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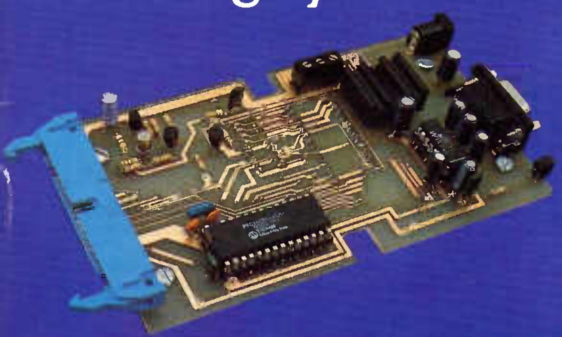
MAY 1995

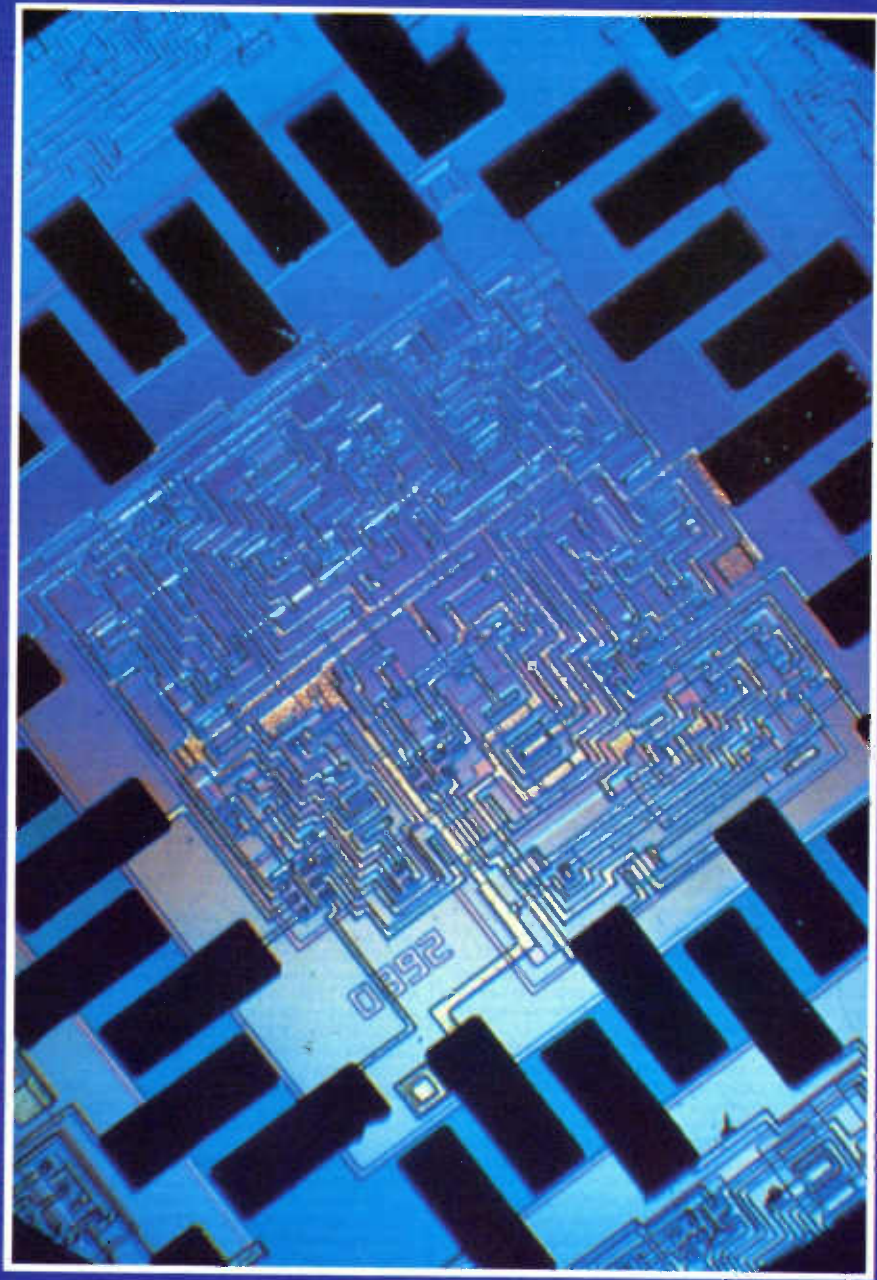
INCORPORATING ELECTRONICS MONTHLY

FULLY S.O.R. £2.25

PIC-DATS

PIC Microcontroller Development and Training System





RF SIGNAL GENERATOR

1·5MHz to 30MHz

MIDI PEDAL UNIT

Sustain, Portamento or Soft Pedal

INGENUITY UNLIMITED

Readers Circuit Ideas

LAS VEGAS CONSUMER ELECTRONICS SHOW

Report by Barry Fox

THE NO. 1 INDEPENDENT MAGAZINE FOR ELECTRONICS TECHNOLOGY & COMPUTER PROJECTS

05
9 770262 361065

MONO VGA MONITORS

Some with slight screen burns but OK at £19.95 Ref EF40 and some without burns at £29.95 Ref EF39.

A4 DTP MONITORS Brand new, 300 DPI. Complete with diagram but no interface details.(so you will have to work it out!) Bargain at just £12.99 each!!!!

OPD MONITORS 9" mono monitor, fully cased complete with rasterboard, switched mode psu etc. CGA/TTL input (15way D), IEC mains. £15.99 ref DEC23. Price including kit to convert to composite monitor for CCTV use etc is £21.99 ref DEC24

PC CONTROLLED 4 CHANNEL TIMER Control (on/off times etc) up to 4 items (8A 240v each) with this kit. Complete with Software, relays, PCB etc. £25.99 Ref 95/26

COMPLETE PC 300 WATT UPS SYSTEM Top of the range UPS system providing protection for your computer system and valuable software against mains power fluctuations and cuts.New and boxed, UK made Provides up to 5 mins running time in the event of complete power failure to allow you to run your system down correctly. **SALE PRICE just £119.00.**

RACAL MODEM BONANZA! 1 Racal MPS1223 1200/75 modem, telephone lead, mains lead, manual and comms software, the cheapest way onto the net! all this for just £13 ref DEC13.

HOW LOW ARE YOUR FLOPPIES? 3.5" (1.44) unbranded. We have sold 100,000+ so ok! Pack of 50 £24.99 ref DEC16

BRITISH TELECOMM MULTIMETERS SA9083 These are 'returns' so they may have faults but look ok. Complete with new leads and leather case. Price for two meters & 1 case is £10 ref DEC89.

5mw LASER POINTER. Supplied in kit form, complete with power adjuster, 1-5mw, and beam divergence adjuster. Runs on 2 AAA batteries. Produces thin red beam ideal for levels, gun sights, experiments etc. Cheapest in the UK! just £39.95 ref DEC49

SHOP WOBBLERS! Small assemblies designed to take D size batteries and 'wobble' cardboard model signs about in shop windows! £3.99 Ref SEP4P2.

RADIO PAGERS Brand new, UK made pocket pagers clearance price is just £4.99 each 100x40x15mm packed with bits! Ref SEP5.

BULL TENS UNIT Fully built and tested TENS (Transcutaneous Electrical Nerve Stimulation) unit, complete with electrodes and full instructions. TENS is used for the relief of pain etc in up to 70% of sufferers. Drug free pain relief, safe and easy to use, can be used in conjunction with analgesics etc. £49 Ref TEN/1

COMPUTER RS232 TERMINALS. (LIBERTY) Excellent quality modem units,(like wyse 50,s) 2xRS232, 20 function keys, 50 thro to 38,400 baud, menu driven port, screen, cursor, and keyboard setup menus (18 menu's). £29 REF NOV4.

OMRON TEMPERATURE CONTROLLERS (E5C2). Brand new controllers, adjustable from -50 deg C to +1,200 deg C using graduated dial, 2% accuracy, thermocouple input, long life relay output ,3A 240v o/p contacts. Perfect for exactly controlling a temperature, Normal trade £50+, ours £15. Ref E5C2.

ELECTRIC MOTOR BONANZA! 110x60mm. Brand new precision, cap start (or spin to start), virtually silent and features a moving outer case that acts as a fly wheel. Because of their unusual design we think that 2 of these in a tube with some homemade fan blades could form the basis for a wind tunnel etc. Clearance price is just £4.99 FOR A PAIR! (note-these will have to be wired in series for 240v operation Ref NOV1.

MOTOR NO 2 BARGAIN 110x90mm. Similar to the above motor but more suitable for mounting vertically (ie turntable etc). Again you will have to wire 2 in series for 240v use. Bargain price is just £4.99 FOR A PAIR!! Ref NOV3.

OMRON ELECTRONIC INTERVAL TIMERS.

Minature adjustable timers, 4 pole c/o output 3A 240v,

HY1230S, 12vDC adjustable from 0-30 secs. £9.99
HY1210M, 12vDC adjustable from 0-10 mins. £9.99
HY1260M, 12vDC adjustable from 0-60 mins. £9.99
HY2460M, 24vAC adjustable from 0-60 mins. £5.99
HY241S, 24vAC adjustable from 0-1 secs. £5.99
HY2460S, 24vAC adjustable from 0-60 secs, £5.99
HY243H, 24vAC adjustable from 0-3 hours. £8.99
HY2401S, 240v adjustable from 0-1 secs. £9.99
HY2405S, 240v adjustable from 0-5 secs. £9.99
HY24060m, 240v adjustable from 0-60 mins. £12.99

PC PAL VGA TO TV CONVERTER Converts a colour TV into a basic VGA screen. Complete with built in psu, lead and s/ware. £49.95. Ideal for laptops or a cheap upgrade. We also can supply this in kit form for home assembly at £34.95 ref EF54.

DRINKING BIRD Remember these? hook onto wine glass (supplied) and they drink, standup,drink,standup ETC! £4 each Ref EF1

EMERGENCY LIGHTING UNIT Complete unit with 2 double bulb floodlights, built in charger and auto switch. Fully cased. 6v 8AH lead acid req'd. (secondhand) £4 ref MAG4P11.

GUIDED MISSILE WIRE. 4,200 metre reel of ultra thin 4 core insulated cable, 28lbs breaking strain, less than 1mm thick! Ideal alarms, intercoms, fishing, dolls house's etc. £14.99 ref MAG15P5

300v PANEL METER 70X60X50MM, AC, 90 degree scale. Good quality meter. £5.99 ref MAG 6P14. Ideal for monitoring mains etc.

ASTEC SWITCHED MODE PSU BM41012 Gives +5 @ 3.75A, +12@1.5A, -12@.4A. 230/110, cased, BM41012. £5.99 ref AUG6P3.

TORRODIAL TX 30-0-30 480VA. Perfect for Mosfet amplifiers etc. 120mm dia 55mm thick. £18.99 ref APR19.

AUTO SUNCHARGER 155x300mm solar panel with diode and 3 metre lead fitted with a cigar plug. 12v 2watt. £9.99 ea ref AUG10P3.

FLOPPY DISCS DSDD Top quality 5.25" discs, these have been written to once and are unused. Pack of 20 is £4 ref AUG4P1.

ECLATRON FLASH TUBE As used in police car flashing lights etc, full spec supplied, 60-100 flashes a min. £9.99 ref APR10P5.

24v AC 96WATT Cased power supply. New. £13.99 ref APR14.

MILITARY SPEC GEIGER COUNTERS Unused anstraightfrom Her majesty's forces. £50 ref MAG 50P3.

STETHOSCOPE Fully functioning stethoscope, ideal for listening to hearts, pipes, motors etc. £6 ref MAR6P6.

OUTDOOR SOLAR PATH LIGHT Captures sunlight during the day and automatically switches on a built in lamp at dusk. Complete with sealed lead acid battery etc £19.99 ref MAR20P1.

ALARM VERSION Of above unit comes with built in alarm and pir to deter intruders. Good value at just £24.99 ref MAR25P4.

CARETAKER VOLUMETRIC Alarm, will cover the whole of the ground floor against forced entry. Includes mains power supply and integral battery backup. Powerful internal sounder, will take external bell if req'd. Retail £150+, ours? £49.99 ref MAR50P1.

TELEPHONE CABLE White 6 core 100m reel complete with a pack of 100 clips. Ideal 'phone extns etc. £7.99 ref MAR8P3.

MICRODRIVE STRIPPER Small cased tape drives ideal for stripping, lots of useful goodies including a smart case, and lots of components. £2 each ref JUN2P3.

SOLAR POWER LAB SPECIAL You get TWO 6"x6" 6v 130mA solar cells, 4 LED's, wire, buzzer, switch plus 1 relay or motor. Superb value kit just £5.99 REF: MAG6P8

SOLID STATE RELAYS Will switch 25A mains. Input 3.5-26v DC 57x43x21mm with terminal screws £3.99 REF MAG4P10

BUGGING TAPE RECORDER Small voice activated recorder, uses micro cassette complete with headphones. £28.99 ref MAR29P1.

ULTRAMINI BUG MIC 6mmx3.5mm made by AKG, .5-12v electret condenser. Cost £12 ea, Ours? just four for £9.99 REF MAG10P2.

RGB/CGA/EGA/TTL COLOUR MONITORS 12" in good condition. Back anodised metal case. £79 each REF JUN79

ANSWERPHONES Returns with 2 faults, we give you the bits for 1 fault, you have to find the other yourself. BT Response 200's £18 ea REF MAG18P1. PSU £5 ref MAG5P12.

SWITCHED MODE PSU ex equip, 60w +5v @5A, -5v@.5A, +12v@2A,-12v@.5A 120/220v cased 245x88x55mm IEC input socket £6.99 REF MAG7P1

PLUG IN PSU 9V 200mA DC £2.99 each REF MAG3P9

PLUG IN ACORN PSU 19v AC 14w , £2.99 REF MAG3P10

POWER SUPPLY fully cased with mains and o/p leads 17v DC 900mA output. Bargain price £5.99 ref MAG6P9

ACORN ARCHIMEDES PSU +5v @ 4.4A. on/off sw uncased, selectable mains input, 145x100x45mm £7 REF MAG7P2

GEIGER COUNTER KIT Low cost professional twin tube, complete with PCB and components. Now only £19 REF AUG19.

9v DC POWER SUPPLY Standard plug in type 150ma 9v DC with lead and DC power plug. price for two is £2.99 ref AUG3P4.

AA NICAD PACK encapsulated pack of 8 AA nicad batteries (tagged) ex equip, 55x32x32mm. £3 a pack. REF MAG3P11

13.8V 1.9A psu cased with leads. Just £9.99 REF MAG10P3

PPCMODEM CARDS. These are high spec plug in cards made for the Amstrad laptop computers. 2400 baud dial up unit complete with leads. Clearance price is £5 REF: **MAG5P1**

INFRA RED REMOTE CONTROLLERS Originally made for hi spec satellite equipment but perfect for all sorts of remote control projects. Our clearance price is just £2 REF: **MAG2**

200 WATT INVERTER Converts 10-15v DC into either 110v or 240v AC. Fully cased 115x36x156mm, complete with heavy duty power lead, cigar plug, AC outlet socket.Auto overload shutdown, auto short circuit shut down, auto input over voltage shutdown, auto input under voltage shut down (with audible alarm), auto temp control, unit shuts down if overheated and sounds audible alarm. Fused reversed polarity protected. output frequency within 2%, voltage within 10%. A extremely well built unit at an excellent price. Just £64.99 ref AUG65.

UNIVERSAL SPEED CONTROLLER KIT Designed by us for the C5 motor but ok for any 12v motor up to 30A. Complete with PCB etc. A heat sink may be required. £17.00 **REF: MAG17**

MAINSCABLE Precut black 2 core 2 metre lengths ideal for repairs, projects etc. 50 metres for £1.99 ref AUG2P7.

COMPUTER COMMUNICATIONS PACK Kit contains 100m of 6 core cable, 100 cable clips, 2 line drivers with RS232 interfaces and all connectors etc. Ideal low cost method of communicating between PC's over a long distance. Complete kit £8.99.

MINI CYCLOPS PIR 52x62x40mm runs on PP3 battery complete with shrill sounder. Cheap protection at only £5.99 ref MAR6P4.

ELECTRIC MOTOR KIT Comprehensive educational kit includes all you need to build an electric motor. £9.99 ref MAR10P4.

VIEWDATA SYSTEMS made by Phillips, complete with internal 1200/75 modem, keyboard, psu etc RGB and composite outputs, menu driven, autodialler etc. £18 each Ref EF88.

BOOMERANG High tech, patented poly propylene, 34cm wing span. Get out and get some exercise for £4.99 ref EF83

AIR RIFLES .22 As used by the Chinese army for training puposes, so there is a lot about! £39.95 Ref EF78. 500 pellets £4.50 ref EF80.

PEANUT TREE Complete kit to grow your own peanuts! full instructions supplied. £3 Ref EF45.

PLUG IN POWER SUPPLYS Plugs in to 13A socket with output lead. three types available, 9vdc 150mA £2 ref EF58, 9vdc 200mA £2.50 ref EF59, 6.5vdc 500mA £3 ref EF61.

VIDEO SENDER UNIT. Transmits both audio and video signals from either a video camera, video recorder, TV or Computer etc to any standard TV set in a 100' range! (tune TV to a spare channel) 12v DC op. Price is £15 **REF: MAG15** 12v psu is £5 extra **REF: MAG5P2**

***FM CORDLESS MICROPHONE** Small hand held unit with a 500' range! 2 transmit power levels. Reqs PP3 9v battery. Tuneable to any FM receiver. Price is £15 **REF: MAG15P1**

LOW COST WALKIE TALKIES Pair of battery operated units with a range of about 200'. Ideal for garden use or as an educational toy. Price is £8 a pair **REF: MAG 8P1** 2 x PP3 req'd.

***MINATURE RADIO TRANSCEIVERS** A pair of walkie talkies with a range of up to 2km in open country. Units measure 22x52x155mm Including cases and earp'ces. 2xPP3 req'd. £30.00pr.**REF: MAG30**

COMPOSITE VIDEO KIT. Converts composite video into separate H sync, V sync, and video. 12v DC. £8.00 **REF: MAG8P2.**

LQ3500 PRINTER ASSEMBLIES Made by Amstrad they are entire mechanical printer assemblies including printhead, stepper motors etc etc In fact everything bar the case and electronics, a good stripper! £5 **REF: MAG5P3** or 2 for £8 **REF: MAG8P3**

LED PACK of 100 standard red 5m leds £5 **REF MAG5P4**

UNIVERSAL PC POWER SUPPLY complete with flyleads, switch, fan etc. Two types available 150w at £15 REF:MAG15P2 (23x23x23mm) and 200w at £20 REF: MAG20P3 (23x23x23mm)

GYROSCOPE About 3" high and an excellent educational toy for all ages! Price with instruction booklet £6 Ref EF15.

FUTURE PC POWER SUPPLIES These are 295x135x60mm, 4 drive connectors 1 mother board connector. 150watt, 12v fan, iec inlet and on/off switch. £12 Ref EF6.

VENUS FLYTRAP KIT Grow your own carnivorous plant with this simple kit £3 ref EF34.

PC POWER SUPPLIES (returns) These are 140x150x90mm. o/ps are +12,-12,+5 and -5v. Built in 12v fan. These are returns so they may well need repairing! £3.50 each ref EF42.

***FM TRANSMITTER** KIT housed in a standard working 13A adapter!! the bug runs directly off the mains so lasts forever! why pay £700? or price is £15 REF: EF62 Transmits to any FM radio. (this is in kit form with full instructions.)

***FM BUG KIT** New design with PCB embedded coil for extra stability. Works to any FM radio. 9v battery req'd. £5 REF: MAG5P5

***FM BUG BUILT AND TESTED** superior design to kit. Supplied to detective agencies. 9v battery req'd. £14 REF: MAG14

TALKING COINBOX STRIPPER originally made to retail at £79 each, these units are designed to convert an ordinary phone into a payphone. The units have the locks missing and sometimes broken hinges. However they can be adapted for their original use or used for something else?? Price is just £3 **REF: MAG3P1**

TOP QUALITY SPEAKERS Made for HI FI televisions these are 10 watt 4R Jap made 4" round with large shielded magnets. Good quality. £2 each **REF: MAG2P4** or 4 for £6 **REF: MAG8P2**

TWEETERS 2" diameter good quality tweeter 140R (ok with the above speaker) 2 for £2 **REF: MAG2P5** or 4 for £3 **REF: MAG3P4**

AT KEYBOARDS Made by Apricot these quality keyboards need just a small mod to run on any AT, they work perfectly but you will have to put up with 1 or 2 foreign keycaps! Price £6 **REF: MAG6P3**

HEADPHONES Ex Virgin Atlantic. 8pairs for £2 **REF: MAG2P8**

DOS PACKS Microsoft version 3.3 or higher complete with all manuals or price just £5 **REF: MAG5P8** Worth it just for the very comprehensive manual! 5.25" only.

GAS HOBS Brand new made by Optimus, basic three burner suitable for small flat etc bargain price just £29.95 ref EF73.

GAT AIR PISTOL PACK Complete with pistol, darts and pellets £12.95 Ref EF82 extra pellets (500) £4.50 ref EF80.

CHRISTMAS TREE KIT Start growing it now! £3 ref EF53.

DOS PACK Microsoft version 5 Original software but no manuals hence only £5.99 3.5" only.

PIR DETECTOR Made by famous UK alarm manufacturer these are hi spec, long range internal units. 12v operation. Slight marks on case and unboxed (although brand new) £8 **REF: MAG8P5**

MOBILE CAR PHONE £5.99 Well almost! complete in car phone excluding the box of electronics normally hidden under seat. Can be made to illuminate with 12v also has built in light sensor so display only illuminates when dark. Totally convincing! REF: MAG6P6

ALARM BEACONS Zenon strobe made to mount on an external bell box but could be used for caravans etc. 12v operation. Just connect up and it flashes regularly) £5 REF: MAG5P11

6"X12" AMORPHOUS SOLAR PANEL 12v 155x310mm 130mA. Bargain price just £5.99 ea REF MAG6P12.

FIBRE OPTIC CABLE BUMPER PACK 10 metres for £4.99 ref MAG5P13 ideal for experimenters! 30 m for £12.99 ref MAG13P1

HEATSINKS (finned) TO220, designed to mount vertically on a pcb 50x40x25mm you can have a pack of 4 for £1 ref JUN1P11.

STROBE LIGHT KIT Adjustable from 1 hz right up to 60hz! (electronic asssembly kit with full instructions) £16 ref EF28.

ROCK LIGHTS Unusual things these, two pieces of rock that glow when rubbed together! belived to cause rain!£3 a pair Ref EF29.

NEW HIGH POWER LASERS

15mW, Helium neon, 3 switchable wavelengths .63um, 1.15um, 3.39um (2 of them are infrared) 500:1 polarizer built in so good for holography. Supplied complete with mains power supply. 790x65mm. Use with EXTREME CAUTION AND QUALIFIED GUIDANCE. £349+Vat.

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PORTABLE RADIATION DETECTOR WITH NEW COMPUTER INTERFACE.

£59.00

A Hand held personal Gamma and X Ray detector. This unit contains two Geiger Tubes, has a 4 digit LCD display with a Piezo speaker, giving an audio visual indication. The unit detects high energy electromagnetic quanta with an energy from 30K eV to over 1.2M eV and a measuring range of 5-9999 UR/h or 10-99990 Nr/h. Supplied complete with handbook.Ref. **NOV 18.**

ISSN 0262 3617
PROJECTS . . . THEORY . . . NEWS . . .
COMMENT . . . POPULAR FEATURES . . .

VOL. 24 No. 5 MAY 1995

EVERYDAY With PRACTICAL ELECTRONICS

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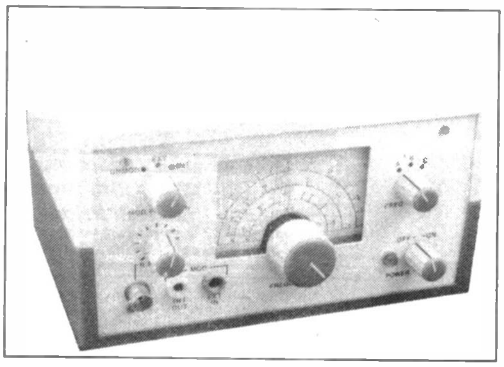
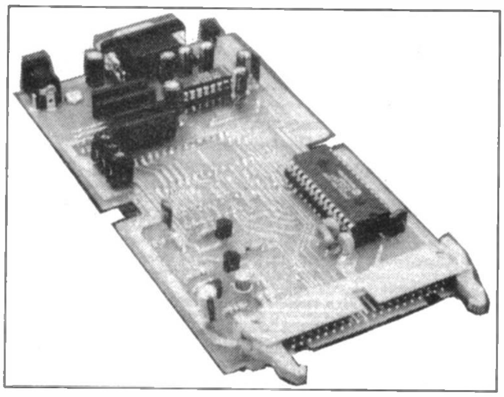
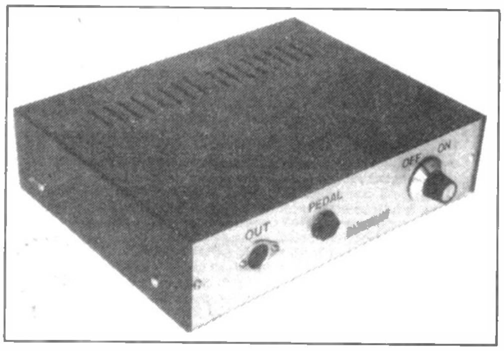
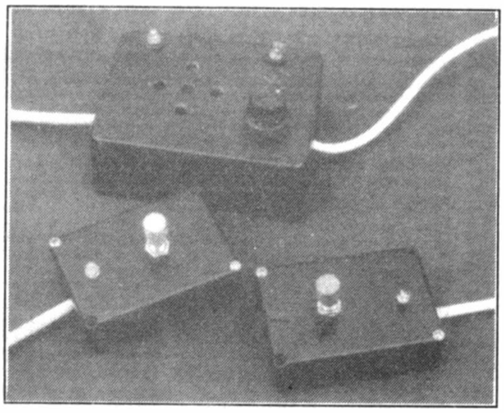








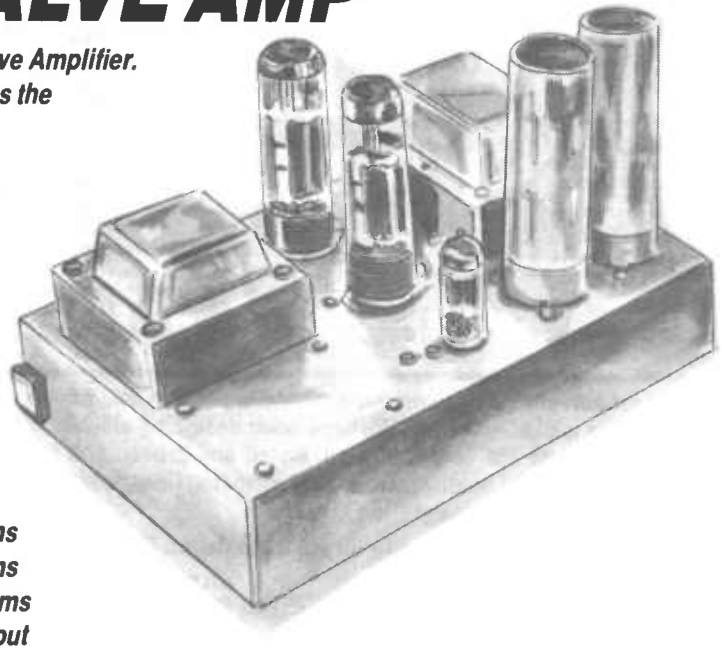
Projects

Series

Features

Our June '95 issue will be published on Friday, 5 May 1995. See page 339 for details.

EPE HiFi VALVE AMP



Here as promised is the EPE HiFi Valve Amplifier. Designed to sound at least as good as the Quad II power-amp described in the February 1994 issue. The design is not a rehashed 1950's circuit. It is based around a brand new hybrid topology combining the positive attributes of vacuum and solid-state technologies. This amp enables the valve sound to be obtained without suffering "antique dealer" prices.

SPECIFICATION

Power Output: 30W r.m.s. into 4 ohms
24W r.m.s. into 8 ohms
17W r.m.s. into 15 ohms
Input Sensitivity: 300mV for full output
Distortion: less than 0·1% THD at 15W into 8 ohms in midband.
0·25% at 50Hz mostly second and third harmonic
Power Consumption: 95W
Signal-to-Noise/Hum Ratio: –100dB
Frequency Response: 20Hz to 20kHz plus and minus 0·2dB

PIC LIGHT CHASER

As a follow up to this month's PIC-DATS project we present a Light Chaser design to demonstrate PIC project development and programming. The unit has the following features:

- ★ Four independent channels
- ★ 500W per channel output
- ★ Variable speed, multiple chase patterns
- ★ Can be battery powered during testing and development
- ★ Safe transformer and opto isolation
- ★ PIC allows generation of your own display pattern
- ★ Pre-programmed PIC and/or separate software available

This versatile design provides an excellent demonstration of PIC microcontroller use, but is also an interesting and versatile project in its own right.

SMART CARDS

What they are, how they work, where they are going, are they secure? Before long most of us will be using Smart Cards of one type or another, in this feature Barry Fox looks at the present and future Smart Card scene paying particular attention to security.

EVERYDAY With PRACTICAL ELECTRONICS

JUNE '95 ISSUE ON SALE FRIDAY, MAY 5

NEXT MONTH

SUMMER 1995 CATALOGUE

The Summer '95 edition has 280 pages packed with over 4000 products and now with news and features including a full construction project.

- The computer section is greatly increased with new ranges of equipment and accessories for PCs including:
  - Mother boards, CPUs and SIMMs
  - CD ROM drives and hard drives
  - Sound cards, I/O cards, disc drive cards and video cards
  - Mice, trackerballs and joysticks
  - Power supplies and cases

£1.95 + 30p p&p

- Feature project for an EPROM programmer
- New 20MHz 'scope from Leader, training systems from Flight and an extended range of mobile phone batteries and accessories from Uniross
- Latest addition from Velleman kits including a video digitiser card
- 280 pages, 26 sections, over 4000 products from some of the worlds finest manufactures and suppliers
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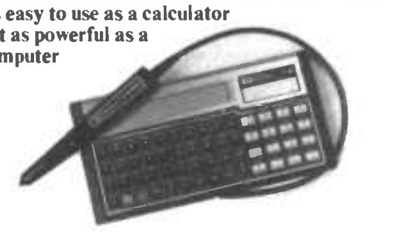
HEWLETT PACKARD HP71B

As easy to use as a calculator but as powerful as a computer

BARCODE READER
Smart wand

– Automatically recognises and decodes all major bar-code standards.



- A powerful set of basic functions, statements, and operators – over 230 in all – many larger computers don't have a set of basic instructions this complete.
- Advanced statistics functions enabling computations on up to 15 independent variables.
- Recursive subprograms and user defined functions.
- An advanced internal file system for storing programs and data – The HP71 has continuous memory – when you turn the computer off it retains programs and data.
- A keyboard that can be easily customised for your specific application.
- HP-IL Interface pre-installed to create a system that can print, plot, store, retrieve and display information. Control or read instruments or speak to other computers. 5000 bytes/sec. Built in ROM includes 46 separate commands. Interface to HP-IL, HP-IB, RS232C, GPIO or series 80. Includes connection cables.

These are second users systems, ex NHS, are fully tested and working but have no programming (THAT IS UP TO YOU).

HP71B	**£29.95**
Bar-code Reader	**£12.95**
A.C. Power Supply (Works from batteries normally)	**£4.95**
Keyboard Overlay (Limited quantities)	**£1.00**
(Unkown Program – Memory Modules (2 different types) (Limited quantities)	**£3.00**
Complete kit of HP71B, Bar-code Reader and power supply	**£39.50**

(Prices include VAT – Delivery Next day £3.00)
(Currently selling in US for over £500!)

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Please rush me
- ☐ HP71B Powerful Calc/Computer @ **£29.95**
- ☐ Bar-code Reader @ **£12.95**
- ☐ Power Supply @ **£4.95**
- ☐ Keyboard overlay @ **£1.00**
- ☐ Memory module @ **£3.00**
- ☐ Complete kit of HP71B, Bar-code Reader and Power Supply @ **£39.50**

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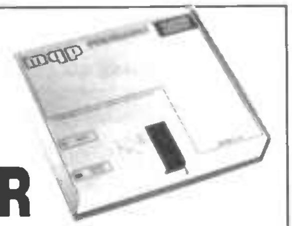
SYSTEM 200 DEVICE PROGRAMMER



SYSTEM

Programs 24, 28, 32 pin EPROMS, EE-PROMS, FLASH and Emulators as standard, quickly, reliably and at low cost.

Expandable to cover virtually any programmable part including serial E^2, PALS, GALS, EPLD's and microcontrollers from all manufacturers.

DESIGN

Not a plug in card but connects to the PC serial or parallel port; it comes complete with powerful yet easy to control software, cable and manual.

SUPPORT

UK design, manufacture and support. Same day dispatch, 12 month warranty. 10 day money back guarantee.

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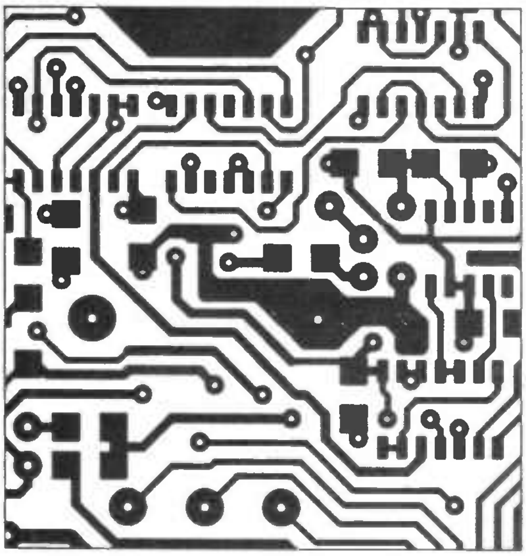

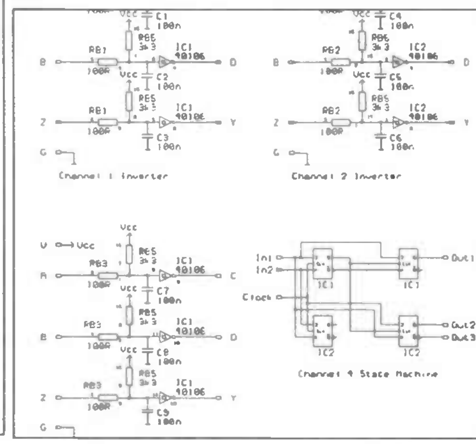

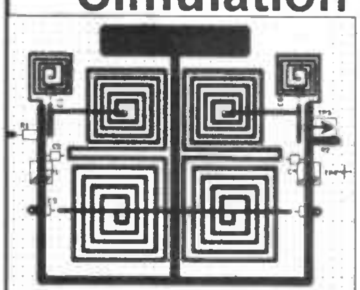

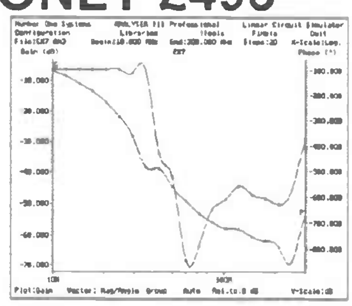

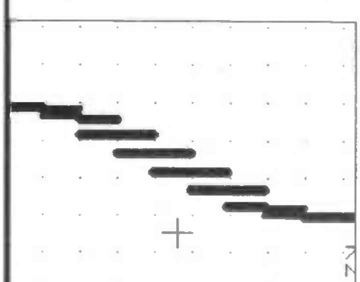

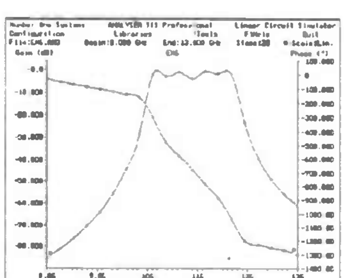

EVERYDAY With PRACTICAL
ELECTRONICS
INCORPORATING ELECTRONICS MONTHLY

VOL. 24 No. 5 **MAY '95**

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FUNNY

Funny isn't it how a piece of gadgetry can catch the imagination of readers. Sales of p.c.bs for the *National Lottery Predictor* have gone mad since last month's issue came out. There is a story behind this project; it was originally designed to illustrate our *Understanding PIC Microcontrollers* article in the March issue, something we feel it does quite well. What sort of project could the author dream up that would generate random numbers and display them – before the National Lottery had got under way he produced a Bingo Number Generator, not a project that would have had tremendous appeal but it served a useful educational purpose.

A month or so before we were to publish the project the author asked if he could change it to a *National Lottery Predictor* – we were, of course, delighted with this new, more topical approach. It illustrates the versatility of microprocessors – it was relatively easy to make the software changes that produced numbers from 1 to 49 for the Lottery instead of 1 to 90 for Bingo, no hardware changes were necessary.

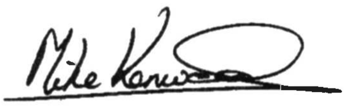
The Predictor has already produced winning numbers for one member of staff – fortunately for us only a small payout – so Pam will not be off round the world just yet!

All this leads me neatly to this month's *PIC-DATS* (PIC Development and Training System) article because with this relatively inexpensive bit of kit and your own PC you too can start enjoying the benefits of using PICs to design projects tailored to your own requirements. As Mark Stuart points out in the article the PIC can bring the fun "fiddle factor" back to electronics *and* you get to play with your PC at the same time. Maybe this is the best link yet between programmer and electronics hobbyist. If you find electronics fun we are sure this added dimension will enhance the hobby for you – read *PIC-DATS* to find out.

We have plenty of ideas for projects to publish in future issues, projects which would have been complex and expensive using "conventional" logic but which are now fairly simple and cheap using a PIC Microcontroller.

DAFT

Daft isn't it that alongside this modern technology next month we will publish a valve hifi amp. Say what you will about hifi and valves there is a strong demand for this type of equipment and our project sets new standards for a relatively inexpensive valve amplifier. It is not just a re-hash of a thirty year old design, although it does use the best circuit ideas from the valve era.



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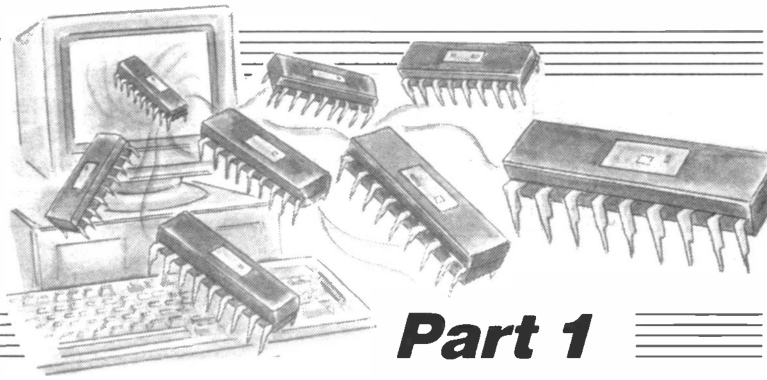
Constructional Project



PIC-DATS

MARK STUART — Part 1

A development and training system for the PIC16C5x family of microcontrollers. For educational purposes the system can be used as a classroom training aid.

A NUMBER of recent projects in *EPE* have used programmed PIC microcontroller devices. Like most other i.c.s in everyday use, they can be used without any knowledge of their internal operation, and so the project builder can complete and use the circuit without knowing anything about the program.

Microcontrollers have been used by the project designers for several reasons. The main one is that they allow a complicated function – such as a timer, or display driver – to be built without using lots of chips and having to design a complicated printed circuit board (p.c.b.) to fit them.

With the microcontroller approach, the circuit is made as simple as possible, and then the microcontroller is programmed to make it all work.

PIC-ING FUN

Once the project is connected and working, the real fun can begin, because during development the program can be altered to make the circuit operate in different ways without changing the hardware.

A fine example of this is the *National Lottery Predictor* project featured in *EPE* April 1995. This started life as a Bingo caller, with a top number of 90. An inspired thought made its application for the lottery much more topical and an elementary program change made the top number 49. If the design had been made using i.c.s, the change would have had to be made by altering the connections between various pins, and so a new p.c.b. would have been needed – or, more likely, the project would have remained a Bingo caller!

To the project builder, programmability is all very well, but can also be very limiting. It is fine for the designer, but once he has programmed and "blown" the program into the chip, it becomes dedicated to only one function for the user.

Part of the enjoyment of project building – and having electronics as a hobby – is being able to "fiddle about" with circuits and make them do things other than originally intended. Microcontrollers, and programmable devices in general have made this more difficult, and so there is now great interest in learning how to program and use them.

Getting to understand microcontrollers is a challenge, but it is also an enormous opportunity that will advance the hobby and, for some readers, will also advance their career prospects.

Once mastered, being able to program microcontrollers puts back the "fiddle factor" into the hobby. It also allows simple projects to be designed even with only basic electronics knowledge, because most of the problems can be solved in software.

PIC-DATS SYSTEM

Until recently, "fiddling" with programmable microcontroller chips has been complicated by two factors: One is the high cost of programmers and program development equipment. The other is the shortage of simple step-by-step instructions on how to do it.

Part One of the PIC-DATS project described here addresses the first problem, and Part Two next month will address the second one. Using this project system and its two *EPE* articles, it is intended to make it possible for electronics enthusiasts, even with no previous programming experience, to begin using PIC chips.

PIC-DATS supports PIC16C54, PIC16C55, PIC16C56, and PIC16C57 microcontrollers. Details of these devices are given in Fig.1, Table 1 and Table 2.

WHAT IS A PIC?

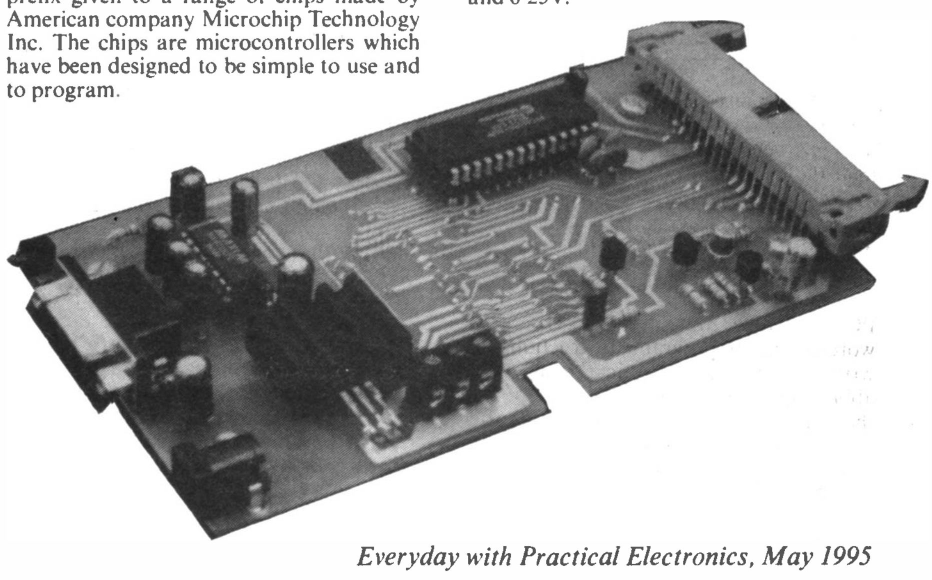
The term PIC is used because it is the prefix given to a range of chips made by American company Microchip Technology Inc. The chips are microcontrollers which have been designed to be simple to use and to program.

> **FEATURES**
>
> - Enables real-world emulation so that the target system can be run and modified.
> - Cross-assembler, communications program and editor in integrated software package.
> - Simulator allows programs to be checked before using the hardware emulator.
> - Uses a 16C55 microcontroller running at 4MHz.
> - I/O and control lines accessed via a 40-pin IDC connector
> - RS232 port
> - On-board voltage regulation.

A microcontroller is a chip which contains all of the elements of a small computer. It has a central processor (CPU), a program memory (ROM), a data memory (RAM), and input and output pins (I/O PORTS). As well as these main elements, there are also a number of others which provide the necessary "housekeeping" functions such as clock oscillator and "power-on" reset circuits. There are other useful functions as well but these will be introduced later.

To operate, the simplest PIC devices need only a single resistor and capacitor to be added to the clock oscillator pins. Apart from that, they run as they stand. This is one of the major advantages of the PIC devices over other microcontrollers – some of which require quite a number of external components.

PICs are very low current devices, drawing less than 2mA with a clock oscillator speed of 4MHz and much less at lower speeds – 15μA at 32kHz – and less than 3μA when the clock is stopped (which can be done without losing memory data). The basic supply voltage can be between 2·5V and 6·25V.



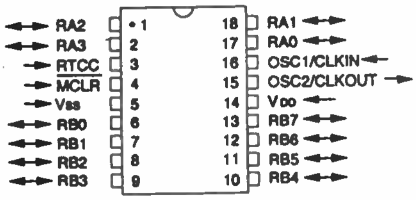


Fig. 1a. Pinouts for the PIC16C54 and PIC16C56 microcontrollers.

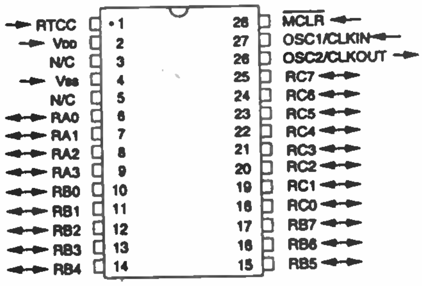


Fig. 1b. Pinouts for the PIC16C55 and PIC16C57 microcontrollers.

Table 1. Basic details of the PIC16C54 to C57 microcontrollers.

DEVICE	EPROM	RAM*	I/O	PINS
PIC16C54	512 x 12	32 x 8	12	18
PIC16C55	512 x 12	32 x 8	20	28
PIC16C56	1K x 12	32 x 8	12	18
PIC16C57	2K x 12	80 x 8	20	28

*Including special function registers.

Table 2. Name-pin functions for PICs in Fig. 1.

Name	Function
RA0-RA3	I/O PORT A
RB0-RB7	I/O PORT B
RC0-RC7	I/O PORT C (C55/57 only)
$\overline{\text{RTCC}}$	Real Time Clock/Counter
$\overline{\text{MCLR}}$	Master Clear
OSC1/CLKIN	Oscillator (Input)
OSC2/CLKOUT	Oscillator (Output)
V_{DD}	Power Supply
V_{SS}	Ground
N/C	No (internal) Connection

HOW PICS WORK

As soon as the supply is applied, the CPU in the PIC looks at the first program memory address and executes the instruction there. It then continues, executing one instruction at a time. Each instruction tells the CPU what to do, and where to go.

If this process continued, each instruction would be executed until the end of the program was reached and the CPU would stop. This does not happen, however, because instructions are available which make the processor jump back to an earlier program address so that it can execute continuous loops of instructions.

In a simple example, a program loop could be set up so that the CPU keeps checking one of the I/O pins. If the pin is read as a logic 0 (at or close to 0V) the program would continue looping, but if the pin reads as a logic 1 (at or near to the positive supply voltage) the program jumps to another place and sets one of the other I/O pins to a logic 1.

