of getting some practice at hard-wiring is to hammer some panel pins about half-way into a scrap of wood or particle board. Then wire up pairs of pins using some multi-strand p.v.c. insulated connecting wire. As with practically any skill, practice makes perfect.

Soldering is not a particularly difficult skill, but resist the temptation to rush in and start putting together your first project before you have mastered soldering. To do so would almost certainly be a case of "more haste — less speed."

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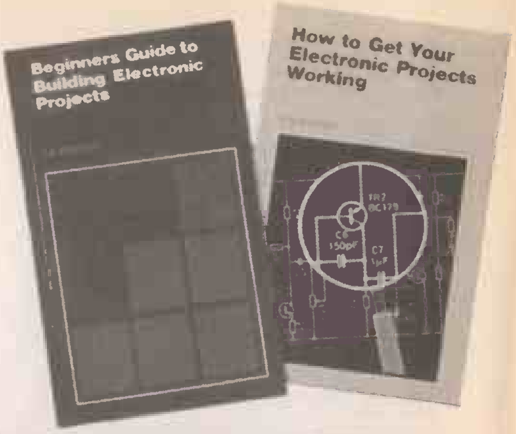

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BOOK 2 contains: Amplifiers—low level discrete and op-amp circuits, voltage and buffer amplifiers including d.c. types. Also low-noise audio and voltage controlled amplifiers. Filters—high-pass, low-pass, 6, 12, and 24dB per octave types. Miscellaneous—i.c. power amplifiers, mixers, voltage and current regulators, etc.

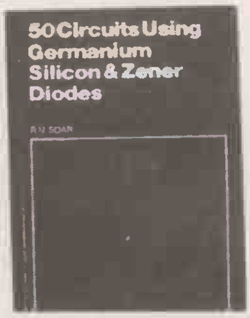
BOOK 1 *128 pages* **Order code BP117 £1.95**
BOOK 2 *112 pages* **Order code BP118 £1.95**

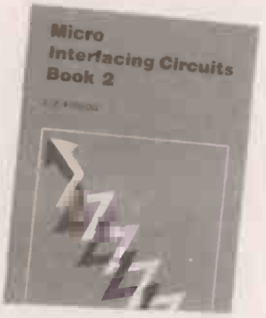
CIRCUITS AND DESIGN

ELECTRONICS SIMPLIFIED —CRYSTAL SET CONSTRUCTION
F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.
Especially written for those who wish to participate in the intricacies of electronics more through practical construction than by theoretical study. It is designed for all ages upwards from the day one can read intelligently and handle simple tools.
80 pages **Order Code BP92** **£1.75**

MICRO INTERFACING CIRCUITS–BOOK 1
MICRO INTERFACING CIRCUITS–BOOK 2
R. A. Penfold
Both books include practical circuits together with details of the circuit operation and useful background information. Any special constructional points are covered but p.c.b. layouts and other detailed constructional information are not included.
Book 1 is mainly concerned with getting signals in and out of the computer;. Book 2 deals primarily with circuits for practical applications.
Book 1 *112 pages* Order code BP130 £2.25
Book 2 *112 pages* Order code BP131 £2.75

ELECTRONIC CIRCUITS HANDBOOK
Michael Tooley BA
This book aims to explode two popular misconceptions concerning the design of electronic circuits: that only those with many years of experience should undertake circuit design and that the process relies on an understanding of advanced mathematics. Provided one is not too ambitious, neither of these popularly held beliefs is true.
Specifically, this book aims to provide the reader with a unique collection of practical working circuits together with supporting information so that circuits can be produced in the shortest possible time and without recourse to theoretical texts.
Furthermore, information has been included so that the circuits can readily be modified and extended by readers to meet their own individual needs. Related circuits have been grouped together and cross-referenced within the text (and also in the index) so that readers are aware of which circuits can be readily connected together to form more complex systems. As far as possible, a common range of supply voltages, signal levels and impedances has been adopted.
As a bonus, ten test gear projects have been included. These not only serve to illustrate the techniques described but also provide a range of test equipment which is useful in its own right.
277 pages Order code NE05 £14.95





50 CIRCUITS USING GERMANIUM SILICON AND ZENER DIODES
R. N. Soar
Contains 50 interesting and useful circuits and applications, covering many different branches of electronics, using one of the most simple and inexpensive of components—the diode. Includes the use of germanium and silicon signal diodes, silicon rectifier diodes and Zener diodes, etc.
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50 SIMPLE LED CIRCUITS
R. N. Soar
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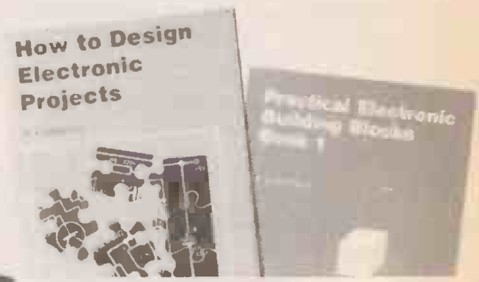
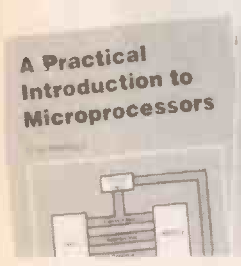
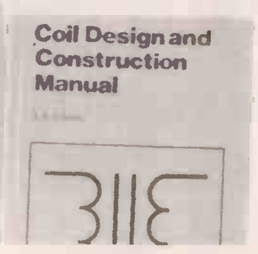
BOOK 2 50 more l.e.d. circuits Order code BP87 £1.35

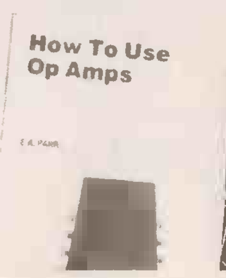
A MICROPROCESSOR PRIMER
E. A. Parr, B.SC., C.Eng., M.I.E.E.
Starts by designing a small computer which, because of its simplicity and logical structure, enables the language to be easily learnt and understood. The shortcomings are then discussed and the reader is shown how these can be overcome by changes and additions to the instruction set. In this way, such ideas as relative addressing, index registers, etc., are developed.
96 pages Order code BP72 £1.75

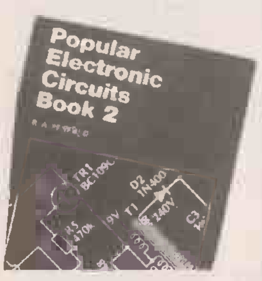
A PRACTICAL INTRODUCTION TO MICROPROCESSORS
R. A. Penfold
Provides an introduction which includes a very simple microprocessor circuit which can be constructed so that the reader can experiment and gain practical experience.
96 pages **Temporarily out of print**











