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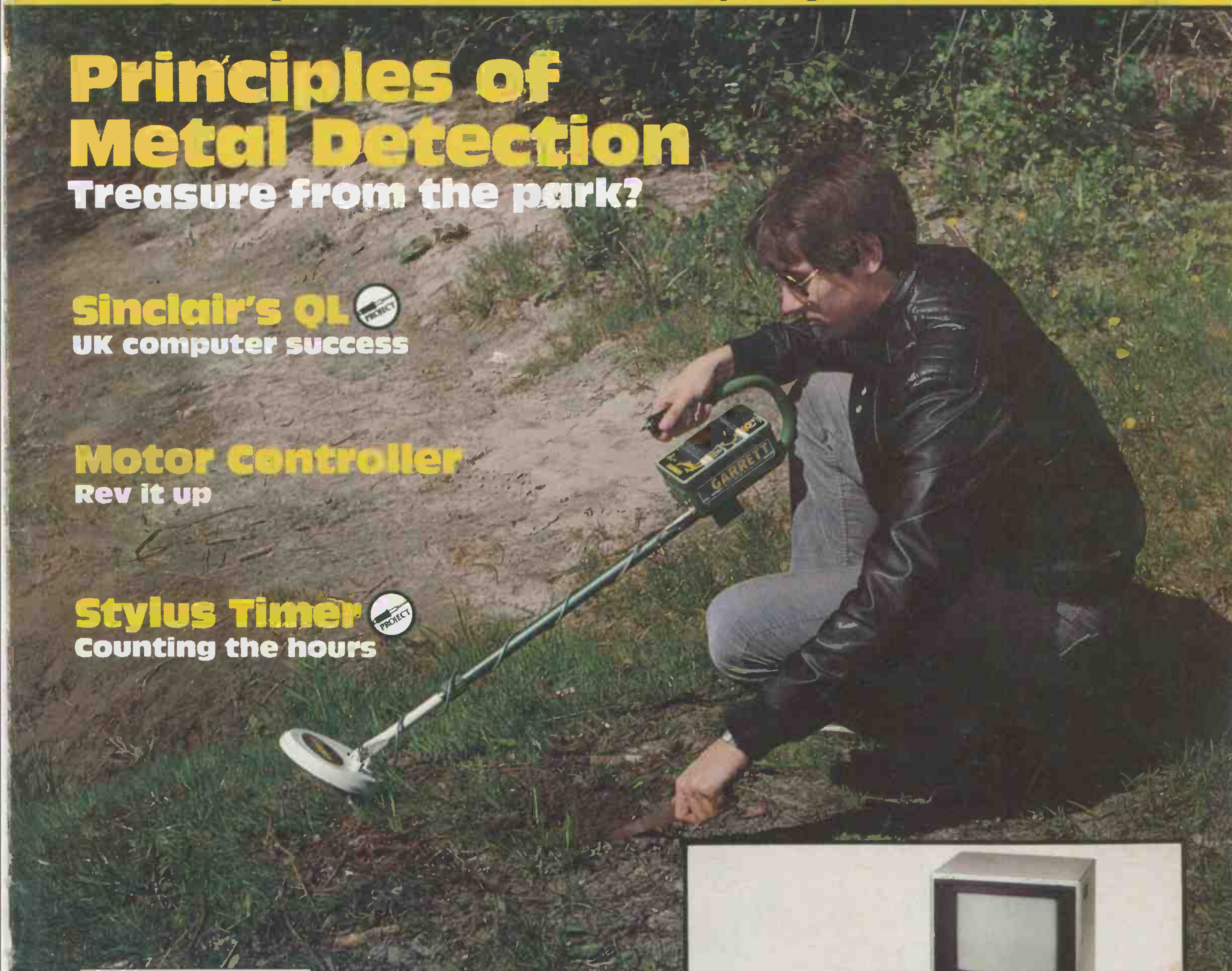
July 1984

Super Timer

Canada's Magazine for Electronics & Computing Enthusiasts



Principles of Metal Detection
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Computer Review
Sony SMC-70

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Electronics Today INTERNATIONAL

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July 1984 Vol. 8. No. 7 ISSN 07038984

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Projects

Columns, News and Information

Our Cover

Visions of treasure dance in Ed's head; see page 11. Photo by Bill Markwick. The Sony SMC-70 is reviewed on page 32; photo courtesy of Sony.

Electronics Today is Published by:
Moorshead Publications
Editorial and Advertising Offices
Suite 601, 25 Overlea Boulevard,
Toronto, Ontario, M4H 1B1
Telephone (416) 423-3262

Editor: **William Markwick**
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Circulation Manager: **Lisa Salvatori**
Advertising: **Omar Vogt**, **Rick May**
Advertising (Que.): **John McGowan & Associates (514) 735-5191**

Publisher: H.W. Moorshead; **Executive Vice-President:** V.K. Marskell; **General Manager:** S. Harrison; **Controller:** B. Shankman; **Accounts:** P. Dunphy; **Reader Services:** C. Wyatt, S. Halladay, H. Brooks, K. Adams; **Advertising Services:** C. Zyvitski, **Dealer Services:** A. Nagels.

Newsstand Distribution:
Master Media, Oakville, Ontario

Subscriptions
$19.95 (one year), $34.95 (two years). For US add $3.00 per year, other countries add $5.00 per year. Please specify if subscription is new or a renewal.

Postal Information
Second Class Mail Registration No. 3955. Mailing address for subscription orders, undeliverable copies and change of address notice is:
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Component Notation and Units
We normally specify components using an international standard. Many readers will be unfamiliar with this but it's simple, less likely to lead to error and will be widely used everywhere sooner or later. ETI has opted for sooner!
Firstly decimal points are dropped and substituted with the multiplier: thus 4.7uF is written 4u7. Capacitors also use the multiplier nano (one nanofarad is 1000pF). Thus 0.1 uF is 100nF, 5600pF is 5n6. Other examples are 5.6pF = 5p6 and 0.5pF = 0p5.
Resistors are treated similarly: 1.8Mohms is 1M8, 56kohms is the same, 4.7kohms is 4k7, 100ohms is 100R and 5.6ohms is 5R6.