This is a very simple program, but more complicated ones are made up from similar simple steps which are executed at a very fast rate – one million per second if a 4MHz clock crystal is used.

The PIC has a vocabulary of 33 different simple instructions. This is a small number by normal microprocessor standards, and is known as a Reduced Instruction Set. The PIC is thus described as a "RISC" type device. Having fewer instructions allows the CPU to run faster than it would otherwise. In many instances, even though some more complicated operations may use three or four instructions, these can still run faster than the equivalent operation done in one instruction by a "normal" processor.

PIC PROGRAM WRITING

A PIC program can be written on a PC-compatible computer using a normal word-processor program. Instructions are written one line at a time using their abbreviated names, and adding any further information on the same line after the instruction. The instruction names are given in the PIC data sheets which describe each one and its application.

This type of programming is called "Assembly Language" programming. The program is not usable in this form by the PIC and must be converted to code which the processor can execute. To do this a computer program called an Assembler is used. This takes the assembly language code (known as the Source Code) and produces executable code (known as Object Code) which can be loaded into the PIC.

PROGRAMMING PICS

To put the program into the PIC, data is set up in parallel onto the I/O lines, and a 13·0V to 13·25V programming voltage is pulsed onto another pin. The process is similar to EPROM programming but not exactly the same and so a special programming set up is used. The code must be taken from the computer file and converted to a form which can be set up on the I/O pins. In the PIC-DATS system this is done via one of the computer serial ports. The PIC-DATS board then takes the data and loads it onto the pins of the PIC to be programmed.

PIC devices are available in several forms: the cheapest is plastic packaged and cannot be erased once programmed – it is known as an OTP (One Time Programmable) device. A much more expensive version with a window is also available which allows program erasure using ultra-violet light, so enabling the chip to be repeatedly re-programmed (within reasonable limits). Electrically erasable (EEPROM) versions are also available.

As well as the program, there are certain other things that need to be set up in the PIC. These are known as "configuration fuses" and are set in a similar way to programming. They allow the PIC to be set up for different types of oscillator, and alter other functions which will be discussed later.

PROGRAM TESTING

An experienced programmer could possibly write, assemble, and program code straight into a PIC without first testing it. This is not a very reliable or easy way of producing code, however, and it is unlikely anyone would do this except for the very shortest program. In practice, the code needs to be written, assembled, run, and corrected several times before it operates satisfactorily.

This can be done by programming and erasing a PIC repeatedly but is not a very productive method. The main drawback is that it is impossible to see what is going wrong inside the program. So although the nature of the fault is clear, the program error that is causing it can only be found by painstakingly checking the code.

Using the PIC-DATS system it is possible to run the code in the computer, either continuously, or one step at a time, and to see exactly what has happened inside and outside the PIC after each step. When the code is running in this way, the conditions of the input and output ports are set up and read on the PIC-DATS pins exactly as they would be on the real chip so that input and output devices may be connected and will function fully.

In this way, the operation of the chip is "Emulated" by the computer and PIC-DATS system, and code can be tested, altered and re-run with a minimum of fuss.

Using such a system is engaging, and teaches so much about programming for "Real World" applications (that is, applications that interface with things like switches, motors, buzzers, lamps, etc.). It soon becomes apparent how to make things happen and allows ideas to be tried and tested very quickly and easily. Using PIC-DATS makes it possible to use PICs for not only very simple applications but even for quite complicated ones. It provides a springboard for ideas and then helps make them become reality.

PIC-DATS HARDWARE

The first requirement for using the PIC-DATS system is a PC-compatible computer with a serial port. These are now commonplace; low spec. types are relatively cheap and perfectly adequate for this system.

The serial port links to the PIC-DATS board via a simple serial cable. On the board is a power supply regulator, a bidirectional communications chip, and a specially programmed PIC which communicates with the computer via the serial link. This PIC sets up its I/O ports in response to each instruction when a program is being tested.

The same programmed PIC I/O ports are used to drive two programming sockets which allow 18-pin and 28-pin PIC devices to be programmed.

PIC-DATS CIRCUIT

The circuit diagram for the Emulator part of the system is shown in Fig.2. Plug PL2 is a 9-way D-type serial connector for the lead from the computer serial port and connects to IC2, which is a MAX232 serial line driver/receiver chip. This chip operates from the regulated 5V supply and generates its own ±12V rails to produce the necessary voltage swings to drive the serial outputs.

From IC2, the serial data – now at 0V to 5V levels – is connected to IC3, the programmed PIC device which controls all of the input and output pin functions of the emulator. These pins are linked to the main emulator connector PL4. When the system is set up for use, a socket connected to PL4 will be run to the corresponding pins where the PIC will be fitted on the system for which the PIC program is being developed – the "Target System". This purpose will become more apparent in Part 2 when a real application is described.

Power for the board is derived from a separate 12V unregulated supply via regulator IC1 which produces a +5V rail. Capacitors C1, C2, C4, C5 and C9 provide supply decoupling and, via resistor R1, l.e.d. D1 lights to show that power is applied.

The PIC programming part of the design is shown in Fig.3. IC4 together with resistors R6 and R7 provide a regulated 13.2V from the unregulated input supply voltage (which at low load levels rises well above the 15V necessary at the input of IC4). Capacitor C13 ensures that IC4 remains stable and does not oscillate at high frequency. Resistor R11 limits the current available from the programming pin.

The programming voltage is turned on and off by transistor TR3 which is driven by TR2 via resistor R8. TR2 receives its drive current from IC3 via resistor R10. With current limited by resistor R2, l.e.d. D2 lights whenever the programming pin is active. TR1 is used to connect and remove power from the programming socket when necessary so that PICs being programmed can be plugged in and out without switching off the main supply.

PRINTED CIRCUIT BOARD

The whole circuit is built on a single printed circuit board. This board is available from the *EPE PCB Service*, code 940.

The ready-made p.c.b. is manufactured with holes that are plated through from one side to the other (PTH). This makes soldering much easier and enables a simpler track pattern to be used. If for any reason a hole needs to be drilled out, then the top and bottom connections must be remade by soldering the associated component leg on both sides of the board.

The component layout details of the board are shown in Fig.4. Details of the full size double-sided copper foil track layouts are shown in Fig. 5. Except for the programming sockets, all components are mounted on the board as shown in Fig. 4. The programming sockets are fitted on the opposite side of the board. Zero insertion force (ZIF) sockets can be used if required. However, these are somewhat expensive and are, perhaps, unnecessary unless a large number of devices are to be programmed. For many hobbyists, the use of good quality turned-pin sockets should be perfectly satisfactory.

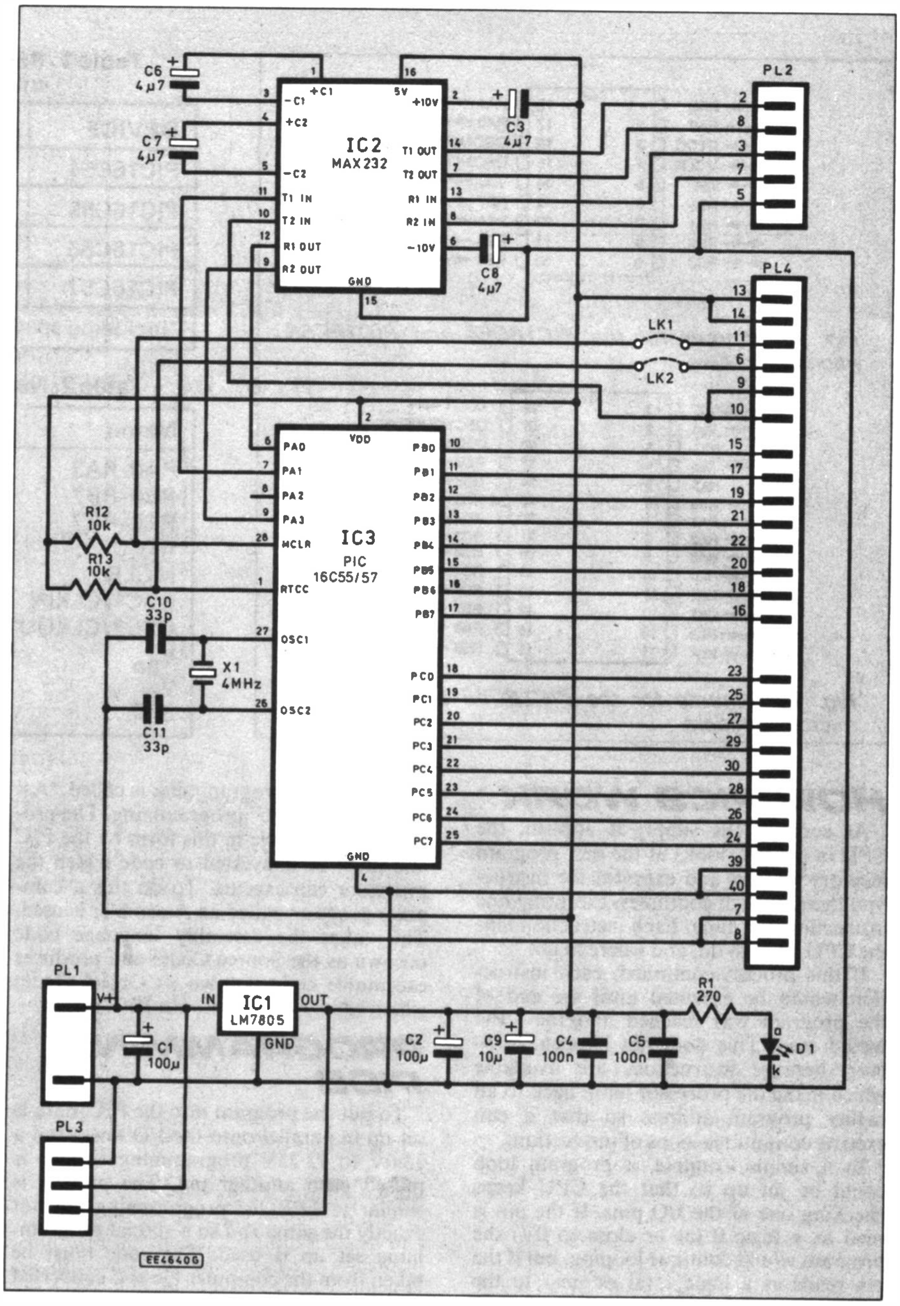


Fig. 2. Circuit diagram for the Emulator part of the PIC-DATS system.

CONSTRUCTION

After soldering in the sockets, insert and solder all the resistors, then the capacitors. Make sure the capacitors are fitted the right way round. The transistors should be identified carefully and fitted with their curved sides as shown. Voltage regulator IC1 may stand upright, but is better fitted lying down on the board. A short M3 screw should be used to secure IC1 to its heatsink and to the board.

The 4MHz crystal X1 (or a 4MHz ceramic resonator, if preferred) may stand upright on the board, or can be mounted on its side using a small double-sided sticky pad to hold it in place.

Connectors PL1 to PL4 must be fitted next. Make sure they are fitted to the correct side of the board – it is very hard to remove them once they have been soldered. The short lead of l.e.d. D2 is the cathode lead (k), and should be fitted nearer to the edge of the p.c.b. The other l.e.d., D1, is a special sideways mounting component and is fitted so that it can be viewed from the edge of the board.

Four plastic pillars should be fitted to the underside of the board using short self-tapping screws. These serve as feet and allow the board to stand level on the bench. The use of a case for this project was considered to be unnecessary.

Once the board has been completed, check the quality of all the soldered joints and make sure that there are no solder bridges or whiskers. If a suitable serial lead is not available, make up one to suit the computer using the connections shown for plug PL2 in Fig. 2.

POWER SUPPLY

For emulation use, the programming voltage is not needed and so power for the board may be from a regulated 5V d.c. supply connected to the 5V terminal of PL3. Alternatively, the supply may be from any regulated or unregulated voltage between 9V and 13V connected to PL1 or the 9V terminal of PL3.

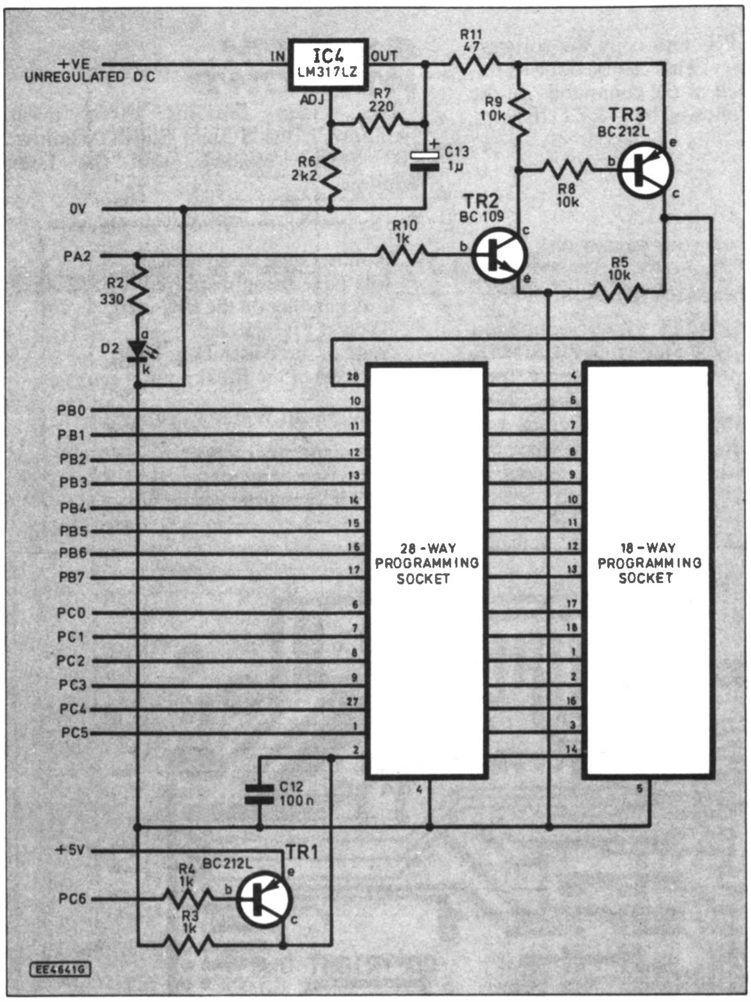


Fig. 3. Circuit diagram for the PIC programming part of the PIC-DATS system.

COMPONENTS

Resistors

R1	270	
R2	330	
R3, R4, R10	1k (3 off)	
R5, R8, R9, R12, R13	10k (5 off)	
R6	2k2	
R7	220	
R11	47	

All 0·25W 5% carbon film

See SHOP TALK Page

Capacitors

C1	100µ radial elect. 25V
C2	100µ radial elect. 6.3V
C3, C6 to C8	4µ7 radial elect. 16V (4 off)
C4, C5, C12	100n polyester (3 off)
C9	10µ radial elect. 6.3V
C10, C11	33p ceramic (2 off)
C13	1µ radial elect. 16V

Semiconductors

D1	l.e.d. red, 3mm, 90° p.c.b. mounting
D2	l.e.d. red, 3mm, standard
TR1, TR3	BC212L *pnp* transistor (2 off)
TR2	BC109 *npn* transistor
IC1	7805 5V 1A regulator
IC2	MAX232CPE line driver/receiver
IC3	PIC16C55XTP pre-programmed microcontroller (see text)
IC4	LM317L voltage regulator

Miscellaneous

X1 4MHz crystal or ceramic resonator (see text)

Printed circuit board (double-sided, through-hole-plated) available from the *EPE PCB Service*, code 940; operating software (see text) 16-pin d.i.l. socket; 18-way d.i.l. socket (see text); 28-pin d.i.l. socket (see text); 9-way 90° D-socket, p.c.b. mounting; 90° d.c. power socket, 2·1mm; 3-way p.c.b. terminal block; 9-way serial computer cable with connectors; clip-on TO220 heatsink for IC1, approx. 25°C/W; 90° 40-way IDC p.c.b. header; screws, nuts; p.c.b. pillar (4 off); connecting wire; solder, etc.

Approx cost guidance only **£99**

For programming, the supply must be at least 15V d.c. This is normally available from most unregulated 12V d.c. supplies when run at low loads. If a 15V regulated supply is available this also may be used, but will raise the power dissipated in IC1 when all of the I/O lines are in use.

Once the power and computer connections are correctly made, switch on the computer, load the software, and the system is ready to run.

SOFTWARE

Although broad details of the software and its operation are presented now, most of them will be meaningless to newcomers. Do not be concerned, they will all be explained in Part Two!

The programs required to run the full PIC-DATS system are:

Word-processing package	e.g. PCWRITE
PIC cross-assembler program	MPASM
PIC-DATS operating program	PICSIM5X
PIC-DATS EPROM programming software	PICPROG

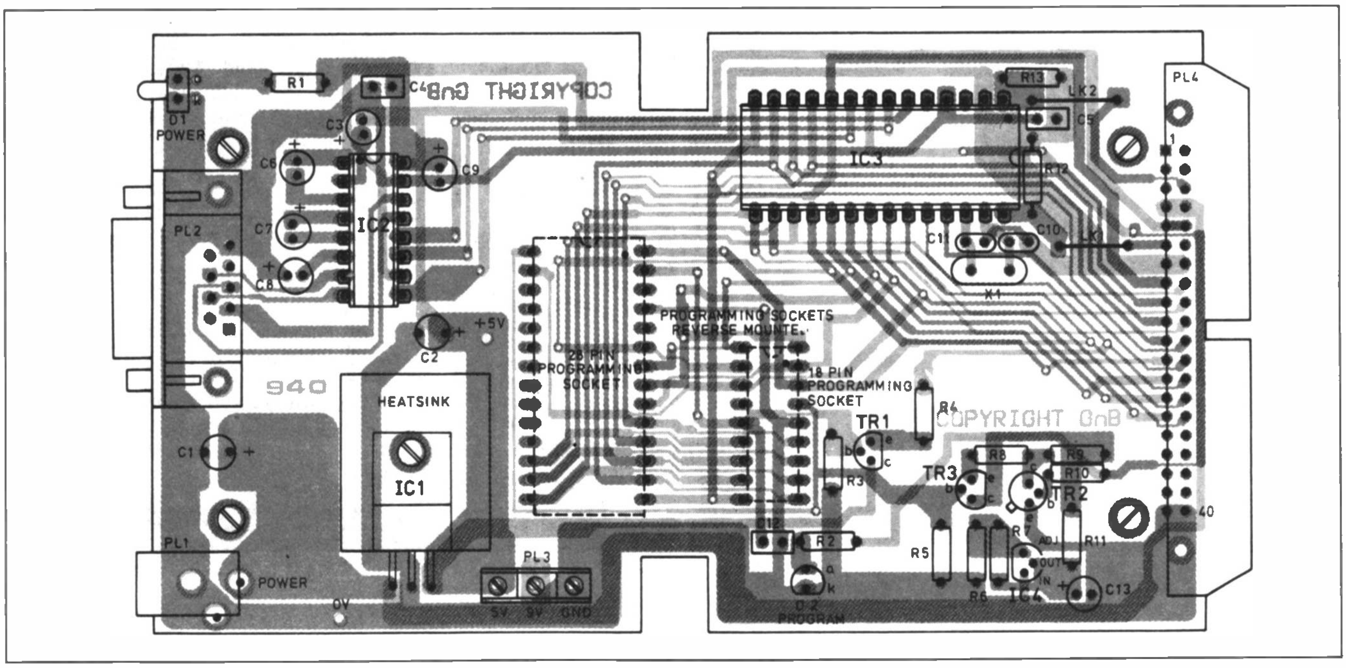


Fig. 4. Component layout on the top side of the double-sided PTH board. Note that the 18-pin and 28-pin programming sockets are mounted on the rear of the board.

The word-processor can be any that is capable of producing simple ASCII files. Most users will already have such a program and be familiar with its use. The author uses PCWRITE which is a Shareware program and is ideal for this type of application.

The cross-assembler program MPASM is written by Microchip and can be downloaded from their bulletin board. This provides regular information on PIC products and is accessible via modem. Full details of this will be supplied in Part Two.

Programs PICSIM5X, PICPROG and the latest version of MPASM are available from Magenta, as is the pre-programmed microcontroller IC3 – see *Shop Talk* page.

To use the software, first make backup copies of the disks. Then, from the normal DOS environment, make a directory on the C-drive called PIC and copy the software into this directory. This can be done as follows, typing each of the commands on the DOS prompt, followed by <RETURN>:

C:
MD PIC
CD PIC
COPY B: *.*

(or, depending on your second disk drive, type COPY A:*.*).

The system is then ready to be run.

With the PIC-DATS system connected and turned on, type and enter PICSIM5X This assumes that the serial port used is COM1. If COM2 is used, type PICSIM5X 2 the PICSIM program will then check the hardware, and produce the PICSIM entry screen as partly shown in Fig. 6.

SYSTEM WINDOWS

The screen contains three main "windows": the System Status Window, PIC Status Window, and the User Window.

The System Status Window displays:

- Number base being used.
- File page being displayed: 0, 1, 2, or 3 depending on the PIC used.
- Type of PIC selected.
- State of the Watch Dog Timer.
- Address of the Breakpoint if set.

The PIC Status Window displays:

- File register contents.
- W register contents.
- OPTION register contents.

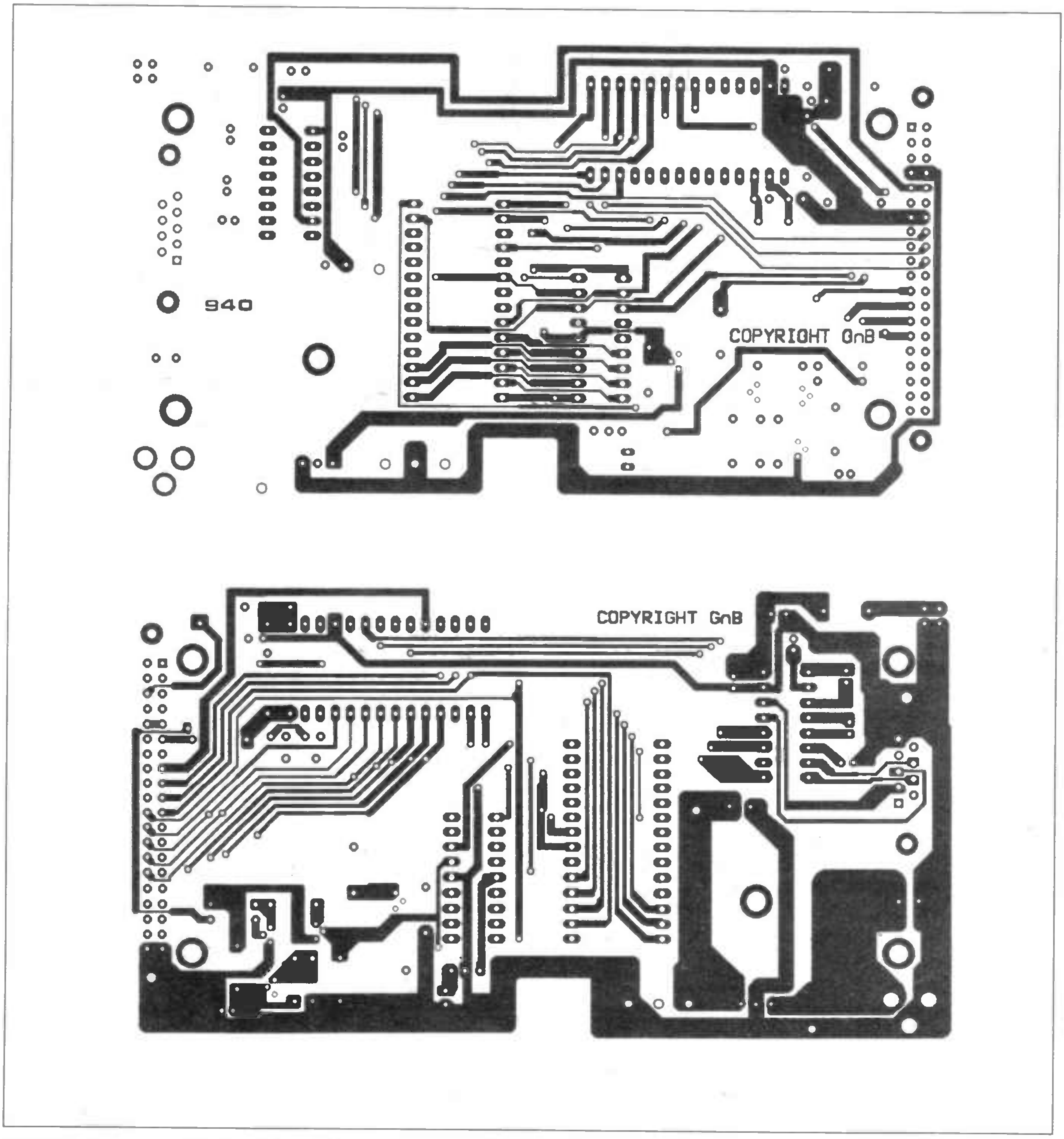


Fig. 5. Full size copper foil track layouts for the component side (top) and normal trackside (lower) of the double-sided printed circuit board for the PIC-DATS system. The ready-made board is through-hole-plated (PTH).

Contents of TRISA, TRISB, and TRISC.
Contents of the Watch Dog Timer register.
Current Stack Level.
Contents of the Program Counter.

The User Window displays the 17 available user-selectable commands:

- A Line assembler
- B Toggle number base
- D DOS command
- E Edit a file – using user's word-processor
- F Update Register File display
- I Disassemble
- L Load assembled file
- M Select type of PIC
- P Select Register File displayed
- Q Quit (exit)
- R Run a program
- S Single-step a program
- T Trace a program
- W Enable/disable Watchdog Timer
- X Change data in a Register File
- XA Assemble a file using user's cross-assembler
- ? Help

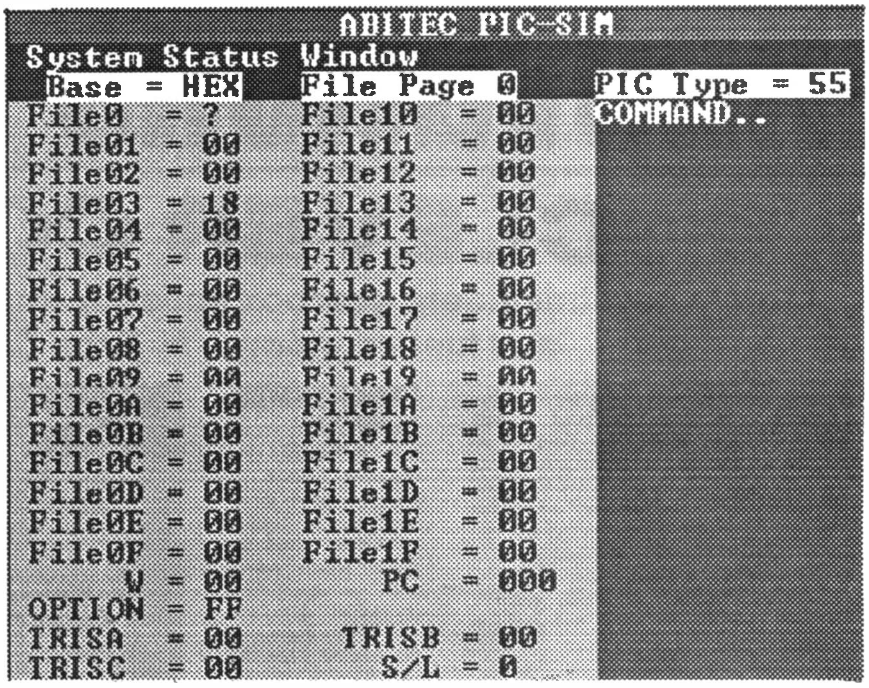
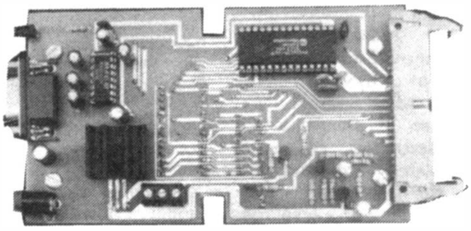


Fig. 6. Part of the PICSIM software entry screen.

NEXT MONTH

The function and use of the User commands will be explained fully next month in Part Two. Also to be described will be the design and programming of a PIC-driven Light Chaser development project. This will include details of another disk containing Assembler and Object code files to go with it.



Resource

See *Shop Talk* page for details on how to obtain a complete kit, the software programs and pre-programmed PIC microcontroller for this project.

Innovations

A roundup of the latest Everyday News from the world of electronics

CLEVER COGS

Merc's new intelligent gearbox speedily improves road-handling and fuel economy – *by Hazel Cavendish*

MAKERS of one the world's most distinguished cars have produced a fully electronic gearbox which they claim is an advance on any gearbox in current production. Mercedes-Benz of Germany unveiled their new "intelligent" gearbox in February which has five forward and two reverse gears, and can adjust to every driver's individual style of driving. In addition it has half the number of parts of a conventional automatic gearbox, is 30 per cent lighter, and reduces fuel consumption.

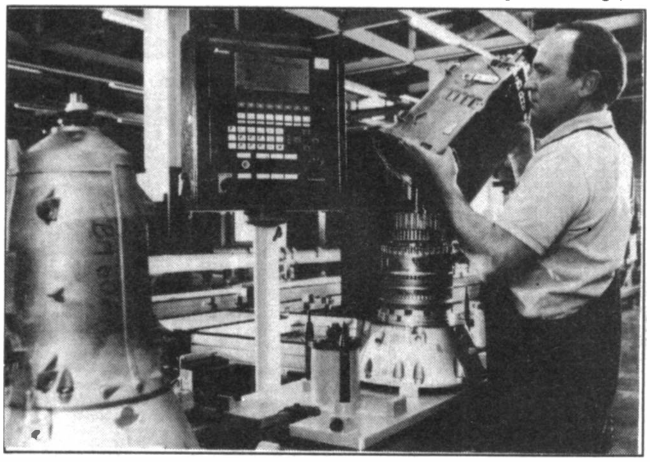
MATCHING CONDITIONS

Any driver who has experienced the kick-down lag of most automatic transmissions will welcome the news that the advanced electronics of the new Mercedes system produces instant changes. The new system also includes a winter driving gear-range which can be called up at the touch of a button, making starting off in snow or ice safer and easier.

The winter programme also has a special second reverse gear with a longer ratio. Although English drivers have less snow to deal with than their European counterparts, this advantage could be invaluable to business men travelling in Europe in Continental winter conditions.

At the heart of this technical innovation are sophisticated electronic controls which automatically adapt the gear-changing characteristics of the car to match road conditions and the driver's style of driving. If the driver makes rapid and frequent use of the accelerator the gearbox senses that he or she is looking for a dynamic, sporty response, and the gear-change characteristics are altered accordingly. On hills and when cornering the electronic control unit modifies gear shift points to prevent any sudden gear changes which might affect the car's handling.

These quick-as-lightning adjustments are made by permanent comparison of information provided by sensors against sets of stored information. The sensors constantly exchange data with the engine management system and before every gear-change the ignition is automatically retarded for a few seconds to prevent any tiresome jerking as the car changes gear.



Electronically monitored quality control features during gear box assembly.

PROGRAMMED CLUTCH

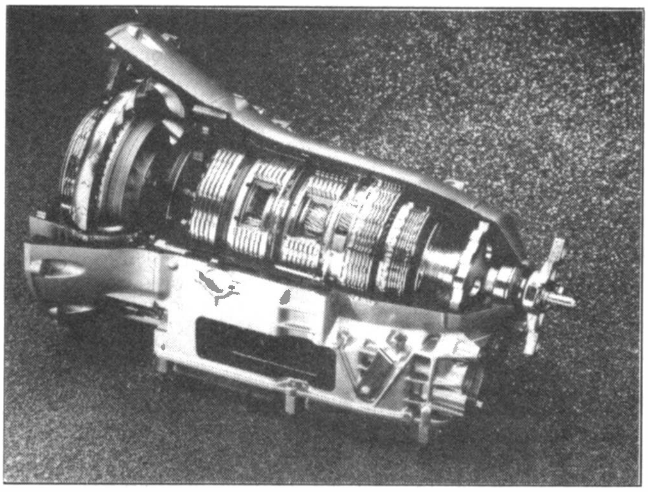
A particularly interesting feature of the five-speed gearbox is a torque converter lock-up clutch which works with a computer-controlled constant slip. This decouples the engine from the transmission to such an extent that any uncomfortable vibrations are ruled out, and fuel consumption is reduced. This innovation would not have been possible without the use of transmission electronics. A complete control programme is devoted entirely to the lock-up clutch. Diverse parameters, such as "driving on a level road", "uphill or downhill", "sharp, medium or gentle acceleration", "cold or warm engine" are the basis for the decision between "clutch opened" or "clutch closed without slip."

The electronic unit is also given the task of deciding exactly when to engage whichever of the five driving stages to give the best drive ratio. For the past 35 years three generations of automatic transmission produced by the company were controlled more or less solely by hydraulics, whereas today this has been taken over by the electronics. The hydraulic system is only responsible for the transfer of control commands, or to ensure emergency operation functions.

SMALLER, FEWER, LIGHTER

A further triumph for the company's engineers is that they have been able to reduce the number of parts in the new transmission from 1,160 to 630, and have slimmed the weight of the unit by 30 per cent to 80kg. Amazingly, it is only 600mm long, 150mm shorter than comparable transmissions.

Because of the additional fifth gear the engine speed in top can be lowered, giving greater fuel economy. It also gives more power in reverse. In winter mode, gear-changes are automatically made at lower engine speeds and the transmission's ability to "sense" hill climbs and descents is retained. The sensor prudently refuses to allow rapid kick-down while in the winter programme.



Cut-away view of the Mercedes-Benz intelligent gear box.

CANNILY CONTROLLED

The core element of the electronic transmission control unit is a microprocessor with an integrated CAN (Control Area Network) module, linked with other engine and vehicle management systems, using existing signals. The ABS (Anti-lock Braking System) control unit constantly supplies up-to-date wheel speed data, and the electronic transmission control unit uses this data to calculate, among other things, longitudinal and transverse acceleration which makes the installation of expensive acceleration sensors superfluous.

Fast data transmission between the individual control units is the task of the CAN data bus, allowing the exchange of large quantities of data with minimum cabling. All CAN data are defined right from the start so as to avoid conversion problems at the interfaces. The engine control unit, for instance, does not use the injection quantity or the air mass as load signal but the engine torque rating in Newton metres.

In the same way, the electronic transmission unit does not use a complicated instruction such as "retard ignition by X degrees" to cause a torque reduction during a gear-change but gives a straightforward command "X Newton metres less, please." (Note the ever-correct German instructions even includes "please"!).

INTELLIGENT INTERVENTION

All adjustments effected by the electronic control unit are instantaneous reactions to driving situations at any given point in time. When the computer recognises that there is no longer a need for intervention, it reverts, without delay, to the basic shift programme which is geared to minimal fuel consumption. With this reactive strategy, the new Mercedes-Benz automatic transmission differs from all so-called adaptive transmission control systems whose learning and adjustment processes take considerably longer.

Although the advanced gearbox will be introduced as standard equipment on the Mercedes-Benz S600 coupé in Germany in a few months time, Britain will have to wait until the autumn for it to be standard on both the S600 and S500 coupés. At a later date it will be available on all four and six-cylinder Mercedes saloons.

PIC 'N CHOOSE

Arizona Microchip, the manufacturers of the PIC microcontrollers featured in this month's PIC-DATS project, have recently released a new *Embedded Control Handbook*. This book should prove to be an indispensable reference tool for designers using Microchip's PIC16/17 field-programmable 8-bit microcontrollers and speciality non-volatile memory products.

Covering both system and application issues, the 1375-page handbook is the largest of its kind. It includes more than 78 application notes and code examples written for specific embedded control applications. These cover subjects such as "Multiplexing LED Drive and 4×4 Keypad Sampling", "Implementation of an Asynchronous Serial I/O", "Implementing Ohmmeter/Temperature Sensors" and "Serial Port Utilities".

Additional features include schematic and timing diagrams, maths routines and associated figures for comprehensive application support.

Also available from Microchip is their *Third Party Guide*, a comprehensive 160-page handbook detailing companies who manufacture programmers, emulators, assemblers etc. for use with PC16/17 microcontrollers.

For more information contact Arizona Microchip Technology Ltd., Unit 6, The Courtyard, Meadowbank, Furlong Road, Bourne End, Bucks, SL8 5AJ. Tel: 01628 851077.

TWIN-PROM MCU

Texas Instruments' TMS370 family of 8-bit microcontrollers offers features such as EEPROM and EPROM on the same chip. This technique allows prototypes to be developed quickly and for subsequent software updates or calibration factors to be more readily integrated.

TI quote as an example the use of the TMS370C710, the simplest member of the family, to control a light meter system based around the TSL230 light-to-frequency sensor. The TSL230 generates a square wave output in proportion to the amount of light energy incident to its integrated photodiode.

The microcontroller's software is programmed into part of the 4K Eprom and converts the frequency into a direct display of lux on an external l.c.d. display. The lux meter can be recalibrated at any time against a reference light source by simply updating constants stored in the 256 bytes of on-chip EEPROM.

For more information contact Texas Instruments Ltd., Manton Lane, Bedford, MK41 7PA. Tel: 0234 270111.

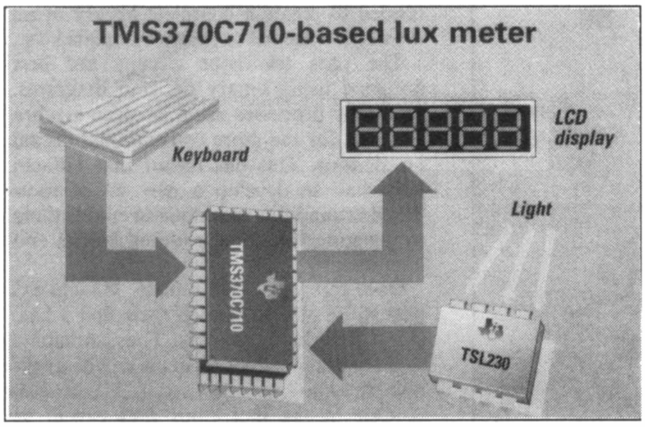


Illustration courtesy of Texas Instruments

MICRO PLC

The Dianamic MPLC1000 is a new low power Micro PLC (Programmable Logic Controller) having a standard configuration of 16 I/O ports, and costing under £100. The ports can be configured as analogue ports with an 8-bit resolution, digital ports, or counters at frequencies up to 2·5kHz. The power supply is DC-DC with an input tolerance of between 6·5V and 30V.

Full Basic language implementation is featured on the PLC with full maths implementation including Boolean logic. GOSUB routines up to three levels are supported and 4096 bits of tokenised program space is available. Other functions included a keyboard port, buzzer driver and l.c.d. driver. The device can be further expanded to support an extra 128 ports, 7-segment displays, real-time clock, 8-bit A-D-A converter, or a 256 x 8-bit static CMOS EEPROM/RAM. An on-line RS232 serial port enables communication with a PC. Development kits and detailed manuals are available.

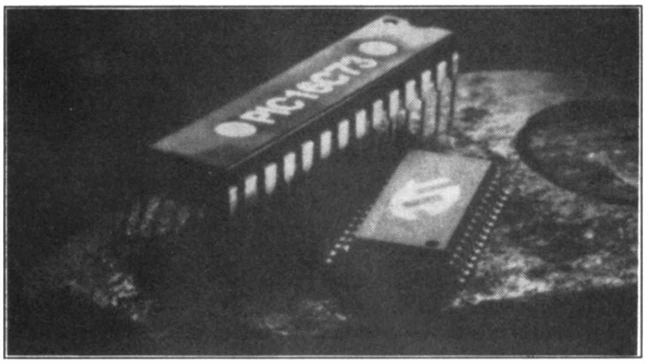
For more information contact NMB Marketing Ltd., London House, 100 New Kings Road, London SW6 4LX. Tel: 0171 731 8199.

PIC-ING FASTER

Microchip's new PIC16C73 is reputedly one of the most powerful 28-pin 8-bit microcontrollers available. With a performance of up to 5MIPs (million instructions per second), this field programmable RISC-based device provides large OTP (one time programmable) memory arranged as 4K words of EPROM and 192 bytes of data RAM.

The PIC16C73 also provides a very low power on-chip 5-channel 8-bit analogue to digital converter and extensive communications facilities. It is available in 28-pin UV-erasable ceramic and other packages. Microchip describe the device as an excellent upgrade for users of their PIC16/17 family of products.

For more information contact Arizona Microchip Technology Ltd., Unit 6, The Courtyard, Meadowbank, Furlong Road, Bourne End, Bucks, SL8 5AJ. Tel: 01628 851077.



Two package variants of Microchip's PIC16C73 microcontroller.

MORE MCU GENERATION

Additional instructions have been added to Siemens' second generation family of C16x microcontrollers. Address space has also been increased to 16MB externally, and to 2KB of internal RAM. Included in the family are the C165 and C167 types which have a standardised internal bus (the XBUS) which represents the external interface and simplifies its use with peripheral devices.

As a result of this approach, the integration of a CAN (Control Area Network) module into some of the devices has been made possible. (The new Merc gearbox reported by Hazel Cavendish this month uses a microcontroller with a CAN module).

The C165/7 microcontrollers have a 16-bit CPU and exhibit a 100ns minimum instruction cycle time. Most instructions are executed in a single cycle and data can be processed as bits, bytes or 16-bit words. In many control applications the ability to easily manipulate bits is of particular importance.

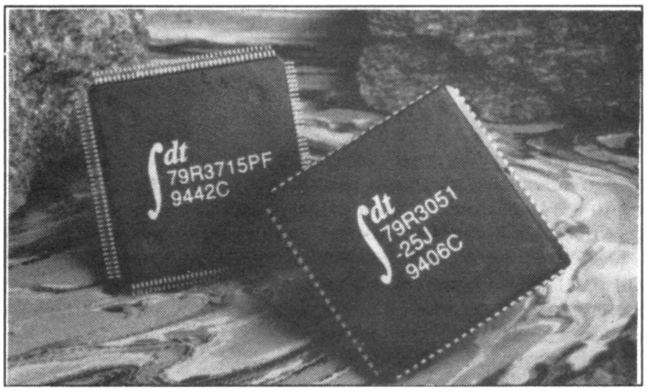
For more information contact Seimens Ltd., Seimens House, Windmill Road, Sunbury-on-Thames, Middx, TW16 7HS. Tel: 09327 85691.

32-BIT EMBEDDED RISC

Integrated Device Technology's new IDTR3715 controller supports the IDT3051 family of 32-bit embedded RISControllers and has been specifically designed for use in data communications, telecommunications and office automation.

Comprising a tightly-coupled CPU interface plus controllers for up to 20MB of ROM and 40MB of DRAM, the IDTR3715 also features a Centronics interface, three DMA channels, a 16-bit I/O bus and has an operating speed of 33MHz.

For further information contact Integrated Device Technology, Prime House, Barnett Wood Lane, Leatherhead, Surrey, KT22 7DG. Tel: 0372 363734.



32-bit embedded RISControllers from IDT.

New Technology Update

Ian Poole investigates the latest research development that is expected to LEAP ahead of CMOS technology.

THERE is a great variety of developments taking place in the field of electronics. Some find applications in specialized areas whilst others have more widespread uses. Many never leave the research laboratory because the idea may have been overtaken by other developments, or it may be that no manufacturer takes any interest in them.

However, a few are quite revolutionary and change the whole face of electronics. The thermionic valve in the first decade of this century was one. It enabled radio to become established and in doing so people discovered other uses for these new devices.

The invention of the transistor in 1949 was another major landmark. It enabled circuits to be made far more reliable than was previously possible. It also meant that circuits could be made much smaller and consume far less power.

The integrated circuit was a third major landmark. Again it enabled circuits to be made much smaller and more reliable, and in doing so it revolutionized the whole electronics scene.

Successful CMOS

Many others have built on these successes. A good example is CMOS technology. This has enabled i.c. designers to reduce the power consumption of the circuits within their chips. As a result it has had a revolutionary effect on i.c.s.

In the early days of i.c.s it was soon found that power dissipation was the major factor limiting the degree of i.c. integration. The solution to the problem arrived when CMOS technology was introduced. This dramatically reduced the power consumption of circuits within the i.c. allowing the number of circuits on a single chip to rise.

Soon very large scale integration (v.l.s.i.) was seen, and microprocessors arrived. In fact electronics and computing would be very different today if it was not for CMOS. Computers would be much larger, and far more costly. They would dissipate far more heat, and they would have a much larger number of i.c.s in them. Had this been the case then the personal computer revolution would not have taken place.

Giant LEAP Forward

In view of the importance of CMOS and its derivative technologies, it is very exciting to see that a new technology has been developed which could replace it.

Developed by Hitachi in Tokyo, and called LEAP technology (LEAn integration with Pass transistor), it is reported to beat standard CMOS circuits by factors of up to 100 per cent in some circumstances. The idea is based around a circuit configuration using a single pass transistor which charges up and discharges the capacitive output load.

Loads for digital i.c.s tend to be only capacitive in view of the very high input resistances of the f.e.t. circuits used. A CMOS circuit uses a PMOS and NMOS transistor pair: one for charging and the other for discharging the load. By using the single pass transistor operating speeds are improved and less area is taken up on the chip. See Fig. 1. for comparison.

The benefits of pass transistors are particularly pronounced at low voltages. This is of great importance as low voltage logic is becoming widely available. The new 3·3V standard is being adopted more widely by users needing to operate low power or battery powered portable systems.

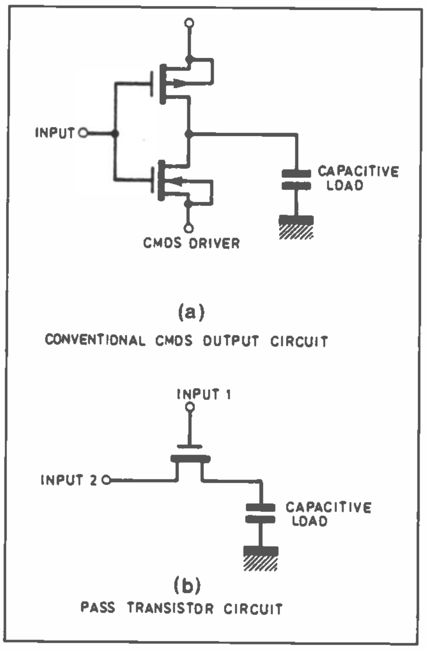


Fig. 1. Comparision of CMOS and LEAP technology output circuits.

To illustrate the importance of low voltage technology, even now new lower voltage standards are being proposed. This could prove another reason why LEAP technology is about to take off.

The idea of using a pass transistor is not new, but very little work has been put into the research of the idea until recently. Now that this development has been undertaken the possibilities of the improvements which can be obtained have been amply demonstrated. However, to use the pass transistor, new circuit structures have needed to be built up because standard NAND and NOR configurations cannot be used.

This has meant that the i.c.s which have been tested to date have only incorporated relatively simple circuits. Even so several LEAP i.c.s have been made and compared along side equivalent CMOS ones. This has enabled direct comparisons to be made and it has proved that the LEAP circuits greatly out perform their CMOS equivalents.