HOW TO DESIGN ELECTRONIC PROJECTS
R. A. Penfold
The aim of this book is to help the reader to put together projects from standard circuit blocks with a minimum of trial and error, but without resorting to any advanced mathematics. Hints on designing circuit blocks to meet your special requirements are also provided.
128 pages **Order code BP127** **£2.25**

COIL DESIGN AND CONSTRUCTION MANUAL
B. B. Babani
A complete book for the home constructor on "how to make" RF, IF, audio and power coils, chokes and transformers. Practically every possible type is discussed and calculations necessary are given and explained in detail. Although this book is now rather old, with the exception of torroids and pulse transformers little has changed in coil design since it was written.
96 pages **Order Code 160** **£2.50**

HOW TO USE OP-AMPS
E. A. Parr
This book has been written as a designer's guide covering many operational amplifiers, serving both as a source book of circuits and a reference book for design calculations. The approach has been made as non-mathematical as possible.
160 pages **Order code BP88** **£2.95**

POPULAR ELECTRONIC CIRCUITS –BOOK 1
POPULAR ELECTRONIC CIRCUITS –BOOK 2
R. A. Penfold
Each book provides a wide range of designs for electronic enthusiasts who are capable of producing working projects from just a circuit diagram without the aid of detailed construction information. Any special setting-up procedures are described.
BOOK 1 *160 pages* Order code BP80 £2.95
BOOK 2 *160 pages* Order code BP98 £2.25

ELECTRONIC CIRCUITS FOR THE COMPUTER CONTROL OF MODEL RAILWAYS
R.A. Penfold
Home computers may easily be applied to the control of model railways and really quite sophisticated control, which needs only simple programming, is not too difficult to achieve. The main problem lies in interfacing the computer to the layout, but fortunately it is not too difficult or expensive to build suitable interfaces, and this book shows you how.
The projects consist of various types of controller, including a high quality pulse type, as well as circuits for train position sensing, signal and electric points control etc. The use of computers does not have to be restricted to massive layouts. Something as simple as an oval of track with a single siding can be given a new dimension by adding computer control and much fun can be had from these relatively simple set-ups.
88 pages **Order code BP180** **£2.95**

MODERN OPTO DEVICE PROJECTS
R.A. Penfold
In recent years, the range of opto devices available to the home constructor has expanded and changed radically. These devices now represent one of the more interesting areas of modern electronics for the hobbyist to experiment in, and many of these devices have useful practical applications as well. This book provides a number of practical designs which utilize a range of modern opto-electric devices, including such things as fibre optics, ultra bright l.e.d.s and passive IR detectors etc.
While many of these designs are not in the "dead simple" category, they should be within the capabilities of anyone with a reasonable amount of experience in electronics construction and some of the more simple designs are suitable for beginners.
104 pages **Temporarily out of print**

ELECTRONIC CIRCUITS FOR THE COMPUTER CONTROL OF ROBOTS
Robert Penfold
Robots and robotics offer one of the most interesting areas for the electronics hobbyist to experiment in. Today the mechanical side of robots is not too difficult, as there are robotics kits and a wide range of mechanical components available. The micro controller is not too much of a problem either, since the software need not be terribly complex and many inexpensive home computers are well suited to the task.
The main stumbling block for most would-be robot builders is the electronics to interface the computer to the motors, and the sensors which provide feedback from the robot to the computer. The purpose of this book is to explain and provide some relatively simple electronic circuits which bridge this gap.
92 pages **Order code BP179** **£2.95**

DATA AND REFERENCE

ELECTRONICS TEACH-IN
Michael Tooley BA and David Whitfield MA MSc CEng MIEE (published by *Everyday Electronics*)
This value for money *EE* book provides a comprehensive background to modern electronics including test gear projects. A complete course in basic electronics; designed for the complete newcomer it will however also be of val to those with some previous experience of electronics. Wherever possible the course is related to "real life" working circuits and each part includes a set of detailed practical assignments. Includes details of eight items of related test gear giving full constructional information and diagrams for each one. They are: Safe Power Supply; Universal LCR Bridge; Diode/Transistor Tester; Audio Signal Tracer; Audio Signal Generator; RF Signal Generator; FET Voltmeter; Pulse Generator. An excellent companion for anyone interested in electronics and invaluable for those taking G.C.S.E. and BTEC electronics courses.
104 pages (A4 size) **Order code EE/T-I** **£1.95**

PRACTICAL ELECTRONICS CALCULATIONS AND FORMULAE
F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.
Bridges the gap between complicated technical theory, and "cut-and-tried" methods which may bring success in design but leave the experimenter unfulfilled. A strong practical bias—tedious and higher mathematics have been avoided where possible and many tables have been included.
The book is divided into six basic sections: Units and Constants, Direct-current Circuits, Passive Components, Alternating-current Circuits, Networks and Theorems, Measurements.
256 pages **Order code BP53** **£3.95**

ESSENTIAL THEORY FOR THE ELECTRONICS HOBBYIST
G. T. Rubaroe, T.Eng (C.E.I.), Assoc.I.E.R.E.
The object of this book is to supply the hobbyist with a background knowledge tailored to meet his or her specific requirements and the author has brought together the relevant material and presented it in a readable manner with minimum recourse to mathematics.
128 pages **Order Code 228** **£2.50**

MICROPROCESSING SYSTEMS AND CIRCUITS
F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.
A truly comprehensive guide to the elements of microprocessing systems which really starts at the beginning. Teaches the reader the essential fundamentals that are so important for a sound understanding of the subject.
256 pages **Order Code BP77** **£2.95**

CHART OF RADIO, ELECTRONIC, SEMICONDUCTOR AND LOGIC SYMBOLS
M. H. Banani, B.Sc.(Eng.)
Illustrates the common, and many of the not-so-common, radio, electronic, semiconductor and logic symbols that are used in books, magazines and instruction manuals, etc., in most countries throughout the world.
Chart **Order Code BP27** **£0.95**

ELECTRONICS TEACH-IN 88/89— INTRODUCING MICROPROCESSORS
Mike Tooley BA (published by *Everyday Electronics*)
A complete course that can lead successful readers to the award of a City and Guilds Certificate in Introductory Microprocessors (726/303). The book contains everything you need to know including full details on registering for assessment, etc.
80 pages (A4 size) **Order code TI-88/89** **£2.45**

ELECTRONIC HOBBYISTS HANDBOOK
R.A. Penfold
Provides an inexpensive single source of easily located information that the amateur electronics enthusiast is likely to need for the day-to-day pursuance of this fascinating hobby. Covers common component colour codes. Details the characteristics and pinouts of many popular semiconductor devices, including various types of logic ICs, operational amplifiers, transistors, FETs, unijunctions, diodes, rectifiers, SCRs, diacs, triacs, regulators and SMDs, etc. Illustrates many useful types of circuits, such as timers and oscillators, audio amplifiers and filters, as well as including a separate section on power supplies. Also contains a multitude of other useful data.
88 pages **Order code BP233** **£4.95**