PCB Suppliers
ETI magazine does NOT supply PCBs or kits but we do issue manufacturing permits for companies to manufacture boards and kits to our designs, Contact the following companies when ordering boards.

Please note we do not keep track of what is available from who so please don't contact us for information on PCBs and kits. Similarly do not ask PCB suppliers for help with projects.

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Spectrum Electronics, 14 Knightswood Crescent, Brantford, Ontario N3R 7E6.

Franklin CX Series

Franklin Computer of New Jersey has unveiled their new four-model CX line of computers. The biggest feature is compatibility with various operating systems — the top-of-the-line 2M, for instance, can run Apple DOS, CP/M, and MSDOS; it also can read Kaypro and Osborne formats. Other features are one or two DSDD drives, business software by Artsci, a minimum of 64K RAM, and a seven inch monitor. Available in Canada shortly, the U.S. models start at $1,395.

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Cesco Electronics, 4050 Jean Talon W., Montreal, Que. H4P 1W1 (514) 735-5511, has a new catalogue of components and accessories; it's free by phoning, writing, or visiting. There are branches in Quebec City, Ottawa, and Toronto.

IBM has announced the success of an experimental one-megabit memory chip. It uses IBM's silicon-aluminum-metal oxide process (SAMOS), and operates from a single 5 volt supply. Access time is 150 nanoseconds. No mention was made of availability or price, but the prototypes were made on the same production line as their 64K-bit chips, so it shouldn't take too long to hear more about them.

Speaking of IBM, they have filed a lawsuit against Spirales Computers of Montreal; they're seeking an injunction to prevent the importing and marketing of a Taiwanese computer which IBM says is infringing their copyright. Cloners beware.

Electronic Packaging Systems announced yet another dealer for their line of BICC Vero hardware: Montcalm Electroniques Inc., 97 Boul. des Laurentides, Ville de Laval, Quebec H7G 2T2.

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Spud

Shamrock Computer Inc. has announced the introduction of the Shamrock professional Utility Drive (SPUD).
Shamrock Computer Inc. is a Canadian company which has been manufacturing disk drives for Apple and Apple compatible computers for over a year. The Shamrock SPUD 3.5" Apple II compatible disk drive, offering 328K storage on 80 tracks, was introduced at both the Ottawa High Technology and Toronto Computer Fair shows. The SPUD 3.5" drive plugs into the existing Apple controller card and is supplied with a menu driven 5-¼" utility diskette that allows users to configure their Apple II system and to copy their existing 5-¼" software onto the more convenient 3.5" plastic-encased diskettes. Contact them at 89 Telson Rd., Markham, Ont. L3R 1E4 (416) 474-0113.

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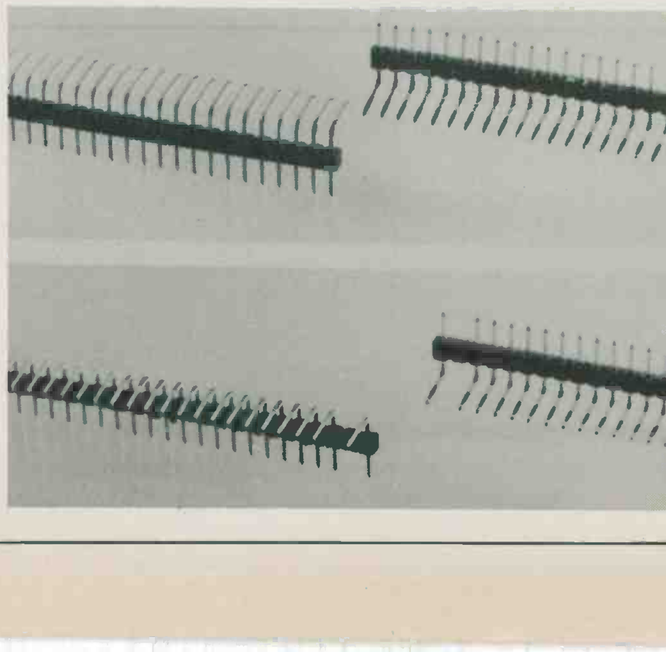

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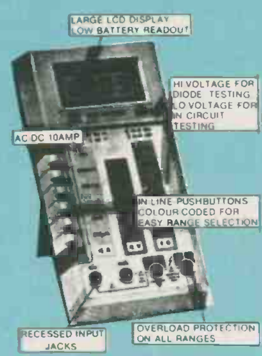

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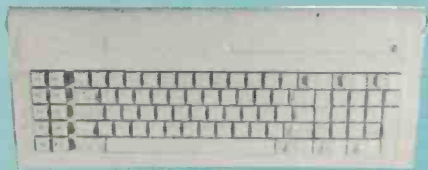

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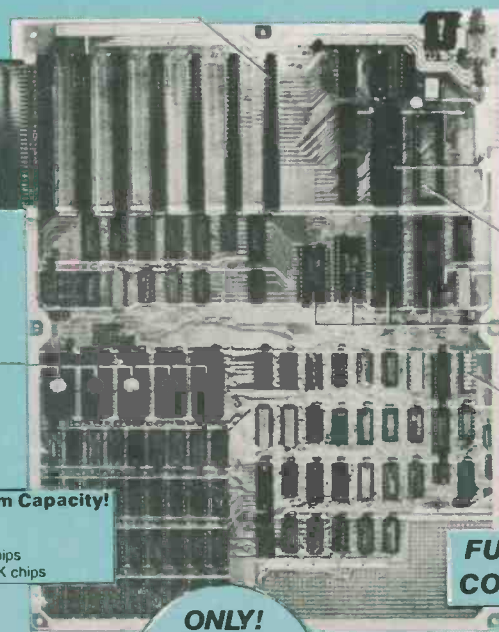

