ELECTRONICS, COMPUTERS, TECHNOLOGY

SEPTEMBER 1993 £1.95

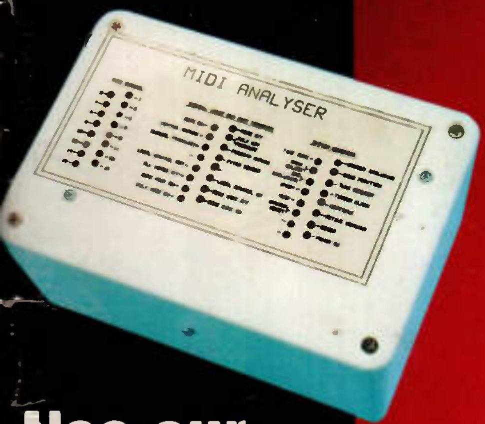
ETI ELECTRONICS TODAY INTERNATIONAL

RF SIGNAL GENERATOR

TECH TIPS

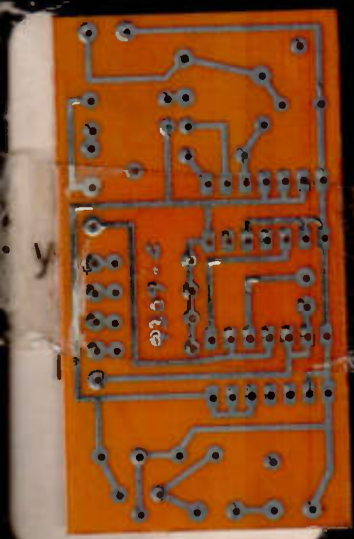
DIGITAL COMPRESSION FOR TV

MIDI ANALYSER
Making sense of those control signals



Use our cover PCB to construct a

4 RANGE CAPACITANCE METER



METRONOME
A Musical Time-check

BEST VALUE argus SPECIALIST PUBLICATION
09
9 770142 722023

Features & Projects

Flashing Beacon for radio controlled models 12
A Craig Talbot provides another 'bolt-on' for your mini mobiles.

4 Range Capacitance Meter 18
Robert Penfold begins a new series on small but invaluable pieces of Test-Gear.

RF Signal Generator 22
A constructional project by Raymond Haigh.

Tech Tips 28
More of your favorite circuit ideas.

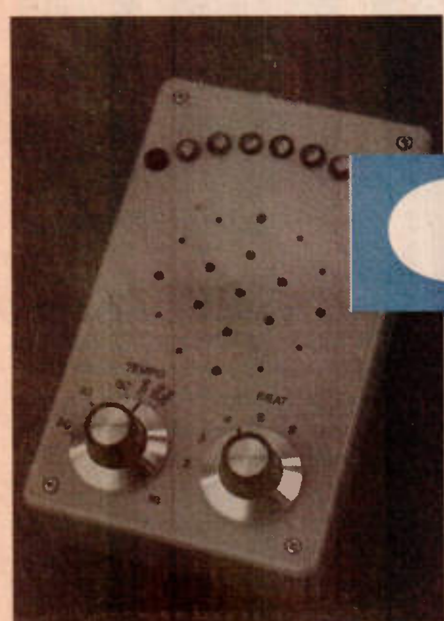
MIDI Analyser 32
Tom Scarff provides a clue to what MIDI signal is going where, when and how in this project.

Automate 39
Mike Meechan gets to grips with Mixdown, Overdubbing and Subgrouping in this part of the mixer series.

Metronome 47
Keeping time is an essential part of playing music. The electronic timepiece shown here, constructed by Will Chester could be an inexpensive way to achieve perfect timing.

Digital Television News 52
More on the latest ideas regarding Digital compression from Jim Slater.

Volume 22 No.9
September 1993


Page 36

Contents

Regulars

Open Channel 4
News 5
News Stateside 9
Read/Write 16
PCB Service 60
PCB Foils 61

Editorial

by Paul Freeman

The internal combustion engine in the motor car is a very conservative beast. The basic workings of this source of 20th century mobility has not changed since its very early development. True, there has been mechanical refinements to improve performance but the electrical ignition system remains the same as it ever was. There are still only very few cars with electronic ignition.

What will prove to be an interesting area of research in the US is in 'plasma conduction' for fuel ignition. In, what appears to be a long period of development, the team has developed a system whereby high frequency electromagnetic fields surround the vapour/air mixture to keep the fuel burning longer and hence reduce harmful emissions by 90%! This longer burning time also leads to better fuel efficiency aswell.

I seem to recall Nikola Tesla, that genius of an inventor, having similar interests many years ago. I suspect a consciousness to preserving our enviroment and our health was not paramount in his mind at the time.

Whatever the benefits it may bring to the enviroment and the car industry it still does not change the fact that this is another example of steady developmental design, to a tried and tested product, not an example of an inspirational, radical new approach to the concept of powered transportation.

OPEN CHANNEL

There's a newish term being bandied about excitedly among the computer networking fraternity - asynchronous transfer mode (ATM). It's not actually a new term in its own right - it's been used for a while by telephone operators as the basis for future generations of public telephone network services. These networks will use broadband transmission throughout the medium - from a caller's 'phone to the recipient's 'phone - and as such will ensure that signals as diverse as television pictures and data as well as voice can be communicated between users.

But computer engineers are nothing if not smart and they can see a use for it within the office, as well as outside it. Computers need to communicate with each other in a small environment as much as they do within the larger world environment and local area networks (LANs) have done this job relatively well to date. Where a synchronous transfer mode will aid in-office data communications however, is in the speed of signal transmission and hence the amount of data which can be shifted between computers.

Current local area networks work by shifting packets of data around a wired network between computers. Occasionally these packets get delayed if the network is busy, so presentation of the complete data transmission between users is delayed.

With simple on-screen textual data or application-movement over a network, a delay of a few seconds or so isn't a problem, but computer use is changing rapidly. The days of simple textual networking are numbered and users are going to need to be able to shift large quantities of data more rapidly and with a much smaller time delay. Multimedia applications and presentations, in particular, demand high-speed and instant communications.

Current local area networks typically use data packets which can vary in the amount of data they contain. This means that packets may move at different speeds between users, depending on packet size. In effect, it's possible for packets to arrive at their recipient in a different order to that in which they were sent. Packet header information is used to number the packets as they are transmitted and to reorder the packets if needs be when they are received. Connections between users are never permanent, so each packet header also has to contain information about where it comes from and where it's going. All information is put into the packet header by the sander and decoded by the receipient. This encoding, decoding and re-ordering, of course, takes time.

Asynchronous transfer mode networks, on the other hand, have fixed sized packets (actually called cells). Only the first few cells contain information about who has sent them and where they're going to, to set up the communication link. Thereafter the link is maintained by intelligent routing systems within the network itself. To all intents and purposes the connection is thereafter a direct one between the users. Following initial connection, contents of cells are devoted purely to shifting data between sender and recipient. In effect, asynchronous transfer mode works on the premise that cells are switched through to users in a virtual connection, whereas most existing local area networks route each and every of their packets through a network. Switching naturally gives a faster throughput of data.

Networks built using asynchronous transfer mode principles are expected to be able to shift gigabytes of information between computers each second. Compare this with the (only!) megabytes per second date rates of existing local area networks and you see the reason why the excitement.

One report recently has predicted that asynchronous transfer mode networks will grow to a market of some $1.17 billion by 1997. Already networks are appearing, although it's still early days and they tend to be very expensive. Integrated circuits capable cf doing the job are in short supply and larger chip companies haven't yet reached silicon stage with proposed devices. Once they do prices will fall and some standardisation of networks can be expected.

Higher and Higher

The high-definition television (HDTV) debate took a new twist recently with an alliance being formed in the US of an between rival system producers. While the alliance is new and probably still quite shaky it does represent a significant advance on previous dogfights to promote what each system maker naturally thinks is the best system. Now the idea is to compromise and present the final system as being the best of the bunch. Once the final high-definition television system is found manufacturers can then get on with the business of building the receivers and selling them.

This is bound to have repercussions in Europe's quest to do the same. Currently we are in the midst of our own dogfight to produce a system which should be every bit as innovative as theirs. Whatever, we've been arguing as long as the Yanks have (six years or so) and it's about time we got to our own conclusion. Now that an American high-definition television system is close to being defined (digital, as it happens) maybe we could get our act together, too. However, as history will probably record it, maybe not.

Hot Air

There's some evidence that the new cellular telephone standard causes interference, picked up by séveral types of electrical and electronic appliances such as hearing aids, automobile airbags and anti-lock braking systems. While no-one says the problem is severe, most do acknowledge there is nevertheless, a problem. No solace, perhaps, for the user who receives a call on his car mobile cellular 'phone and finds himself without brakes, or pinned to the seat by his on-board airbag.

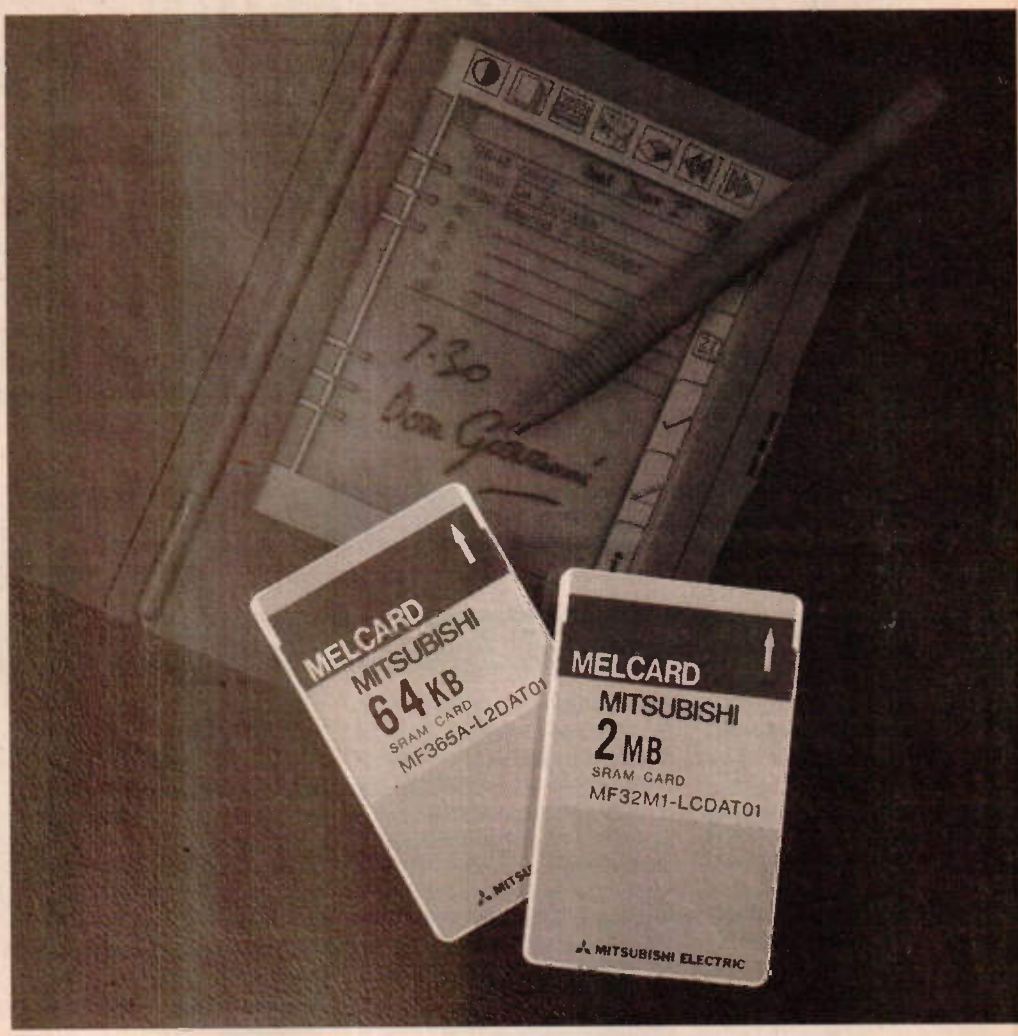
Keith Brindley

SOFTWARE FOR PENPAD

Penfriend, the first business software package developed for the Amstrad PenPad has been announced by C-Star Software, just 3 weeks after supplies of the PenPad went into distribution.

Penfriend is a flexible data capture application, which allows multi-page forms to be designed and created on a PC, before being transferred to the PenPad. Penfriend makes full use of the hand-writing recognition technology incorporated in the PenPad. Aimed at the business community, or any organisation involved in information collection, data collected uses Penfriend on Amstrad's PDA can be uploaded back to a PC and then imported into databases or spreadsheets.

A form template created on a PC can be ported onto a PCMCIA card for use in a PenPad wherever data capture is required. Forms can contain a number of different data types, including text, numeric, date, time, multi-choice, touch buttons and even electronic ink for capturing signatures or diagrams if necessary.



ITC ISSUES DISCUSSION DOCUMENT ON DIGITAL TV POLICY

The ITC has issued a discussion document for public comment on how they should go about implementing earth based digital television services.

The document summarises the technical background relating to digital television broadcasting, whether delivered by satellite or terrestrially, and provides options for the introduction of digital TV terrestrially. The major benefit of digital terrestrial television is seen to be its ability to provide a substantial improvement in spectrum efficiency in the long term, providing existing PAL transmissions are stopped. A variety of ways an orderly transition to an all-digital future in broadcasting is considered. These include a simulcast model, whereby digital capacity might be set aside for existing broadcasters to deliver a version of their services in digital form, and a new services model, whereby all new digital capacity would be made available for the provision of new services. The discussion document favours a third option, a combination of simulcast and new services, coupled with a national policy decision to discontinue existing PAL transmissions with a notice period of at least 10 years.

The ITC believes it is important for there to be an informed policy debate now, in advance of digital broadcasting systems arriving in the market place. The discussion document is intended to stimulate this debate. Comments are to be made to the ITC by the end of September. The ITC has issued a discussion document for public comment on how they should go about implementing earth based digital television services.

LOW COST FLOPPY DISKS

New from MAPLIN Electronics is the comprehensive range of high quality floppy disks from Maxell. Covering 5¹/₄ and 3¹/₂ in. sizes, available as double-sided, double-density high-density formats. Also available, the 3in. 'CF2' type floppy disk, as used in the Armstrad PCW and CFM range of computers. Supplied singly or in boxes of ten.

Also new from MAPLIN, a range of low cost, quality floppy disks in 5¹/₄in and 3¹/₂in. size, available as double-sided, double-density and also high density formats. Supplied in quantities of 10 complete with envelopes and labels.

Typical prices:

¹/₂in.	DSDD	£4.45 (incl VAT)	code: BZ89W
3 ¹/₂in.	DSHD	£7.00 (incl VAT)	code: BZ90X
5 ¹/₄in.	DSDD	£2.95 (incl VAT)	code: CK09K
5 ¹/₄in.	DSHD	£5.00 (incl VAT)	code: BZ88V

See Computer section in the new MAPLIN catalogue for full details.

100MHz,10 TRACE, 4 CHANNEL OSCILLOSCOPE

The new CS 6030 10 trace, 4 channel 100MHz oscilloscope, offers peak performance at low cost, provides 100 step programming and PAL/NTSC Tx line counter.

All four channels have 100MHz bandwidth and separate vertical position controls. The instrument provides comprehensive cursor measurement control, with on screen read out and a delayed timebase which allows independent setting of A and B sweep triggering.

The 'scope provides a maximum vertical sensitivity of 1mV per division with sweep speeds of 20ns to 0.55 per division on the A sweep and 20ns to 50ms per division on sweep B. Both A and B sweeps can be magnified independently.

The delayed timebase function includes trigger after delay and modes and a trigger count function, allowing the user to select delay times as a count (up to 999) with respect to the main sweep which is video waveforms.

The field signal can be triggered on the main sweep to give a stable display of any expanded portion of the line signal.

Other features include: Individual A and B intensity controls and A and B trace separation.

The CG 6030 is supplied with probes and costs £1699.00 + VAT. For further information please contact

Tony Starling
Trio-Kenwood UK Ltd

SMART CARDS FOR PAY TV

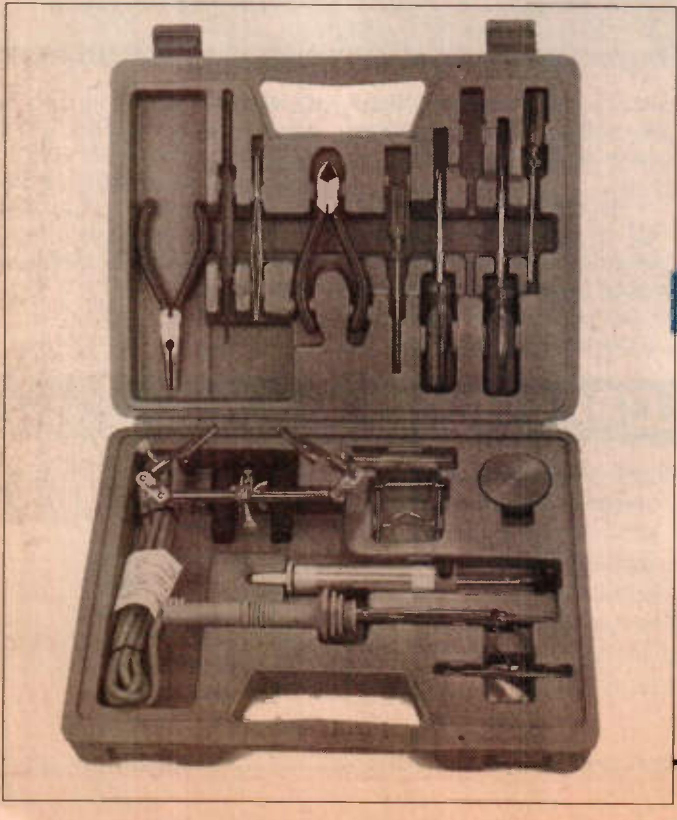
Schlumberger Technologies has announced SmartCrypt, a new encryption system which frees cable and satellite TV broadcasters from traditional subscription-based methods of charging for services. SmartCrypt's dual smart card interface provides a secure technology. Using the smartcard, viewers are free to access programmes on a 'pay per view' basis for the first time.

The new control mechanism makes it possible for the service providers to sell programmes in highly targeted forms, as viewing rights to, say, the latest Hollywood film release, a sports competition, or an opera season. It is now possible to buy electronic 'tickets' to these events in just the same way as you would a newspaper over the counter. Alternatively, access rights can be sold as units of viewing time which are cancelled as they are used. The product now makes it possible for the programme makers to publish programme material from a very wide selection of independent producers.

This fast-growing market, still in its infancy in Europe is predicted to triple its size from the current 50 million consumers, to 150 million, by the year 2005.

The SmartCrypt system includes a programme encryption encoder, a set-top decoder, and an administration system. The decoder has two smart card readers, one card functions as a detachable security processor and the second card is used for a wide variety of payment options. The card holds electronic tokens for the consumer to use to watch programmes, or view for a unit of time. This information is transfered to the primary smart card when inserted into the decoder.

The system uses on-screen display, and is based on state-of-the-art scrambling technology.



15 PIECE TOOL KIT

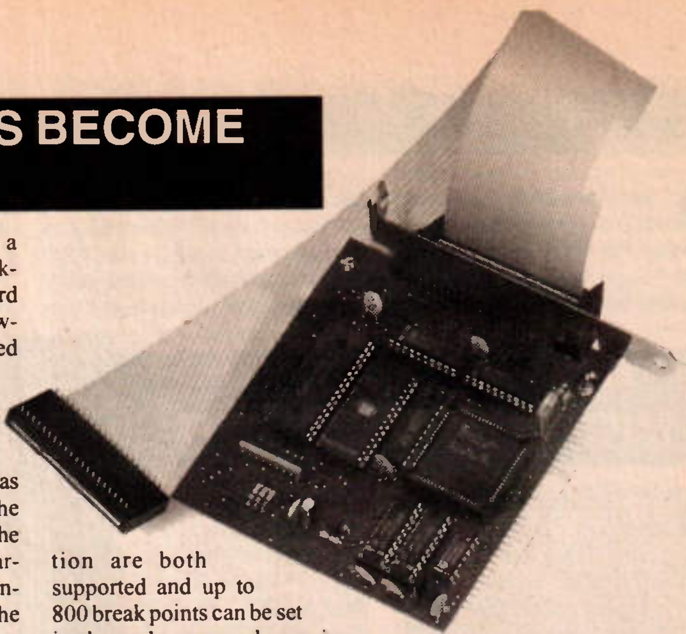
New from Maplin Electronics is a 15-piece Students Tool Kit, ideal for electronics courses at schools, colleagues and all electronics hobbyists. The kit includes a 25W soldering iron with two interchangeable bits (flat & pointed), a detachable hook and small fold-up stand, desoldering tool, a supply of solder and a pot of flux.

For working on PCBs and delicate equipment, a 'helping hands' a 'scraper and a wire wrap tool are included. To help in assembly and repair of most work and projects, two crosspoint and two standard screwdrivers are included, a pair of pliers and wire cutters, and for delicate work, a pair of tweezers

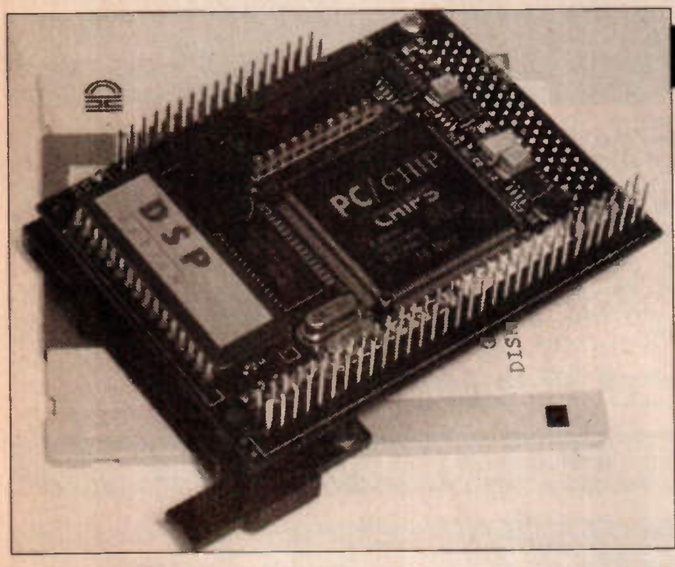
All tools are housed in a tough carrying case with preformed sockets to hold tools in place during transit.

Students Tool Kit. £14.95 (to incl VAT).

IN-CIRCUIT-EMULATORS BECOME AFFORDABLE



The benefits of using in-circuit-emulators for developing applications for eight bit micros have long been appreciated only by large organisations not deterred by price tags in the order of thousands of pounds. Raisonance (France's largest manufacturer of microprocessor development tools) has now resolved this situation with the launch of the TINY-ICE, a low cost in-circuit-emulator for the Intel 8031 & 80C31 microprocessors. Priced at £299, this emulator will enable the electronics enthusiast with a PC to develop applications for these popular eight bit microprocessors. The TINY-ICE comes as a plug in card for PC compatibles and runs at 12MHz. It is supplied with a 300mm probe for 40 pin DIL packages. An EPROM on the card contains monitor software allowing applications to be developed using up to 32K of code space and 64K of external data memory. Software developed on the PC in either Assembler or a high level language such as 'C' can be downloaded to the target system and control of the programme execution can be carried out using the emulator. Windows on the PC speed up the debugging process by simultaneously showing the source code together with the changing contents of the internal registers and RAM of the microprocessor. Single step and continuous emulation are both supported and up to 800 break points can be set in the code space when using continuous emulation. All the hardware resources of the user's target board remain available with the exception of one of the interrupt signals which is reserved for the monitor. Raisonance development tools are distributed in the UK by Logicom Communications Ltd on 081 756 1284.



CREDIT CARD PC

A low power, credit card sized PC compatible board, UK produced by DSP Design is extending application frontiers into areas inconceivable using lap-top technology. It works similarly to a desk-top PC but in, miniature. This makes it particularly useful for lightweight mobile applications, where space is limited, or areas where a long term embedded life are essential.

This computer is said to be the smallest size and the highest integrated PC in the world. It is also far easier and faster to program than microcontrollers.

The GCAT-3000 Processor Card is the heart of the product range. It is expandable or can operate as a stand alone board. A GCAT-2000 Peripheral Card and GCAT-1000 Prototype Card are exactly the same size as the GCAT-3000 and are designed to stack as a 2 or 3 board sandwich. The '2000' provides extra I/O functions and the GCAT-1000 is a blank card to allow users to prototype their own circuits.

NEW RF WIDE-BAND AMPLIFIER

NEC Electronics' new family of wide-band RF amplifiers achieve extremely high performance from a six pin SOT23 type package with outline dimensions of only 1.1mm x 2.8mm x 2.8mm. The µPC27XX devices, which have frequency responses ranging from 1GHz to 3GHz, are based on NEC's new MMIC monolithic microwave integrated circuit) technology.

There are eight products in the family and NEC has used the new 20GHz DNP3 process technology to achieve the ultra small size. The amplifiers are intended for low cost gain and buffer stages in cellular and PCN telephones, GPS (global positioning system) receivers, DBS tuners and RF test and measurement equipment.

The amplifier family can be divided into three groups; medium output power, low noise and low power consumption.

The low power versions operate from a 3.4 volt supply and dissipate 15.3 milliwatts. Their frequency responses are 1.8GHz and 1.2GHz respectively.

The µPC2711/12/13 are the low noise amplifiers running off a single +5 volt supply with a noise figure ranging from 3dB to 12dB at f = 1GHz. The medium output power devices, µPC2708/9/10 also run off a single +5 volt supply and have a saturated power output ranging from +10dBm to +13.5dBm. Frequency responses of all six amplifiers range from 1.5GHz to 3GHz.

Contact:
Malcolm Spencer
NEC Electronics (UK) Ltd
Tel:0908-691133
Fax: 0908-670290

NEW PETROL FUELCARD

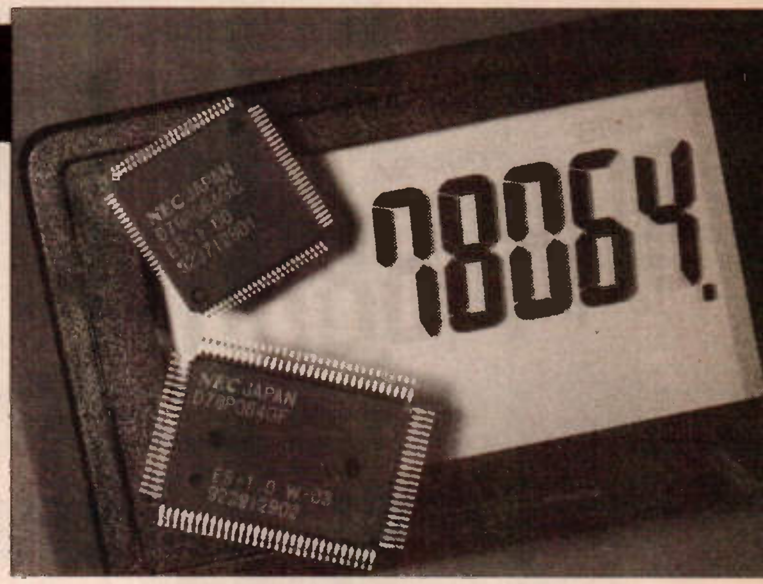
A new computerised credit card pay system is set to change the face of garage forecourts.

The Integrated Payment Terminal (IPT) is made by Triscan, the largest manufacturer of fuel management systems. It offers customers the choice of paying by credit or debit card for petrol instead of have to wait long cues at the kiosk.

Having successfully passed the trials, 30 terminals have now been installed at Sainsbury and Tesco sites all over the country.

The service also provides a receipt for payment.

NEW LCD DRIVER MICROCONTROLLER



NEC Electronics has started sampling LCD driver versions of its new 78K0 low cost 8-bit microcontroller product range. The company claims that the new µPD7806X versions offer the industry's highest performance 8-bit microcontrollers with on-chip display capability and will allow many traditional 4-bit applications to be upgraded in performance.

NEC Electronics' recently introduced 78K0 product range combines 16-bit performance with the price, size and power dissipation advantages normally associated with 4-bit microcontrollers. A major strength of the devices lies in the number of on-chip peripheral options available. This includes A to D and D to A converters, I²C serial interface, UARTs and extensive input/output capabilities.

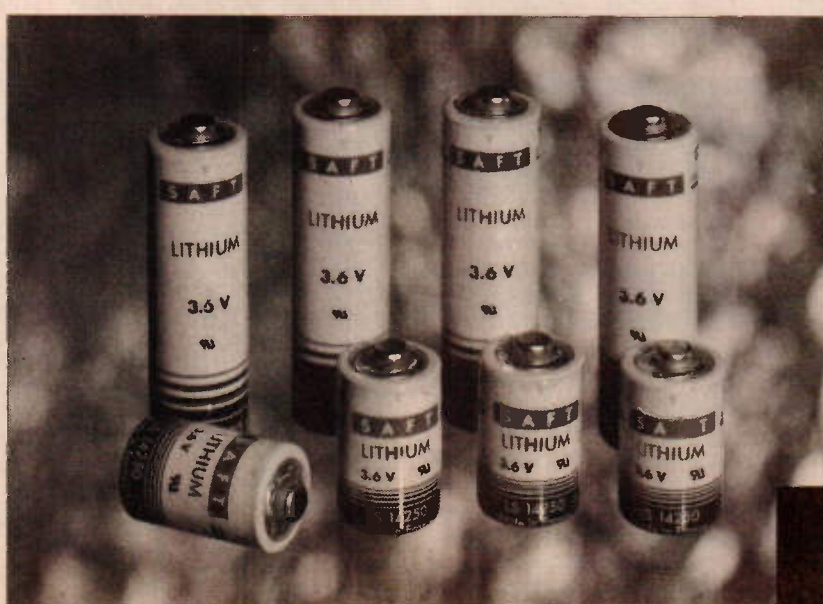
The new versions include an on-chip LCD driver capable of controlling LCD displays organised in 4 x 40 segments (160 total) Traditionally, designers of products such as telephones, car dashboards, electricity meters and intruder alarms have used 4-bit microcontrollers with on-chip LCD drivers; for 8-bit micro designs, an additional LCD driver circuit has been required. The new products allow designers to take advantage of 8 bit performance and a lower chip count, saving size and cost.

The 78K0 microcontrollers are based on 0.8 micron CMOS technology and operate with supplies ranging from 2.0 volts to 6.0 volts with a power dissipation of 2.4mW (typical) at 8MHz, making them suitable for battery powered products. The devices can be used with the 10MHz main clock or the 32kHz subsystem clock, the latter reducing current consumption to 35 microamps.

The three products in the 78K0 LCD driver range are the µPD78062, which has 16Kbytes on-chip ROM, µPD78063 which has 24Kbytes and the µPD78064 with 32Kbytes. An EPROM version (µPD78P064) allows the designer to repeatedly erase code for use in development, and an OTP version is available for prototyping and production start up.

The products operate over the -40° to +85° temperature range and are available in 100 pin QFP packages.

EXPANDED LITHIUM CELL RANGE



Saft Nife has expanded its LS High Energy lithium range with two new high capacity, vented cells. The L514250 and the LS14500 (AA) offer up to 20% more energy density at moderate and low rates than other lithium systems.

Based on Lithium Thionyl Chloride electrochemistry, the cells have an operating voltage of 3.5V (1mA at 20°C). Nominal capacities exceed 2Ah for the L514500 and 0.9Ah for the LS14250.

The cells are fitted with a safety vent and a glass-to-metal seal, and resist leakage occurring even in harsh operating conditions.

The LS cells have an operating and Storage temperature range of -55°C to +85°(and a typical shelf life of 10 years or more.

The LS range is available either as single cells or as customised battery packs, complete with diodes and fuses to protect against short circuits, overloads, over-discharge, and re-charging.

These high energy density, light weight cells make them ideal power sources for applications such as memory back-up in office and industrial equipment, meters and measuring equipment. They can also be used in electronic devices requiring long storage and/or operating life and low to moderate drain capabilities

MORE NEWS NEXT MONTH

ETI

NEWS

...Stateside...

Problems and advantages of RAIDs

Although interest in redundant arrays of independent disks (RAID) continues to remain high, the complexities of disk arrays continue to trouble engineers charged with implementing them.

RAID's benefits continue to attract designers of multi-user systems — fault tolerance, faster accessing and transfer times and higher capacity. However, even RAID users who love the technology note that the process of getting a system up and running is not to be undertaken lightly.

Integrating RAID subsystems is a complex task. Anyone using RAID is likely to be tying the array to a fairly complex network and all the parts must work together well, if the peak performance of the host, the network and the array are all to be realised. Since arrays appear to the system as extremely large disks, users may have to do some analysis to figure out how to get optimal performance.

There now are more RAID suppliers than the market will be able to sustain as it matures. Some early players in the RAID market are already on their third-generation products and they acknowledge that earlier generations did not provide optimal solutions.

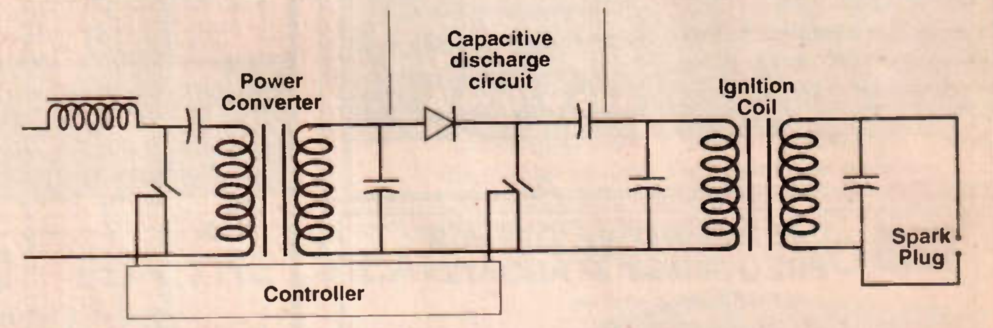
Today, the most commonly used levels are RAID 1, 3 and 5. Level 1, mirroring, simply uses duplicate disks to promote fault tolerance. Level 3 uses a single parity drive, storing only data on the other drives. The approach offers high bandwidth for the fast transfer rates needed for large files. RAID level 5 spreads parity data across all drives in the array - a technique suited for applications with high I/O demands because it permits more accesses per second than the other levels.

"I've been studying RAID since the Berkeley paper came out and, no matter what, I keep running into compromises," said Peter Dougherty, senior staff engineer for peripheral planning at Unisys Corp.'s Peripheral Products Division.

RAID systems are very time-consuming to develop, partly because so many things can go wrong that the debugging process can seem endless. That drives their cost up well beyond the price for individual disks with the same capacity. Although RAID offers varying levels of fault tolerance and improved performance, many users still view cost as a major sticking point.

The type of high-performance drive that should be used, however, depends on what type of accessing will typically be done with the array.

"In sequential applications, a drive that spins at 5,400 rpm is 6 per cent faster than one that spins at 7,200 rpm. For random seeks, 7,200-rpm drives are 8% faster than 5,400 rpm. In RAID 3 products, sequential transfers are a key parameter. In RAID 5, random access is very important," said systems engineer Jim McGrath, of the disk-drive maker Quantum Corp.



Plasma conduction ignition cuts emmissions

A spark of genius

A new ignition system based on plasma conduction cuts car emissions by 90% while increasing mileage.

The result of 15 years of research and development at Combustion Electromagnetics Inc., the approach views fuel combustion as an electromagnetic component that must be included in a complete model of ignition electronics. The redesigned ignition system uses a novel spark-plug design that enhances the plasma interface between spark and fuel mixture, but otherwise employs standard car electrical components and can be retrofitted to any car.

In present arrangements, the electric spark is just there to light the mixture and the subsequent dynamics of the combustion process depends on a relatively rich fuel-air mixture to develop power.

In contrast, the new system uses high-frequency electromagnetic fields to continuously feed energy to the burning fuel mixture, resulting in a more controlled burn. The more precise control translates into higher fuel efficiency and fewer unwanted by-products, such as hydrocarbons and oxides of nitrogen.

Molecular beam epitaxy techniques

A team, led by the Texas Instruments Central Research Laboratory and Hughes Research Laboratories, has been formed to study molecular-beam epitaxy techniques in the construction of resonant-tunnelling devices for photonics applications.

The partners will be developing intelligent-material-processing techniques, including the use of expert systems, case-based reasoning and other computer-assisted methods. Objectives include the creation of sensors to enable real-time control of the MBE growth process, improvement of models to predict device performance, and fabrication and testing of new high performance devices.

The two-year project is funded at $10 million, with part of that coming from the Advanced Research Projects Agency (Arpa) and more than half coming from the industrial partners.

The programme represents the first example of President Clinton's technology reinvestment commitment, commented Hughes.

Developing cooled subassemblies

A US company, Superconductor Technologies Inc., has received a $1.2 million contract from the US Naval Research Laboratory to develop cooled subassemblies for high-performance workstations.

The contract will focus on hardware development, evaluation of cryogenic packaging and cooling of silicon ICs, interconnects for multichip modules made from high-temperature superconducting (HTS) films, as well as appropriate computer architectures.

HTS science and CMOS technology should complement each other extremely well. Apparently, the performance of CMOS ICs improves when cooled. Since the HTS films have to be cryogenically cooled to liquid-nitrogen temperatures, there is no cost penalty for refrigerating the CMOS circuitry to reap additional increases in performance without any re-engineering.

Cryogenic coolers are still large enough that the technology would be impractical for anything smaller than a desktop system, but some companies are actively exploring more compact and efficient cryo pumps that can be manufactured in commercial volume.