In the 4-bit adder/subtracter used for the test, the LEAP circuit was 45 per cent smaller than the equivalent CMOS one. Also it had a delay of 2·7nS compared to 3·6nS and it consumed 3·4mW per MHz; 64 per cent less power than its CMOS counterpart.

First Launch

Hitachi expect that LEAP technology will eventually replace standard CMOS for most v.l.s.i. applications. However, at the moment they are not ready to use it in commercial products.

The reason for this is the new circuit structures which are required. As the circuits needed for LEAP i.c.s are harder to design than those for CMOS, new design tools are required. Despite this, Hitachi have already designed many of the basic building blocks although more work is still needed to create a complete library of all the circuits needed to design complete i.c.s.

The pass transistor circuits are best designed using binary decision diagrams. Normally processes using Boolean algebra are used for the more conventional digital i.c. designs. This has meant that Hitachi have had to develop a new set of tools based around this technique to enable them to generate their new building blocks and circuits.

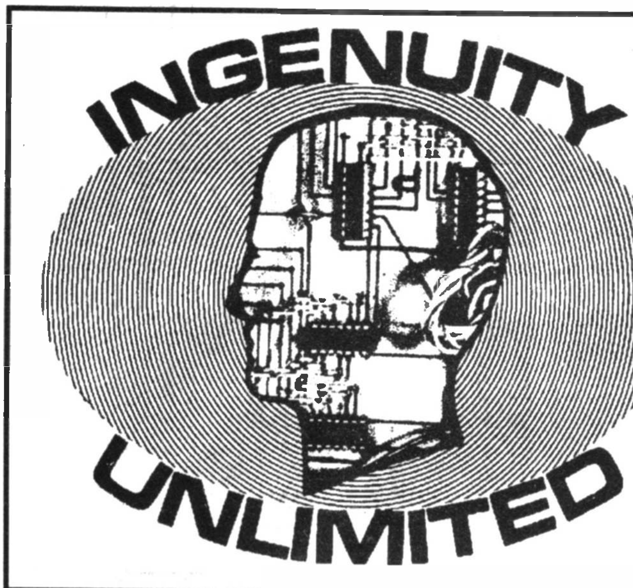
Once this work is complete, Hitachi expect to be able to launch their first v.l.s.i. chips remarkably quickly. They anticipate that the first production items will be available by 1996-7.

One of the first chips they expect to launch will be a 100MIPS processor. This will be manufactured using a 0·35μ technology. Plans are also being made to launch a 2·5V 300MIPS processor the following year. This should consume a little less than a watt.

Conclusion

This technology promises to have a major impact on the electronics we know today. With Hitachi placing major importance on its development it is likely that within a few years the new technology will become as standard as CMOS is at present.

It is also interesting to see that Hitachi is becoming a major force in the development of new semiconductor technologies. After the announcement last year of their single electron memory technology, the new LEAP i.c.s and a number of other developments promise to take them far into the lead in many areas.



Our regular round-up of readers' own circuits. We pay between £10-£50 for all material published, depending on length and technical merit. We're looking for novel applications and circuit tips, not simply mechanical or electrical ideas. Ideas must be the reader's own work and **not have been submitted for publication elsewhere.** The circuits shown have NOT been proven by us. *Ingenuity Unlimited* is open to ALL abilities, but items for consideration in this column should preferably be typed or word-processed, with a brief circuit description showing all relevant component values. Please draw all circuit schematics as clearly as possible.

Send your circuit ideas to: Alan Winstanley, *Ingenuity Unlimited,* Wimborne Publishing Ltd., Allen House, East Borough, Wimborne, Dorset, BH21 1PF. They could earn you some real cash!

"Shakeable" Dice

– for fun and games

A circuit which relies on the make/break action of a mercury tilt switch to produce a seven-spot l.e.d. display similar to a traditional dice is shown in Fig. 1. As the project box is "shaken", the mercury switch contacts are bridged repeatedly to form a series of clock pulses at pin 14 of IC1. This chip is a 4022 octal counter which switches on one of eight outputs sequentially with each new clock pulse.

The diodes D1 to D5 and the transistor switch TR1 gate the output signals to create the familiar pattern of the dice. For example, when output "1" goes high, TR1 is forced out of conduction by diode D2. However, D3 also connects to D9, the central l.e.d., which indicates "1" on the dice face. When output "3" goes high, the central l.e.d. again lights but now TR1 can conduct and illuminate both D6 and D13. Thus we see a diagonal line of three l.e.d.s.

One slightly different arrangement is that of the l.e.d.s connected to the carry out pin (12). This goes high on the count of four, and low on the count of zero. Looking at the position of the "spots" in the D7 and D11 positions, you will note that they appear on faces 4, 5 and 6, but not on 1, 2 and 3 – which is exactly the switching arrangement we have just emulated. The extra light-emitting diode D12 *does not* feature in the display but was incorporated to maintain the overall consistency of the display brightness, as two devices are then driven.

Finally, the enable pin 13 of IC1 is connected to a pushswitch S2. As soon as this is released by the player, the count is frozen on the display. It also breaks the 0V return of the display so that the display is blanked, and this prevents players cheating as they cannot select a required number.

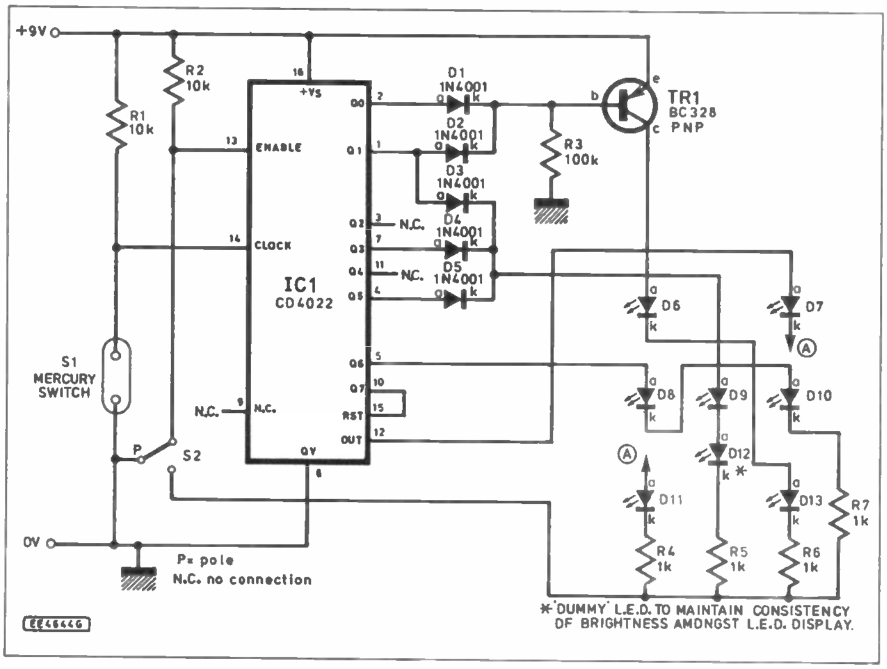


Fig. 1. Circuit diagram for the "Shakeable" Dice

Chris Brown,
Witham, Essex.

Alarm Time-Out – silences nuisance alarms

The circuit diagram in Fig. 2 came about following a request from a friend who asked for a cheap add-on timer for burglar alarm sounders, which would allow the sounder to run for about twenty minutes and then switch off. This would permit older alarm systems to be upgraded to comply with latest anti-nuisance requirements. It needed to be spliced in series with the bell wires at either the bell-box or the control panel if it was to be easily installed.

The circuit has been used successfully in several installations and is based around a 555 monostable. To trigger a normally-configured monostable, it needs a negative-going pulse on pin 2. In this design, the trigger pin is held low by capacitor C1 when the supply is starting up, so the 555 will trigger for a period calculated by 1·1 R2.C2 seconds.

During timing, an *npn* Darlington transistor pair TR1/TR2 (e.g. a ZTX300 and BC140 respectively) complete the circuit to the sounder which operates for the monostable period only, and then times out. A Darlington transistor such as a TIP122 could be used instead of individual transistors, to simplify assembly.

The components can be chosen to obtain the desired time period, the main condition being that the "trigger" time period R1.C1 must be less than the monostable period or the timer will re-trigger and run on.

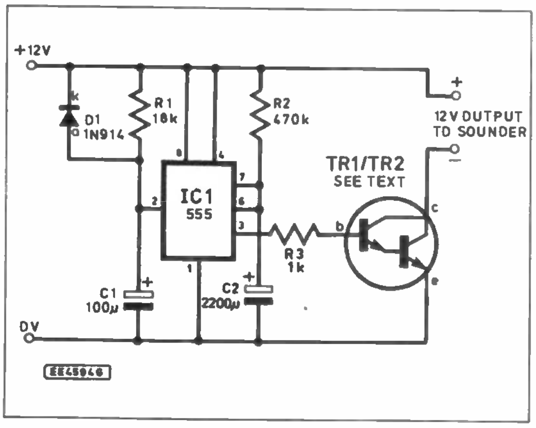


Fig. 2. Alarm Time-Out circuit diagram.

Peter Nutt,
Middleton, Manchester.

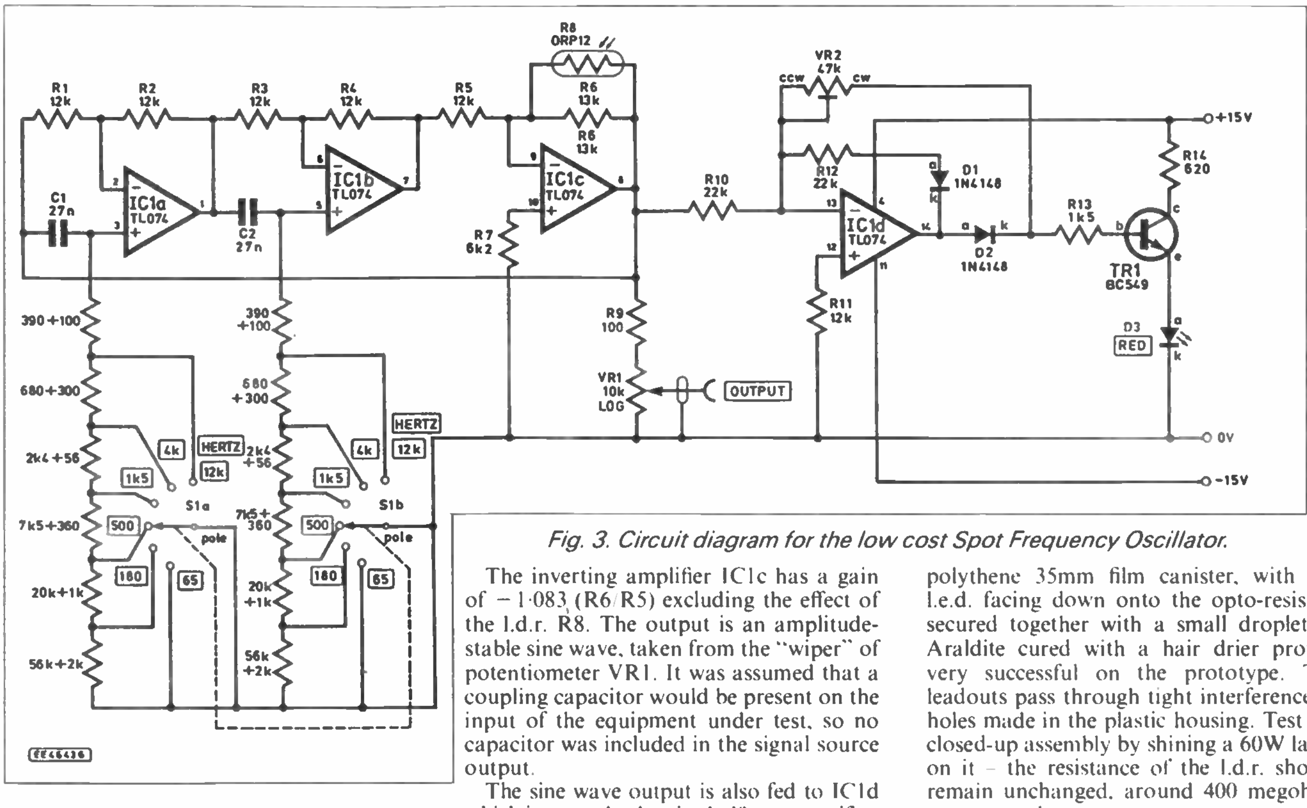


Fig. 3. Circuit diagram for the low cost Spot Frequency Oscillator.

Spot Frequency Oscillator

a stable signal source

The circuit diagram shown in Fig. 3 is for a "spot frequency" oscillator which was designed to provide a means of rapidly checking the frequency response of audio equipment, where a fully variable signal generator would be inconvenient or too expensive to buy. It might be of interest to hospital radio groups and disco operators, as well as the experimenter.

The design generates six different frequencies and is very economical to build. It is stabilised by a novel arrangement using an l.e.d. with a light-dependent resistor (l.d.r.). This obviates the need to use a very expensive glass bead thermistor which you often see in stabilisation circuits.

The circuit is based around two all-pass filters, IC1a and IC1b, connected in series. An all-pass filter has a phase shift of 90 degrees at a frequency given by:

$$f = \frac{1}{2\pi R.C}$$

where C is C1 or C2 in the circuit, and R is the resistance between (+) the non-inverting input of the op.amp and ground. Two such filters in series provide 180 degress phase shift, and if the output of the second filter is fed back to the input of the first, via an inverting amplifier IC1c of unity gain, 360 degrees of phase shift is obtained and the circuit will oscillate at the frequency calculated above.

A 2-pole 6-way switch S1a and S1b selects the desired frequency by switching a series of resistors. The frequencies are switchable at intervals of approximately 1½ octaves giving a reasonable range from 65Hz to 12kHz.

Each resistor in the network is formed from two resistors, with values as shown which are selected by a *break-before-make* switch, so that the non-inverting inputs are never left floating – it worked out cheaper than a 2-gang potentiometer! Note that *all* resistors are precision one per cent types; the capacitors should be five per cent or better.

The inverting amplifier IC1c has a gain of −1·083 (R6/R5) excluding the effect of the l.d.r. R8. The output is an amplitude-stable sine wave, taken from the "wiper" of potentiometer VR1. It was assumed that a coupling capacitor would be present on the input of the equipment under test, so no capacitor was included in the signal source output.

The sine wave output is also fed to IC1d which is a standard active half-wave rectifier, whose positive-going output illuminates the l.e.d. D3, via transistor TR1. The negative output transitions of IC1d are not used.

Preset potentiometer VR2 determines the gain of IC1d and thus the brightness of the l.e.d. is controlled. The average current through the l.e.d. is only about 0·15mA. Resistor R14 limits the current at switch-on.

The l.e.d. D3 is closely positioned against the l.d.r. R8, whose resistance is reduced to approximately 156 kilohms. This value in parallel with resistor R6 produces a net resistance of about 12 kilohms in the feedback loop of IC1c, so the gain of IC1c then has a value of one.

The oscillator will always start on switch-on, since the gain is initially greater than one until the l.d.r. resistance settles down. Preset VR2 will vary the output from gross overload down to 0·75V approx., and should be set at no more than 1·5V.

It is critical that the l.d.r and l.e.d. are mounted together in close physical contact in a *completely lightproof* enclosure. A polythene 35mm film canister, with the l.e.d. facing down onto the opto-resistor, secured together with a small droplet of Araldite cured with a hair drier proved very successful on the prototype. The leadouts pass through tight interference-fit holes made in the plastic housing. Test the closed-up assembly by shining a 60W lamp on it – the resistance of the l.d.r. should remain unchanged, around 400 megohms as measured.

Performance

The performance exceed my expectations. The change in amplitude-vs.-frequency was about 0·2dB and distortion was estimated at 0·2 per cent at 65Hz, and 0·02 per cent at 12kHz.

There is no reason why the unit could not be built as a Variable Frequency Signal Generator. With a 10k (reverse log. law) ganged potentiometer with 680 ohm end stop resistors, together with switched pairs of capacitors of 1µF, 100nF and 10nF, a variable oscillator running from 15Hz to 23kHz in three ranges would result.

It was intended for use on an existing ±15V stabilised power supply, with the rails being decoupled with 100nF capacitors. The total cost of the components shown was about £6 – less than half the price of an RA53 glass bead thermistor, so the objective of low cost was well and truly achieved!

B.J. Taylor, Rickmansworth, Herts.

Simple Heat Sensor

– a hot tip

A circuit diagram for a simple project which will provide a relative heat indication of a solid fuel stove, useful for providing an "at-a-glance" reading of whether to stoke up or dampen down, is suggested in Fig. 4. It could be used in other applications where a simple meter output is all that's required.

The circuit uses an OC81 *pnp* transistor TR1 with the emitter (e) left open circuit. The leakage current flowing through the meter is related to the temperature of the transistor, which should be clamped carefully against the flue pipe, suitably adjusted for the best position to indicate "warm", "hot" or "very hot".

A 100µA meter should be used for M1, and the output from transistor TR1 base (b) could perhaps be used to drive external circuits such as a remote indicator/slave system. The circuit runs from a single 1·5V cell and has been successfully tested on my "shack" stove.

P. Wilkinson, Alford, Lincs.

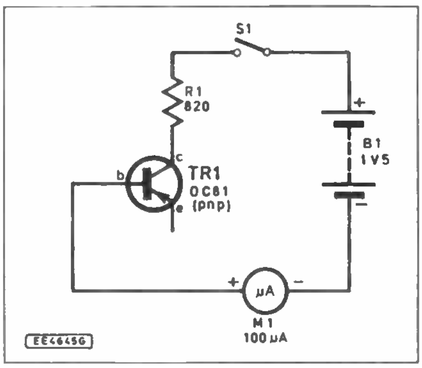


Fig. 4. Simple Heat Sensor circuit diagram.

Las Vegas WINTER CONSUMER ELECTRONICS SHOW

by Barry Fox

Our globetrotting scribe gets all animated trying to unravel the latest betting on who will win the race to fulfil the "American Dream" in home entertainment.

ANOTHER opening. Another show. And another standards battle to bemuse the consumer, cripple the electronics industry and keep journalists busy for another year.

I am talking about Las Vegas, the *Winter Consumer Electronics Show* held there in January and the first demonstration of DVD, the Digital Video Disc that uses the MPEG-2 broadcast compression system to get a full length feature movie on a single-sided 5 inch CD, with picture quality that betters Laser Disc.

Along with a lot of other things besides, of course.

Opening Remarks

The show opened with Keynote speeches from Joe Clayton, Head of Thomson and RCA in the USA, Reed Hundt, Chairman of the Federal Communications Commission which controls American broadcasting, and Michael Schulhof, President of Sony in the USA.

Joe Clayton told how the launch of DSS, Hughes' direct to home digital satellite system, had been a roaring success. "Digital Destiny" he explained "is now an important part of the American Dream".

Reed Hundt seemed curiously ill-informed on the world politics of broadcasting. He said that the US was the only country in the world that is selling off frequencies for wireless communications, that new digital TV systems will make it possible to broadcast test messages, for instance on traffic flow, and that the extra channel capacity which digital TV creates could be used to give politicians free air time. All this he too saw as part of the "American Dream".

Reminded afterwards that the UK already auctions TV frequencies, has had Teletext for 20 years and party political broadcasts for even longer, Hundt was nonplussed.

"Congratulations" he said, nonplussed.

Michael Schulhof reinforced Sony's committment to a digital future, encouraging show visitors to see Sony's demonstration of DVD which, he pledged, would be "affordably priced for the consumer" – at least he did not mention the American Dream.

Digital Video Disc

The promise of DVD inevitably puts a big question mark over the Video CD format, which currently stores an hour of VHS or better quality on a CD, using the MPEG-1 compression coding standard.

Philips demonstrated the high quality available from MPEG-1 Video CD, with movie discs played at Las Vegas on CD-i players fitted with Digital Video cartridges. But the quality is good only if the discs have been carefully coded and the players are well designed. Panasonic's demonstration of MPEG-1 was very disappointing.

The Japanese company was showing the SL-VM500, which takes five discs. Picture quality was poor compared to the results Philips were getting from the same discs. Picture quality from a Panasonic 3DO player fitted with an MPEG adaptor was even worse. Panasonic also showed a portable unit, which looks similar to an audio CD portable, but plays Video CDs when plugged into a TV set. Picture quality was slightly better, but probably only because the screen sizes were smaller. Impressive demonstrations of the *Jurassic Park* movie turned out to be sourced from a Laser Disc player.

Although the demonstrations of MPEG Full Motion Video from 3DO players were poor, the system can deliver surprisingly good FMV from "base case" software, i.e. video material that needs only software to decode it. For example a 3DO ski tutorial and game was delivering full screen, full motion video which was nearly as good as the FSFMV running from Panasonic's players with MPEG decoders. This base case picture quality was better than Video for Windows usually delivers from a high specification personal computer.

Talk-Back

The ground-breaking demonstration of MPEG-2 Digital Video Disc was jointly given by Sony and Philips, but it was clear from the outset that Sony was the prime mover. And it was not hard to see why. DVD makes Video CD obsolete unless it is – as Philips has been saying – six or eight years away. At Las Vegas Sony was talking about a launch in 1996.

Shortly after Las Vegas, Toshiba tied up with Time Warner to demonstrate a rival DVD system which is similar but incompatible. Panasonic has backed Toshiba against Philips. So has Thomson of France (so much for European unity).

It now looks likely that the two camps will get together and set a single standard which combines the best features of each. But Toshiba is also talking about a launch in 1996.

The demonstrations of DVD at Las Vegas give a very clear idea of what we can expect. Even if the 1996 date slips or applies only to the USA and Japan, Europe can now expect DVD in 1997. This looks likely to drive MPEG-1 and Video CD back to their origins as an adjunct to interactive games, and a budget carrier for karaoke.

The use of MPEG-1 is now being seen as the ideal technology to breath live action into CD-i games like the ex-arcade game *Mad Dog Macree*.

Said Sony privately, because of the political climate:

"Video CD is an embarrassment; frankly we wish it had never happened and we see its entire purpose as being a carrier for karaoke".

For the DVD demonstrations Sony had gone out and bought VHS and Laser Disc copies of *In the Line of Fire*. These were shown in split screen comparison with a DVD copy of the studio master tape. DVD made even LD look inadequate.

The denouement was a remarkable split screen comparision of the original studio master tape on professional digital D1 format, and DVD. The two look identical.

Insiders say that when the Hollywood studios saw this split screen demonstraton, at a private viewing just before Christmas, they were "shocked".

(Typifying the bitter rivalry between Sony and Toshiba on DVD, when Toshiba demonstrated its own system in Hollywood a week or so later they invited Clint Eastwood, star of *In the Line of Fire*, to make a personal appearance in support of Toshiba's system.)

Toshiba's DVD glues two DVDs together, back to back, to double playing time. Sony and Philips claim success with a system developed by 3M which doubles the running time of DVD by recording two separate tracks, at different depths in the same single-side plastics pressing. But no-one has yet demonstrated this, which may be one reason why Panasonic has backed the known technology used by Toshiba.

Says Philips:

"This is just the beginning. We have proposed a standard. They have proposed a standard. Now we have to get together and talk about them".

Mini Stuntman

One of the cleverest publicity stunts of the show was pulled by Sony in its open stand. Every visitor was loaned a Mini Disc player, and a disc with a recorded commentary on the exhibits. Visitors had only to skip to the next track when moving from one exhibit to the next. So everyone visiting the exhibition got some hands-on brainwash experience of the latest MD player, without even thinking about it.

There was no sign of the rival digital audio system, DCC, on either of its backers' stands, Philips or Panasonic.

Friendly CD

In the computer section of the show I found the first signs of what many people have been waiting for, a domestic CD recorder. Although dedicated audio CD recorders are too expensive for home use, several computer companies are now selling CD-ROM writers, with software which lets a PC write CD-audio to the disc.

The "Smart and Friendly" CD-recorder costs $1500. It dubs at twice normal speed and comes with Corel software that designs and prints jewel box artwork. S and F also sell a Video CD version. For under $5000 it transfers VHS video tapes to digital Video disc.

The Smart & Friendly stand was demonstrating its CD Recorder, with software, which lets a PC write CD audio to disc.

Direct TV

Although Thomson/Ferguson in the UK plays with an increasingly low profile, Thomson/RCA in the USA has a team of professional PR people spreading the word. They were working overtime in Las Vegas to tell anyone who would listen about "the greatest success story of the year". This is the Hughes DirecTV service.

The first receivers, made by RCA, went on sale on June 17 1994, in Jackson Mississippi. Distribution went nationwide on the Halloween weekend. RCA and Hughes say they originally forecast 395,000 units. The actual number is 600,000, and demand outstrips supply. In June Thomson's US factory was making 200 digital receivers a day. Now it is producing 100,000 a month.

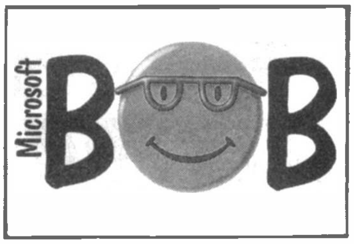
Across the USA there are 10,000 dealers selling the system. RCA will have sold one million well ahead of the 18 month target. After that threshold number, other manufacturers are free to make receivers. Sony is first to take a licence.

"It was a flawless execution of a startup business" say the Thomson/RCA/Hughes team with characteristic North American modesty.

The big surprise was that RCA claims that more than half the sales are in areas where homes can already connect to a cable system, and thus do not actualy need a satellite dish. Why are people paying around $700 for the satellite hardware, another $150 for installation, between $8 and $35 per month for a subscription and $3 per movie watched on the pay-per-view channels, when they could cut the cost of hardware and pay a similar subscription to a cable company?

In the USA people hate their cable companies, with a passion, for charging high prices for low quality pictures and poor service.

Social Software



Significantly Microsoft broke with past tradition and launched its new home computer software at *CES* instead of the *Comdex* computer show. Founder and Chairman Bill Gates was there and cheerfully admitted that DOS is "very cold" and is now "completely obsolete". But DOS, he argued, was the best he could offer ten years ago when the first CPUs coped with less than a million calculations a second.

Chaos the cat, one of Microsoft Bob's personal guides, helps the user start a program. Other "personal guides" include Lexi; Jarva; Digger, Hank and many more.

Gates now sees his next market oppportunity in the two thirds of homes that are still too scared to use PCs. Microsoft also hopes to save on the $200 million a year it now spends on Help Lines.

The next wave of computing, says Gates, will ride on "social interface" software. And Microsoft is offering Utopia, now called Bob.

Bob will cost $99 (from March) and uses a series of colourful animated cartoon characters (some of which are shown on these pages) to guide a PC user through pictorial rooms which contain letter-writing, address book and diary programs. Different members of the family adopt overpoweringly cute characters, like a coffee-swigging dragon.

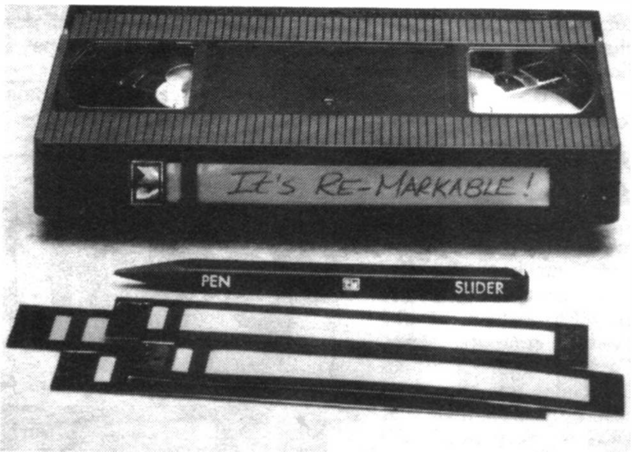
These characters keep mouthing whacky phrases like "Ooo la la" or "whaddy ya know camper", so many people will quickly yearn to turn them off.

Bob sits on top of Windows and DOS relying on the speed of modern CPUs to generate pictures and sound effects in real time. Bob also needs a lot of space, 30 Megabytes on the hard disk and a basic requirement of 8 Meg of RAM. So family PCs that were bought a a year or so ago and stuck in a drawer are unlikely to cope.

Also, although Bill Gates and his team of demonstrators repeatedly assured that Bob was designed to work on computers with 486 chips, I discovered (only by asking and making myself unpopular) that there was actually not a single 486 in use at the demonstrations, or on Microsoft's stand at the show. All were Pentiums.

After more pushing Microsoft let me play with Bob on a 486 portable in a private hotel room. It worked, noticeably more slowly. It also threw up some error messages, which may not have been the result of denying Bob its Pentium power.

3DO Interacting Multiplayer model FZ-10 from Panasonic.



Re-Markable video cassette "magic marker" spine labels from MTC Electronic Technologies of Canada.

It's Magic

I really liked a neat little gadget from Canadian company, MTC Electronic Technologies. It uses the old "Magic Slate" idea to put an end to messy labels on video cassettes.

"Re-Markable" is a strip label that sticks to the spine of a video cassette. The label is a sandwich of two thin plastic sheets which stick together when pressed with a plastic pointer pen. A visible dark line is left where the sheets stick. When you make a recording you write a note of its name on the plastic label. When you erase the tape, you can also erase the writing on the label by moving a slider along the strip. This separates the two plastic film sheets, leaving them ready to be written on all over again.

The system was designed in England and is sold by a Canadian company, the labels are assembled in China from plastic parts made in Israel. Price in the USA is around $1 per label. The UK price is likely to be one pound.

Service Call

One Call from Universal Electronics of Ohio is a remote control which is completely dumb when sold. It is activated when the owner makes a toll-free phone call to a service centre which sends electronic codes down the line.

Users call a toll-free number, and tell the operator what make and model TV set, VCR and satellite tuner they want to control. The operator keys these details into a database and then streams the control codes down the line like Email tones.

Coupling is electromagnetic, not acoustic. As audio signals run through the coils in the handset, they generate a field which leaks out. The remote control contains a coil which picks up and demodulates this field. Transfer works over a range of around 10cm. The demodulated code is stored in the remote's memory. The loading process takes only around ten seconds for each code.

The makers pledge to keep updating their database with the codes needed for new equipment. So anyone who replaces an old VCR with a new one need only make one phone call to update the remote.

One Call should be available later this year at around $25 or £25 each.

Convenient Entertainment

Korean electronics company Daewoo was supposed to be showing the first working prototype of a system called EMC (Entertainment Made Convenient), proposed by American entrepreneur William Graven.

The idea is to convert video into a compressed digital code, transmit it by cable or satellite at high speed, record the high speed stream in the home and play it back at a reduced rate to deliver normal speed pictures.

EMC promises to deliver a 100 minute movie in five minutes. The Daewoo prototype runs at half that speed, taking ten minutes. The demonstration system relied on a computer server but this had been dropped on the flight from Korea, and the hard disc was damaged. So we did not get a chance to see picture quality.

The system works by converting the movie into MPEG digital code, as used for a Video CD, but at 1MBit/second instead of the Video CD rate of 1·5 Mbit/second. This is a large percentage difference, which must compromise picture quality.

This code is then transmitted at 20 times normal speed (i.e. 20 Mbit/s) or ten times (10Mbit/s) to time-compress the movie.

The VCR records digital code, rather than analogue video, at normal VHS recording speed. On playback the VCR runs slowly, in jerks, and feeds the code into a buffer. From there it clocks out at normal speed into an MPEG decoder.

The satellite transmission channel is 30Mbit/s wide, with 20Mbit/s used for raw data and 10Mbit/s for redundancy. At Las Vegas EMC's representative was promising "real product" in September 1995, at a cost of around $400 for the modifed VCR, and $3 per movie viewed.

I will believe that when I see it.

Hard Rock

Nevertheless, first prize for oddest gadget at the show must go to Panasonic's RQ-197 portable cassette player. This can be switched to a mode in which the headphones physically vibrate to distort the music. Why should anyone want to do this?

The demonstrators thought it might be useful to simulate the effect of standing too close to the speaker banks at a rock concert.

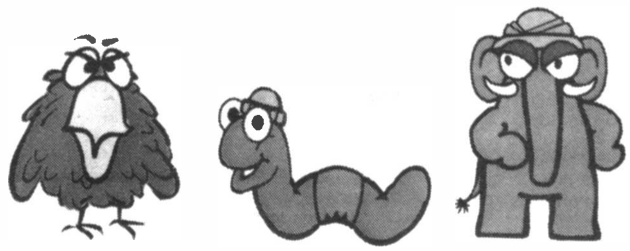
Panasonic's RQ-197 portable cassette player features an "active motion system" which physically vibrates the headphones to distort the sound.

Foot-Note:

It is every bit as easy to find your way around the *Winter Consumer Electronics Show* in Las Vegas, as it is to navigate the Barbican Centre and its approach roads in London. Even on what is supposedly the main exhibition site, the *WCES* straggles between a gaggle of North, East, South, West and Pavilion halls. The catalogues and signs give no clues on which stands are in which halls and how to get from one to the other. I missed one meeting because even the Visitor Information kiosk did not know where it was.

All it needs, I suggested to the organisers on the last day, is a colour coding system. Red, Green, Blue, Yellow, White and Black zones, with coloured arrows round the show.

The very way the organisers said they would think about it made it all too clear they are unlikely to. So next year visitors will still be looking for lost exhibits.



Cartoon characters © Microsoft.

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Volume and Balance controls are provided and as befits any unit with serious aspirations to quality these are the ultra high quality Alps "Blue Velvet" components.

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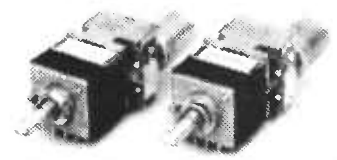

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Now you can throw out those noisy ill-matched carbon pots and replace with the real hi-fi components only used selectively in the very top flight of World class amplifiers. The improvement in track accuracy and matching really is incredible giving better tonal balance between channels and rock solid image stability.

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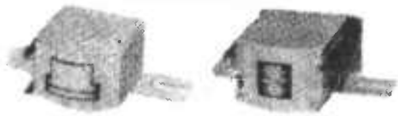

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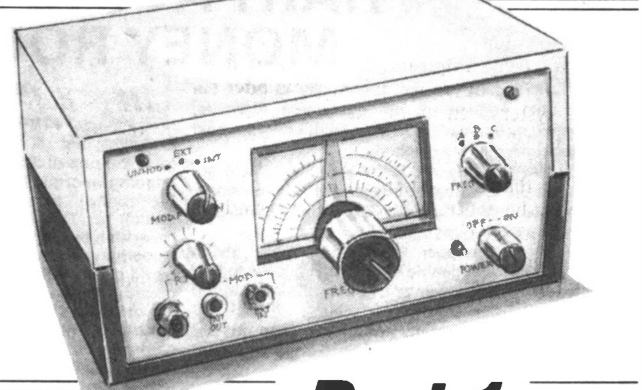


STEVE KNIGHT

Part 1

A high performance, relatively low cost design that covers the range 1·5MHz to 30MHz in three switched bands.

SIGNAL generators (or function generators as the types in question are more generally called) covering the frequency range from a few Hertz up to something of the order of 100kHz and sometimes as far as 2MHz, have turned up as electronic projects on a fairly regular basis. These generators usually have *sine*, *triangular* and *square* wave output signals and, in general, have been designed for the checking and testing of audio and other relatively low frequency amplifiers and similar equipment.

Signal generators covering radio frequencies (r.f.) from about 1·5MHz upwards to 30MHz, having some form of amplitude modulation and providing coverage of the 15 metre through to 80 metre amateur bands are not so common and are, in fact, distinguished by their continued absence from the scene of home constructed projects.

The reasons for this are not hard to discover. It is difficult to find ready made inductances on the market which can be used without modification to provide the frequency coverage required, so these have to be fabricated to a rather tight specification by the constructor.

Twin-ganged air-spaced tuning capacitors, really necessary for the best results, are a bit on the pricey side. Also, a Frequency Meter ranging up to at least 30MHz, together with an Oscilloscope (although this does not have to be a top class instrument) are strictly needed for a close tolerance calibration of the various frequency ranges if a tuning scale is decided on.

OPTIONS

This present design has one or two options which get around some of the above difficulties (apart from the price of one or two components) by methods which will be described as we go on, and a useful and attractive instrument can be made for as little as £60. For this price, of course, we don't finish up with a professional Signal Generator with standard facilities.

Many years ago, when employed by Marconi research and the thermionic valve reigned supreme, a small team of us designed such a sophisticated instrument with precise crystal harmonic markers, precisely controlled depths of modulation and a precise output attenuator system, with a frequency range up to 1500MHz. The work took two years to develop and must have cost a lot of "lolly".

Our present project, which happily hasn't taken so long to design and costs considerably less can, however, still be calibrated within two per cent with care, or much better if you use a frequency counter alternative for your readout. It has a fixed modulation factor of about 30 per cent at a frequency of 500Hz and a controllable output level from some 100mV down; comparable with commercially available general purpose R.F. Generators costing £150 or more.

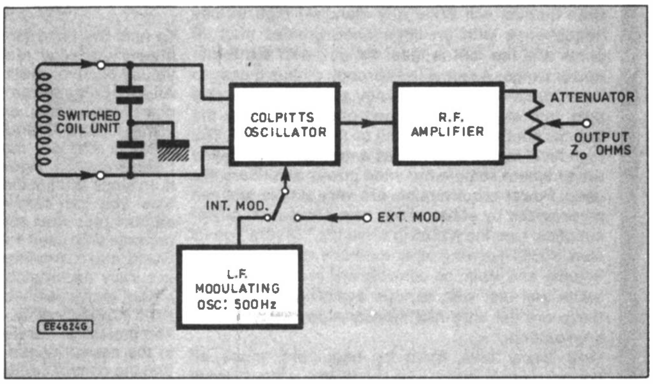


Fig. 2. Simplified system block diagram for the R.F. Signal Generator.

So basically this project can be looked on as something of a challenge, and for those whose inclinations lean that way, the construction and calibration should provide exactly that. It is *NOT* a project for *beginners* and the *inexperienced*, this must be said at the onset; at the same time, you don't have to be a time honoured engineer. So let us first take a brief look at the general design of Signal Generators and see how we can simplify things without affecting the overall performance or usefulness of the completed instrument.

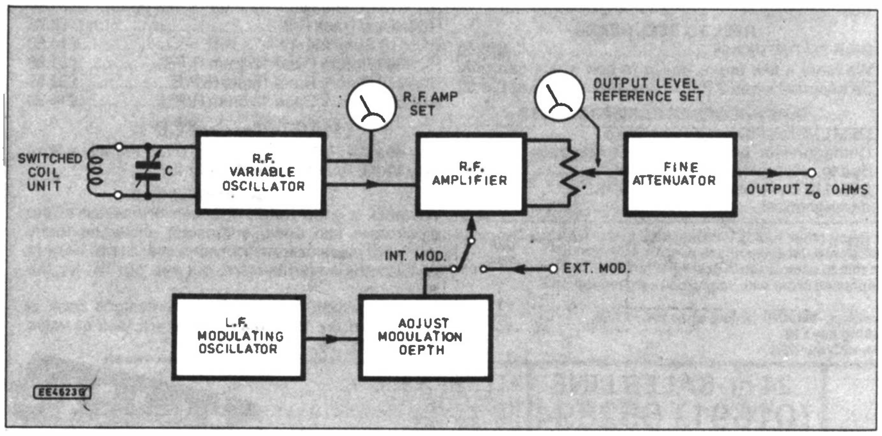


Fig. 1. Block diagram for a typical high quality standard Signal Generator.

DESIGN

The block diagram of a conventional (and expensive) R.F. Signal Generator is shown in Fig. 1. This may or may not be designed to the top high accuracy level of the so called standard signal generator which may well cost more than several thousand pounds, particularly if it covers the u.h.f. bands.

For models taking us up to the 100MHz point the fundamental radio frequency or carrier wave is generated by a stable variable-frequency oscillator using lumped tuning components and switched inductors. Beyond some 100MHz u.h.f. tuning techniques have to be employed.

It is usual to employ a Colpitts style oscillator for this part of the circuit as this is particularly suited to relatively high frequencies and can generate a stable output of sufficient amplitude to give enough in hand for the operation of the remainder of the system. In addition, this oscillator has very low harmonic distortion. The tuning capacitor is effectually centre tapped so that a twin-ganged type can be used with the rotor plates commoned and "earthed" as the Colpitts demands.

Means are provided for amplitude modulation of the generated carrier wave by imposing a low audio frequency signal either from an internal oscillator or an external source on to the r.f. signal. The modulated carrier is then amplified and matched to the requirements of the output attenuator where its level can be controlled and matched in turn to the impedance of the output cable.

Additionally, monitoring of the oscillator output (or the attenuator input), adjustment of the modulation factor and calibration of the attenuator, perhaps through the range 0dB to 100dB relative to, say, one microvolt, will be found on standard level equipment. In our present project, the block diagram is rather as shown in Fig. 2; here the points of simplification are obvious, but these do not detract from the basic usefulness of the instrument for general purpose work on the enthusiastist's or the amateur's benchtop.

CIRCUIT DESCRIPTION

The complete circuit diagram for the R.F. Signal Generator is given in Fig. 3. It is assembled on three small printed circuit boards (p.c.b.s): the main r.f. oscillator and amplifier, audio oscillator and modulator board; the coil assembly board, and the power supply board.

One or two other small components are associated with the front panel switching. The board interconnections between themselves and the panel mounted components are indicated with appropriate lettering.

Transistor TR1, a 2N5486 high-frequency field-effect component is connected into a Colpitts oscillator configuration. The coils L1, L2 and L3 covering the range 1·5MHz to 30MHz, can be switched into circuit as required by the Frequency Range switch S1 and together with the twin-ganged tuning capacitor, VC1/VC2, form the three tuning ranges.

The coils are centre tapped to allow modulation to be introduced; end feeding the drain of the f.e.t., with the modulation as in the conventional Colpitts, needed additional components and was not considered worth while in this application. The exact tapping point is not critical.

At the coil tap, the voltage supply to the f.e.t. drain (d) from the 15V supply is varied by the action of the modulator transistor TR3 and hence the amplitude of the generated carrier is also varied at the relatively low modulation frequency of 500Hz.

Diode D2 helps to maintain a constant output amplitude over each of the three bands by stabilizing the gate (g) bias and the oscillation is maintained by feedback from the drain electrode to the gate of the f.e.t. by way of the tuned circuit and capacitor C11.

R.F. AMPLIFIER

The oscillator output, which is about 4V peak-to-peak at this point, is then taken from the gate end of the tuning coil and fed to the r.f. amplifier TR2 by way of attenuator network made up of resistors R14, R15 and capacitor C13.

This amplfier, a 2N2222A high frequency transistor, is wired as an emitter follower. The stage is sufficiently wideband to cover all the generated frequencies and provides a low impedance output at the emitter (e).

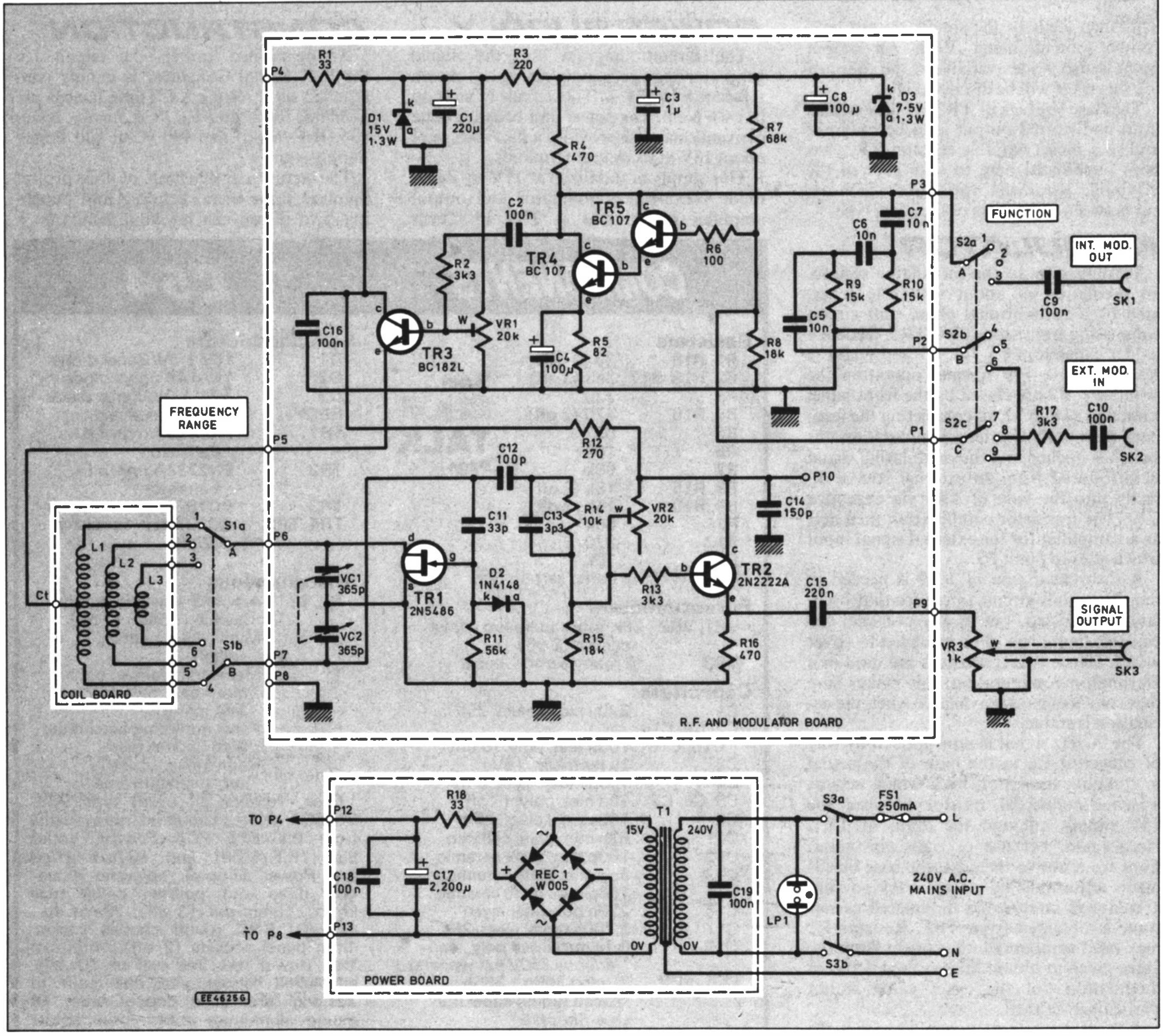
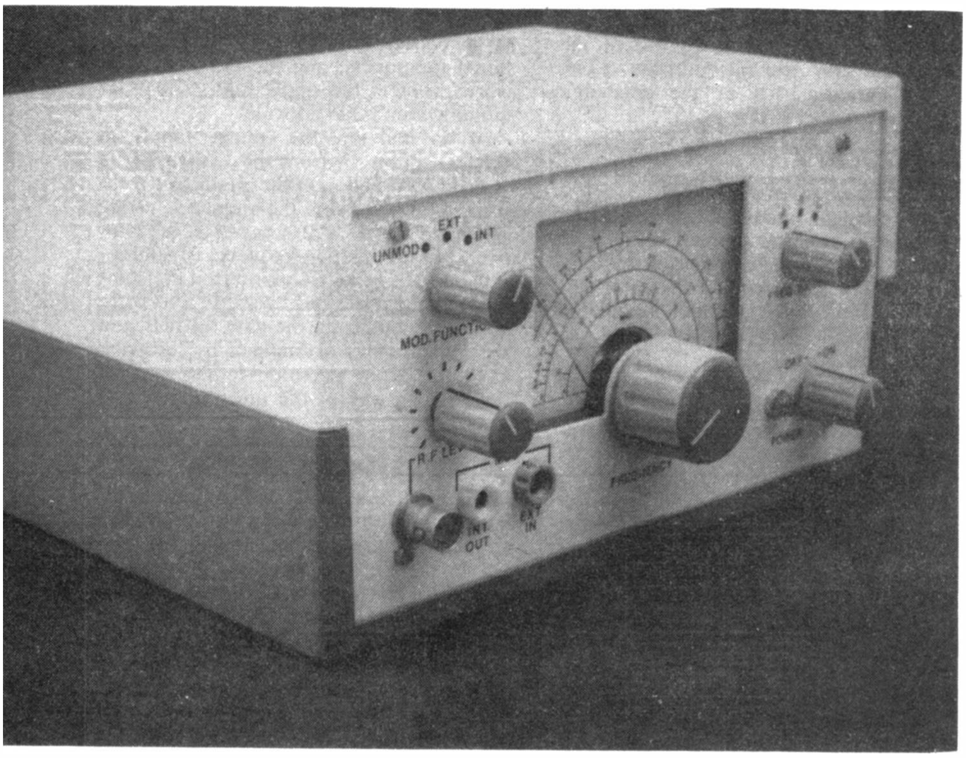


Fig. 3. Full circuit diagram for the R.F. Signal Generator. The inter-board connections are given by the "P" points and switch connections by the pole and contact tag numbering. Note: transformer T1 has 15V at 0·1A split secondary widings wired in parallel to provide approx. 15V at 0·2A output.