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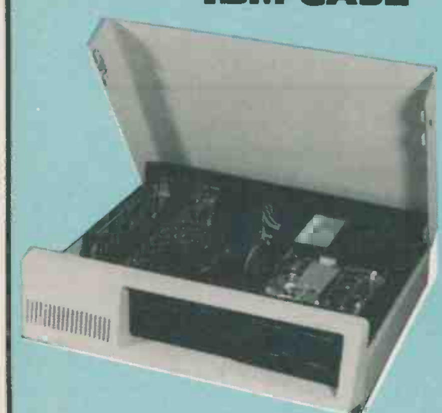

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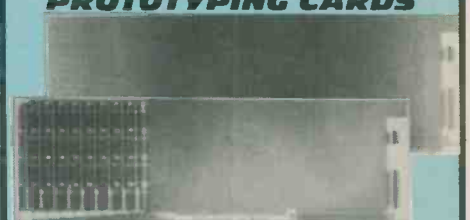

(A) WIRE WRAP ONLY CARD. An ideal card for high density wire wrap work. There are WW holes everywhere with a DB-25 and a DB-9 Footprint at one end 29.95

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Circle No. 8 on Reader Service Card

Olivetti Portable

The M10 is based on CMOS technology and uses the 80C85 processor. Standard interfaces include a parallel printer port, an RS232 (up to 19200 baud), integrated modem, cassette and bar code reader interface. The liquid crystal display (LCD) tilts to a thirty degree angle for optimum viewing while leaving the keyboard at a proper angle for typing. The M10 is even further enhanced by a complete library of software which includes spreadsheets, databases, order entry, word processing, sales management, Forth, assembler etc. For further information, contact: Patricia Smith, Olivetti Canada Limited, 1390 Don Mills Road, Don Mills, Ontario, M3B 2X3 (416) 447-3351.

Circle No.56 on Reader Service Card

Hi-tech Mouseketeer

Will Walt Disney Productions reinstate the famous Mickey Mouse Club? And will they be using, as this photo suggests, a microprocessor-controlled, servo-operated, 256K, MS-DOS compatible mouse hat? We leave this to the reader's speculation.

TVRO Filter

Terrestrial interference Trap 4616-60/80 incorporates a 60 MHz trap and 80 MHz trap, both switchable in and out.

The trap may be used as a diagnostic tool during installation or as a receiver accessory to optimize reception channel by channel. Impedance is 75 ohms and connectors are type F. Notch loss is 20 db minimum and 3 db bandwidth is approximately 4 MHz. Each notch is frequency tunable ± 5 MHz to compensate for nominal downconversion error. For more information contact Emily Bostick, Microwave Filter Company, Inc., 6743 Kinne St., East Syracuse, NY 13057.

Circle No.55 on Reader Service Card

Who is the Tradeport Electronics Group? Well, they're a new manufacturer's rep, located at 1179 Finch Ave. W., Downsview, Ont., M3J 2G1 (416) 736-0866. They represent all sorts of electrical and electronic measuring instruments, training devices, and R&D equipment, especially hard-to-locate firms from Europe: Black Star, Radford, Ferrograph, ITT France, Grundig, etc.

Circle No.51 on Reader Service Card

Multitech PC/XT

Following the introduction of the MPF-PC in November 1983, Multitech announces its latest addition to the company's MPF line of IBM PC compatible computers. The MPF-PC/XT features an integrated 10 megabyte fixed disk drive. Backing up the Winchester hard disk drive is a 360 KB capacity floppy disk drive, facilitating new program entry and copying of data files. The MPF-PC/XT also provides a standard 128K bytes of RAM expandable on board to 256K bytes, dual serial communication ports, one parallel port, monochrome/color graphics adaptor, five IBM compatible system expansion slots, and more. The suggested retail price of the MPF-PC/XT, including the monochrome video monitor, is U.S. $3,995. At Multitech dealers.

Circle No.54 on Reader Service Card

Comet Antenna

Mitsubishi Electric Corporation recently finished assembling a huge, 64-meter diameter antenna for observation of Halley's Comet. When completed in late October this year, it will be Japan's largest, and one of the world's largest, deep space probing antenna. Mitsubishi Electric is building the antenna for the Education Ministry's Institute of Space and Astronautical Science, which is in charge of the PLANET-A Project to observe Halley's Comet approaching the sun in 1986. The comet comes close to the sun every 76 years.

More on piracy: a Provincial Court in Calgary convicted a 26-year old gentleman on 50 counts of software piracy. He was duplicating commercial software from a flea market booth on a while-you-wait basis, at five to ten dollars a shot. Despite pleas from the software industry for a public hanging, the judge delayed sentencing. The case will no doubt set a legal precedent.

The Ferranti range of CM Series CO_2 waveguide lasers, RF or DC excited, covers the power rating from 1 watt to 30 watts and is intended for applications such as rangefinding, communications, beacons, velocimetry, laser surgery, in addition to a wide range of industrial applications such as cutting and welding of plastics, mask fabrication, engraving, etc. For additional information, please contact: EP Electronics International Inc., 187 Denison St., Markham, Ont. L3R 1B5, (416)475-8316.

Circle No.53 on Reader Service Card

The Ontario Government has a new catalogue — slightly used civil servants. No, but really, they've compiled a list of more than 900 Canadian producers of computers, word processors, components and software. It's available for $10.00 from the Ontario Government Bookstore, Publication Services, 5th Floor, 880 Bay St., Toronto, Ont. M7A 1N8 (416) 965-6015.

Circle No.52 on Reader Service Card

continued on page 66

Principles of Metal Detection

ETI looks at the history, techniques and uses of all kinds of metal detecting, from treasure-hunting to bomb disposal.

by Richard Turner

METAL DETECTION is a subject seldom mentioned in electronics journals, but recently it has attracted much attention in the daily press. Detectorists have been featured on many a front page with their finds of explosives or buried treasure, and perhaps even more while assisting the police in searches for weapons in some very controversial murder cases. However, metal detection has been around for about ten decades now and has been used for a very wide range of applications, and thus should be of interest to electronics enthusiasts.