AUDIO
F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.
Analysis of the sound wave and an explanation of acoustical quantities prepare the way. These are followed by a study of the mechanism of hearing and examination of the various sounds we hear. A look at room acoustics with a subsequent chapter on microphones and loudspeakers then sets the scene for the main chapter on audio systems—amplifiers, oscillators, disc and magnetic recording and electronic music.
320 pages **Order Code BP111** **£3.50**

HOW TO IDENTIFY UNMARKED ICs
K. H. Recorr
Shows the reader how, with just a test-meter, to go about recording the particular signature of an unmarked i.c. which should enable the i.c. to then be identified with reference to manufacturers' or other data. An i.c. signature is a specially plotted chart produced by measuring the resistances between all terminal pairs of an i.c.
Chart **Order code BP101** **£0.95**

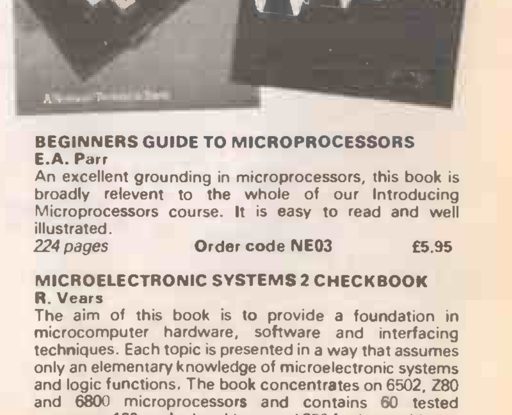
RADIO AND ELECTRONIC COLOUR CODES AND DATA CHART
B. B. Babani
Although this chart was first published in 1971 it provides basic information on many colour codes in use throughout the world, for most radio and electronic components. Includes resistors, capacitors, transformers, field coils, fuses, battery leads, speakers, etc. It is particularly useful for finding the values of old components.
Chart **Order code BP7** **£0.95**

RECOMMENDED READING

FOR INTRODUCING DIGITAL ELECTRONICS

ELECTRONICS - A "MADE SIMPLE" BOOK
G. H. Olsen
This book provides excellent background reading for our *Introducing Digital Electronics* series and will be of interest to everyone studying electronics. The subject is simply explained and well illustrated and the book assumes only a very basic knowledge of electricity.
330 pages **Order code NE10** **£4.95**

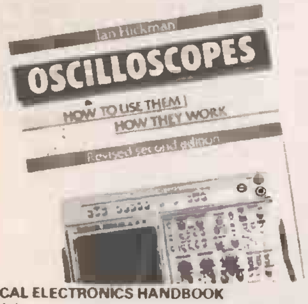
PRACTICAL DIGITAL ELECTRONICS HANDBOOK
Mike Tooley (Published in association with *Everyday Electronics*)
The vast majority of modern electronic systems rely heavily on the application of digital electronics, and the *Practical Digital Electronics Handbook* aims to provide readers with a practically based introduction to this subject. The book will prove invaluable to anyone involved with the design, manufacture or servicing of digital circuitry, as well as to those wishing to update their knowledge of modern digital devices and techniques. Contents: Introduction to integrated circuits; basic logic gates; monostable and bistable devices; timers; microprocessors; memories; input and output devices; interfaces; microprocessor buses. Appendix 1: Data. Appendix 2: Digital test gear projects; tools and test equipment; regulated bench power supply; logic probe; logic pulser; versatile pulse generator; digital IC tester; current tracer; audio logic tracer; RS-232C breakout box; versatile digital counter/frequency meter. Appendix 3: The oscilloscope. Appendix 4: Suggested reading. Appendix 5: Further study.
208 pages **Order code PC100** **£6.95**



BEGINNERS GUIDE TO MICROPROCESSORS
E.A. Parr
An excellent grounding in microprocessors, this book is broadly relevent to the whole of our Introducing Microprocessors course. It is easy to read and well illustrated.
224 pages **Order code NE03** **£5.95**

MICROELECTRONIC SYSTEMS 2 CHECKBOOK
R. Vears
The aim of this book is to provide a foundation in microcomputer hardware, software and interfacing techniques. Each topic is presented in a way that assumes only an elementary knowledge of microelectronic systems and logic functions. The book concentrates on 6502, Z80 and 6800 microprocessors and contains 60 tested programs, 160 worked problems and 250 further problems.
Now replaced by Microelectronic Systems N2 Checkbook
Order code NE04N **£6.95**

OSCILLOSCOPES: HOW TO USE THEM – HOW THEY WORK
Ian Hickman
Oscilloscopes are essential tools for checking circuit operation and diagnosing faults, and an enormous range of models is available. But which is the right 'scope for a particular application? Which features are essential, which not so important? What techniques will get the best out of the instrument?
Ian Hickman, experienced in both professional and hobbyist electronics, has revised this well-established book to help all oscilloscope users – and potential users.
133 pages Order code NE09 £6.95