This then feeds to the simple output level control potentiometer VR3. An output point is also made available at the collector (c), this stage will be discussed later.

The base (b) bias of TR2 is fairly critical if an undistorted output is to be obtained and so a preset variable resistor, VR2, has been introduced here to take care of the inevitable parameter variations which occur between transistors of the same type.

MODULATOR

Turning now to the modulator section, an oscillation of about 500Hz is generated by a conventional phase-shift circuit comprising transistors TR4, TR5, feedback ladder capacitors C5, C6, C7 and resistors R8, R9, R10. For normal operation the points *P1, P2* are closed by the front panel Function switch S2, so completing the feedback path, but for external modulation this switch is opened and the modulating signal is introduced from an external source directly into the base of TR5 via capacitor C10. The transistor combination then acts as an amplifier for the external signal input which goes to point *P1*.

A theoretical gain of −29 is needed in the phase-shift circuit to ensure that oscillation can occur, but in any practical circuit this figure has to be exceeded to cover losses. Hence two transistors are used in a Darlington configuration; this makes sure that sufficient gain is available when the oscillation is stable.

The 500Hz signal is now applied by way of capacitor C2 to the base of the actual modulating transistor TR3, which acts as a series connected resistor between the 15V supply rail and the drain of TR1. Here again, because of transistor variations from one to the next, the base bias is made adjustable by preset VR1 so that a balanced undistorted modulated carrier wave is obtained from TR1. Resistor R2 may need some small adjustment from the value given to obtain the required depth of modulation but the exact value is not particularly critical.

A third position of switch S2 makes the 500Hz signal available for audio testing purposes at a panel terminal.

POWER SUPPLY

The circuit diagram for the signal generator power supply stage is shown separately in Fig. 3. This circuit is built on its own p.c.b. The power unit board is quite conventional and provides a d.c. voltage of about 18V at its output terminals.

This supply is stabilized at 15V by Zener diode D1 for the modulator and output amplifier stages, and at 7·5V by Zener diode D3 for the phase-shift oscillator. Both of these Zeners are located on the main board.

A current of about 50mA is required from the supply so no high-power-rated components are called for and a small 3VA transformer is quite adequate.

FUNCTION SWITCHING

The function switching is self explanatory from a look at the circuit diagram, Fig. 3. A 3-pole 3-way switch S2 selects either (a) Internal Modulation Output (sometimes useful as an audio check signal for other purposes), (b) External Modulation Input (if you wish, perhaps, to modulate the carrier with a square or triangular waveform) – in this position also an unmodulated carrier is available at the signal output, and (c) normal working, that is, a modulated output signal.

For the coil range switching, a 2-pole 3-way switch is used; S1a and S1b. The centre tapping points of the coils are commoned and connect to the emitter of the modulator TR3.

Both of the above switches are of the 4-pole 3-way types, only some of the available poles being used.

CONSTRUCTION

As mentioned earlier, the circuit for the R.F. Signal Generator is mainly constructed on three p.c.b.s. These boards are available from the *EPE PCB Service*, codes 936 (R.F./Mod) and 937 (Coil and Power Supply – pair).

The actual construction of this project involves some metal bending and punching, and if you can lay your hands on a

COMPONENTS

Approx cost guidance only **£54** excluding case

Resistors

R1, R18	33 (2 off)
R2, R13, R17	3k3 (3 off)
R3	220
R4, R16	470 (2 off)
R5	82
R6	100
R7	68k
R8, R15	18k (2 off)
R9, R10	15k (2 off)
R11	56k
R12	270
R14	10k

All 0·25W 5% or better carbon film

See SHOP TALK Page

Potentiometers

VR1, VR2	20k ³/₈in. square top adjust cermet (2 off)
VR3	1k rotary carbon, linear

Capacitors

C1	220µ radial elect. 25V
C2, C9, C10, C16, C18	100n met. poly. (5 off)
C3	1µ tantalum, 16V
C4	100µ radial elect. 6·3V
C5, C6, C7	10n met. poly. (3 off)
C8	100µ axial elect. 25V
C11	33p min. plate ceramic
C12	100p min. plate ceramic
C13	3p3 min. plate ceramic
C14	150p min. plate ceramic
C15	220n polyester layer
C17	2,200µ radial elect. 25V
C19	0·1µ metallised poly., *continuous 250V a.c. working*
VC1, VC2	2-gang 365p + 365p air spaced tuning capacitor (see *Shoptalk*)

Voltages indicated are minimum "working" values

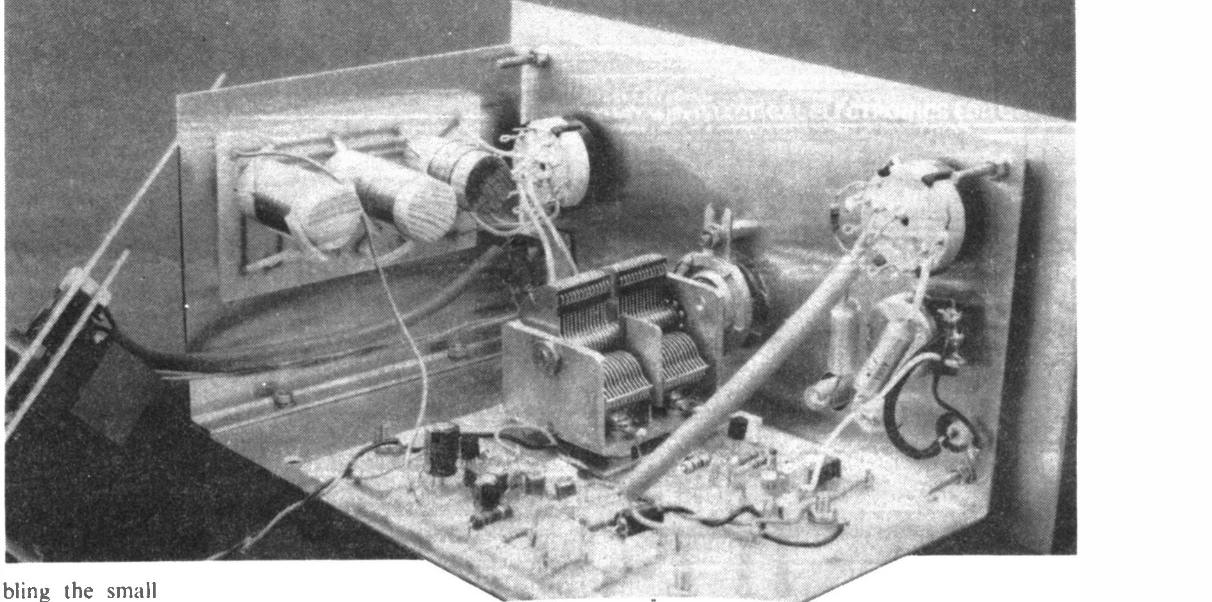
Semiconductors

D1	15V 1·3W Zener diode
D2	1N4148 signal diode
D3	7·5V 1·3W Zener diode
REC1	W005 bridge rectifier
TR1	2N5486 *n*-type f.e.t. transistor
TR2	2N2222A *npn* h.f. transistor
TR3	BC182L *npn* transistor
TR4, TR5	BC107 *npn* transistor (2 off)

Miscellaneous

S1, S2	4-pole 3-way min. rotary switch (Lorlin) (2 off)
S3	Mains d.p.d.t. rotary switch
T1	Mains transformer, p.c.b. mounting, twin 15V secs, 3VA rating
FS1	Panel mounting fuseholder with 250mA fuse
LP1	Neon indicator, 240V sub-miniature type

Case, Verobox (if used) type 202-21036G; printed circuit boards available from the *EPE PCB Service*, codes 936 (R.F./Mod) and 937a/b (Coil and Power Supply); epicyclic reduction drive and pointer; collet type knobs, 16mm dia. (3 off), 28mm dia. (1 off); BNC round chassis socket; 4mm panel sockets (2 off); length of ⁵/₈in. dowel rod; 2oz reel of 30s.w.g. enamelled copper wire; one metre of 22s.w.g. enamelled copper wire; 18 gauge aluminium sheet; 1mm solder pins; 6BA, 4BA nuts and screws, washers; connecting wire, solder, etc.



The completed main p.c.b. bolted to the base of the mounting chassis.

simple bender and a selection of hole punches (particularly a one-inch), there should be no great problem over the metal work. A good bench vice with jaw extensions up to 114mm (4½") will serve as a bender.

However, starting with the assembly of the main printed board, the full size copper track side and the component mounting side are shown in Fig. 4. There should be no problem in assembling the small components, the usual precautions being taken with the soldering and orientation of the diodes, transistors and electrolytic capacitors.

Before actually doing this, however, it is best to mount the tuning capacitor VC1/VC2 on to the board. If you use the twin-ganged tuning capacitor specified, the hole positions on the board will be correct; any alternative tuning capacitor will necessitate a re-drilling of the p.c.b. to accommodate it.

TUNING CAPACITOR

The tuning capacitor is a somewhat pricey component and should be handled with care. Keep the moving plates fully enmeshed all the time when working on the board. There are two fixing holes provided in the base plate of VC1/VC2 tuning capacitor and these coincide with the p.c.b. holes marked X-X.

Do not mount VC1/VC2 directly on the board, however, or the board will distort when the fixing screws are tightened. Get a piece of 18 gauge aluminium measuring about 38mm square, drilling out two fixing holes and the third central hole to match the board positions, and clamp this between the base of the capacitor and the board; this will prevent any board distortion.

The body and the rotor of the tuning capacitor will be automatically "earthed" to the board foil when screwed down but if you wish you will find a central earth tag on the base between the fixing holes that can be used to make a soldered connection. Solder a short length of thin wire to this tag before mounting the capacitor and this can then in turn be soldered to the projecting foil piece on the underside of the board.

One very important point here; the two fixing screws (4BA) *must not* be more than 9mm (⅜") long or they will be forced into the vanes from below and short-circuit the capacitors (VC1/VC2), quite apart from damaging them. Check very carefully on this point and *do not* overtighten these screws in any event. Round heads are probably best used.

The stator tags on the capacitor should be soldered with short, but not overtight, bare wires to the board pads on both sides of the gang as the component layout shows.

Just one other point: the preset trimming resistors (potentiometers), VR1 and VR2 are top adjust ⅜-inches square enclosed cermet types. Alternatives may not fit to the board grid and lead to mounting difficulties and component cramping.

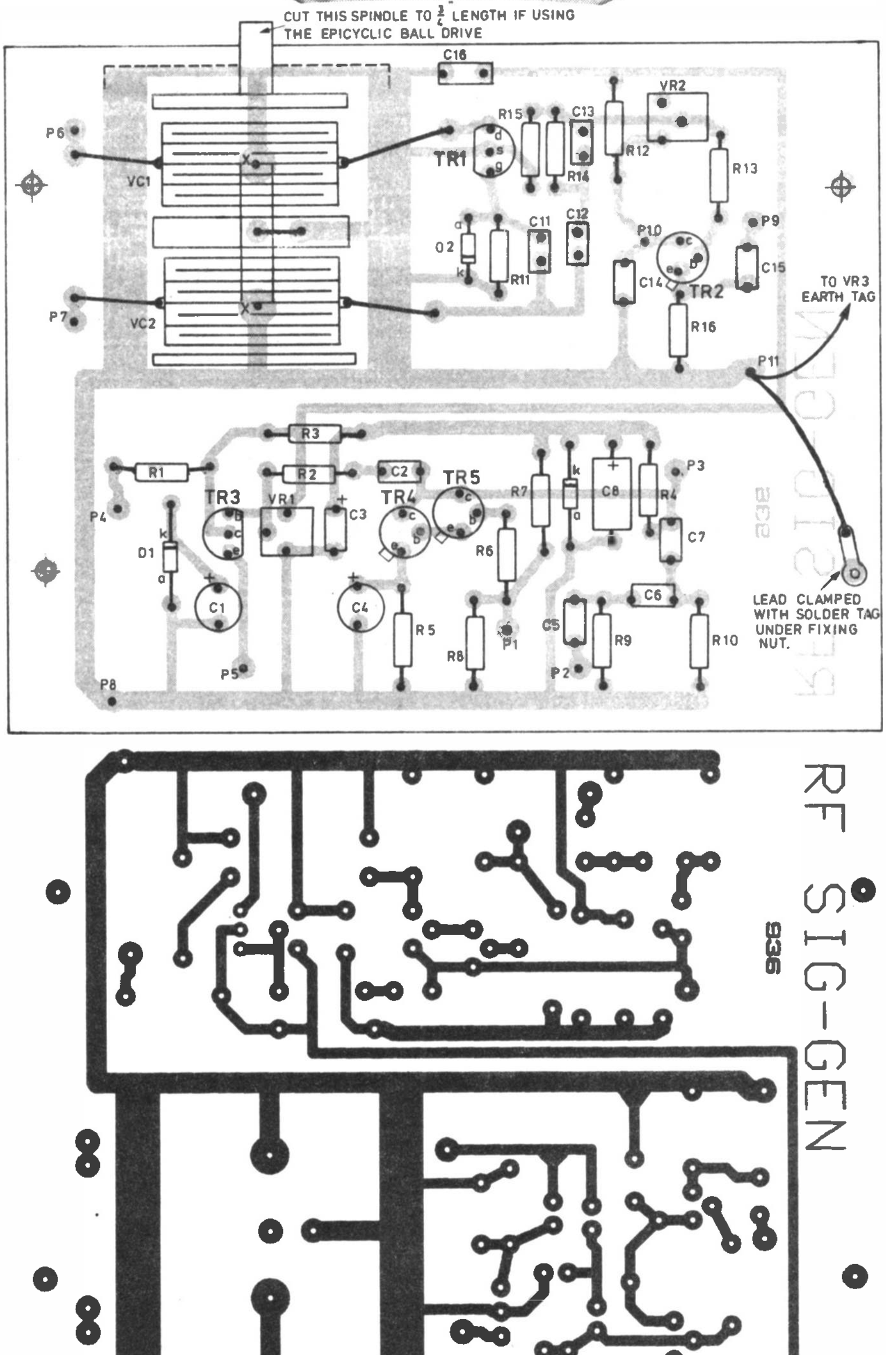


Fig. 4. Main p.c.b. component layout and full size copper foil master. The tuning capacitor fixing holes are marked X-X and the aluminium underplate is indicated by the broken lines. Mount the tuning capacitor first.

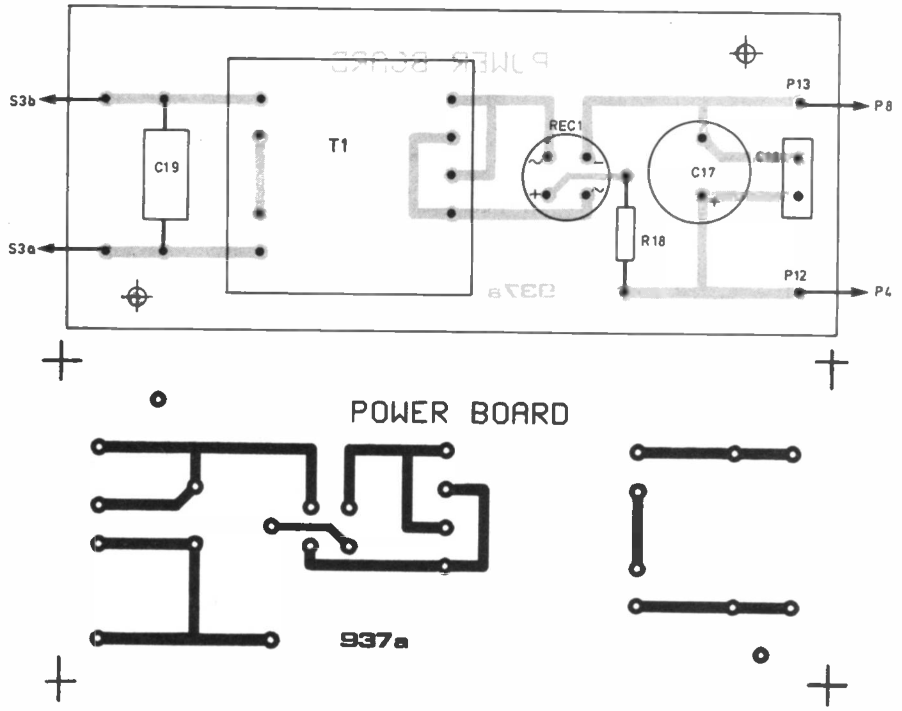
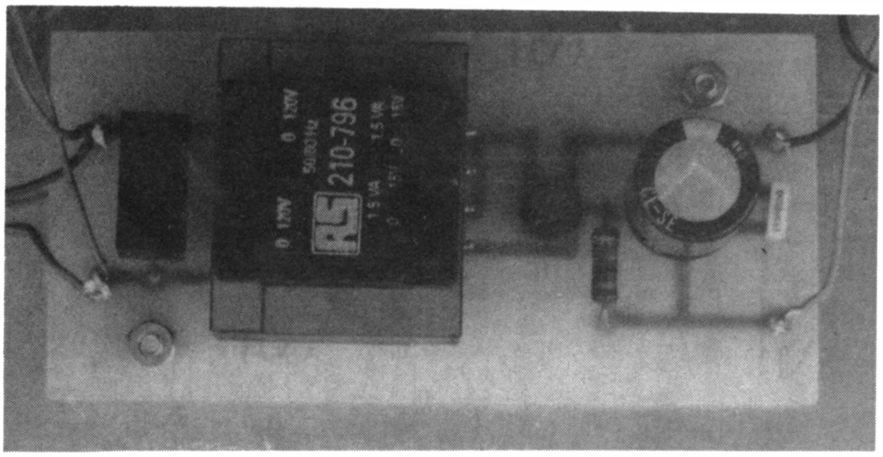


Fig. 5. Power supply p.c.b. component layout, full size copper foil master pattern and completed board (below).



POWER BOARD

The full size copper track and component layout for the Power Supply board are shown in Fig. 5. There is little to comment on in this assembly; the transformer used is a p.c.b. mounting type, rated at 3VA, with a split secondary output of 15V at 0·1A. These two secondaries are paralleled to provide 15V at 0·2A.

If you make your own p.c.b. there is no objection to your using a clamp type, above-board mounting transformer, adjusting the copper track on that part of the board to suit the alternative. Capacitor C19 *MUST* be rated at least for 250V *a.c. continuous* working. A 250V *d.c.* component is *not* suitable.

COIL WINDING

We will leave the coil mounting p.c.b. fabrication until later, concentrating now on the winding of the three coils L1, L2 and L3. The winding of coils for projects such as this where the frequency bands have to be covered fairly precisely, is always a bit of a problem since they need to be reproducible within close limits.

For the highest frequency band a few turns of heavy gauge wire does simplify things, but for frequencies below about 5MHz, a large number of turns are necessary and the disposition of the winding, if the inductance value is to be reproducible, is important. Commercially produced windings, "wave-wound" accurately by machine, of course, answer the problem, (as does the ownership of a good inductance bridge!), but a home constructed "piled" winding does give a wide variation from coil to coil and is not a practicable method.

Because of this, the coils used in this project have all been made "single-layer" types, using specific wire gauges and easily obtainable coil formers; a few test pieces have then demonstrated that the inductance values do not vary by more than one per cent from one specimen to another.

The choice of coil former may seem a bit primitive and way out; but, after hunting around unsuccessfully for Bakelite formers and considering the use of a plastic overflow pipe from the local DIY, it was finally decided to use 16mm (5/8") dowel rod from the local timber yard. This provides a good solid former for the coils and helps with the start and finishing points.

However, the wood must be thoroughly dry, and should be kept indoors in a warm environment for a week or so before use to ensure that this is so. After winding, a couple of sprays of lacquer (the printed board type is suitable) fix the windings firmly and prevent the wood from absorbing atmospheric moisture. A number of tests were carried out, leaving the coils exposed in a cold garage environment, but no detectable changes in either the measured inductance of the coils or their Q factors could be found even after a damp spell in the weather.

Using dowel rod enables the coil endings and tapping points to be easily secured by the use of holes of roughly the wire diameter drilled diametrically through the dowel as Fig. 6 illustrates. It is important, or course, that when you reach the tapping point of each coil and carry on with the remainder of the winding that the same direction is maintained, otherwise you will finish up with no inductance at all!

The winding dispositions and specifications for the three coils are given in Fig. 7.

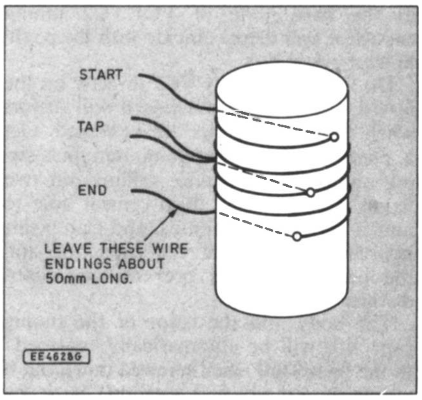
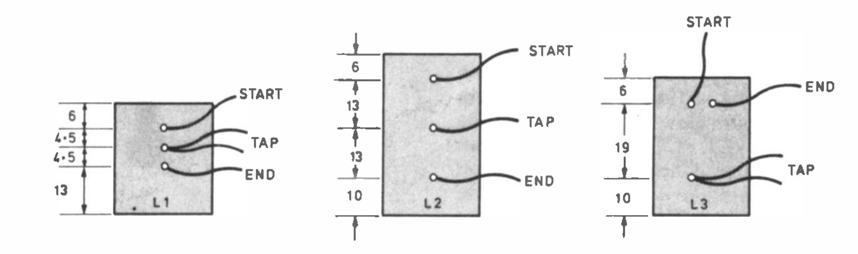


Fig. 6. General method of winding the coils and of fixing the terminations by way of diametrically drilled holes.



L1	L2	L3
Holes 1·5mm dia.	Holes 1mm dia.	Holes 1mm dia.
wound 5 + 5 turns	wound 27 + 27 turns	wound 40 + 40 turns
22 s.w.g.	30 s.w.g.	30 s.w.g. in two layers
Total former length	Total former length	Total former length
28mm (1 1/8")	42mm (1 5/8")	35mm (1 3/8")

Fig. 7. Disposition of coil windings. All windings close wound enamelled copper wire.

When the dowel lengths and hole drillings are as shown, the windings (all close wound) should fit comfortably into the spaces provided.

The lowest range coil L3 does not have a central hole for the tapping point as it is wound in two overlapping layers: the coil ends both come out at the top of the winding and the centre tap at the bottom. After winding the first layer of this coil, cover it with a single turn of 19mm (¾") wide draughting tape: this makes the second layer much easier to wind and count.

It is wise to give yourself at least 76mm (3") of dowel to begin with for each coil to have something to hold on to as you wind: the excess can then be carefully removed when the winding is completed. Give each coil at least two coats of clear lacquer: as mentioned earlier, the aerosol type made for p.c.b. protection is suitable.

COIL BOARD

The coils are mounted on a simple p.c.b. which is designed to accommodate the wire terminations and provide lead output points to the Frequency range switch S1 and the modulator input (*P5*). The full size copper foil track side and the component overlay for this board are shown in Fig. 8.

The coils are screwed to the board by 6mm (¼") No. 4 brass screws (or thinner), screwed centrally into the base of each coil, positioning the coils on the three holes marked L1, L2 and L3. The taps are then commoned to the upper foil strip, while the start and finish points connect to the lower pads provided: which way round at these pads is unimportant.

Make sure that the enamel covering the wire is properly scraped off from the coil terminations and that the soldered connections are good. Do *not* pull the wires taut down to the boards pads.

Two fixing holes are marked X-X: drill these out 6BA (or 2·5mm) clearance for board mounting purposes later on.

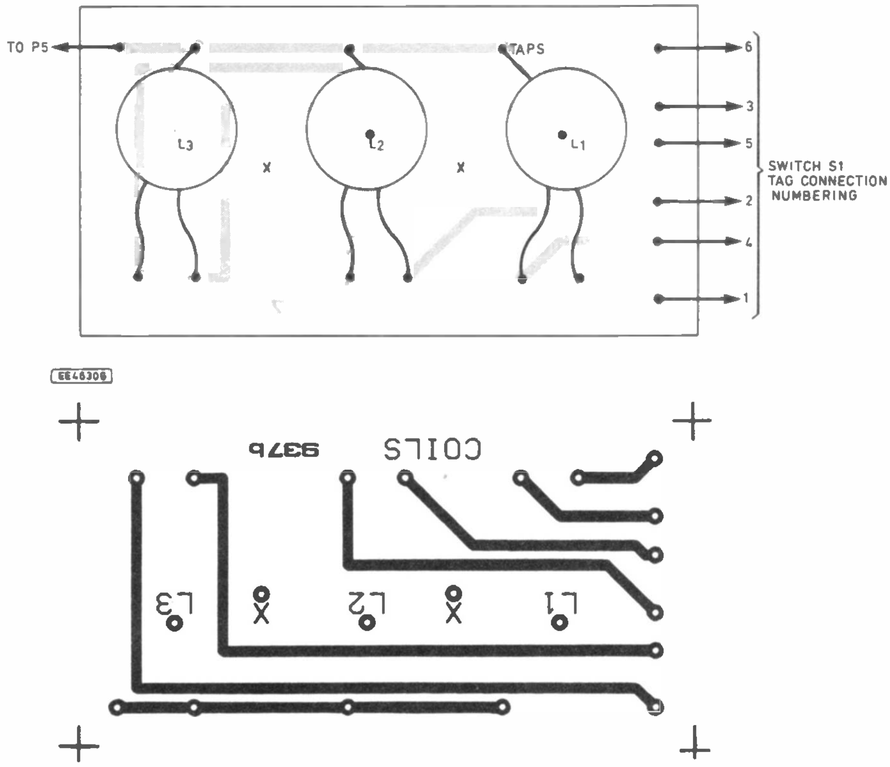


Fig. 8. Coils mounted on the board and full size underside copper foil master pattern.

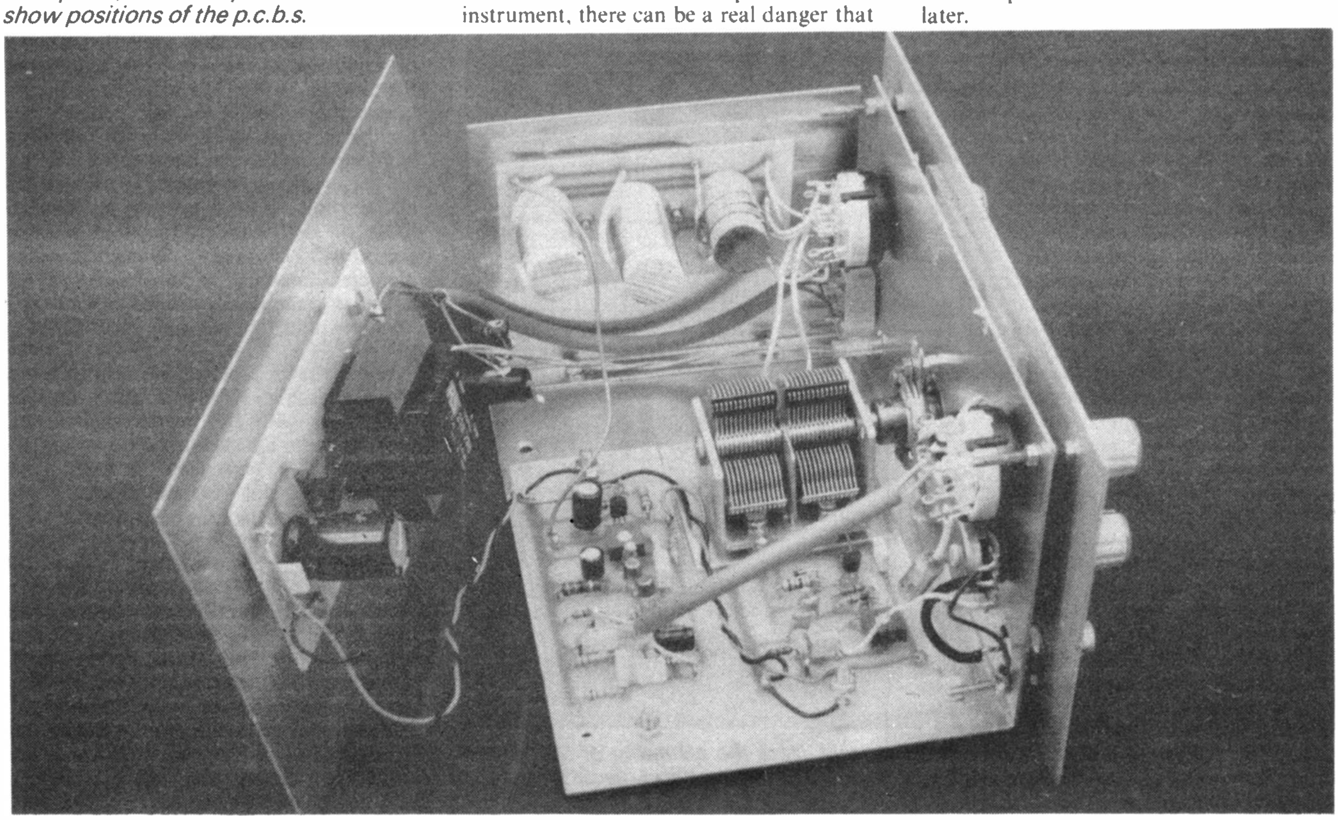
BRINGING THINGS TOGETHER

We have now completed the three p.c.b.s and the time has arrived to assemble these on to a suitable chassis and think about what sort of box we are going to use. Strictly speaking, an *all-metal* box should be used with any oscillating system to prevent undue external radiation. This in no way means that this signal generator is going to blot out the neighbour's radio or cause turmoil throughout the area, but in laboratory style situations where the engineer may be working with a few microvolts of wanted output from his instrument, there can be a real danger that unwanted leakage will exceed the level he actually wants.

Since we are unlikely to find ourselves in this situation, the material of the box is not critical, and the one eventually used was a Verobox. This can be readily obtained but, like the tuning capacitor, is a trifle expensive. Therefore, if you happen to have a box on the shelf already with a free front panel measuring not less than 203mm (8") by 102mm (4"), there is no reason why (with a bit of additional thought) you shouldn't use it.

So the following description will concern the specified box mounting, but one or two cheaper alternatives will be mentioned later.

The mounting chassis, together with front panel, and back panel removed to show positions of the p.c.b.s.



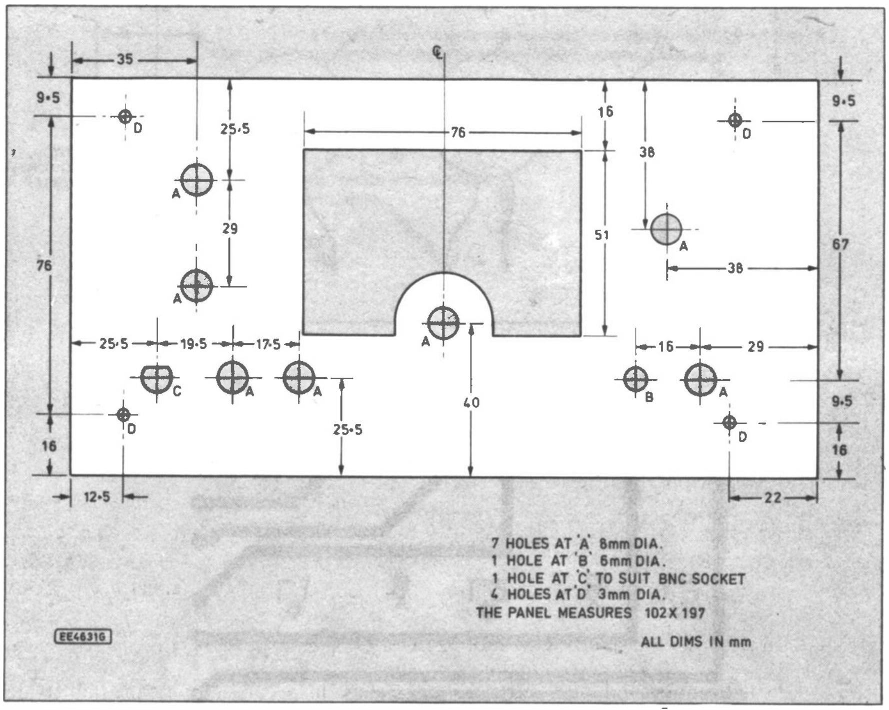


Fig. 9. Front panel drilling details and tuning scale cutout.

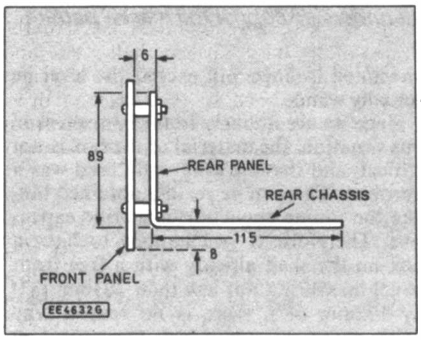


Fig. 10. (above) Side view and measurements of the "front" mounting panel and rear chassis assembly.

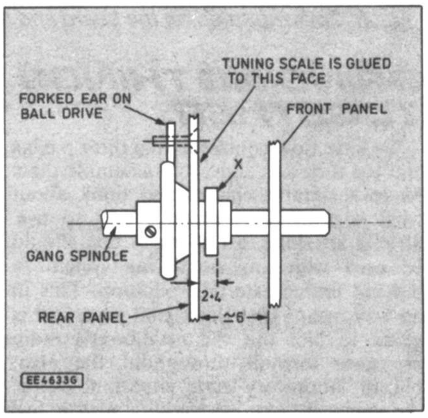
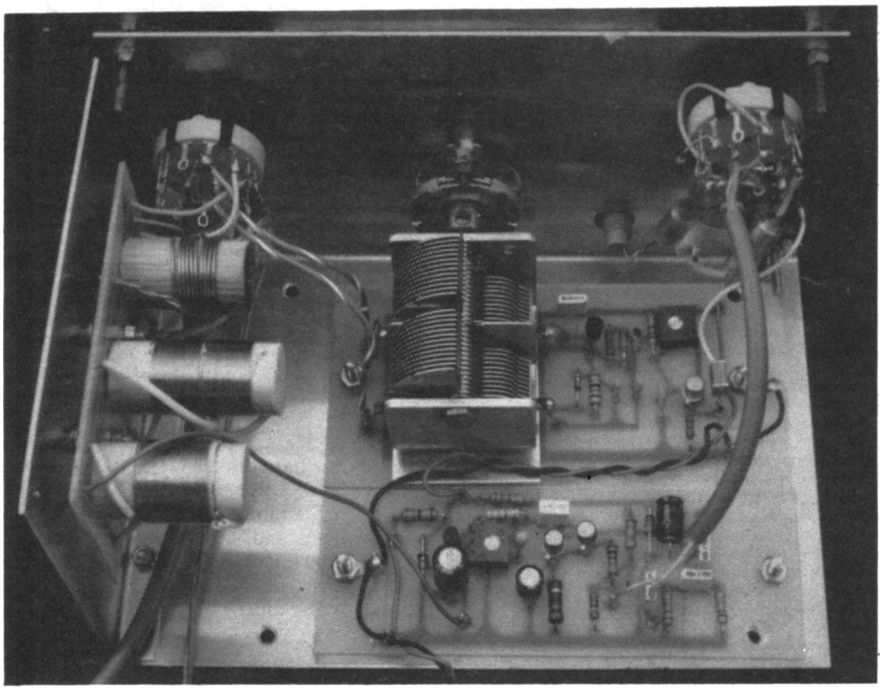


Fig. 11. (right) Ball drive fitting details. The flange face marked X holds the scale pointer and must be accurately positioned relative to the rear panel.



Layout of components on the mounting chassis. Note the clamping of the tuning drive "forked ear." The prototype main p.c.b. is shown here as two pieces but in the final version is one single board.

CASE DETAILS

The form that the construction takes is a simple aluminium L-shaped chassis carrying the boards and most of the control components fitted behind the front panel proper. The drilling of the front panel is given in Fig. 9. Mark out all the hole positions carefully and drill their centres with a small guide drill, say 2mm (1/16"). Do *not* drill out full size at this stage as the panel will be used as a template for the rear L-shaped mounting chassis.

The scale cut-out can be managed with an ordinary fretsaw, using a drop of paraffin or turpentine as a lubricant. Drill the four corners of the cut-out with a 3mm (1/8") drill and work around from these; if you have a one-inch square hole punch, of course, use it and finish off with the saw.

The panel supplied with the case is of hard aluminium; if you replace it with a soft aluminium piece of the same size and gauge, the cutting of the scale hole is easier. That choice is up to you. As we will see later, if you are going to use a Frequency Meter as your "scale", this cut-out is not required. Tidy up the hole with a fine file and some fine emery paper and/or wire wool.

REAR CHASSIS

The rear mounting chassis now needs to be fabricated. This is made up from a sheet of 18s.w.g. aluminium measuring 203mm (8") by 168mm (6⅝") which is bent through a right angle to the form shown in side view in Fig. 10. This figure also illustrates how the rear component mounting chassis is later attached to the main front panel with 6BA screws and spacing pieces through the four "D" holes.

Now using the front panel as a template, clamp the rear chassis to it directly so that the base part of the rear chassis is raised 8mm (5/16") above the lower edge of the main panel; see Fig. 10 again.

Draughting tape around the three edges of the rear panel provides enough effective clamping for the next stage; mark through all the main front panel guide holes onto the rear chassis (including the four fixing holes), making sure that the position of the rear panel does not shift while this is being done. The parts can now be separated and the holes in both of them drilled to the required shapes and sizes. Fig. 9 shows this for the front panel but note the following with regard to the rear panel very carefully.

There is no scale cut-out in this panel, also the holes in the equivalent positions to those of Fig. 9 are changed as follows: the central "A" hole is punched one-inch diameter, the other "A" holes plus the "C" hole are punched or drilled 10mm (3/8") diameter, and the "C" hole has no flat in this case.

When the two pieces are now screwed together as Fig. 10 shows, using the four "D" holes with the proper spacing, all holes between the panels should accurately coincide. Also, now slide the front panel into the box guide slots and check that the assembly clears the four corner fixing posts of the box and rests just clear of the bottom stand-off pillars. These pillars are not used in any way for fixing purposes.

The above instructions may have seemed unnecessarily detailed and long winded, but it is absolutely essential that the panels are aligned and "check-fitted" in the manner described before going any further with this project. Apart now from a simple side panel which will carry the coils and a few small fixing holes, the metal "bashing" is now over. Go off and have a cup of tea!

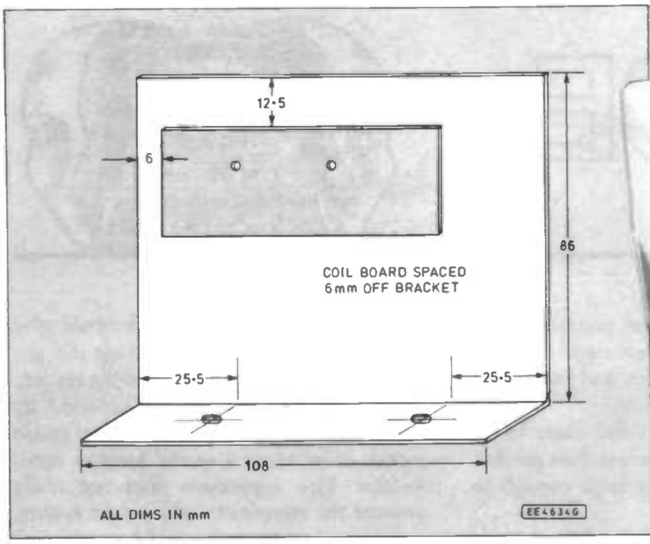
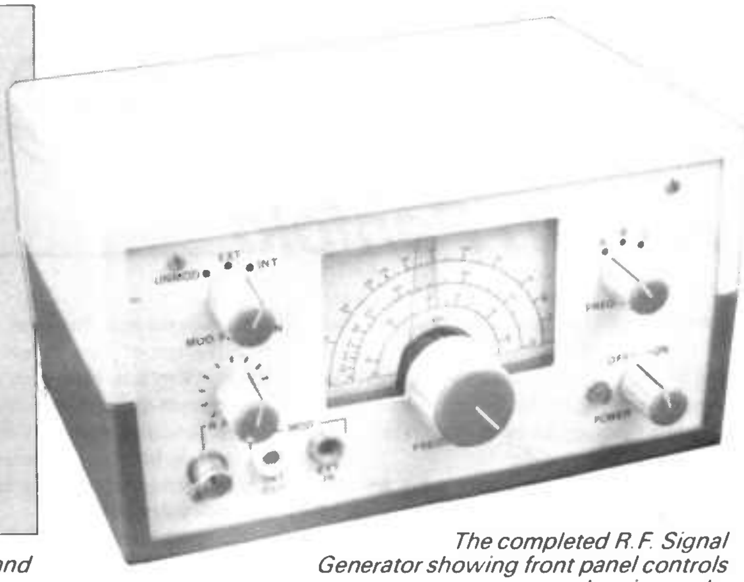


Fig. 12. Details of the coil board aluminium bracket and position of the coil board.



The completed R.F. Signal Generator showing front panel controls and tuning scale.

ASSEMBLY

The metal work for the front panel and the rear mounting chassis, behind the front panel, having been completed, the next step is to position the main r.f. and modulator board on to the rear chassis. A certain amount of care and accuracy is called for here, as it is not just a matter of bolting the board down anywhere on the aluminium base. This board has to be aligned with the front panel so that the tuning capacitor spindle, with the epicylcic ball drive reduction fitted, matches to the large centre cut-out in the rear panel and the central hole in the main front panel – see photographs.

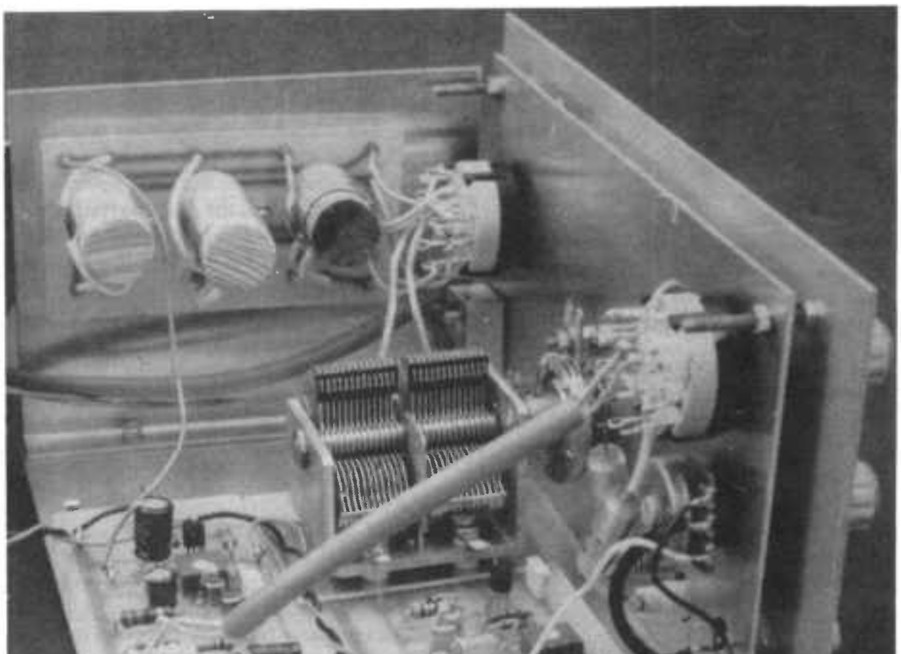
First of all, shorten the spindle length of the tuning capacitor to 10mm (3/8") making sure when you do this metal dust does not get into the capacitor vanes. Now fit the ball drive and temporarily tighten one of the two grubscrews to secure it on to the spindle.

Place the main p.c.b. on to the base of the rear chassis and manoeuvre the whole board so that the drive spindle passes through the central hole "A" and on to the central hole in the front panel. Fig. 11 (not to scale) shows how the ball drive has to be positioned with respect to the front and rear panels when the board height above the floor of the rear chassis has been adjusted.

When this has been done, the four fixing holes can be marked through (using the board as a template) and finally screwed down with four screws. The board will actually be a bare 6mm (1/4") above the aluminium base; using half-nuts and washers as appropriate, the exact height can be established so that the ball drive spindle passes accurately through the front panel hole and is positioned fore and aft as Fig. 11 shows.

To allow the ball drive to work properly, the body has to be prevented from rotating. This is done by drilling a 6BA clear hole about 10mm (3/8") above the top of the one-inch cut-out on the rear panel and putting a screw (with nuts as appropriate) through the forked ear on the drive.

The orientation here is not important and Fig. 11 also illustrates this. The screw should be *countersunk* as the scale will be later glued to the face of the rear panel.



The completed coil board is mounted on an aluminium bracket which is bolted to one edge of the mounting chassis. The tuning capacitor has a small aluminium plate between it and the main p.c.b. to prevent distortion of the board (see text).