Histories

While for hundreds of years treasure seekers and prospectors have used devices such as divining rods, magnetic needles and a variety of "doodlebugs" to aid their searches, it was not until 1879 that the first practical, scientifically proven instrument was built. The credit for this dicovery goes to Professor D.E. Hughes, who demonstrated his 'Induction Balance' to the Royal Society in that year.

The Induction Balance attracted a great deal of interest among the scientists of the day, including the Chief Chemist of the Royal Mint who acquired one of the first units for the assaying of coins. Alexander Graham Bell applied the Induction Balance to the location of an assissin's bullet in the body of American President James Garfield.

This 'electric' metal detection had a good scientific start and it is worth examining in closer detail some of the many uses of the technology.

In Hughes' Induction Balance, a Leyden Jar supplied current to a microphone which was placed in contact with a ticking clock. Alternating current was achieved by a manually activated resonating spring contact assembly feeding two induction coils wound in opposition to each other. The pick up consisted of another pair of identical coils wired as a circuit with a further three coils and a telephone. This arrangement was adjusted for complete silence in the telephone. To 'detect' or 'analyse' metal, the sample was placed on the primary coils, thus disturbing the mutual induction so that sound was heard in the telephone. Then the indicating coil in the secondary circuit was moved along a scale marked in degrees until silence was obtained again. Different samples could be identified against a previously prepared chart. This instrument was sensitive to such a degree that coins of the same denomination, but with varying amounts of wear, could be distinguished from each other.

Another detection principle developed in Victorian days worked on 'Secondary Induction'. This involved a complex set-up but gave a considerable detection range. And indeed, when demonstrated at a Welsh metal mine at the turn of the century, it was found that metal ores could be detected up to three hundred yards away.

Briefly, the set-up was as follows: a battery supplied the primary current to a motorized contact breaker which 'chopped' it into a high frequency and fed the primary winding of a transformer, where the voltage was stepped up. The secondary output was fed to a pair of probes placed in the earth. A similar pair of probes placed some distance away fed another transformer to which there was connected a galvanometer. If there was no metal in between probles, the input signal would 'scatter' in all directions and the galvanometer would remain at zero. The presence of ores or large metal objects would attract the voltage fed into the ground, producing an indication on the meter.

Electronic Principles

With the advent of electronics, the transmit-receive technique was quite accidentally developed. During World War One, the military developed sound ranging and direction finding equipment. It was soon found that large masses of metal such as bridges, railways and ships at sea interfered with the equipment and much re-design was necessary for proper operation. However, the 'interference' turned out to be a benefit as this led to the development of metal detectors for sensing enemy submarines and tanks at a considerable distance.

In the post World War One years, the transmit-receive technique was used for electrical prospecting and forms the basis of most metal detectors today. The heterodyne principle found much favour in the late 1930s and was used extensively until about five years ago. A more recent innovation in metal detection technology operates on the DECCO principle which was developed at Oxford Archaeological Research Laboratory in 1966. *Decay of Eddy Currents in Conducting Objects* is now better known as pulse induction. Few people are aware of what an important function metal detectors perform for their wellbeing and comfort. Most and possibly all food and pharmaceutical products are passed through metal detectors to ensure there are no nuts, bolts, swarf, pins or other alien items in them. Medicines like pills and powders receive the same treatment. Shoes are tested for unwanted insole tacks and even such products as textiles, carpets and linoleum are passed through a metal detector before dispatch to the customer.

In quarrying and mining industries the burden is checked for tramp metal such as drill rods, dipper teeth, and pick and shovel ends to prevent damage to cutters and diamond tipped grinders. Most of the world's airports are equipped with 'walk through' metal detectors to combat the carrying of illegal weapons. Accurate location of pipes has to be known when mechanized road or trench digging takes place. Lumber jacks and tree surgeons screen trees to detect bracing tie bars, bolts or nails which may be covered by growth and thus prevent a danger to power operated saws. Reclaiming timber is very much a practice with DIY enthusiasts, but why risk damage to your electric plane or sander by nails etc, when a quick scan will save the expense of new plane blades or sanding strips?

Medical Applications

As already mentioned, Bell used the Induction Balance to detect a bullet in a human body, and ever since that time medical metal detection has flourished. In 1885 the Royal Army Medical Corps developed quite a different metal detector for locating bullets and shrapnel in wounded soldiers. During World War Two electronic metal detectors were developed in Britain (Barnato Joel Laboratories), Germany (Siemens Electric) and the USA (Waugh Laboratories). The European detectors used the heterodyne principle at VHF, while the American unit was an electronic version of Induction Balance.

Currently the world's most advanced medical and veterinary detectors are of British manufacture, the Rope-Hall locator for Opthalmic and Medical applications (Keeler Instruments) and Tektamet PI for veterinary use (Goring Kerr PLC). These high technology and patent protected detectors not only distinguish ferrous from non-ferrous metals but also indicate which metal is predominant. Thus the surgeon or vet has an instant indication as to what technique to use for extraction. If the metal is non-ferrous, a conventional cut and sew method would be employed, but a metal which has ferrous content can be removed by an electromagnetic extraction technique, eliminating surgery.