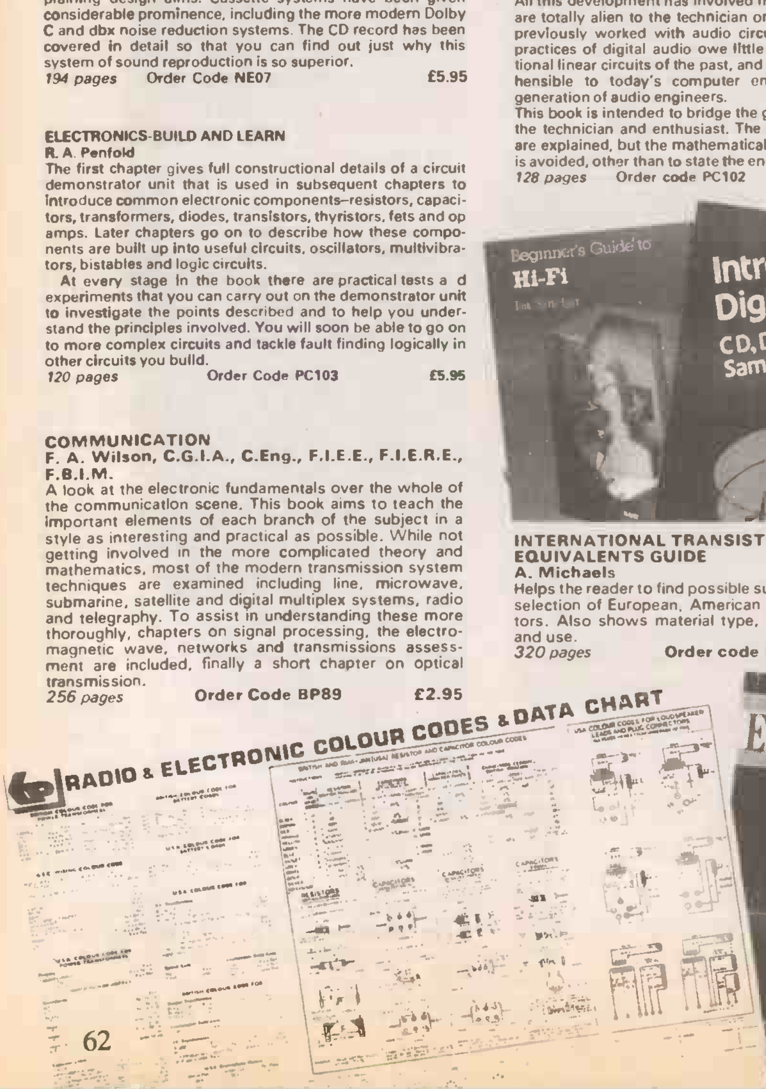


PRACTICAL ELECTRONICS HANDBOOK
Ian Sinclair
Ian Sinclair has now revised this useful and carefully selected collection of standard circuits, rules-of-thumb, and design data for professional engineers, students and enthusiasts involved in radio and electronics. Covering passive and active components, discrete component circuits (such as amplifiers, filters and oscillators) and linear and digital i.c.s, the book includes many items which are not elsewhere available in a single handy volume. The operation and functions of typical circuits are described, while mathematics is limited to that necessary for deciding component values for any application.
This revised edition contains more details on computers and microprocessors and has been brought up to date throughout.
199 pages Order Code NE06 £7.95

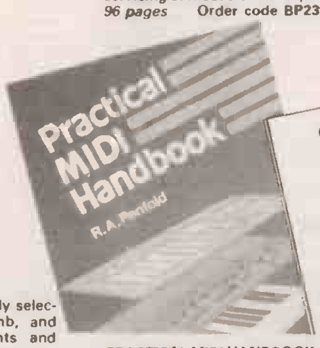
BEGINNER'S GUIDE TO HI-FI
Ian Sinclair
The *Beginner's Guide to Hi-Fi* will appeal to the audio enthusiast, whether newly won over by advances in technology or well established and wondering whether to update equipment. The book deals with the sound from its sources in the studio to its ultimate end in your ears, and shows what sound is, how it is recorded and how it is reproduced.
Every aspect of Hi-Fi, from pickup cartridges to loudspeakers, has been covered, and the emphasis has been on explaining design aims. Cassette systems have been given considerable prominence, including the more modern Dolby C and dbx noise reduction systems. The CD record has been covered in detail so that you can find out just why this system of sound reproduction is so superior.
194 pages Order Code NE07 £5.95

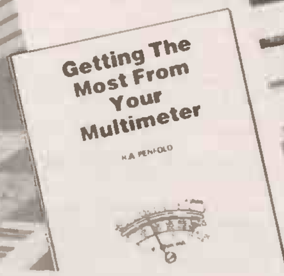
ELECTRONICS-BUILD AND LEARN
R. A. Penfold
The first chapter gives full constructional details of a circuit demonstrator unit that is used in subsequent chapters to introduce common electronic components–resistors, capacitors, transformers, diodes, transistors, thyristors, fets and op amps. Later chapters go on to describe how these components are built up into useful circuits, oscillators, multivibrators, bistables and logic circuits.
At every stage in the book there are practical tests a d experiments that you can carry out on the demonstrator unit to investigate the points described and to help you understand the principles involved. You will soon be able to go on to more complex circuits and tackle fault finding logically in other circuits you build.
120 pages Order Code PC103 £5.95

COMMUNICATION
F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.
A look at the electronic fundamentals over the whole of the communication scene. This book aims to teach the important elements of each branch of the subject in a style as interesting and practical as possible. While not getting involved in the more complicated theory and mathematics, most of the modern transmission system techniques are examined including line, microwave, submarine, satellite and digital multiplex systems, radio and telegraphy. To assist in understanding these more thoroughly, chapters on signal processing, the electromagnetic wave, networks and transmissions assessment are included, finally a short chapter on optical transmission.
256 pages Order Code BP89 £2.95



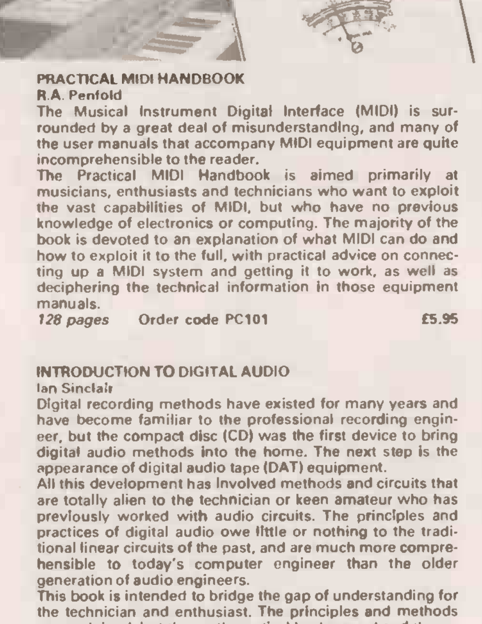
GETTING THE MOST FROM YOUR MULTIMETER
R.A. Penfold
This book is primarily aimed at beginners and those of limited experience of electronics. Chapter 1 covers the basics of analogue and digital multimeters, discussing the relative merits and the limitations of the two types. In Chapter 2 various methods of component checking are described, including tests for transistors, thyristors, resistors, capacitors and diodes. Circuit testing is covered in Chapter 3, with subjects such as voltage, current and continuity checks being discussed.
In the main little or no previous knowledge or experience is assumed. Using these simple component and circuit testing techniques the reader should be able to confidently tackle servicing of most electronic projects.
96 pages Order code BP239 £2.95