LEDs 3mm or 5mm red or green 6p each, yellow 11p each. High intensity red, green or yellow, 5mm 30p each.
Cable ties 1p each, £5.95 per 1000, £49.50 per 10,000.
Steping motor 4 phase 12V 7.5' step 50 ohms £8.95
SAA1027 stepping motor driver chip £3.95
FM Transmitter kit, good quality sound £8.60

High quality photo resist copper clad epoxy glass boards

Dimensions	single sided	double sided
3x4 inches	£0.95	£1.07
4x8 inches	£2.40	£2.68
6x12 inches	£5.37	–
12x12 inches	£10.66	–

Rechargeable Batteries

AA (HP7) 500mAH £0.99
AA 700mAH £1.95
C 2AH with solder tags £3.60
D 4AH with solder tags £4.95
1/2AA with solder tags £1.55
AAA (HP16) 180mAH £1.75
AA 500mAH with solder tags £1.55
C (HP11) 1.8AH £2.20
D (HP2) 1.2AH £2.60
PP3 8.4V 110mAH £4.95
Sub C with solder tags £2.50
1/3 AA with tags (Philips CTV) £1.95
Standard charger, charges 4 AA cells in 5 hours or 4Cs or Ds in 12-14 hours + 1xPP3 (1, 2, 3 or 4 cells may be charged at a time) £5.95
High power charger, as above but charges the Cs and Ds in 5 hours. AAs, Cs and Ds must be charged in 2s or 4s £10.95

Special offers – please check for availability

F cells 32dia x 87mm £3.95
F cell with solder tags, 1.2V £4.30
42mm x 16mm dia 1.2V £1.45
Stick of 4 171mm x 16mm dia, with red & black leads 4.8V £5.95
4 cell battery 94mm x 25mm dia (1/2C cells) £3.50
Computer grade capacitors with screw terminals. 38000µf 20V £2.50; 87000µf 10V £1.95; 68000µf 15V £2.95; 10000µf 16V £1.50
7 segment common anode led display, 12mm £0.45
LM2931AT 5.0 low drop out 5V regulator TO220 package £0.85
7812 and 7912 12V 1A regulators £20.00 per 100
LM337k TO3 case variable regulator .... £1.60 100+ £1.10
BS250 P channel mosfet 45p, BC559 transistor per 100 £3.95
74LS06 hex invertor .... £10.00 per 100
Used 8748 Microcontroller £3.50
SL952 UHF Limiting amplifier LC 16 surface mounting package with data sheet £1.95
AM27S02 .... £1.25 each, 90p 100+
CD4007UB .... 10p 100+, 6p 1000+
TV Mains switch, 4A double pole with momentry contacts for remote control, pack of 10 £3.95 box of 60 £19.95
DC-DC convertor, Reliability model, V12P5, 12V in 5V 200mA out, 300V input to output, Isolation with data, £4.95 each or pack of 10 – £39.50
Hour counter used 7 digit 240V ac 50Hz £1.45
Resistor pack 2500 resistors 1/8-2W 50 different values £8.95

Resistor jumbo pack 25000, 1/4 and 1/2W resistors our choice of values and size, will be mainly in boxes or rolls of 1000, 2000 and 5000 of one type £25.00
Qwerty keyboard, 58 key good quality switches, new £5.00
Qwerty keyboard with serial output, no data (used) £6.00
Polyester capacitors box type, 22.5mm lead pitch 1µf 250V dc 20p each, 15p 100+, 10p 1000+ 2.2uf 250V dc 30p each, 20p 100+, 15p 1000+ 3.3uf 100V dc 30p each, 20p 100+ 15p 1000+
1µf 50V bipolar electrolytic axial leads, 15p each, 7.5p 1000+
0.22µf 250v polyester axial leads, 15p each, 100+ 7.5p each
Philips 123 series solid aluminium axial leads, 33µf 10V & 2.2µf 40V 40p each, 25p 100+
Multilayer AVX cerami capacitors, all 5mm pitch, 100V 100pf, 150pf, 220pf, 10,000pf (10n) 10p each, 5p 100+, 3.5p 1000+
Welwyn W23 9W 120 ohm 35p each, 20p 100+
680 ohm 2W metal film resistor, 4p 100+, 2p 1000+
Solid carbon resistors, very low inductance, ideal for RF circuits, 27ohm 2W, 68ohm 2W 25p each, 15p each 100+, we have a range of 0.25W, 0.5w, 1w and 2w solid carbon resistors – please send SAE for list
Intelegent 4 digit alphanumeric (5x7 dot 0.145") red LED display, 12 pin 0.6 inch wide package. Siemens type DLR1414 £2.50 each, £2.00 30+, data sheets £1.00
AMD 27256-3 Eproms £2.00 each, £1.25 100+
DIP switch 3PCO 12 pin (ERG SDC-3-023) 60p each, 40p 100+

Disk Drive Boxes for 5.25 disk drive with room for a power supply light grey plastic 67x268x247mm £7.95 or £49.50 for 10
Hand Held Ultrasonic remote control £3.95
Computer grade 5800uf 60v capacitors with screw terminals £4.95
CV 2486 gas relay 30mm x 10mm dia with 3 wire terminals will also work as a neon light 20p each £7.50 per 100
A23 12v car alarm remote control and lighter battery 75p each £50.00 100+
40 uf 370vac motor start capacitor (dielectrol type containing no PCBs) £5.95 each £49.50 for 10.

All products advertised are new and unused unless otherwise stated.

Wide range of CMOS TTL 74HC 74F Linear Transistors kits, rechargeable batteries, capacitors, tools etc. always in stock

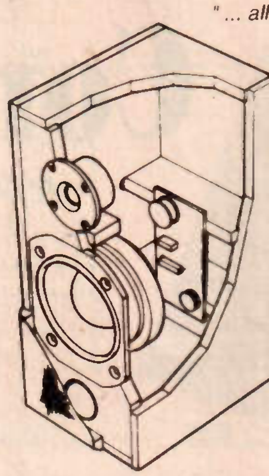
Please add 95p towards P&P
VAT included in all prices

JPG ELECTRONICS
276-278 Chatsworth Road
Chesterfield S40 2BH
Access Visa Orders:
(0246) 211202
Callers welcome

VOLT HOME STUDIO MONITOR

Designed specifically for studio use, this design also gives excellent results when used for conventional HiFi reproduction. The HSM kit is remarkable value - you would have to spend many times its cost to achieve comparable results from a ready-made speaker. The HSM will produce high undistorted sound pressure levels & has massive power handling capability (full unclipped output of 200 watts). Split circuitry crossover is used to enable biwiring to be employed without any modifications.

"... all in all, highly recommended"
Paul White, Home & Studio Recording magazine.



The kit includes bass and treble units, flat pack cabinets (accurately machined from smooth MDF for easy assembly), acoustilux, assembled crossovers, reflex ports, binding posts, grille fabric etc...

Dimensions: *508 x 267 x 343mm*
Response: *30 HZ - 20 KHZ*
Sensitivity: *90db/1w/1m*
AMP Suitability: *20-200w*
£379.00 per pair inc VAT
carriage/Ins. £18.00

Wilmslow Audio

Dept. ETI, Wellington Close,
Parkgate Trading Estate
Knutsford, Cheshire
WA16 8DX
Tel: (0565) 650605
Fax: (0565) 650080

DIY Speaker catalogue £2.00 post free (export £3.50)

Telephone credit card orders welcome

Open Tuesday to Saturday, 4 demonstration rooms available.

OFFTRON FOR THE CHEAPEST PRICES IN TOWN

POWER SUPPLIES & TV ACCESSORIES

12/13.5/15/17/18Vdc 800mA for Ans Machine	£24.95
800MA 3/4.5/6/7.5/9/12V dc REGULATED	£14.95
1A 3/4.5/6/7.5/9/12V dc REGULATED	£15.95
1200MA 1.5/3/4.5/6/7.5/9/12VDC REGULATED	£17.95
650MA 12V REGULATED	£8.95
100MA 13.8V PLUG IN POWER SUPPLY/CHARGER	£4.95
SWITCHED COAXIAL Y SPLITTER FOR GAMES	£1.95
BT21 3 INPUT SCART CONTROL BOX	£34.95
TV TO GAMES LEAD (TV PLUG-PHONO LEAD)	£0.85
1 WAY AERIAL AMPLIFIER	£10.95
1 WAY PLUG IN VAR. GAIN AMPLIFIER	£10.95
1 WAY HIGH GAIN AMPLIFIER	£12.95
2 WAY MAST HEAD AMPLIFIER	£19.95
9 PIECES AUDIO/VIDEO SCART LEAD KIT	£9.95
SINGLE FLUSH MOUNTT AERIAL OUTPUT	£1.00
SINGLE FLUSH MOUNT AERIAL OUTPUT	£10.00
METAL CO-AX PLUG	£0.35

SPEAKERS & TWEETERS

2x6" WIDE DISPERSION HORN TWEETER 35V	£12.95
3" HORN TWEETER 35V	£8.95
3.5" SUPER HORN TWEETER 35V	£6.95
2.5" ROUND CONE TWEETER 20W	£3.25
400W HIGH POWER HORN DRIVER	£24.95
WIDE DISPERSION HORN FOR ABOVE	£14.95
5.25" FULL RANGE SPEAKER 60W	£14.95
6" WIDE RANGE SPEAKER 10W	£5.50
8" CABINET GRILL	£3.95
12" CABINET GRILL	£4.95
15" CABINET GRILL	£5.95

DISCO AND HI-FI

MIXER MRT 60 WITH 10BAND EQ	£148.95
MIXER PDM909 WITH 8 DIGI SAMP.	£229.95
COMPACT ADD ON DIGI. SAMP. PROCESSOR (NEW)	£84.95
VOICE PROCESSOR/SOUND EFFECTS	£49.95
MINI STROBE	£29.95
VARIABLE SPEED STROBE UNIT	£34.95
SELF CONTAINED 4 LIGHT SEQUENCER	£39.95
DYNAMIC MIC 500 OHM	£22.95
STANDARD UNI-DIRECTIONAL MIC 500 OHM	£6.95
MIC DESK STAND	£3.95
JAW CLIP MIC HOLDER	£1.49
FULL GRIP MIC HOLDER	£1.49
6.35mm TO 6.35mm RIGHT ANGLE LEAD 3.m	£2.49
6.35 TO 6.35mm COILED RIGHT ANGLE LEAD 6m	£3.29

AUDIO

CD LASER LENS AUTOCLEANER (WET&DRY SYS.)	£9.95
STEREO HEAD PHONES + 6.35mm ADAPTOR	£1.29
STEREO EAR PHONES + CASE	£3.60
STEREO H/PHONES + 6.35mm MONO ADAPTOR (TV)	£5.50
EAR PHONES PADS (3 PAIRS)	£0.80
HEAD PHONE PADS (3 PAIRS)	£0.90
STANDARD EARPIECE	£0.65
FM AERIAL SPADE TERMINALS	£0.99
FM AERIAL CO AX CONNECTION	£1.75
CASSETTE HEAD CLEANER (DRY)	£0.65
CASSETTE HEAD CLEANER + SOLUTION	£0.95
AC POWER LEAD (FIG 8) 2m	£0.85
TELEPHONE PICK UP COIL	£0.95
TELEPHONE PICK UP COIL LARGE	£1.49

COMMUNICATION

2-WAY TRANBCEIVERS WITH CALL BUTTON TRANSMIT/REC. KEY	£29.95
HANDHELD BROADBAND RADIO REC. COVERS CB, FM RADIO, TV, AIR.	£17.95
12BAND HANDHELD RECEIVER	£24.95
4 BAND RADIO WITH PLL SYNTH. TUNING MW, FM, SW & LW	£34.95

TOOLS & ACCESSORIES

12 RANGE ANALOG MULTIMETER	£7.95
19 RANGE ANALOG MULTIMETER	£18.95
19 RANGE ANALOG MULTIMETER + CONTINUITY	£21.95
SERVISOL SWITCH CLEANER	£1.85
SERVISOL CIRCUIT FREEZER	£2.25
400ml CAN SPRAY ADHESIVE	£3.95
15W LIGHT WEIGHT SOLDER IRON	£6.95
SOLDER IRON STAND	£2.95
MINI VICE	£1.95
SCREWDRIVER SET 4 FLAT 2 CROSS	£2.95
PRECISION SCREWDRIVER SET 3 FLAT 3 CROSS	£5.95
5" SIDE CUTTERS	£3.45
RATCHET CRIMPING FLIERS	£18.95
TWIN 13A SOCKET SWITCHED	£4.99
4 GANG 13A SOCKET UNFUSED	£4.59

IN CAR & TRAVELLER

SOUNDLAB 2 x 75W AMPLIFIER	£49.95
SOUNDLAB 2x100W AMPLIFIER	£89.95
SOUNDLAB 2x200W AMPLIFIER	£108.95
100W DOOR/SHELF SPEAKERS	£24.95
60W DOOR SPEAKERS	£16.95
LOW PROFILE 2 PIN DIN SPEAKER LEADS 0.3m	£0.89
3A 2 PIN IN LINE LINE POWER LEAD 1.8m	£0.99
AIR PURIFIER/IONIZER	£12.95
SUPER TRANSFORMER CONVERTS 220V TO 110V (35W)	£17.95
SUPER CONVERTER CONVERTS 220V TO 110V (1650W)	£18.95
TRA3 MARK ?? FOR UK TRAVELLER AROUND THE WORLD	£5.49
BUZZ-OFF MOSQUITO KILLERS B011	£5.49
BUZZ-OFF MOSQUITO KILLERS B022 110/220V	£6.49
BUZZ-OFF REFILL TABLETS 20 TABLETS BOR001	£2.59

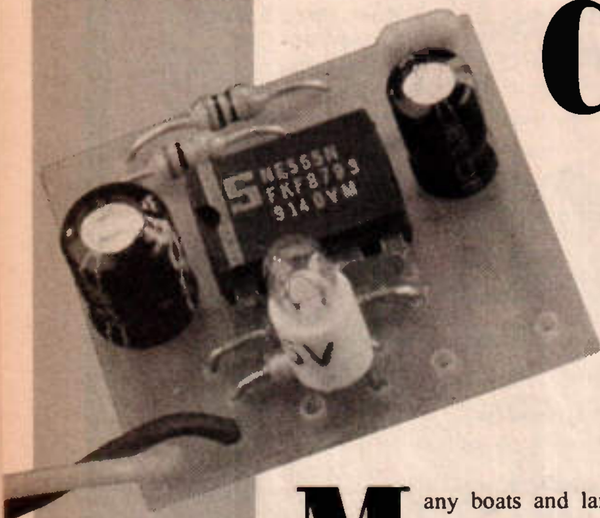
OFFTRON LTD
UNIT B3A ALLADDIN WORK SPACE
426 LONG DRIVE, GREENFORD MIDDX. UB6 8UH

MAIL ORDER TERMS
POSTAL ORDER/CHEQUE WITH ORDER
P&P £1.50 ON ORDERS BELOW £15.00
£2.50 P&P ON ALL OTHER ORDERS.
ALL PRICES INCLUSIVE OF V.A.T.

ALSO 24 HOUR ANSWERPHONE SERVICE.
TELEPHONE 081 575 8812 FAX 081 575 8791
OFFICIAL ORDERS FROM TRADE, SCHOOLS AND COLLEGES WELCOME.

Simple Flashing Beacon for Radio Control Models

A Craig Talbot provides an add-on project for the Radio controlled switch.



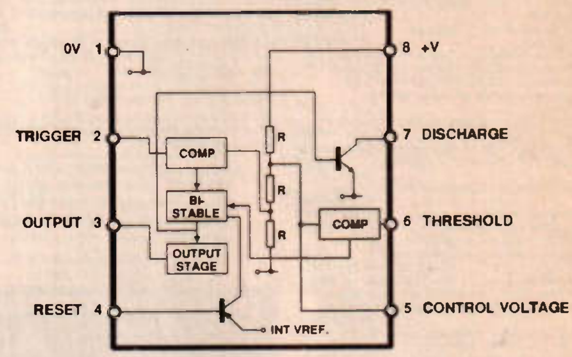


Fig.1 Internal structure of 555 timer chip

Many boats and land vehicles these days have a flashing warning beacon of some kind, an obvious example being the blue flashing light on a police vehicle or boat. However, a wide variety of vehicles use warning beacons and what I needed was a bright flashing light on top of the forks of a model fork lift truck (a visual warning system in common use on full size fork lifts). In this particular case the flasher could run whenever the truck was switched on, but a controlled version adds versatility to the circuit and the one presented here can be controlled by using an R/C Switch. If you built the Radio Control Switch as presented in a previous issue of ETI, then this add-on is for you.

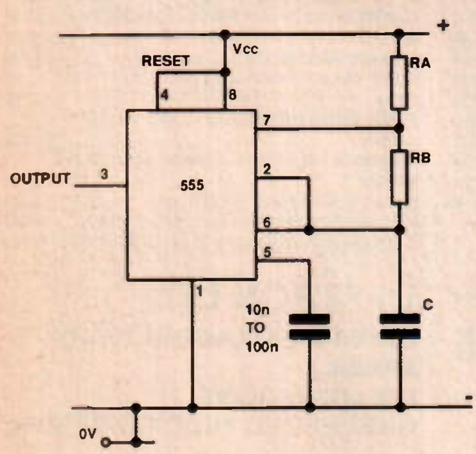


Fig.2 555 Astable configuration

Service vehicles usually have a yellow warning flasher and the fork lift was no exception. Self-flashing LEDs are not normally yellow and Ultra Bright types were unsuitable for this application. In the interests of low component count, IC solutions were sought.

The first IC I considered was the 3909 LED flasher. As the circuit would have to drive a bright light with a wide field of vision, the high brightness LEDs were tried. Ultra bright LED's would give the level of light but not the viewing angle required. The 3909 was also designed to produce very short on times for the light but I needed the on to off period about the same. I would require a lamp for this task.

I next looked at 4000 series CMOS oscillators. To drive the current that a lamp would require, the output current capability would need to be enhanced with another device. The other point is that the IC would be a 14 pin device, when an 8 pin would be preferable. The next IC for consideration was the 555. This IC will deliver a couple of hundred milliamps and drive a lamp as required, requires few support components, has an input suitable for control and is very cheap. For all these reasons and the fact that it is one of the best building blocks in the business, the 555 was chosen. This IC is ideal for the voltage range required and, because timing is not critical, the stability it offers is a bonus. The timing stability is due to the way it operates as a free running oscillator.

The range of drive voltage must be from 5 to 12V for this application, while the maximum working voltage of this IC in other applications is 15V. The CMOS version is an 18V Maximum device but delivers a low output current, so the standard 555 is the best choice for the job.

The circuit described is built on a small PCB but may also be built on something like Vero board, if you prefer. I make no apologies for the simple nature of this project as it is ideal for its intended purpose. There are no medals for designing complicated circuits to perform simple tasks.

Construction

No particular order for mounting the components will be given as the layout is very simple. The only things to note are, the fitting of the IC, notch at the left, and the polarity of two of the capacitors, C1 and C3. Both are clear from the layout

HOW IT WORKS

Telling the readers of a magazine like ETI how a 555 works may be like teaching a dog to bark. Nevertheless, there are always new readers, so here is a quick description of what it's all about.

The 555 consists of a couple of voltage comparators, a bistable latch, an output stage and a discharge transistor.(see Figure 1) The other vital ingredient in this IC is a chain of three reference resistors all of the same value. As all three resistors are the same, the two reference voltages they produce are one third and two thirds of the supply volts.

As you can see from the 555 internal structure (Figure 1) the comparators can detect the two voltages and their outputs and can then trigger the bistable, which in turn will switch the output stage. If a capacitor C is charged via RA and RB, as shown by the 555 astable (free running) circuit, Figure 2, when two thirds voltage is reached, the top comparator will trigger the bistable to set. This action will switch on the discharge transistor, causing it to discharge C via RB to the one third level, when the bottom comparator will detect this, switch off the discharge transistor and reset the bistable. As the discharge transistor is now switched off, C can charge once again. As long as pins 2 (trigger pin) and 6 are joined it will retrigger, starting the action over again. In other words, it will free run. The other way to stop it is to hold pin 4 (Reset) at a low voltage (it should normally be held high by tying it to the positive rail, either directly or through a resistor). As the charge path is via RA and RB and discharge is only via RB, an uneven mark to space ratio is bound to happen. If RB is made very large in comparison to RA, the mark space can be controlled close to unity, but not absolutely.

The Charge Time (output high) is $t1 = 0.7(RA + RB)C$

The Discharge (output low) is $t2 = 0.7(RB)C$

The actual figure is not 0.7 but 0.693, although 0.7 is near enough for real components as they are not perfect, especially electrolytic capacitors with their +/- 20% tolerance.

The output stage will source or sink a current of 200mA, so the load may be driven to positive or to negative. Selection of the values of RA, RB and C will enable the 555 to oscillate at the frequency that is most suitable for the application.

Figure 3 shows the circuit of the beacon. As you can see it is the normal 555 astable with hardly a change. The reset (pin 4) is tied to the positive via R1 and we only have to pull pin 4 down to near 0V to stop it operating. The small PowerFET in the RC switch will do that. The diode D1 is there in case you wish to pulse an inductive load, such as a buzzer. D1 will remove the back EMF produced by such a load.

The remaining components are all that the 555 needs to do the job. The only ones not yet covered are the capacitors C2, which is used as a noise decoupling component on pin 5 and C3, for supply noise decoupling.

With pin 4 at positive the beacon will pulse. When the RC Switch PCB is used to drive this point it will stop the lamp pulsing when switched on. (I could have inverted this action, but it would have given little advantage except to ensure that the switch On position did in fact switch the beacon on rather than off. Turning the switch round on the transmitter would do the same thing.

Incidentally, with pin 5 of the 555 you can do such things as frequency modulate the output. The 555 and its possible uses have been covered in depth by several books ands its well worth a bit of reading, if you have not done so already.

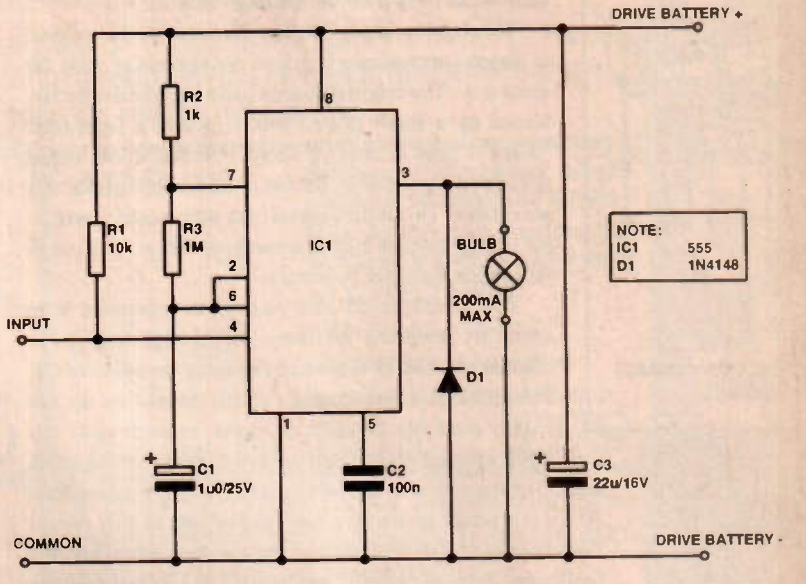


Fig.3 The circuit

in figure 4, as is the bar end of the diode, D1.

Red and black wires would be a good idea for the positive and negative to the drive battery but the colour of the lamp wiring is not important. The lamp will have to be selected to suit the voltage that you are using to drive it but the main point is to keep its current rating below 200mA. The lamp should be connected with a couple of wires to the points marked, appropriately, Lamp.

Finally, wire from the point marked In, which we will later connect to the RC Switch PCB at the point marked Out and a wire from Common on the Beacon to connect to Common on the RC Switch (that's after we have initially tested it).

Now the board construction is complete, it would be a good point to look for solder bridges and poor solder joints. Make sure that the wires are clipped off cleanly, giving no possibility of short circuits. The only place that the tracks are close is where the 0V track goes between pins 3 and 4.

Having done this, we are ready to test.

Testing

When you connect the Red and Black wires momentarily to the Drive Battery you should see a flashing lamp. OK, so it works, now to connect it to a R/C switch PCB so that you can control it. Figure 5 shows the equally simple inter-board wiring. Disconnect the Battery while you wire the Common on the RC Switch PCB to Common on the Beacon PCB and the Input on the Beacon PCB to Output on the Switch PCB. When wiring has been completed, the red and black wires can again be connected to the + and - of the drive battery. Now you can control it with your Radio Control.

Bear in mind that the circuit will draw a small current even when the lamp is not flashing, so make sure that, wherever you use it, you have a switch to disconnect when out of use. If you are using it in conjunction with a Low Power Speed Controller, then the switch in the positive drive battery lead of that board will do the job.

Heatshrink tubing would be an excellent encapsulation for this little PCB, or a potting box of suitable proportions. If the lamp is in a lampholder, a couple of 1/2W resistor leads would be strong enough to hold the PCB when connected between the lampholder and the lamp connections on the PCB, that is assuming you have the available space.

In Conclusion

The first conclusion is that this project is in no way exclusive to Radio Control. It gives you a very compact PCB for any 555 astable application, if you think about it, there must be many uses. It is in fact a 'board for all reasons' (apologies to the Bard).

You may wonder why I did not drive the whole Beacon PCB directly as a load on the R/C Switch. The reason is to retain the 200mA capability of the 555 without overrunning the 300mA capability of the Switch, due to the not inconsiderable current that is drawn by this IC during switching and the lamp current. There is also the fact that C3 has to be charged when power is applied.

For my application, I obtained a yellow cap lampholder. Lampholders are available with caps in most of the colours that you may require. I only used the cap, as the lampholder was a bit on the large side.

This beacon is more or less the same as the original in general appearance but does not operate in quite the same way. The original beacon had a lamp and reflector, turned by a small geared motor, giving a lighthouse 'beam of light' action. At about 1/16 Scale, this would not have been possible, but the one described looks very acceptable. This is the general idea with model electronics - better to have a go at something that gives a rough simulation than not to bother.

This circuit could also be used to produce a horn sound by replacing the lamp with a high impedance speaker of 120R or more and changing the value of C1. The problem is that speakers of that impedance are not readily available. It could, of course, be made up of say a 40R speaker and a fixed resistor to make up the 120R but 2/3 of the power would be dissipated in the fixed resistor. At 6V this would give a very low volume and, as only part of the power would be available for the speaker, would be very inefficient. Running a small, modern, 6V or 12V buzzer from this PCB will give an efficient pulsed tone.

If you require just a horn sound, a buzzer can be switched by an RC switch.

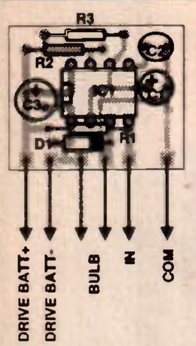


Fig.4 Component overlay

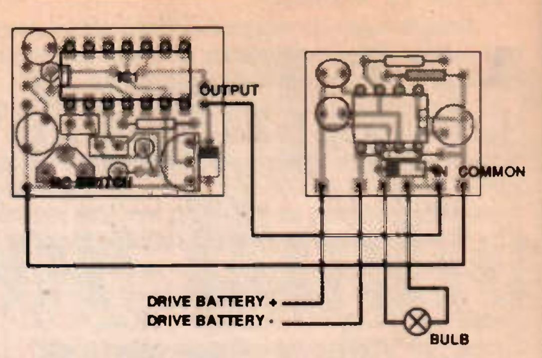


Fig.5 Interconnection diagram

PARTS LIST

RESISTORS		SEMICONDUCTORS	
R1	10k 1/8 Watt 5%	IC1	555 IC
R2	1k 1/8 Watt 5%		
R3	1M 1/8 Watt 5%	**MISCELLANEOUS**	
		LAMP	less than 200mA -to suit
CAPACITORS		PCB	(See BUYLINES)
C1	1µ/25V min radial Elect	WIRE	Red, Black plus any other colour
C2	10n or 100n ceramic		
C3	22µ/16V MIN radial elect		

BUYLINES

All of the components are widely available by mail order.

The PCB is available from:- ACTion, 140 Holme Court Ave, Biggleswade, Beds. SG18 8PB

Price £1.80 plus £0-50 postage & handling.

READ/WRITE ETI Letters

Output Transformers

I have found a source of output transformers suitable for the Hybrid Valve Amp (Sept. 1992). They are from The Vintage Wireless Company Ltd in Bristol.

John Condy
Manchester

Readers might like to know of the items available from this company, supplied by Mr Condy.

Push Pull audio output transformers to suit EL34s

35W output	*£35*
50W output	*£27*
100W output	*£39*
EL34 (Mullard)	*£19*
" (Siemens)	*£7-50*
" (Imported)	*£4-00*

All are exclusive of VAT and postage and packing.

The Vintage Valve Company Ltd can be contacted at
Tudor House
Cossham St
Mangotsfield
Bristol
BS17 3EN
Tel: 0272 565472

The company has a wide variety of catalogues on audio,radio and valves. They also claim to be the worlds largest stockists of service sheets, manuals and historical information on valve and early transistor audio radio and TV. They also have large stocks of vintage components.

If you have any old valves, the Vintage wireless company is always interested in possible purchases. Please get intouch with them for valves urgently required.

Valve Alternatives

I read with interest the recent comments concerning the 45W Hybrid Valve Amp. Having invested more than I care to admit on this project, I have none-theless successfully completed one for myself and another for a friend to whom money is no object, and the experiments on the way have taught me a few useful things.

Messrs Bentley and Corsi in June '93 Read/Write have already mentioned the benefits of matching the MPSA92 transistors and providing adjustment of the bias current via R3. Anyone foolish enough to have used MPSA 42 transistors and then gone off to get a cup of tea and consider the problem will have found the isolating transformer having suffered an internal meltdown (unless they use a suitable fuse). The EL34 valves are fine, although I initially used Sovtek K5881s (as used by Eric Clapton no less) since they were cheaper and are said to sound richer than EL34s. Using a 240V supply, I am not certain how the voltages stated in the project are obtained as even under no load conditions the maximum calculated and measured high tension voltage is only 336V (not 350V) and the transistor supply -56V. If you live in a foreign country (as I do) where the supply voltage varies from 200V to 220V and a wide variety of valve step up transformers of every value except the one desired can be obtained, so some improvisation is required. It would seem to me that with a 240V supply the high voltage transformer would require a 250V tap and the transistor supply 22-0-22V taps. Having used a variety of different high tension voltages, the amp seems perfectly happy with anything from 300V to 380V, providing the bias current is correctly adjusted (although I assume there is some sacrifice in power output at the lower end of the scale).

Lower voltages may make it easier to obtain a suitable capacitor, although there seems to be plenty of 400V (450V surge) caps around with values up to about 2800µ for less than £20. Calculations suggest a bias current of around 280 to 290µA through R3 and a similar current flows through PR1 (half from each collector). Using these figures it is possible to adjust the resistances to reach the required negative grid voltage, depending on the transformer output. Although I have been using the designated -30V, a check of the valve characteristics for the K5881 suggests -37V may be more appropriate.

As Mr Bentley stated, the amp is very sensitive to any input DC offset voltage from pre-amps and I had to critically adjust my FET pre-amp to eliminate the problem (yep, you guessed it - hold your tongue in the correct position while doing this). The other alternative is to use DC blocking capacitors on the inputs.

Anyway. for all that I am quite pleased with the sound and although it has been the source of a great deal of initial frustration, the article inspired me to build a valve amp for a projected cost of less than £90 or so (plus the burned out transformer). The amp has worked reliably for 4 months and is used for up to 8 hours a day.

Like all home-built projects you can tweak and modify as much as you like depending on your budget. You are less likely to be so daring with a commercially made version. Music always sounds better when played through equipment you have constructed yourself (well, mostly) and puts the fun back into Hi-Fi at reasonable cost. While it would be nice not have these problems with setting up, I believe the basic principles in the amp are sound and the project not only interested myself but a large number of others.

Perhaps some of your distinguished readers might be able to suggest some more crude but simple enhancements or alternative designs. The original PCB is not complicated and could be redesigned to accommodate adjustable bias. If anyone else wants to use K5881 tubes the following data may be useful:

Filament current	0.9A	
Plate volts	450v	(500V Max.)
Screen volts	400V	(450V Max.)
Neg. grid volt	37V	
Plate current	116mA no signal	
Screen current	5.6mA no signal	
Load for rated output	5600 ohms	
Power output push-pull config., class A-B. 55W		

B Lawford, Hong Kong

Calling all Music Chips

Please could you or any of your readers tell me if Digisound Ltd, (formally of Brookmans Green in Blackpool), suppliers of the Curtis range of specialist chips for the music industry, are still trading.

If not, does anybody know of another supplier of Curtis chips, in particular the CEM3340 or CEM3345 voltage controlled oscillator ICs. I would be most grateful for any help.

John Scott Paterson,
Newcastle upon Tyne

EQ PC/Mac Maths Conversion Problem

In the August issue of ETI, our Read/Write column contained a mathematical analysis for the Graphic equaliser featured in the June issue. For some reason, the square root and multiplication sign were converted to other signs. We show the correct equations here:

$f = 1/2\pi\sqrt{LC}$

where C is the external capacitor

Q is calculated using:

$Q = 2\pi fL/R$

$= 2\pi L/R \times 1/2\pi\sqrt{LC}$

$= \sqrt{L}/R\sqrt{C}$

Capacitance Meter

1

In the first of a series, Robert Penfold uses our cover PCB to construct this useful piece of test gear.

Capacitors are used in vast quantities in electronic projects, and resistors are probably the only components that are used in greater numbers. It is an unfortunate fact that despite their popularity, few constructors are equipped to test these components properly. This is almost certainly due to the relatively high cost of ready-made capacitance meters, plus the lack of any capacitance ranges on most multimeters.

Basic Checks

It is actually possible to make one or two simple but useful tests on capacitors using a multimeter. A check for a short circuited component (a common fault) can be made using the test meter set to a resistance range. If all is well, an infinite resistance through the component should be indicated. With higher value components there will be an initial low reading while a high charge current flows, but the reading will soon return to infinity, or a very high reading anyway. The rough value of the component can be gauged by the time taken for the reading to rise towards infinity. With low and middle value capacitors the initial charge current is too low to produce this effect to a noticeable degree.

ETI Cover PCB Project

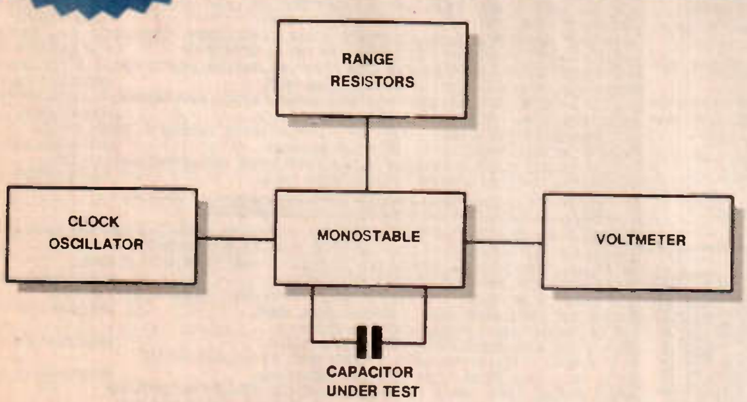


Fig.1 Block Diagram for the capacitance meter

Note that when testing polarised capacitors using an analogue multimeter the positive test prod connects to the negative lead of the capacitor, and the negative test prod connects to the positive lead. For digital multimeters the more logical positive-to-positive and negative-to-negative method of connection is used.

Ranges

In order to test low a medium value capacitors properly it is necessary to use some form of capacitance meter. An analogue capacitance meter still represents the simplest and most cost effective method, and the unit featured here is a simple unit of this type. It has four measuring ranges, as follows:-

Range	**1**	**0 to 1n**
Range	**2**	**0 to 10n**
Range	**3**	**0 to 100n**
Range	**4**	**0 to 1µ**

It can therefore be used to measure capacitors in the problem range of a few picofarads to one microfarad. The linearity and general accuracy of the unit is very good. The main limitation on accuracy is probably the accuracy with which the panel meter can be read.

Operating Principle

This capacitance meter uses the simple arrangement shown in the block diagram of Figure 1. The clock oscillator triggers the monostable at regular intervals, and the approximate clock frequency is 50Hz. A monostable produces an output pulse having a duration that is controlled by a C-R timing network, and which is independent of the trigger pulse duration. The timing components in this case are a reference resistor, and the capacitor under test. Four switched reference resistors provide the unit with its four measuring ranges.

Suppose that a 1n test component produced the monostable output waveform shown in Figure 2(a). The mark-space ratio is one to nine. This means that the output is high for 10% of the time, and that the average output voltage is therefore is equal to 10% of the supply voltage. A 2n test capacitor would give output pulses twice as long, producing the output waveform of Figure 2(b). This gives a markspace ratio of 1 to 4, and an average output voltage that is equal to 20% of the supply voltage. A 3n component gives the output waveform of Figure 2(c), a markspace ratio of three to seven, and an average output voltage that is equal to 30% of the supply voltage.

This arrangement therefore gives a capacitance to voltage conversion, with a linear relationship between test capacitance and the average output voltage. The voltmeter at the output of the monostable can therefore be calibrated in terms of test capacitance, will have linear scaling.

Circuit operation

Figure 3 shows the full circuit diagram for the capacitance meter. The clock oscillator is a simple C-R oscillator circuit based on IC1, which is a CMOS 4047BE used as a straightforward freerunning astable. The original design used a crystal controlled clock generator, but a simple C-R oscillator was found to give perfectly adequate stability for this application.

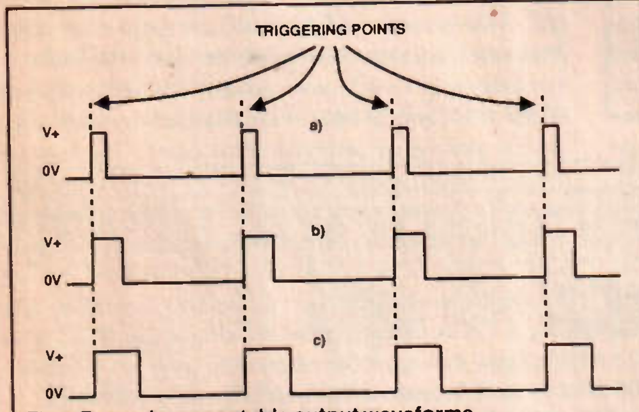


Fig.2 Example monostable output waveforms

The monostable is a very simple type based on a couple of CMOS two input NOR gates (IC2a and IC2b). Although this is very simple form of monostable, it is well suited to this application. It is a non-retriggerable type, which means that it does not require very short trigger pulses in order to function properly. The output from IC1 is a very accurate squarewave signal incidentally. This type of monostable also has an extremely low level of self-capacitance. This is an important factor, since a significant level of built-in capacitance would seriously affect accuracy on the lowest range. The selfcapacitance of this monostable is far too low to give a noticeable offset, even on the 1n range.

R2 to R4 are the four switched timing resistors which provide the unit with its four measuring ranges. In order to obtain good accuracy on all four ranges these resistors must be close tolerance types having a tolerance of 1% or better. Note that the other two gates in IC2 are unused, but their inputs are tied to one or other of the supply lines. This prevents spurious operation of these gates, and avoids possible damage to IC2 due to stray static charges.

The voltmeter section is a simple analogue type based on moving coil panel meter ME1. R7 and RV1 provide the series

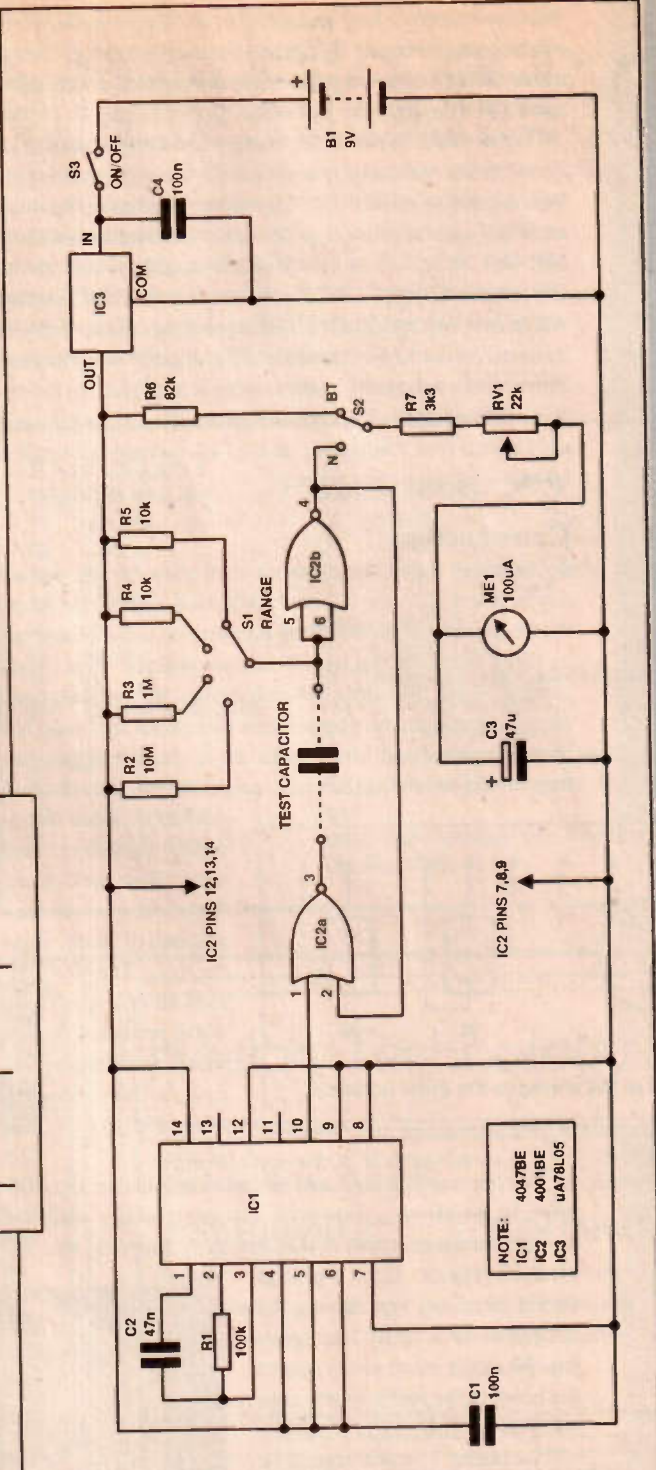


Fig.3 Capacitance meter circuit diagram

resistance. RV1 is adjusted to give the correct full scale capacitance values. With a pulsed input signal a moving coil meter will effectively provide its own smoothing, and respond to the average current flow, but only if the input frequency is more than about 20Hz. Smoothing capacitor C3 would therefore seem to be superfluous, since the pulse frequency is about 50Hz in this case. However, a frequency of 50Hz is quite low, and could cause problems with pointer-jitter due to mechanical resonances in the meter movement. C3 should ensure that the meter provides completely jitter-free results.