Treasure Seeking

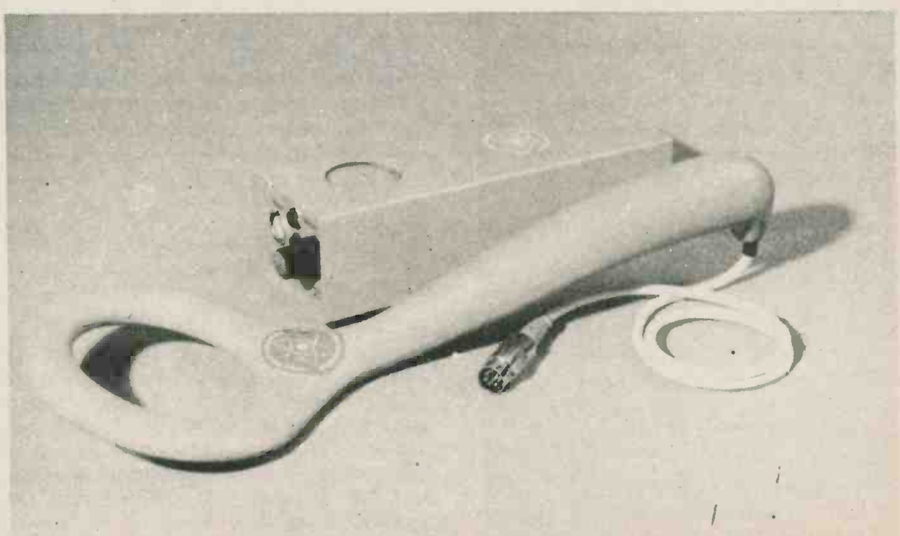
With the Royal Mint using the Induction Balance for the assaying of coins, it became apparent that this instrument could be adapted for the location of precious metals. Soon 'Buried Treasure Finders' were very much the fad of Victorian society, and were seen wandering about the countryside with very strange looking devices. However treasure hunting did not reach its peak until the early Twenties, when an Englishman by the name of Williams emigrated to Panama where he got a concession from the government to seek out the treasure concealed before the sacking of Panama City by the notorious pirate Captain Morgan.

Devising a transmit-receive metal detector capable of locating metals up to forty feet beneath the ground, he soon located cellars and secret tunnels packed with precious metals. Williams became very rich and his fame spread far and wide. Being a generous man he gave the plans for his metal detector to anybody who asked for it, and some of those ungrateful individuals even filed patents for it as their own invention. Thus with metal detectors being produced on a large scale, the rich with time on their hands once again took up the seeking of buried treasures. Most of them headed for the Cocos Islands where legend said that much treasure had been concealed by pirates. Franklin D. Roosevelt, a prominent lawyer, was one of the first to land, and even after he had become President of the USA he returned for another try. Malcolm Campbell, Admiral Nicholson and Commander Worlsey also led expeditions to the Cocos Islands.

Detectorists Today

However, pirate and legendary treasures are very much of a myth and today's detectorists take a much more practical view, seeking lost coins, jewellery and the like which has accumulated in the ground over the last two thousand years. Many previously unknown coins and artifacts have enriched our museums after being found in that way. Occasionally large hordes of coins are found.

Even wrecked ships can spread danger on the coasts, and an example of



The portable, belt-carried MD 199 can be used with a variety of probes. The one shown is a hand probe.

this was the wreck of *Aeolian Sky* which discharged its cargo of deadly cyanide canisters. In a situation like this a prompt search and recovery operation is required with metal detectors, as shifting sands and seaweed were quickly concealing the canisters. In this particular instance, the Detector Information Group (DIG) organized a search to assist Coastguards and Police, whose resources were stretched to the limit. This operation proved such a success that an annual beach clearance now takes place in May along the South Coast of England.

In the second half of this article, we shall take a closer look at the technical aspects of various detection techniques and brief specifications of commercial equipment. The block diagrams are in simplified form and show only the basic requirements for such detectors.

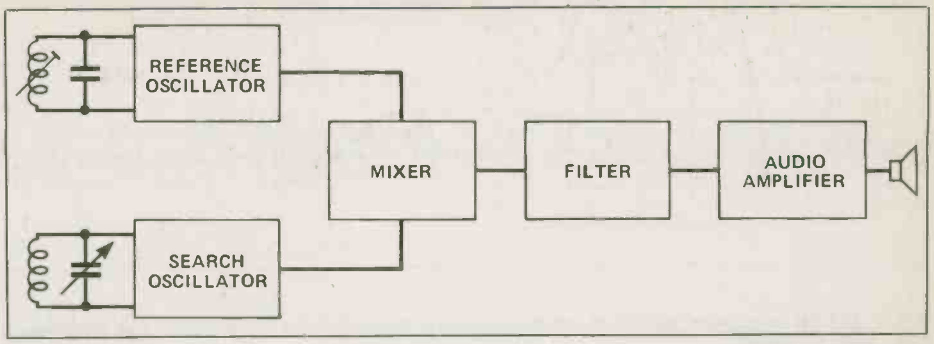


Fig. 1. A block diagram for a Heterodyne Principle (BFO) detector, the simplest type for a home constructor to design.

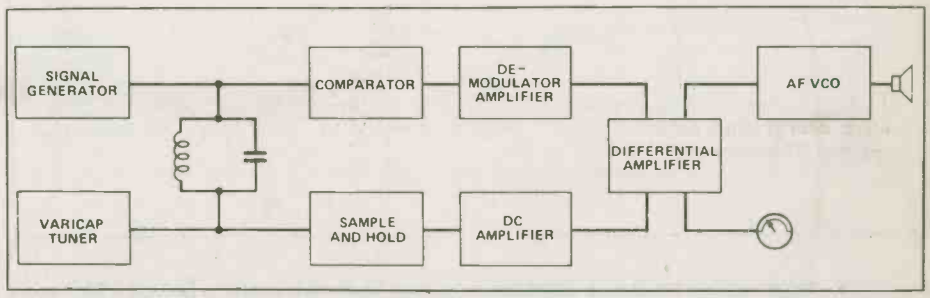


Fig. 2. The Off Resonance Descrimination System. Very selective, this method is favoured by "treasure hunters".

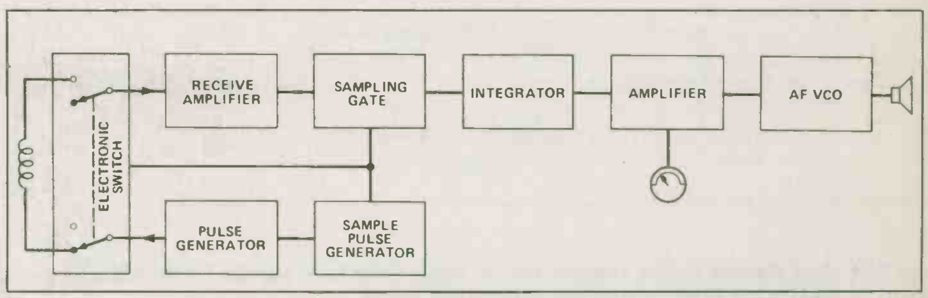


Fig. 3. The block diagram of a pulse induction system. This method uses the ability of metal objects to absorb and reflect electromagnetic radiation as eddy currents which can be detected.