COIL ASSEMBLY

The three coils L1, L2 and L3 should be ready on their p.c.b. at this stage; it now requires a simple, L-shaped metal bracket so that the board can be attached to the existing chassis. This bracket is shown in Fig. 12 and after the metal work we have already been through, is seen to be nothing more intimidating than a piece of aluminium measuring 108mm (4¼") 92mm (3⅝") overall with a simple 90 degree bend for fixing purposes.

When prepared, the bracket is screwed to the left-hand side of the rear chassis base, the face being flush with the edges of the chassis as the photographs show. The coil board position on this bracket is not critical but should not vary significantly from those dimensions indicated.

The two fixing holes marked X-X in the earlier Fig. 8 are easily marked through onto the aluminium so that the board can be attached and spaced about 6mm (1/4") off the bracket. Before actually mounting the board, solder 50mm (2") lengths of preferably coloured wire to the pads numbered 1 to 6 and a 102mm (4") length to the taps pad; these are for later connection to the "Frequency" switch S1 and the main board respectively.

Next Month: Final wiring, assembly and setting-up details.

INTERFACE

Robert Penfold

THE SUBJECT of biofeedback is one that tends to be rediscovered every now and then. With stress levels amongst the general population becoming ever higher, it seems destined to be rediscovered with increasing frequency!

For the benefit of those who are not familiar with the general principles of biofeedback, I should perhaps start by explaining a few basics. The purpose of biofeedback is to enable users to put themselves into a state of deep relaxation.

Strain Gauges

A number of changes occur in someone's body when they become stressed. These include changes in breathing patterns, increased heart rate, increased perspiration, and reduced temperature at the extremities such as the fingers and toes.

The basic idea behind biofeedback is to provide the user with a means of monitoring one or more of the tell-tale signs of stress, so that they can use information from the monitor as an aid to controlling stress. For example, suppose the user monitors his or her stress via a heart rate monitor.

The subject tries to relax, and the monitor enables them to check their success. If they do something that causes an increase in heart rate, they try to avoid repeating that action. Conversely, if something works and produces reduced heart rate, the user tries to do that some more so as to produce a deepened state of relaxation.

In effect, the user is part of a negative feedback network that is used to control stress. Biofeedback represents an attractive means of controlling stress, as it does not involve the use of drugs which could be addictive or have potentially harmful effects in the long-term.

The effectiveness of biofeedback is something that is open to debate, but many users apparently find it extremely effective. Virtually anyone can produce at least a modest amount of stress reduction using these methods.

Biofeedback monitors can be extremely simple, or highly complex devices based on computers with the imaginative use of graphics, or anywhere between these two extremes. It is not difficult to produce a biofeedback monitor using a PC, an analogue input port of the type described in last month's *Interface* article, and a simple add-on monitor circuit. The feedback to the user can make use of the computer's graphics and (or) sound generator, or can simply provide numeric information.

Thick Skinned

The biofeedback interface featured here monitors the user's skin resistance. Most skin is fairly thick and dry, giving quite a high resistance between practically any two patches of skin. Perspiration increases the skin's moisture content, and produces a reduction in its resistance.

The actual resistance is still likely to be quite high, but it is much less than normal. The difference is certainly large enough to be readily detectable.

No special sensors are needed in order to monitor skin resistance. It requires nothing more than two metal electrodes on the user's skin.

On the face of it, the interface could consist of nothing more than a potential divider connected across the supply lines, with its output fed to the input of the analogue port. This basic scheme of things is shown in Fig. 1. Increased perspiration gives reduced skin resistance and increased output voltage – reduced perspiration gives increased skin resistance and a lower output voltage.

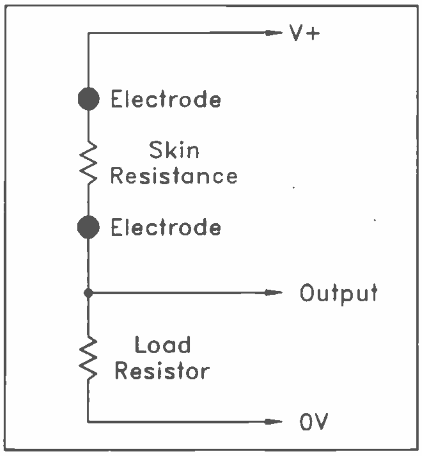


Fig. 1. The setup used to convert skin resistance to a proportionate voltage.

A set up of this type will actually work quite well, but is not acceptable as it would breach safety regulations. Unless the interface was used in conjunction with a battery powered portable PC, there would be a risk of a fault giving the user a severe electric shock. As the electrodes are normally taped in place, it would be difficult for the user to escape in the event of such a fault.

In Isolation

In order to keep within the safety regulations the equipment must include an isolation circuit between the user and the computer. The obvious choice for an application of this type is an opto-isolator. The problem with a simple opto-isolator is that it has an extremely non-linear transfer characteristic.

Obviously this application does not require a high degree of linearity, since it is *relative* rather than *absolute* skin resistance that is of interest. On the other hand, a large amount of amplitude distortion could give unusable results, with some voltage changes at the input having little effect at the output.

Improved linearity can be obtained by using either some form of pulse coded signal, or by using a special form of opto-isolator. This application does not really warrant the complexity of a pulsed system, such as a p.w.m. (pulse width modulated) type.

An opto-isolator such as the IL300 offers a much more simple alternative that gives an adequate degree of linearity for this application. Fig. 2 shows the circuit diagram for a Biofeedback Interface which uses the IL300.

Balancing Act

Operation of the IL300 was covered in the *Interface* article which appeared in the May 1994 issue of *EPE*. This circuit is based on the d.c. version of the opto-coupler that appeared in that article. Therefore, the way in which the IL300 functions will not be considered in detail again here.

The IL300 is basically just an ordinary opto-isolator having an l.e.d. driving a phototransistor. However, it actually has two *matched* phototransistors.

One transistor is used to provide negative feedback over IC1, and the other provides the signal coupling. Although the negative feedback to pin 2 of IC1 is provided via one section of IC2, the feedback action still operates in much the same way as normal.

The voltage at the inverting input of IC1 (pin 2) is maintained at the same potential as the input voltage to the non-inverting input (pin 3). This gives an output voltage from the other section of IC2 that is also equal to the input voltage.

In effect, the non-linear feedback is used to distort the output signal from IC1 in such a fashion that it balances the distortion through the other section of the opto-isolator. In practice the anti-distortion will not precisely cancel the distortion, and there will be some non-linearity through the system.

This is simply because there will inevitably be a small degree of mismatch in the two phototransistors of IC2. The distortion should be relatively low though, and it should certainly not be high enough to be of any significance in this application.

Being Selective

Capacitor C2 provides frequency selective negative feedback over IC1 that severely rolls-off its high frequency response. This loss of high frequency response is of no consequence since any changes in the input level will be very slow indeed. Without the roll-off there is a strong risk of IC1 becoming unstable, and the circuit is also more vulnerable to stray pickup of electrical noise.

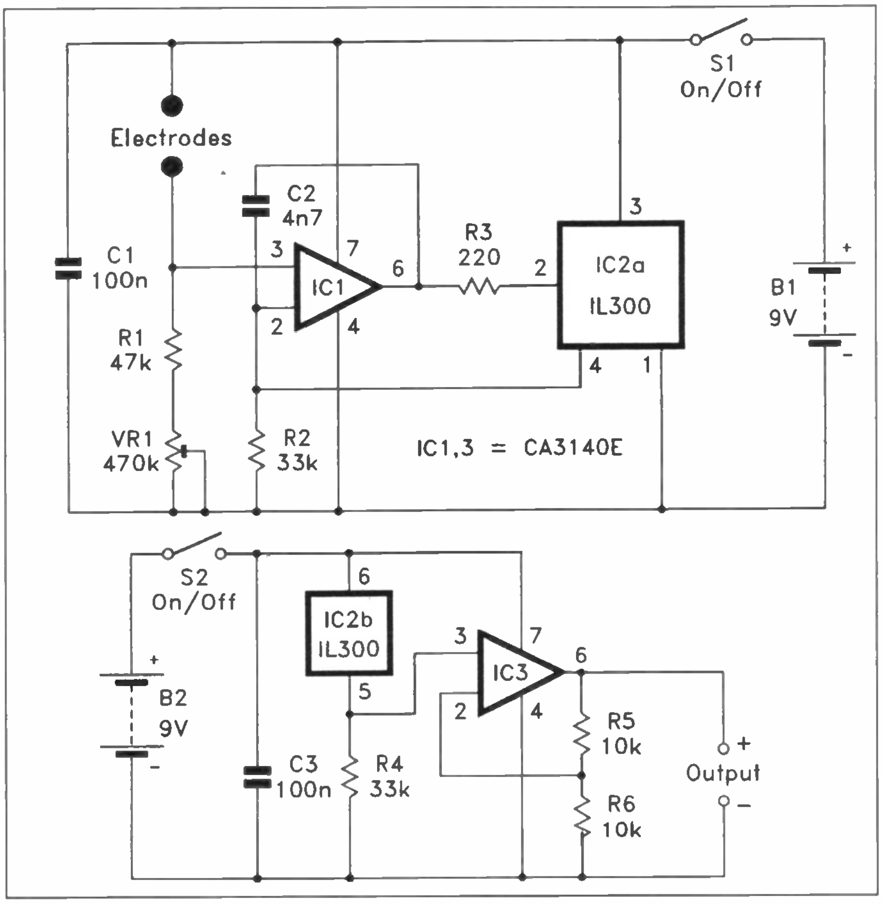


Fig. 2. Circuit diagram for the Biofeedback Interface. There must be no direct connection between the two sections.

Resistor R1 and preset VR1 form the lower arm of the potential divider at the input of the circuit. VR1 enables the sensitivity of the circuit to be adjusted to suit the particular electrodes used, and the skin resistance of the user. Some people have much higher skin resistances than others. IC3 acts as an output buffer and also provides a small amount of voltage gain.

It is, of course, essential that there is no direct electrical connection between the input and output sections of the circuit. The two sections of the circuit must therefore be powered from separate 9V batteries.

The current consumption of the output circuit is only a couple of milliamps, and a PP3 size battery is more than adequate to supply this. The consumption of the input circuit is much higher because it provides the internal l.e.d. current to IC2.

A PP3 size battery is just about adequate to power the input circuit, but a higher capacity battery is likely to be more economic. Six HP7 size cells in a plastic holder were found to be perfectly adequate.

Although this interface was designed for use with the PC analogue port described last month, it should work equally well with any analogue input port that has a full scale voltage of about 5V. For operation with ports that have a full scale value of about 2·5V resistor R6 should be omitted, and R5 should be replaced with a shorting link. Of course, this interface is not only suitable for use with PCs. It should work well with (say) the analogue port of the BBC machines.

Making Contact

Quite good results have always been obtained with this simple method of biofeedback, provided consistent contact is made between each electrode and the user's skin. Simply holding the electrodes is not good enough, since the readings obtained would reflect how hard (or otherwise) the electrodes were gripped, more than they would reveal any changes in skin resistance.

In order to obtain usable results the electrodes must be taped in place. In medicine it is normal practice to use a conductive jelly to obtain a better contact between each electrode and the subject's skin. Here we are relying on sweat to provide a better or worse contact, and *no* conductive paste or jelly should be used.

Original experiments were done using electrodes made from small pieces of aluminium foil. These did not work too well, and seemed to give ever increasing readings regardless of the user's state of relaxation.

Better results are obtained using small pieces of aluminium sheet or copper laminate board. Wires can be soldered direct to pieces of copper laminate, but with aluminium electrodes the connections must be made via soldertags or crocodile clips.

Electrodes about 10mm by 20mm will suffice, and these should be taped to two fingers on the same hand. The electrodes must be reasonably clean, and should be kept as still as possible in use.

Preset potentiometer VR1 should be adjusted for an initial reading of about half full scale (i.e. about 127). This leaves plenty of scope for readings to rise or fall.

If it is impossible to get a reasonably high reading, either make VR1 higher in value, or use slightly larger electrodes. In use, higher readings represent increased stress, and lower readings indicate increased relaxation.

The system is usable if the software does nothing more than print the returned values on the screen of the monitor, but with a computer based system there are opportunities to make the feedback an aid to relaxation. For example, the screen could be made to change colour as values from the interface reduce, with your favourite colours being used for the lowest readings.

The readings from the interface could also be used to control the pitch of the computer's sound generator, with high readings giving a middle audio frequency, and low readings giving a very low pitched sound. There is plenty of room for some imaginative experimentation here.

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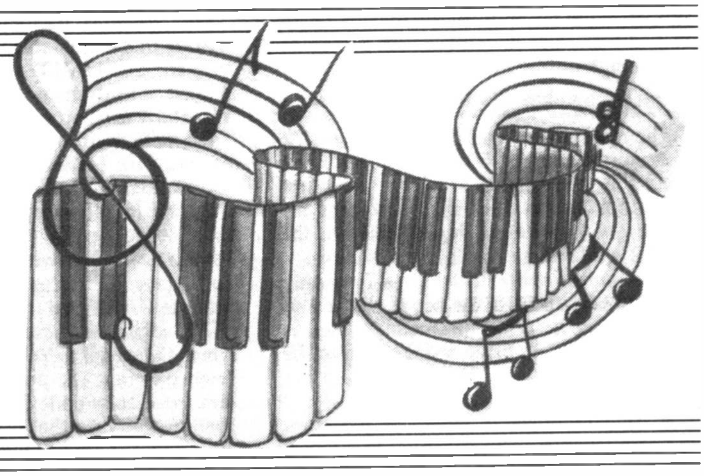


MIDI PEDAL

ROBERT PENFOLD

Sustain the versatility of your MIDI with this relatively inexpensive and easy-to-build unit. Can be set up as sustain, portamento or soft pedal.

OLD STYLE synthesisers have input sockets for a sustain pedal, plus (possibly) other types of pedal, such as soft and portamento types. In most cases the pedals themselves are simple foot-operated switches.

Input sockets for pedals are not unknown on modern synthesisers, but there seems to be a definite trend towards external control only via MIDI. While MIDI undoubtedly offers a level of control that was not previously available, it does seem rather like "a sledgehammer to crack a nut" when applied to pedals.

Where only a footswitch was needed previously, pedal control via MIDI involves a footswitch plus a substantial amount of electronics. Ready-made MIDI pedals tend to be quite expensive. Many of these units are quite sophisticated, but probably go well beyond the requirements of most users.

The basic MIDI Pedal featured here can be built at relatively low cost, and with a suitable synthesiser it acts as the sustain pedal. It can also be "hard wired" to control any MIDI switch type control though. It can therefore be set up for use as a soft pedal, portamento pedal, etc.

Exactly what can and cannot be controlled via a unit such as this depends on the MIDI implementation of your synthesiser. The MIDI implementation chart should clearly show which MIDI control functions the instrument will respond to. A simple on/off pedal such as this one can only control the switchable functions (those having control numbers from 64 to 90).

SYSTEM OPERATION

The block diagram of Fig. 1 helps to explain the basic way in which the MIDI pedal functions. This is actually a very slightly simplified version of the "real thing", but the essential stages are all included in Fig. 1.

A MIDI signal is a serial type which is similar to an ordinary RS232C asynchronous serial signal. The baud rate is relatively high at 31250, and MIDI uses a 5mA current loop rather than the plus and minus 12V signal levels of an RS232C interface.

The word format is the common one of one start bit, eight data bits, one stop bit, and no parity. The serial signal is generated using a standard UART (universal asynchronous receiver/transmitter). In this case only the transmitter section is required, and the receiver section is left completely unused.

The baud rate is set by a clock signal which must be at 16 times the required baud rate, which works out at 500kHz in this case. This clock signal is provided by a 4MHz crystal oscillator and a divide-by-eight circuit. The serial output from the UART is at normal 5V logic levels, but these are converted to the required 5mA loop signal using a simple driver/inverter stage.

MIDI MESSAGE

A MIDI control change message is a three byte type. This means that the pedal must send a three byte sequence when the pedal is pressed, and a slightly different three byte sequence when it is released.

The first byte is the status byte. The most significant nibble of this byte carries the control change code, and the least significant nibble contains the MIDI channel value.

The next byte carries the value of the MIDI control that must be altered, and a value of 64 is used here for a sustain pedal. The third byte is either 127 to switch a function on, or 0 to switch it off.

Under the current version of the MIDI specification, values from 0 to 63 must be interpreted as "off", and values from 64 to 127 must be interpreted as "on". As there is a vast amount of equipment in use which predates the current scheme of things, and will only recognise 0 and 127 for a switch type control, correct operation can only be guaranteed if these two values are used in the third byte.

IN A STATE

Three 8-bit tristate buffers drive the data inputs of the UART. The first of these is fed from a code generator which provides the correct binary pattern for a program change message on Channel 1. The second is fed from a code generator which provides the binary pattern for a (decimal) value of 64, or the appropriate value for the MIDI function that the pedal must control. These two binary codes are actually produced simply by wiring the inputs of the tristate buffers to the appropriate supply rails.

The code generator for the third tristate buffer is slightly less straightforward, because the binary pattern provided must reflect the setting of the footswitch (127 when it is depressed – 0 when it is not). This

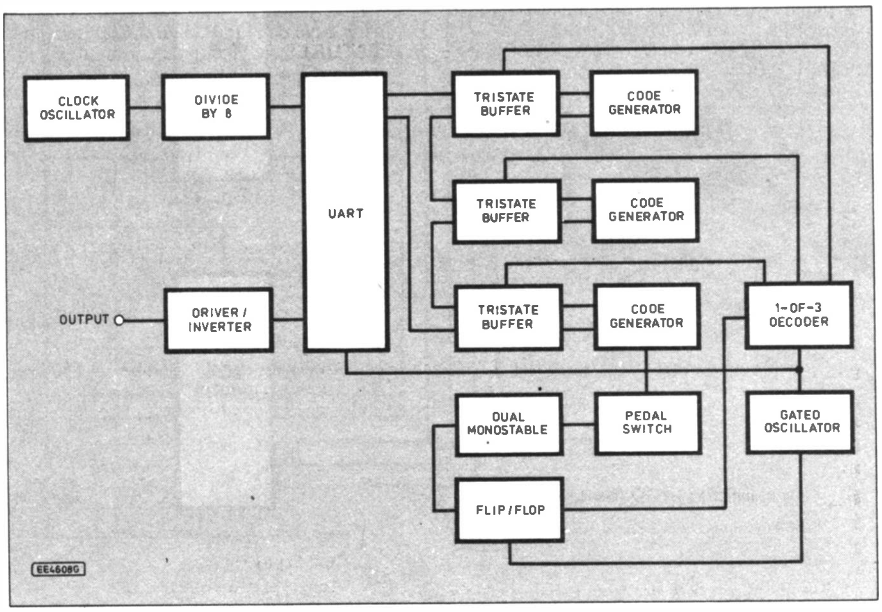


Fig. 1. System block diagram for the MIDI Pedal.

simply requires the most significant bit to be tied high, and the other seven bits to be pulled high or low by the footswitch.

UNDER CONTROL

The remaining stages of the unit provide the control logic. When the pedal is pressed, the tristate buffers must be activated, one-by-one, in the correct sequence, with a pulse being supplied to the UART while each of the buffers is active.

Each pulse results in the UART loading the byte of data from the active buffer and transmitting it. When the pedal switch is released the same basic sequence must be repeated, but with the value of zero rather than 127 in the final byte.

A dual monostable circuit is fed from the pedal switch. This circuit consists of a positive edge triggered monostable, a negative edge triggered type, and a simple gate circuit.

Whether the pedal is pressed or released, one or other of the monostables will produce an output pulse that sets a simple flip/flop. The output from the flip/flop provides the control signal for a gated oscillator, and when the flip/flop is set, the oscillator is enabled.

The output of the oscillator drives both a one-of-three decoder and the trigger input of the UART. The three outputs of the one-of-three decoder are used to drive the enable inputs of the three tristate buffers.

On the first oscillator cycle the first tristate buffer is enabled, and the oscillator triggers the UART so that this byte is loaded and transmitted. On the second and third oscillator cycles the second and third buffers are enabled, and their bytes of data are loaded into the UART and transmitted.

On the fourth oscillator cycle the one-of-three decoder resets itself, and it also resets the flip/flop. This switches off the oscillator, and prevents further bytes being loaded into the UART and transmitted.

The sequence of events is much the same when the pedal is released. The only difference is that the pedal switch circuit alters the binary code provided to the third tristate buffer, so that the required value of zero is sent in the last byte of the message.

CIRCUIT OPERATION

The main circuit for the MIDI pedal appears in Fig. 2, with the control logic circuits shown separately in Fig. 3. IC2 is the UART, and this is the industry standard 6402 (or an exact equivalent). Capacitor C4 and resistor R7 provide a reset pulse to IC2 at switch-on.

A UART can handle any normal word format, and it is just a matter of connecting pins 34 to 39 to the appropriate logic levels for the required format. In this case IC2 is obviously wired for eight data bits, one stop bit, and no parity.

Transistor TR2 is the inverter/driver stage, and this is a simple common emitter switch. Current limiting at the output is provided by resistors R3 and R4. The 4MHz clock oscillator is based on TR1, and is of conventional design.

The divide-by-eight action is provided by IC1, giving a 500kHz clock signal to IC2. IC1 is a 7-stage binary divider, but in this circuit only the first three stages are utilized. Note that a 74HC4024 MUST be used for IC1, and that an ordinary 4024BE is not suitable as it might not work properly with a 4MHz input signal and a 5V supply.

NIBBLES AND BYTES

The three tristate buffers are made up of IC3, IC4 and IC5. They are actually 74HC245 octal transceivers, but in this circuit they are hard wired in the receive mode, and they act as octal tristate buffers.

The inputs of IC3 are wired with 1011 as the most significant nibble, and this is the control change code. The least significant nibble is wired with 0000, which means that the unit transmits on MIDI Channel 1 (a conventional MIDI channel number is one higher than the binary value transmitted in the MIDI status byte).

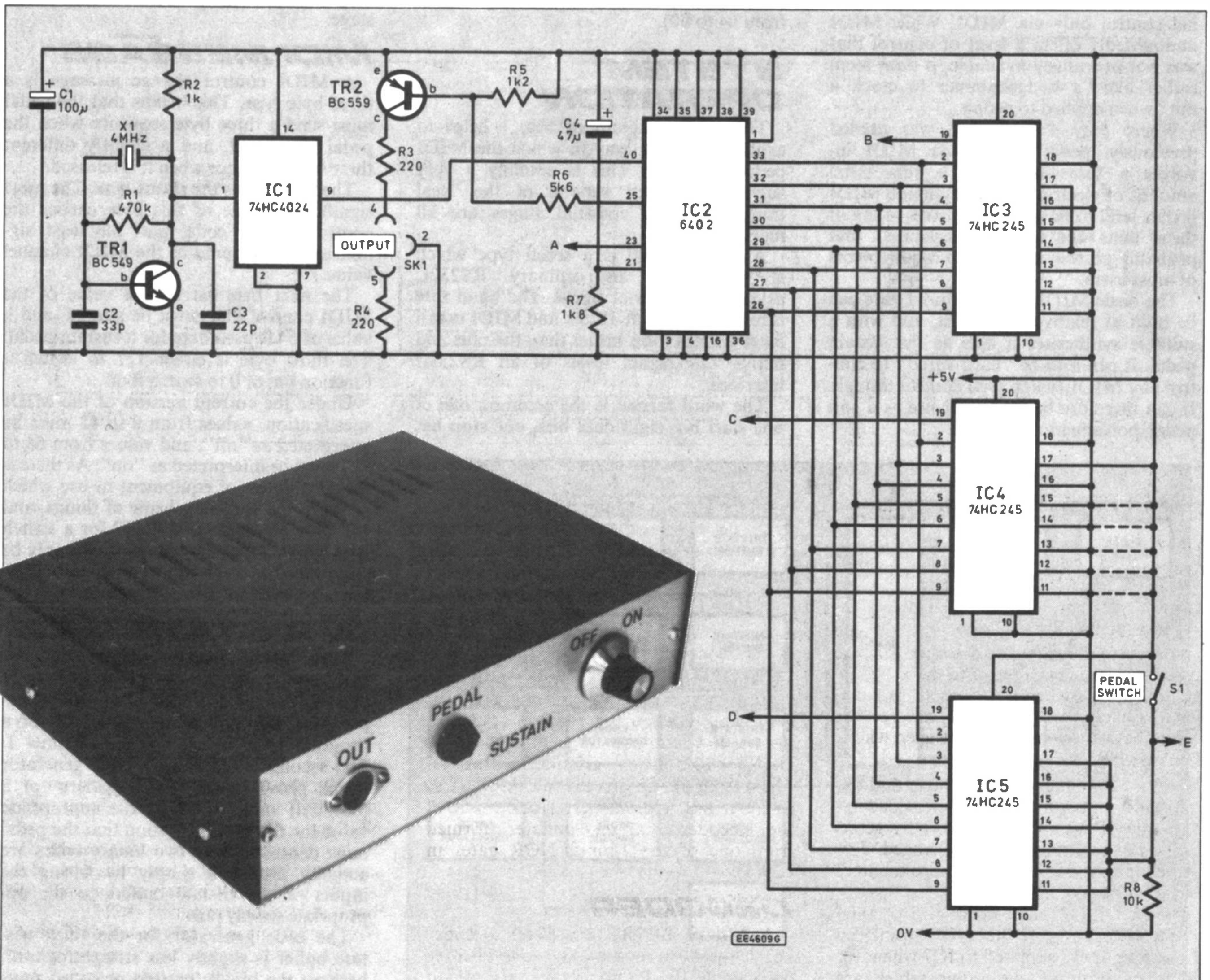


Fig. 2. The main circuit diagram for the MIDI Pedal. The output socket SK1 is a 5-pin DIN type and switch S1 can be a robust footswitch (mounted in the top of the case), or a pedal type switch which plugs into the front panel jack socket..

It would not be too difficult to give the unit an adjustable channel number, but this would probably not be worthwhile. In practice there should be no difficulty in using the unit on Channel 1. In many cases the synthesiser can be used in Mode 1 (omni on/poly), and the operating channel of the pedal is then unimportant.

MIDI data bytes always have the most significant bit set to zero so that they are easily distinguished from status bytes, which always have the most significant bit set to 1. Consequently, IC4 and IC5 both have their most significant input tied low. IC4 normally has bit 6 taken high, and bits 0 to 5 tied low. This gives a decimal value of 64, which is the MIDI control number for a sustain pedal. Link-wires on the printed circuit board enable any inputs from bit 0 to bit 5 to be taken high if necessary, so that the unit can be used to control other MIDI switch type controls.

Inputs 0 to 6 of IC5 are normally held low by resistor R8. All seven of these inputs are taken high when pedal switch S1 is initially operated, giving a value of 127 in the third data byte. This results in the sustain function (or whatever) being switched on. R8 pulls these inputs low again when S1 is released, and a value of 0 is used in the third byte of the transmitted message. This switches off the sustain or other function.

COMPONENTS

Approx cost guidance only **£30** *excluding case & Batt*

See SHOP TALK Page

Resistors

R1	470k
R2	1k
R3, R4	220 (2 off)
R5	1k2
R6	5k6
R7	1k8
R8, R11 R13	10k (3 off)
R9, R10, R15	56k (3 off)
R12	47k
R14	4M7

All 0·25W 5% carbon film

Capacitors

C1	100µ radial elect. 10V
C2	33p ceramic plate
C3	22p ceramic plate
C4	47µ radial elect. 16V
C5, C6, C7, C8	100n polyester (4 off)
C9, C10	100n ceramic (2 off)

Semiconductors

D1, D2, D3	1N4148 signal diode (3 off)
TR1	BC549 *npn* transistor
TR2	BC559 *pnp* transistor
IC1	74HC4024 7-stage ripple counter
IC2	6402 UART
IC3, IC4, IC5	74HC245 octal transceiver (3 off)
IC6	4098BE CMOS dual monostable
IC7	4013BE CMOS dual D type flip/flop
IC8	TLC555C low power timer
IC9	4001BE CMOS quad 2-input NOR gate
IC10	4017BE CMOS 1-of-10 decoder
IC11	µA78L05 +5V 100mA voltage regulator

Miscellaneous

B1	9V battery, with clips (PP3 size)
S1	footswitch (see text)
S2	s.p.s.t. min. toggle switch
X1	4MHz wire-ended crystal
SK1	5-pin 180 degree DIN socket, chassis mounting

Printed circuit board available from *EPE PCB Service*, code 938; metal instrument case, size about 230mm x 133mm x 63mm; 8-pin d.i.l. socket; 14-pin d.i.l. socket (3 off); 16-pin d.i.l. socket (2 off); 20-pin d.i.l. socket (3 off); 40-pin d.i.l. socket; connecting wire; solder pins; solder; fixings, etc.

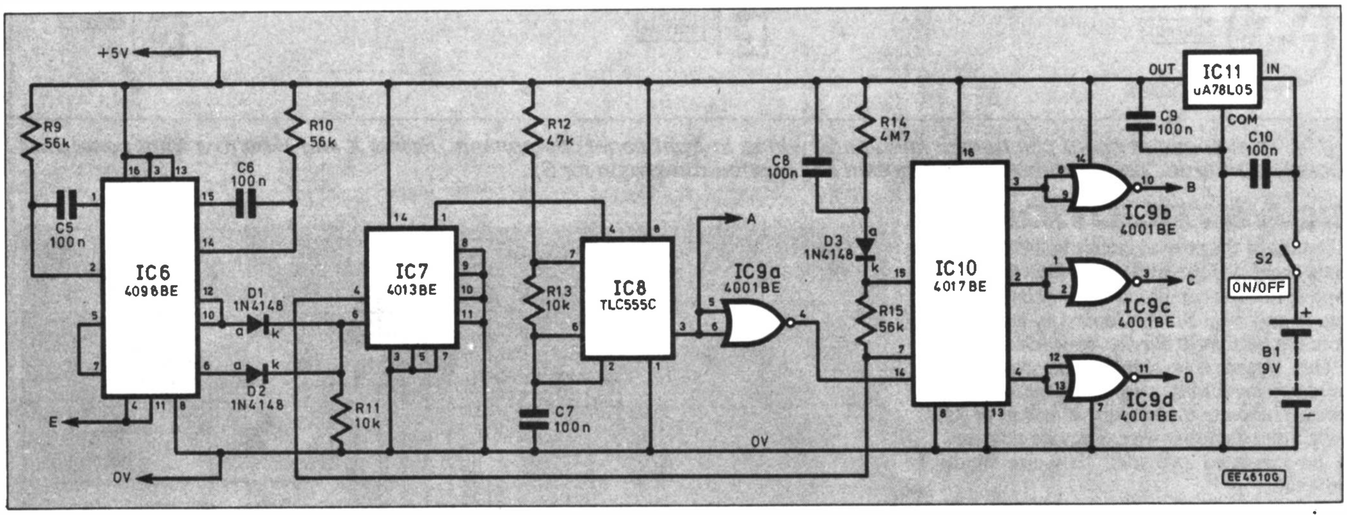


Fig. 3. Circuit diagram of the control logic for the MIDI Pedal.

CONTROL LOGIC

The circuit diagram for the control logic stages is shown in Fig. 3. IC6 is a CMOS 4098BE dual monostable, and it has both its inputs driven from the pedal switch S1 and resistor R8 (Fig. 2).

In theory, the right hand section of IC6 triggers when S1 is closed, and the left hand section triggers when it is opened. In practice it is likely that contact bounce usually causes both monostables to trigger whenever switch S1 is opened or closed.

This is of no importance though, and the unit will function properly provided at least one of the monostables is triggered each time the setting of S1 is changed. The output pulse duration is approximately 2·8ms for both monostables.

Diodes D1, D2, and resistor R11 provide simple OR gating of the two outputs, so that a set pulse is supplied to IC7 whenever either or both of the monostables are triggered. IC7 is a CMOS dual D-type flip/flop, but in this circuit only one section is used, and this acts as a simple set/reset flip/flop. The unused inputs of IC7 are tied to the 0V rail in order to prevent spurious operations.

The oscillator, IC8, is a standard gated 555 type, but a low power version of the 555 timer i.c. is used in order to minimise the current consumption of the circuit. IC8's operating frequency is about 215Hz, which is high enough to ensure that three byte groups are sent very rapidly when the pedal is operated, but is low enough to ensure that the UART will not be overloaded with data. The output of IC8 drives the UART (IC2) directly, but it drives the clock input of the decoder via an inverter formed from one of the 2-input NOR gates in IC9(a).

DECODER

A CMOS 4017BE one-of-ten decoder i.c. is used to act as the one-of-three decoder IC10. However, in this circuit output "3" is used to reset the device, which effectively eliminates outputs "3" to "9" and gives a one of three action. Resistor R15 provides the coupling from output "3" to the reset input.

Capacitor C8, resistor R14, and diode D3 provide IC10 with a reset pulse at switch-on, so that it starts correctly with output "0" high. This ensures that there are no spurious transmissions the first time the pedal switch S1 (Fig. 2) is operated, which could have unwanted effects on the synthesiser.

The outputs of IC10 go high when they are active, but the tristate buffers are activated by a low logic level. Consequently, the tristate buffers are driven via inverters formed from the remaining three NOR gates of IC9 (b, c, d).

The circuit requires a reasonably stable 5V supply at a current of a few milliamps. This is provided by a 9V battery and a small 5V monolithic voltage regulator (IC11).

As the circuit is largely based on CMOS integrated circuits its current consumption is quite low. In fact the total current consumption is only about 5mA to 6mA, and a PP3 size battery is therefore adequate as the power source.

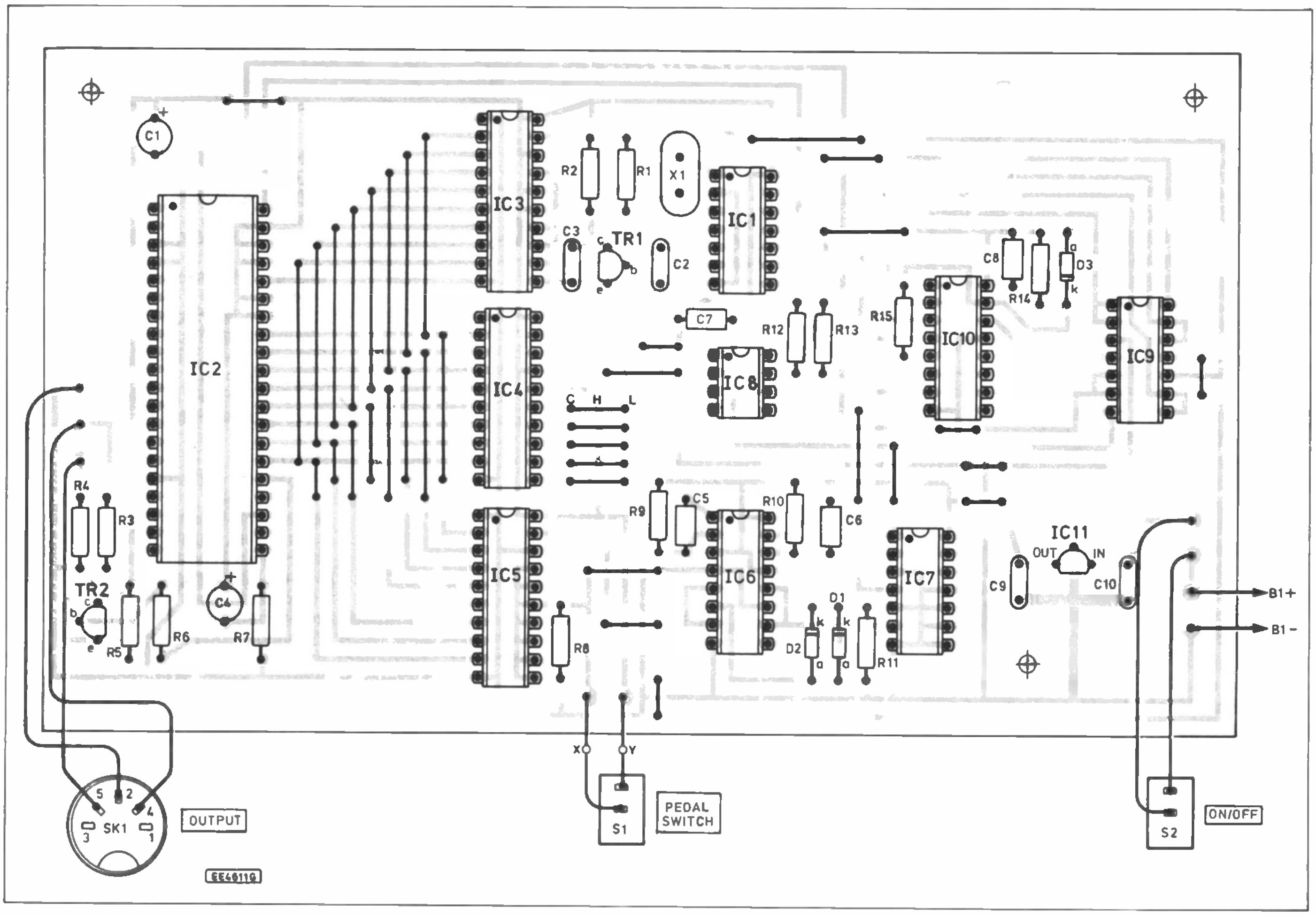


Fig. 4. Printed circuit board component layout and wiring to front panel components. Points X and Y go to a front panel jack socket if a plug-in "pedal switch" is used instead of a pushbutton switch for S1.

CONSTRUCTION

Details of the printed circuit board (p.c.b.) component layout and underside full size copper foil master pattern are provided in Fig. 4 and Fig. 5. This board is available from the *EPE PCB Service*, code 938.

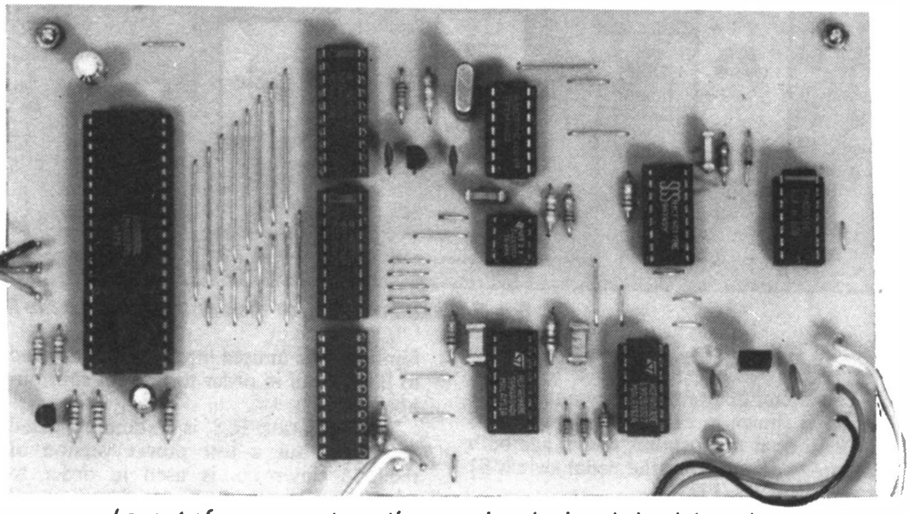
This board is a single-sided type, but there are inevitably a fair number of link-wires. These are made from 22 s.w.g. or 24 s.w.g. tinned copper wire. They do not need to be insulated provided they are made quite taut.

The d.i.l. integrated circuits are all CMOS types, and they therefore require the usual anti-static handling precautions. In particular, they should all be fitted in sockets, but they should not be fitted into place until the unit is complete in all other respects. Handle the integrated circuits as little as possible.

Crystal X1 must be an HC-49/U type (i.e. a wire-ended crystal having 7·5mm (0·3in.) lead spacing). Some crystals are not very tolerant of heat, so it is advisable not to apply the soldering iron to the joints any longer than is really necessary when fitting this component.

Capacitors C5 to C8 should be miniature printed circuit mounting types having a lead spacing of 7·5mm (0·3in.). Single-sided solder pins are fitted to the board at the points where connections to the off-board components will be made.

The five link wires just to the right of IC4 are used to select the function of the pedal. As shown in Fig. 4 all five of IC4's programmable inputs are taken low. As explained previously, this results in a value of 64 being used in the second byte of each message, which makes the unit function as a sustain pedal.



Layout of components on the completed printed circuit board.

Other functions can be accommodated by taking one or more of these inputs high. In order to take an input high, simply wire the common ("C") pad to the high ("H") pad instead of the low ("L") pad. Table. 1 provides connection details for portamento, sostenuto, and soft pedals.

Table. 1: Pedal Effect Selection

Function	*Control No. (Dec.)*	*IC4 Connections*
Portamento	65	11 high, 12 to 15 low
Sostenuto	66	12 high, 11, 13, 14, and 15 low
Soft	67	11 and 12 high, 13 to 15 low

CASE DETAILS

A medium size metal instrument case will accommodate this project. The component p.c.b. is fixed to the base panel using three metric M3 or 6BA mounting bolts, or plastic stand-offs. If you use mounting bolts, spacers about 6mm to 10mm long are needed in order to keep the connections on the underside of the board well clear of the metal case.

Switch S2 and DIN socket SK1 are mounted on the front panel. SK1 requires a main mounting hole about 15mm in

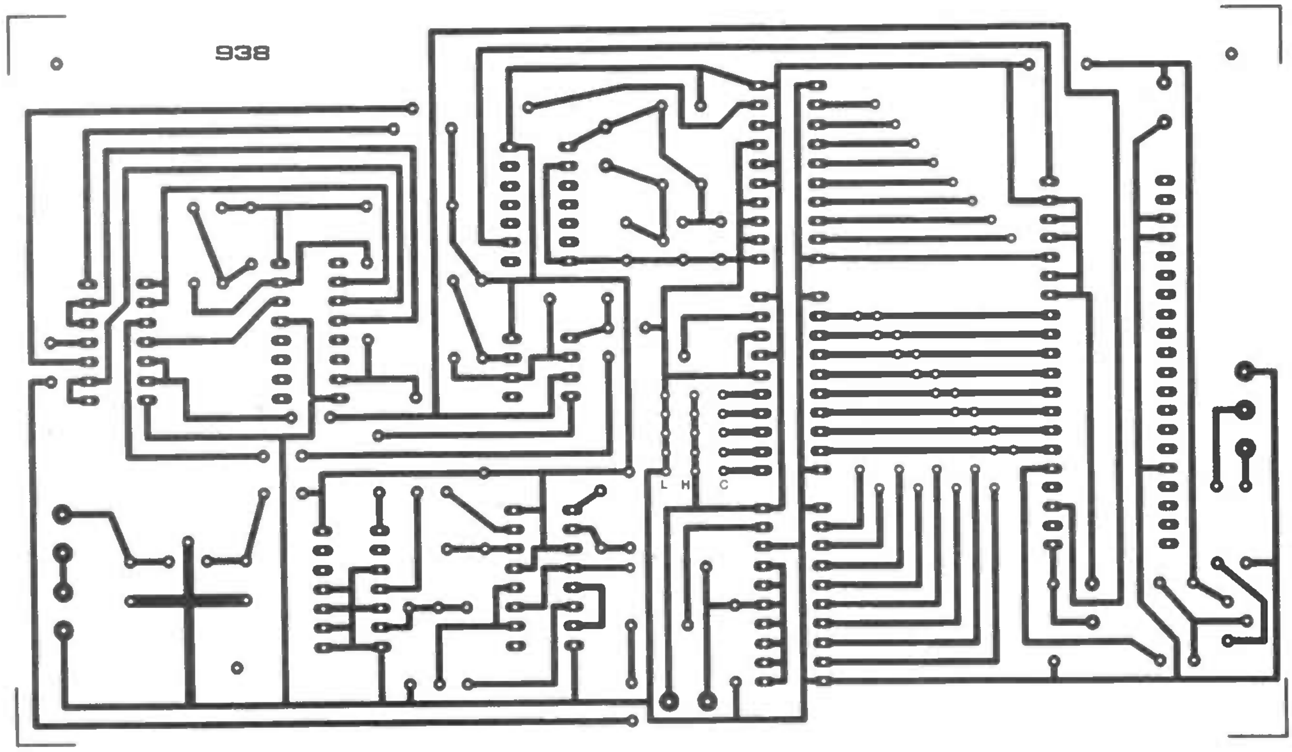


Fig. 5. Full size underside copper foil master pattern for the MIDI Pedal.

diameter, plus two smaller (3·3mm dia.) holes for the short 6BA or M3 mounting bolts. The mounting bolts and nuts are not normally supplied with the socket. Once the main cutout has been made, the positions of the two smaller holes can be marked using the socket itself as a template.

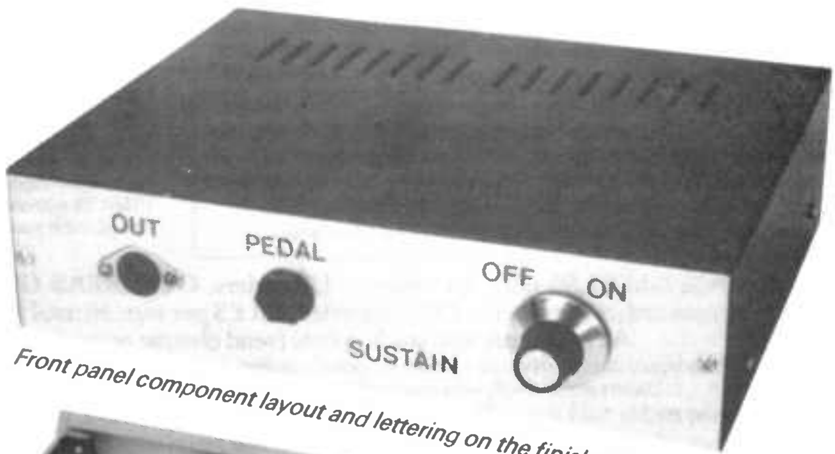
There are two possible approaches to footswitch S1. The cheaper method is to use a large push-to-make, non-locking pushbutton switch for S1, and to mount this on the top panel of the case. If this method is used it is obviously important to use a strong case, and a good quality switch for S1.

The better but more expensive method is to use a conventional pedal switch for S1, as used with old style synthesisers. Connections to this switch are made via a 6·35mm (0·25in.) jack socket mounted on the front panel of the case (see photographs).