It is essential that the circuit is powered from a well stabilised supply. Any variations in the supply voltage will produce proportionate changes in the meter readings. IC3 is a monolithic voltage regulator which produces a well stabilised 5 volt supply from the 9 volt battery supply.

When SW2 is set to the battery test ('BT') position it connects the voltmeter circuit across the regulated supply lines via series resistor R6. The meter then has an approximate full scale sensitivity of 10 volts, and should read about half full scale. It is not absolute readings that are of importance though. SW2 should be set to the 'BT' position with a new battery installed, and the reading obtained should be noted (or marked on the scale of the meter). When at some future time a noticeably lower reading is obtained, the battery should be replaced. The current consumption of the circuit is only about four milliamps, and a PP3 battery is therefore adequate as the power source.

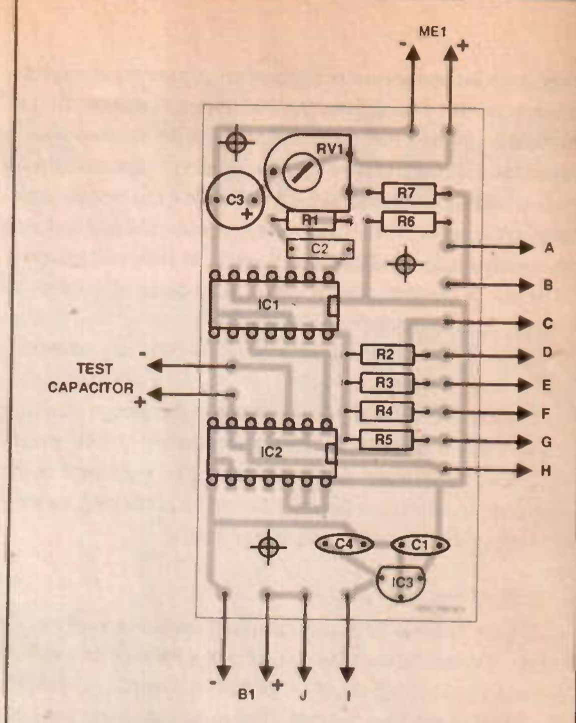


Fig.4 Component overlay

Construction

Figure 4 shows the component overlay for the printed circuit board. IC1 and IC2 are CMOS integrated circuits, and the normal anti-static handling precautions should therefore be taken when dealing with these components. This means using a 14 pin dil holder for each device, but the integrated circuits should not be plugged into place until the board has been completed and wired to the rest of the unit. Until then they should be left in their anti-static packaging. Handle both devices no more than is really necessary, and keep them well away from any obvious sources of static electricity. The 4047BE used for IC1 is not fully static protected, and it would therefore be unwise to take liberties when dealing with this device.

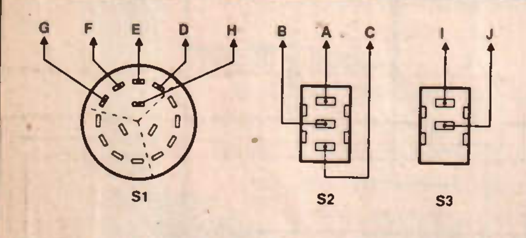


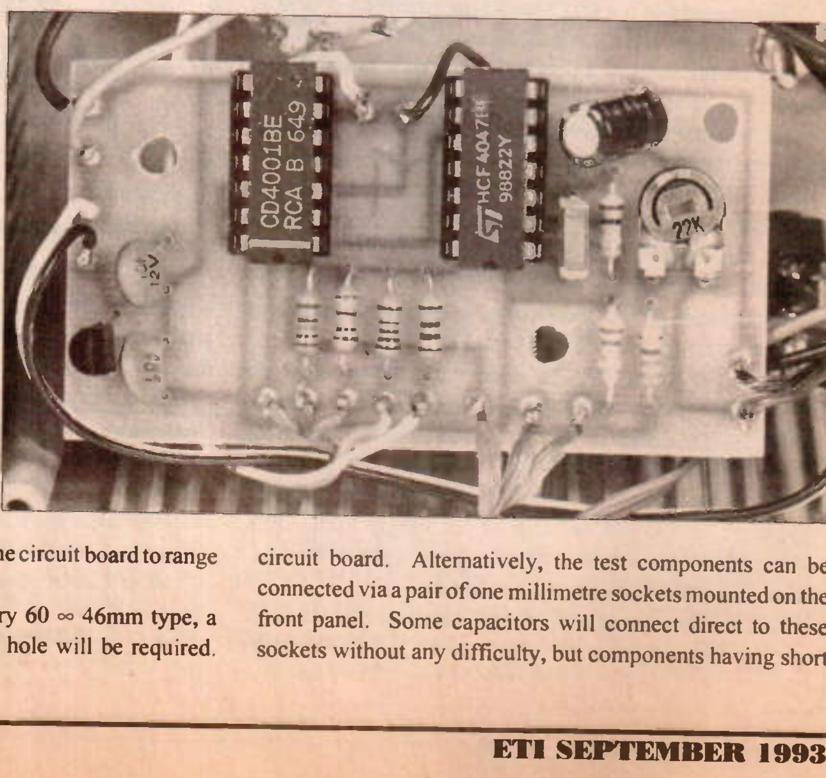
Fig.5 Details of the wiring to the three controls

In other respects the board is very simple and straightforward to construct. However, the components must be modern miniature types if they are to fit properly into the available spaces. C2 is a printed circuit mounting type having 7.5 millimetre (0.3 inch) lead spacing. Fit single-sided solder pins to the board at the points where connections to off-board components will be made. The pins should be tinned with a copious amount of solder.

A medium size metal instrument case is ideal for this project, but a case of this type could easily cost more than the total for all the other components! A low cost plastic box having dimensions of around 150 ∞ 100 ∞ 50mm makes a good low-cost alternative. The exact layout used is not too important, but try to avoid long leads from the circuit board to range switch SW1.

Assuming the meter is an ordinary 60 ∞ 46mm type, a 38mm (1.5 inch) diameter mounting hole will be required. This is easily made in a plastic case using a fretsaw, coping saw, or a miniature round file. The same methods are viable if the case has a metal front panel, but making the cutout is then likely to be a much slower process. Unless you are very skilful at this type of thing, it is advisable to cut just inside the line marking the perimeter of the cutout. The hole can then be enlarged to precisely the right size using a large half-round file. Four smaller (3.3 millimetre diameter) holes are needed for the meter's integral mounting screws. The positions of these can be located using the meter itself as a sort of template, once the main cutout has been completed. The accuracy of the circuit is more than adequate to justify the use of a larger meter, but these tend to be relatively expensive, and would necessitate the use of a much larger case.

The test capacitors can be connected to the unit via a couple of short crocodile clip leads connected direct to the



circuit board. Alternatively, the test components can be connected via a pair of one millimetre sockets mounted on the front panel. Some capacitors will connect direct to these sockets without any difficulty, but components having short

PROJECT

leads must be connected via a pair of crocodile clip leads. Either way, the wiring from test components to the circuit board must be as short as practical, in order to keep stray capacitance down to an acceptable level. The unit can be used to check polarised capacitors such as tantalum and electrolytic types, but they must be connected with the polarity shown in Figures 3 and 4. It is advisable to use red and black test leads and sockets to indicate the correct polarity for test components.

The printed circuit board is mounted on the base panel of the case using 6BA or metric M3 screws. The hard wiring is then added. Figure.5 shows the wiring to the three controls. This diagram should be used in conjunction with Figure 4 (e.g. point "A" in Figure 4 connects to point "A" in Figure 5). SW1 is a standard 3 way 4 pole rotary switch, but in this case only one pole of the switch is utilized.

Calibration

In order to accurately calibrate the unit it is necessary to have a close tolerance capacitor having a value equal to the full scale value of one of the ranges. For example, a 10n 1% polystyrene capacitor could be used to calibrate the unit on range 2. Initially RV1 should be set for maximum resistance (adjusted fully clockwise). With SW1 set to the appropriate range, SW2 set for normal operation, and the calibration capacitor connected to the unit, RV1 should be carefully adjusted for precisely full scale deflection on ME1. The capacitance meter is then ready for use, and should give good accuracy on all four ranges.

If desired, the lettering of the meter's scale plate can be altered to suit this application. Modern meters almost invariably have clip-on fronts which are easily unclipped. Removing a couple of small screws then enables the scale plate to be slid free from the rest of the meter. Relabelling is far from essential though, since readings on the 0 to 100 scale are easily converted into corresponding capacitance values. It just requires some mental arithmetic to adjust the decimal point when taking readings on ranges 1, 2, and 4. However, it is very useful to mark the scale plate with the correct"battery check' reading. Be very careful indeed when working on the meter though, since moving coil meters are very delicate, and are easily damaged.

PARTS LIST

RESISTORS (All 0.25w)

R1	100k 5%
R2	10M 1%
R3	1M 1%
R4	100k 1%
R5	10k 1%
R6	82k 5%
R7	3k3
RV1	22k sub-min hor preset

CAPACITORS

C1,4	100n disc ceramic
C2	100n polyester
C3	47µ10V radial elect

SEMICONDUCTORS

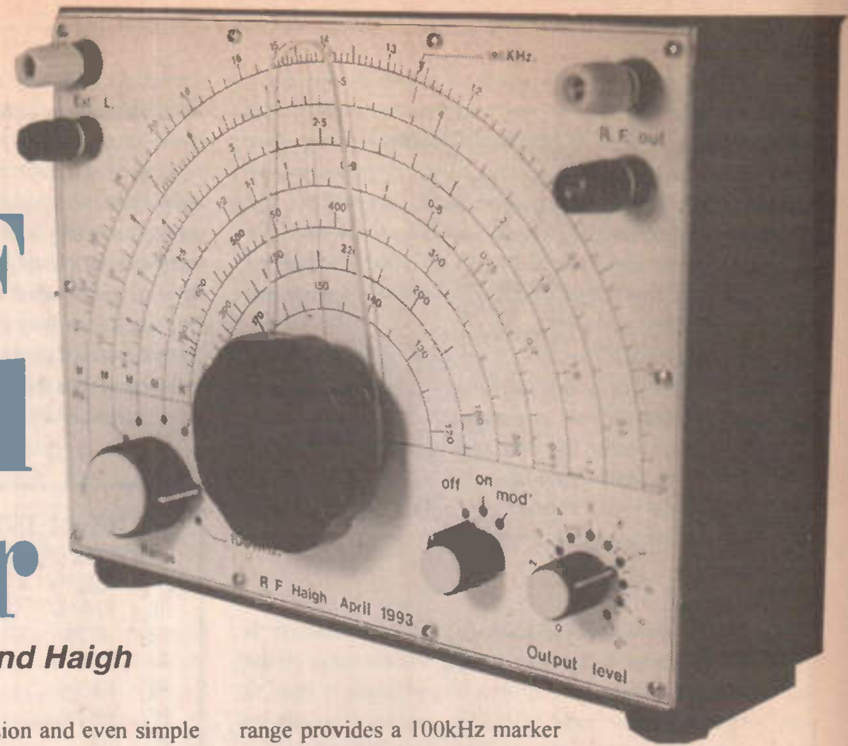
IC1	4047BE
IC2	4001BE
IC3	uA78L05 (5V 100mA positive regulator)

MISCELLANEOUS

B1	9 volt (PP3 size)
SW1	4 way 3 pole rotary (only one pole used)
SW2	SPDT sub-min toggle
SW3	SPST sub-min toggle
ME1	100µA moving coil panel meter

PCB,medium size plastic box, red 1mm socket, black 1mm socket, battery connector, two 14 pin dil holders, solder pins, wire, solder, etc.

An RF Signal Generator



A project by Raymond Haigh

Although TRF, direct conversion and even simple superhet radios can be set up without recourse to a signal generator, test equipment of this kind is essential for the correct alignment of more complex receivers. And whether the receiver is simple or complex, a signal generator will be found extremely useful for checking coverage, locating specific bands and as an aid to dial calibration.

Searching the radio frequency spectrum for transmissions to identify receiver coverage is a time consuming process and a signal generator is an invaluable means of determining ranges, or pinpointing amateur bands. Unless the signal generator is up to laboratory standard, final calibration of a receiver dial is best carried out with a crystal marker. However, anyone who has attempted this process will know that it is not easy to identify weak crystal harmonics, especially when the situation is confused by spurious responses from the receiver itself. Under these conditions, an instrument which can inject stronger, modulated signals, at fundamental frequencies, is an enormous help in resolving the confusion.

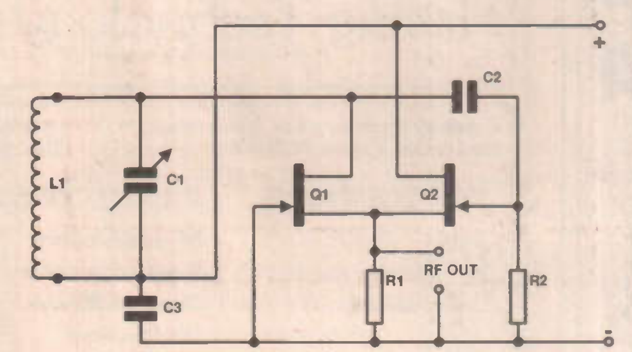


Fig.1 The basic Butler circuit

The signal generator which forms the subject of this article does not call for any special or critical components and many constructors will be able to assemble it from parts already in their spares box. It generates signals over seven, overlapping ranges, from 120kHz to 40MHz. An additional range provides a 100kHz marker signal and the instrument can also be used to check the coverage of tuning coils.

Design Considerations

The heart of any signal generator is, of course, the oscillator. The circuit adopted here is a FET version of the cathode-coupled oscillator first described by the late Frederick Butler in 1944. Butler listed a number of advantages for his original valve circuit, the most significant being the absence of feedback windings or feedback tappings on the tuning inductor. This greatly simplifies coil construction and range switching. The FET version oscillates reliably, even with coils of modest Q and with comparatively high tuning capacitor values. The circuit is reduced to its essentials in Figure 1.

The series (drain) mode has been adopted as this avoids the need for a radio frequency choke in the drain circuit of Q1. It does, however, call for the tuned circuit to be isolated from the negative supply rail and the moving vanes of C1 are insulated from the case and earthed to radio frequencies by C3. (In the shunt-fed version, the tuned circuit is connected to the gate of Q2 in place of R2 and the drain of Q1 is loaded by the radio frequency choke).

The feedback capacitor, C2, should be of the lowest possible value in order to minimise coupling to the tuned circuit, and the 10p component specified is probably the best compromise for the frequency range covered by the generator.

Referring now to the detailed circuit diagram, Figure 2, tuning inductor, L1, is a continuous winding with six tapping points. S1(b) acts as the range switch by progressively shorting out sections of the coil in order to reduce its inductance and increase the frequency of oscillation. The remaining wafers of SW1 control refinements and additional functions and, if all that is required is a very basic signal generator, the switching circuit can be reduced to a one pole, seven way switch (six ways if the rotating switch contact can be turned until it aligns with its own wiping contact). Shorting out the coil windings causes absorption effects which deaden oscillation at around 4MHz and 20MHz. The two notches are extremely sharp and do not materially detract from the useful-

HOW IT WORKS

L1 and C1 form the tuned circuit and Q1 and Q2 are the active devices in the source-coupled oscillator stage. Q1 functions as a grounded gate amplifier and Q2 as a high-impedance, unity gain source follower. Loading on the tuned circuit is light. Signals developed across the shared source resistor, R1, are coupled, via DC blocking capacitor, C5, to the gate of the FET source-follower buffer amplifier stage, Q3.

Generator output is developed across R6, the source load resistor for Q3 and one section of a twin-gang potentiometer, R6 and R7. This arrangement of variable resistors controls the output level while at the same time presenting a reasonably constant impedance to the circuit under test. Capacitors C6 and C7 act as DC blockers.

Although the oscillator is reasonably immune from drift caused by temperature and supply voltage fluctuations, operating frequency does shift slightly as battery potential falls. Zener diode, ZD1, stabilises the working voltage of Q1 and Q2 and reduces this drift to negligible proportions.

The radio frequency signal is modulated by the series-fed Hartley oscillator stage formed by T1, C11 and Q4. T1 is a small, push-pull, transistor radio output transformer. Its centre-tapped primary winding and C11 form a tuned circuit resonant at about 1kHz. The audio oscillations produced by this stage are imposed on the radio frequency by connecting the secondary of T1 in series with the power supply to Q1 and Q2. This is the classic or Heising method of amplitude modulating a carrier wave. Modulation is switched on and off by SW2(a) which connects Q4 to the power supply.

ness of the instrument, but constructors who wish to eliminate this phenomenon can fit SW1(d). This wafer is wired to short out both ends of offending sections of the coil and prevent the absorption of energy at these two spot frequencies.

A 100kHz signal and its harmonics are useful for calibrating receiver dials. SW1(c) connects an additional 390p capacitor, C4, into circuit, thereby enabling C1 to tune the inductor down to this frequency.

There is often a need to check the coverage of tuning coils before they are wired into circuit. SW1(a) switches out the generator's internal inductor so that coils can be connected to the oscillator circuit via the terminals provided. Checking the frequency of oscillation at the extreme settings of C1 against a receiver tuning dial will give a good idea of the coverage (and inductance) of the coil.

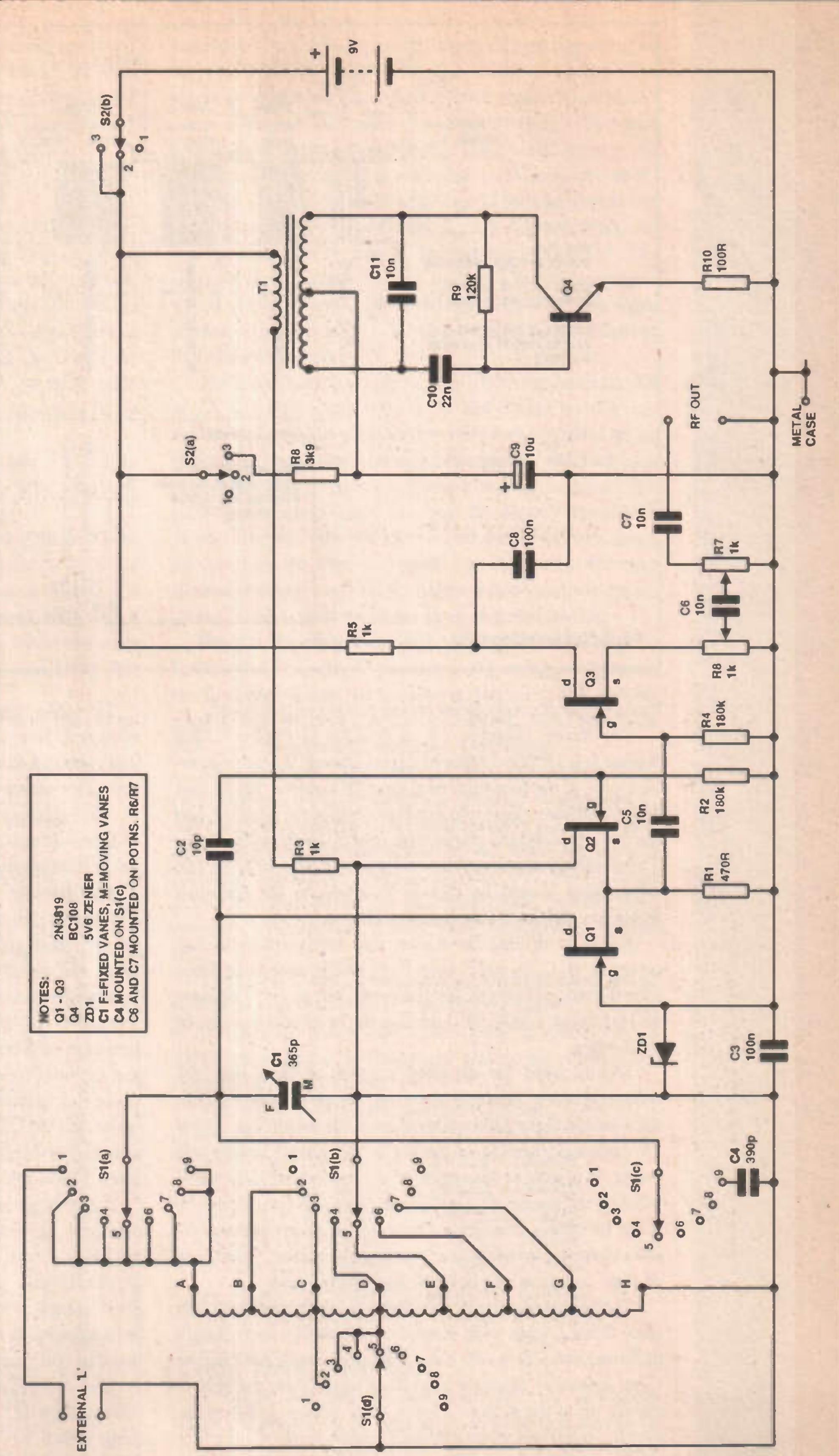


Fig.2 RF Signal Generator circuit diagram

Construction

Details of the printed circuit board and component placement are given in Figure 4. Vero pins inserted at the lead-out points aid wiring up and, if metal stand-offs are used to mount the board, they will connect the metal case to battery negative. Note that C4 is mounted on the wafer of SW1(c), and C6 and C7 on potentiometers R6/R7. Provision is not

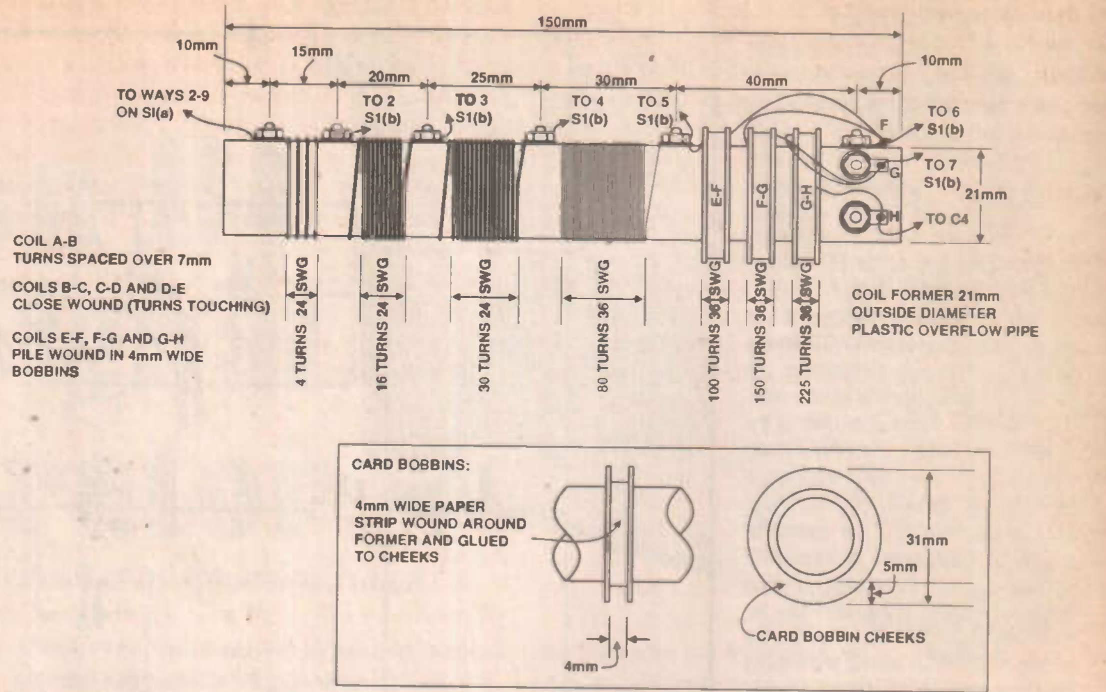


Fig.3 Coil winding data

made for these components on the printed circuit board.

The tuning inductor, L1, is detailed in Figure 3. The former is a 150mm length of 21mm outside diameter overflow pipe of the type retailed at most DIY stores. Solder tags anchor the start, finish and tapping points of the winding, and the three, pile-wound sections are held in cardboard bobbins. The guidance regarding dimensions, numbers of turns and wire gauge should be closely followed or the specified frequency coverage may not be achieved.

Begin by drilling the former and fixing solder tags at points A, B, C, D, and E (tags F, G, and H have to be fitted after the wound bobbins have been slid into place). Tweezers will be found helpful for inserting the bolts at the centre of the former.

Tightly wind the specified number of turns onto the former, keeping them neat and even. Scrape the enamel from the wire and make good connections to the solder tags. Avoid the prolonged heating of the tag or the plastic former will soften. It is easy to lose track of the number of turns when winding the longer, single-layer sections and a check can be made by slowly drawing a tooth-pick or sharpened matchstick down the winding and counting the clicks. A thin coat of clear cellulose will hold the turns in position.

The bobbins for the larger windings are formed from thin card. Wind a 4mm wide strip of card around a spare length of former and glue it with balsa cement or Bostic All Purpose Clear Adhesive. Slide the card discs which form the bobbin cheeks up to the strip and apply more adhesive. When the glue has hardened, make a pinhole at the bottom of one of the cheeks, thread the start of the winding through, then wind on the specified number of turns. A narrow strip of insulating tape will secure the final turns and protect the winding.

Slide the wound bobbins onto the former and space them as shown in Figure 3. If they are a loose fit, tighten them by winding tape around the former. The entire coil assembly must be rigid or a knock could jolt the instrument out of calibration.

Fit solder tags F, G, and H, and connect up the pile windings. Note that all turns must be wound in the same direction and the finish of one pile winding must be connected to the start of the next.

The prototype was assembled inside a standard 203mm ∞ 153mm ∞63mm aluminium box. A metal enclosure is essential. It does not do much to limit the escape of RF energy, but it does prevent the calibration of the instrument being affected by external metal objects. A case smaller than the one specified is not recommended as the dial will become too small and clearance between case sides and coil will be excessively reduced. The 9V battery pack of six AA cells is secured to the back cover with an aluminium strap. Great care must be taken when handling the variable capacitor, C1, and the front fixing bolts must be short or they will foul the vanes and damage the component. The capacitor must not be connected directly to the metal case. Fix it to a sheet of paxoline or Perspex with countersunk screws, insulate the screw heads, and bolt the paxoline to the case front.

Figure 5. gives full details of the range switch wiring. An ingenious, split moving contact arrangement on one side of the Maka-switch wafers enables two, 9-way switches to be accommodated on each wafer. Wiring up the unit, and positioning it in the manner shown will ensure that the range pointer moves in a logical way, beneath the bands on the dial and that coil connections are short and direct.

The coil is mounted behind the case front, on 25mm stand-offs, with the start of the winding (tag A) close to the range switch, S1. The printed circuit board is mounted on the floor of the case, beneath the tuning capacitor, on 6mm stand-offs.

Wiring between the off-board components should be carried out in reasonably heavy, single-strand hook-up wire, and all leads must be kept as short and direct as possible. Any subsequent movement of the tuned circuit wiring will have a noticeable effect on calibration.

Black spray paint was used to decorate the case. The dial and front panel were drawn on cartridge paper, annotated with rubdown lettering and protected by 1.5mm Perspex (acrylic) sheet. The dial pointer was formed by wiping red paint into a line scribed on a strip of Perspex, the strip being fixed to the control knob.

Testing And Calibration

It is a good idea to test the unit before the various components are mounted in the case. Make temporary connections between the PCB and the coil and tuning capacitor, wire up S2, R6 and R7, and connect up a fresh 9V battery. Current consumption with modulation off should be approximately 5.5mA and this should rise to about 6mA with the modulation stage switched into circuit. A portable radio placed near to the generator should be almost swamped by signals.

Peak-to-peak output voltage is approximately 1V up to 20MHz. Beyond 20MHz, output gradually falls until it is about 0.5V at 40MHz.

The quickest and easiest way of calibrating the unit is to connect it to a frequency counter, setting C1 to give the required round-figure read-outs and marking up the dial. If a frequency counter is not available, an all-band radio with a digital frequency read-out could be used. Receivers with analogue dials are not likely to be accurate enough for this purpose.

In the absence of digital read-out equipment, the instrument can be calibrated to a high degree of accuracy using an all-band radio in combination with a crystal marker. The signal generator is set to zero beat with signals injected into the receiver from the marker, moving from marker harmonic to marker harmonic around the dial. The correct setting of the generator tuning control is very clear — whistles are heard on either side and the point of silence in between represents the optimum matching of the two signals. A simple regenerative receiver is better than an inexpensive superhet for this purpose, as the latter is likely to have spurious responses which can cause confusion. However, with care, both types of receiver can be used in combination with a crystal marker to calibrate the unit.

The author used a crystal marker which produced signals at 4, 2, and 1MHz, and 100, 50, 25, and 10kHz, in combination with a simple regenerative receiver, to calibrate the generator. The calibration was subsequently checked by a digital frequency counter and found to be accurate. If this method is adopted, make sure that the correct crystal harmonic has been selected by cross-checking the harmonics produced by the generator itself, e.g. check that when the generator is set to, say, 8MHz, harmonics are produced at 16, 24 and 32MHz, and that there is no output at 4MHz.

When calibrating the lowest frequency range and the 100kHz marker point, listen for second harmonics of generator fundamentals on the long-wave band, e.g. the 100kHz marker will produce a signal at 200kHz, 2kHz above the BBC's Radio 4 transmission from Droitwitch.

Keep generator output low during the calibration process (direct connection to the receiver is not likely to be necessary) and check from time to time that the battery voltage has not fallen so much that the action of the zener stabiliser is impaired. Switching on the modulation will help with the initial identification of the generator signal, but the final, precise tuning to zero beat is best carried out with modulation off.

The author's dial is reproduced in Figure 6. There are no coil cores or trimmers and, if the specified tuning capacitor is used and the coil wound as described, it should form a useful guide to the coverage and calibration points to be expected with other units.

Frequency coverage with the specified tuning capacitor is as follows:-

(1) Full coil winding	120kHz - 190kHz.
(2) Taps G - H shorted	180kHz - 350kHz.
(3) Taps F - H shorted	300kHz - 750kHz.
(4) Taps E - H shorted	650kHz - 2.1MHz.
(5) Taps D - H shorted	1.7MHz - 6.4MHz.
(6) Taps C - H shorted	3.2MHz - 12 MHz.
(7) Taps B - H shorted	9.5MHz - 40 MHz.

Using The Generator

Coupling between the instrument and the equipment under test should be as light as possible and, in almost all cases, a length of wire laid near to the receiver aerial socket or test point will transfer enough signal. The metal-box screening arrangement does not completely prevent the escape of RF energy (laboratory instruments incorporate heavier and more elaborate screening systems) and the simple output control does not reduce the signal to zero. It will, however, reduce the output to a lower level. Radio manufacturers and set designers usually give detailed alignment guidance for their radio receivers and this should be

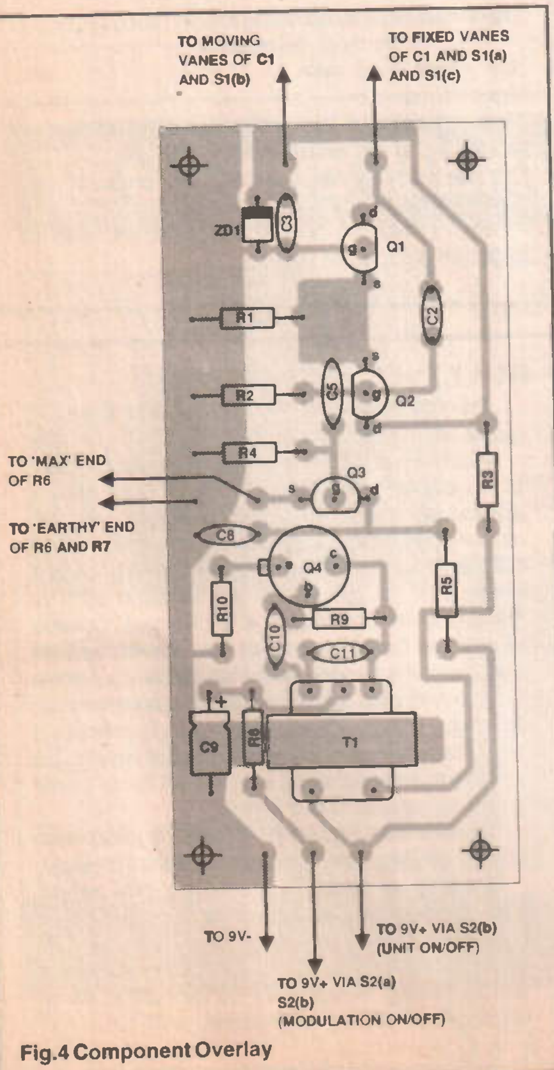


Fig.4 Component Overlay

PROJECT

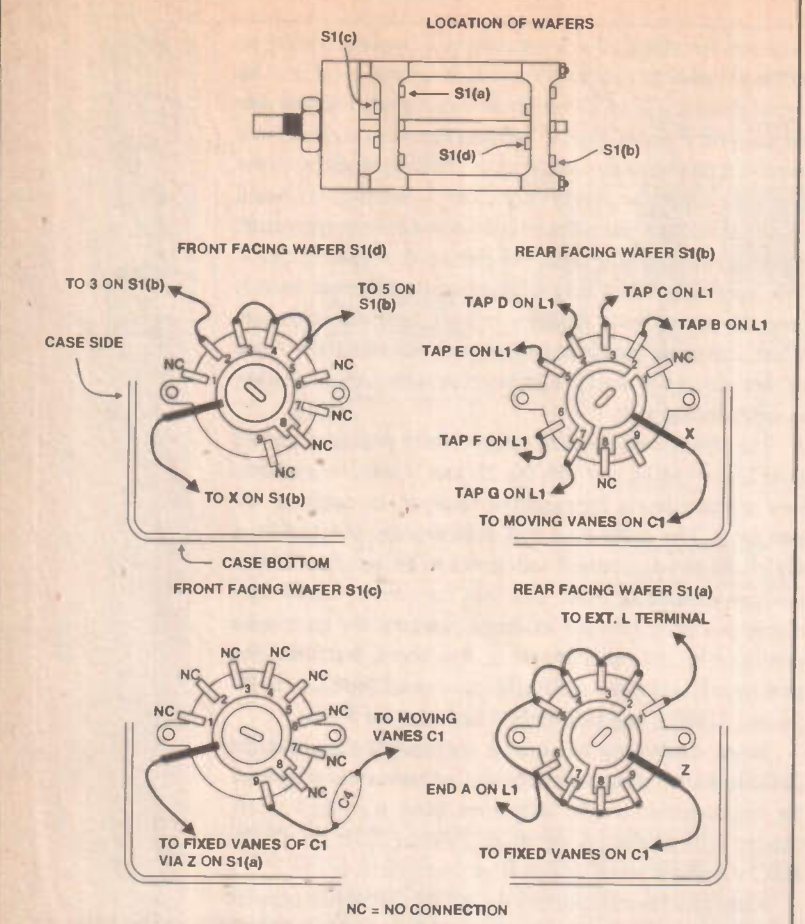


Fig.5 Range switching details.

followed. Using the generator to locate amateur bands on a new receiver is quite straight forward, but make sure that the receiver is not inadvertently set to a harmonic of the generator fundamental, e.g. 7MHz instead of the required 3.5MHz. This can be checked by ensuring that the receiver does not respond more strongly when the signal generator is tuned up to the second harmonic. The coverage of tuning coils can be assessed by connecting them to the generator, injecting the resulting signal into a radio receiver and swinging C1.

Further Refinements

The simple signal generator performs well, as designed and most amateurs will find it meets their needs. Constructors who wish to build a more refined instrument could fit a slow motion drive to C1 and, possibly, use a larger case which would provide space for a bigger dial. If expense is no object, the dial could be replaced by a digital frequency display module.

The oscillator circuit will function into the VHF region. Constructors wishing to extend the range of the instrument could fit an air-spaced AM/FM tuning gang and use one of the FM sections to tune suitable coils. As it stands, the third harmonics of 25-40MHz fundamentals extend strongly into the VHF region. Increasing coverage on fundamentals to VHF would produce harmonics into the UHF range. Indeed, this is the practice of some manufacturers who rely on the third harmonic of a 150MHz fundamental to extend the coverage of their equipment to 450MHz. These possibilities were not explored by the author and some experimentation with coil, capacitor and switching arrangements would be required to extend the range of the unit in this way.

PARTS LIST.

RESISTORS (All 0.5W, 5% tolerance).

R1	470
R2,4	180k
R3,5	1k
R6,7	1k x 1k twin-gang potentiometer.
R8	3k9
R9	120k
R10	100

CAPACITORS

C1	10-365p air-spaced variable. Jackson type 01
C2	10p ceramic, 5% tolerance.
C3,8	100n ceramic
C4	390p polystyrene, 1% tolerance.
C5,6,7,11	10n ceramic
C9	10µ/25V axial lead elect
C10	22n metallised polyester.

INDUCTORS AND TRANSFORMERS

L1	See text and miscellaneous
T1	Transistor radio push-pull output transformer. Type LT700 or similar: see text.

SEMICONDUCTORS

Q1,2,3.	2N3819
Q4	BC108
ZD1	5V6 zener diode.

MISCELLANEOUS

Switches.
S1(a-d) Maka-switch shaft assembly and 2No, 2-pole, 9-way, wafers.
S2(a-b) 2-pole, 3-way, switch.
Materials for coil (L1):
21mm outside diameter plastic overflow pipe, solder tags, thin card, adhesive, and 24 and 36SWG enamelled copper wire.
Vero pins, terminals, aluminium box or chassis for case 203mm x 153mm x 63mm,
1 x large, 1 x medium and 2 x small knobs; hook-up wire, battery and holder, nuts and bolts and stand-offs.

BUYLINES

The components are all readily available from a variety of sources and none is particularly critical.

A Jackson type 01 gang, 10-365p air-spaced variable capacitor was used for C1, but most constructors will have a salvaged airspaced component in their spares box which can be used successfully in this circuit. Ensure that it is clean and dry, that the vanes are not shorting, and remove any built-in trimmers. It is quite in order to use one gang of a twin-gang unit and to switch the second gang into circuit in place of C4. Air-spaced capacitors salvaged from domestic receivers are likely to have a maximum capacitance within the range 360 to 500p. Provided the minimum capacitance is not too high, this will ensure continuous coverage. Constructors who are a little apprehensive about the calibration of the instrument may wish to fit the specified Jackson capacitor. The dial on the prototype, reproduced in Figure 6, will then be a useful guide to the calibration of their generator.

The range switch fitted, detailed in Figure 5, is a Maka-switch assembly with two, 2-pole, 9-way wafers, available from Maplin.

Modulation transformer, T1, is a transistor radio push-pull output transformer and a salvaged unit was fitted in the prototype instrument. If this component has to be purchased, the LT700 transformer retailed by Maplin and others should prove suitable. A push-pull interstage transformer can be used instead, but the modulation depth will be greatly increased.