Heterodyne (BFO) Principle

Of all the possible ways of detecting metal, the heterodyne principle is perhaps the best known. After all, most radios use BFO (Beat Frequency Oscillator), so the system is easily understood even by a layman. The technique is simple, economical and produces very satisfactory results. The detector can be constructed from readily available radio parts; if a search coil of small but intense field is required (for instance, for medical applications) a ready made ferrite rod aerial can be used!

For larger areas and deeper penetration, the search coil is usually wound in multilayers on a circular former although printed circuit coils are also known. On a detector with wide range tuning, it is possible to detect metal against a metallic background, for instance, copper pipe embedded in reinforced concrete.

Off Resonance Discrimination (ORD)

In this technique, the search coil is driven by a frequency which typically differs by about 3 dB from the natural resonant frequency of the tuned circuit. This arrangement automatically gives a very selective detection. If for instance a discriminating detector is required for non-ferrous metals, the signal generator is driven at a higher frequency, but for ferrous metals at a frequency which is below the natural resonant frequency of the search coil. Thus in "treasure hunting" applications, excellent rejection of unwanted objects (nails, bottlecaps etc.) is achieved while retaining good sensitivty to desirable finds of coins, jewellery and the like. The main drawback of the system is thermal instability, for instance, if the detector is kept in the trunk of a car during hot weather, the search coil alters its natural resonance, and the separation between the drive and natural frequency of the tuned circuit drifts so far apart that detection becomes difficult, if not impossible.

Pulse Induction System (P.I.)

This system differs from all the other methods as no oscillators or tuned circuits are required. Detection is achieved by the phenomenon of decaying currents in metal objects (DECCO). Thus a high amplitude short duration pulse is injected into the search coil, which emits electromagnetic radiation within its range. Soft objects such as soil or even aluminum foil allow the energy to penetrate and disperse while solid metals, especially magnetic metals, absorb and reflect this energy in the form of eddy currents which readily produce EMF in the search coil, generating a signal in the receive amplifier.

The main drawback of this principle is that Earth's magnetic field renders the detector oversensitive to ferro-magnetic metals. Although discriminating-type pulse detectors are now available, these do not provide such a good selection of desirable objects as continuous wave discriminators.

Induction Balance Method (IB)

This old and complicated, but most sensitive, detection principle requires several (or multitapped) search coils, and so is not exploited very much these days. However its sensitivity to precious metals is unsurpassed. As explained earlier in this feature, with a suitable arrangement even worn coins can be distinguished from new ones. This is achieved by phase-anti-phase magnetic fields which can be generated by

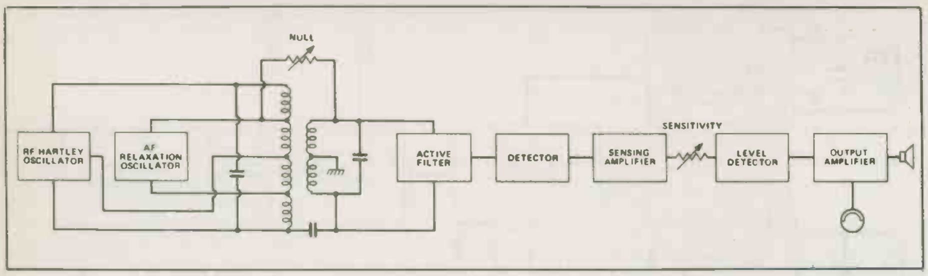


Fig. 4. Induction Balance, the oldest and most sensitive method of detection, is now not much used because of its complexity.

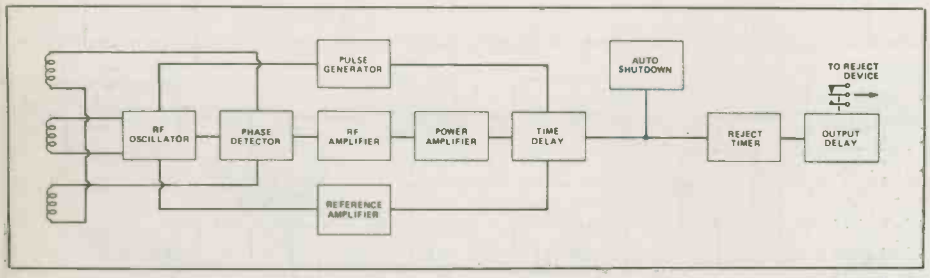


Fig. 5. The Balanced Coil method, a simplified version of Induction Balance, favoured for "production line" detectors because it is very sensitive at speed.

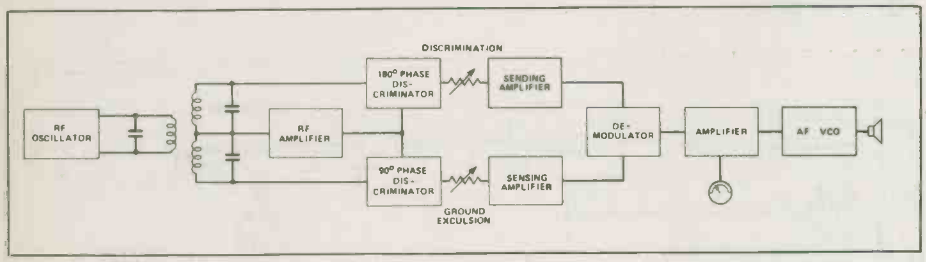


Fig. 6. A block diagram for the Transmit-Receive Radio Technique, popular for its simplicity and ability to discriminate between worthless and valuable metals.

complex coil arrangements, but energized by simple electronic circuitry with a very modest current consumption.