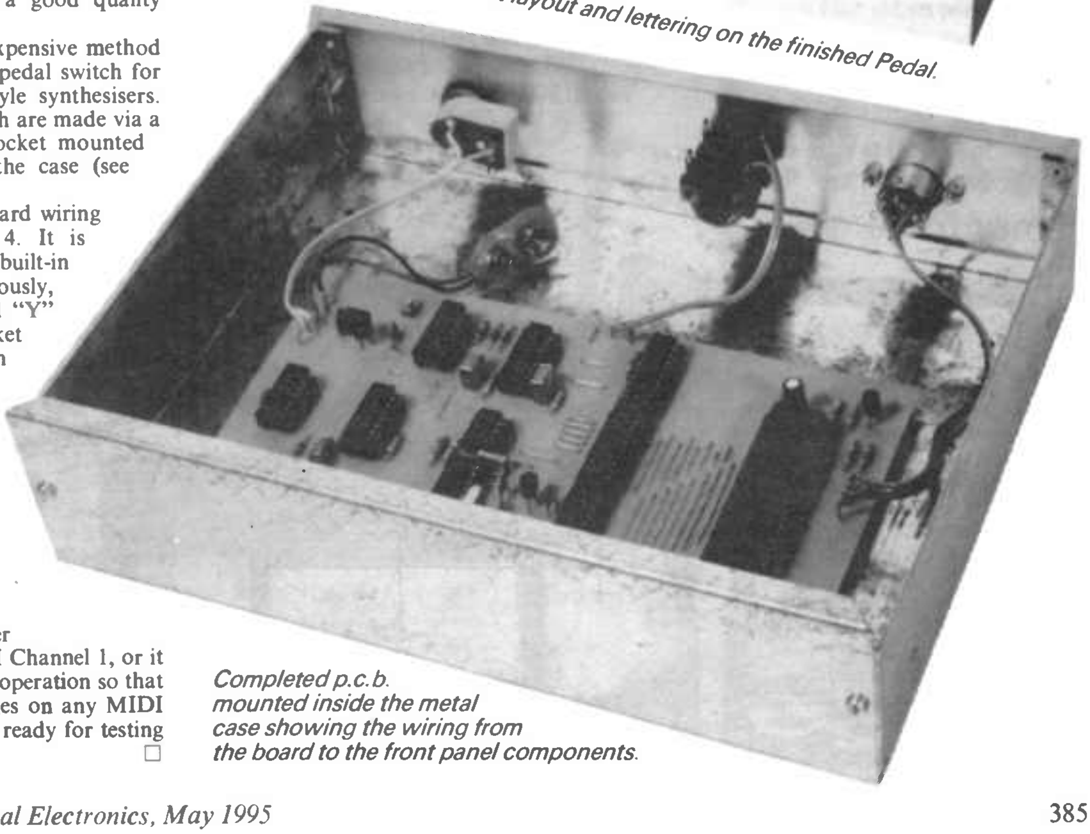
The small amount of hard wiring is also shown in Fig. 4. It is assumed that S1 is a built-in pushbutton switch. Obviously, the connections "X" and "Y" connect to the jack socket (either way round) if an external pedal switch is used.

IN USE

Socket SK1 of the MIDI Pedal is connected to the MIDI "IN" socket of the synthesiser via a standard MIDI lead. The synthesiser should either be set to receive on MIDI Channel 1, or it should be set for Mode 1 operation so that it will respond to messages on any MIDI channel. The unit is then ready for testing and use. □



Front panel component layout and lettering on the finished Pedal.



Completed p.c.b. mounted inside the metal case showing the wiring from the board to the front panel components.

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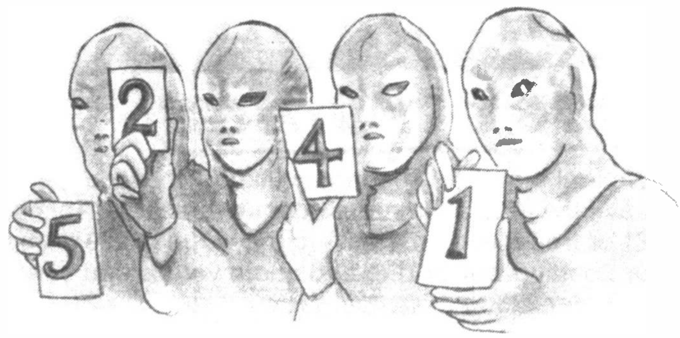

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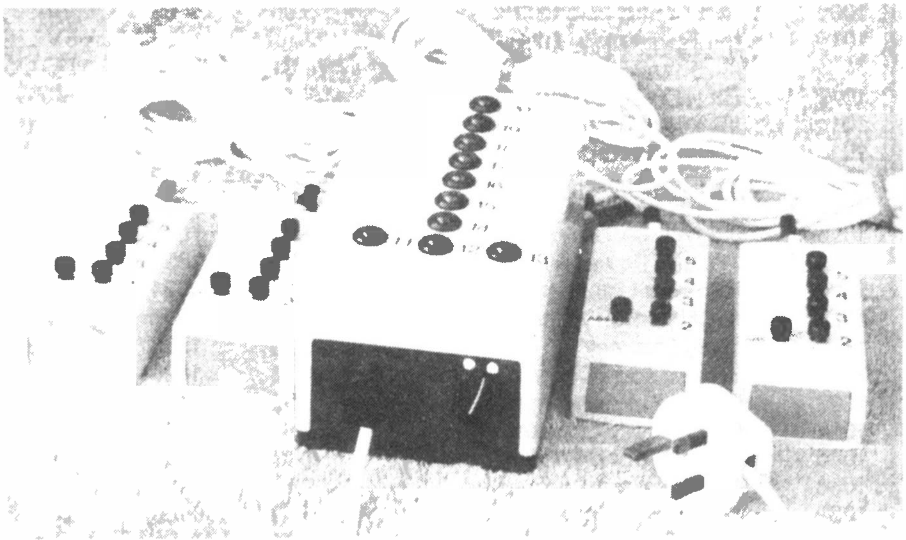
PEOPLE tend by nature to be competitive, a characteristic which is apparent in the activities of clubs and societies, where competitions of one kind or another feature largely in their programmes. Where these competitions can be settled by observable facts, like who gets past the winning post first, or whose vegetable marrow is the largest, there is usually no problem. There are many instances, though, where the choice of winner is a matter of artistic judgment or taste, and in these cases it is customary to ask an expert to consider the entries and pronounce judgment.

Alternatively, the matter can be settled by the votes of a panel of judges drawn from members of the group itself. However, there are snags, of which the major one is that unless there is a secret ballot, which is time consuming to organise and count, the adjudication can be embarrasing for the judges and the judged.



SAVING INTERFACE

In the case of a club vote, both the desirability of a quick verdict and of confidentiality for the voters, can be achieved by the use of a bit of electronics to tot up the points awarded. The author knows of two or three societies who use electronic voting tools of this kind. There are likely to be many others who would welcome this option.

In essence, such tools are based on the use of a number of separate voting handsets having buttons which, when pressed, send the chosen score to a control box where the points awarded from the separate inputs are totalised and displayed.

The method of operation of those devices of which the author is aware seems mainly to be based on some form of digital system. With these the individual handsets generate an appropriate number of pulses according to which key is pressed. The individual pulse inputs are then counted, added together, and displayed on a numerical readout on the control box.

The drawback with this type of arrangement is that pulse generator/counter systems, though impressive, tend to be a bit expensive to implement. This is an important consideration for most clubs who try to run on a shoe-string budget.

JUDGING COSTS

In the case of the Club Vote Totaliser system described here, originally designed for the use of the author's local camera club, the main consideration was that it should be as simple and inexpensive to build as practicable. For this reason, the system was designed so that each handset consists of a pushbutton-selected current generator. The control box then sums the currents, converts them into a voltage by passing them through a fixed resistor and, via an LM3914 dot-bar driver chip, presents the output on a 10 l.e.d. (light emitting diode) calibrated display.

By using a switch to change the value of the summing resistor, the system can be switched to suit the number of judges, between three and five. The gain of the display system can also be switch-selected to permit a judge to abstain.

HANDSETS

The circuit diagram for the handsets is shown in Fig. 1. Each of them contains a group of resistors, R1 to R4, which allows a current output to be selected by any one of four panel-mounting pushbutton switches, S1 to S4. A fifth switch, S5, is connected as an *Abstain* button which allows a +15V potential to be routed back to the control box, where it activates a relay.

In order to avoid possible difficulties in obtaining the less-common resistance values of 165k, 110k, 82k5, and 66k, resistors R1 to R4 are made up by connecting in parallel two or more 330k resistors:

2 × 330k in parallel = 165k
3 × 330k in parallel = 110k
4 × 330k in parallel = 82k5
5 × 330k in parallel = 66k

These resistance values provide a choice of output currents of 90μA, 135μA, 180μA or 227μA respectively from each individual handset.

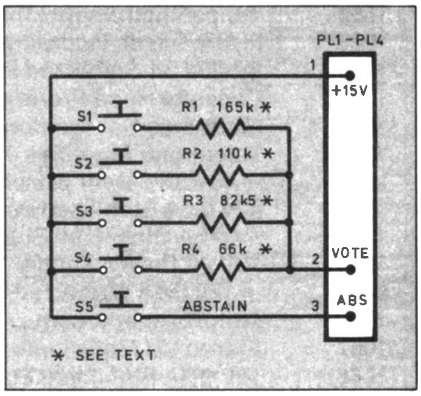


Fig. 1. Handset circuit diagram.

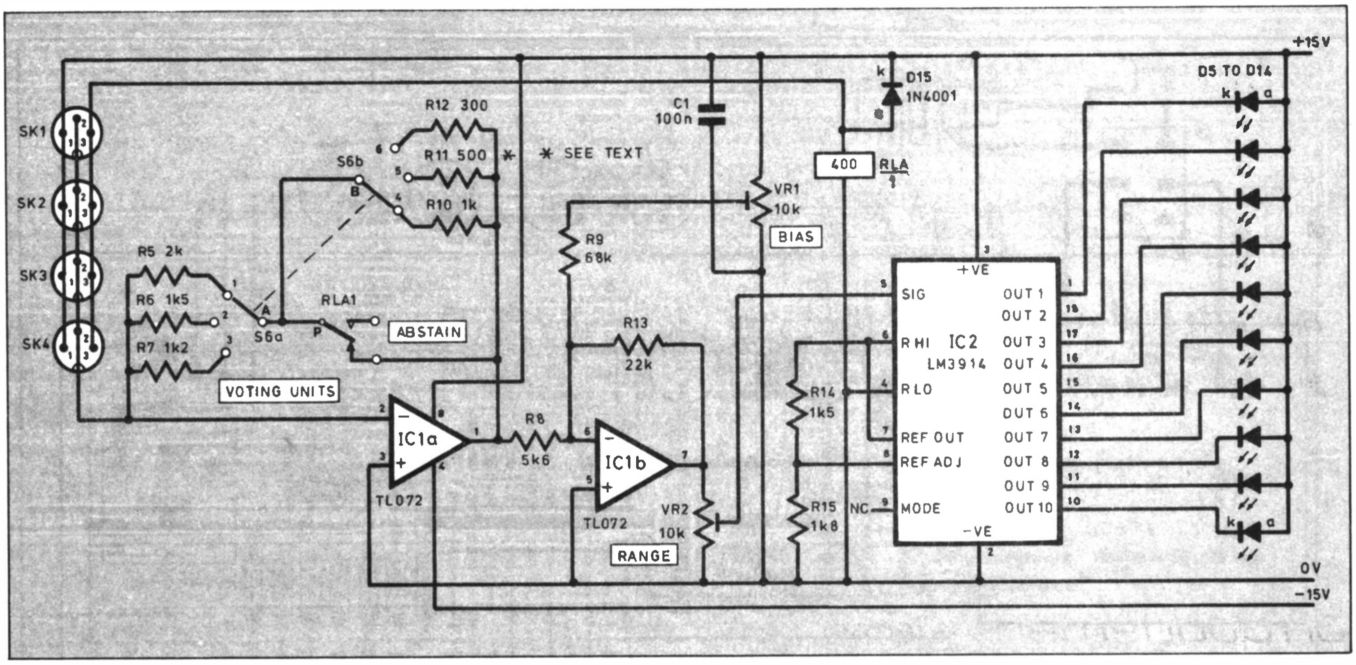


Fig. 2. Circuit diagram for the Club Vote Totaliser controller and readout.

CONTROLLER

The circuit diagram for the Club Vote Totaliser Controller is shown in Fig. 2. In this circuit IC1a, which is one half of a TL072 f.e.t. (field effect transistor) dual op.amp, is connected as a summing amplifier. Its function is to convert the input current from the handsets into an equivalent output voltage. The actual output voltage is dependent upon the gain of the amplifier stage, which in turn is determined by the value of the feedback resistor, R5, R6 or R7, brought into circuit by switch S6a.

Because op.amp IC1a is used in the inverting mode, the polarity of the controlling current from the handsets will cause its output voltage to be negative-going. Consequently, the other half of the TL072, IC1b, is used as a second inverter to produce a positive-going voltage from its output pin 7, as required by the display controller stage around IC2. Preset potentiometer VR2 is used to attenuate the output voltage range actually delivered.

From VR2, the output voltage is brought to input pin 5 of the dot-bar driver IC2. Resistors R14 and R15 set the f.s.d. (full-scale deflection) range of IC2 to 2·75V. Light emitting diodes (D5 to D14) are connected to each of IC2's ten outputs.

As the voltage on IC2 pin 5 increases from zero to the 2·75V f.s.d., each of the outputs 1 to 10 goes low in sequence, so causing its respective l.e.d. to be turned on. As the mode input pin 9 is unconnected, IC2 is held in dot-bar mode, which means that only one l.e.d. is on at any time. (Connecting IC2 pin 9 to the +15V power line would implement the chip's bargraph mode, but with an attendant increase in current consumption.)

ABSTAINING

When the *Abstain* switch S5 is pressed on any of the handsets, the full +15V power line voltage is fed to the relay RLA. As a result, the relay is turned on and its contacts, which normally connect the poles of switch S6 to IC1a pin 1, open up. The feedback across IC1a is now additionally via one of the resistors R10 to R12, as selected by switch S6b.

The insertion of the extra feedback resistance increases the gain of the stage around IC1a. This temporarily increases the voltage fed to the display by a factor of ×1·5, ×1·33 or ×1·25, depending on whether switch S6b has been set to correspond with the use of three, four or five handsets, respectively.

POWER SUPPLY

The power supply circuit diagram is shown in Fig. 3. The circuit is a conventional one which produces a ±15V d.c. supply from a transformer-coupled mains a.c. input.

From one secondary winding of transformer T1, diodes D1 and D2 half-wave rectify the positive supply, which is then smoothed by capacitor C4 and regulated down to +15V by IC3. The negative supply line is similarly derived from the second winding of T1: diodes D3 and D4 rectify the voltage, capacitor C5 smooths it, and IC4 regulates it down to −15V. Capacitors C2 and C3 act as additional reservoir capacitors.

OFFSET

With the author's unit, the scoring l.e.d.s are labelled from 11 to 20. Since there are 10 l.e.d.s controlled by IC2, the range of the display is thus required to run from "*11*" to "*20*". If there are four handsets in use, preset VR2 must be set so that the score of "*20*" is given when all four buttons marked "*5*" are pressed (or three "*5*" buttons plus an "*Abstain*").

However, there also needs to be an offset voltage applied so that scores below "*11*" (which cannot be registered on the 10 l.e.d. display) are ignored. This offset is provided by preset VR1, which injects an additional current into IC1b's inverting input pin 2. VR2 should be adjusted so that "*11*" is indicated when the keys for three

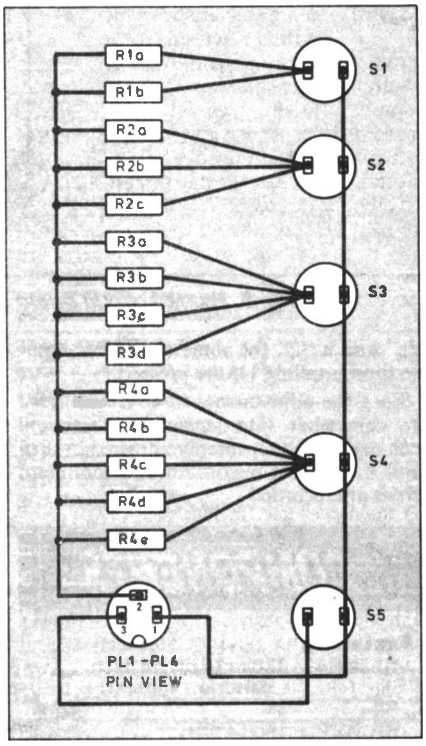


Fig. 4. Wiring diagram for the Club Vote Totaliser handsets.

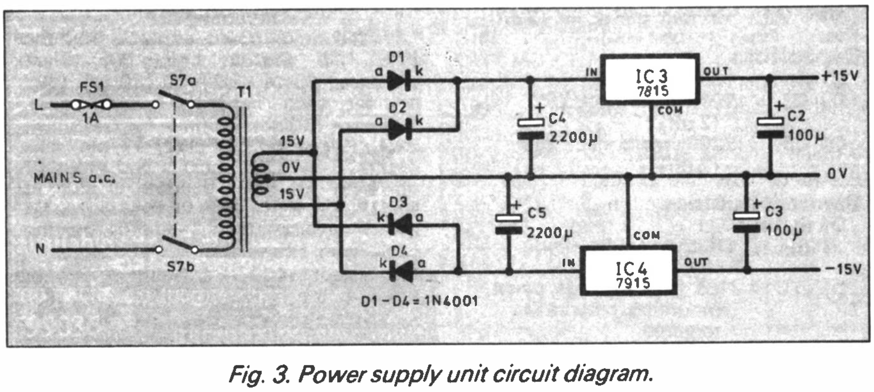


Fig. 3. Power supply unit circuit diagram.

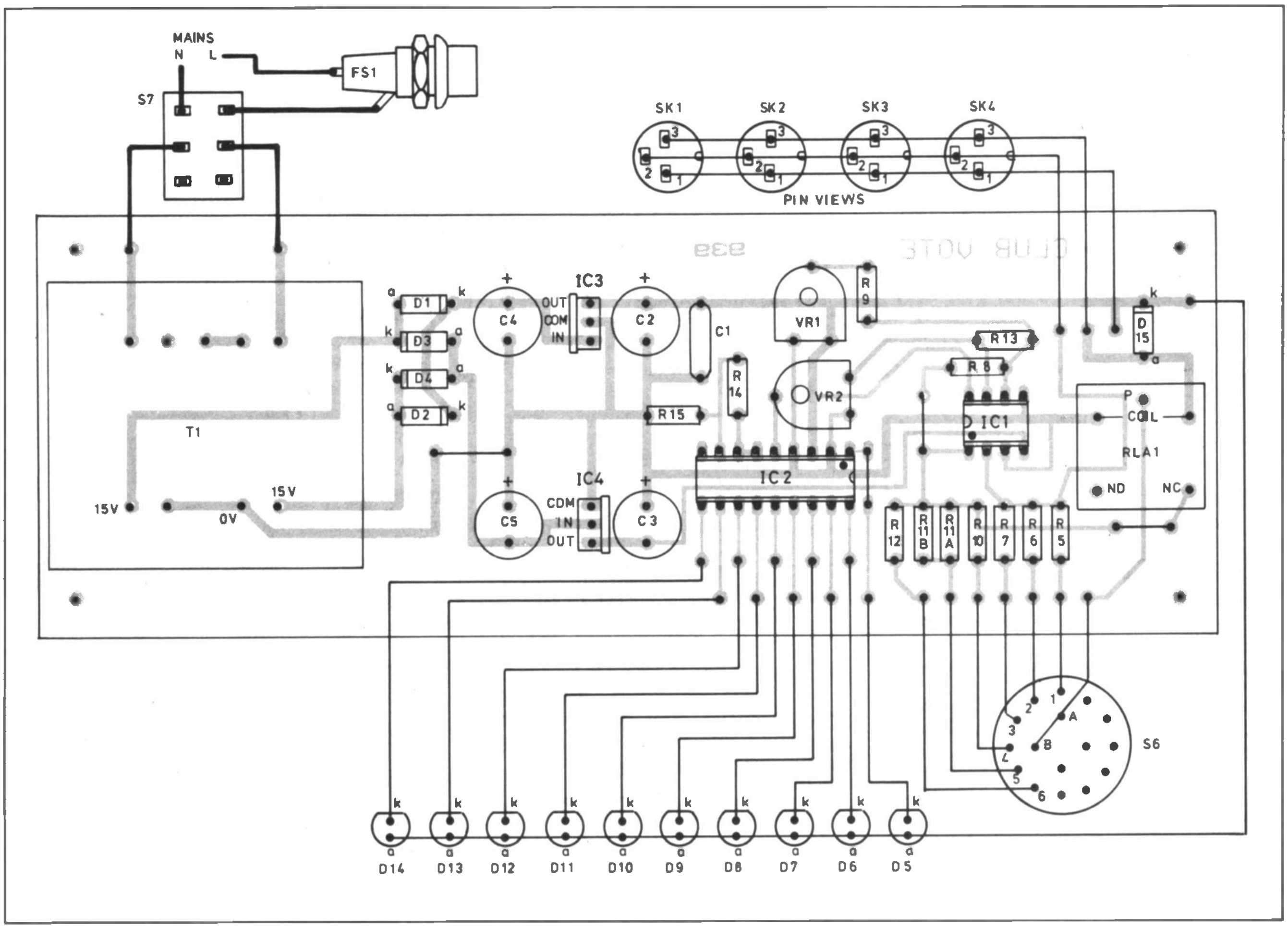


Fig. 5. Printed circuit board component layout and wiring diagram for the Club Vote Totaliser controller.

"*3s*" and a "*2*" (or some equivalent combination totalling 11) are pressed.

Since the adjustments to VR1 and VR2 are somewhat interdependent, they will each need to be repeatedly adjusted in turn until the correct maximum and minimum scores are recorded.

COMPONENTS

Resistors

R1 to R4	330k (14 off for each handset - see text)
R5	2k
R6, R14	1k5 (2 off)
R7	1k2
R8	5k6
R9	68k
R10, R11	1k (3 off - see text)
R12	300
R13	22k
R15	1k8

All 0.4W 1% metal film.

See SHOP TALK Page

Potentiometers

VR1, VR2	10k min. preset, lin. (2 off)

Capacitors

C1	100n polyester
C2, C3	100µ radial elect, 25V (2 off)
C4, C5	2200µ radial elect, 25V (2 off)

Semiconductors

D1 to D4, D15	1N4001 rectifier diode (5 off)
D5 to D14	l.e.d. (10 off), large, panel mounting, colours as required.
IC1	TL072 f.e.t. dual op.amp
IC2	LM3914 dot/bargraph driver
IC3	7815 +15V 1A voltage regulator
IC4	7915 −15V 1A voltage regulator

Miscellaneous

S1 to S5	s.p. push-make switch (5 off for each handset)
S6	4-pole 3-way rotary wafer switch
S7	d.p.d.t. mains rated toggle switch
T1	mains transformer, p.c.b. mounting, 15V-0-15V 6VA
RLA	15V relay, 400 ohms coil, s.p.c.o. contacts (low current rating), p.c.b. mounting

Printed circuit board, available from the *EPE PCB Service*, code 939; plastic case, 40mm × 60mm × 120mm (one off for each handset); plastic case, 188mm × 110mm × 100mm for controller; knob; 8-pin d.i.l. socket; 18-pin d.i.l. socket; 3-pin DIN sockets and plugs (2 off each for each handset – SK1 to SK4/PL1 to PL4); FS1, 1A fuse and panel mounting fuseholder; 3-core connecting cable; wire; solder, etc.

Approx cost guidance only **£43**
(4 handset system) *(Excl cases)*

CONSTRUCTION

As seen in the photograph, identical small plastic boxes were used to house the author's four handsets. As illustrated in Fig. 4, the groups of resistors housed in these are wired directly between the relevant solder tags of the pushbutton switches S1 to S4 and the appropriate pins of the DIN chassis-mounting connectors on the end of the boxes. Cables with complementary connectors on each end connect the handsets to the controller box.

The control circuitry is housed in a somewhat larger, but similarly styled box. This holds the power supply unit, the printed circuit board (p.c.b.), the l.e.d. display, and the "Number of Judges" switch S6.

The p.c.b. component layout is shown in Fig. 5, and the actual size copper foil track pattern for the controller and its power supply circuitry is shown in Fig. 6. This board is available from the *EPE PCB Service*, code 939.

Assemble the components on the board in order of resistors, diodes, d.i.l. (dual-in-line) i.c. sockets, capacitors, regulators, and then the transformer. Solder in and trim any excess wire lengths from each group of components before progressing to the next. Note that resistor R11, value 500 ohms, is made up of two 1 kilohm resistors connected in parallel.

The board is mounted on the bottom of the control box, with the l.e.d.s on the top part, as can be seen in the photograph. Holes will, of course, be needed in the box to accommodate the l.e.d.s, switch S6 and the sockets etc.

CHECKING OUT

After the complete assembly has been wired-up, thoroughly check it for errors of component positioning and polarity, and for unsatisfactory soldering.

Do not insert IC1, IC2 or the relay RLA until the power supply has been tested!

Immediately after switching on the unit for the first time, using a multimeter check

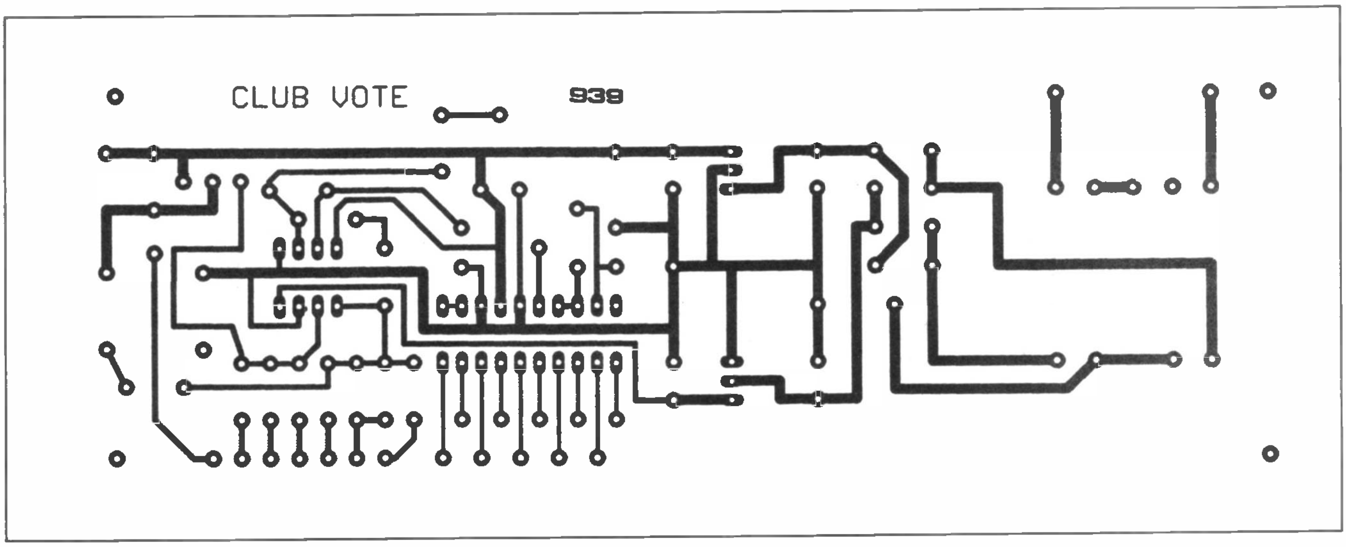


Fig. 6. Full size copper foil track pattern for the Club Vote Totaliser controller p.c.b.

that the output voltages from the two regulators IC3 and IC4 are at +15V and −15V, respectively. If any large voltage difference is observed, immediately switch off, unplug and recheck your construction.

When satisfied with the first test, switch off, insert IC1 and IC2, and solder in the relay. Then, having switched on again, adjust presets VR1 and VR2 as described above in the section headed "Offset", following which, the Club Vote Totaliser is ready for Judgement Day!

CLUBBED TOGETHER

The reaction of members of the author's club to their Club Vote Totaliser has been enthusiastic, once the initial misgivings of one or two members about whether it would give sensible results were allayed. In addition to use as a scoring system for judging competitions, it has also proved useful in selecting entries for inter-club "battles". □

CAUTION

When working on the unit, beware that mains voltages may be present and that they can be lethal. Extra care must be taken when adjusting the circuit whilst it is connected to live mains voltages. If in any doubt about any aspect of the mains connections, consult a qualified electrician.

SHOP TALK
with David Barrington

PIC-DATS

A ready programmed PIC16C55XTP microcontroller, together with software disk, for the *PIC-DATS* Development and Training System is available from Magenta Electronics, price £70. They are also offering a power supply (£8.99), 9-way PC lead (£6) and a 25-way lead (£7).

A full kit of parts for the PIC-DATS system is available from **Magenta Electronics, Dept EPE, 135 Hunter Street, Burton-on-Trent, Staffs. DE14 2ST.** The kit (code 853) includes all required hardware, and the necessary software (on 3·5 inch disks) which includes the programs PICSIM5X, PICPROG and MPASM. The cost of the kit is £99, including VAT and carriage.

The "plated-through-hole" double-sided printed circuit board is available from the *EPE PCB Service*, code 940.

R.F. Signal Generator

Several components needed for the *R.F. Signal Generator* can be classed as special items and may not be available locally.

The first and probably most expensive of these is the Jackson type-O twin-gang air-spaced tuning capacitor. This is available from **Maplin** (code FF40T) or **Electrovalue,** (☎ ***01784 442253***), code 5250/2. The epicyclic reduction drive unit and pointer were purchased from Maplin, codes RX42V and HB47B respectively.

The presets should be as specified or they will not fit on the p.c.b. These were obtained through **Electromail,** (☎ ***01536 204555***), code 186-750. The neon LP1 was also ordered from the same source and is the "slim-line" type, code 576-614.

The only listing we have found for the high frequency f.e.t. type 2N5486 has also been Electromail, code 641-910. The 3VA mains transformer has twin 15V secondaries and came from the above source, code 210-796.

Capacitor C9 **MUST** be a type rated for continuous operation across the mains supply. These are usually classified as class-X or class-Y types and are stocked by most component suppliers.

The p.c.b.s are available from the *EPE PCB Service*, codes 936 (R.F./Mod.) and 937a/b (Coil and Power Supply – pair).

MIDI Pedal

The only decision facing constructors of the *MIDI Pedal* should be whether to opt for a robust toggle type footswitch or a "stage" type foot pedal. A couple of fairly inexpensive pedal switches (GO28/28A) are currently listed by **Bull Electrical** (☎ ***01273 203500***). The rest of the components should be widely available.

Most of our component advertisers now stock a range of the more popular "computer i.c.s" and should have no trouble in supplying you with the 6402 UART chip and the 4MHz wire-ended crystals.

The crystal must be an HC-49/U type (i.e. wire-ended, with 7·5mm lead spacing). Be careful when fitting as crystals do not like heat! So only apply the soldering iron for only as long as absolutely necessary.

The printed circuit board is available from the *EPE PCB Service*, code 938.

Club Vote Totaliser

Although all components required to build the *Club Vote Totaliser* should be readily available from most of our component advertisers, some care will have to be taken when selecting parts.

As the relay has to handle fairly low currents, there are many relays on the market that will function in this circuit. However, before making the final purchase, it should be checked against the circuit board to see that it will fit on the board and, more important, that the contact arrangement agrees with the circuit.

Alternatively, the relay can be mounted off-board, if space in the control box allows, and then "hard wired" from the relay contacts to the board. The relay specified in the components list is the **Maplin** 3A 12V Miniature type, code YX96E. This relay is claimed to work from 9V to 16·8V.

Similar criteria can be applied to the choice of mains transformer. The quality of mains transformers on the market at the moment is very high, but the price does seem to vary quite considerably.

Specialist transformer makers such as **Newmarket Transformers** (☎ ***01638 662989***) should be able to offer a suitable "trannie" for this project. Likewise, advertisers such as **Greenweld, Bull Electrical, Service Trading** and **M&B Electrical** often run "special offers" on mains transformers and it might be worthwhile investigating further.

The transformer chosen for the model has twin primary and secondary windings and seems to be very similar to the one specified in the R.F. Signal Generator project.

The printed circuit board is available from the *EPE PCB Service*, code 939.

Name of the Game

There should be no "fun and games" trying to find components for *On Your Marks*, the first project in this month's *Name of the Game* series. All components appear to be standard off-the-shelf items and should be available from your regular component suppliers.

Don't forget to specify that you require a potentiometer with an *integral switch* when ordering the Volume control.

We do not expect any component buying problems to be encountered by anyone wishing to build the *Games Timer* – the second of the *Name of the Game* projects.

The only point to watch out for is the rating of the piezoelectric sounder. This must be capable of operating from a low voltage and its current consumption must not exceed the 10mA limit imposed as a load for the 4017 counter/divider i.c.

Nearly all of our components advertisers seem to carry a piezo buzzer that will meet the above requirements.

FOX REPORT

by Barry Fox

Not Playing the Game

Japanese companies Sega and Nintendo have used perfectly legitimate legal tactics to build a monopoly games empire. But now the Monopolies and Mergers Commission has decided that they are abusing that monopoly. The MMC's report on the Supply of Video Games in the UK runs to 255 pages, makes heavy reading and costs £19.75. It also has some infuriating blank spaces, like a censored government document, where the MMC has allowed the companies to keep issues like their royalty arrangements secret.

But for anyone with an interest in the games market, the report is still well worth reading.

Nintendo reacted quickly "rejecting any idea that the pricing of products has been either excessive or against the public interest". Sega directed all enquiries to one spokesman inside Sega Europe who switched on his answerphone and failed to return my call or provide a statement.

The DTI wants both companies to make games freely available for rental and also to give third party software companies freedom to make their own cartridges.

If they just turn on their answer machines and refuse to curb their "monopolistic practices" the Secretary of State (Corporate Affairs Minister Jonathan Evans of the DTI) can issue an order, by way of secondary legislation. He will pass a specific law aimed at breaking Sega and Nintendo's monopoly. Any further abuse by Sega and Nintendo would land them in court, up for contempt, with company executives personally liable for whatever fines and jail sentences the judge thinks fit.

Confrontation

This puts the British Government in head-on confrontation with Sega and Nintendo. If the Japanese do not do what the DTI asks, then the DTI will have to act or lose face.

The most interesting part of the report is the analysis of how both Sega and Nintendo have used patents, copyright and trademark protection to control the manufacture and sale of games cartridges which physically fit and electronically work only with their games consoles. This is what stops third party software companies making their own cartridges. They must either buy them from the Japanese or from licensed sub-contractors, at over twice the going rate for comparable ROM cartridges (e.g. £16 instead of £6). They must also pay royalties of up to $10 on each cartridge, in advance, and regardless of whether they succeed in selling any.

The MMC says this "distorts competiton". The "excessive" price of software cartridges (£50 or £60) lets Sega and Nintendo drive down the price of hardware consoles and ward off new competitors. Over seven million UK homes now have Segtendo consoles.

Exclusive Key

The key factor is that both companies have patented different security devices which make the cartridge and console talk to each other and work only if they contain matching code. This system stops the sale of unauthorised cartridges and also stops a cartridge from the US playing on a European console.

Even if competitors use Britain's patent laws to win compulsory licences from Sega and Nintendo to work these patents, the systems will not work without "know how" on the codes which are secret and copyright. Competitors cannot afford the time and money needed to reverse engineer each new code.

Both companies also have industrial design registrations on the physical appearance of their consoles and cartridges, and registered trade marks for game and system names. They also claim copyright in the computer code used in the consoles and cartridges. There is copyright in all manufacturing blueprints and the mask layout for integrated circuits.

Few companies have the legal resources needed to analyse which rights cover what aspects of the system, and whether they have any real legal strength. It took British company Codemasters four years to fight off Nintendo's allegation that the Game Genie video game enhancer infringed Nintendo's IPR.

Cease Gaming

Both companies use their patents and copyrights to stop, or earn more money from, the rental of games. Sega sends "Cease and Desist" letters to retailers citing the Copyright, Designs and Patents Act, 1989. The MMC fears this may "frighten" retailers into abandoning exchange schemes which are in fact legal.

Virtually all cartridges for Nintendo's games are supplied by Nintendo. Sega allows some third party manufacture, but charges a higher royalty to compensate.

The government has now given Sega and Nintendo three months in which to respond.

There is a significant sentence in the DTI's statement which says the British Government is "drawing the MMC's findings to the attention of competition authorities abroad, including those in the EC, the US and Japan".

The US, in particular, is very hostile to Segtendo's demolition of the local games firms, like Atari and Commodore. Last year in New York, Nintendo was "appalled" at a jury's decision to award $208 million in damages to a bankrupt company which claimed infringement of its patent. Nintendo who called the jury's decision "irrational... preposterous and flat wrong", said the "grossly inflated" award "defies belief" and "lends substance to a foreign distrust of the American legal system".

Patent Mapping

In 1975, very early in the TV games era, Wallace Kirschner and Lawrence Haskell of US electronics company Alpex filed for a patent on a "TV display control apparatus". Their aim was to improve on the first generation of "Pong" games, in which the games console could only play one type of game such as tennis or hockey. They wanted one console to be able to play many games when programmed with a plug-in cartridge.

US patent 4 026 555 is a very complex document which shows how the image on screen is broken down into a mosaic of around 32,000 picture point dots, and each dot mapped into RAM. A plug-in cartridge has ROM which stores a library of icon images, like a ball and hockey players. A computer chip works under the control of a player's joystick to shunt the icons from ROM to mapped positions in the RAM. Then the memory feeds its full picture image to the screen. All this happens so fast that the icons appear to move over a stationary background, depicting balls and players on a sports pitch. Although early games were in black and white, the patent says the mapping can work equally well in colour.

In the early 80's Alpex wrote to 73 games companies alleging infringement. Some settled out of court, but Nintendo would not. In 1983 Alpex ran out of money and filed for bankruptcy. Its lawyer worked on a contingency basis, for no fee but a share of any damages.

Nintendo argued that the jury "simply misunderstood" the technology, and how the patented electronics differ from the Nintendo Entertainment System, NES. The jury took only five hours to deliver a verdict, after a four week trial and overwhelming amount of highly technical evidence. It seemed pretty clear that the team of twelve just didn't like Nintendo.

Pico Releases PC Potential

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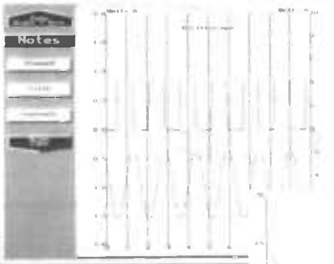

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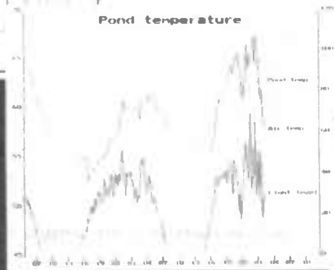
'Virtual instrument' software.



PicoLog
Advanced data logging software.

Hardware and software are supplied together as a package - no more worries about incompatibility or complex set-up procedures. Unlike traditional 'plug in' data acquisition cards, they simply plug into the PC's parallel or serial port, making them ideal for use with portable PC's.

Call for your Guide on 'Virtual Instrumentation'.

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8 channel Thermocouple Amplifier

- **Connects to your serial port - no power supply required.**
- **Supplied with PicoLog datalogging software**
  for advanced temperature processing, min/max detection and alarm.
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TC-08 **£ 199**
complete with PicoLog, software drivers and connecting cable.
A range of thermocouple probes is available.

SLA-16 Logic Analyser

Pocket sized 16 channel Logic Analyser

- **Connects to PC serial port.**
- **Up to 50MHz sampling.**
- **Internal and external clock modes.**
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with software, power supply and cables **£ 219**

ADC-100 Virtual Instrument

Dual Channel 12 bit resolution

- **Digital Storage Scope**
- **Spectrum Analyser**
- **Frequency Meter**
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The ADC-10 gives your computer a single channel of analog input. Simply plug into the parallel port.

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Electronics from the Ground Up

Mike Tooley, BA

Part 8

ELECTRONICS from the Ground Up is designed to provide you with a comprehensive and up-to-date introduction to the world of electronics. The series is based on *Electronics Workbench*, a remarkable software package that lets you use your PC to build and test a wide range of circuits. Back issues of earlier parts of this series are available – see *Back Issues* page.

In this eighth part we introduce bistables (flip-flops). These useful devices provide us with a means of storing transitory logic states for indefinite periods. They also provide us with a means of counting or dividing pulse waveforms. We begin by introducing the three common types of bistable and then continue by exploring some practical bistable applications.

BISTABLES

The output of a bistable has two stable states (logic 0 or logic 1) and, once set in one or other of these states, the device will remain at a particular logic level for an indefinite period until reset. A bistable thus constitutes a simple form of "memory cell" as it will remain in its latched state (whether set or reset) until a signal is applied to it in order to change its state (or until the supply is disconnected).

R-S BISTABLES

The simplest form of bistable is the R-S bistable (see Fig. 8.1). This device has two inputs, SET (S) and RESET (R), and complementary outputs, Q and $\overline{Q}$. A logic 1 applied to the SET input will cause the Q output to become (or remain at) logic 1 whilst a logic 1 applied to the RESET input will cause the $\overline{Q}$ output to become (or remain at) logic 0. In either case, the bistable will remain in its SET or RESET state until an input is applied in such a sense as to change the state.

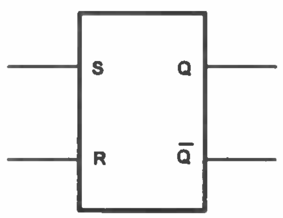
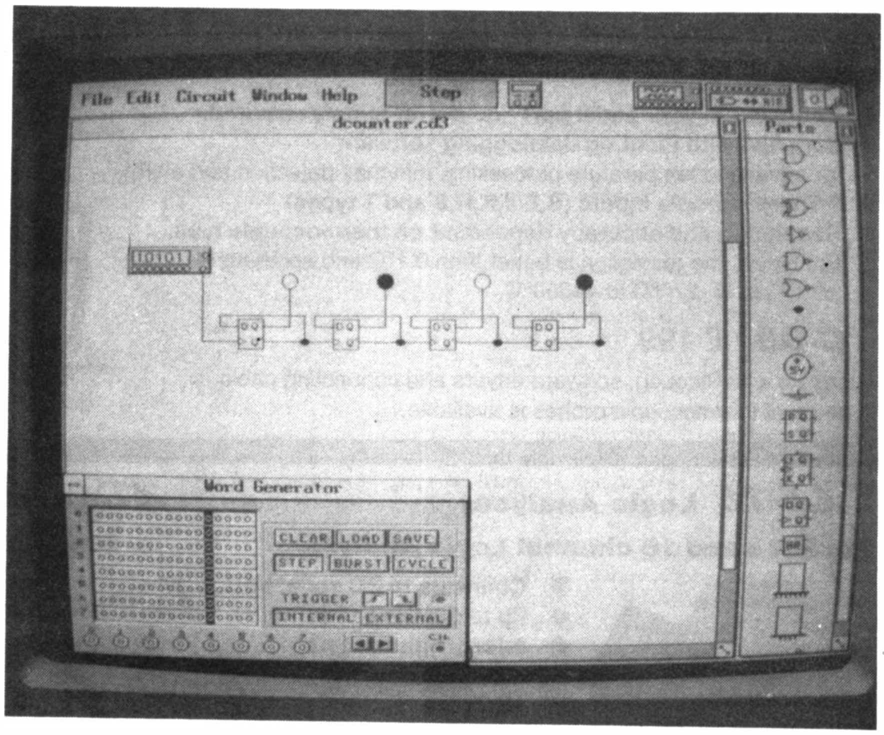


Fig. 8.1 Symbol for an R-S bistable.



A simple form of R-S bistable can be built using cross-coupled logic gates. Fig. 8.2 shows how this can be achieved based on NAND gates whilst Fig. 8.3 shows an alternative arrangement based on NOR gates.

Unfortunately, simple cross-coupled logic gate bistables have a number of serious shortcomings (consider what would happen if a logic 1 was simultaneously present on both the SET and RESET

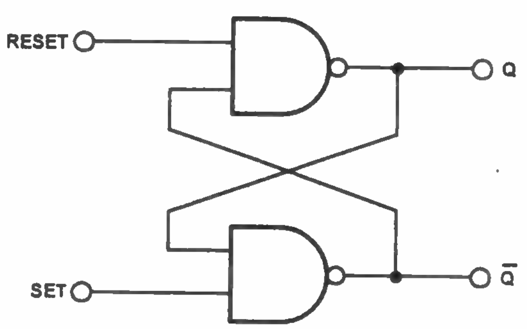


Fig. 8.2 R-S bistable using cross-coupled NAND gates.

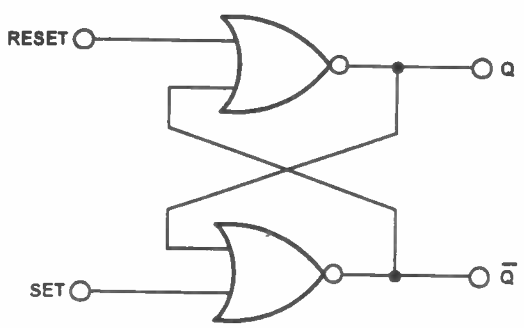


Fig. 8.3 R-S bistable using cross-coupled NOR gates.

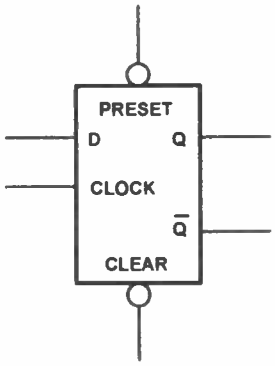


Fig. 8.4 Symbol for a D-type bistable.

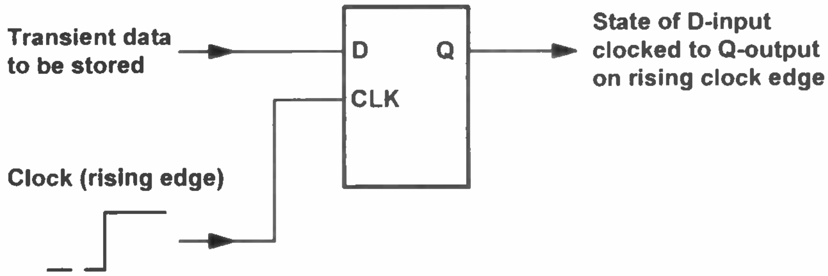


Fig. 8.5 D-type bistable operation.

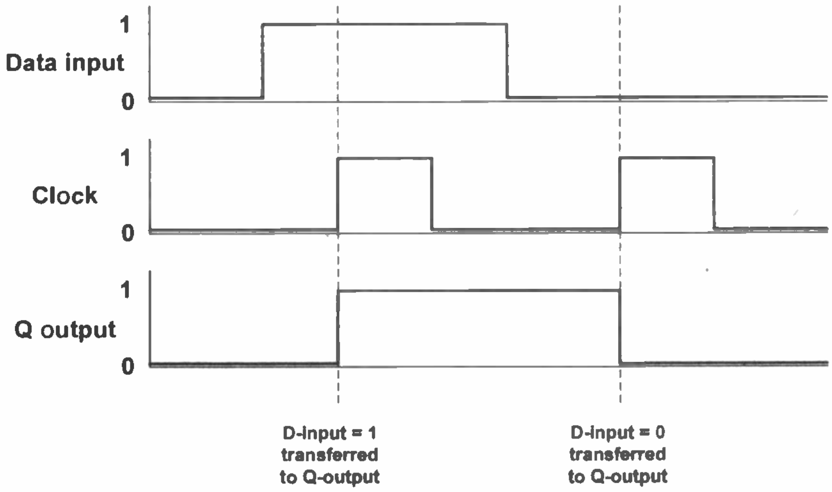


Fig. 8.6 Timing diagram for the D-type bistable.

inputs!). Thus practical forms of bistable make use of much improved purpose-designed logic circuits such as D-type and J-K bistables.