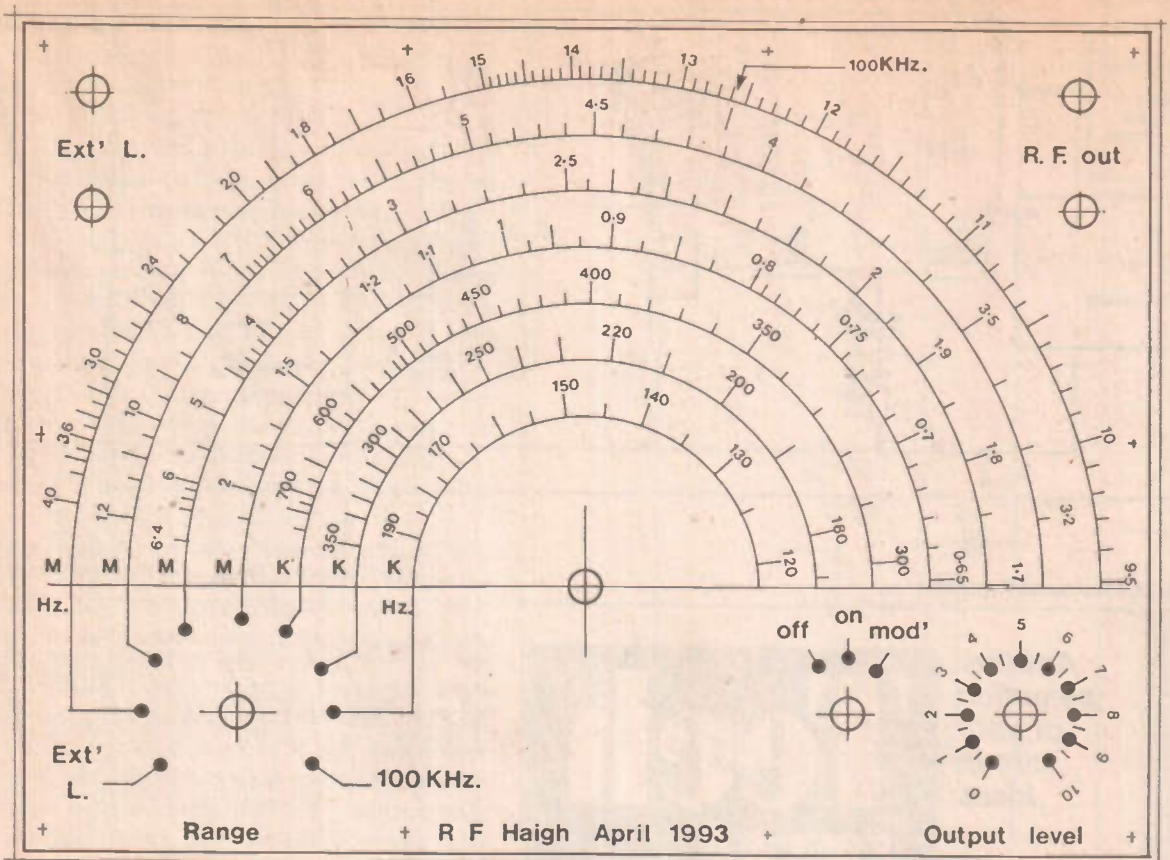
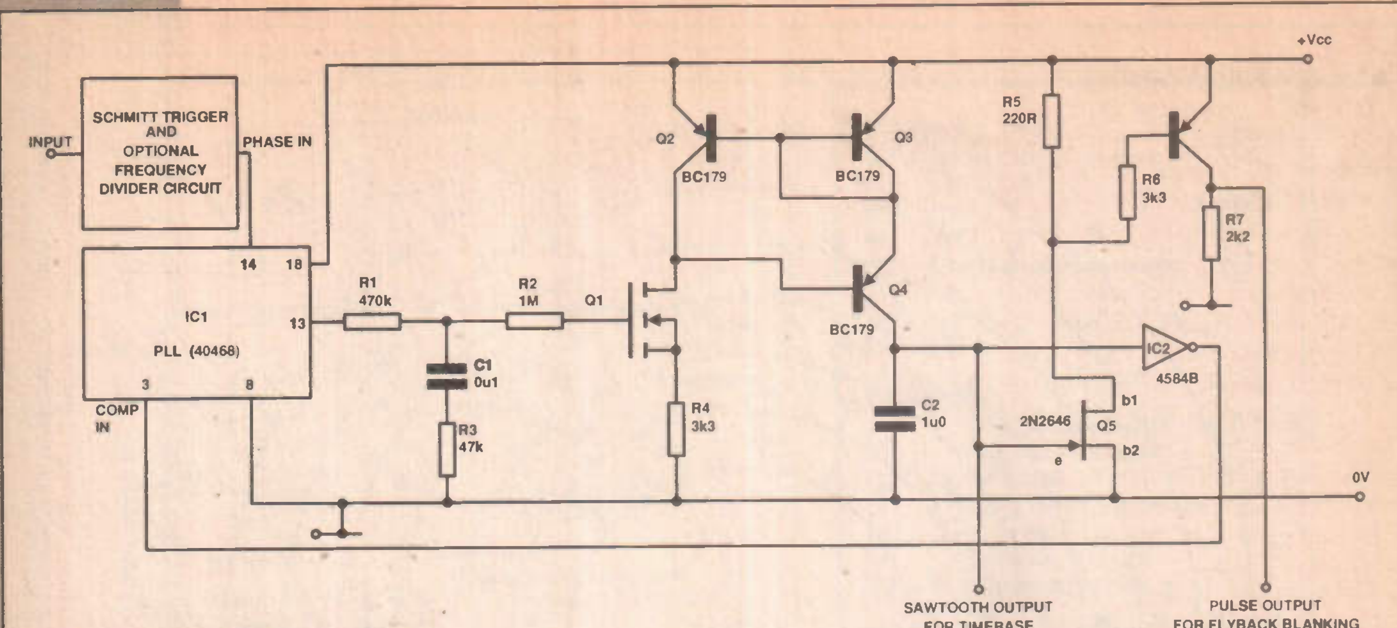


Fig. 6 Front panel reproduced here at 75% reduction



Voltage Controlled Timebase Oscillator

Another selection of your circuit ideas

Tech Tips

Voltage Controlled Timebase Oscillator

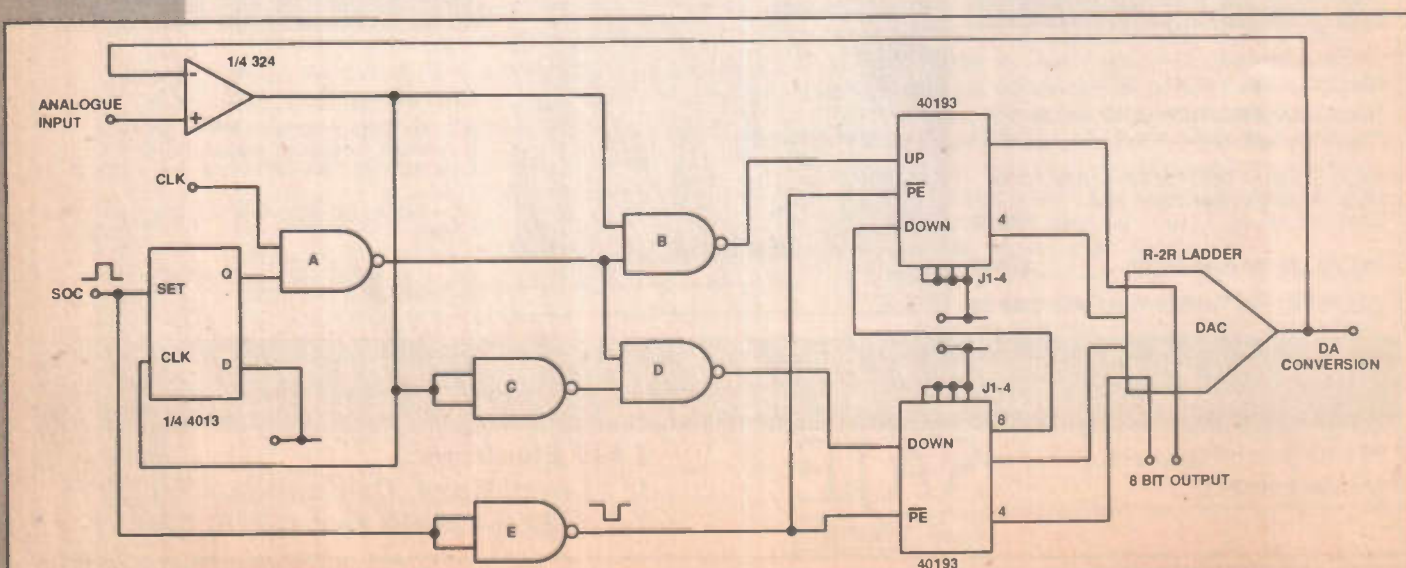
We developed the following circuit module for use with an oscilloscope display. It was designed to produce sawtooth timebase waveform locked to a varying input frequency so that the 'scope showed a fixed number of cycles of the input waveform over a wide range of frequencies.

The circuit consists of three elements: a phase-locked loop, a programmable current mirror and a unijunction oscillator. The UJT oscillator (Q5, C2, R5) produces a ramp waveform of constant amplitude, the steepness of the ramp and hence the oscillator frequency being controlled by the charging current passing through Q3 and Q4 into C2. Q3, Q1 and Q2 are a classic current mirror, the current in this case being determined by the condition of MOSFET Q1. The MOSFET 'sees' the control voltage generated by the phase-locked loop chip IC1: it can be seen thus that the UJT oscillator frequency is dependent upon the PLL's control voltage output. The PLL derives its phase input from the input waveform (the one to be viewed) after this has been cleaned and squared by a Schmitt trigger. The comparison input to the PLL is simply a sampled and squared version of the UJT sawtooth output. Thus the sawtooth is automatically locked in frequency to the input waveform.

In addition to the timebase waveform, provision is made for a blanking pulse to suppress the flyback of the 'scope trace. (This is necessary because we are supplying our own timebase for the x-axis spot movement.) The precise arrangement of this must depend on the particular 'scope used.

The circuit shown was used in the 10-500Hz range but there is no reason why other frequency ranges cannot be used: the values of the PLL low pass filter components (R1, C1, R3) would have to be changed, and C2 replaced with a different value.

The number of cycles of the input waveform displayed may be controlled by the use of a frequency divider at the point shown on the diagram. For example, a simple bistable dividing by two would cause two cycles to be displayed.



Faster Analogue to Digital Convertor

Car Fog Lamp Warning

This unit is designed to produce an audible warning signal if the Fog Lamp switch is left on after bad weather, when the vehicle lights are next switched on.

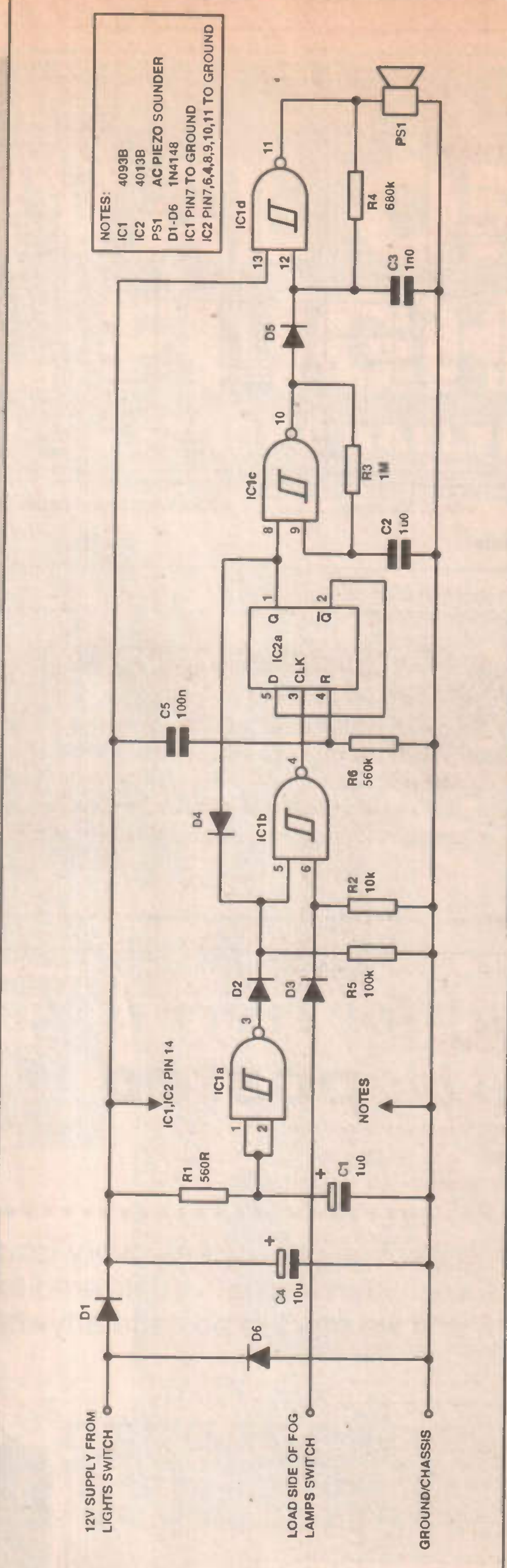
When the lighting circuit is operated. power is applied to the unit. C1 takes around 1 second to charge; if the Fog Lamps switch is on, IC1b will generate a low to high transition once C1 has charged. The Q output of IC2a swings high, taking pin of IC1b high again via diode OR-gate D2.D4,thereby causing IC1bs output to swing low. The 0 output a 1 so enables a pulsed tone astable built around IC1c and IC1d.

If the Fog Lamp switch is now opened, a second low to high transition occurs: clocking the Flip-Flop and disabling IC1b together with the astable. The Fog lamps can now be switched on again without enabling the warning signal.

D6 protects the unit from back-EMF on the supply, while D1 and C4 keep the supply stable. D3 prevents pin 6 of IC1b rising above the supply voltage to IC1 (due to Dl). R2 acts both as a pull down resistor and current sink to maintain the correct voltage drop across D3. C5 and R6 provide a brief reset pulse to IC2a on switch-on. R5 is a pull down resistor to prevent false triggering.

With lights on, fog lamps off, supply current is around 16µA. With Fog lamps on, this rises to around 1.2mA due to R2.

David Geary, Romford, Essex



Car Fog Lamp Warning

Faster Analogue To Digital Converter

This circuit came about whilst experimenting with R-2R ladders and CMOS counters combined as ADC's.

The circuit is shown in the figure and consists of 2 x 4 bit binary up/down counters, an 8 bit R-2R DAC, a comparator and some clock steering logic. Conventional ADC's of this nature have a binary counter starting from zero and counting up until the output of a DAC is greater than the analogue input voltage to be digitised. This works fine, but can be slow when converting signals at the higher end of the conversion range. This circuit is considerably quicker whilst still maintaining the same building blocks. It works as follows:

When the start of conversion pulse goes high, the output of the D-type flip-flop is SET, the MS bits of the counter are set to zero and the LS bits are set to '1'. The clock is gated through gate A to gates B and D.

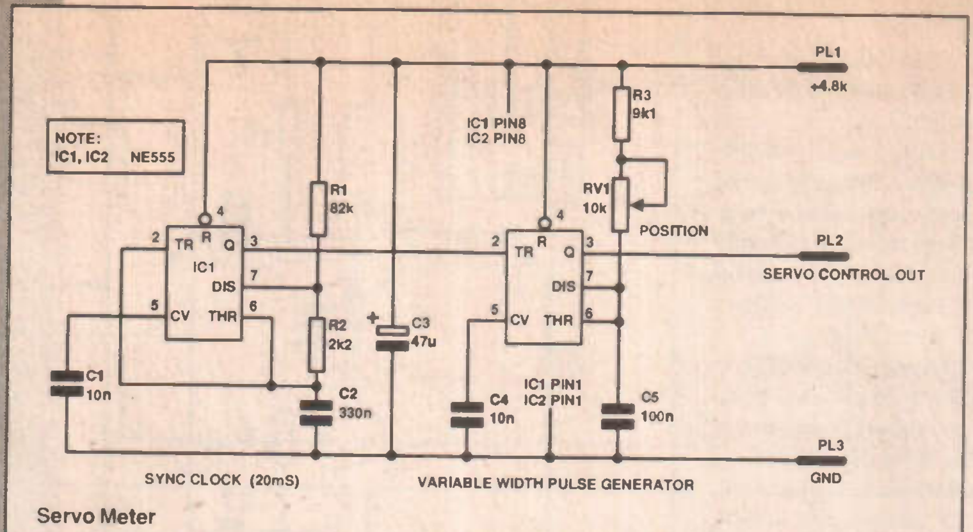
When SOC goes low, the counters will start to count. Initially, the input voltage to be converted will be greater than DAC out so the output of the comparator will be high. This gates the clock through gate B, but stops the clock going through gate D. Thus, the MS bits of the counter will count up and the LS bits will not change.

When DAC out becomes greater than Vin the compartor output will change state to a '0' causing gate D to allow clock pulses through. (The comparator output has no effect on the flip-flop at this stage). The clock pulses are now gated through to the LS bits of the counter which now count down. When DAC out becomes less than Vin the comparator output will change state to a '1'. This will clock through a '0' from the D input of the flip-flop to Q which will gate clock pulses from getting through gate A. The conversion is now complete.

The link between B and DOWN on the 40193 is to provide for the eventuality when Vin level drops below the level that could be achieved when the LS bits were at zero. This allows for some degree of change in the value of Vin during conversion.

The conversion time between this circuit and a conventional circuit is about 3.5 times faster.

Mike Watson, Basingstoke, Hants.



Servo Meter

Servo Tester

The small servo motors used in Radio control cars are very useful devices but can be a bit difficult to test. This circuit was designed to do just that.

The motors are controlled by a Pulse Width Modulated signal, with the position of the arm proportional to the width of the control signal pulse. In most systems this control signal is based on a repetition rate of 20ms and pulse width varying over the range to 2ms, corresponding to the limits of travel in either direction of the arm.

The circuit consists of two blocks. The first block is a sync clock which produces a short pulse every 20ms. It is based around IC1, a 555 timer, configured in astable mode. R1, R2 and C2 define the pulse width and period. In this case the pulse width is 0.5ms and the period equal to 20ms. This sync pulse is used to trigger the second block, a variable width pulse generator.

Again this block is based on a 555 timer, IC2, configured as a monostable. The width of the pulse is determined by the values of C5, R3 and RV1. With RV1 at minimum, the pulse width is 1ms and at maximum the pulse width is 2ms. The whole circuit is designed to operate off the same supply voltage as the servo motor (in most cases this is 4.8V) and the output will drive several servo motors at the same time.

The prototype test unit was mounted in a small plastic box with connectors compatible with those of my radio control servo system to facilitate 'in-car' testing.

Neil Johnson, Northiam, East Sussex.

Don't miss the

FESTIVAL OF MODEL FLIGHT

(INCORPORATING 4 STROKE RALLY)

OLD WARDEN AERODROME
BIGGLESWADE, BEDFORDSHIRE
SATURDAY & SUNDAY 11th – 12th SEPTEMBER 1993

Make a date!
It's a great day for the whole family!

IN ACTION...

- R/C 4 STROKE AIRCRAFT
- HELICOPTERS ● ROCKETS
- CONTROL LINE ● KITES
- ROUND THE POLE
- ELECTRIC SOARERS

PLUS Boat Pool Demonstration

Plus

- **Tethered Racing Cars ● Trade Stands ● Children's Bouncy Castle**
- **Special "All Day" Hog Roast Bar.B.Q**

FREE CAR PARKING

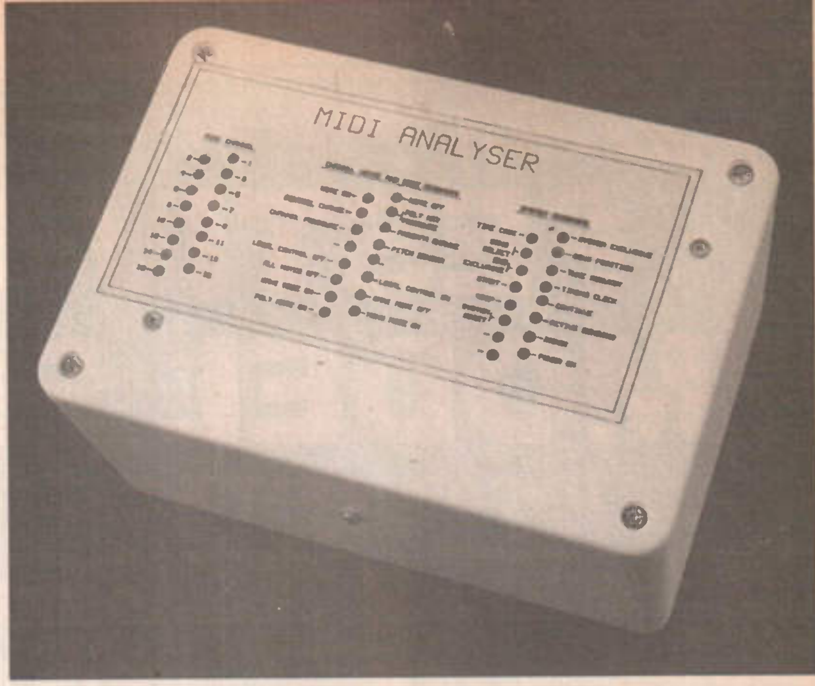
Admission includes entry into

THE Shuttleworth COLLECTION

Admission prices
Adults: £4
Senior Citizens & children: £2.50

AN Argus SPECIALIST EXHIBITION

Argus House, Boundary Way, Hemel Hempstead, Herts HP2 7ST.
Tel: 0442 66551



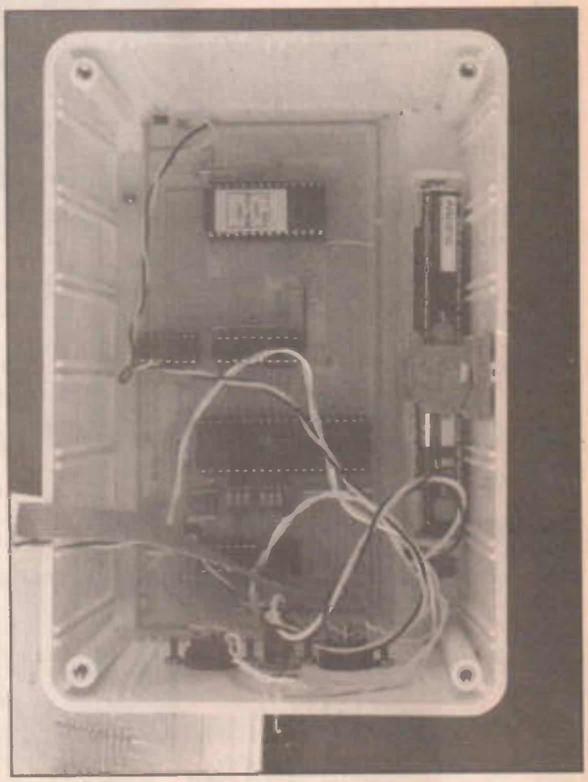
Getting to grips with MIDI signals. Tom Scarff investigates what goes where and when.

Microprocessor MIDI Analyser

Anyone who has ever tried to connect various pieces of MIDI controlled equipment together will understand the difficulty of not knowing what MIDI data is being transmitted down a MIDI cable. While there are a number of software MIDI analysers available which will provide this information, they require the use of a computer. However a portable analyser would be most useful when connecting up unfamiliar equipment in an external environment, so I designed and built a battery powered, stand-alone, microprocessor controlled unit, which checks over 40 MIDI events and includes an error display if an overrun or framing error occurs in the received MIDI data.

MIDI, as most people know by now, is the acronym for Musical Instrument Digital Interface and is at present the universal standard for connecting and controlling electronic musical instruments.

MIDI data is transmitted or received as asynchronous serial data at a rate of 31.25K BAUD, with a format of 1 start bit, 8 data bits and 1 stop bit. The MIDI Out connection operates using a 5mA current loop.



Digital Circuit

The circuit is designed around the Motorola 6803 microprocessor, which contains 128 bytes of RAM, for the programme variables, a Serial Communications Interface, for interfacing to the MIDI in and thru connectors, eight parallel input/output lines, initialised as outputs to drive the LED displays via three 4 to 16 line decoders, and a three function programmable timer.

An internal clock generator with a divide-by-four output is also present. The processor allows the combination of two eight bit accumulators to provide operation of sixteen bit arithmetic. The 6803 CPU is backward compatible with 6800 software.

The operating mode of the 6803 is selected at power-on, or reset by the voltage levels present on the Port 2 pins, P20, P21 and P22. Mode 2 is selected, which makes use of the internal RAM and the multiplexed Data/Address bus.

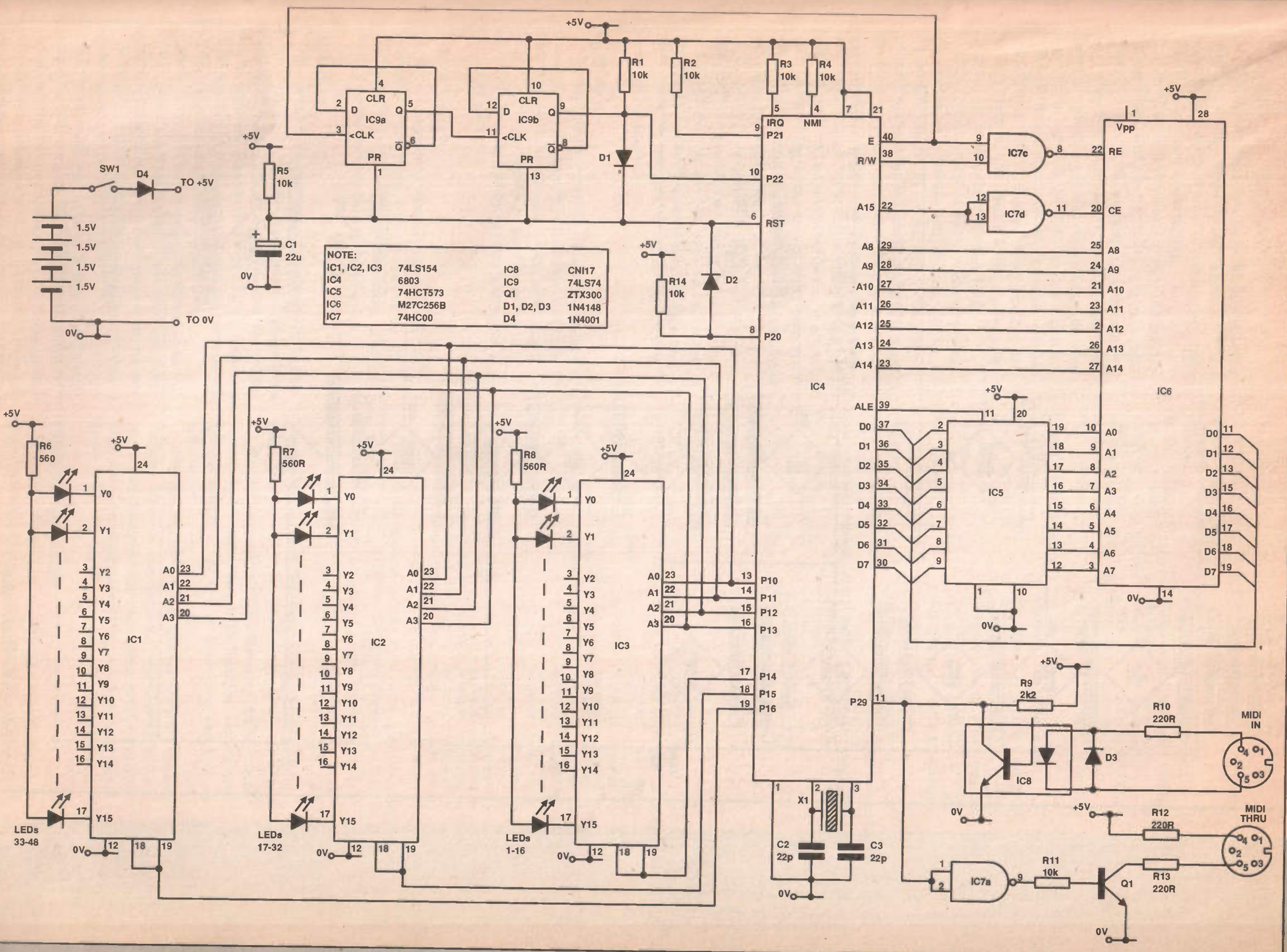


Fig.1 Circuit Diagram of MIDI Analyser

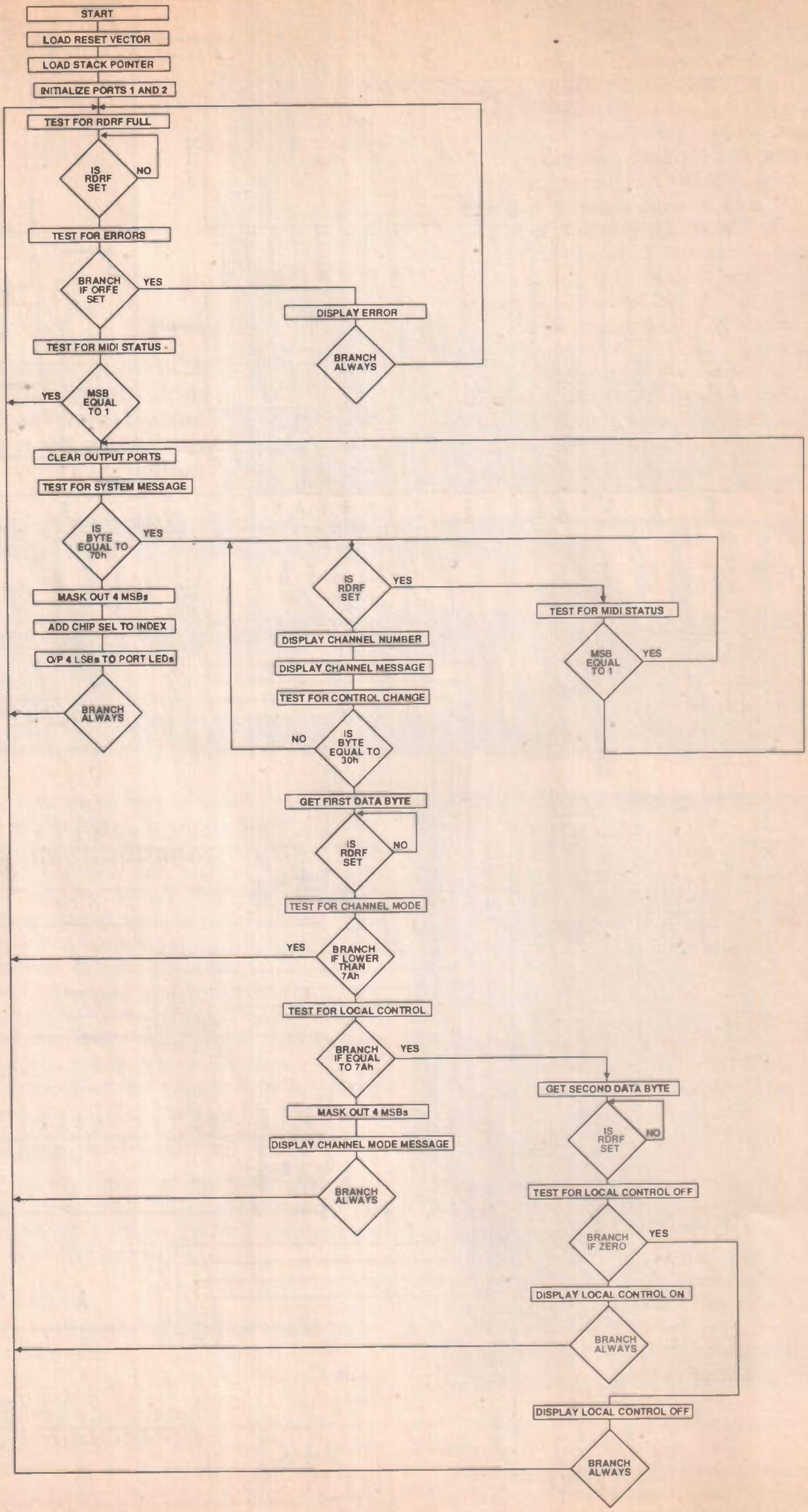


Fig.2 Flowchart for MIDI Analyser

The lower address byte has to be latched before feeding into the address bus. An output signal, the Address Strobe (AS), is provided to enable the latches in IC5 at the correct instant in time.

The EPROM is chip-enabled when address A15 goes high and fed to the active low input via NAND gate IC7D wired as an inverter and is capable of being read when the E pulse and the read/write lines of the microprocessor are both high and fed to the active low read enable line of the EPROM via nand gate IC7c. The EPROM is address decoded to a hex base address of 8000h to FFFFh, allowing direct access to the interrupt vectors. The internal RAM is address decoded to hex address range 0080h to 00FFh.

The 4MHz crystal is divided by 4 internally by the microprocessor, to provide an E pulse of 1MHz and a clock cycle time of 1μs. The timing pulse E is further divided by 4 by the dual D-Type flip-flops, IC3a,b and fed to the serial external clock input on port 2 pin 2 (P22), where it is further divided to provide the correct MIDI baud rate. A 2MHz crystal could be used to generate the baud rate internally but then the clock cycle time would be increased to 2μs, which would not allow enough time between MIDI bytes for the various procedures to be calculated.

The MIDI IN connector is fed to IC8 optocoupler type CNY17, whose output is fed to the serial input P23 of IC4 and via inverting nand gate IC7A and transistor Q1 to the MIDI thru output. The remaining nand gate IC7b can have its inputs connected to ground or left floating.

Display

The display section consists of three 4-to-16 binary decoders which drive the 48 LED displays. The LEDs are arranged in a common anode mode, as the decoders have active low outputs to sink the required LED current, which is fed through the three limiting resistors R6,R7 and R8.

Power Supply

Power is provided by four 1.5V batteries and this 6V is fed to the CPU board, where it is reduced to 5.3V approximately via D4, which prevents damage to the circuit if the batteries are connected incorrectly.

MIDI MESSAGES

Channel Messages:

Message	Status Byte	Data Bytes
Note-On Event	1001bbbb	0kkkkkkk 0vvvvvvv
Note-Off Event	1000bbbb	0kkkkkkk 0vvvvvvv
Polyphonic Key Pressure	1010bbbb	0kkkkkkk 0fffffff
Control Change	1011bbbb	0ccccccc 0CCCCCCC
Program Change	1100bbbb	0nnnnnnn
Channel Pressure	1101bbbb	0ppppppp
Pitch Bend	1110bbbb	0iiiiiii 0hhhhhhh

Channel Mode Messages

Message	Status	Data Bytes
Local Control Off	1011bbbb	01111010 00000000
Local Control On	1011bbbb	01111010 01111111
All Notes Off	1011bbbb	01111011 00000000
Omni Mode Off	1011bbbb	01111100 00000000
Omni Mode On	1011bbbb	01111101 00000000
Mono mode On	1011bbbb	01111110 0zzzzzzz
Poly Mode On	1011bbbb	01111111 00000000

System Messages

Message	Status	Data Bytes
Begin System Exclusive	11110000	0mmmmmmm 0xxxxxxx 0xxxxxxx etc.
MIDI Time Code	11110001	0tttdddd
Song Position Pointer	11110010	0jjjjjjj 0kkkkkkk
Song Select	11110011	0sssssss
Tune Request	11110110	
End System Exclusive	11110111	
Timing Clock	11111000	
Start	11111010	
Continue	11111011	
Stop	11111100	
Active Sensing	11111110	
System Reset	1111111	

MIDI VARIABLE TABLE

Variable	Value	Range
Channel	bbbb	0000 to 1111
Key Number	kkkkkkk	0000000 to 1111111
Velocity of Note On/Off	vvvvvvv	0000000 to 1111111
Force On Key	fffffff	0000000 to 1111111
Address of Control (0-121)	ccccccc	0000000 to 1111111
Value of Control Output	CCCCCCC	0000000 to 1111111
Number of newly selected program	nnnnnn	0000000 to 1111111
Pressure Value	ppppppp	000000 to 1111111
Pitch bend LSB	iiiiiii	0000000 to 1111111
Pitch bend MSB	hhhhhhh	0000000 to 1111111
Number of Channels		0000000 to 1111111
Number of Song	sssssss	0000000 to 1111111
Song Position Pointer LSB	jjjjjj	0000000 to 1111111
Song Position Pointer MSB	kkkkkkk	0000000 to 1111111
Manufacturers Identification Number	mmmmmmm	0000000 to 1111111
Body of System Exclusive Message	xxxxxxx	0000000 to 1111111
MIDI Timecode quarter frame	ttt	000 to 111
	dddd	0000 to 1111

For the MIDI Message tables, bbbb is a four bit binary nibble representing the MIDI channel from 0000 (Channel 0) to 1111 (Channel 15). The seven bit variables, i.e. kkkkkkk, the MIDI key number range from 0000000 to 1111111 from 0 to 127.

Software

The operation of the software can be seen from the flowchart of Figure 2. First the reset vector is loaded from addresses at FFFEh, FFFFh. Next, the serial and parallel ports are initialised. Then the Power on LED is switched on via the parallel port outputs, showing that the hardware and software initialisation are operating correctly.

The software now polls the Receive Data Register Full (RDRF) pin in the Transmit/Receive Control and Status Register of the serial port and when this pin is set, the data in the Receive Register is examined, first for any overrun or framing errors, then for MIDI status.

If an error occurs, the software switches on the error display LED and returns to the start of the programme.

If the received byte is a status byte, i.e. the most significant bit (MSB) is set, otherwise the programme returns to the start. The software then tests for a MIDI system message by checking the top four MSBs and switching on the appropriate display LED.

Whenever the correct MIDI information has been determined and the appropriate LED displayed then the programme returns to the start to receive the next byte of information.

If the data was not a system message then it is a channel message, which is now decoded by the software and the appropriate channel number and channel message LEDs are displayed in a multiplexed mode until the next MIDI status byte is received, when the programme returns to the start.

Mechanical Details

The details for the front panel LED cut-outs are shown in Figure 5 and, when mounting the LEDs into the PCB, enough height should be left for clearance of the decoder ICs mounted

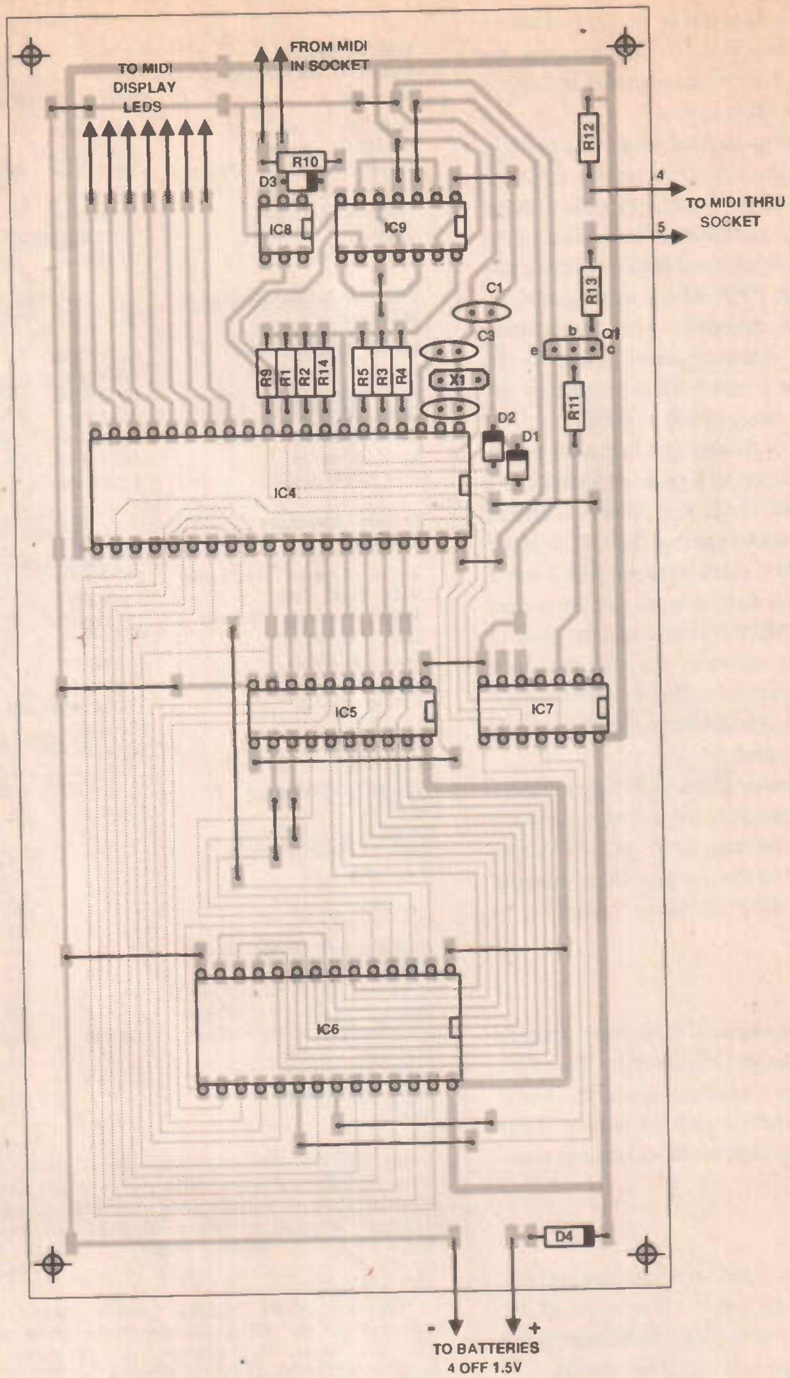


Fig.3 MIDI Analyser overlay for CPU Board

in sockets. Also, the LED display PCB should be mounted so as to leave the LEDs flush on to the front panel.