Balanced Coil Application (BC)

This is a simplified adaptation of the Induction Balance very much favoured by manufacturers of industrial detectors. And indeed the block diagram shows in simplified form an arrangement for a "feedthrough" conveyer type instrument. The search coils are usually of rectangular form wound in single layers, offering very high sensitivity. Typically a one millimetre metal sphere can be detected at a velocity of 40ft per minute through a 12 x 4in aperture.

The oscillator also initiates the pulse generator which is connected in a feedback circuit, thus offering a self checking function and automatically stopping the detector should a fault occur. If unwanted metal is detected, the reject timer allows the product to leave the search head and reach the rejection point where it is removed automatically from the conveyor belt.

Transmit-Receive Radio Technique (T-R)

This technique operates on true radio principles, and it can be seen why metal detectors come under the scope of Wireless Telegraphy Act. In early equipment (as already explained) the transmitter was quite a separate item from the receiver which could be placed a considerable distance away, offering very deep penetration. However in recent times the trend has been to combine both units into one case for compactness and portability. A simple sine wave oscillator drives a tuned circuit of a suitable frequency. A tuned search coil (or coils) feeds an RF amplifier to boost the incoming signal for the purpose of phase discrimination, eliminating unwanted signals from the ground (minerals etc.) and offering discrimination between unwanted objects and precious metals. Straightforward output ciruitry is employed. The simplicity of this technique makes it a very attractive proposition to manufacturers of 'hobby' type detectors which usually operate in the VLF spectrum.

Equipment Survey

To conclude this article, a survey is included of some commercially manufactured equipment manufactured in the UK. Each company has been limited to a maximum of five entries.

Some explanatory notes are worthy of inclusion as some readers may wonder, for instance, what is the difference between a hand and portable detector? A hand detector is a completely self contained one-piece unit whose total length does not usually exceed eighteen inches. However, headphones or earpieces may be supplied as optional extras. Portable units will have a separate search coil (or coils) or probes and electronics case, and can be in a shoulder-slung case or a hip mount design. Usually a range of optional extras are available, as in the case of medical detectors where even a reset foot switch is provided. A bench unit would be usually powered by mains and have a range of search probes for various applications.

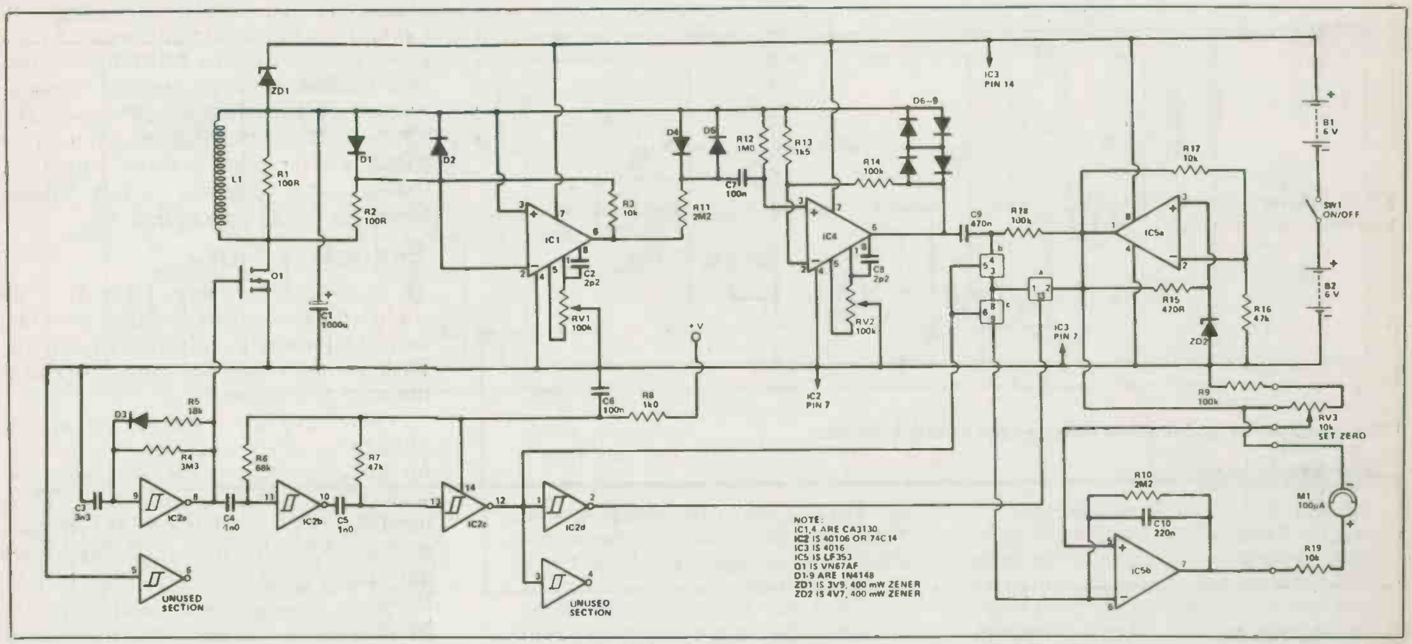
Walk Through, as its name suggests, is a weapons type detector and at least one company manufactures such a unit in a 'portable' version which can be folded up and transported in the trunk of a car! Hobby detectors are usually of one-piece construction with the search coil for ground searching mounted on an adjustable shaft which may be mounted on an electronics case. Some models are available in hip mount versions. This description also applies to underwater detectors. Conveyer type detectors are limited to industrial applications, and such detectors are available with search coils from about 1 inch diameter (for pharmaceutical applications) to 50 feet for textile industries.

ETI would like to thank Terry Cantin of The Midas Touch for his assistance in providing information and metal locators.