D-TYPE BISTABLES

The D-type bistable (Fig. 8.4) has two inputs: D (standing variously for data or delay) and CLOCK (CLK). The data input (logic 0 or logic 1) is clocked into the bistable such that the output state only changes when the clock changes state. Operation is thus said to be synchronous. Additional subsidiary inputs (which are invariably active low) are provided which can be used to directly set or reset the bistable. These are usually called PRESET (PR) and CLEAR (CLR). D-type bistables are used both as latches (a simple form of memory) and as binary dividers.

The simple circuit arrangement in Fig. 8.5 together with the timing diagram shown in Fig. 8.6 illustrates the operation of a D-type bistable. Note that the state of the D-input (i.e. the "data") is transferred to the Q output on a rising clock edge. Thereafter, the state of the Q output remains unchanged until the next rising clock edge appears and it will only then change state if the D-input has previously changed its state.

J-K BISTABLES

J-K bistables (Fig. 8.7) have two clocked inputs (J and K), two direct inputs (PRESET and CLEAR), a CLOCK (CLK) input, and two outputs (Q and $\overline{Q}$). As with R-S bistables, the two outputs are complementary (i.e., when one is 0 the other is 1, and vice versa). Similarly, the PRESET and CLEAR inputs are invariably both active low (i.e., a 0 on the PRESET input will set the Q output to 1 whereas a 0 on the CLEAR input will set the Q output to 0). Table 8.1 and Table 8.2 summarise the operation of a J-K bistable for various input states.

Table 8.1 Truth table for the J and K inputs of a J-K bistable

Inputs J	Inputs K	Output Q_{N+1}	Comments
0	0	Q_N	No change in state of the Q output on the next clock transition
0	1	0	Q output changes to 0 (i.e., Q is reset) on the next clock transition
1	0	1	Q output changes to 1 (i.e., Q is set) on the next clock transition
1	1	$\overline{Q_N}$	Q output changes to the opposite state on the next clock transition

Note: Q_{N+1} means "Q after next clock transition" whilst Q_N means "Q in whatever state it was before".

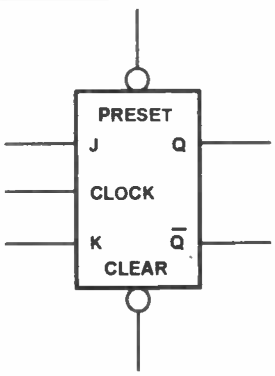


Fig. 8.7 Symbol for a J-K bistable.

Table 8.2 Truth table for the PRESET and CLEAR inputs of a J-K bistable

Inputs PRESET	Inputs CLEAR	Output Q	Comments
0	0	?	Indeterminate
0	1	0	Q output changes to 1 (i.e., Q is reset) regardless of the clock state
1	0	1	Q output changes to 1 (i.e., Q is set) regardless of the clock state
1	1	–	Enables clocked operation (refer to Table 8.1 for state of Q_{N+1})

Note: The PRESET and CLEAR inputs operate regardless of the clock.

Practical assignment 8.1: Bistable investigation

In this practical assignment using *Electronic Workbench* you will investigate the operation of three different types of bistable: R-S, D-type and J-K.

Objectives:

8.1.1 To investigate the behaviour of R-S, D-type and J-K bistables.

8.1.2 To compare the operation of the three types of bistable in 8.1.1.

Instructions:

1. Connect the circuit shown in Fig. 8.8 with the SET and RESET inputs on the R-S bistable both taken to ground (logic 0). Switch on the power to the circuit and observe the output state (Q) of the bistable and record this in Table 8.3.
2. Reconnect the SET and RESET inputs in turn as shown in Fig. 8.9, Fig. 8.10 and Fig. 8.11. For each combination, record the state of the Q output in Table 8.3.
3. Connect the circuit shown in Fig. 8.12 with the D-input taken to ground (logic 0).
4. Connect the clock output of *Electronic Workbench's* Word Generator to the clock input on the bistable (marked with a >). Set the Word Generator to STEP mode (as shown in Fig. 8.13).
5. Note the state of the bistable's Q output. Now use the Word Generator to generate a single clock pulse and once again observe the state of the Q output.
6. Repeat step 5 with the D-input connected to +5V (logic 1). Check that the bistable output changes state.
7. Connect the circuit shown in Fig. 8.14 with the PRESET input (top pin) taken to +5V (logic 0) and the CLEAR input (bottom pin) taken to ground (logic 0). Note the state of the output.
8. Repeat step 7 with the PRESET input taken to ground (0V) and the CLEAR input taken to +5V (logic 1). Once again note the state of the output.
9. Connect both J and K inputs to +5V (logic 1) in order to enable clocked operation (see Fig. 8.15). Connect the Word Generator's clock output to the clock input (marked with >) on the J-K bistable. Check the bistable's operation as a single-stage counter/divider by manually applying clock pulses (as for the D-type bistable).
10. Finally, select CYCLE mode operation on the Word Generator in order to produce a continuous train of pulses at the Word Generator's clock output (see

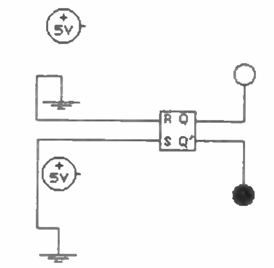


Fig. 8.8 R-S bistable with SET = 0, RESET = 0 (see Assignment 8.1).

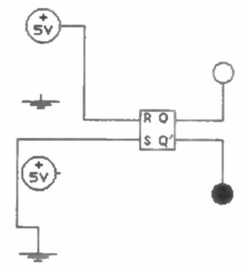


Fig. 8.9 R-S bistable with SET = 0, RESET = 1 (see Assignment 8.1).

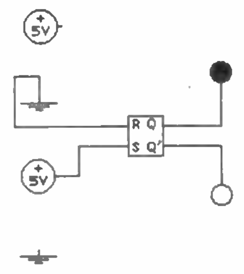


Fig. 8.10 R-S bistable with SET = 1, RESET = 0 (see Assignment 8.1).

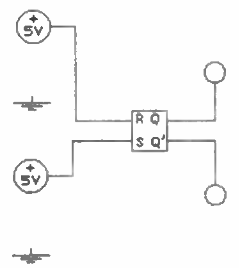


Fig. 8.11 R-S bistable with SET = 1, RESET = 1 (see Assignment 8.1).

Table 8.3 Truth table for the R-S bistable (see Assignment 8.1)

Inputs SET	RESET	Output Q	Comment
0	0		
0	1		
1	0		
1	1		

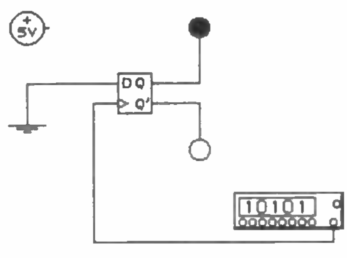


Fig. 8.12 D-type bistable (see Assignment 8.1).

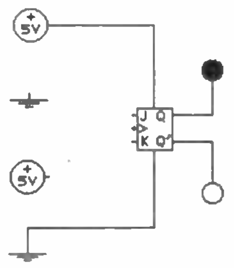


Fig. 8.14 J-K bistable with PRESET = 1, CLEAR = 0 (see Assignment 8.1).

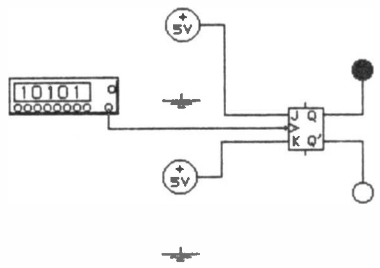


Fig. 8.15 J-K bistable in clocked mode with J = 1, K = 1 (see Assignment 8.1).

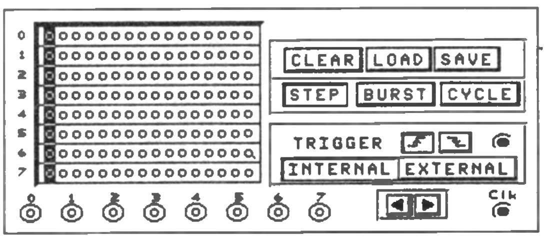


Fig. 8.13 Word generator in STEP mode (see Assignment 8.1).

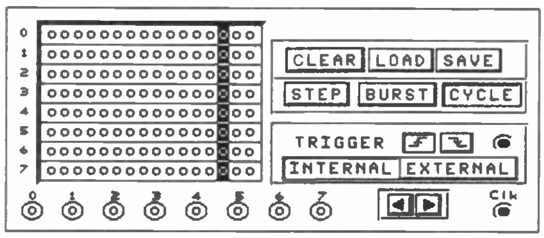


Fig. 8.16 Word generator in CYCLE mode (see Assignment 8.1).

Fig. 8.16). Observe the output of the bistable in this condition (the lamps on the bistable outputs should flash at half the rate of the clock input).

Conclusions:

To what extent have the objectives for this assignment been met? Comment on the operation of each type of bistable. Were the observations what you had expected? Justify the results obtained for the D-type bistable using the timing diagram shown in Fig. 8.6. Justify the results obtained for the J-K bistable in relation to Table 8.1 and Table 8.2. Compare the operation of the three bistable types. In what respect does the J-K bistable combine the characteristics of the two less sophisticated bistables?

BINARY COUNTERS

J-K bistables are the most sophisticated and flexible of the bistable types and they can be configured in various ways including binary counters (or dividers), shift registers, and latches. Fig. 8.17 shows the arrangement of a four stage binary counter based on J-K bistables. The timing diagram for this circuit is shown in Fig. 8.18. Each stage successively divides the clock input signal by a factor of two. Note that a logic 1 input is transferred to the respective Q-output on the falling edge of the clock pulse and all J and K inputs must be taken to logic 1 to enable binary counting.

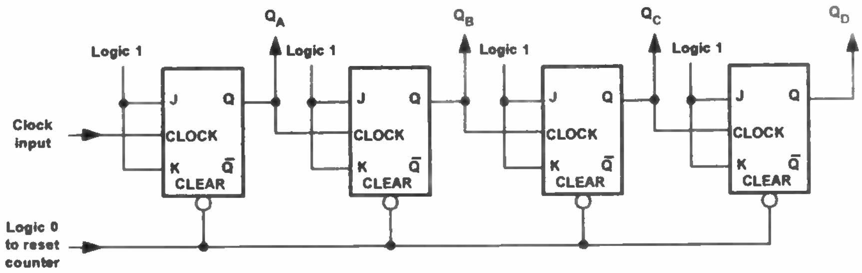


Fig. 8.17 A four-stage binary counter using J-K bistables.

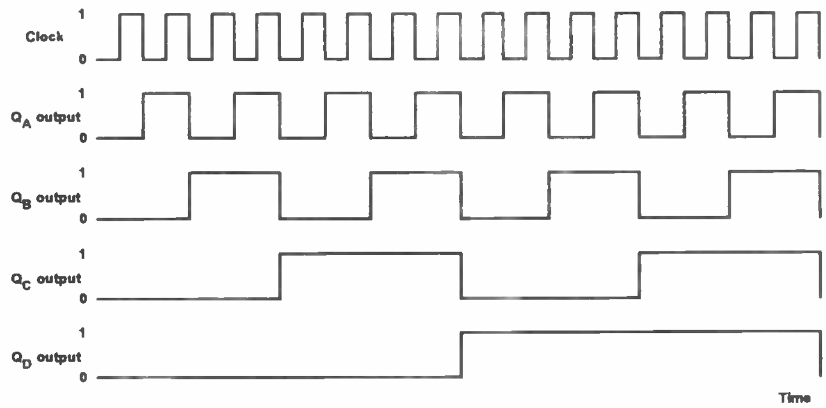


Fig. 8.18 Timing diagram for the four-stage binary counter.

GENERATING PULSE TRAINS

Bistables can be used in conjunction with conventional logic gates to generate asymmetric pulse trains. As an example, assume that it is necessary to generate the waveform shown in Fig. 8.19 from a regular square wave clock input. Fig. 8.20 shows how this can be accomplished using a two-stage binary divider (based on J-K bistables) together with a two-input AND gate. The complete timing diagram for this arrangement is shown in Fig. 8.21.

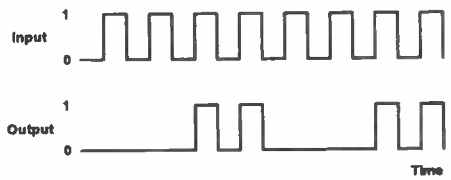


Fig. 8.19 Required pulse train.

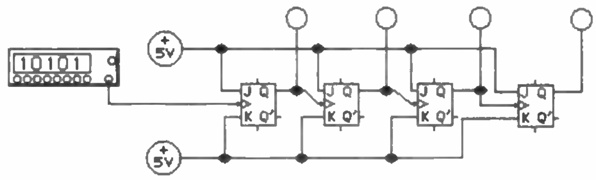


Fig. 8.22 Four-stage binary counter (see Assignment 8.2).

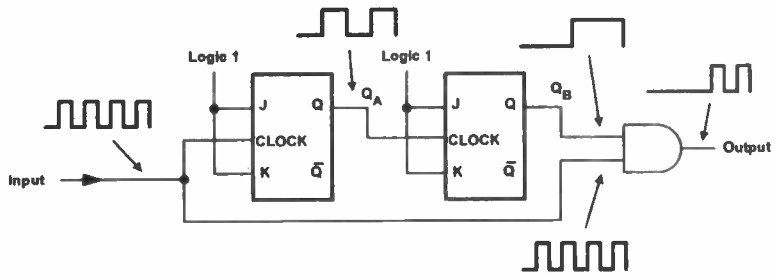


Fig. 8.20 Pulse generator using J-K bistables and an AND gate.

Practical assignment 8.2:
Counter investigation

In this practical assignment you will investigate the operation of a four-stage binary counter using J-K bistables.

Objectives:

8.2.1 To investigate the use of a J-K bistable as a binary counter/divider

8.2.2 To investigate the operation of a decade (divide-by-10) counter.

Instructions:

1. Connect the arrangement shown in Fig. 8.22. The clock input is derived from the Word Generator's clock

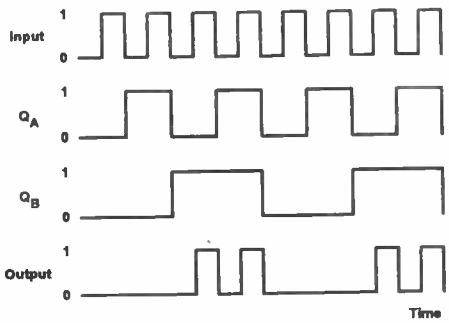


Fig. 8.21 Complete timing diagram for Fig. 8.20.

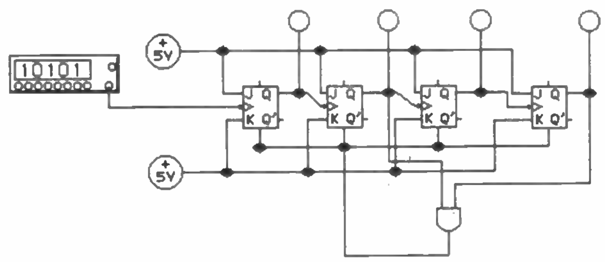


Fig. 8.23 Decade counter (see Assignment 8.2).

output. Note that all J and K inputs are connected to +5V (logic 1).

2. Apply clock pulses to the circuit shown in Fig. 8.22 and observe the state of the Q outputs (you may find it useful to construct a timing diagram after each clock pulse is applied). Check that each stage divides by two (i.e., its output is at half the frequency of the preceding stage). Check that the complete arrangement requires 16 clock pulses in order to produce one output pulse cycle (i.e., check that the circuit divides by 2^4 or 16).
3. Modify the arrangement shown in Fig. 8.22 by adding a two-input AND gate, as shown in Fig. 8.23. Note that the output of the AND gate drives the CLEAR inputs on all four J-K bistables.
4. Apply clock pulses to the circuit shown in Fig. 8.23 and observe the state of the Q outputs (you may find it useful to construct a timing diagram after each clock pulse is applied). Check that the complete arrangement requires 10 clock pulses in order to produce one output pulse cycle (i.e., check that the circuit divides by 10).

Conclusions:

To what extent have the objectives for this assignment been met? Comment on the operation of each counter arrangement (divide-by-16 and divide-by-10). Explain the operation of the decade (divide-by-10) counter arrangement. Can you suggest an application for this arrangement?

SHIFT REGISTERS

The arrangement of a four-stage shift register based on J-K bistables is shown in Fig. 8.24. The timing diagram for this circuit is shown in Fig. 8.25. Note that each stage successively feeds data (Q output) to the next stage. Note that all data transfer occurs on the falling edge of the clock pulse.

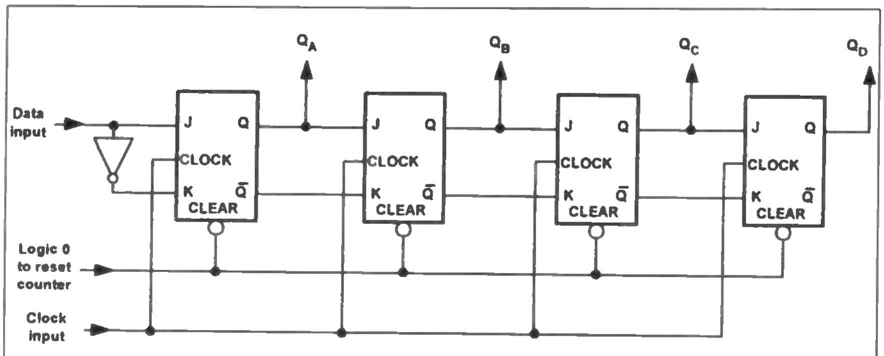


Fig. 8.24 Four-stage shift register using J-K bistables.

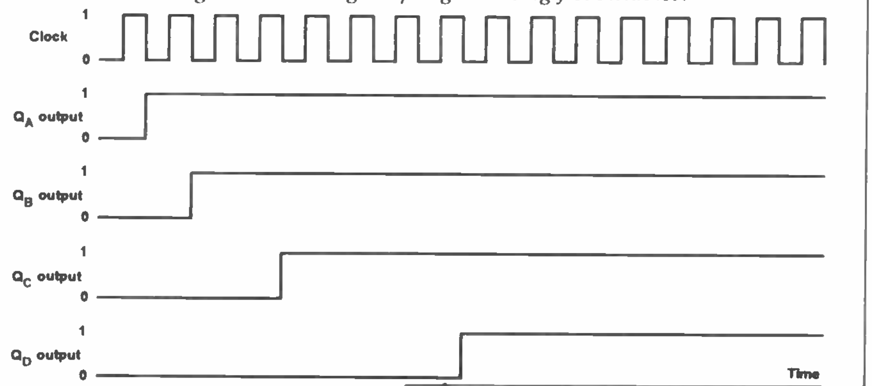


Fig. 8.25 Timing diagram for the four-stage shift register.

Practical assignment 8.3:
Shift register investigation

In this practical assignment you will investigate the operation of a four-stage shift register using J-K bistables.

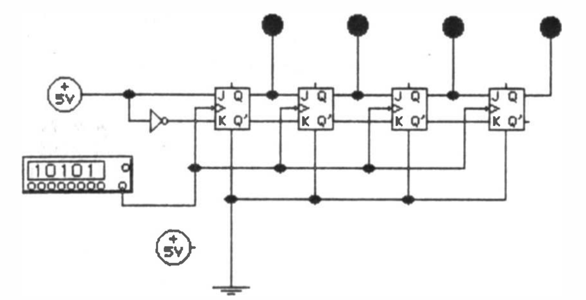


Fig. 8.26 Four-stage shift register (see Assignment 8.3).

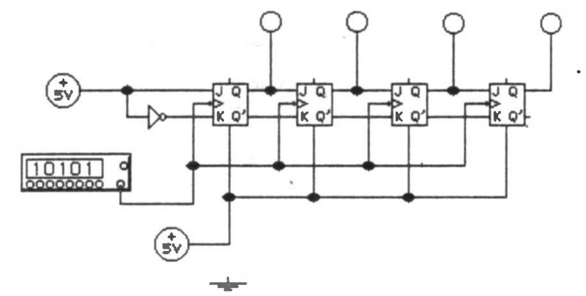


Fig. 8.27 Clearing the shift register (see Assignment 8.3).

Objectives:

8.3.1 To investigate the use of a J-K bistable as a storage element in a shift register.

Instructions:

1. Connect the arrangement shown in Fig. 8.26. The clock input is derived from the Word Generator's clock output and all J-K clock inputs are effectively connected in parallel. Note that the CLEAR input is connected to ground (logic 0) and the first stage data input is derived from +5V (logic 1).
2. Apply clock pulses to the circuit shown in Fig. 8.26 and observe the state of the Q outputs (you may find it useful to construct a timing diagram after each clock pulse is applied). Check that the data is transferred from each stage to the next on each clock cycle.
3. Once the shift register has become full (i.e., all Q outputs have changed to logic 1) modify the logic arrangement as shown in Fig. 8.27. The presence of a logic 1 simultaneously on all CLEAR inputs will reset all of the Q outputs to logic 0. Check that this happens and then reconnect the circuit as shown in Fig. 8.26 and repeat step 2 until the shift register is once more filled with data.

Conclusions:

To what extent have the objectives for this assignment been met? Comment on the operation of the four-stage shift register arrangement. Can you suggest an application for this arrangement?

BRAIN TEASER

This month's challenge for those of you who are using the full *Electronics Workbench* package is to devise a logic arrangement that will generate the waveform shown in Fig. 8.28. Test your solution using *Electronics Workbench*.

Answer to last month's Brain Teaser

Last month's Brain Teaser involved the design of a logic circuit that will produce a "majority vote" function. This circuit is to generate a logic 1 output whenever two or more of its three inputs are at logic 1. Fig. 8.29 shows one solution arrived at using the full version of *Electronics Workbench*.

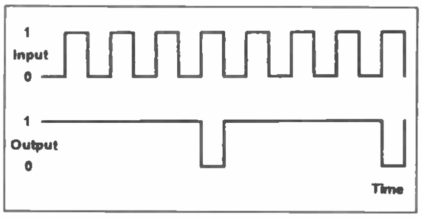


Fig. 8.28 See this month's Brain Teaser.

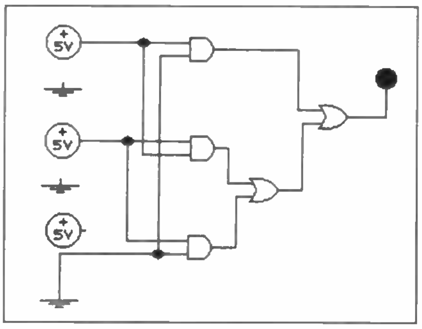
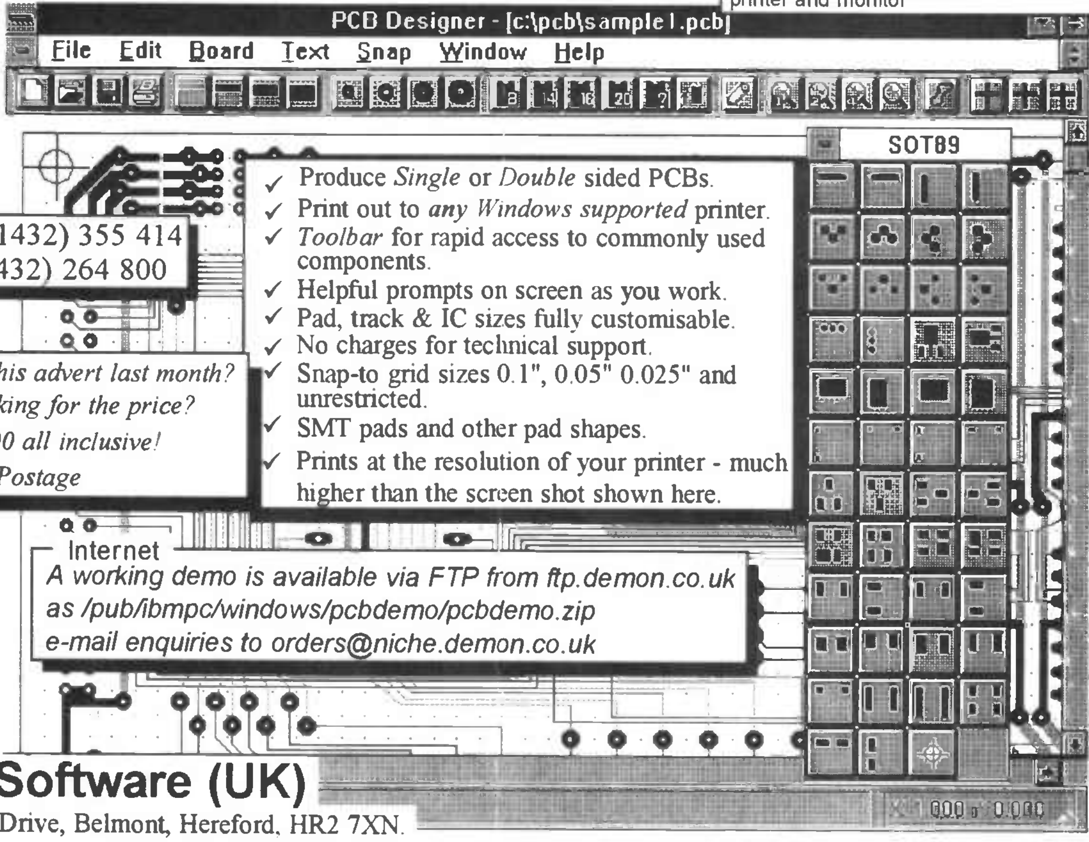


Fig. 8.29 Answer to last month's Brain Teaser.



PCB Designer - [c:\pcb\sample1.pcb]
File Edit Board Text Snap Window Help
SOT89

Techniques
ACTUALLY DOING IT!
by Robert Penfold

MAKING a project "look pretty" might not make it perform any better, but I think that we would all prefer to produce highly presentable projects rather than eyesores.

There are certainly some stylish cases available these days, but most of these are far from cheap. Using an inexpensive case does not necessarily mean that the finished product will look cheap and nasty, but it requires a little more effort to get a really neat looking finished product.

UP TO SCRATCH

A common complaint about many of the cheaper plastic and aluminium cases is that they are supplied "complete" with a few minor scratches. Aluminium cases that include folded sections often have marks left by the metal bending machine used to produce the folds.

The obvious way of covering scratches is to paint the case, but experience has shown that even minor scratches and other marks often show through one or two coats of paint. Also, it can be difficult to get most types of paint to adhere really well to aluminium and many types of plastic.

The easiest way of dealing with very minor scratches and blemishes is to polish them out. Practically any metal polish ("Duraglit", "Brasso", etc.) can be used to polish out minor scratches in both plastic and aluminium cases.

Alternatively, a fairly course grade of wire-wool (or a piece of "Brillo-Pad") can be used to make numerous minute scratches along the full length of an aluminium panel. Once thoroughly scratched the panel can be polished using a cloth, and this should leave a reasonable "brushed aluminium" type effect.

When using this effect, or simply polishing an aluminium panel, it is advisable to spray it with a protective coating of transparent lacquer. Otherwise the surface of the panel soon oxidises, leaving a rather unattractive and dirty appearance.

COVER-UP

The most reliable method of hiding scratches is to simply cover them over with a veneer of some type. Woodgrain effect veneers are suitable for outer casings, but are not generally applicable to front panels.

The same is true of the various leather grained plastic veneers. These are mostly sold as speaker covering material, but are equally suitable for use on project cases. These leather effect materials are not usually of the self-adhesive variety, but can be glued in place using any general purpose adhesive.

Mention of the Maplin brushed aluminium effect veneer has been made in previous articles, but it is well worth mentioning it again here. It seems to be genuine plastic, but it gives a very convincing imitation of the "real thing" (see photograph Fig. 1). It provides a very attractive and hard-wearing finish. Unlike many self-adhesive plastic veneers, it does not seem to deteriorate and become brittle after a few years.

It has a powerful self-adhesive backing that will reliably stick to aluminium or plastic panels. In fact it is so powerful that it is best to fit it accurately in position first time, as it can be difficult to remove and reposition it.

Being semi-rigid it is much easier to deal with than most other self-adhesive materials. It is easily trimmed to size using a sharp modelling knife, a metal ruler, and a cutting board.

Covering front panels of plastic cases can be a bit tricky due to their rounded corners. The best approach is to cut out a piece of veneer of the appropriate size but with "square" corners. Once it has been fitted to the front panel it is not difficult to trim the corners to shape using a small pair of scissors (see Fig. 2).

TO THE LETTER

Practically any project will look more professional if it has all controls and sockets neatly labelled. The easiest way of producing panel legends is to use a labelling machine.

Some of these produce very high quality labels, but are far too expensive for do-it-yourself use. Most stationers can supply less sophisticated labellers such as the "Dymo" types, and these only cost a few pounds complete with at least one self-adhesive tape.

In use you simply dial-up each letter and punch it onto the tape. A full set of labels for even a large project can be produced in just a few minutes.

The quality of the lettering is not particularly high, but the labels are very durable, which is more than can be said for some other methods of labelling. This certainly represents the quickest and easiest method of labelling front panels.

Rub-on transfers are the traditional alternative to self-adhesive labels. They are available in a range of letter styles and sizes from any stationers. It is probably best to use a fairly conservative lettering style for labelling controls and sockets.

For most projects letters about three or four millimetres high are a good choice. It can be useful to have a larger size (about five or six millimetres) if you want to label projects with names, such as "20W + 20W Amp", etc. Letters about 2mm to 2·5mm high are better for miniature projects, or where the available panel space is limited.

Self-adhesive labels can be placed onto an otherwise complete project without difficulty. The same is not true with rub-on transfers.

It is best to complete all the drilling and cutting first, and then add

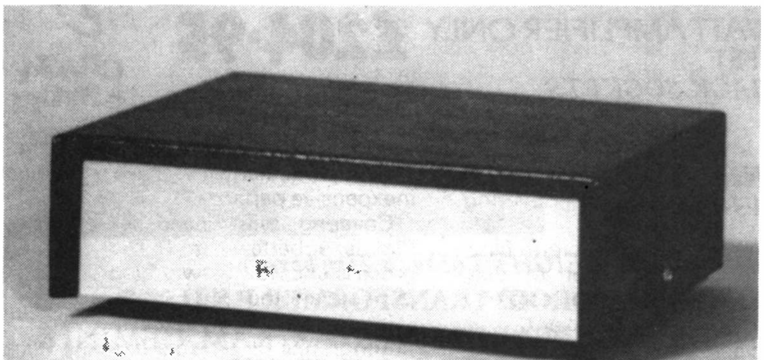
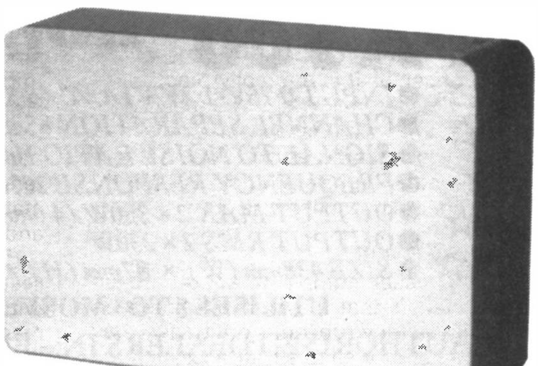


Fig. 1. A brushed-aluminium effect veneer can greatly enhance the appearance of an inexpensive instrument case.



A brushed-aluminium effect panel added to a plastic case. The corners are trimmed once the panel is in place.

the labels. Alternatively, complete and test the project, and then temporarily remove all the controls, sockets, etc. so that the labels can be added.

ON THE LEVEL

With self-adhesive labels results are usually quite good if you simply position the labels by eye. You can use lengths of tape across the panel to act as guides if you like, but this sort of approach has never been found to be really necessary in the past.

The same in not true of rub-on transfers. The transfer sheets normally have some alignment marks for use with tapes or other guide lines marked on the panel. The use of brightly coloured p.v.c. insulation tape acts as a good guide. It is easily stripped-off and repositioned if it is laid at an angle. Pull the tape fairly taut so that it is kept straight. If the transfers are not all on the same line, start at the top and work your way down.

When using rub-on transfers some careful planning and measuring is needed in order to produce a neat end result. In particular, you need to take great care to get the labels properly centred with their controls and sockets.

Centre marks can be placed onto the tape using a soft pencil or a fibre-tipped pen. Then, rather than starting with the first letter of each word and working to the end, start in the middle and work your way outwards. For example, with the word "treble", the "e" and "b" would be placed just each side of the centre mark.

In order to get things really neat you need to take into account the different widths of the letters. Look for letters that are wider or narrower than normal.

In the "treble" example the letters are all much the same width except for the "l". This is narrower than the other letters, which offsets the true centre point slightly to the left. To compensate for this the letters must all be shifted fractionally to the right.

Probably the easiest way of doing this is to place the centre mark on the tape slightly to the right of the true centre point. You have to guesstimate the offset, as it is not really practical to calculate it. This type of thing becomes easier with experience. Assuming that you use lettering about three to four millimetres high, any offset is unlikely be more than a millimetre or two.

COVER-UP

The usual complaint about rub-on transfers is that they rub-off almost as easily as they rub-on. Admittedly, they do not stick well to all surfaces, and are not particularly scratch resistant.

Some of these transfers do not stick at all well to metal panels, and it can be difficult to lay down the lettering in the first place. Results seem to be much better if the rubbing is accomplished using the proper spatula rather than an old ball-point pen, soft pencil, or other improvised implement.

The only way to make rub-on transfers truly scratch resistant is to cover them with a transparent film. The simplest method is to use one of the spray-on lacquers or fixatives that are available from art shops and some stationers.

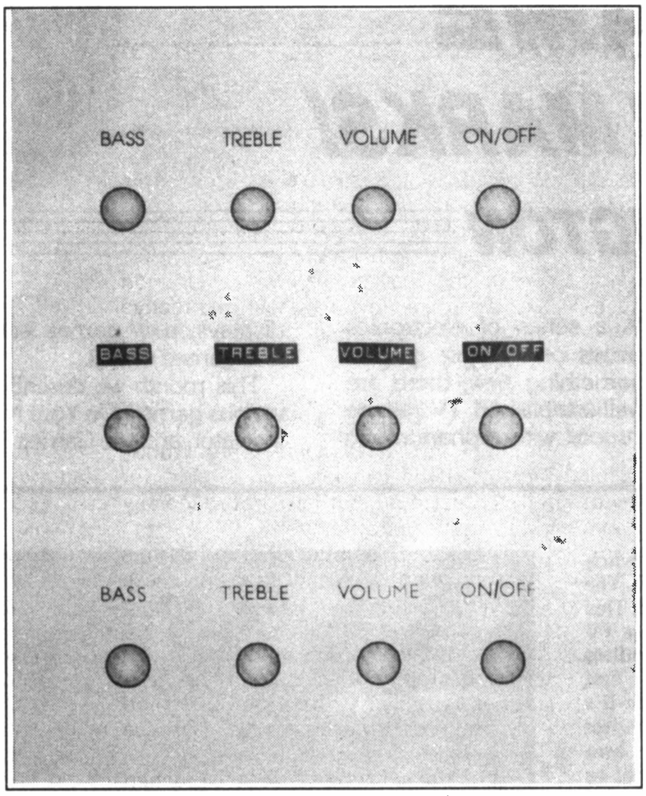


Fig. 3. Three "dummy" front panels. From the top to bottom: laser printout, Dymo labels and rub-down transfers.

To build-up a reasonably thick coating over the panel use *several* thin coats. Using one heavy application is likely to give an inconsistent finish. This still leaves the lettering vulnerable to scratches, but it is rendered much less vulnerable to general wear and tear.

The most resilient finish is produced by covering the complete panel with a self-adhesive transparent plastic material. This can be obtained from stationers.

In the past this method has been found difficult to implement because most material of this type is rather thin, and it can be difficult to get it to lay perfectly flat first time. Unfortunately, it is not possible to peel it back and try again since the transfers tend to come away on the plastic material, ruining both the covering and the lettering.

However, modern transparent films seem to be slightly easier to deal with, and can usually be carefully manoeuvred into place. Thicker grades are easier to use if you can obtain them. Start at one end of the panel using an oversize piece of film, and work your way steadily along to the other end of the panel. Sometimes small bubbles of air become trapped under the film, but these can be burst using a pin and then pressed out.

Using rub-on transfers and a self-adhesive film it is quite easy to make your own self-adhesive labels. This represents a very easy way of adding panel legends, but it provides quite neat results. The transfers adhere well to most plastic films, as do the films to front panels.

HI-TECH

If you own a computer and a printer, or have access to such equipment, it is well worth experimenting with computer produced labels. Virtually any word processor or DTP program can be used to produce simple labels. There will probably be several fonts (lettering styles) to choose from, together with a vast range of sizes.

There are various types of drawing program available, and virtually any of these should be suitable for producing simple labels, or even complete front panel overlays. Probably the best software for this type of thing is an illustration package ("Corel Draw!", "Design Works", etc.). These permit accurate drawing to scale, and have ranges of fonts and letter sizes to rival DTP programs.

The quality of the labels will be largely dependent on the printer used. There is a definite advantage in using a laser type, as apart from the excellent quality, there is no risk of the ink running if it ever gets damp. In fact, laser printers do not use ink at all, but instead use a fine powder plus heat to bind the particles together and fix them to the paper.

This enables printouts to be made onto various plastic films, including coloured types and a transparent self-adhesive material. Some of these are quite expensive, but excellent results can be produced. Laser printouts seem to be more rub-resistant than labels produced using rub-on transfers, but they can still benefit from a protective coating of clear lacquer.

If you print onto paper using an ink that is not fully waterproof it is virtually essential to give the lettering a protective coating. Spraying with a clear lacquer should fix the lettering properly, but it can have odd effects on the paper. It might turn it semi-translucent, particularly if you use a thin and inexpensive paper.

Covering with clear self-adhesive film is a better bet. If the covering process should go awry, you can soon print out another copy and try again.

It is worth looking at the exterior photographs of projects in some back issues of *Everyday with Practical Electronics*. This will give you some good pointers on how to go about the task of producing a more professional finish.

THE NAME OF THE GAME

ON YOUR MARKS!

ROY BEBBINGTON PART 3

THE Name of the Game is a series of electronics projects based on party games or TV quiz games. Featuring something old, something new, there are electronic versions of popular, well-established TV games such as *Countdown* and *Catchword* with alphanumeric displays, new games employing electronic word-making, and games of skill.

This month we describe two more accessories for use in various games: On Your Marks! is an audio/visual precedence indicator, and the Games Timer lives up to its name!

QUESTION: "What *P* is a switch that takes priority in time?" The *Precedence* switch, of course! This switch is a familiar accessory to most TV quiz games and prevents those endless arguments as to who was the first contestant to come up with an answer. It's no longer the contestant with the loudest voice: the first one to press their own pushbutton switch "captures" the right to answer by an unquestionable sure-fire audio/visual indication.

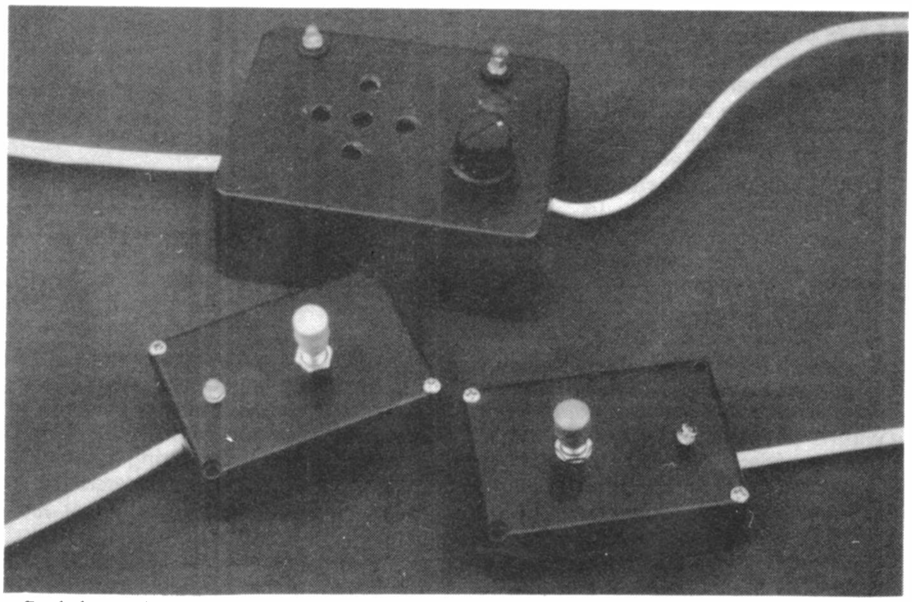
The circuit described here is a simple precedence indicator for two contestants (or two teams as in the TV game *Countdown*). The first contestant to press their pushbutton switches on a coloured l.e.d. on their key-pad and an associated l.e.d. of the same colour on the quiz controller's monitor. At the same time, an audible tone is sounded for about a second. The pitch of this sound is distinctive for each keypad to assist in distinguishing the successful contestant who pressed first.

The two associated l.e.d.s remain on constantly while the pushbutton is pressed and the opponent's pushbutton is inhibited. If non-latching pushbutton switches are used, then it is essential to hold the pushbutton down until the controller has checked and acknowledged the contestant's light on the monitor (green or red in this circuit).

If desired, latching pushbutton switches can be used to obviate the need to keep the buttons held down. In this case, after each question, the pushbutton, or pushbuttons, need to be reset ready for the next round.

FRONT PANELS

The quiz controller's box houses most of the circuit components and gives audio and visual indication of which contestant has captured the question. The front panel carries a red and a green l.e.d., and a combined rotary switch and volume control for on/off and audio output respectively. The lower end of the control is useful for those games where no audible output is required.



Both keypad panels carry a pushbutton and an l.e.d. The only difference between the keypads are the colours of the l.e.d.s. Each l.e.d. is wired in series with its matching colour on the control monitor panel and provides the contestant with a personal indication that the question has been captured.

APPLICATIONS

Although designed for use in the game *Countdown*, where hopefully you may be fortunate to solve the *Countdown* conundrum, there are other quiz games, like the TV game *Blockbusters*, which are almost entirely based on "finger on the buzzer" contests.

There are numerous quizzes where questions are asked of two players or teams. In fact, a precedence switch is useful in any situation where it helps to have a hand up first to score points. So, "On your marks!", here are the circuit details:

PRECEDENCE BISTABLE

The complete circuit diagram of the On Your Marks precedence indicator is shown in Fig. 1. It can be conveniently divided into three stages:

- precedence bistable,
- monostable, and
- output voltage-controlled oscillator.

The bistable multivibrator is formed by two gates of a quad two-input NOR-gate, IC1. Gates IC1a and IC1b each have their inputs wired together and are used as inverters. Since each input is biased to the +9V rail via resistors R1 and R2, at switch on, the inputs of both gates will be high. Consequently, both gate outputs, pin 3 and pin 4, will be low, and no l.e.d.s will be supplied with current. However, if a pushbutton is operated, then one of these high

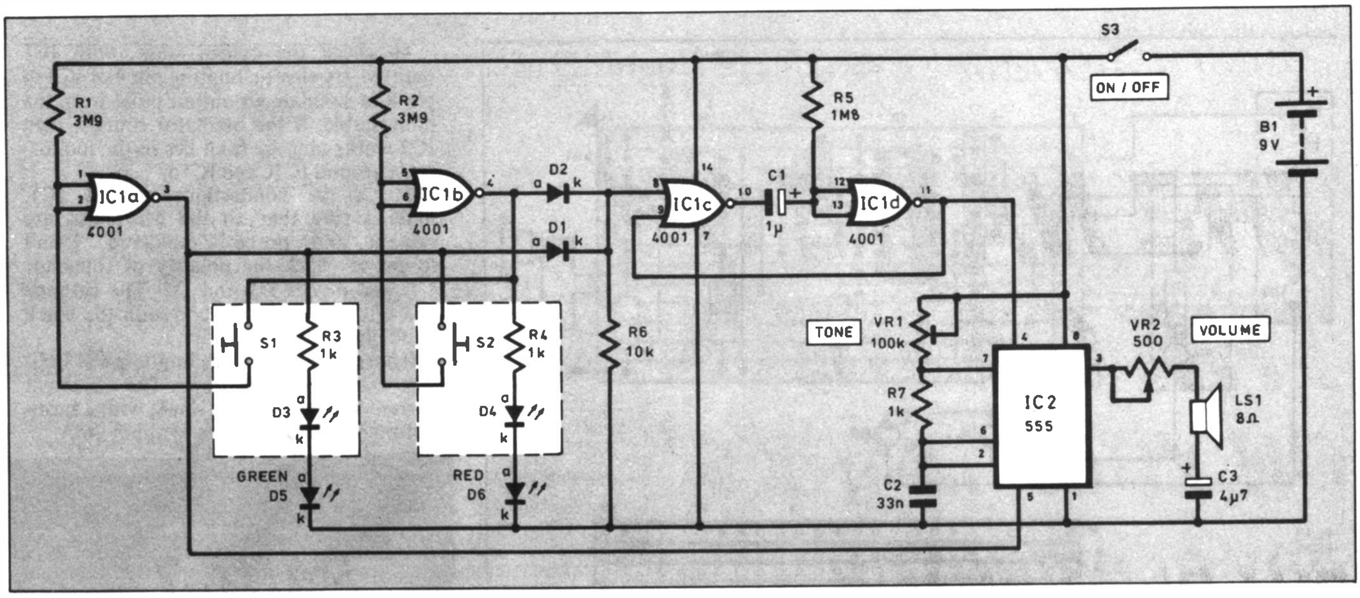


Fig. 1. Complete circuit diagram for On Your Marks! – the Audio/Visual Precedence Indicator.

inputs will be connected to the low output of the other gate.

For instance, if switch S1 is pressed, IC1a input pins 1 and 2 are connected to the low output pin 4 of IC1b, so inverter IC1a output pin 3 goes high and the green l.e.d.s (D3, D5) light. In this condition, if switch S2 is pressed, the high output on pin 3 is connected to IC1b input pins 5 and 6 and will only serve to keep the output of this inverter (pin 4) low.

Conversely, if S2 is pressed before S1, then IC1b output pin 4 goes high and the red l.e.d.s (D4, D6) light to the exclusion of the green l.e.d.s.

This part of the circuit is complete in itself, and can be used perfectly well as a precedence switch if the audio output is not considered necessary. Simply terminate the circuit before diodes D1 and D2.

MONOSTABLE

The monostable formed by gates IC1c and IC1d is inserted to ensure that when a pushbutton is pressed, the audio output tone sounds long enough to be heard, and to draw attention that a light is on, but not long enough to be annoying.

The output of this monostable controls the audio output stage formed around IC2 and operates as follows: At switch-on, input pins 12 and 13 of NOR gate IC1d are held high by the bias resistor R5 so IC1d output pin 11 is low. Since pin 11 is connected back to input pin 9 of IC1c, this latter input is low. With no pushbutton pressed, the other input of IC1c, pin 8, is also low, so the gate's output, pin 10, will be high.

When a pushbutton is pressed, even briefly, a positive pulse through diodes D1 or D2 will take IC1c input pin 8 high and the gate's output, pin 10, will go low. Capacitor C1 feeds this negative-going output pulse to input pins 12 and 13 of IC1d, which is used simply as an inverter, and consequently its output pin 11 goes high.