The label for the front panel can be created by photocopying Figure 6 onto a Xerox transparency and then gluing it in place.

MIDI Standard Messages

MIDI serial data flows at the rate of 31.25 kilobits per second and is organised into 10-bit words. The first bit is called the Start bit (which is always 0), the next eight are the desired information and the last is the Stop bit (which is always 1). The start and stop bits delineate the desired data and provide the required synchronisation, but do not carry MIDI information themselves. A complete word is transmitted in 320 microseconds.

The eight-bit MIDI data is contained between the start and stop bits. There are two main types of bytes, Status and Data. The lead bit of the status byte is always 1 and that of a data byte is always 0. This enables the microprocessor to distinguish between the two types of bytes and so make a corresponding decision.

So, a MIDI message consists of a status byte followed by 0, 1 or 2 data bytes. The MIDI message can be either a channel or system message. The channel message can be addressed to one of sixteen channels, whereas a system message is addressed to all channels. The channel message can operate either on channel voices or on channel modes. The system messages provide real-time, common or exclusive control of the MIDI equipment.

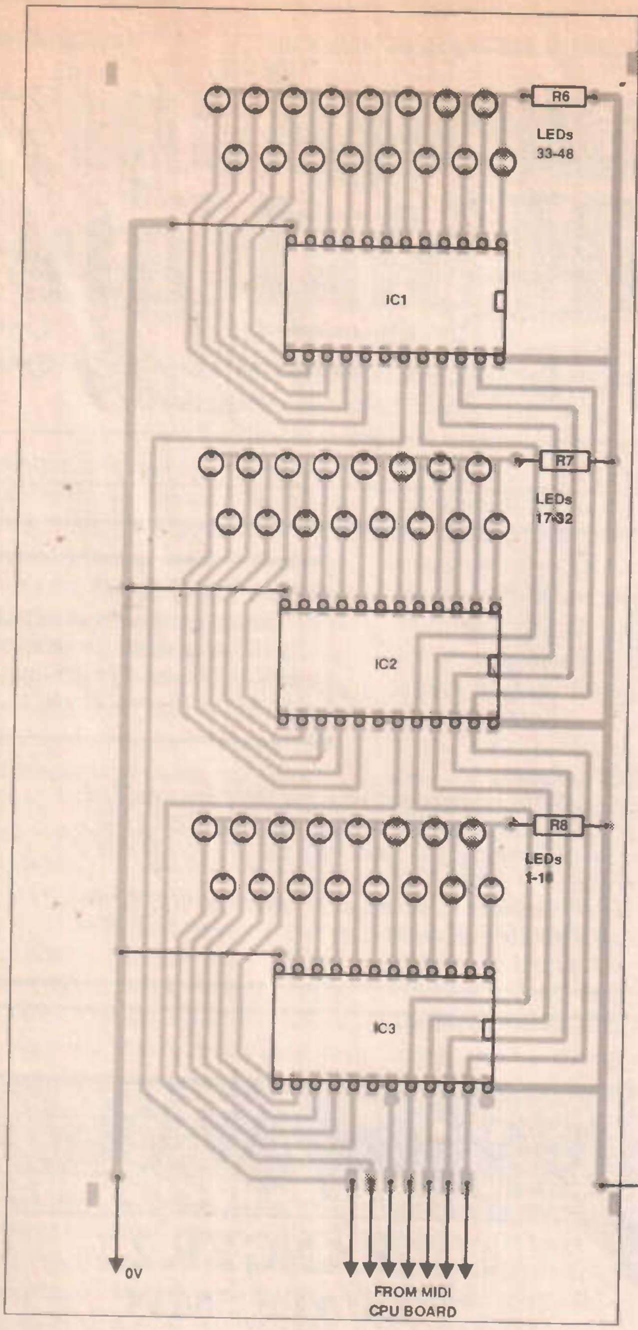


Fig.4 MIDI Analyser Display overlay

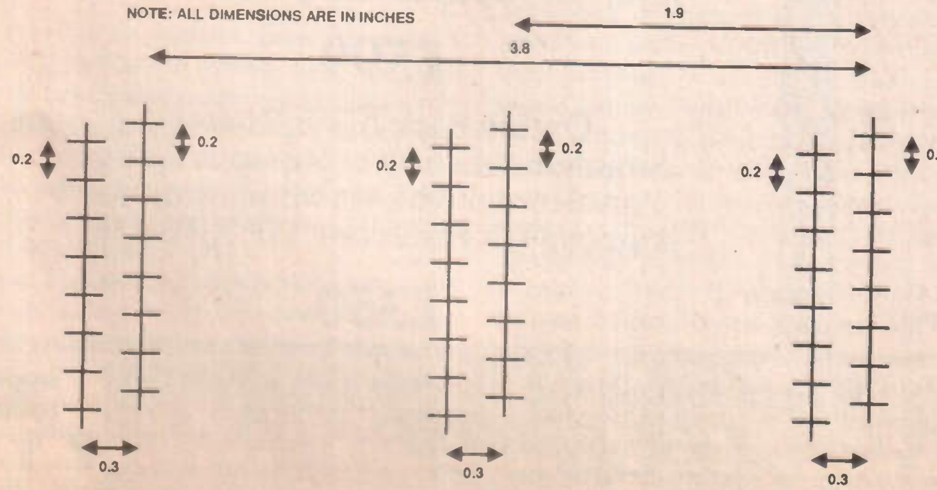


Fig.5 Details for LED cut-outs

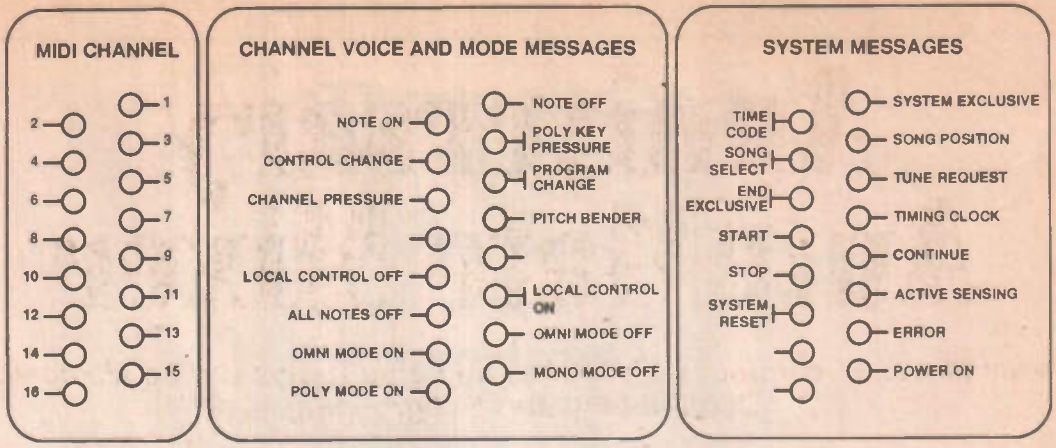


Fig.6 Front panel template

PARTS LIST

RESISTORS

R1,2,3,4,5,11,14	10k
R6,7,8	560R
R9	2k2
R10,12,13	220R

CAPACITORS

C1	22µ
C2,3	22p

SEMICONDUCTORS

IC1,2,3	74LS154
IC4	6803
IC5	74HCT573
IC6	M27C256B
IC7	74HC00
IC8	CNY17
IC9a,b	74LS74
Q1	ZTX300
D1,2,3	1N4148
D4	1N4001

MISCELLANEOUS

LEDS (48 OFF) 3mm diameter, pure orange type, Maplin order code CK36P; 4MHz crystal; Battery holder long 4AA Maplin order code HF29G; 2 OFF 5-Pin Din (180) connectors; SPST switch; Plastic box 177 x 120 x 83 white or light grey;
4 OFF AA or equivalent 1.5 volt batteries; IC holders 6 pin, 14 pin (2 OFF), 20 pin, 24 pin (3 OFF), 28 pin and 40 pin.

BUYLINES

Most of the components are available from many sources. The 6803 microprocessor is available from Farnell, order code HD6803P. For a copy of the MIDI Analyser routine, send in an SAE to ETI at the normal address.

PROJECT

Anniversary AutoMate Mixer

Mike Meechan continues his look at audio pathways during Mixdown, Overdubbing and Subgrouping.

With some consoles, it is possible for the channel input to come from a third source (Mic and Line being the other two). This source is labelled Sub or something similar and is sourced from the bus output associated with that channel strip. In other words, pressing the Sub button on, for example, Input/ Output module 3 would access bus 3. If there was a collage of three sounds mixed onto this bus via the group routing matrix, Channel 3 fader could control the level for all three simultaneously. This is a very powerful facility to have. Every input channel has an associated output jack. In effect, a 24 input desk is also a 24 (track) output desk and could be connected to and used with a 24 track machine. It is obviously not economical of tape tracks to allocate one sound to an individual track. This is where the Bus or Sub routing comes in, since it enables 16, 24, 32 or 48 track recording with a much smaller bus/routing system. Tracks on which only one sound will be recorded are sourced from the channel output jacks. Where a collage - group - of mixed signals is required, the sounds are sent via the group routing matrix onto the relevant bus.

The bus amp sums the signals, this group is accessed via the Sub button associated with that particular bus and they can then be inputted to a channel as a mic or line might be. This sub-group signal could then be further mixed with another group or sub-group or sent directly to bus and from there onto a tape track. It is obvious that with this particular track sourcing/routing system, a much smaller routing matrix/bus is required for a given number of multitrack tape tracks when compared to a split architecture of similar track capability. Figure 5 shows a sub-group routing configuration.

Mixdown

Mixdown is when the multitrack master tape is mixed down to stereo. The split console normally employs some sort of switch in the input channel architecture which allows the 'normalled', dedicated tape returns from the multitrack to be inputted to the console on a channel by channel basis. Track 1 is normalled through to Channel 1, 2 to Channel 2, etc.. This arrangement avoids the need to carry out a lot of messy repatching of the multitrack outputs.

By this time, all of the musicians will have left the studio and the best must be made of the sounds captured on multitrack. Now is when individual sounds from the various tracks can be tailored in accordance with the producer's/ artists' wishes. Consequently, all of the facilities available on the channel strip will now be put to good use. Many different permutations of EQ, FX, level, stereo position, etc., can be experimented with since the original sound is now captured safely in the multitrack tape domain and cannot be harmed. This procedure is repeated over and over again, instrument by instrument and track by track until an acceptable mix of the session has been captured in stereo. Mixdown sessions often last all day and all of the night, to paraphrase The Kinks, with the engineer trying to recapture the mix which was 'almost' right eight hours ago. The monitor sections are now no longer in active use and can be employed as extra inputs for line level sources such as synthesisers or FX returns.

The in-line console handles Mixdown in much the same way, with all of the channel facilities flipped across into the tape return path. Again, the monitor sections can be used as extra inputs. This is where the in-line architecture can again score highly. A 24-input desk has 24 channel inputs and 24 monitor inputs. even if it's only an eight bus system. This equates to 48 inputs at Mixdown (plus, of course, the FX returns). A 24 input, 8 bus split console, on the other hand, will have only 24 channel inputs and 8 monitor inputs, equating only to 32 inputs at Mixdown. The advantages of the in-line console in this aspect are there for all to see. A further advantage inherent to the in-line architecture is in the provision of facilities to direct audio from the output of the channel (large) fader via the small fader to the multitrack routing matrix. The bus outputs can be used as extra FX sends and connected to FX units. Obviously with this arrangement, and subject to certain other constraints, the engineer has access to a possible 8 or 16 or 32 extra FX sends. Conversely, the monitor inputs on a split desk have access only to perhaps 2 or 4 Aux Mix busses for the purposes of FX sends and the limitations are obvious.

Some of the more up-market desks arrange for the EQ to be split into two sections - parametric (2 or more bands only) and shelving. To be entirely flexible, the parametric sections must be able to sweep from low bass frequencies up to high treble and so will be able to cover those frequencies more usually associated with the shelving equaliser, i.e. extreme LF and extreme HF. Conversely, it is useful if the centre frequency of the shelving equaliser is able to be swept up - in the case of an LF section - and down - in the case of an HF section - to the centre frequencies. In this way, they extend into the range of frequencies more usually covered by the parametric. Whichever signal - monitor or input - requires the more flexible of the two equalisers (usually that coming off the tape) will have the parametric inserted in its path while the other, the shelving equaliser, will be used during Mixdown with the signal inserted into the desk on the spare, line input (e.g. a synthesiser). This facility isn't available on all in-line desks, but in those where it is available, the amount of added flexibility is easy to see. Figure 5 shows how Mixdown is achieved in both types of desks.

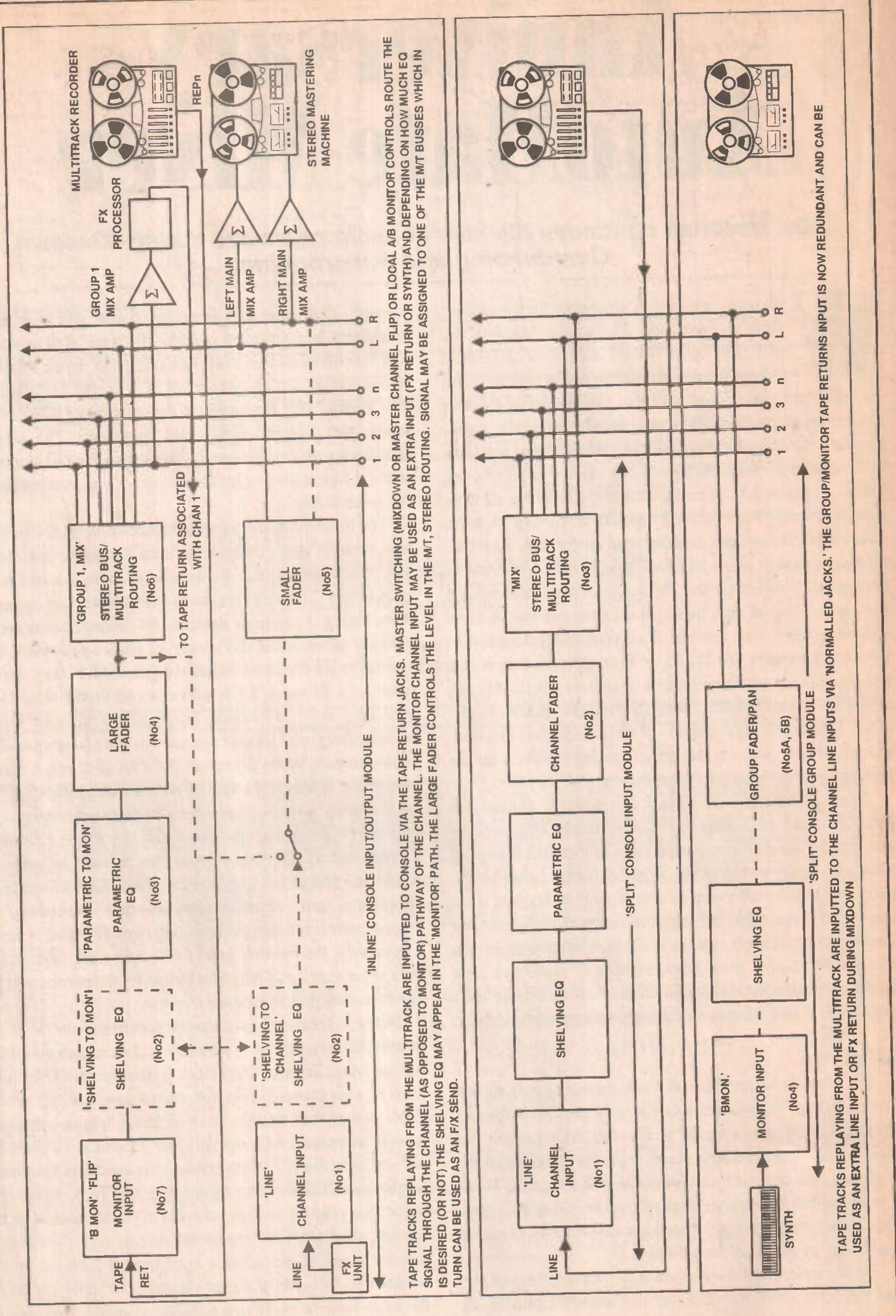


Fig.5 Inline and split methods of Mixdown.

Overdub

Somewhere between the Recording and Mixdown modes lies one known as Overdub. This is when most of the console is configured for Mixdown but a few are set for record (for the purposes of touching up individual tracks). Channel/Monitor facilities are all in the channel (recording) mode but for the large and small fader, which are reversed with reference to the normal recording routing of these controls. The large (channel) fader is now in the monitor path and the small (monitor) one is in the channel path. This is so that the

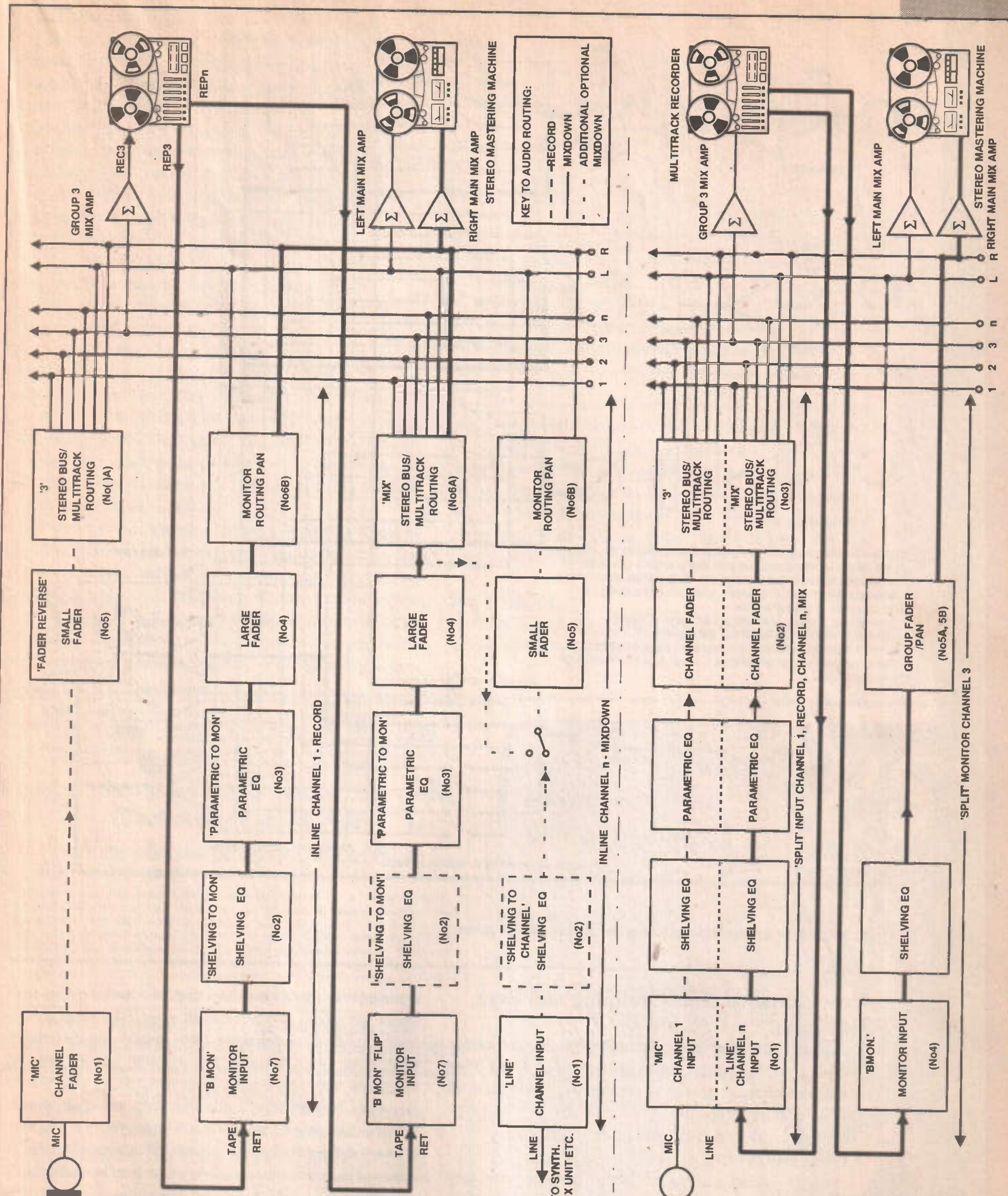


Fig.5 Inline and Split methods of Overdubbing

operation of the large fader corresponds to that of the others across the width of the console. It is normal - if the facility is available on the desk - for the large fader to be the one which has optional VCA control. Allocating the monitor mix to the large faders means that the monitor mix can then become part of the console automation system. Since monitor mix levels will be constantly adjusted - the original reason for reversing the large and small faders in this mode - the advantages of being able to call up stored settings are obvious. Such an arrangement appeals to those engineers who 'mix as they go', and who eventually transform the monitor mix into the final stereo mix. Figure 7 shows what this means in practise.

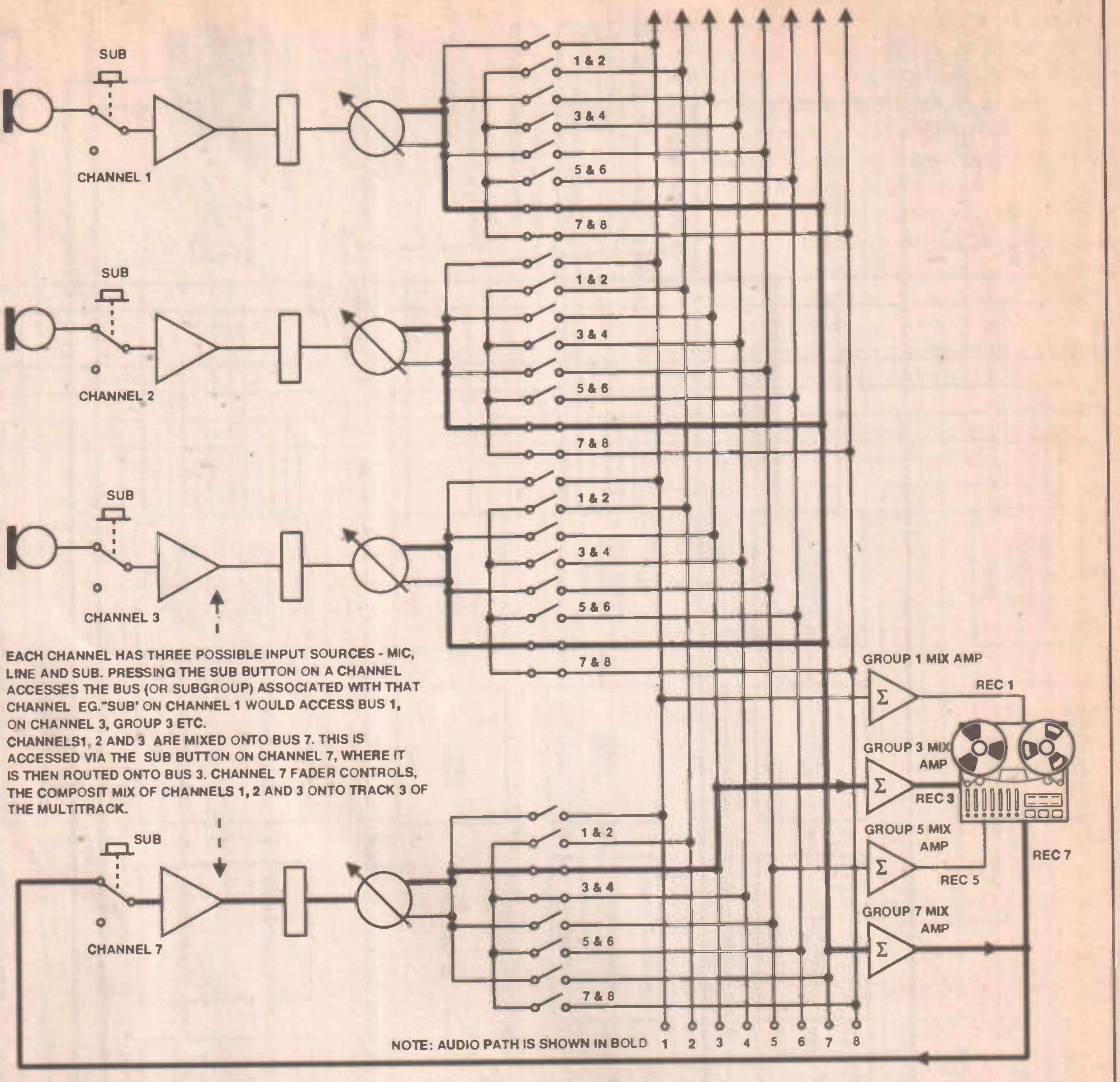


Fig.7 Principle of sub-grouping using console routing system.

Track Bounce, Sub-Grouping and Free Grouping

All of the above are facilities/configurations incorporated into the console to maximise the flexibility of it and other outboard equipment such as the multitrack, while using as little electronics as possible.

Track Bouncing

Track bouncing is a long established and often used way of fitting the most amount of information on to the least amount of tape. Before large multitrack machines were available, it involved machine to machine overdubbing. At present, it frequently involves track to track bouncing on the same machine, although on a 'heavy' session - a television show recording of a band/vocalist, say - two or more multitrack machines may be linked and synched together for overdubbing. For the uninitiated, the process involves the storing of original, first generation sounds on discrete tracks of the multitrack, tracks 2, 3 and 4, say. These tracks are then replayed via the appropriate monitor sections, the three tracks are mixed together and then recorded onto another track (1). It is a technique often used with the smaller multitracks (4 or 8 track, for example) and by amateur musicians, who very quickly exhaust the tracks available for recording. Nonetheless, it does find uses in bigger, professional console/multitrack set-ups. The drawback is that there is a very definite limit to the amount of bounces which can be achieved before the generation losses caused by each successive bounce means an objectionable loss of quality. (In theory, digital multitracks should enable completely lossless track bouncing and therefore the availability of an indefinite number of track bounces). Despite the shortcomings inherent in track bouncing with analogue machines, it is a very powerful facility to have and has proven its versatility over the years in many commercially successful mixes - the Sergeant Pepper album is a prime example of a bounced four track recording.

Subgrouping and Free grouping

These use many of the same philosophies and elements as the track bounce pathway switching (an example of the versatile and economical deployment of the console electronics). Free grouping involves a system like that shown in Figure 8. The group select switches are shown represented by rotary types, but this is in the interests of simplicity and different types may well be used in their place. The group selection matrix can place signals onto any one of the group mix busses or itself be sourced from a particular bus. In this way, and in the example shown, three signals are mixed onto the bus, via the relevant group selectors, where the fourth group then accesses then and places them onto another bus. In this way, the Group 4 fader acts as a grand master for the other three. Sub-grouping achieves a similar effect in a slightly different way. This system finds uses where, for example, all of the backing vocalists must occupy only one stereo pair of tracks. The levels of the individual vocalists are set using their relative group faders, while the level of the collective backing vocalist mix is controlled with the final 'grand master' group fader.

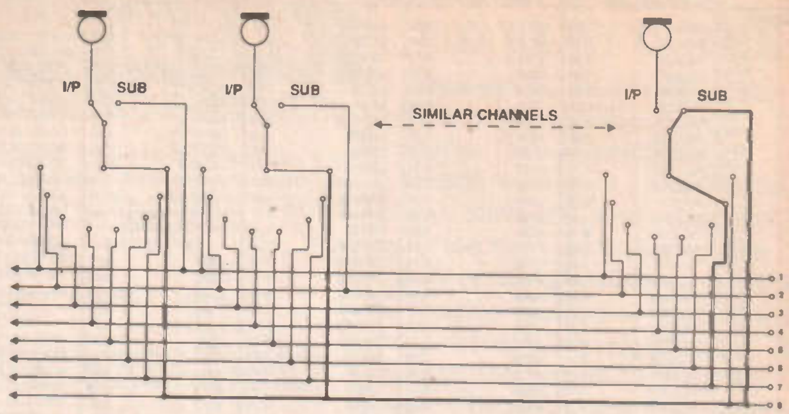


Fig.8 Simplified schematic of the sub-group routing theory

To sum up, the console designer is trying to eliminate wherever possible repatching and replugging in normal use of the desk. Certain unusual circumstances might dictate that pluggery is necessary, but if it has to be done for the simplest of arrangments, or oft-repeated configurations, then either the designer has come up with a bad product, or one which isn't user-friendly, or the engineer is using the desk in a situation for which it was never intended. Comprehensive jackfields placed within easy reach of the engineer make life a lot more bearable when sources have to be swapped. Unfortunately, these are expensive and normally found only on the more upmarket desks, the type where routing capabilities have been well-thought-out and a patch bay is a nicety, rather than with cheaper desks, where it may well be considered a necessity.

References

Dove, Steve, Consoles and Systems, The Audio Cyclopedia (edited by Glen M. Ballou), SAMS

EXPRESS COMPONENTS

74LS SERIES

74LS00	0.10
74LS01	0.10
74LS02	0.10
74LS03	0.10
74LS04	0.10
74LS05	0.10
74LS06	0.39
74LS07	0.39
74LS08	0.10
74LS09	0.12
74LS10	0.10
74LS11	0.10
74LS12	0.10
74LS13	0.18
74LS14	0.22
74LS15	0.12
74LS20	0.12
74LS21	0.12
74LS22	0.12
74LS24	0.33
74LS26	0.12
74LS27	0.12
74LS28	0.12
74LS30	0.12
74LS32	0.13
74LS33	0.13
74LS37	0.14
74LS38	0.13
74LS40	0.13
74LS42	0.23
74LS44	1.62
74LS47	0.50
74LS48	0.46
74LS49	0.62
74LS51	0.11
74LS54	0.11
74LS55	0.13
74LS73	0.20
74LS73A	0.26
74LS74	0.16
74LS74A	0.18
74LS75	0.21
74LS76	0.22
74LS76A	0.24
74LS77	0.42
74LS83	0.34
74LS85	0.34
74LS86	0.22
74LS90	0.24
74LS91	0.50
74LS92	0.29
74LS93	0.24
74LS95	0.38
74LS96	0.46
74LS107	0.25
74LS109	0.25
74LS112	0.25
74LS113	0.25
74LS114	0.25
74LS122	0.33
74LS123	0.33
74LS125	0.28
74LS126	0.21
74LS132	0.28
74LS133	0.25
74LS136	0.21
74LS137	0.62
74LS138	0.24
74LS139	0.26
74LS145	0.58
74LS147	0.86
74LS148	0.70
74LS151	0.25
74LS153	0.28
74LS154	0.70
74LS155	0.25
74LS156	0.25
74LS157	0.20
74LS158	0.25
74LS160	0.32
74LS161	0.32
74LS162	0.32
74LS163	0.32
74LS164	0.30
74LS165	0.48
74LS166	0.53
74LS168	0.58
74LS169	0.53
74LS170	0.66
74LS173	0.56
74LS174	0.24
74LS175	0.24
74LS181	1.48
74LS182	1.58
74LS183	1.58
74LS190	0.25
74LS191	0.24
74LS192	0.29
74LS193	0.39
74LS194	0.39
74LS195	0.24
74LS196	0.24
74LS197	0.24
74LS221	0.36
74LS240	0.32
74LS241	0.32
74LS242	0.32
74LS243	0.32
74LS244	0.32
74LS245	0.33
74LS247	0.32
74LS248	0.38
74LS249	0.68
74LS251	0.24
74LS253	0.34
74LS256	0.50
74LS257	0.24
74LS258	0.24
74LS259	0.48
74LS260	0.28
74LS266	0.14
74LS273	0.32
74LS279	0.25
74LS280	0.86
74LS283	0.49
74LS290	0.24
74LS293	0.24
74LS295	0.58
74LS298	0.63
74LS299	1.18
74LS322	1.58
74LS323	1.78
74LS347	0.90
74LS348	1.18
74LS352	0.78
74LS353	0.88
74LS363	1.38
74LS364	1.38
74LS365	0.24
74LS366	0.28
74LS367	0.26
74LS368	0.28
74LS373	0.32
74LS374	0.32
74LS375	0.34
74LS377	0.32
74LS378	0.62
74LS379	0.86
74LS385	2.22
74LS386	0.46
74LS390	0.25
74LS393	0.24
74LS395	0.32
74LS396	1.68
74LS398	1.22
74LS399	0.62
74LS445	1.50
74LS490	0.90

D CONNECTORS
SOLDER BUCKET

9 PIN SOCKET	0.27
9 PIN PLUG	0.26
15 PIN SOCKET	0.34
15 PIN PLUG	0.34
25 PIN SOCKET	0.42
25 PIN PLUG	0.40

4000 SERIES

4000	0.16
4001	0.16
4002	0.16
4006	0.31
4007	0.16
4008	0.30
4010	0.22
4011	0.15
4012	0.15
4013	0.16
4014	0.29
4015	0.30
4016	0.17
4017	0.24
4018	0.26
4019	0.18
4020	0.30
4021	0.30
4022	0.32
4023	0.16
4024	0.21
4025	0.15
4026	0.40
4027	0.18
4028	0.28
4029	0.27
4030	0.17
4031	0.70
4033	0.55
4034	1.23
4035	0.30
4040	0.28
4041	0.30
4042	0.21
4043	0.27
4044	0.30
4046	0.30
4047	0.24
4048	0.30
4049	0.19
4050	0.19
4051	0.24
4052	0.24
4053	0.24
4054	0.55
4055	0.29
4060	0.30
4063	0.28
4066	0.18
4067	1.90
4068	0.15
4069	0.19
4070	0.16
4071	0.20
4072	0.17
4073	0.17
4075	0.17
4076	0.30
4077	0.17
4081	0.14
4082	0.17
4085	0.27
4086	0.26
4089	0.55
4093	0.15
4094	0.30
4095	0.55
4097	1.19
4098	0.31
4099	0.37
4502	0.37
4503	0.31
4508	0.89
4510	0.25
4511	0.28
4512	0.30
4514	0.72
4515	0.77
4516	0.30
4518	0.26
4520	0.25
4521	0.62
4526	0.39
4527	0.38
4528	0.39
4529	0.43
4532	0.31
4534	2.20
4536	0.99
4538	0.36
4541	0.30
4543	0.45
4555	0.34
4556	0.33
4560	1.17
4566	1.95
4572	0.24
4584	0.23
4585	0.32
4724	0.69
40106	0.30
40109	0.49
40163	0.45
40174	0.33
40175	0.35
40193	0.59

VOLTAGE REGS

78L05	0.23
78L12	0.23
78L15	0.23
79L05	0.27
79L12	0.27
79L15	0.27
7805	0.27
7812	0.27
7815	0.27
7905	0.37
7912	0.37
7915	0.37
78S05	0.48
78S12	0.48
LM317T	0.43
LM323K	2.49
LM338K	4.95

IC SOCKETS

8 PIN	0.06
14 PIN	0.10
16 PIN	0.14
18 PIN	0.14
20 PIN	0.15
24 PIN	0.18
28 PIN	0.20
40 PIN	0.24

RESISTORS

ALL 1/4 WATT MF 1% 10 FOR £0.15 (1 VALUE). INDIVIDUAL RESISTORS £0.03 EA. SKELETON PRESETS £0.10 ANY VALUE. STANDARD POTS 1/4" SHAFT, LOG OR LIN £0.35 EACH. SWITCHED POTS £0.45 EACH.