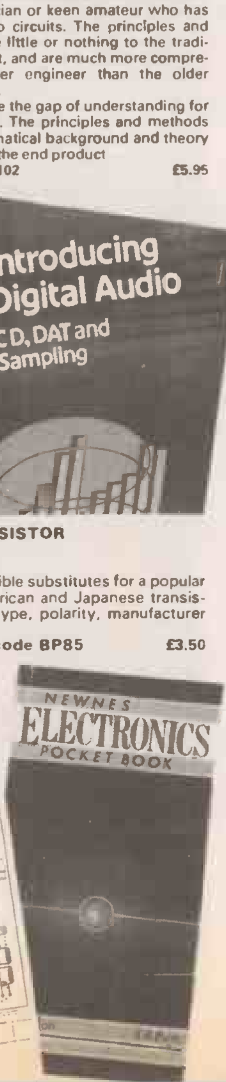


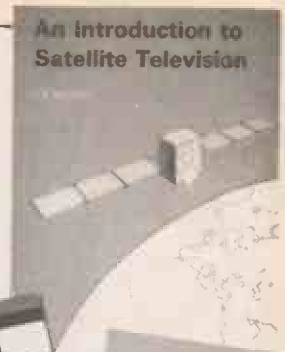
PRACTICAL MIDI HANDBOOK
R.A. Penfold
The Musical Instrument Digital Interface (MIDI) is surrounded by a great deal of misunderstanding, and many of the user manuals that accompany MIDI equipment are quite incomprehensible to the reader.
The Practical MIDI Handbook is aimed primarily at musicians, enthusiasts and technicians who want to exploit the vast capabilities of MIDI, but who have no previous knowledge of electronics or computing. The majority of the book is devoted to an explanation of what MIDI can do and how to exploit it to the full, with practical advice on connecting up a MIDI system and getting it to work, as well as deciphering the technical information in those equipment manuals.
128 pages Order code PC101 £5.95

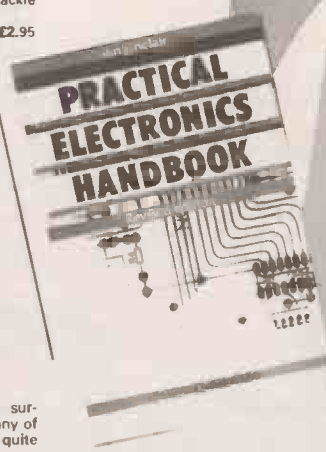
INTRODUCTION TO DIGITAL AUDIO
Ian Sinclair
Digital recording methods have existed for many years and have become familiar to the professional recording engineer, but the compact disc (CD) was the first device to bring digital audio methods into the home. The next step is the appearance of digital audio tape (DAT) equipment.
All this development has involved methods and circuits that are totally alien to the technician or keen amateur who has previously worked with audio circuits. The principles and practices of digital audio owe little or nothing to the traditional linear circuits of the past, and are much more comprehensible to today's computer engineer than the older generation of audio engineers.
This book is intended to bridge the gap of understanding for the technician and enthusiast. The principles and methods are explained, but the mathematical background and theory is avoided, other than to state the end product
128 pages Order code PC102 £5.95



INTERNATIONAL TRANSISTOR EQUIVALENTS GUIDE
A. Michaels
Helps the reader to find possible substitutes for a popular selection of European, American and Japanese transistors. Also shows material type, polarity, manufacturer and use.
320 pages Order code BP85 £3.50







TRANSISTOR RADIO FAULT-FINDING CHART
C. E. Miller
Used properly, should enable the reader to trace most common faults reasonably quickly. Across the top of the chart will be found four rectangles containing brief description of these faults, *vis*—sound weak but undistorted, set dead, sound low or distorted and background noises. One then selects the most appropriate of these and following the arrows, carries out the suggested checks in sequence until the fault is cleared.
Chart Order code BP70 £0.95

DIGITAL IC EQUIVALENTS AND PIN CONNECTIONS
A. Michaels
Shows equivalents and pin connections of a popular selection of European, American and Japanese digital i.c.s. Also includes details of packaging, families, functions, manufacturer and country of origin.
256 pages Order code BP140 £5.95

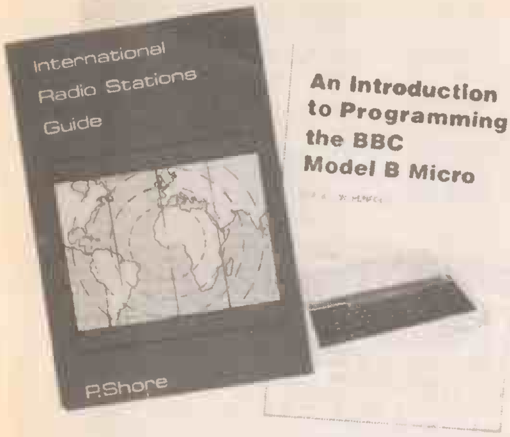
LINEAR IC EQUIVALENTS AND PIN CONNECTIONS
A. Michaels
Shows equivalents and pin connections of a popular selection of European, American and Japanese linear i.c.s. Also includes details of functions, manufacturer and country of origin.
320 pages Order code BP141 £5.95

INTERNATIONAL DIODE EQUIVALENTS GUIDE
A. Michaels
Designed to help the user in finding possible substitutes for a large selection of the many different types of diodes that are available. Besides simple rectifier diodes, also included are Zener diodes, l.e.d.s, diacs, triacs, thyristors, OCIs, photo and display diodes.
144 pages Order code BP108 £2.25

NEWNES ELECTRONICS POCKET BOOK
E. A. Parr
Newnes Electronics Pocket Book has been in print for over twenty years and has covered the development of electronics from valve to semiconductor technology and from transistors to LSI integrated circuits and microprocessors. To keep up to date with the rapidly changing world of electronics, continuous revision has been necessary. This new Fifth Edition takes account of recent changes and includes material suggested by readers of previous editions. New descriptions of op.amp. applications and the design of digital circuits have been added, along with a totally new chapter on computing, plus other revisions throughout.
315 pages (hard cover) Order Code NE02 £9.95

TRANSISTOR SELECTOR GUIDE
This unique guide offers a range of selection tables compiled so as to be of maximum use to all electronics engineers, designers and hobbyists.
Section 1: Covers component markings, codings and standards, as well as explaining the symbols used.
Section 2: Tabulates in alpha-numeric sequence the comprehensive specifications of over 1400 devices.
Section 3: Tabulates the devices by case type.
Section 4: Considers particular limits to the electrical parameters when compiling the tables.
Section 5: Illustrates package outlines and leadouts.
Section 6: Consists of a surface mounting device markings conversion list.
192 pages Order code BP234 £4.95

RADIO/TELEVISION



AN INTRODUCTION TO RADIO DXING
R. A. Penfold
Anyone can switch on a short wave receiver and play with the controls until they pick up something, but to find a particular station, country or type of broadcast and to receive it as clearly as possible requires a little more skill and knowledge. The object of this book is to help the reader to do just that, which in essence is the fascinating hobby of radio DXing.
112 pages **Order code BP91** **£1.95**

INTERNATIONAL RADIO STATIONS GUIDE
P. Shore
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DOWN TO EARTH

BY GEORGE HYLTON

THERMISTORS

BAD behaviour can sometimes be turned to good use. A resistance which changes with temperature is normally to be avoided, but when it's a thermistor this vice becomes a positive virtue.