At the moment that the output pin 10 of gate IC1c goes low, C1 starts to recharge via resistor R5 and when it reaches the transfer voltage of gate IC1d the output on pin 11 goes low.

The duration of this positive pulse from IC1d is set to about 1·5 seconds, but the time constant can be varied by selecting other values for resistor R5 and/or capacitor C1. Note that the pulse length is fixed by this time constant and is not dependent on the time for which the input to IC1c pin 8 is held high.

COMPONENTS

Resistors

R1, R2 3M9 (2 off)
R3, R4, R7 1k (3 off)
R5 1M8
R6 10k
All 0·25W 5% carbon film

See SHOP TALK Page

Potentiometers

VR1 100k skeleton preset (vert.)
VR2 500ohms, rotary carbon with s.p.s.t. switch (S3)

Capacitors

C1 1µ radial elect. 63V
C2 33n polyester
C3 4µ7 axial elect. 25V

Semiconductors

D1, D2 1N4148 signal diode (2 off)
D3, D5 l.e.d. 5mm green (2 off)
D4, D6 l.e.d. 5mm red (2 off)
IC1 4001 quad 2-input NOR gate
IC2 555 timer

Miscellaneous

S1, S2 push-to-make switch (see text (2 off)
S3 s.p.s.t. switch (part of VR2)
LS1 8 ohm loudspeaker, 45mm dia.

Plastic ABS case 97mm x 73mm x 39.5mm internal measurement; ABS plastic case 75mm x 50mm x 25mm (2 off – for key-pads); stripboard 0·1 inch grid, 13 strips x 25 holes; 8-pin d.i.l. socket; 14-pin d.i.l. socket; PP3 9V battery and clip; knob; stranded connecting wire; solder, etc.

Approx cost guidance only **£13** *excl. batteries*

VOLTAGE CONTROLLED OSCILLATOR

The audio output stage, around IC2, uses the popular 555 timer as an astable multivibrator. The audio frequency is determined by the values of resistor R7, capacitor C2 and preset VR1. The positive-going pulse on output pin 11 of the monostable IC1d is applied directly to the reset input pin 4 of IC2. The oscillator output appears on IC2 pin 3 for the short duration of this input pulse.

The front panel Volume control VR2 operates in series with the loudspeaker LS1 to regulate the output level.

The 555 timer (IC2) has a control voltage facility for changing the oscillator frequency, which can be brought into play for varying the audio tones between the two pushbutton outputs. This is achieved by connecting one of the precedence bistable outputs (IC1a pin 3 in this case) to the control voltage input, IC2 pin 5. When S1 is pressed, the high output on pin 3 applied to this control voltage input gives a decrease in oscillator frequency.

CONSTRUCTION

The circuit is housed in three small plastic project boxes, as seen in the first photograph. Apart from three components housed in each of the keypads, the rest are contained in the controller's monitor box. The two i.c.s and their associated components fit comfortably on a small piece of 0·1in. matrix stripboard (13 strips × 25 holes), assembly details for which are shown in Fig.2.

The i.c.s are best kept in their original packing until needed and mounted last to avoid damage by static charges. Also, the use of d.i.l. sockets prevents damage by excessive heat to the pins during soldering.

The wire links should first be soldered in place and then the components. Make sure that diodes D1 and D2, l.e.d.s D3 to D6, and electrolytic capacitors C1 and C3, are connected the right way round. The colour of each front panel l.e.d. should match the colour of the appropriate keypad l.e.d., that is, adjacent to the lead-out wires.

The four connecting leads to each keypad are shown in Fig.2. All common connections between keypads are made within the controller's monitor. Multi-strand wires should be used for interconnections to allow flexibility.

The legs of the l.e.d.s protruding through front panels can be anchored by soldering to a small piece of stripboard. This also provides a convenient means of mounting for resistors R3 and R4 in the keypads.

Cable ends to and from the keypads can be bound with insulating tape or anchored with a restraining wire to take any tension off the soldered connections.

The front panel can be annotated with contestant numbers if preferred, using

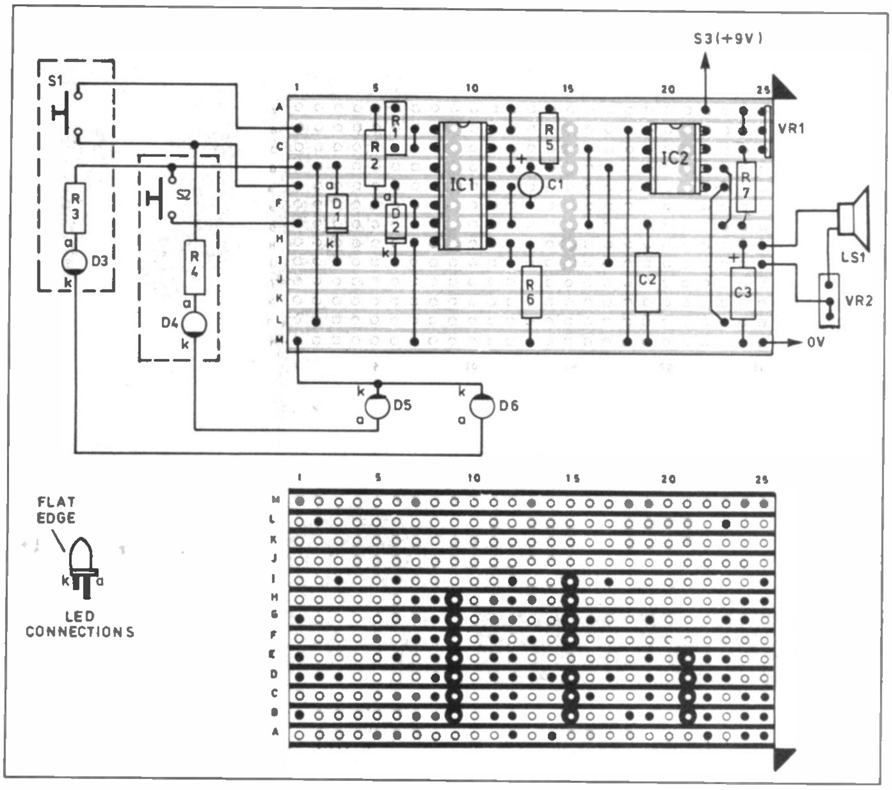
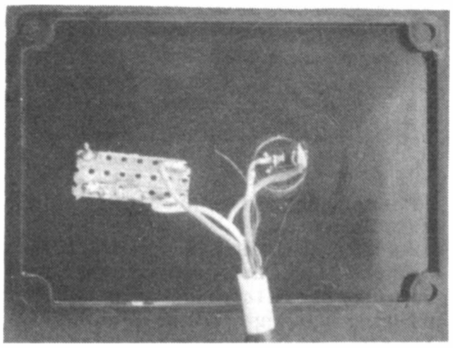


Fig. 2. Topside component layout and underside stripboard track cuts and solder joints for the On Your Marks unit. Components inside the dashed boxes represent the slave units.

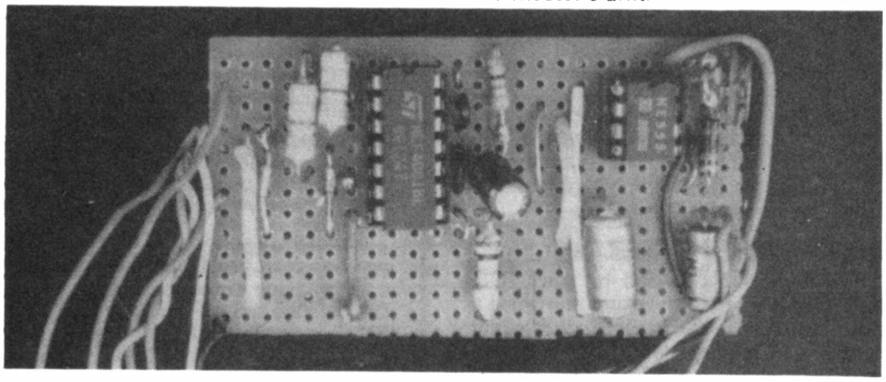
To check the output stage, with IC1 omitted, try short-circuiting pin 4 of IC2 to pin 8 to simulate an output pulse from the monostable. If the oscillator sounds, then IC2 works and the fault lies in the monostable around IC1c and IC1d.

Check the connections around IC1, making sure that all the wire links are present and properly soldered. Don't forget to check the polarity of capacitor C1, and diodes D1 and D2! The cathode end of each diode, the end with the black band, goes to pin 8 of IC1c.

Incorrect current consumption will indicate faulty circuit wiring. The quiescent current should be about 4mA; with a pushbutton operated this rises to about 9mA.



Above: Interior view of one of the contestant's pushbutton units. Below: Assembled stripboard for the Quizmaster's unit.

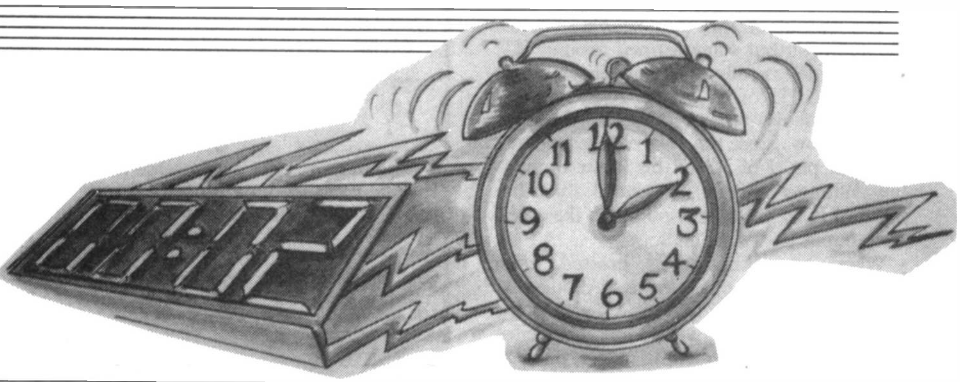


rub-down lettering. Several holes need to be drilled in the panel for the cone of the miniature loudspeaker; the rim can be glued to the rear of the panel.

CHECKING

Before connecting the battery, check over the wiring and make sure that all cuts have been made in the copper strips and that there are no whiskers of copper to cause short-circuits. If the l.e.d.s operate satisfactorily when the pushbuttons are operated, but there is no audible response, you can be sure that the precedence bistable works as far as diodes D1 and D2.

GAMES TIMER



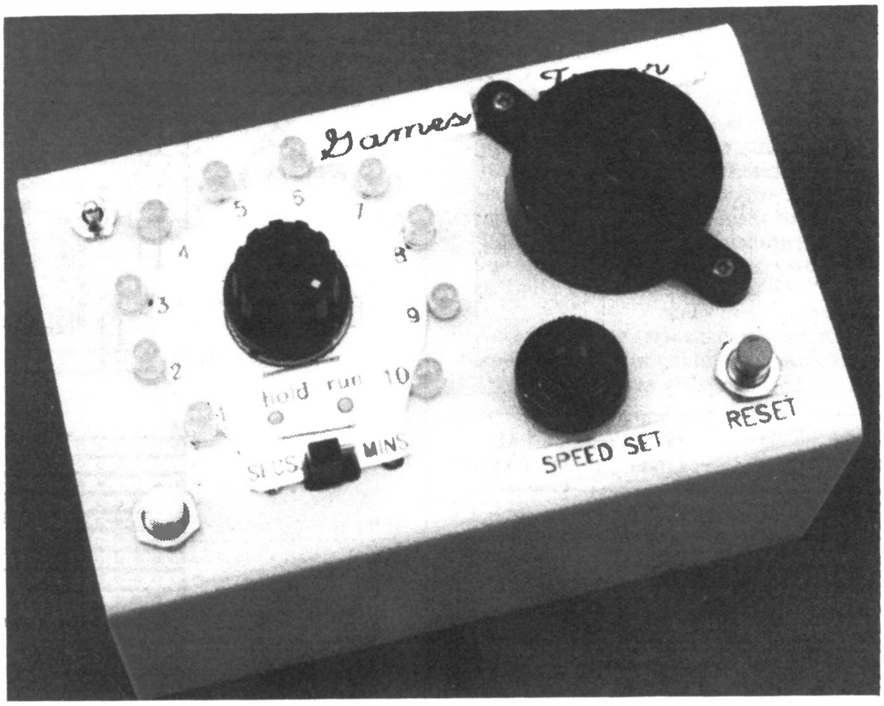
Switched selection of delay periods from a few seconds to over two hours enhances the tension of the game.

Many quiz games make use of a timer to limit action or thinking time in order to keep the game moving. It's a good idea that can be adapted for many board games, which could benefit from a time limit to cut time-wasting and to prevent players getting bored. Here's a timer that can be switched to give various delay intervals using a seconds or a minutes range, up to over two hours.

The simplest type of electronic timer allows a required delay to be set and then gives an audible indication when that time has elapsed. The 30-second timer in the TV quiz game *Countdown* is an analogue device using a mechanical pointer, like a second hand, that moves through an arc of 180 degrees. In a game situation, this heightens the suspense and interest, as the arm moves inexorably towards the 30-second mark and the buzzer sounds.

With the suspense effect in mind, this Games Timer has been designed with a ten l.e.d. display to give a visual indication of time elapsed and time remaining, in addition to the final sounder. Also, the unit incorporates a decade counter for the l.e.d. display and, either because it's there, or because the author has an economical streak, it begged the question: "What else can it be used for?".

Since there are many games that require a random selection of questions, and to save sorting, shuffling (and dropping) all those cards, the timer has thus been given an extra facility called *Decade Decision*, for want of a better name. Its function is described later.



PANEL EXPLORATION

The front panel photograph shows all the controls and indications for the Games Timer. It's a busy control panel, with five switches (one of them optional), ten l.e.d.s, a variable speed control and a piezo sounder.

The ten l.e.d.s are arranged concentrically around a 12-way rotary switch (S3 in Fig. 1) their anodes (a) each connected to adjacent contacts. The switch is wired so that when rotated through the first ten positions, each position represents a segment or unit of elapsed time.

Whichever position is selected, the preceding l.e.d.s are displayed in sequence, and the piezo buzzer (WD1) sounds when the selected l.e.d. is finally reached. This time will depend on the setting of the *Speed* control (VR1) and whether the slider switch (S1) is on *Seconds* or *Minutes*. Pressing the *Reset* switch button (S2) silences the piezo sounder and returns the timer to the start position, with only the first l.e.d. remaining on.

DECADE DECISION

The last two of the twelve switch positions of S3 (without l.e.d.s), labelled *Hold* and *Run*, offer the *Decade Decision* facility previously mentioned. This enables the timer to be used as a random number decade counter, e.g., for making a random selection from a sheet of ten questions. This facility is achieved by switching as follows:

- Switch S3 set to the *Run* position,
- *Speed* control VR1 rotated to the fastest position (clockwise),
- Switch S4 set to *On*. The l.e.d.s run sequentially from one to 10 continuously at a fast speed and the sounder is inhibited.
- Switch S3 from *Run* to *Hold* and the display will be held on the particular number being displayed at the instant of switchover.

If this random number facility is considered a useful addition to the timer, it is actually physically easier to freeze the number with a pushbutton switch instead of turning a rotary switch. This option is readily provided by disconnecting the lower end of resistor R5 from the *Hold* position of switch S3 and connecting it via an additional push-to-make switch to the *Run* position. (Hence the unmarked fifth switch seen in the panel photo.)

CIRCUIT DETAILS

Now we know what the Games Timer can do, it's time to look at the circuit diagram details, as shown in Fig. 1. The circuit is relatively straightforward and consists of two popular i.c. stages: a 555 timer, IC1, followed by a 4017 decade divider/counter, IC2.

Timer IC1 is wired in the astable multivibrator mode to produce positive-going output pulses at pin 3. The output pulse frequency is determined by the time

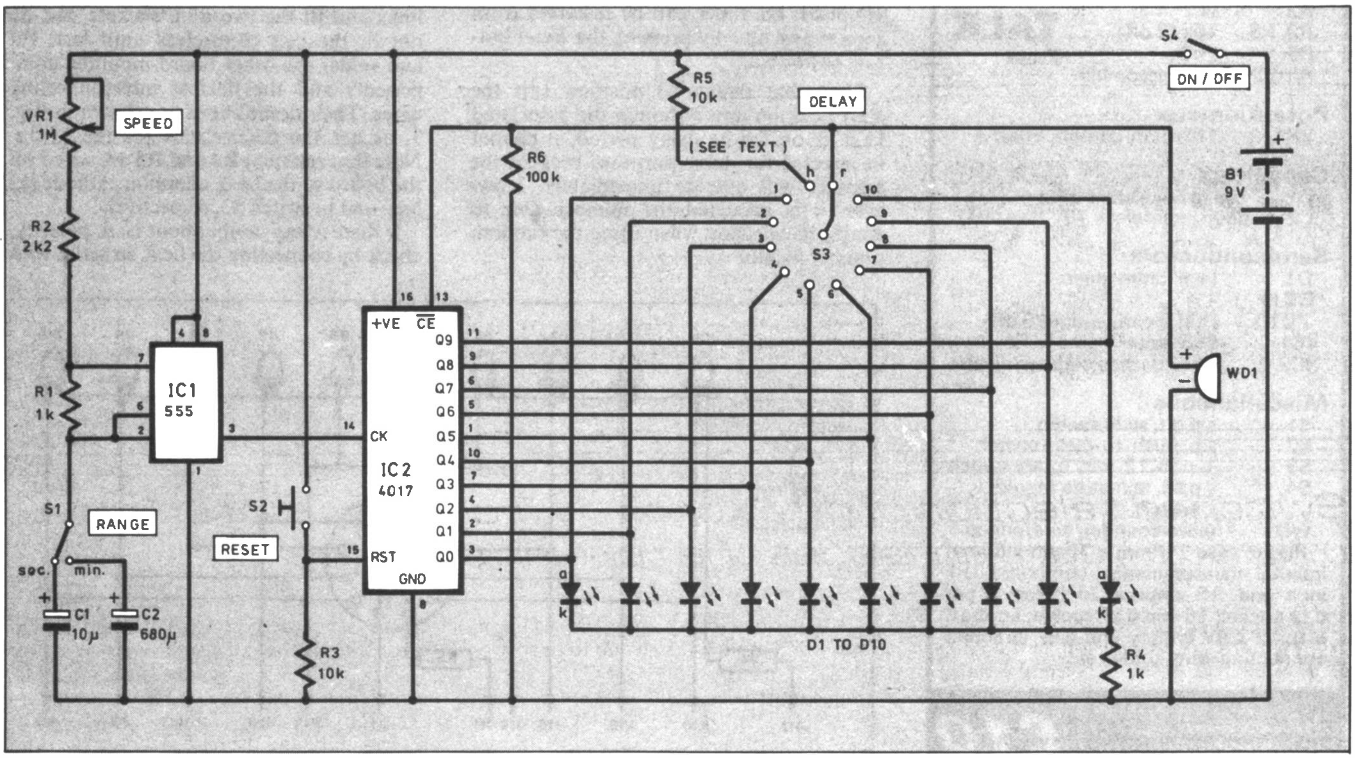


Fig. 1. Complete circuit diagram of the Games Timer unit. Note that D1 is a green l.e.d. the rest (D2-D10) are red types.

constant created by the values of resistors R1 and R2, potentiometer VR1, and either of the electrolytic capacitors C1 or C2 as selected by the *Secs/Mins* switch S1.

The tolerances of electrolytic capacitors are notoriously wide, so if you are looking for an accurate switchover from seconds to minutes it will be necessary to pad one or other of these capacitors with another value in parallel. Also, the value of 680µF for C2 may be difficult to obtain, but you can use a 470µF in parallel with a 220µF as a close equivalent value.

With the nominal values stated in the circuit diagram, the timing with the prototype unit was approximately as follows:

VR1	S1	DELAY UNIT	TOTAL DELAY
MIN.	SECS	0·05 sec.	0·5 sec.
MIN.	MINS	0·05 min.	0·5 min.
MAX.	SECS	15 sec.	150 sec.
MAX.	MINS	15 min.	150 min.

If desired, potentiometer VR1 could be calibrated as a multiplier of ×0·5 to ×15, or otherwise marked according to individual requirements.

COUNTER

From pin 3 of timer IC1, the output pulses are connected directly to input pin 14 of decade counter/divider IC2. The ten outputs of IC2 are each connected to the anode of one of the l.e.d.s (D1 to D10) and to the appropriate first 10 contacts of rotary switch S3.

At switch-on, the pulses routed to the counter IC2 cause each of its outputs to go high in turn, causing the associated l.e.d.s to light in sequence. However, any of the outputs can be routed via switch S3 to the counter's clock enable pin 13 and to the buzzer WD1. When, via S3, pin 13 goes high the count is halted, the currently lit l.e.d. stays on and the sounder operates.

For example, if switch S3 position 3 is selected then l.e.d.s D1, D2 and D3 will be triggered on in turn, but l.e.d. D3 will stay on because the count has now been inhibited since the clock enable, pin 13, is held high by the counter's third output (pin 4). Normally, clock enable pin 13 is held active by the low on the output selected. In switch S3 position 11, IC2 pin 13 is held low by resistor R6, allowing the count to continue indefinitely. When the count is inhibited, the timer can be restarted from zero at any time by pressing the *Reset* button, switch S2.

Note that switch S3 position 1 is the start position and although the associated l.e.d. is on for its delay period, it cannot be selected for delay purposes because the sounder will operate immediately. However, it is allocated the number *One* to enable its selection when using the random number facility.

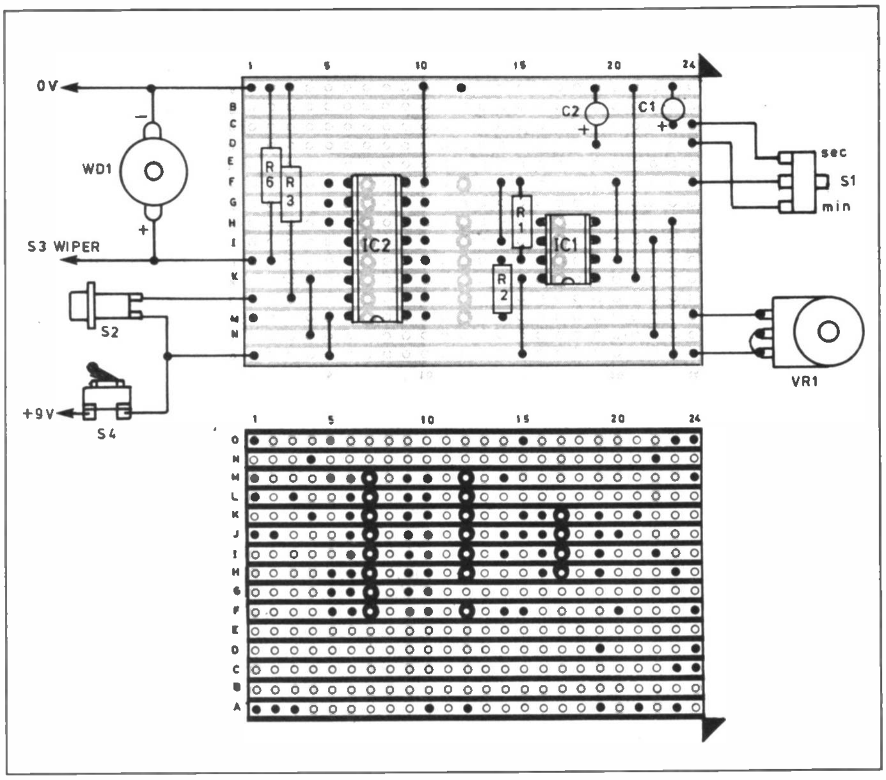


Fig. 2. Topside component layout and underside stripboard track cuts and solder joints for the Games Timer.

CONSTRUCTION

The majority of the components are located on a piece of stripboard, 0·1 inch matrix, 15 strips by 24 holes, assembly details for which are shown in Fig. 2.

Start by making the necessary cuts in the copper track as shown in the underside layout drawing, using a drill bit or a tool specifically intended for the job. It is then advisable to check with a continuity tester or ohmmeter that there are no whiskers of copper shorting the tracks. Also drill out the holes in the front panel as required by the l.e.d.s, switches and the buzzer.

Solder into the stripboard the rigid wire links and fit the two d.i.l. sockets, but do not fit the i.c.s themselves until last. Fit and solder the other board-mounted components and the flexible interconnecting wires. Their destinations are shown in Fig. 3, as are the connections for the l.e.d.s. Note that resistors R4 and R5 are wired off the board to the l.e.d. common cathode (k) line, and to switch S3, respectively.

If there is any doubt about l.e.d. polarity, check by connecting the l.e.d. in series with

COMPONENTS

Resistors — See SHOP TALK Page
R1, R4 1k (2 off)
R2 2k2
R3, R5 10k (2 off)
R6 100k
All 0·25W 5% carbon film

Potentiometer
VR1 1M rotary carbon, linear

Capacitors
C1 10µ radial elect. 16V
C2 680µ radial elect. 16V (see text)

Semiconductors
D1 l.e.d. 5mm green
D2 to D10 l.e.d. 5mm orange (9 off)
IC1 555 timer
IC2 4017 decade counter/divider

Miscellaneous
S1 s.p.d.t. slide switch
S2 s.p. push-to-make switch
S3 1-pole 12-way rotary switch
S4 s.p.s.t. miniature toggle switch
WD1 piezo sounder, wire-ended

Plastic case 110mm x 70mm x 50mm internal measurements; stripboard 0·1 inch grid, 15 strips x 24 holes; 8-pin d.i.l. socket; 16-pin d.i.l. socket; knob (2 off); PP3 9V battery and clip; stranded connecting wire; solder, etc.

Approx cost guidance only **£10** *excl. batteries*

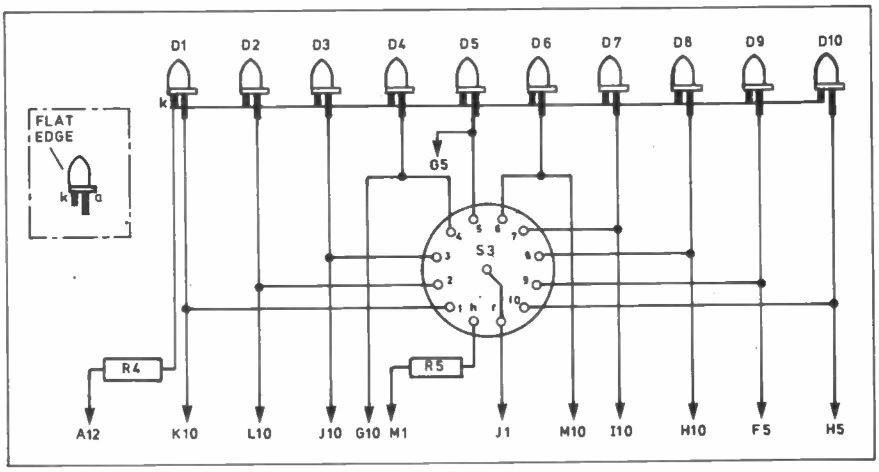


Fig. 3. Switch and l.e.d. wiring details.

a PP3 battery and a 1k resistor. The l.e.d. will light when the anode end (*a*) is connected to the positive (+) of the battery and the cathode end (*k*) is connected via the resistor to the negative (−) of the battery.

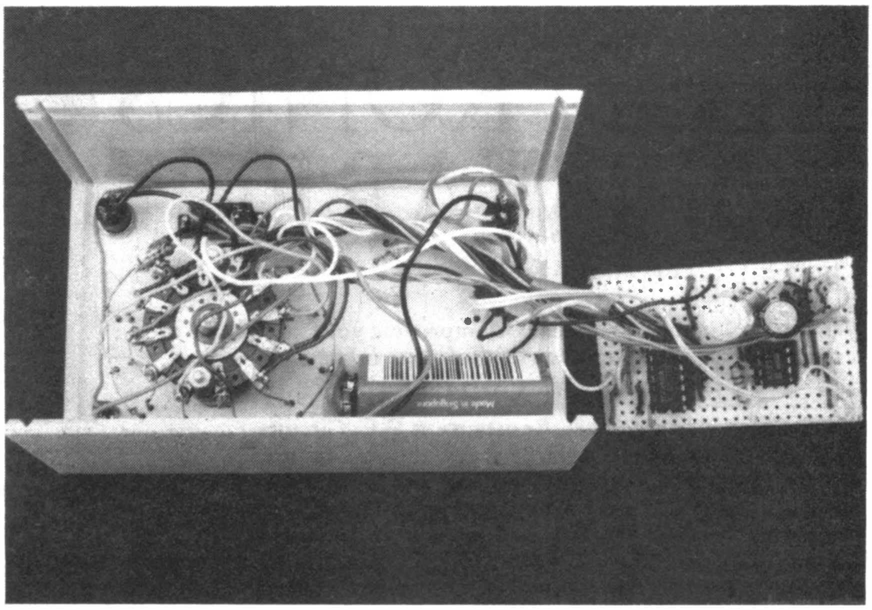
The piezo sounder must be capable of operating from a low voltage and its current consumption must not exceed the 10mA maximum limit imposed as a load for a 4017 output.

The unit can be adequately powered from a 9V PP3 battery as the current consumption is only about 12mA.

OTHER NAMES OF THE GAME

Part One of The Name of the Game described *Counterspell*, which allowed random selection of alphabet characters. *Counterspin* in Part Two showed how to build a versatile random number selector. Back issues of earlier parts of this series are available – see *Back Issues* page.

Next month we present *Starstruck* in which the aim (literally) is to make a star change colour by throwing soft balls at it's neighbouring stars! □



Interior view of the Games Timer showing the switch and stripboard wiring details.

Ohm Sweet Ohm

Max Fidling

Butter wouldn't melt . . .

One particular morning at breakfast time, I had just dished out Piddles' cat food into his favourite bowl and had sat down to tackle my own toast and marmalade. The toaster nearby bore the marks of one of my earlier repairs, since I had lost some of the chromium fasteners when I took it apart, so I'd re-assembled it using some odd self-tapping screws instead. A minor detail which did nothing to instil others' faith in my abilities!

The butter was rock hard. Somehow it had undergone a cryogenic freezing process overnight in the fridge. Perhaps the Boss intended to preserve it for posterity, I pondered wistfully, as I chipped away. Whatever had happened, I could only hack little bits off the butter rather than knife out a copious hollow in the yellow slab as I normally did. "Pity you can't invent something useful for a change!" came the early morning opening salvo from the Boss.

The granite-hard butter set me thinking and that familiar glint came into my eye as I pondered this latest problem. I spotted a Tupperware butter dish – brand new and still in its box – on the kitchen worktop. Of course! An electronic butter warmer! Bound to earn me some long overdue respect! I pocketed the butter dish and sauntered into the workshop, munching some toast and marmalade.

Buried somewhere in a large chest of junk I had a length of waterproof heating wire. I think it had originally been intended for an electric blanket: I had bought it by mail order several years ago and had never got around to twiddling with it. It had a clear plastic flexible outer sheath, with a core of nichrome heating wire snaking through the middle. An idea formed . . .

Even with my trusty Weller 100W Heating Gun, my Doomsday weapon of last resort, I couldn't solder the wire ends so I fitted an old ceramic terminal block, after having guestimated the resistance and worked out the likely wattage of a couple of metres of the stuff. Plugging in and switching on, the waterproof wire writhed a little as it heated up – looks promising, I thought, as I switched off and tackled the next phase of this pioneering project.

Hot Wired

The plan I had in mind was to make a gadget which could be placed over the butter with a view to thawing it from its sub-zero state, back to spreadability. By fitting the heating wire around the inside of the butter cover and placing it over the rock-hard lard, the butter could thaw out, I theorised. Piddles had by now waltzed in, licking his lips, having been shooed out of the kitchen.

How to fit the wire to the butter cover, that was the question. Scanning my shelves of assorted bits and pieces, I spotted the Super Glue, a valuable member of my repair armoury. I placed several spots of the acrid adhesive inside the butter cover and started to lay the heating cable down into position, spiralling it around the butter dish until the whole of the inside was covered. The Super Glue had set within minutes and soon the heating wire wouldn't budge.

So far so good. By now Piddles had found my half-finished toast on the bench and had starting scoffing it with gusto. I found an old three-pin plug and had it fitted in a flash, as it were, before pushing it into the workshop's ELCB (probably my only gesture towards my personal safety).

Switching on, the neon indicator on the wall socket glowed brightly as my latest brainchild received the full force of Electricity Board Domestic Tariff. Much to my dismay, nothing happened – though I wasn't sure what to expect, not having built an electrically heated butter warmer before.

Could I patent it? Maybe I could sell it to the Chinese. Fidling Butter Warmers could take the world by storm, I fantasised.

At precisely the point where I had visions of millions of these things pouring off a Far Eastern production line (with Pound signs flashing around my eyes, fruit-machine-like), an ominous plume of smoke started to ascend into the atmosphere of the workshop. Perhaps the soldering iron was on – no! Tupperware's finest and newest food-grade polypropylene butter dish (with hygienic base, complete, Quantity One, as it said on the box) seemed to be disappearing into a molten heap on the bench!

I quickly switched off but the damage was done. A terminally re-moulded Tupperware butter dish after a melt-down was not a pretty sight, as I scraped its remains off the bench. Another failure, unfortunately, I consigned the thermoplastic heap to the bin. I headed back to the kitchen. How would I explain the demise of the dish to the Boss? Perhaps I could blame it on the cat . . . If only.

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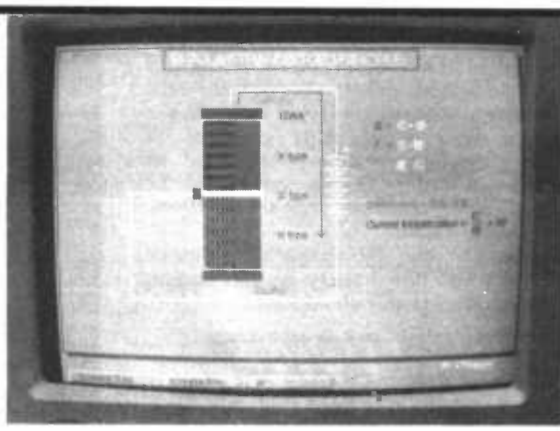

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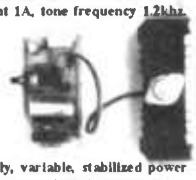
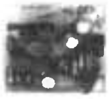
A mini FM transmitter, very high gain preamp, supplied complete with FET electret microphone. Designed to cover 88-108 Mhz but it is easy to change it to cover 63-130Mhz. Works with a common 9v (PP3) battery. 0.2W RF. £8.22 Kit no 1001.

Electronic siren kit with an impressive 5 watt power output. Ideal for car/bike alarms etc. 6-12vdc, max current 1A, tone frequency 1.2khz. £7.05 Kit no 1003.

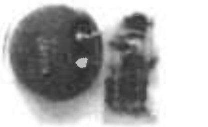


3-30v Power supply, variable, stabilized power supply for laboratory use. Shortcircuit protected, suitable for professional or amateur applications. 24v 3A transformer is also needed to complete the kit. £16.45 Kit 1007.

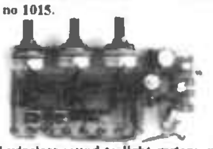


Powerful 1 watt FM transmitter supplied complete with piezoelectric microphone. 8-30vdc. At 25-30v you will get nearly 2 watts!. £14.10 Kit no 1009.

FM/AM Scanner, well not quite you have to turn the knob yourself but you will hear things on this radio (even TV) that you would not hear on an ordinary radio!. Receiver covers 50-160Mhz both AM and FM. Built in 5 watt amplifier. £17.62 Kit no 1013.

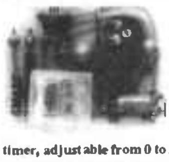


Mosquito repeller, modern way to keep midges at bay! Runs for about a month on a 1.5v battery. £8.22 Kit no 1015.



3 channel wireless sound to light system, mains operated, separate sensitivity adjustment for each channel, 1,200 watt power handling. Microphone included. £16.45 Kit no 1014.

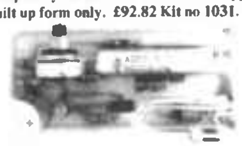
Motorbike/cycle trembler alarm, adjustable sensitivity, preset alarm time, auto reset. Could be connected to bikes horn etc. £14.10 Kit no 1011



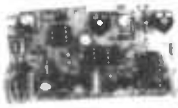
0-5 minute timer, adjustable from 0 to 5 mins, will switch up to 2A mains. Perfect for alarms, photographic laboratories etc. 12vdc. £8.22 Kit no 1020.

4 watt FM transmitter, small but powerful transmitter, 3 RF stages, microphone and an audio preamp include in kit. £23.50 Kit no 1028.

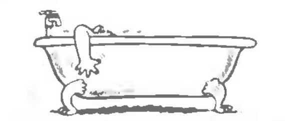
25 watt FM transmitter 4 RF stages, preamp required (our kit 1068 is suitable). Due to the complexity of the transmitter it is supplied in built up form only. £92.82 Kit no 1031.



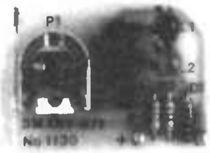
Strobe light, adjustable frequency from 1- to 60 Hz (a lot faster than conventional strobes) mains operated. £18.80 Kit no 1037.



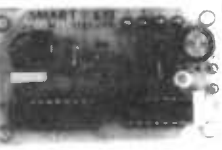
Ultrasonic radar ideal as a movement detector with a range of about 10 metres, automate your cat flap! 12v operation so ideal for cars, caravans etc. £16.45 Kit no 1049.



Liquid level detector useful for detecting fluid levels in tanks, fishponds, baths or as a rain or leak alarm. Will switch 2A mains. £5.87 Kit no 1081.



Combination lock 9 key, easily programmable, will switch 2A mains. Complete with keypad. 9v operation. £11.75 Kit 1114.



Phone bug detector, this device will warn you if somebody is eavesdropping on your phone line. £7.05 Kit no 1130.

Robot voice, interesting circuit that distorts your voice! adjustable, answer the phone with a different voice! 12vdc £10.57 Kit no 1131.

Telephone bug, small bug powered by the telephone line, starts transmitting as soon as the handset is picked up! £9.40 Kit no 1135.

function generator, produces sinusoidal, saw tooth and square waves adjustable from 20hz-20khz, separate level controls for each shape. Will produce all 3 together. 24vac £17.62 Kit no 1008.

3 Channel light chaser, 800 watts per channel, speed and direction controls supplied with 12 leds and mains triacs, so you can use mains light bulbs if you want. 9-15vdc £19.97 Kit no 1026.

12v flourescent. A useful kit that will enable you to light 4' flourescent tubes from your car battery! (you will also need a 9v 2A transformer, not supplied) £9.40 Kit no 1069.

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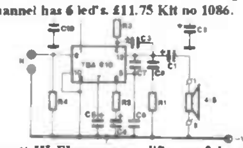

Incar sound to light, Put some atmosphere in your car with this mini 3 channel sound to light. Each channel has 6 led's. £11.75 Kit no 1086.

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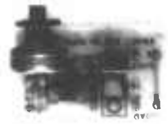
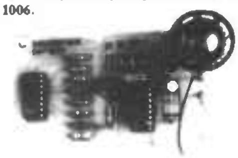
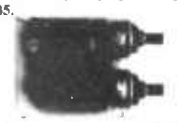


800 watt single channel sound to light kit, mains operated, add rhythm to your party for only £9.40 Kit no 1006.

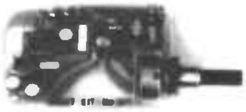


Sound effects generator, produce sounds ranging from bird chips to sirens, complete with speaker, add sound effects to your projects for just £10.57 Kit no 1045.



Guitar preamp with tone controls, small enough to fit inside any guitar, based on TL082 1C, 9-12vdc, 50mA. £9.40 Kit no 1091.

15 watt FM transmitter, 4 stage high power, preamp required. 12-18vdc. Can use either ground plane, open dipole, or Yagi. Supplied in built form only at £81.07 Kit 1021.



Telephone amplifier, Very sensitive amplifier which uses a 'phone pickup coil (supplied) will let you follow a conversation without holding the phone. £12.92 Kit no 1059.

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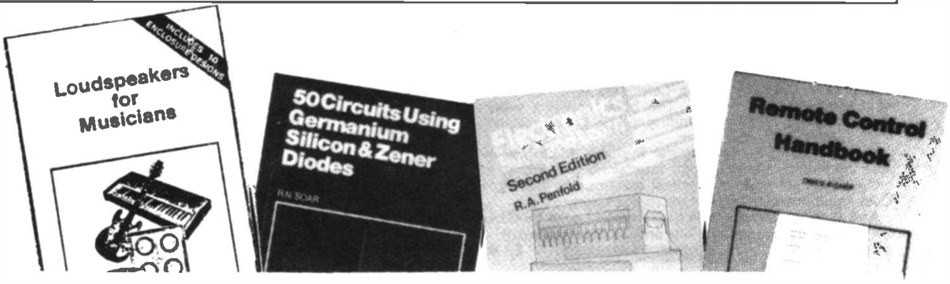

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REPORTING AMATEUR RADIO

Tony Smith G4FAI

UPROAR IN OZ

The interest of governments in obtaining maximum revenue from the use of the radio spectrum has been mentioned several times in this column. As well as in the UK, countries around the world have been considering how best to tax, auction or "contract out" sections of the spectrum to commercial users.

Usually, or perhaps the word should now be "provisionally", amateur radio has been accepted as a special case, and until now there has been no suggestion that amateur operators should pay more for the use of their internationally allocated frequencies.

In December, however, Australia's Spectrum Management Agency (SMA) dropped a bombshell by announcing amateur radio licence fee increases of up to 92 per cent, including a new "Spectrum Access Tax", effective from March 1995.

There has been a strong reaction to the increases by Australian amateurs and matters have been made worse by the decision of the SMA that CBers will not only be exempt from the new tax but will get their licences totally free of charge from now on.

INAPPROPRIATE TAX

The amateurs feel that such a tax is not appropriate for an activity that is recreational, educational, and community orientated. During disaster situations such as bushfires, cyclones, and earthquakes they help provide emergency communications, freely supplementing or even replacing civil and military systems when they are unable to cope with unexpected demands on them.

They point out other benefits to the community. Amateur radio is an activity that leads many young people into a career in electronics. The Scout and Guide movements have many stations used in training their members. There is great social benefit in the suitability of amateur radio for handicapped people and senior citizens.

In some areas, particularly satellite technology and radio propagation studies, they say, Australian amateurs have made significant contributions in the field of research. It is quite wrong, they argue, for a tax to be imposed on the use of radio spectrum that has already been set aside by International Convention for amateur use.

The story has been picked up by the media across the country following a press release from the Wireless Institute of Australia, and the Institute is pursuing the matter actively with the SMA. Radio amateurs around the world await the outcome with great interest. They are also, no doubt, wondering how soon their own governments will come up with similar schemes for taxing their own activities.

CLEAR MESSAGE

Last month's report on the background to the International Amateur Radio Union's decision to continue to support the amateur Morse test should have made those pressing for the abolition of the test stop and think.

The message is clear enough. It is unlikely that the test will be abolished in the near future. It remains as the regulatory requirement for operation on frequencies below 30MHz, supported by the top echelons of international amateur radio.

For the regulations to be changed, IARU member-societies worldwide need to agree precise proposals among themselves; and they need to persuade their national administrations' delegations to the ITU to support the proposals.

These would then have to wait for submission to an appropriate ITU conference. Such a process, according to the IARU CW Ad Hoc Committee, could take years. For those really wanting to get onto HF, therefore, there is still a need to learn Morse and take a test!

Several readers have asked me where they can obtain the full text of the IARU's 26-page document *"The Morse Code and Amateur Radio* – A Summary from the work of the IARU CW Ad Hoc Committee", which was briefly summarised in this column last month. This document explains in detail why the IARU took the decision that it did.

I don't know if it is generally available at present, but for those interested, there is a long (8-page) summary, with extensive quotes from the most important parts of the document, in the February issue of *Morsum Magnificat*, the Morse magazine (MM38). A single copy costs £2.20, including postage, and can be obtained from: G.C. Arnold Partners, 9 Wetherby Close, Broadstone, Dorset BH18 8JB. Please mention *EPE*.

IARU NEWS

Five more national radio societies have been elected to membership of the IARU. These are: The Iraqui Amateur Radio Club (IARC); the Belarus Federation of Radioamateurs & Sportsmen (BFRR); the Latvian Radio Amateur League (LRL); the Ukrainian Amateur Radio League (UARL), and the The Union of Radioamateurs of Russia (URR).

IARU Region 1, which covers Europe and Africa, now has 76 member societies. The Association des Radioamateurs du Burkina Faso (ARBF) and the Turkmènistan Radio Amateur League (TRAL) are currently undergoing the election process. *(IARU Region 1 News)*.

A confusing situation has arisen from the election of URR to IARU membership. After the break-up of the Soviet Union the former IARU member-society, RSF, ceased to exist, and the Krenkel Central Radio Club (which runs the famous Box 88 QSL bureau and claims to have over 30,000, members) applied to be considered the automatic successor to that society.

The IARU would not accept this application and advised the Krenkel Club to apply formally for membership, in effect as if it were a new and unknown organisation. For some reason (probably indignation!) the KCRC did not respond to this suggestion.

Another society, URR, then submitted a correctly completed application which, in the absence of any other, was voted on and approved by the IARU, so that URR is now the officially recognised IARU member-society for Russia.

KCRC has responded by claiming that the IARU constitution has been violated, that Box 88 is still the "official" QSL bureau for Russia and that URR's own bureau is inefficient.

Undoubtedly, the Krenkel Club was a major part of amateur radio in the old Soviet Union and many amateurs will be surprised that it was not recognised as the successor to RSF. We can only hope that the Russians can now sort out their differences among themselves so that their country can have one universally recognised representative organisation at international level.

VE CELEBRATIONS AT DUXFORD

The Duxford Radio Society (DRS), located at the Imperial War Museum's Duxford Airfield in Cambridgeshire, will be celebrating *VE-Day* on May 7 and May 8 with a special station operating with Morse, and making prearranged contacts with Resistance Groups who operated in Europe during WW2.

The provisional frequencies for this operation are 7·007MHz (listening on 7·010MHz) and 14·007MHz (listening on 14·010MHz), depending on conditions. The station will be open to all when the scheduled calls are completed.

On May 8, an SSB (speech) station will also be on the air from Duxford as a celebratory link with other amateurs. This will be around 3·770MHz and the operators will listen at +3kHz from 0900Hrs on that day. Visitors to the museum will be able to observe the radio activities in Building 177.

An amusing, and revealing, story is told in the latest issue of the *DRS Newsletter*. This will be of particular interest to those who remember Tommy Handley's wartime radio show *ITMA*, which he ended each week with the catch phrase "TTFN".

Recently, one of the Duxford operators had a QSO (contact) with a German station. He finished the contact with the usual "73s and good luck", and was most surprised when the German replied "73s and TTFN." "Do you know what TTFN means?" asked Duxford. "Yes", said the German, "It means Ta Ta For Now. We also used to listen to ITMA in the desert"!

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