LEDS

3MM RED	0.05
3MM GREEN	0.10
3MM YELLOW	0.12
5MM RED	0.05
5MM GREEN	0.07
5MM YELLOW	0.07
5MM FLASH RED	0.48
5MM FLASH G'RN	0.51
8MM FLASH RED	0.99
3MM CLIPS	0.04
5MM CLIPS	0.04
8MM CLIPS	0.18
COMMON CATHODES	
3" 7 SEG RED	0.70
5" 7 SEG RED	0.75
.56" 7 SEG RED	0.85
COMMON ANODES	
3" 7 SEG RED	0.70
5" 7 SEG RED	0.75
.56" 7 SEG RED	0.85
10 BAR DIL RED	1.39
ORP12 (LDR)	0.65

LINEAR

TL061	0.33
TL062	0.39
TL064	0.43
TL071	0.30
TL072	0.33
TL074	0.45
TL081	0.32
TL082	0.32
TL084	0.45
TBA120S	0.62
L165V	1.85
TLC271	0.55
TLC272	0.96
L272M	1.65
L293B	3.20
L297	4.90
L298	4.90
LM301A	0.30
LM311	0.32
LM318	0.80
LM324	0.22
LM334Z	0.80
LM335Z	0.90
LM339	0.34
LM348	0.32
LF351	0.35
LF353	0.35
LF356	0.79
LM358	0.26
LM380	1.10
LM381	2.60
LM386	0.46
LM393	0.27
ZN414Z	0.99
ZN416E	1.59
ZN423	1.45
ZN424P	1.20
ZN425E	4.90
ZN426E	2.90
ZN427E	9.40
ZN428E	7.90
ZN435E	6.25
ZN448E	9.20
SL486	2.70
SL490	2.35
NE531	1.54
NE544	2.75
NE555	0.19
7555	0.41
NE556	0.34
NE565	1.49
NE566	1.10
NE567	0.35
NE570	2.35
NE571	1.98
LM710	0.80
LM711	0.80
LM725	4.80
741	0.17
LM747	0.38
LM748	0.30
TBA810	0.67
TBA820	0.38
ML924	4.65
ML926	4.25
ML927	4.25
TDA1024	1.80
SAA1027	3.20
ZN1034E	3.20
LM1458	0.30
ULN2003	0.39
ULN2004	0.42
TDA2004	1.75
TDA2030	1.18
ULN2064	1.20
ULN2065	1.20
ULN2068	1.20
XR2206	4.20
UA2240	2.60
ULN2803	0.64
LM2917N8	2.60
CA3046	0.35
CA3080E	0.71
CA3130E	0.97
CA3140E	0.55
CA3240E	1.20
MC3302	0.60
MC3340	1.75
LM3900	0.70
LM3909	1.45
LM3911	2.20
LM3914	2.65
LM3915	2.65
RC4558	0.36
NE5532	0.79
NE5534	0.80
ICL7106	5.80
ICM7555	0.45
ICM7556	1.20
ICL8038	4.90
LM13600	1.10

ELECTROLYTICS AXIAL

47UF 16V	0.09
100UF 16V	0.09
220UF 16V	0.10
470UF 16V	0.19
1,000UF 16V	0.28
2,200UF 16V	0.45
4,700UF 16V	0.75
10UF 25V	0.05
22UF 25V	0.05
47UF 25V	0.06
100UF 25V	0.09
220UF 25V	0.11
470UF 25V	0.22
1,000UF 25V	0.35
2,200UF 25V	0.52
4,700 25V	1.35

ELECTROLYTIC RADIAL

47UF 16V	0.05
100UF 16V	0.06
220UF 16V	0.08
470UF 16V	0.12
1,000UF 16V	0.19
2,200 16V	0.35
10UF 25V	0.05
22UF 25V	0.05
47UF 25V	0.05
100UF 25V	0.08
220UF 25V	0.11
470UF 25V	0.17
1,000UF 25V	0.25
2,200UF 25V	0.49

TANTALUM CAPACITORS

0.1UF 35V	0.10
0.22UF 35V	0.10
0.33UF 35V	0.10
0.47UF 35V	0.10
1UF 35V	0.12
2.2UF 25V	0.14
3.3UF 25V	0.16
4.7UF 25V	0.18
6.8UF 25V	0.20
10UF 25V	0.22
15UF 16V	0.28
22UF 16V	0.28
33UF 16V	0.50
47UF 16V	0.62
68UF 6V	0.72
100UF 10V	1.40
100UF 16V	1.70

CERAMIC CAPACITORS

1.8PF	0.05
2.2PF	0.05
3.3PF	0.05
4.7PF	0.05
6.8PF	0.05
10PF	0.05
15PF	0.05
22PF	0.05
33PF	0.05
47PF	0.05
56PF	0.05
68PF	0.05
82PF	0.05
100PF	0.05
120PF	0.07
150PF	0.07
180PF	0.07
220PF	0.07
270PF	0.07
330PF	0.07
390PF	0.07
470PF	0.07
560PF	0.07
680PF	0.07
820PF	0.07
1NF	0.07
1N5F	0.07
2N2F	0.07
3N3F	0.07
4N7F	0.07
6N8F	0.07
10NF	0.07
100NF	0.07

POLYESTER/MICA CAPACITORS 15V

1NF	0.05
2N2	0.05
4N7	0.05
10N	0.05
22N	0.05
47N	0.05
100N	0.05
220N	0.05
470N	0.05
680N	0.05

POLYSTYRENE CAPACITORS 120V

47PF	0.09
68PF	0.09
82PF	0.09
100PF	0.09
120PF	0.09
150PF	0.09
180PF	0.09
220PF	0.09
270PF	0.09
330PF	0.09
390PF	0.09
470PF	0.09
560PF	0.09
680PF	0.09
820PF	0.09
1NF	0.09
1N5F	0.09
2N2F	0.09
3N3F	0.09
4N7F	0.09
6N8F	0.09
10NF	0.09

TRIMMER CAPACITORS

2-10PF	0.38
2-22PF	0.38
5.5-65PF	0.38

BRIDGE RECTIFIERS

W005 50V 1.5A	0.18
W02 200V 1.5A	0.19
W04 400V 1.5A	0.22
BR32 200V 3A	0.34
BR34 400V 3A	0.38
DB602 200V 6A	0.59
DB608 800V 6A	0.78
DB2502 200V 25A	1.40
DB2506 600V 25A	1.90

TRIACS/DIACS THYRISTORS

Z0105DA	0.40
Z0102MA	0.42
TIC206D	0.62
TIC226D	0.69
TIC246D	0.99
BR100 DIAC	0.19
TIC106D	0.40
TIC116D	0.69
TIC126D	0.79

CONNECTORS

BNC 50R PLUG	0.69
BNC 75R PLUG	0.69
BNC CH'S SOC	0.59
TNC 50R PLUG	0.89
TNC CH'S SOC	0.65
PL259 PLUG	0.55
REDUCER (PL259)	0.16
PL259 SOCKET	0.55
COAX PLUG	0.18
COAX LINE SOC	0.38
SCART PLUG	0.65
IEC CH'S PLUG	0.49
IEC LINE SOCKET	1.70
IEC 2M LEAD	1.80
IEC RA 2M LEAD	2.40
1/4" MONO PLUG	0.18
1/4" STEREO PLUG	0.29
2.5 MONO PLUG	0.12
3.5 MONO PLUG	0.12
3.5 STEREO PLUG	0.20

TOGGLE SWITCHES

SPDT 3A 250V	0.57
SPDTC/O 3A 250V	0.62
DPDT 3A 250V	0.67
DPDTC/O 3A 250V	0.79

MINATURE PUSH TO MAKE SWITCHES

RED	0.19
BLACK	0.19
GREEN	0.19
BLUE	0.19
YELLOW	0.19
WHITE	0.19

ROTARY SWITCHES

1 POLE 12 WAY	0.75
2 POLE 6 WAY	0.75
3 POLE 4 WAY	0.75
4 POLE 3 WAY	0.75

DIL SWITCHES

4 WAY 8 PIN	0.49
6 WAY 12 PIN	0.69
8 WAY 16 PIN	0.79

TRANSISTORS

AC125	0.30
AC126	0.29
AC127	0.29
AC128	0.28
AC176	0.34
AC187	0.35
AC188	0.36
AD142	1.90
AD161	0.78
AD162	0.85
AF124	0.78
AF126	0.46
BC107	0.12
BC107B	0.13
BC108	0.11
BC108B	0.13
BC108C	0.14
BC109	0.13
BC109C	0.14
BC140	0.24
BC141	0.26
BC142	0.30
BC143	0.33
BC147	0.33
BC148	0.33
BC149	0.11
BC157	0.11
BC158	0.11
BC159	0.11
BC160	0.27
BC168C	0.16
BC169C	0.16
BC171	0.11
BC177	0.17
BC178	0.17
BC179	0.17
BC182	0.07
BC182L	0.07
BC183	0.07
BC183L	0.07
BC184	0.07
BC184L	0.07
BC212	0.07
BC212L	0.07
BC213	0.07
BC213L	0.07
BC214	0.07
BC214L	0.07
BC237B	0.08
BC238B	0.08
BC308	0.09
BC327	0.09
BC328	0.09
BC337	0.09
BC338	0.09
BC477	0.33
BC478	0.33
BC479	0.33
BC517	0.19
BC547	0.07
BC548	0.07
BC549	0.07
BC557	0.07
BC558	0.07
BCY70	0.20
BCY71	0.19
BCY72	0.19
BD115	0.48
BD131	0.36
BD132	0.36
BD135	0.19
BD136	0.19
BD137	0.19
BD138	0.19
BD139	0.22
BD140	0.23
BF180	0.30
BF182	0.30
BF185	0.30
BF194	0.18
BF195	0.18
BF196	0.19
BF197	0.19
BF198	0.19
BF199	0.19
BF257	0.32
BF258	0.35
BF259	0.32
BF337	0.35
BFR40	0.38
BFR80	0.38
BFR81	0.38
BFX29	0.28
BFX84	0.30
BFX85	0.30
BFX87	0.43
BFX88	0.43
BFY50	0.28
BFY51	0.25
BFY52	0.27
BFY53	0.46
BFY55	0.46
BSX20	0.26
BSX29	0.55
BSY95A	0.48
BU205	1.39
BU206	1.40
BU208	1.65
MJ2955	0.75
MJE340	0.35
MJE520	0.44
MJE521	0.60
MJE3055	0.85
MPSA05	0.27
MPSA06	0.27
MPSA12	0.27
MPSA56	0.17
MPSU05	0.56
MPSU06	0.56
TIP29A	0.30
TIP29B	0.30
TIP29C	0.31
TIP30	0.31
TIP30A	0.31
TIP30B	0.30
TIP30C	0.30
TIP31A	0.30
TIP31B	0.30
TIP31C	0.31
TIP32A	0.30
TIP32B	0.30
TIP32C	0.31
TIP33A	0.66
TIP33C	0.71
TIP34A	0.69
TIP34C	0.74
TIP35A	1.05
TIP35C	1.15
TIP36A	1.15
TIP36C	1.25
TIP41A	0.35
TIP42A	0.35
TIP120	0.37
TIP121	0.34
TIP122	0.36
TIP141	1.20
TIP142	1.05
TIP147	1.10
TIP2955	0.62
TIP3055	0.62
ZTX107	0.17
ZTX108	0.17
ZTX109	0.17
ZTX300	0.16
ZTX302	0.20
ZTX341	0.24
ZTX500	0.15
ZTX501	0.24
ZTX502	0.24
ZTX504	0.24
2N2219A	0.27
2N2222A	0.15
2N2369	0.24
2N2484	0.24
2N2904	0.24
2N2904A	0.24
2N2905	0.20
2N2905A	0.20
2N2906A	0.20
2N2907	0.19
2N2907A	0.19
2N2926	0.14
2N3053	0.26
2N3054	0.85
2N3055	0.56
2N3442	1.34
2N3702	0.09
2N3703	0.09
2N3704	0.09
2N3705	0.09
2N3706	0.09
2N3773	1.78
2N3866	1.18
2N3903	0.09
2N3904	0.09
2N3905	0.09
2N3906	0.09
2N4062	0.16

FETS

BF244B	0.34
BF256B	0.36
2N3819	0.39
2N3820	0.58
2N5457	0.49
2N5458	0.49
2N5485	0.42

DIODES

1N4001 (10 PACK)	0.24
1N4002 (10 PACK)	0.25
1N4003 (10 PACK)	0.26
1N4004 (10 PACK)	0.27
1N4006 (10 PACK)	0.28
1N4007 (10 PACK)	0.29
1N5401 (5 PACK)	0.30
1N5402 (5 PACK)	0.31
1N5404 (5 PACK)	0.33
1N5406 (5 PACK)	0.34
1N5408 (5 PACK)	0.37
OA47 (5 PACK)	0.95
OA90 (5 PACK)	0.40
OA91 (5 PACK)	0.50
1N914 (5 PACK)	0.20
1N4148 (10 PACK)	0.22

74HC SERIES

74HC00	0.14
74HC02	0.14
74HC03	0.14
74HC04	0.14
74HC08	0.14
74HC10	0.14
74HC11	0.14
74HC14	0.18
74HC20	0.14
74HC27	0.14
74HC30	0.14
74HC32	0.14
74HC42	0.26
74HC73	0.26
74HC74	0.19
74HC75	0.19
74HC76	0.19
74HC85	0.25
74HC86	0.19
74HC107	0.19
74HC123	0.32
74HC125	0.23
74HC126	0.22
74HC132	0.25
74HC133	0.26
74HC138	0.25
74HC139	0.25
74HC151	0.25
74HC153	0.25
74HC154	0.38
74HC157	0.28
74HC158	0.26
74HC160	0.32
74HC161	0.25
74HC162	0.25
74HC163	0.25
74HC164	0.25
74HC165	0.40
74HC173	0.32
74HC174	0.25
74HC175	0.25
74HC192	0.47
74HC193	0.40
74HC194	0.36
74HC195	0.32
74HC240	0.35
74HC241	0.36
74HC242	0.36
74HC243	0.46
74HC244	0.34
74HC245	0.49
74HC251	0.28
74HC253	0.28
74HC257	0.28
74HC259	0.34
74HC266	0.25
74HC273	0.34
74HC280	0.36
74HC299	0.59
74HC354	0.42
74HC356	0.44
74HC365	0.32
74HC366	0.32
74HC367	0.25
74HC368	0.25
74HC373	0.34
74HC374	0.34
74HC390	0.44
74HC393	0.32
74HC423	0.36
74HC533	0.42
74HC534	0.42
74HC563	0.46
74HC564	0.46
74HC573	0.42
74HC574	0.42
74HC640	0.60
74HC643	0.72
74HC646	1.10
74HC648	1.10
74HC688	0.48
74HC4002	0.34
74HC4017	0.32
74HC4020	0.38
74HC4040	0.39
74HC4049	0.26
74HC4050	0.26
74HC4060	0.40
74HC4075	0.16
74HC4078	0.16
74HC4511	0.40
74HC4514	0.80
74HC4538	0.40
74HC4543	0.66
74HC7266	0.26

CRYSTALS

1MHZ	1.10
1.8432MHZ	1.78
2MHZ	1.66
2.097MHZ	0.76
2.4576MHZ	0.98
3.276MHZ	0.76
3.579MHZ	0.76
4MHZ	0.76
4.194MHZ	0.76
4.43MHZ	1.78
4.915MHZ	0.76
5.008MHZ	0.76
5.06MHZ	0.76
6MHZ	0.76
6.144MHZ	0.76
8MHZ	0.76
10MHZ	0.76
11.05MHZ	0.76
12MHZ	0.76
16MHZ	0.76
18MHZ	0.76
39.925MHZ	0.76

MEMORIES

2114	1.25
4164-10	1.16
4164-12	1.08
4164-15	0.98
41256-8	1.60
41256-10	1.46
41464-10	4.24
41464-12	4.20

WIRE AND CABLE

SPEAKER WIRE 7P A METRE ANY LENGTH.
STEREO SCREENED CABLE 16P A METRE ANY LENGTH.
4 CORE SCREENED ANY LENGTH 28P A METRE.
STANDARD TV COAX CABLE 20P A METRE ANY LENGTH

EXPRESS COMPONENTS

SALES 0273 771156

FAX 0273 206875

ALL PRICES ARE SUBJECT TO VAT (17.5%).
POSTAGE AND PACKING IS 99P + VAT PER ORDER.
AUTOMATIC ACCOUNT FACILITIES FOR SCHOOLS ETC.
NO MINIMUM ORDER.
NO COUNTER FACILITIES.

PO BOX 517 HOVE, E SUSSEX BN3 5QZ

LAST MONTHS OFFERS

AMSTRAD MP3 £19.00

VHF/UHF TV Receiver, converts RGB or composite monitor into colour TV. Brand new and cased.

Our Price: £19.00
Our Ref :ET19P1

INDUCTIVE AMPS £5.00

Made for amplifying a telephone handset for the hard of hearing. However if you hold one against a piece of wire carrying a telephone conversation you can hear both sides of the conversation! It can also be used for tracing live wires in a wall or detecting cables carrying mains etc.
Fully cased complete with battery and fixing strap.
Aprox 2.5" diameter 1" thick.

Our Price:£5.00
Our Ref :ET5P1

CORDLESS PHONES (non working) £30.00 for 3

These are BT Curlews. They are not new and have been stored in sunlight so the plastic cases are discoloured. They also have the hanset aerial missing. This is a standard telescopic aerial - a piece of wire will do!
These are NON RETURNABLE!!

Our Price: £30.00 for 3
Our Ref :ET30P1

DISC DRIVES BBC MOD £9.00

JVC 3.5" drive supplied with well explained modification details to enable use with a BBC computer. Price includes drive and data.

Our Price: £9.00
Our Ref :ET9P1

RABBIT VIDEO SYSTEM £29.00

Enables video/audio signal to be received on any TV in the house. Use VCR remote with any TV (even non-remote) to control VCR functions dowstairs etc. Transmits via 2 wire system. Retails at £60.00.

Our Price: £29.00
Our Ref : ET29P1

CTM644 COLOUR MONITOR £79

Refurbished monitor suitable for many home computers standard RGB input.

Our Price: £79.00
Our Ref : ET79P1

MINIMUM GOODS ORDER £5.00. TRADE ORDERS FROM GOVERNMENT, SCHOOLS, UNIVERSITIES & LOCAL AUTHORITIES WELCOME. ALL GOODS SUPPLIED SUBJECT TO OUR CONDITIONS OF SALE AND UNLESS OTHERWISE STATED GUARANTEED FOR 30 DAYS.
RIGHTS RESERVED TO CHANGE PRICES & SPECIFICATIONS WITHOUT PRIOR NOTICE. ORDERS SUBJECT TO STOCK. QUOTATIONS WILLINGLY GIVEN FOR QUANTITIES HIGHER THAN THOSE STATED.

THIS MONTHS BIG OFFERS

100W DOOR/SHELF SPEAKERS

Hi-fi quality 3-way co-axial flush mounting speaker system. Unique design gunmetal and blackgrille. 100W max. power handling per speaker. Frequency repsonce -=60-200000Hz
Speaker size =6.5"woofer, 2"mid, 1"tweeter
Impedance = 4 Ohm
Mounting Depth -=39mm

OurSpecial Price: £23.99
Our Ref : ET24P1

3 BUTTON LOGITECH MOUSE

Originally made for the Acorn Archimedies but could be easily adapted for other machines. Pin details are supplied. NO SOFTWARE.

Our Price: £4.99
Our Ref : ET5P2

5 VOLT 4.4 AMP PSU

Acompact switch mode PSU with on/off switch, selectablevoltage input 110/240. NEW. O/P via fly leads. GOOD STOCKS AVAILABLE

Our Price : £4.99
Our Ref : ET5P3

XENON STROBE (ALARM BEACON)

12V stobe, clear lens, ideal for alarm box idicator or in multiples as a display array. Great for special effects and other leisure applications. Could be used as a vehicle tamper indicator.

Our Price: £5.00
Our Ref :ET5P4

AA NICADS AND CHARGER PCB

150x80mm board includes 5 x AA, fast and tricklecharge facility change over relay, connector strip.
NO CONECTION DETAILS.

Our Price :£2.99
Our Ref : ET3P1

PIR MOVEMENT DETECTOR

Once again we have aquired stocks of this popular line and are able to offer you a very high quality and professional detector at only **£15.00**. Range: 20 Mtrs with a 90 arc. Day and Night mode. Diamensions: 15cm x 9cm x 11cm. New and boxed complete with installation guide.

Our Price: £15.00
Our Ref :ET15P1

ACORN ELECTRON AC PSU

19V AC 14W very easily adaptable simply add a small bridge rectifier, 3 pin plug in.

Our Price: £2.99 each
Our Ref :ET3P2

SOME OF OUR PRODUCTS MAY BE UNLICENSABLE IN THE UK

BULL ELECTRICAL

250 PORTLAND ROAD HOVE SUSSEX BN3 5QT

MAIL ORDER TERMS: CASH PO OR CHEQUE WITH ORDER PLUS £3.00 POST PLUS VAT.

PLEASE ALLOW 7 - 10 DAYS FOR DELIVERY
TELEPHONE ORDERS WELCOME
TEL: 0273 203500
FAX: 0273 323077

THIS AUTUMNS FASTEST GROWING MEDIA!

CD ROM DRIVE

The Mitsumi CD ROM DRIVE will realise the true potential of your computer. Once installed through Microsoft Windows 3.1 over 500Mbyte of data can be stored on a single disk, but it is a read only medium. A vast library of CD ROM disks are available from a huge numbers of suppliers and titles include whole encyclopedias. This unit can also reproduce HiFi quality music CDs and delivers high resolution digital pictures. The Mitsumi drive is Kodak CD compatible enabling you to transfer 35mm film onto a CD, a process undertaken in the chemist or with a Kodak CD lab. View your holiday photos on your computer monitor using the ROM DRIVE.

OUR PRICE: £169.00
OUR REF : ET169P1

We also stock the following titles at **£29.00 each:**
Wing commander **REF:ET29P1,**
Guinness Disk of Records **REF:ET29P2**
World Atlas **REF:ET29P3**
and Sherlock Holmes **REF:ET29P4**

MANY MORE SPECIAL OFFERS IN OUR REGULAR NEWSLETTERS

WE HAVE HUNDREDS AND HUNDREDS MORE STOCK LINES - TOO MANY TO LIST IN ONE ADVERT CHOOSE FROM...

AERIAL AMPLIFIERS	FANS
AEROSOLS	FUSES
ALARMS	GLUEGUN AND GLUE
AMPLIFIED SPEAKERS	HEADPHONES
ANALOUGUE MULTIMETERS	HEATSHRINK SLEEVING
APPLIANCE LEADS	HI FI SPEAKERS
BATTERIES AND HOLDERS	IONISERS
BATTERY CHARGERS	LED's
BOOKS	LASERS AND LASER PSU's
BOXES AND CASES	LOGIC PROBES
CAMCORDER BITS	LOUD AND MARINE SPKRS
CAPACITORS	MICROPHONES
CAR AMPS, RADIOS & SPKRS	PIR LIGHTS AND DETECTOR
CB SPEAKERS AND PSU's	POWER SUPPLIES
COMPUTER BITS	POWER AMPLIFIERS
CONNECTORS	RADIOS
DESOLDER PUMP	SERVICE AIDS
DIGITAL MULTIMETERS	SOLDERING EQUIPMENT
DISCO LIGHTING	STEAM ENGINES
DISPLAYS	TRANSEIVERS
DUBBING KIT	TRANSFORMERS
DRILLS	WIRELESS MICROPHONES

IN SUSSEX? CALL IN AND SEE US!!

TURN YOUR SURPLUS STOCK INTO CASH. IMMEDIATE SETTLEMENT. WE WILL ALSO QUOTE FOR COMPLETE FACTORY CLEARANCE.

MUCH MUCH MORE IN OUR 1993 **CATALOGUE**. PLEASE SEND 41P, A4 SIZED SAE FOR YOUR FREE COPY.

Surplus always wanted for cash!

THE *ORIGINAL* SURPLUS WONDERLAND!

Surplus always wanted for cash!

LOW COST PC SPECIALISTS - ALL EXPANDABLE - ALL PC COMPATIBLE

8088 XT - PC99

- 256k RAM - expandable to 640k
- 4.7 Mhz speed
- 360k 5-1/4" floppy
- 2 serial & 1 parallel ports
- MS-DOS 4.01
- Factory burnt-in
- Standard 84 key keyboard
- 12" green screen included
- In good used condition

Optional FITTED extras: 640K RAM £39. 12" CGA colour monitor with card £39. 2nd 5-1/4" 360K floppy £29.95. 20 mbyte MFM hard drive £99.

Only £99.00 (F)

286 AT - PC286

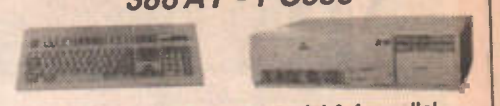
- 640k RAM expandable with standard SIMMS
- 12 Mhz Landmark speed
- 20 meg hard disk
- 1.2 meg 5-1/4" floppy
- 1.4 meg 3-1/2" floppy
- EGA driver on board
- 2 serial & 1 parallel ports
- MS-DOS 4.01
- Co-processor socket
- Enhanced 102 key keyboard
- Clock & calendar with battery back up

BRAND NEW AND BOXED!

Only £249.00 (F)

The Philips 9CM073 is suggested for the PC286 and the CM8873 for the PC386. Either may use the SVGA MTS-9600 if a suitable card is installed. We can fit this at a cost of £49.00 for the PC286 and £39.00 for the PC386.

386 AT - PC386



- 2 meg RAM expanded by slots
- 20 Mhz with 32k cache. Expandable to 64k
- 40 meg hard disk
- 1.2 meg 5-1/4" floppy
- VGA card installed
- 2 serial & 1 parallel ports
- MS-DOS 4.01
- Co-processor socket
- Enhanced 102 keyboard
- Kwik Disk Accelerator Software - FREE

BRAND NEW AND BOXED!

Only £425.00 (F)

FLOPPY DISK DRIVES

5¼" from £22.95 - 3½" from £21.95!

Massive purchases of standard 5¼" and 3½" drives enables us to present prime product at industry beating low prices! All units (unless stated) are removed from often brand new equipment and are fully tested, aligned and shipped to you with a 90 day guarantee and operate from standard voltages and are of standard size. All are IBM-PC compatible (if 3½" supported).

3.5" Panasonic JU363/4 720K or equivalent	£29.95(B)
3.5" Mitsubishi MF355C-L. 1.4 Meg. Laptops only*	£29.95(B)
3.5" Mitsubishi MF355C-D. 1.4 Meg. Non laptop	£29.95(B)
5.25" EXTRA SPECIAL BRAND NEW Mitsubishi MF501B 360K. Absolutely standard fits most computers	£22.95(B)
* Data cable included in price.	
Shugart 800/801 SS refurbished & tested	£175.00(E)
Shugart 851 double sided refurbished & tested	£275.00(E)
Mitsubishi M2894-63 double sided switchable hard or soft sectors- BRAND NEW	£250.00(E)
Dual 8" drives with 2 mbyte capacity housed in a smart case with built in power supply! Ideal as exterior drives!	£499.00(F)

End of line purchase scoop! Brand new **NEC D2246** 8" 85 megabyte of hard disk storage! Full CPU control and industry standard SMD interface. Ultra hi speed transfer and access time leaves the good old ST506 interface standing. In mint condition and comes complete with manual. Only........................£299(E)

THE *AMAZING* TELEBOX!

Converts your colour monitor into a QUALITY COLOUR TV!!

TV SOUND & VIDEO TUNER!

The TELEBOX consists of an attractive fully cased mains powered unit, containing all electronics ready to plug into a host of video monitors made by manufacturers such as MICROVITEC, ATARI, SANYO, SONY, COMMODORE, PHILIPS, TATUNG, AMSTRAD and many more. The composite video output will also plug directly into most video recorders, allowing reception of TV channels not normally receivable on most television receivers (TELEBOX MB). Push button controls on the front panel allow reception of 8 fully tuneable 'off air' UHF colour television or video channels. TELEBOX MB covers virtually all television frequencies VHF and UHF including the HYPERBAND as used by most cable TV operators. Composite and RGB video outputs are located on the rear panel for direct connection to most makes of monitor. For complete compatibility - even for monitors without sound - an integral 4 watt audio amplifier and low level Hi Fi audio output are provided as standard.

Telebox ST	for composite video input monitors	£32.95
Telebox STL	as ST but with integral speaker	£36.50
Telebox MB	as ST with Multiband tuner VHF-UHF-Cable. & hyperband For overseas PAL versions state 5.5 or 6mhz sound specification.	£69.95
Telebox RGB	for analogue RGB monitors (15khz)	£69.95

Shipping code on all Teleboxes is (B)

RGB Telebox also suitable for IBM multisync monitors with RGB analog and composite sync. Overseas versions VHF & UHF call. SECAM / NTSC not available.

No Break Uninterruptable PSU's

Brand new and boxed 230 volts uninterruptable power supplies from Densel. Model MUK 0565-AUAF is 0.5 kva and MUD 1085-AHBH is 1 kva. Both have sealed lead acid batteries. MUK are internal, MUD has them in a matching case. Times from interrupt are 5 and 15 minutes respectively. Complete with full operation manuals............MUK......£249 (F) MUD.....£525 (G)

POWER SUPPLIES

Power One SPL200-5200P 200 watt (250 w peak). Semi open frame giving +5v 35a, -5v 1.5a, +12v 4a (8a peak), -12v 1.5a, +24v 4a (6a peak). All outputs fully regulated with over voltage protection on the +5v output. AC input selectable for 110/240 vac. Dims 13" x 5" x 2.5". Fully guaranteed RFE. £85.00 (B)

Power One SPL130. 130 watts. Selectable for 12v (4A) or 24 v (2A). 5v @ 20A. ± 12v @ 1.5A. Switch mode. New. £59.95(B)

Astec AC-8151 40 watts. Switch mode. +5v @ 2.5a. +12v @ 2a. -12v @ 0.1a. 6-1/4" x 4" x 1-3/4".New £22.95(B)

Greendale 19AB0E 60 watts switch mode.+5v @ 6a,±12v @ 1a,+15v @ 1a. RFE and fully tested.11 x 20 x5.5cms. £24.95(C)

Conver AC130. 130 watt hi-grade VDE spec.Switch mode.+5v @ 15a,-5v @ 1a,±12v @ 6a.27 x 12.5 x 6.5cms.New. £49.95(C)

Boshert 13090. Switch mode.Ideal for drives & system. +5v @ 6a, +12v @ 2.5a, -12v @ 0.5a, -5v @ 0.5a. £29.95(B)

Farnell G6/40A. Switch mode. 5v @ 40a.Encased £95.00(C)

Farnell G24/5S. As above but 24v @ 5a. £65.00(C)

BBC Model B APM Board

WIN £100 CASH!

£100 CASH FOR THE MOST NOVEL DEMONSTRATABLE APPLICATION!

BBC Model B type computer on a board. A major purchase allows us to offer you the **PROFESSIONAL** version of the BBC computer at a parts only price. Used as a front end graphics system on large networked systems the architecture of the BBC board has so many similarities to the regular BBC model B that we are sure that with a bit of experimentation and ingenuity many useful applications will be found for this board!! It is supplied complete with a connector panel which brings all the I/O to 'D' and BNC type connectors - all you have to do is provide +5 and ± 12 v DC. The APM consists of a single PCB with most major ic's socketed. The ic's are too numerous to list but include a 6502, RAM and an SAA5050 teletext chip. Three 27128 EPROMS contain the custom operating system on which we have no data, On application of DC power the system boots and provides diagnostic information on the video output. On board DIP switches and jumpers select the ECONET address and enable the four extra EPROM sockets for user software. Appx. dims: main board 13" x 10". I/O board 14" x 3". Supplied tested with circuit diagram, data and competition entry form.

Only £29.95 or 2 for £53 (B)

SPECIAL INTEREST

Trio 0-18 vdc bench PSU. 30 amps. New	£ 470
Fujitsu M3041 600 LPM band printer	£2950
DEC LS/02 CPU board	£ 150
Rhode & Schwarz SBUF TV test transmitter 25-1000mhz. Complete with SBTF2 Modulator	£6500
Calcomp 1036 large drum 3 pen plotter	£ 650
Thurlby LA 160B logic analyser	£ 375
1.5kw 115v 60hz power source	£ 950
Anton Pillar 400 Hz 3 phase frequency converter 75Kw	POA
Newton Derby 400 Hz 70 Kw converter	POA
Nikon PL-2 Projection lens meter/scope	£750
Sekonic SD 150H 18 channel Hybrid recorder	£2000
HP 7580A A1 8 pen high speed drum plotter	£1850
Kenwood DA-3501 CD tester, laser pickup simulator	£ 350

BRAND NEW PRINTERS

Microline 183. NLQ 17x17 dot matrix. Full width.	£139 (D)
Hyundai HDP-920. NLQ 24x18 dot matrix full width.	£149 (D)
Qume LetterPro 20 daisy. Qume QS-3 interface.	£39.95 (D)
Centronics 152-2 9 x 7 dot matrix. Full width.	£149 (D)
Centronics 159-4 9 x 7 dot matrix.Serial. 9-1/2" width	£ 99 (D)

MONITORS

14" Forefront Model MTS-9600 SVGA multisync with resolution of 1024 x 768. 0.28 pitch. "Text" switch for word processing etc. Overscan switch included. Ideal for the PC-386 or PC-286 with SVGA card added. Also compatibe with BBC, Amiga, Atari (including the monochrome high resolution mode), Archimedes etc. In good used condition (possible minor screen bums). 90 day guarantee. 15" x 14" x 12". Only..............£159(E)

14" Philips Model CM8873 VGA multisync with 640 x 480 resolution. CGA, EGA or VGA, digital/analog, switch selectable. Sound with volume control. There is also a special "Text" switch for word processing, spreadsheets and the like. Compatible with IBM PC's, Amiga, Atari (excluding the monochrome high resolution mode), BBC, Archimedes etc. Good used condition (possible minor screen bums) 90 day guarantee. 15" x 14" x 12". Only ....£139(E)

Philips 9CM073 similar (not identical) to above for **EGA/CGA** PC and compats. 640 x 350 resolution. With Text switch with amber or green screen selection. 14" x 12" x 13-1/2".......£99(E)

KME 10" high definition colour monitors. Nice tight 0.28" dot pitch for superb clarity and modem styling. Operates from any 15.625 khz sync RGB video source, with RGB analog and composite sync such as Atari, Commodore Amiga, Acorn Archimedes & BBC. Measures only 13.5" x 12" x 11". Also works as quality Tv with our RGB Telebox. Good used condition. 90 day guarantee. Only..£125 (E)

KME as above for PC EGA standard...........................£145 (E)

Brand new Centronic 14" monitor for IBM PC and compatibles at a lower than ever price! Completely CGA equivalent. Hi-res Mitsubishi 0.42 dot pitch giving 669 x 507 pixels. Big 28 Mhz bandwidth. A super monitor in attractive style moulded case.Full 90 day guarantee. Only .... £129 (E)

NEC CGA 12" IBM-PC compatible. High quality ex-equipment fully tested with a 90 day guarantee. In an attractive two tone ribbed grey plastic case measuring 15"L x 13"W x 12"H. The front cosmetic bezel has been removed for contractual reasons. Only......... **£69** (E)

20", 22" and 26" AV SPECIALS

Superbly made UK manufacture. PIL all solid state colour monitors, complete with composite video & sound inputs. Attractive teak style case. Perfect for Schools,Shops,Disco, Clubs. In EXCELLENT little used condition with full 90 day guarantee.

20"....£135 22"....£155 26"....£185 (F)

CALL FOR PRICING ON NTSC VERSIONS!

Superb Quality 6 foot 40u

19" Rack Cabinets

Massive Reductions

Virtually New, Ultra Smart!

Less Than Half Price!

Top quality 19" rack cabinets made in UK by Optima Enclosures Ltd. Units feature designer, smoked acrylic lockable front door, full height lockable half louvered back door and removable side panels. Fully adjustable internal fixing struts, ready punched for any configuration of equipment mounting plus ready mounted integral 12 way 13 amp socket switched mains distribution strip make these racks some of the most versatile we have ever sold. Racks may be stacked side by side and therefore require only two side panels or stand singly. Overall dimensions are 77-1/2"H x 32-1/2"D x 22"W. Order as:

Rack 1	Complete with removable side panels........	£275.00 (G)
Rack 2	Less side panels	£145.00 (G)

1992 Winter Issue of *Display News* now available - send large SAE - PACKED with bargains!

DISPLAY -ELECTRONICS-

MAIL ORDER & OFFICES
Open Mon-Fri 9.00-5.30
Dept ET,32 Biggin Way,
Upper Norwood,
London SE19 3XF.

LONDON SHOP
Open Mon-Sat 9-5.30
Thursday till 9.00pm
215 Whitehorse Lane,
South Norwood,
London, SE25.

DISTEL © The Original
Free dial-up database!
1000's of items+info on line
V21, V22 & V22 bis
081-679-1888

ALL ENQUIRIES
081-679-4414
Fax- 081-679-1927

Visa

All prices for UK Mainland. UK customers add 17.5% VAT to TOTAL order amount. Minimum order £10. PO orders from Government,Universities,Schools & Local Authorities welcome-minimum account order £30. Carriage charges (A)=£2.00. (A1)=£3.75. (B)=£5.50. (C)=£8.50. (D)=£11.50. (E)=£14.00 (F)=£18.00 (G)=Call . Scotland surcharge: call. All goods supplied subject to our standard Conditions of Sale and unless otherwise stated guaranteed for 90 days. All guarantees on a return to base basis. Rights reserved to change prices & specifications without prior notice. Orders subject to stock. Quotations willingly given for higher quantities than those stated. Bulk surplus always wanted for cash.

Metronome

Will Chester keeps tempo with his electronic timekeeper

Keeping time in music has long been a requirement of students keen to learn their chosen instrument. There are, of course, several ways of achieving the same end. You can tap your foot on the floor; count evenly in your head (or aloud!): enlist the eager help of a friend to beat a drum or biscuit tin lid; or you can use a metronome.

The traditional, age old, pre-electronic metronome is quite elegant in appearance and exudes a certain character reflecting the craftsman-like care with which it was built. The familiar pyramid case is made from pearwood or mahogany. A pendulum swings from side to side, producing a consistent rhythmic tick at each change of direction. The tick automatically denotes each beat within each bar of music, thereby freeing the musician to concentrate on his playing technique.

The electronic cousin presented here offers the degree of beat accuracy available from simple electronics. The pendulum is replaced by a light display that uses nine light emitting diodes. A loudspeaker gives audible indication of the beats. An additional feature is provided by counter circuitry which enables one beat within each bar to be accented. On the environmental front, the mahogany case is replaced with one of grey ABS. A good or bad thing dependent on your point of view!

Circuit building blocks used in this design may indeed prove useful for many other applications.

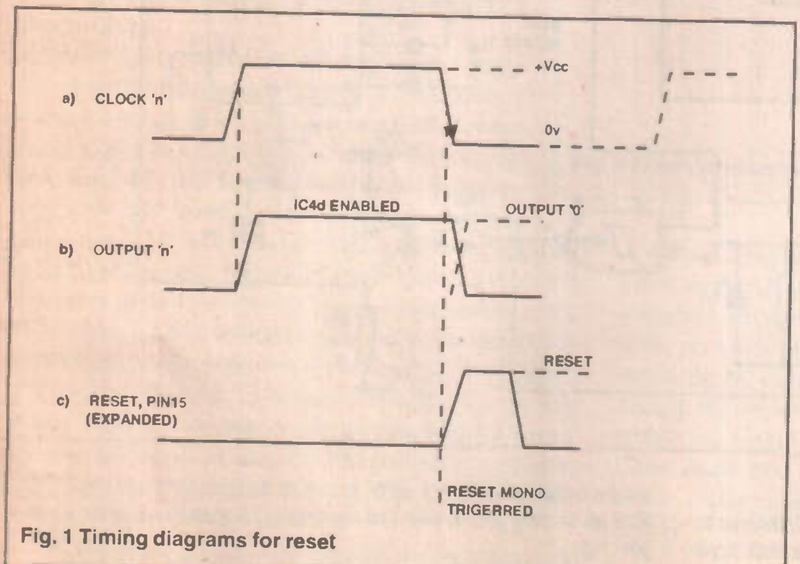


Fig. 1 Timing diagrams for reset

Design Considerations

The initial design requirement concerned the problem of how to emulate the swinging pendulum idea. Retaining this may seem pointless to some of you, but closer consideration will yield an important benefit. The visual 'swing' actually helps to convey the sensation of passing time just as readily as a consistent tick. The swing may even allow the next beat to be anticipated, which must surely aid. not hinder the musicians' performance. Provision of the means to suppress audible ticks might also prove useful in some instances, the LED display then maintains indication for silent running.

The final design uses nine LEDs. This means that the fifth LED is exactly in the middle (top dead centre) and thus denotes half-beat time. Full beat indications are shown by the first and ninth LEDs.