Thermistors are made from materials whose resistance changes a great deal with temperature. One obvious use is to sense the temperature (measure the resistance and you know its temperature) but there are many more: surge limiting, time delay, amplitude control, temperature compensation, and liquid level detection are just a few.

NTC and PTC

Perhaps the best-known application of a temperature sensitive resistance is the platinum wire thermometer. This is an old (pre-electronic) device, used for high temperature measurements.

Platinum is chemically inert. It doesn't oxidise, even when very hot. Like most metals, its resistance increases with temperature. It has a positive temperature coefficient; materials whose resistance falls as they get hotter have a negative temperature coefficient. This difference gives two classes of thermistors: *NTC* devices and *PTC* devices.

Platinum wire isn't usually described as thermistor material. That name is reserved for devices with much greater sensitivity to temperature. The early varieties were NTC devices and were made from metal oxides. They are really semiconductors, in the true sense of materials whose resistivity is greater than that of metals but less than that of insulators.

Thermistors of the PTC variety became available much later. One material which can be used for PTC devices is suitably doped silicon, whose resistance rises by 0.7 per cent for each temperature increase of 1°C.

On circuit diagrams, several symbols for thermistors are seen (Fig. 1) the secondary symbol to the right of the middle one says "minus theta" and shows that the component in question is an NTC thermistor.

SELF HEATING

If a current is forced through a thermistor the power dissipation inside the device raises its temperature, so its resistance falls. This self-heating behaviour is the basis of many applications.

A thermistor in series with a filament lamp (Fig. 2) has a high resistance when cold. This limits the inrush current when the lamp is turned on and the cold-filament resistance is low. The thermistor soon warms up and its resistance falls, so that most of the power is now dissipated in the filament. Soft-starting filament lamps in this way is said to increase their life.

In such applications the thermistor gets quite a jolt when the power is turned on. Can they stand it? Yes, if you use the correct type. Mullard (Philips components division) ran some tests in which this sort of thermistor was repeatedly subjected to bursts of 200 current pulses, each pulse at 18A and a large voltage. They survived happily.

You may find a thermistor (NTC) in series with a power rectifier (Fig. 3) to pro tect the equipment being powered from switch-on surges. There is an element of time delay in this type of circuit since the thermistor takes time to heat up.

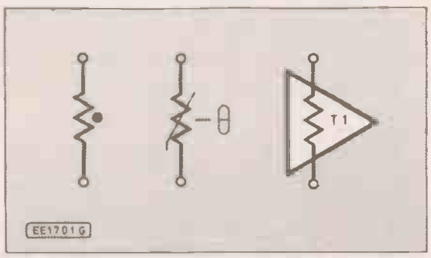


Fig. 1. Thermistor symbols

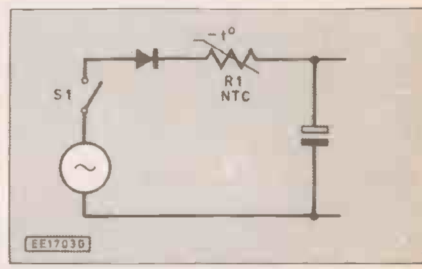


Fig. 3. Surge limiter for power rectifier

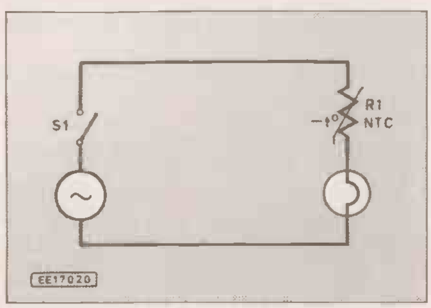


Fig. 2. Surge limiter for lamp protection

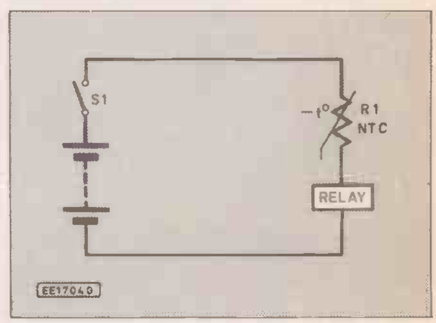


Fig. 4. Relay delaying circuit

How much time depends on the mass of material in the thermistor as well as on the power being spent in it; a big chunky device takes longer than a tiny one.

This delay can be exploited to provide a cheap-and-cheerful switch-on delay, using a relay. All you do is connect a suitable NTC thermistor in series with the operating coil, see Fig. 4.

THERMAL RUNAWAY

If an NTC thermistor is connected to a variable voltage supply and the voltage is slowly increased, at first nothing spectacular happens. But when the voltage reaches a critical value the thermistor suddenly gets very hot and burns out. The reason is simple. As the device self-heats, its resistance falls, so it draws more current, heats yet more, and so on. A catastrophe.!

To avoid this sort of disaster, it's necessary to include enough ordinary resistance in series to limit the current to a safe amount. If this is done as shown in Fig. 5, a potential divider is created whose output voltage rises as the input is increased until the critical voltage is reached then stabilises.

Not, perhaps, a very efficient stabiliser, but one which has the advantage over Zener circuits in that it works with a.c. as well as d.c. Clearly, the stabilizing action might be increased by using a PTC thermistor or a filament lamp for R2.

In *RC* oscillators of the low-distortion kind, this voltage-limiting property of NTC thermistors is used for automatic amplitude control. The usual arrangement is to connect the thermistor in a negative feedback path, so that the feedback increases sharply, reducing gain once the critical voltage is reached.

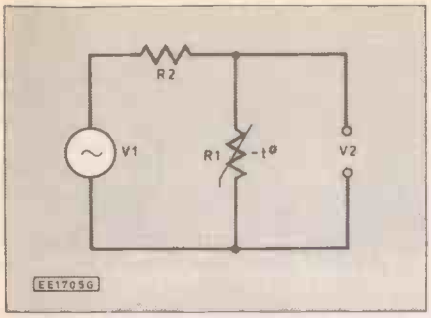
Since a thermistor behaves as a pure resistance it operates without distorting the audio signal. Note, however, that this is not true at very low frequencies, where the resistance can change appreciably during each half cycle. The very small bead-type thermistors used for automatic amplitude control have thermal time constants of the order of one second, so provided that a half cycle is much shorter than a second there is not much distortion.

DEGAUSSING

It is sometimes useful to arrange for one thermistor to warm another by putting them in thermal contact. Many colour TVs have degaussing coils whose job it is to demagnetise the receiver (and in particular the picture tube) every time the set is switched on. What is needed is a strong a.c. magnetic field which dies away smoothly.