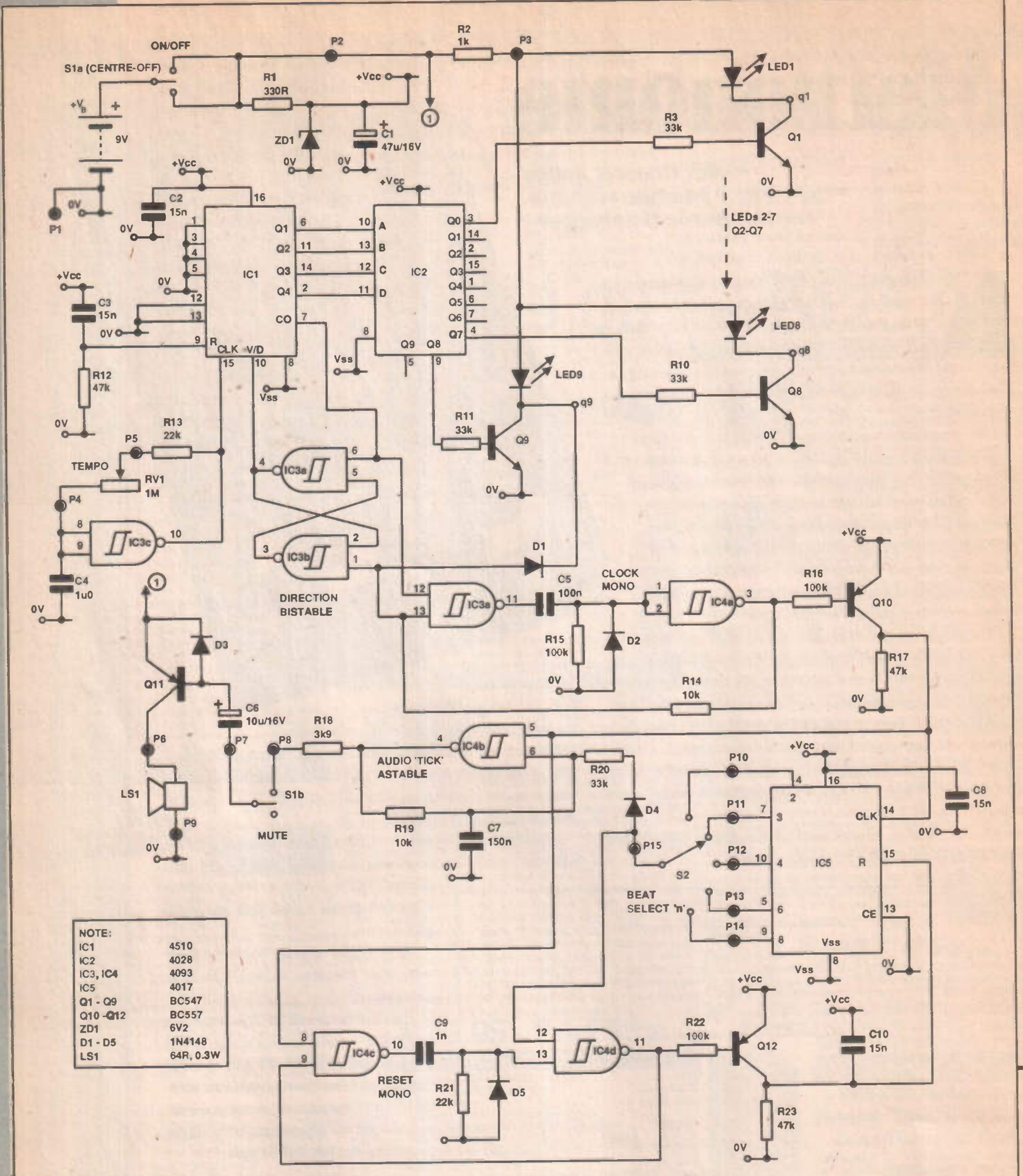
Why not have green lights for these latter two positions to highlight their importance?

The common red LED is used for LEDs 2 to 4 and 6 to 8 inclusive. A red or green LED may suffice for LED5. Essential for any metronome is the ability to vary the beat rate, or tempo. This is provided by adjustment of a single potentiometer labelled Tempo.

The Circuit

The circuit diagram is shown in Figure 2. The beating heart of this metronome is based upon IC1, a 4510 CMOS programmable up/down BCD counter. The logic level on IC1, pin 10 determines the count direction. Logic 1 (+Vcc volts) makes IC1 count from binary 0000 to 1001 on successive clock pulses at pin 15. Logic 0 at pin 10 ensures a count down from 1001 to 0000.

In the metronome we need to count upward (to the right) then change direction and start a count down, back to the left



NOTE:	
IC1	4510
IC2	4028
IC3, IC4	4093
IC5	4017
Q1 - Q9	BC547
Q10 - Q12	BC557
ZD1	6V2
D1 - D5	1N4148
LS1	64R, 0.3W

Fig. 2 Circuit diagram

HOW IT WORKS

Astable IC3c continuously clocks binary up/down counter IC1. IC2 decodes the BCD output from IC1 and turns on LED1 at power- up. Successive clock pulses cause the nine LEDs to be lit separately in turn.

Initial logic 1 output of bistable IC3a, IC3b allows IC1 to count up, (LED1 to LED9). When led 9 is ON, Q9 collector goes low (0V) and resets the bistable. Pin 10 of IC1 is taken to logic 0, allowing a count-down (LED9 to LED1) to begin on the next clock pulse. Transistor Q9 also triggers clock-mono IC3d, IC4a by logic 0 through diode D1. Transistor Q10 turns On for time defined by C5∝R15. The rising edge appears at IC5 clock input, pin 14 and steps the counter from output '0' to '1'. While Q10 collector is high, it enables tick-astable IC4b causing the audio tone to be heard from LS1.

IC1 begins counting down at the next positive pulse from IC3c. When minimum count (LED1 On) is reached a fast logic 0 pulse from IC1 pin 7 sets the direction bistable output back to logic 1. At the same time the clock-mono is re-triggered at IC3d, pin 12 giving another audio beat and clocking IC5 again so that output '2' now goes high.

When LED9 is lit, at the next count-up, another beat is heard and IC5 output '3' goes high. This potential (assuming SW2 is set to '3') modulates tick-astable IC4b causing the audio beat- tone to change frequency. When Q10 collector returns to 0V reset-mono IC4c, IC4d is fired and IC5 is reset. At the next beat pulse (from clock-mono), IC5 starts it's count from '0' again.

Diodes D2 and D5 are for protection purposes, so that the respective NAND gate inputs do not go below -0.6V when the capacitors discharge.

Transistor Q11 is biased into cut-off and negative going pulses from IC4b are coupled through C6 to operate Q11 for the period of the tone burst.

Components R1, ZD1 provide supply regulation for the counter and timer circuitry. The tone burst, or tick is muted by opening switch SW1b.

end of the display. The direction change is needed at minimum count (LED1 lit) and at maximum count (LED 9 lit). Fortunately pin 7, IC1 provides a brief but useful single pulse output whenever the count is at 0000. This pulse is taken to a bistable formed by IC3a, IC3b.

The other bistable input is taken from LED9. The bistable is triggered whenever one of its inputs sees a momentary logic 0. This conveniently toggles the bistable between it's two output states, at the extremities of the count. It therefore serves well to program the up, down, up, down action of IC1.

Integrated circuit IC2 is a 4028 CMOS BCD-to-decimal decoder. Only one of it's ten outputs (Q0 to Q9) will go high for each distinct binary-coded-decimal code presented at input lines A, B, C and D. Note that when output Q8 is high, the next clock pulse at IC1, pin 15 will cause Q7 to go high. This means unused output Q9 never sees the light of day since the direction bistable has already been toggled to initiate count down.

Tempo control RV1 is in the feedback loop of a Schmitt trigger-action NAND gate astable multivibrator which, in it's simplest form, needs only two discrete components for correct operation. The output of this astable provides regular clock pulses to IC1, pin 15 clock input. The tick itself is produced by another Schmitt NAND astable, IC4b. This is gated On momentarily by monostable IC3d, IC4a whenever LED1 or LED9 is on. Transistor Q10 also feeds positive monostable pulses to the clock input (pin 14) of IC5, a 4017 CMOS decade counter. At power-on counter IC5 is reset by a short capacitive pulse through C10.

IC5 counts successive rising edges from the monostable output at transistor Q10's collector.

Switch SW2 is used to select the required beat that is to be subtly accented. At the third beat, IC5 output 3 goes high; at the fourth bear output 4 goes high - and so on. In this way all outputs of IC5 could go to a selector switch, but this would then become impractically large. Five selectable outputs are chosen to give a useful range.

Resistor R20 applies the selected counter output voltage to the 'tick' astable IC4b. When the selected output is low, i.e. at 0V, R20 has no effect. Reverse biased diode D4 ensures this and the tick tone from loudspeaker LS1 will be at the fundamental frequency defined by R19 and C7. When the selected output assumes logic 1 (+Vcc), this potential is impressed upon the astable time constant. The result is perceived as a slight fall in the tone of the tick. The tick duration corresponds to the active high level from Q10 collector. A following logic 0 seen at IC4b pin 5 disables the tick astable and LS1 is silenced.

Changing the value of resistor R19 will alter the tick astable frequency. For best results the relationship between R19 and R20 should be such that R20 is equal to, or greater than (2∞R19). Values of R20 lower than this may cause inadequate operation of the astable.

The clock-mono, IC3d, IC4a standardises the tick period. As the tempo is increased the pulse width at Q9 collector narrows. Conversely, as tempo is made slower, the pulse width available at Q9 collector becomes wider. Without the clock-mono, this would give short or long tick durations according to temp rate. The clock-mono also lengthens the very narrow pulse from IC1 pin 7, so that a beat can be heard at minimum count.

Since we want counter IC5 to reset after the selected count, call this 'n', a further monostable built around IC4s, IC4d is necessary. Reference to Figure 1 timing diagram will make this point clearer. Figure 1(a) shows the clock-mono, output; the rising edge corresponds to the selected 'n' count clock pulse. Figure 1(b) is the 'n' output of IC5 going high, nanoseconds after the 'n'th clock transition. This selected output enables NAND gate IC4d whose monostable action is fired only when clock pulse 'n' falls back to 0V. Transistor Q12 inverts the pulse and a resultant +Vcc reset appears at IC5, pin 15, shown at Figure 1(c).

This always occurs at the start of a negative clock period to be sure that counting is resumed on the very next rising clock edge.

Note that time constant R21∞C9 sets the reset-mono pulse width - which must be much smaller than any negative clock period (10 to 20μs is used). If the selected 'n' line were directly coupled to IC5 pin 15, the accented beat would not be heard.

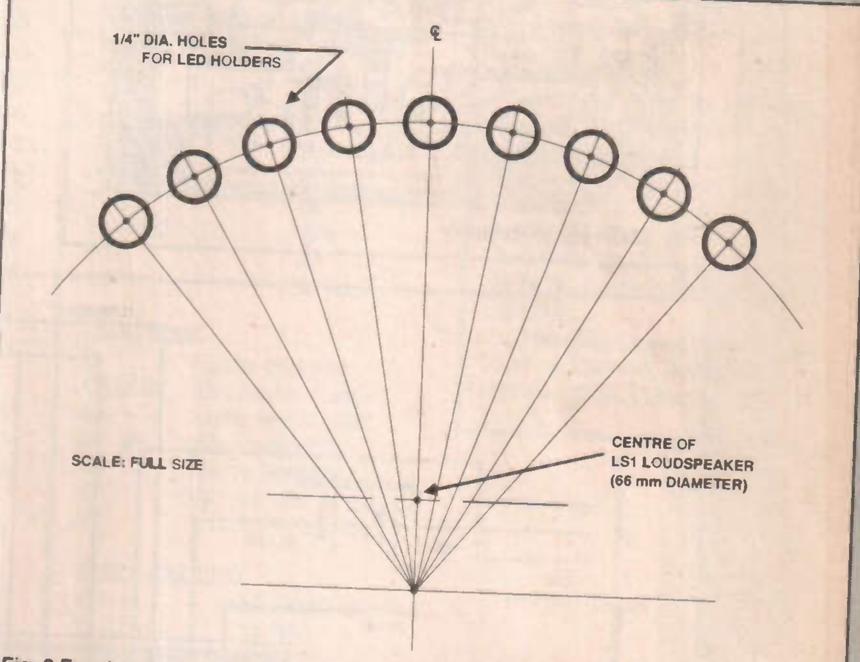


Fig. 3 Front panel template showing LED arrangement

Output transistor Q11 is normally cut-off and is only biased on for falling edge pulses from IC4b. When tick-tone is disabled, emitter of Q11 will be approximately 9V whereas IC4b, pin 4 will be at 6.2V. Capacitor C6 is thus needed to isolate the DC offset to prevent a large DC current flowing through the loudspeaker. Diode D3 limits the base-emitter reverse bias on Q11 to 0.6V, during the discharge cycle of C6. Zener diode ZD1 provides simple voltage regulation to ensure consistent beat accuracy throughout the life of the battery.

Construction

Using the design given, construction of the PCB is straight forward. It may be wise to use sockets for the ICs, especially if you are unfamiliar with handling static sensitive CMOS chips. Begin assembly by soldering links LK1, LK2 and LK3 using single core wire. Solder in place all resistors and diodes ensuring correct polarisation. Use the component

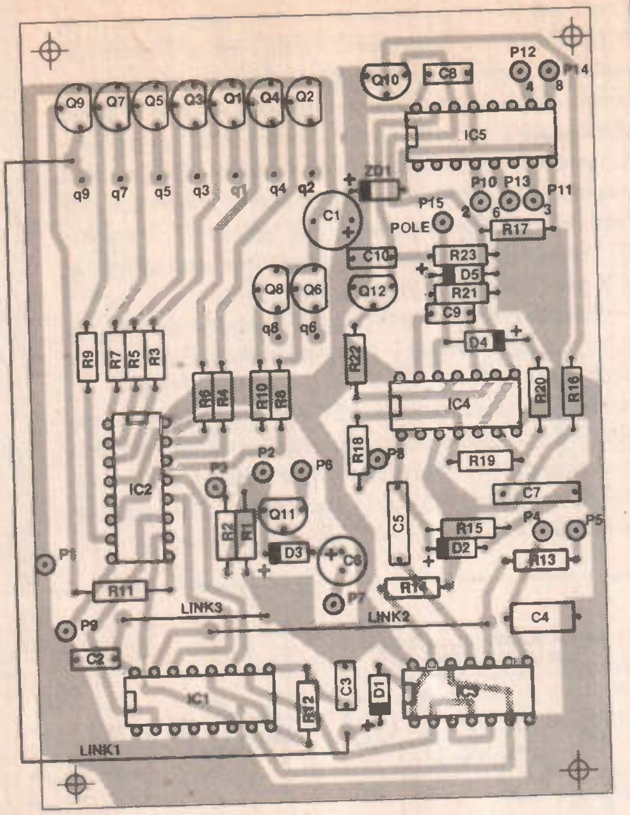


Fig. 4 Component overlay

overlay Figure 4 as a guide. Next, fit and solder capacitors C9, C10, C8, C2 and C3. Now fit polyester layer caps, C5, C7 and C4, taking care not to damage the leads. Electrolytics C1 and C6 should be checked for correct polarity before soldering. Fix transistors Q1 to Q9. Flatten the leads on the solder side first before soldering and cropping off excess. Do the same for Q10, Q11 and Q12; the flat on each body points away from IC1. The ICs can be fitted now or after fixing the connecting wires. The prototype does not use terminal pins but they can be used if preferred. A length of 10-way ribbon cable (about 7 inches) provided a neat solution for the PCB to LED display wiring. A 6-way length to switch SW2 was also used. The wires from P6 and P9 are best kept as short as possible and twisted together. The four wires to SW1 are best soldered before mounting the switch in the case. Wire the battery clip to P1 (black) and S1a (red) then solder two wires to P4, P5.

Case

The prototype case has internal dimensions 144 ∞ 84 ∞ 50 deep (mm). The PCB needs only to be fixed at two diagonally opposite corners. Plastic spacers 6mm long and M2.5 or M3 countersunk head screws give good fixing. Two further spacers can be glued on the underside of the remaining corners to provide support. Fix the PCB towards one end of the case, allowing the battery to sit at the other (lower) end in normal use. Drill a 6.5mm hole in the centre of the case top (see photo) to take SW1 which may then be fitted. Make holes in the case lid for the LEDs and controls. The template,

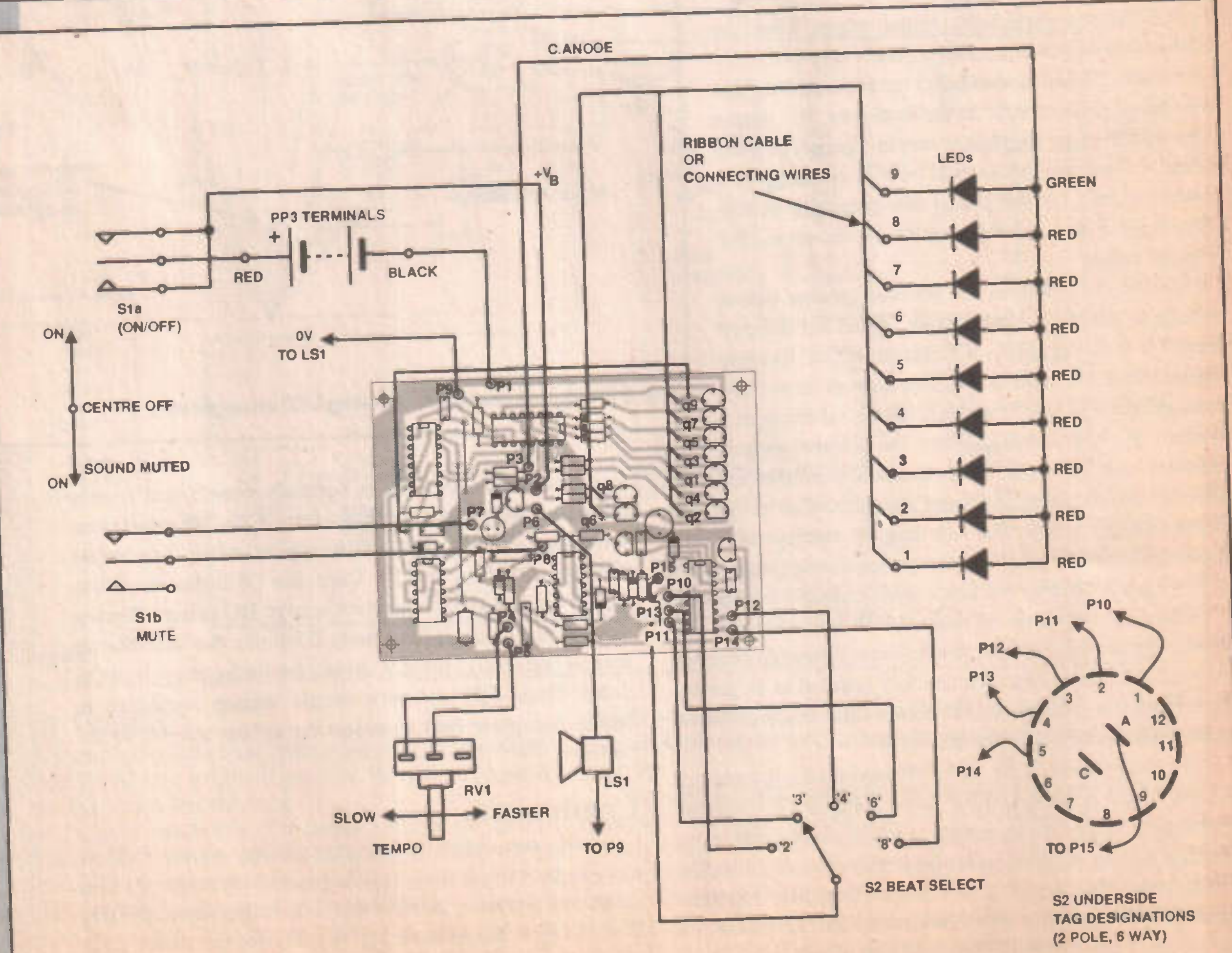


Fig. 5 Wire interconnections from PCB

shown actual size in Figure 3, defines the LED centres used on the prototype. It also indicates the centre for LS1. A matrix of drilled holes in the lid allows sound to propagate from the loudspeaker. Drill two holes, each 9mm diameter for RV1 and switch SW2 then bolt these directly to the lid. The loudspeaker can be fixed by various means: glue, twin-stick tape and metal brackets are three examples. The nine 5mm LEDs are clipped into holders. On the lid underside, the LED anode leads are bent over at right-angles then soldered together. This is the common- anode connection to P3. The nine remaining ribbon wires go to their respective LED cathode leads. Crop these to a length of 5 to 10mm. Solder the P4, P5 wires to RV1. Finally solder P15 wire to a pole of SW2 and P10 to P14 wires to consecutive switch tags.

Testing and Setting Up

Before connecting the battery, do a quick check to ensure there are no short circuits between +Vcc (P2) and 0V (P1) supply rails. Use a multimeter set on a low ohms range. Some multimeters will feed 2V or so to the +ve probe on a particular low ohms range. This may be sufficient to check that each LED, 1 to 9 inclusive is correctly polarised. Placing +ve probe on LED anode and -ve probe on cathode will light the LED under test.

Set the tempo control to approximately middle position and turn switch SW2 to select '3'. Now connect the battery and switch SW1 so that sound is muted. The display should immediately spring into action. LED1 will be lit first, followed by LED2, then 3, 4 and so on. Upon reaching LED9, the direction will reverse and head back toward LED1. No two LED's should be lit simultaneously. Now adjust the tempo and check that the rate of 'swing' can be slowed and then quickened.

While the light dances from side to side, flick switch SW1 to 'sound on'. An audible beep should now occur coincident with LED 1 On and LED9 On. If this is not the case, recheck your values of R19 and R20 and correct polarisation of D4. If no beep is coincident with LED9 On, check for correct polarisation of diode D1.

Within a short time of throwing mute off, it will be clear that one beat is of differing tone to the other two. This is the accented beat. Try selecting beats '2', '4' then '6' and count to see that the correct beat is accented. If no accented beat is present for any setting, check that Q12 collector-emitter junction is not short circuit and that diode D4 is correctly sited. An accent on every tenth beat only suggests that the reset-mono is not functioning. Check that D5 anode goes to 0V before suspecting IC4.

Absolutely no beat is symptomatic of the lock-mono not working. In this instance, check D2 polarisation and C5, R15 values before changing IC3 or IC4.

In Use

Before putting the metronome to good use, it is advisable to calibrate the tempo adjustment, RV1.

Only a few rates need marking on the front panel around the tempo control knob. The markings serve to give a reasonably good initial setting. Real accuracy can only be obtained by counting beats (ticks) in a fixed time period, one minute being the norm (giving beats per minute).

To find the 60 beats per minute mark, rotate RV1 until exactly 30 beats are heard in any 30 second time period. Then simply fix a 60 number or other marking adjacent to the pointer position.

Faster tempo rates, for example 100 beats per minute and higher might be more easily found by counting beats in a 15 second period. In this case, exactly 25 will be heard at the 100 beats per minute setting.

Four or five calibration points, found and marked in the fashion just described may be perfectly adequate.

During normal use, intermediate tempo settings can be estimated.

Some notes may be useful regarding a particular hardware adjustment. The clock-mono output pulse width is determined by C5 and R15. This positive pulse enables audio tick output. Resistor R15 value may be increased to extend the tone duration. However, bear in mind a limitation. At the fastest tempo, the tone duration should be less than the time for the display to travel from LED1 to LED9. Otherwise the correct beat registration is lost.

PARTS LIST

RESISTORS - 0.6W (or 1/4W)
Metal film +/- 5% or better.

R1	330R
R2	1k
R3,4,5,6,7,8,9,10,11,20	33k
R12,17,23	47k
R13,21	22k
R14,19	10k
R15,16,22	100k
R18	3k9
RV1	1M Linear

CAPACITORS

C1	47µ/16V Electrolytic
C2,3,8,10	15n polyester or ceramic
C4	1µ poly. layer 5% 100V
C5	100n polyester 10%
C6	10µ/16V Electrolytic
C7	150n poly. layer 5% 250V
C9	1n ceramic or mylar film

SEMICONDUCTORS

ZD1	BZY88C6V2 6V2 Zener
D1,2,3,4,5	1N4148
Q1,2,3,4,5,6,7,8,9	BC547
Q 10,11,12	BC557
IC1	4510
IC2	4028
IC3,4	4093
IC5	4017

MISCELLANEOUS

SW1	Two-pole changeover switch, (centre-off)
SW2	Two-pole 6-way rotary switch (one pole not needed)
LED2,3,4,5,6,7,8	Red 5mm
LED1,9	Green 5mm
LS1	Miniature loudspeaker, 64R impedance

Printed Circuit Board
9V. battery (e.g. PP3)
Battery clip
Case
Connecting wire
0.5 metres of 10 way Ribbon cable (optional)
Vero-pins (optional)
3 16-pin IC sockets (optional)
2 14-pin IC sockets (optional)

BUYLINES

A complete kit, including all miscellaneous items (except battery, Veropins and IC sockets) and PCB, case, control knobs, ribbon cable, transfers and templates is available for £21.25 +£1.50 postage and packing (£22.75 total, VAT inclusive) within the UK. Alternatively, the PCB is available for £4.40 +40p postage and packing (VAT inclusive)

Please send payment, cheque or postal order to Electrotek Developments, 13 Carnarvon Grove, Carlton, Notts. NG4 1RP

Digital Television News

DTV down to 3Mbit/s - Digital Compression Squeezes Even Harder

ITC Research Open Day lifts the veil on the latest progress in Digital TV, and gives a glance at some of the others 'goodies' now in the research labs.

Readers learned earlier this year (ETI April '93) that the ITC had demonstrated live over-air transmissions of widescreen enhanced digital television programmes at a data rate of about 10Mbit/s from its transmitter sites in Devon, representing a more than twenty-fold reduction in the data rate coming from the digital studio. At a series of 'open days', designed to show how ITC engineering research works, and the achievements it has made during its first couple of years of operation, this work was taken even further and transmissions were made from Crystal Palace, the main London Transmitter. Demonstrations were also given of digital pictures coded at the incredibly low date rate of just 3.5 Mbit/s, the sort of data rates that could be recorded on simple domestic 'VCRs.

Jim Slater reports on the various exciting developments that were to be seen at the exhibition.

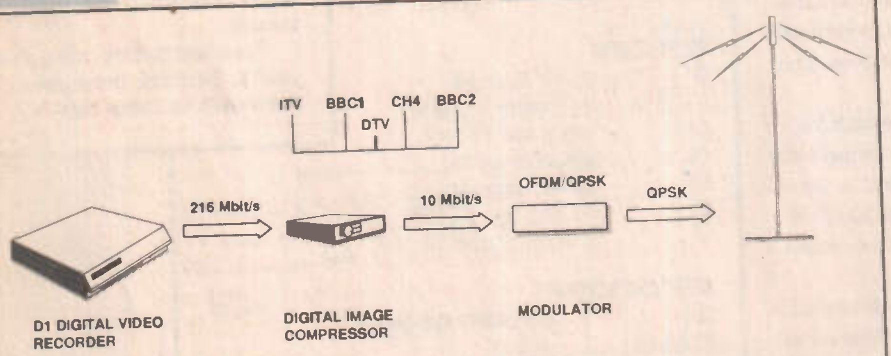


Figure 1 Arrangements for digital transmissions from Crystal Palace

Changes in Broadcasting Research

Although the effects of the Broadcasting Act 1990 have given rise to acres of press coverage, one of the act's most significant proposals has been virtually ignored. Prior to its breakup and 'privatisation', the IBA had been one of the world's foremost broadcast engineering research establishments, and there were real fears that the private company, National Transcommunications Ltd would not wish to spend anything like as much time or money on the 'blue skies' research that IBA had traditionally carried out. After much well-targetted lobbying by those who understood the importance of engineering research to the future of this country's electronics industry, an interesting arrangement was finally arrived at. The ITC, whereby the Commission may 'promote the carrying out by other persons of research and development work relating to television broadcasting'. Effectively, then, the ITC may not actually carry out its own research work, and so the ITC takes money from the Channel Three licence holders, currently some £2 million per year, and uses this to place specific research contracts with other organisations. The open day at the ITC's London HQ was the first time that the results of this policy were shown publicly, and the numerous demonstrations and stands manned by different contractors were a good indication that the system, very different from anything that has gone before, seems to be working well. The title of the technology exhibition was 'Working with Industry to Research the Future'.

Digital Transmission

For those of us who are keenly watching the fast moving developments in the field of digital television transmission, the demonstrations of the ITC sponsored work being carried out by National Transcommunications Ltd. were fascinating. Without affecting the existing four television services on UHF Channels 23, 26, 30 & 33 from the Crystal Palace transmitter in any way, the researchers managed to squeeze into Channel 28 a completely separate widescreen 625-line digital programme channel. The first demonstrations that were shown used a data rate of about 10 Mbit/s, and the picture quality on the large widescreen displays was superb; the 39" Sony monitor provided up-converted pseudo 1250 line pictures, and the 36 inch Nokia widescreen receiver showed clearly just how well the current generation of 625-line domestic receivers can perform. Readers will know from our earlier articles that the key to being able to squeeze extra digital programmes into the existing UHF spectrum without causing interference to the existing programmes is to keep the digital transmissions at very low power, and for these tests a maximum effective radiated power of fifty watts was used, although the directivity characteristics of the transmitting aerial were such that only about 5 watts ERP was used in the direction of the ITC HQ receiving site. Compare that with the 1 Megawatt ERP of the existing Crystal Palace transmissions, and you really do begin to appreciate something of the magic that digital television will be able to provide. The ITC/NTL designed SPECTRE coding and OFDM modulation system that was used in previous trials once again demonstrated its inbuilt ruggedness and inherent error protection; no errors at all were seen on the displayed pictures, even though the signals were being received over a transmission path that included one of the busiest parts of central London, and the digital stereo sound transmissions were completely free of the irritating clicks that can sometimes disturb such signals when there is a lot of traffic about.

Three into one will go!

There has been much talk in recent months of digital transmissions from future Astra satellites using bit rates of 5Mbit/s or less, which would give the satellite operators the opportunity to provide perhaps 80 different programme channels on just 16 radio frequency transmission channels, but, having seen some of the results on satellite tests from America, I have had my doubts about whether the quality of the resulting pictures would be acceptable to the viewer. It was therefore especially interesting to see the second ITC demonstration, in which they showed three different programme channels coded simultaneously into the 10Mbit/s digital data stream. The demonstration actually used pictures from three PAL videotape recorders, each providing a different programme, and to illustrate the possibilities the ITC had chosen to use the three different regional 'opt-out' news programmes from Meridian, the ITV company that serves the south of England. Each of the programmes was digitally compressed down to only 3.5 Mbit/s, and the data from all three was then coded and multiplexed together into a single 10 Mbit/s data stream. The three decoded pictures were then shown on separate 26 inch monitors, allowing critical viewing of the picture material.

In general, the quality of the 3.5Mbit/s pictures was very good, with virtually no noise, but as with all digitally compressed pictures, the quality varied with the picture material being shown. Still pictures, or those containing little movement, seemed virtually perfect, whereas fast-moving areas of the picture could sometimes be seen to made up from coarse blocks of colour, a side effect of the discrete cosine transform coding used as part of the bit-rate reduction system. Some pictures containing a lot of detail also looked slightly 'artificial', rather like a photograph that has been through a 'solarisation' process, although it was difficult to describe exactly what was wrong. The major difficulty for we so-called 'experts', however, is that we are used to classifying picture quality under the most critical viewing conditions, effectively using a magnifying glass to look for faults, and I have no doubt that the vast majority of viewers would consider the 3.5 Mbit/s pictures to be very acceptable; they are certainly of very much better quality than those provided by many VHS machines, and the continuing popularity of video rental shops shows that the programme content is much more important than the picture quality as far as the typical viewer is concerned.

A side issue of this demonstration that nobody at the ITC wanted to talk about was the possibility of being able to receive lots of different ITV regional programmes. Low bit rate digital transmissions could allow viewers a much wider choice of programmes, meaning that they would no longer have to be restricted to the programmes from their own particular regional ITV contractor. Such a revolution could ruin the carefully planned marketing strategies of the regional ITV companies, and those of the advertisers upon which the companies so heavily depend, so the pros and cons of offering viewers more choice will have to be carefully considered before transmissions begin. The ITC's Controller of Engineering admitted that digital terrestrial transmissions will not come until some years after satellites start to transmit the signals, but he stressed the importance of the existing terrestrial broadcasters keeping up with their satellite competitors, and said that since the future of TV was obviously going to be digital, viewers would have to be given the greatest possible choice. Digital TV bitstreams could be used to carry HDTV pictures, or to carry extremely rugged, less-detailed pictures which could be received on portable receivers virtually anywhere.

No detailed information about the bit-rate reduction algorithms being used was available, but it is known that NTL are currently working with Scientific Atlanta on low bit rate digital transmission equipment for use in the USA, so we can presume that the quality of the pictures shown was very similar to what our American friends will be receiving. The NTL equipment was developed prior to the MPEG-2 low bit-rate digital video standard being finalised, but now that many of the world's broadcasters and video equipment makers have agreed on MPEG-2, we can expect the NTL engineers to be carefully considering how to make the best use of the chips that should start to become available in quantity during 1994. Although it would seem sensible for digital terrestrial broadcasters to use exactly the same MPEG-2 chips as the satellite broadcasters, at the moment the European digital terrestrial television researchers are demanding more; they would like to use a multi-level hierarchical digital system that would allow a single bitstream to carry various qualities of picture, so that the same bitstream could provide stable, reasonably detailed pictures to a portable receiver and more detailed, perhaps even HDTV pictures, on more exotic receivers connected to good quality aerial systems. The idea may be laudable, but those who were involved in the MAC fiasco will know the dangers of including too many technological bells and whistles, just because research engineers are clever enough to include everybody's 'wish list' in their specification. In the end, it is the provision of a cost-effective system that counts, and it certainly looks as though satellite receiving systems based on MPEG-2 chips will be on the market in time for the start of digital transmissions from Astra in 1995; surely it would make sense for the terrestrial broadcasters to ensure that the same receiving equipment can be used for their digital signals, too?

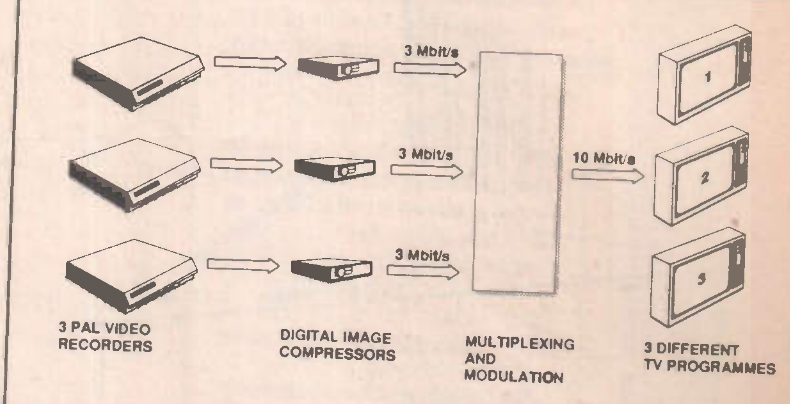


Figure 2. Equipment layout for ITC 3.5 Mbit/s digital demonstrations

PALplus - Improving on what we have already got!

After the excellent digital transmission demonstrations, it might have been thought that other demonstrations of ITC research projects would have come as something of an anticlimax, but in fact there were several different areas which proved of great interest. Researchers from UK Independent Television and from the BBC have been working as part of the European PALplus project since 1991. PAL plus is designed to allow broadcasters to transmit high quality widescreen 16:9 aspect ratio pictures over their existing networks to those viewers who will be buying widescreen receivers, whilst providing existing viewers with a reasonable degree of compatibility. Such a development could be extremely important commercially, since at the present time the standard UHF PAL transmissions are available to virtually the whole population, and if widescreen capabilities and picture enhancement can be incorporated into these transmissions, then the danger of the existing terrestrial systems becoming 'old-fashioned' or 'second-rate' when compared with satellite systems can be counteracted. The ITC demonstration showed a complete, working, PALplus encodcr/decoder chain, and the pictures shown on a standard widescreen receiver were excellent, even when using a compromise 14:9 aspect ratio picture, which may be used at the start of PALplus transmissions in order to make the pictures received on standard 4:3 aspect ratio receivers more acceptable to viewers. The PALplus research group includes Philips, Thomson, Grundig, and Nokia, and the firm intention is to have the system operational during 1995.

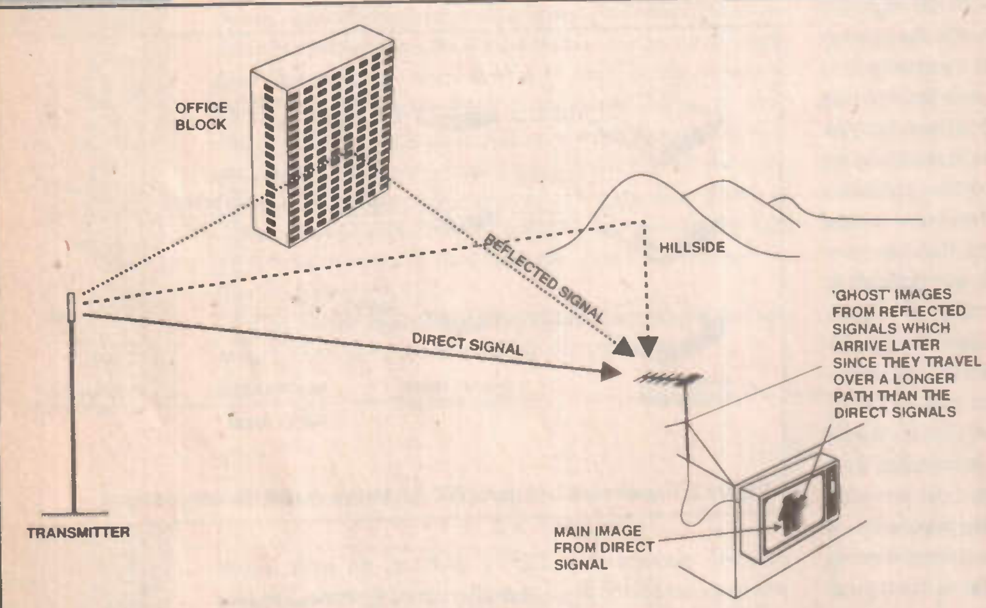


Figure 4 How multi-path reception causes 'ghosting'

PALplus system

Various other enhancements which could be added to PAL transmissions were also demonstrated, together with some impressive pictures showing how effective the inclusion of 'ghost-cancelling' signals can be. A reference signal consisting of short bursts of various different frequencies, known as a 'chirp' signal, is included in the vertical blarking interval of each picture, and the receiver, by comparing the received signal and its reflections with what it knows the original 'chirp' looked like, can introduce variable video delays which can cancel out multiple ghosts. Japanese chips have been available for some time which claim to do the same thing, but whilst they worked well on simple 'ghosts', the results were never good enough on the far more frequently occurring complex ghost signals to make it worthwhile for receiver manufacturers to include them. This new system works well, and broadcasters throughout Europe are currently negotiating to see if they can agree on a standard way of incorporating the signals into the TV waveform. Although ghosting may seem a trivial problem to most of us, there are in fact hundreds of thousands of people in the UK whose pictures are degraded by multiple reflections, and the recently built Canary Wharf tower has ruined reception for more than 100,000 people in the Lea Valley.

Microwave TV Transmissions

One of the potential ways of transmitting dozens of television channels directly to homes is to use microwaves; the high frequency band between 40.5-42.5GHz has been reserved by the Radiocommunications Agency for so-called MVDS - Microwave Video Distribution Services, and there is sufficient bandwidth to carry perhaps 30 or more channels. Some systems of this type are already in use in the USA and in Ireland, although on lower microwave frequencies, and MVDS is sometimes called 'wireless cable' because it provides the multichannel capability of cable systems without having to dig up the streets. If such a system is to be used in the UK a frequency plan will be required, to ensure that systems in adjacent areas use different frequencies, so as not to cause mutual interference. Little is known of the way in which signals at 40GHz behave in different atmospheric conditions, and so the ITC has commissioned the Radio Communications Research Unit of the Rutherford Appleton Laboratory to carry out a series of propagation studies. An inland link is to be installed in Oxfordshire, and a coastal link near Colchester, and data from these experiments will enable planning engineers to determine the optimum distance apart that transmitters must be if frequency re-use is to be maximised. Some of the microwave equipment which has been developed for these tests was on show at the exhibition, including a complete 40GHz transmit-receive chain working at 1kW ERP.

With some 4000 UHF TV transmitters now on the air in the UK, the problems of UHF frequency planning are as complex as ever, and the exhibition included a PC-based demonstration of how the coverage area of a UHF transmitting station can be predicted, and how the path profile between transmit and receive sites can be calculated from a computerised terrain data base. It was fascinating for this PC user to see how the wellknown AUTOROUTE map programme had been used to provide displays of the limit of service contours for each of the UK main transmitting stations, and to enable the planners to calculate the numbers of people living within these contours. The system is also used to show the areas covered by each of the UK cable franchises, which are awarded by the ITC.

Television for the blind!