One way of arranging this is to connect the degaussing coil across the mains via a PTC thermistor (see Fig. 6). On switch-on, the PTC resistance is low and a large current flows in the degaussing coil. As the thermistor self-heats, the current falls, producing the required diminishing field.

However, it is desirable to reduce the field to zero, or at any rate to a low value,



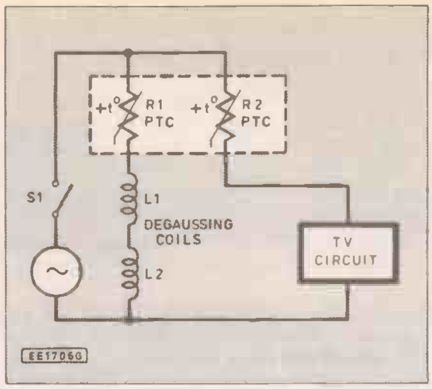


Fig. 5. Voltage stabilising

Fig. 6. Degaussing circuit

once degaussing is completed. A second PTC thermistor (R2), heated by the current taken by the receiver, can be used to increase the temperature of the degaussing thermistor, further reducing the current.

HEATING

When a PTC thermistor is subjected to a rising voltage there is no thermal runaway. Self-heating raises the resistance and reduces the rate of current increase.

This makes a PTC thermistor a self-regulating heat source. This may be useful where small amounts of regulated heating are needed, e.g. to keep a quartz oscillator crystal at an even temperature.

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EE MARKET PLACE JAN '89

...REPORTING AMATEUR RADIO...

TONY SMITH G4FAI

DXCC

One way of demonstrating achievement in amateur radio is to work for awards. There are hundreds of these available, from national organisations down to local radio clubs, around the world. They all require proof of contact with a certain number of stations within specified rules, and in return issue certificates, often rather grand ones, to commemorate the achievement.

Probably the most prestigious of all awards is that of the DX Century Club (DXCC) administered and issued by the national radio society of the USA, the American Radio Relay League (ARRL). The basic award is for confirmed contacts with 100 countries listed in the ARRL DXCC countries list, and additional credits are given for contacts in multiples of 10 from 110 to 300, and in multiples of 5 over 300. It gets a bit difficult to find new countries when you reach that level, although there are still some 20 more to go to complete the full list!

Even more difficult than DXCC is five-band DXCC which requires confirmed contacts with 100 countries on each of five separate amateur radio bands. "Confirmed" means receipt of a valid, unaltered, QSL card for each contact, and cards have to be submitted as proof of contacts made with applications for the award.

The DXCC countries list is reviewed by the ARRL as and when the status of particular countries change, and the organisers of Dxpeditions (see last month) frequently seek to persuade ARRL to give "country" status to rare locations where they are operating to add status to their expedition and to give the thousands of operators who hope to contact them the opportunity of working a "new country".

STRICT RULES

For a country to be included in the DXCC list it must have its own government or it can be a Territory, Protectorate, Dependency, or Associated State subject to certain other criteria. For example, an island or group of islands which is part of a self-governing DXCC country but which is separated by over 225 miles of water from any other part of the "parent" country can qualify as a separate DXCC country.

As I write, plans are at an advanced stage for a DXpedition to the Pacific island of Rotuma (formerly Grenville Island) which is administered by Fiji. Concurrently the organisers have submitted an application to the ARRL for recognition of Rotuma as a DXCC country, under the "225 miles of water" rule, preferably before the DXpedition takes place.

It appears that a German amateur filed an application for DXCC status for Rotuma in 1982 which was rejected. This was partly because the proximity of the island to Fiji was thought to be complicated by the existence of Balmoral Reef south-southeast of Rotuma. The present applicants have however submitted nautical charts which they say confirm that the reef is totally underwater and that it is in any case more than 225 miles from Rotuma.

IN A HURRY

Because there is no tourist accommodation on Rotuma, visitors must be housed by an island resident. An invitation was recently extended for a small group to make such a visit and urgent plans were put in hand for four experienced DXpeditioners from Australia and the USA, including one YL (Young Lady) operator, to take advantage of this unique opportunity.

An interesting aspect of this Dxpedition is that because Rotuma is nearly antipodal to Europe a special effort was to be made to focus attention exclusively on Europe during the expected sparse "openings". A special appeal was being made to DXers in other parts of the world to understand and respect this situation by not calling the Rotuma station during these brief opportunities for trans-global contacts.

The expedition was expected to arrive at its destination on October 21st, 1988, and remain until November 4th. Its members were hoping for recognition of Rotuma as a new DXCC country before the event. Whether they got it or not I will report later!.

EARLY SOLAR PEAK?

The Rotuma expedition's expectation of sparse openings to Europe may have been over-pessimistic. According to Dr Patrick McIntosh, Director of Solar Physics Research at a Space Environment Laboratory in Colorado, the peak of the present solar cycle may occur as early as the end of 1988, instead of in 1992 as predicted by traditional methods. The present cycle, No. 22 was two years old in September 1988.

During the last fourteen 11-year cycles, for which reliable data is available, no cycle has peaked earlier than 3¼ years after it started, and those with early peaks have been "high" cycles. Perhaps we are heading for an all-time "high"! There has certainly been a rapid rise in solar activity this year judging by conditions on the high frequency bands.

According to reports in the ARRL Newsletter, NASA are taking no chances over the Colorado forecast. They have instigated precautionary measures with their low earth orbiting satellites to protect them from the "drag" that increases during periods of high solar activity.

HAMS WITH NASA

Amateur Satellite Report, June 8, 1988, reported that Astronaut Tony England, WOORE, who operated amateur radio equipment from the July 1985 Challenger shuttle flight, is retiring from NASA to take up a teaching position at the University of Michigan. He hopes to work with AMSAT (the Radio Amateur Satellite Corporation) in future satellite projects.

With his departure from NASA, the next opportunity to continue the amateurs in space programme lies with Dr Ron Parise, WA4SIR, a visiting scientist to NASA. His proposed inclusion of a packet radio experiment aboard the ASTRO-1 mission has however been delayed while the shuttle programme has been re-organised following the Challenger accident in January 1986.

REVISED SYLLABUS

The syllabus of the Radio Amateur's Examination (RAE) has been revised by the City and Guilds of London Institute. This will be first examined in May 1989 when, apart from covering the new licensing conditions effective from 1st January, 1989, (reported in this column, November 1988) there will be a major addition in the form of a section on electromagnetic compatibility (EMC) introduced by request of the DTI. The new section requires knowledge of:

a) EMC problems when an amateur station is operated close to other equipment.
b) Amateur equipment which is capable of generating interference.
c) Interfering signal paths.
d) How to improve the immunity of affected equipment.
e) How to improve station design.
f) Method of approach relating to the investigation of EMC problems.