Incredible as it may at first seem, millions of visually impaired people watch television regularly, and the ITC showed off some of the results of research work which it has sponsored as part of the AUDETEL (Audio Description of Television) consortium, where methods have been found of providing blind viewers with more information about what is happening on screen. Demonstrations were given, via infrared coupled headphones, of an audio commentary which is transmitted during the natural gaps that occur in a television programme between episodes of dialogue. Test transmissions have already been carried out, and a pilot service will be introduced within the next year. This project has been

PALplus - Widescreen higher quality with existing transmissions

- **Terrestrial widescreen via existing networks**
- **Suitable for all PAL countries**
- **16:9 widescreen - compatible**
- **Not new - PAL with add-ons**
- **Helper signals give format control**
- **Helper signals give improved pictures**

Once widescreen receivers move out of the showrooms into significant numbers of homes, conventional terrestrial broadcasters are faced with a problem - their pictures are only 4:3 aspect ratio, and leave black lines at each side of the widescreen picture display. This would rapidly make terrestrial broadcasting seem old-fashioned or second rate, which cannot be allowed to happen when your services are paid for, whether directly by the viewer, or indirectly via advertising. Realising that the PAL television system that is used throughout most of Europe still has enormous potential, a group of majormanufacturers and broadcasters has decided to develop a system called PALplus, which gives existing transmission networks the capability to transmit widescreen higher quality pictures, without affecting existing receivers.

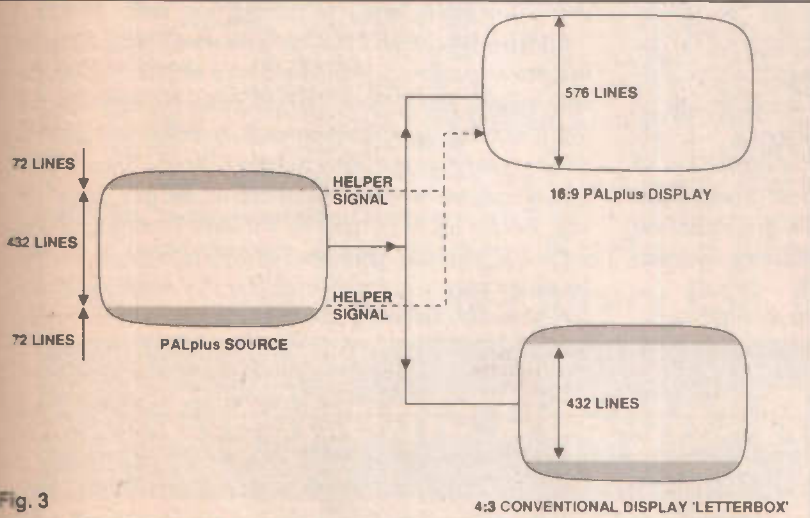


Fig. 3

The technique which PALplus uses to provide widescreen pictures assumes that viewers with existing receivers will be happy with a 'letterbox' style of presentation, which gives a black band at the top and bottom of the picture. In the standard PAL system only 576 of the 625 transmitted lines actually carry picture information. The PALplus system actually downconverts these 576 active lines to form a new picture with only 432 lines. This results, for the conventional viewer, in a picture of about three-quarters the original height , with an aspect ratio of 16:9. The information on the 144 lines which were effectively discarded is not actually thrown away, but during the downconversion process it is used to generate so-called 'helper' signals. The helper information is then inserted into the blank bands at the top and bottom of the cropped picture, in a 'blacker than black' part of the video signal, so that it is invisible to the viewer with a conventional receiver. The area between the black level and half the sync pulse level, typically between the 150 and 300mV levels of the standard video signal has been tested, and seems likely to prove suitable for carrying the 'helper' signals without causing distress to the viewer with a conventional receiver.A top-end wide screen PALplus receiver can make use of these invisible helper signals to instruct its display circuitry to reconstruct the original 576 line wide-screen display, this time in a progressively scanned, i.e. non-interlaced format. Tests in laboratories and at exhibitions have shown that the system works well, and a programme of longer term field tests has already started, and will continue during the months ahead, to find out whether there are any hidden snags or needs for modifications.

All this can be achieved without changes to the transmitters and transmission network, apart from the insertion of PALplus coders at the studio outputs, but the big question remains: Will viewers with conventional receivers accept black bands on many of their pictures without complaining? Although French and German viewers have become used to letterbox transmissions of films, their reactions to having many other programmes in this format are not clear, and in the UK there is considerable evidence that viewers would not be happy. In order to overcome this problem the PALplus team are looking at possible intermediate letterbox formats, not quite so wide as 16:9, and therefore without such big black bands at the top and bottom of the picture. Such a format, perhaps 14:9, could be used in the transition phase, until sufficient viewers have bought wide-screen receivers, when the final move to 16:9 could be made without upsetting too many people.

The PALplus timescale is tight; the system parameters have been agreed, trade demonstrations were given in Amsterdam in July, and after substantial field trials, some of which have already started, as insomniacs amongst you may know, the aim is to have PAL plus receivers on sale in the shops by 1995.

Within three to four years existing transmitters throughout Europe could be providing these enhanced pictures, which should encourage the sale of widescreen receivers and provide yet another marketing opportunity for the retail trade.

You will see from the list of PALplus partners that this project is being taken very seriously indeed.

Some of the techniques being proposed for use in PALplus could equally well be applied to SECAM signals, and Thompson are looking at a system called 'Colour-plus' which could encompass both PAL and SECAM systems.

PALplus project partners

British Broadcasting Corporation
UK Independent Television
Independent Television Commission
ARD(Germany)
ORF(Austria)
SRG (Switzerland)
Philips
Thomson
Grundig
Nokia

partially funded by the European Commission. The AUDETEL speech has to be extensively coded and compressed in order to be able to squeeze it into the small amount of channel space available, and the ITC subcontracted SPEKA Ltd, a spin-off company from the University of Surrey, to develop the speech coding algorithms. On the SPEKA stand it was interesting to listen to the high quality of speech that can now be obtained at data rates as low as 2.4kbit/s, which compares well with the standard 64kbit/s used for digital telephony.

One of the companies being used as a contractor by the ITC to design and develop AUDETEL receivers, Portset Systems Ltd, had its own exhibition stand on which it was showing a whole range of novel equipment designed to help blind and disabled people. Clever electronics and smart thinking have been combined by this company to provide such things as 'Talking Teletext' receivers, a 'Talking Statement' machine for use by Bank of Scotland customers who are blind, and other gadgets such as a 'LITEFINDER' which helps blind people to detect when lights are on or off, whether they are interested in daylight, room lights, or LED indicators on electrical equipment. Of use to a far wider range of people will be their 'Talking Timeswitch' which gives you the ability to set two different sockets to switch on and off at various times, literally talking you through the process of programming the unit. Anyone who has spent ages fiddling with the tiny bits of plastic that need to be carefully positioned on standard time switches will appreciate this unit - it actually tells you what time it is due to switch on and off, and you certainly don't need to be disabled to find this useful!

Picture Quality and colour fidelity

Traditionally, the ITC has been responsible for not only the quality of the programmes we see, (and who would want to admit to that!), but also for technical quality. Demonstrations of the ITC work on colorimetry in television were given, showing a commercially available measuring system controlled by a PC, which can be used for measurements on camera equipment and on displays and lighting. It is very important that different makes and types of camera can all produce matching colours when they are used in programme making, and it was impressive to see how this equipment could be used to ensure that different cameras are as closely colour-matched as possible.

Picture quality assessments have been carried out subjectively for many decades using the five-point grading scale, which ranges from 'excellent' to 'bad', with picture impairments being classified between 'imperceptible' and 'unusable', but the coming of digital picture processing has led to new problems. The quality of a digitally processed picture may well vary according to the scene content; for example, still parts of the picture may be sharp and clear, whereas fast moving parts may appear distorted. The ITC has realised that methods will need to be developed which give realistic assessments of many different types of picture, and on the MOSAIC (Methods for Optimisation and Subjective Assessment in Image Communications) stand it gave excellent demonstrations of the various problems that can occur. ITC research, in conjunction with several other partners, including the University of Essex, has put forward a proposal for European research funding which will allow these important areas to be studied in detail.

New Technology - Waiting for next year

Anyone who wasn't familiar with what is happening in broadcasting research would have been surprised to see the wide ranging nature of the research projects with which the ITC is currently involved. It certainly seems that the concerns of those who were originally worried about the future of this type of research have been taken care of, and that 'privatisation' has not led to the disaster that some predicted. It just seemed a pity that attendance at this exhibition was by invitation only - in future years the ITC might be brave enough to show its New Technology Exhibition to a far wider audience.

Don't miss the

NATIONAL WOODWORKER SHOW

SANDOWN EXHIBITION CENTRE 23rd – 26th SEPTEMBER 1993

Come one, come all – to the National Woodworker Show!

You'll be amazed at the artistry – the craftsmanship – the labour of love represented by the wide range of exhibits on show at Sandown this year. There will be competitions, demonstrations, displays by colleges, trade stands – and much, much more. Sandown Exhibition Centre is easy to get to – and car parking is free! Come early – stay late!

EASY TO FIND!

SANDOWN EXHIBITION CENTRE, ESHER SURREY

- Free car parking
- Easy access
- Within easy reach of London
- Well sign posted for motorists

By car; Sandown is just 15 minutes from the M25 (junction 10) and national motorway network, 35 minutes from central London and 30 minutes from Heathrow or Gatwick.

By rail; British Rail's Esher station from Waterloo is in the immediate vicinity. Trains journey time just 21 minutes – run at least every half hour, more frequently at peak times.

Bus services run regularly from central London and neighbouring towns towns of Guildford and Kingston-upon-Thames.

Admission prices

Adults: £5
Senior citizens: £3.50
Children: 5–16 years £2.

Opening times

10am–6pm daily except Sun. 26th, 10am–5pm

Further information from Argus Specialist Exhibitions, Argus House, Boundary Way, Hemel Hempstead, Herts HP2 7ST Tel: 0442 66551

ADVANCE TICKET DISCOUNT

Use this coupon to save money when you buy tickets in advance!

	Standard Entrance	Advance Discount	No. of tickets
Adults	£5	£4.50	....
Senior Citizens	£3.50	£3	....
Children (5–16 years)	£2	£1.50	....

Cheque enclosed for £.................... made payable to Argus Specialist Exhibitons

NAME....................

ADDRESS....................

.... POST CODE....................

Complete coupon and return to Argus Specialist Exhibitions (AT), Argus House, Boundary Way, Hemel Hempstead, HERTS HP2 7ST

There is no limit to the number of tickets you may order. Special rates for coach parties available on request. Hurry! Offer closes on Tuesday 1st September.

Competition entry form

If woodworking is your skill, why not enter an exhibit in the National Woodworker Show competition? Complete this coupon to receive details and entry form (one per exhibit) and send to Argus Specialist Exhibitions at the address shown in advance tickets coupon on left.

NAME....................

ADDRESS....................

....

.... POST CODE....................

Closing dates for entry: 5th July for show catalogue entry. FINAL CLOSING DATE 30th August

TELEPHONE ORDERS may be made on **(0442) 66551** ACCESS or VISA

ELECTRONICS TODAY INTERNATIONAL

PCB Service September

Price code	Price (inc. VAT)
C	£1.80
D	£2.50
E	£3.25
F	£4.00
G	£4.75
H	£5.50
J	£6.62
K	£7.20
L	£8.80
M	£10.60
N	£13.10
O	£15.80
P	£17.90
Q	£21.80
R	£23.90
S	£25.90
T	£29.00
U	£32.20
V	£35.80
W	£37.90
X	£40.70

E9309-1 RF Signal Generator .... F
E9309-2 MIDI Analyser CPU Board .... K
E9309-3 MIDI Analyser Display Board .... J
E9309-4 Metronome .... G
E9309-FC 4 Range Capacitance Meter .... E

PCBs for the remaining projects are available from the companies listed in Buylines.
Use the form or a photocopy for your order. Please fill out all parts of the form. Make sure you use the board reference numbers. This not only identifies the board but also tells you when the project was published. The first two numbers are the year, the next two are the month.
Terms are strictly payment with order. We cannot accept official orders but we can supply a proforma invoice if required.
Such orders will not be processed until payment is received.

E9204-1 Auto Car Lights .... F
E9205-1 Bat Detector .... E
E9205-2 Pond Controller .... F
E9206-FC Stereo amplifier .... G
E9206-2 Xenon flash trigger Main Board .... J
E9206-3 Xenon flash trigger Flash Board .... F
E9206-4 Scanner for audio generator .... D
E9207-1 Improved Rear Bike Lamp .... D
E9207-2 Mini Baby Bug Monitor C
E9207-3 Ultrasonic Audio Sender (2 boards) .... H
E9207-4 Camera Add-on unit (4 boards) .... O
E9207-5 AutoMate 5V/48V Mixer power supply .... J
E9207-6 AutoMate Precision 17V power supply .... J
E9207-FC Surround Sound Decoder .... F
E9208-1 Dynamic Noise Limiter .... F
E9208-2 Touch Controlled Intercom (2 boards) .... H
E9208-3 MIDI Keyboard .... K
E9208-FC Battery charger .... F
E9209-1 Intercom for light aircraft .... H
E9209-2 Alarm protector C
E9209-3 Temperature controller .... M
E9209-FC 45W Hybrid power amp .... F
E9210-1 Universal I/O Interface for PC (2 Sided) .... N
E2910-2 Rapid Fuse Checker .... E
E9210-3 Heartbeat/Audio Listener .... E
E9210-FC Wizards Hat .... E
E9211-1 Electronic Die .... E
E9211-FC Car Alarm .... F
E9212-1 Digital Circuit Tester .... F
E9212-2 Communications Link by RS232 L
E9212-FC Mains Inverter .... E
E9301-2 Fading Festoonery .... G
E9301-FC Infra Red Receiver .... F
E9302-1 EPROM Programmer (2 Sided) .... N
E9302-2 Sound to MIDI Board L
E9302-3 Puddle Tec .... E
E9302-4 DiscoAmiga Light Selector .... H
E9302-FC Infra Red Transmitter .... E
E9303-1 Ni-Cd Battery Charger .... E
E9303-2 IC Tester .... E
E9303-3 Disco Amiga (motor driver board) .... H
E9303-4 Direct Conversion Reciever (2 Sided) .... N
E9303-FC LED Stoboscope .... F
E9304-1 Solo Mic Pre-Amplifier .... F
E9304-2 Multimate Tester C
E9304-3 The Keepsafe Alarm .... F
E9304-4 Proving Unit .... E
E9304-5 Infra Guide Receiver Module C
E9304-6 Infra Guide Transmitter .... F
E9304-FC (AutoMate) Peak Program Meter .... F
E9305-1 Pentacode Main Board .... F
E9305-2 Pentacode Relay Board .... F
E9305-4 Vibration Detector .... D
E9305-FC The Fuzztone .... E
E9306-1 Graphic Equaliser .... F
E9306-2 Super Spooker .... D
E9306-3 Middle & Side Stereo Coding .... H
E9306-FC The Chaperon .... F
E9307-1 Car Battery Tester (Double Sided - Surface Mount) .... E
E9307-2 Mind Trainer .... F
E9307-FC Microwave Monitor .... F
E9308-1 Window Monitor (4 Boards) .... K
E9308-2 Alternative 12V Supply .... M
E9308-3 Single Channel Lumitec .... E
E9308-4 Four Channel Lumitec .... H
E9308-FC Twi-light Zone .... F

ETI PCB Service, Reader's Services, Argus House, Boundary Way, Hemel Hempstead HP2 7ST

Please Supply:

Quantity	Ref No.	Price Code	Price	Total Price
	E		£	£
	E		£	£
	E		£	£
			Post & Packing	£ 0.75
			Total Enclosed	£

Please send my PCBs to:

Name ....

Address ....

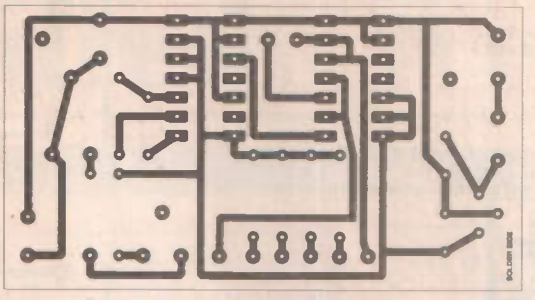
....

.... Postcode ....

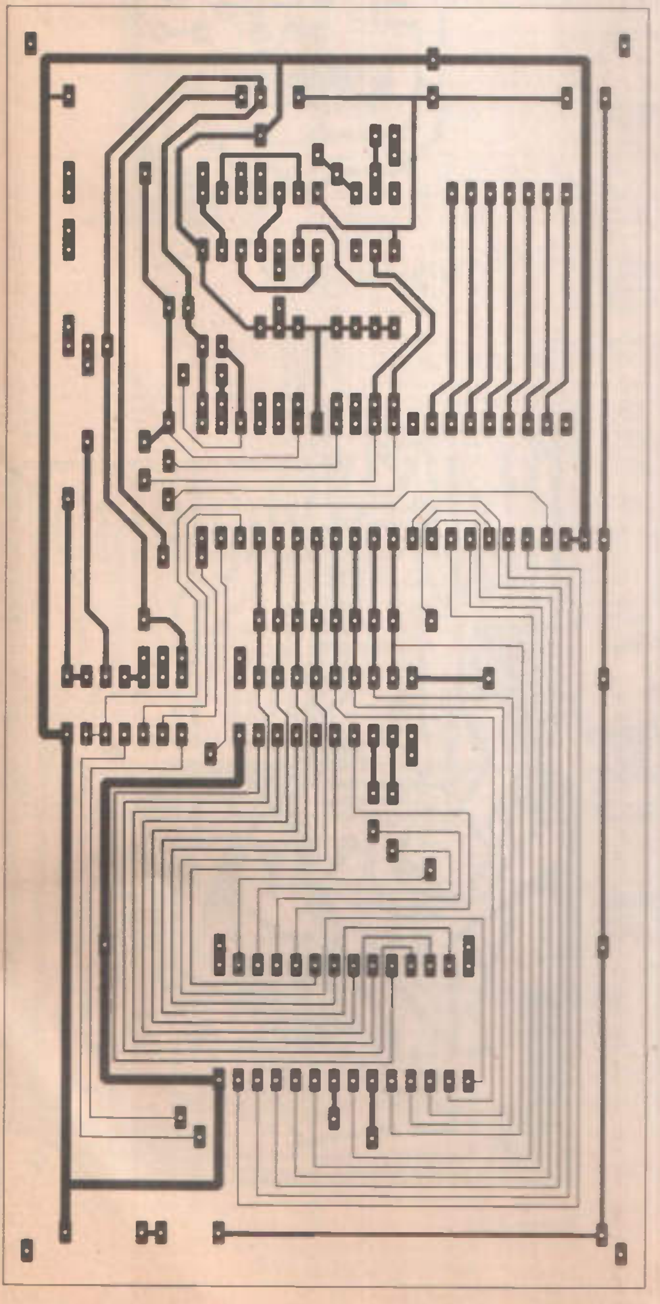
CHEQUES SHOULD BE MADE PAYABLE TO ASP.

PCB Foils

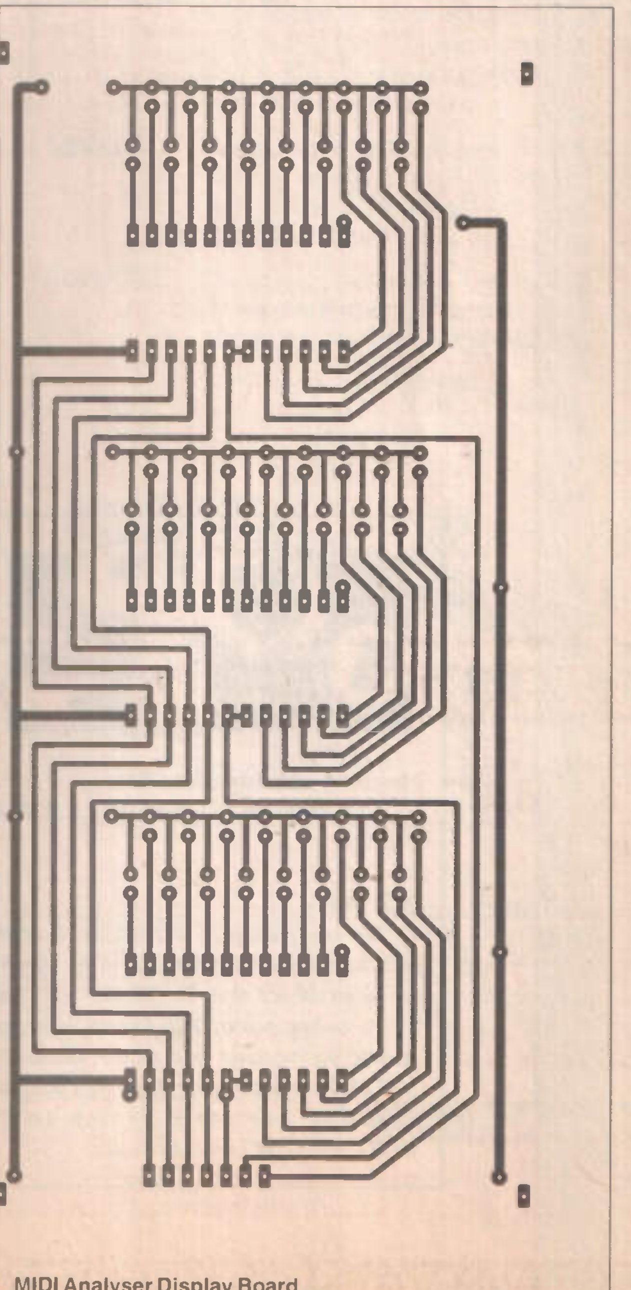
The PCB foil patterns presented here are intended as a guide only. They can be used as a template when using tape and transfer for the creation of a foil.



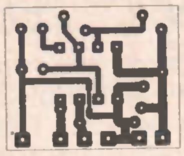
Capacitance Meter



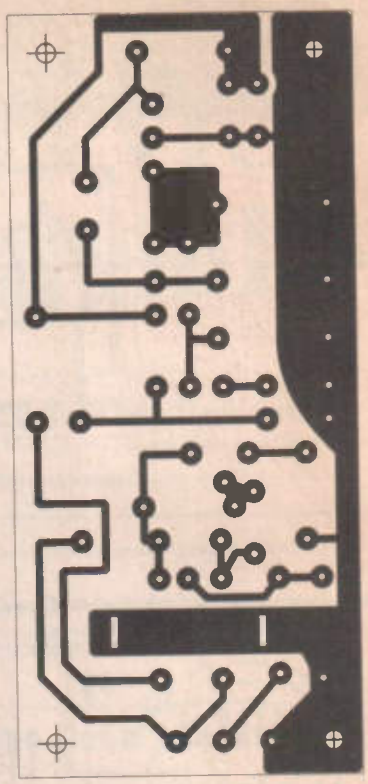
MIDI Analyser CPU Board



MIDI Analyser Display Board



Flashing Beacon for Remote Control



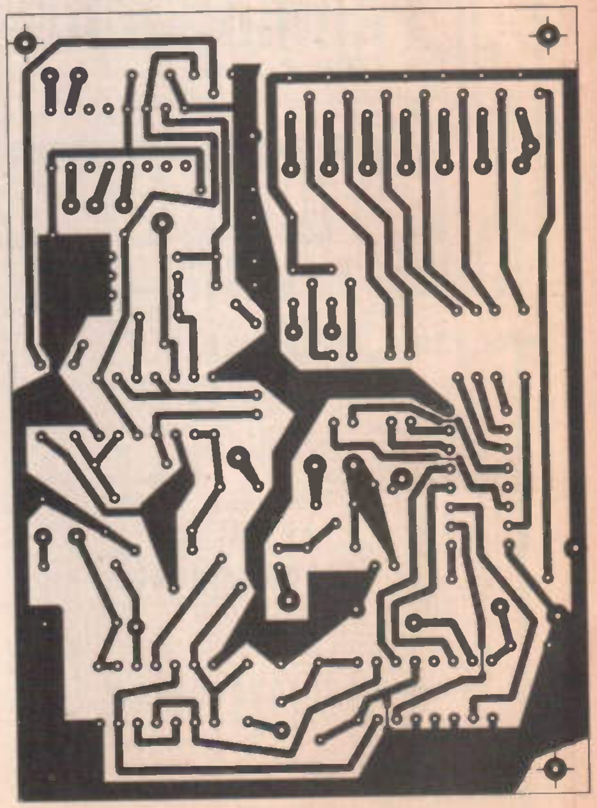
RF Signal Generator

Microwave Monitor July '93

In the Parts List, IC1 should be CA3130 not CA3103.

PCB Foils

The June Foil page showed the incorrect sides for the lower (solder side) of the Graphic Equalizer board and the Middle and Side Stereo coding board. The August issue also showed an incorrect side to the Alternative 12V PSU. Anyone using these as a template for making their own PCBs must use the 'mirror reflection' of these images.



Metronome

ETI Classified

James Gale 0442 66551

Send your requirements to:
ETI Classified Department, ASP, Argus House, Boundary Way, Hemel Hempstead, HP2 7ST
Lineage: 60p per word (+ VAT) (minimum 15 words)
Semi display: (minimum 2.5cms)
£8.00 + VAT per single column centimetre } Per Insertion
Electromart £24.00 (+ VAT) } Per Insertion
Ring for information on series bookings/discounts.
All advertisements in this section must be prepaid.
Advertisements are accepted subject to the terms and conditions printed on the advertisement rate card (available on request).

VISA · Access

FOR SALE

VALVE SOUNDS! 6 valve 15 watt amplifier, 3 Gaines, base, treble, unboxed transformer and accessorie supplies. X-professional projector: heavy! £19.00 + carriage. M.W. Jarvis, 6 Peggy's Mill Road, Edinburgh EH4 6JY.

PLANS

ELECTRONIC PLANS. laser designs solar and wind generators high voltage teslas surveillance devices pyrotechnics and computer graphics tablet 150 projects For catalogue SAE to Plancentre Publications Unit 7 Old Wharf Industrial Estate Dymock Road Ledbury Herefordshire HR8 2HS

For KITS & COMPONENTS

Choose the easy way with TK

Send £2.00 for CATALOGUE

ORDERS: RING 081-579-9794 - 24 HRS.

MICROPROCESSOR TIMER KIT

Designed to control 4 outputs indepenently switching on and preset times over a 7-day cycle.
LED display of time and day, easily programmed via 20 way keyboard. Ideal for central heating control including different swithing time for weekends. Battery back-up circuit. Includes box. 18 time settings.

CT6000K £65.95
XK114: Relay kit for CT6000, includes PCB, connectors and one relay. Will accept up to 4 relays. 3A/24oV c/o contacts £10.50
701 312 Additional relays £1.60

COMPUTERS

COMPUTERS
LOW COST SYSTEMS
286's FROM £449
386's FROM £489
486's FROM £545

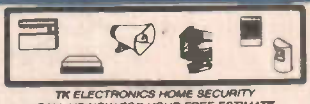
All low cost systems include: Mono VGA Monitor, 1MB RAM, 42 MB Hard Drive Mini Tower or Desktop Case, 3.5 Inch 1.44MB Floppy Disk Drive, 2 Serial, 1 Parallel, 1 Games, 102 Enhanced KeyBoard, Three Year Warranty (first year parts & labour, then labour only).

HOME CONTROL CENTRE

XK128 SUPER-SENSITIVE FM MICROBUG

FM transmitter measuring only 46x26x16mm, including built-in microphone. Frequency 88-93MHz enabling reception on a standard domestic FM radio. Range approximately 300m, depending on terrain. Powered by 9V PP3 (7mA). Its small size and highly sensitive electret microphone makes it ideal for surveillance, baby alarm, etc.
.... £10.25

SECURITY EQUIPMENT



TK ELECTRONICS HOME SECURITY
CALL US NOW FOR YOUR FREE ESTIMATE

HIGH.TEC

EEPROM CARDS NOW AVAILABLE

COMMUNICATIONS

PRIVATE MOBILE RADIOS AND ACCESSORIES

DISCO LIGHTING KITS

XK141: SEQUENCER. four channel chaser with 32 different sequence patterns £29.95
XK 130: STROBOSCOPE designed to produce a high intensity light pulse, Built in Audio Trigger £21.85
XK153: Extra - Highpower strobe... as above but more powerfull £25.85
DL3000K - 3-channel sound to light kit features zero voltage switching, automatic level control and built-in microphone 1kW per channel £24.95

VERSATILE REMOTE CONTROL KIT

This kit includes all components (+ transformers) to make a sensitive IR receiver with 16 logic output (0.15V) which with suitable interface circuitry (relays, triacs, etc - details supplied) can be used to switch up to 16 items of equipment on or off remotely. The outputs may be latched (to the last received code) or momentary (on during transmission) by specifying the decoder IC and a 15V stabilised supply is available to power external circuits. Supply: 240V AC or 15-24V DC at 10mA. Size (excluding transformer) 9 x 4 x 2cms. The companion transmitter is the MK18 which operates from a 9V PP3 battery and gives a range of up to 60ft. Two keyboards are available MK9 (4-way) and MK10 (16-way), depending on the number of out-puts to be used.

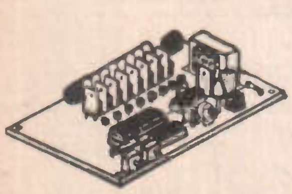
MK12 IR Receiver (incl. transformer) £24.95
MK18 Transmitter £12.75
MK9 4-Way Keyboard £6.35
MK10 16-Way Keyboard £12.75
601 133 Box for Transmitter £3.10

8 WAY SEQUENCER KIT

DON'T CHASE AROUND FOR ANOTHER SEQUENCER

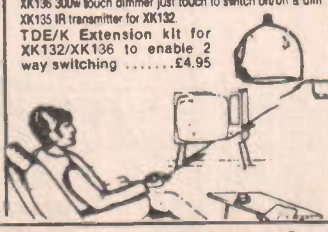
The DL8000K is an 8-way sequencer kit with built in opto-isolated sound to light input which comes complete with a pre-programmed EPROM containing EIGHTY - YES 80! different sequences including standard flashing and chase routines. The kit includes full instructions and all components (even the PCB connectors) and requires only a box and a control knob to complete. Other features include manual sequence speed adjustment, zero voltage switching, LED mimic lamps and sound to light LED and a 300W output per channel.
And the best thing about it is the price.

ONLY £49.95



HOME LIGHTING KITS

These kits contain all necessary components and full instructions & are designed to replace a standard wall switch and control up to 300w of lighting.
See XK132 300W touch dimmer - IR remote control
XK136 300w touch dimmer just touch to switch on/off & dim
XK135 IR transmitter for XK132.
TDE/K Extension kit for XK132/XK136 to enable 2 way switching £4.95



ELECTRONICS
13 BOSTON RD.
LONDON W7 3SJ
TEL. 081 579 9794
FAX: 081 840 6519

SEND £2.00 FOR CATALOGUE OR CALL AT SHOP
Mon-Sat 9.30-6.00

ORDERING INFORMATION:

P&P:- UK £1.25 Europe & Eire £3.60. Elsewhere £10.00
(unless otherwise notified)
Barclaycard/Access No. with order.

LOCAL AUTHORITY AND EXPORT ORDERS WELCOME
GOODS BY RETURN SUBJECT TO AVAILABILTY

FOR SALE

PC TECHNICAL SHAREWARE

Would you like to see the best range of low cost technical and scientific public domain & shareware for IBM PC in the UK? HUGE RANGE includes:- PACKET, FAX, RX/TX control, PCB design, Circuit and ANTENNA analysis, QSO logging, CAD ELECTRONIC & MECH engineering, SCIENTIFIC, MATHS & STATS, MEDICAL, PROGRAMMING, SOURCE CODE, DATA, EDUCATIONAL, WINDOWS, BUSINESS and lots more

Write, phone or fax today for your free 124 page printed catalogue

The Public Domain Software Library
Winscombe House, Beacon Road,
Crowborough, Sussex TN6 1UL
Tel 0892 663298, Fax 0892 667473

!!!! ON OFFER THIS MONTH !!!!

Red Super Led 5mm	15p	Crystal Earphone	65p
IR Receiver	20p	Neon Bulb	
0.1uF X rated	65p	25OAC	15p
0.1 Poly	5p	BD332 PNP Darl	40p
33uF 16v RAD	10p	BC639 100V 1A	30p
47uF 35v RAD	10p	LM337 VREG	45p
4.7uF 16v RAD	10p	LM7924 VREG	45p
2.2uF Non Pol	30p	2718 Eprom	£10.00
25OuF 16v RAD	10p	2732 Eprom	£1.65
27OOpF 1% Tol	10p	Contact Restorer	£1.25
Contact Cleaner	£1.25	2pf-10pf Trim	40p
Flux-Off	£1.25	Tilt Switch	£1.00
2pf-26pF	65p	4Way Tilt SW	£2.95
IN4001	6p	5 Watt 300 OHM	10p
47uF 350v DC	45p	20Ouf 300V DC	65p
74H075	30p		
Crystal 45Mhz	40p		

STRIP OF ASSORTED COMPONENTS 1M LENGTH £1.

WIDE RANGE OF ELECTRONIC COMPONENTS ALWAYS IN STOCK RING FOR DETAILS

- FM TRANSMITTERS ALSO IN STOCK -

ELEY ELECTRONIC LTD
100-104 BEATRICE ROAD, LEIVESTER, LES 9FF
TEL: 0533 515944
PAY BY:- VISA/ACCESS
OPEN 10-6 MON-SAT

SELL YOUR PRODUCTS HERE TEL. JAMES ON 0442 66551

THE AFFORDABLE COMMUNITY BROADCAST MIXING DESK ELEGANT IN STYLE SOUND AND QUALITY THE NO SQUARE BOX LOOK

MANUFACTURERS OF MIXERS AND AUDIO EQUIPMENT SINCE 1951

TRIED AND PROVEN PRODUCTS

EVERY PART OF THIS FULLY MODULAR MIXER AVAILABLE SEPARATELY IN KIT FORM OR TESTED SUB UNITS FOR DESIGNER CONSTRUCTORS CLIENT DESKS

VISIT OUR WORKING STUDIO AND TEST DRIVE THIS DESK
PHONE: 0268 793256

☆ Uncluttered Operational Area
☆ Presenter Designed Layout
☆ Full remote Control Facilities
☆ The Low Profile User Friendly

PARTRIDGE ELECTRONICS

WORKS: UNIT D, 318 HIGH ROAD BENFLEET, ESSEX SS7 5HB

A.C. PARTRIDGE LTD.
PHONE: 0268 793381 FAX: 0268 565759

ELECTROMART

LIVERPOOL

PROGRESSIVE RADIO

87/93 Dale Street
Tel: 051 236 0982 051 236 0154

47 Whitechapel
Tel: 051 236 5489
Liverpool 2

'THE ELECTRONICS SPECIALISTS'

Open: Tues-Sat 9.30-5.30

L.F. HANNEY

Your Electric Component Specialist for Avon, Wilts & Somerset.

77 Lower Bristol Road, Bath, Avon.
Tel: 0225 424811

FAX YOUR ADVERT ON 0442 66998

COURSES

Start training now for the following courses. Send for our brochure — without obligation or Telephone us on 0626 779398

ETI 9/93

Name ____________________

☐ Telecomms Tech C&G 271
☐ Radio Amateur Licence C&G
☐ Micro-processor
☐ Introduction to Television

Radio & Telecommunications Correspondence School
12 Moor View Drive, Teignmouth, Devon TQ14 9UN

ETI

ELECTRONICS TODAY INTERNATIONAL
CLASSIFIED ADVERTISEMENT DEPARTMENT
ARGUS HOUSE, BOUNDARY WAY, HEMEL HEMPSTEAD HP2 7ST

Rates: Lineage 55p per word + VAT minimum 15 words.
Semi-display £14.00 per single column cm plus VAT. No reimbursement for cancellations. All ads must be pre-paid.

Name ....

Address ....

.... Daytime Tel. No: ....

Signature .... Date ....

PLEASE DEBIT MY ACCESS/BARCLAYCARD No. | | | | | | | | | | | | | | | | Expiry Date ....

☐ **FOR SALE** ☐ **COMPONENTS** ☐ **PLANS** ☐ **OTHERS STATE**

ETI
ELECTRONICS TODAY INTERNATIONAL

EDITORIAL
Editor ***Paul Freeman***
Sub Editor ***Jim Bluck***

CREATIVE
Art Editor ***Peter Kirby***
Designer ***Iain Houston***
Technical Illustration ***John Puczynski***
Photography ***Manny Cefai***

ADVERTISEMENT SALES
Display Sales
Tony Hill
Advertisement Copy Control
Marie Quilter
Classified Sales
James Gale

MANAGEMENT
Managing Director
Terry Pattisson
Circulation & Promotions Manager
Debra Stupple
Production Manager
Tony Dowdeswell
Group Editor
Stuart Cooke
Group Advertisement Manager
Claire Jenkinson

ABC CONSUMER PRESS

ISSN 0142-7229

● Subscription rates...UK £23.40 Europe £29.50 Sterling Overseas £31.00 US Dollars Overseas $56.00

Published by Argus Specialist Publications, Argus House, Boundary Way, Hemel Hempstead HP2 7ST. Telephone (0442) 66551. UK newstrade distribution by SM Distribution Ltd, 6 Leigham Court Road, London SW16 2PG. Telephone 081-667 8111. Overseas and non-newstrade sales by Magazine Sales Department, Argus House, Boundary Way, Hemel Hempstead, HP2 7ST. Telephone (0442) 66551. Subscriptions by Argus Subscription Services, ETI, Queensway House, 2 Queensway, Redhill, Surrey RH1 1QS. US subscriptions by Wise Owl Worldwide Publications, 4314 West 238th Street, Torrance, CA90505 USA. Telephone (310) 375 6258. Typesetting and origination by Ebony, Liskeard, Cornwall. Printed by Wiltshire Ltd. Bristol.

AN ARGUS SPECIALIST PUBLICATION

Argus House, Boundary Way,
Hemel Hempstead HP2 7ST
Telephone (0442) 66551 Fax (0442) 66998

Next Month

Test equipment has always been popular with constructors and next month we feature a simple but very effective continuity tester for construction. To help you on your way, we give the PCB away for this on our front cover.

A moving message display from an LED matrix can provide an effective way to convey messages to people at a distance. The Electronic Picture will also provide entertainment in the form of illuminating pictures, the informational content being only limited by your creativity.

Giving the impression that there is somebody always in residence in a house even, when it is empty, is a good deterrant to would-be burglers. The 'Home Monitor' will switch your house-lights on and off at predetermined times.

It's a long time since we have presented a basic transistor amplifier design and so we rectify that in the next issue.

Finally, we feature a review of a selection of currently available PCB design software systems.

The October edition of **ETI** will be on sale **3rd September.**

The above articles are in preparation but circumstances may prevent publication

LastMonth

Our August issue featured:

Window Monitor
Transformerless Power Supplies
Brake Lights for Radio Control
Measuring Light Spectra
Lumitec
AutoMate Mixer
Twi-light Zone
Alternative 12 Volt Supply

Back issues can be obtained from Argus Subscription Services. Address in column to left.

ADVERTISERS' INDEX

ABI	10	JAYTEE ELECTRONICS	11
BADGER BOARDS	43	JPG	10
BK ELECTRONICS	17	MAPLIN ELECTRONICS	OBC
BONEX	14	NUMBER ONE SYSTEMS	57
CP TECHNOLOGY	21	OFFTRON	11
CANAL BRIDGE AUDIO	59	OMNI ELECTRONICS	21
DISPLAY ELECTRONICS	46	PICO TECHNOLOGY	15
ELECTROMAIL	IBC	RN ELECTRONICS	43
EQT	21	SEETRAX	38
HALCYON ELECTRONICS	10	TSIEN (UK) Ltd.	IFC
HESING TECHNOLOGY	21	WILMSLOW AUDIO	10
J&N BULL	44,45		

MECHANICAL • COMPONENTS • EQUIPMENT •
ELECTROMAIL