The RAE continues to consist of two separate papers, and the multiple-choice questions are divided up as follows:

Part 1 — Licensing conditions, 15; Transmitter interference, 15; EMC, 15 (time allowed 1¼ hours).

Part 2 — Operating procedures and practices, 9; Electrical theory, 6; Solid-state devices, 7; Receivers, 7; Transmitters, 8; Propagation and antennas, 9; Measurements, 9 (time 1½ hours).

The revised *765 radio Amateur's Syllabus* (£1.80) and Specimen RAE questions (£1.70) can be obtained from the C&G Institute, 46, Brittania Street, London, WC1X 9RG.

Pending the introduction of a Student Licence at some future date, this examination is still the only way into amateur radio, opening up a whole new world of hobby activities as I try to show in this column. It is not a difficult exam to pass if the candidate has enthusiasm for the subject, and those who already have some knowledge of and interest in electronics, such as keen constructor-readers of EE, ought to find it a doddle!

PCB SERVICE

Printed circuit boards for certain constructional projects (up to two years old) are available from the PCB Service, see list. These are fabricated in glass fibre, and are fully drilled and roller tinned. All prices include VAT and postage and packing. Add £1 per board for overseas airmail. Remittances should be sent to: The PCB Service, *Everyday Electronics* Editorial Offices, 6 Church Street, Wimborne, Dorset BH21 1JH. Cheques should be crossed and made payable to *Everyday Electronics (Payment in £ sterling only.)*

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NOTE: *Boards for older projects–not listed here–can often be obtained from Magenta Electronics, 135 Hunter St., Burton-on-Trent, Staffs DE14 2ST. Tel: 0283 65435 or Lake Electronics, 7 Middleton Close, Nuthall, Nottingham NG16 1BX. Tel: 0602 382509.*

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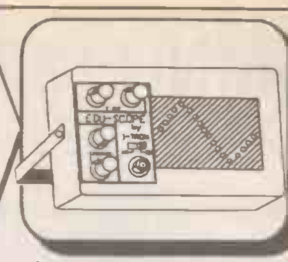

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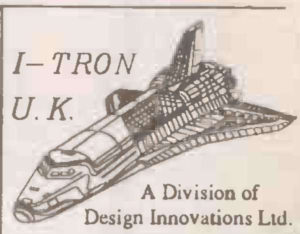

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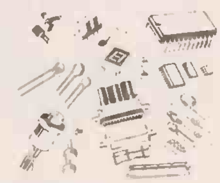

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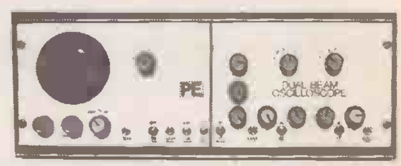

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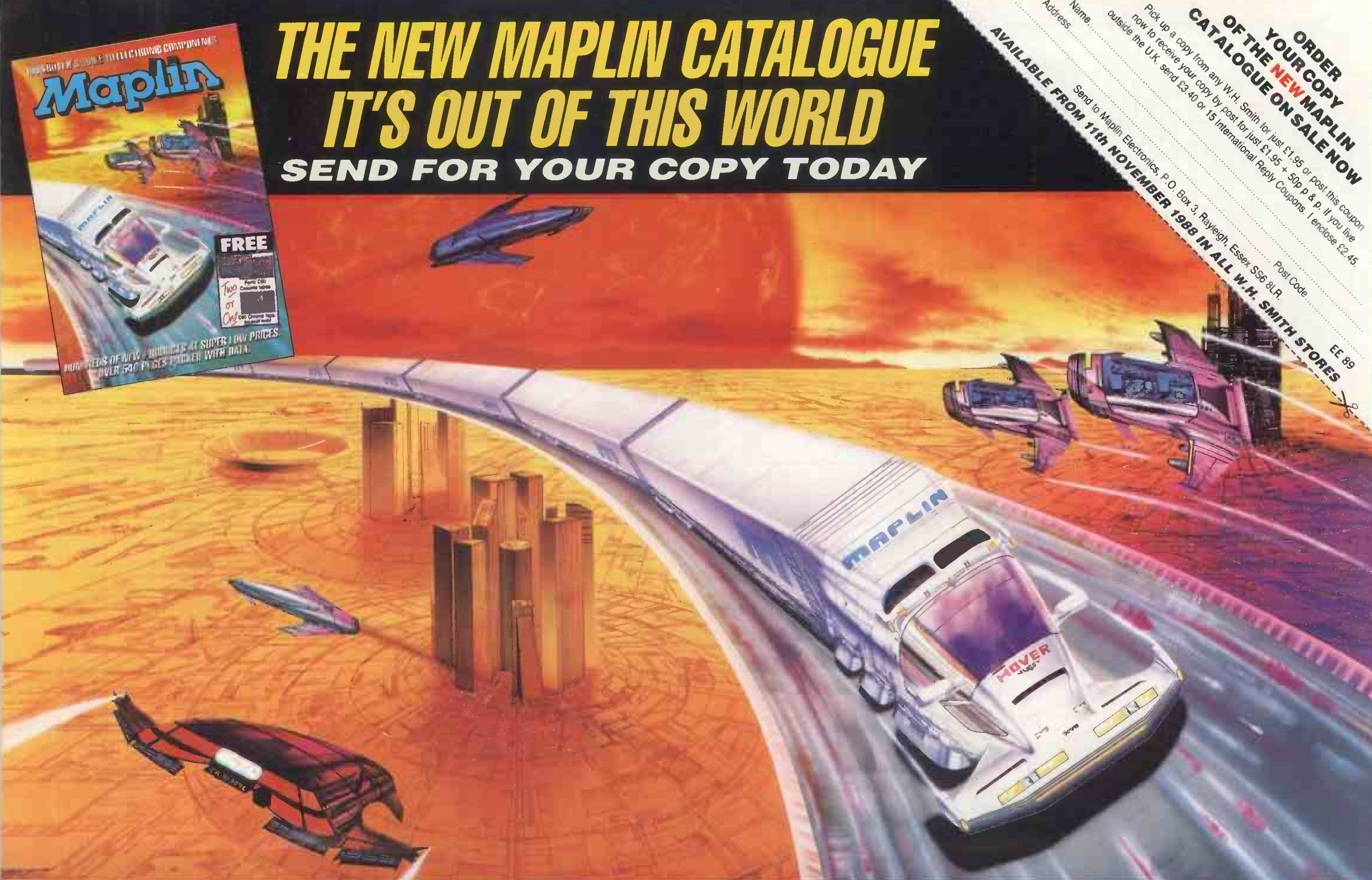

Evening on the planet Oldana, as the Maplin Juggertrain thunders along the highway; captured on canvas by galaxy famous artist Lionel Jeans and featured on the cover of the new Maplin Catalogue.