For further information:

The Midas Touch,
207 McRae Drive,
Toronto, M4G 1T4
(416) 421-4249

A Pulse Induction Metal Detector



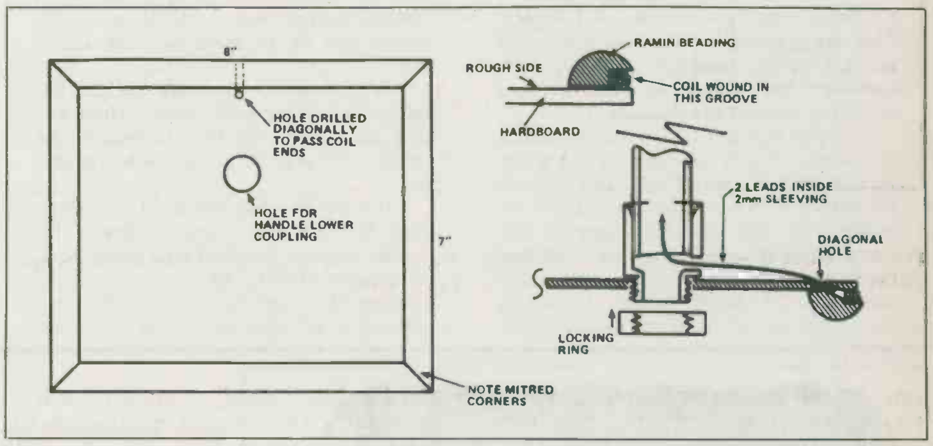
The schematic of a pulse induction type of metal detector.

HOW IT WORKS

Oscillator IC2a generates a positive pulse which turns on Q1, with the result that a current builds up in search coil L1. At the end of this pulse, Q1 is turned off and the voltage waveform shown below appears across the coil, and falls to zero in time X. If metal is near the coil, the voltage falls more slowly to zero (i.e., time Y). Operational amplifiers IC1 and IC4 amplify the coil voltage 10,000 times. Monostable multivibrators IC2b and c generate a second pulse, accurately timed after the first pulse, which is used to turn on an electronic switch (formed by IC3a,b and c) just as the coil voltage is reaching zero.

As metal approaches the coil, the voltage across it decays more slowly. Therefore, the pulses passed by the electronic switch get bigger.

Integrator IC5b amplifies and smooths the pulses from the electronic switch and drives meter ME1. The output voltage from the integrator thus increases as the coil approaches metal, and this is registered on the meter.

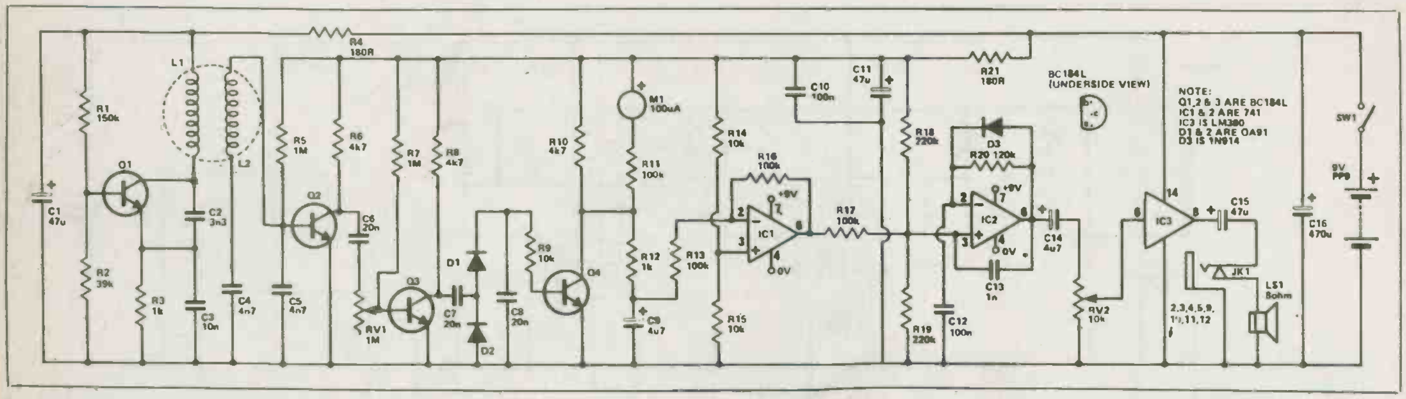


The underside of the search coil head and sections of the head showing coil wire leadout and routed up into the handle.

Winding The Coils

The housing is plywood or hardboard. 178 mm x 203 mm (7 x 8 inches) with grooved beading on the edges to hold the wire. Pass about 1 metre of 28 swg enamelled copper wire through the hole and then wind 22 turns of wire around the grooved beading. Pass another metre through the hole; the two ends of the wire should be long enough to easily reach the electronics.

An Induction Balance Metal Detector



The schematic of an Induction Balance type of metal detector.

HOW IT WORKS

The heart of the circuit is the search coil, L1 and L2. These two coils, which are essentially identical, are arranged in the same plane with a small overlap in such a way that there is practically no inductive coupling between the two. There is minimum pickup when the fields generated in L1 are cancelled in L2 when in free air. Any metal brought into the electro-magnetic field of L1 will distort the field, causing pickup in L2.

Q1 is a straightforward Colpitt's oscillator working at a nominal 130 kHz. This type of circuit is very stable and the use of polystyrene capacitors also help with stability. The supply to this stage is separately decoupled by R4 and C1.

The pickup coil L2 is tuned by means of C4 and C5 and amplified by Q2 which feeds to the level control RV1. This controls the "free air" state of the circuit and is set to the point where the later stages are just operating. The signal is further amplified by Q3 (here it is still an RF signal) and is detected by D1 and D2. When no metal is in the vicinity of the search coil and with RV1 correctly adjusted, a DC voltage of about 500 mV appears across C8. R9 increases the effective input impedance of Q4 as seen by the detector stage.

Q4 is just held off by the voltage available but as soon as any metal distorts the electromagnetic field, L2 produces a larger RF signal, a higher voltage across C8 and a consequent fall (from 8 V) in the voltage at the collector of Q4. This voltage is also monitored by the meter in parallel with the load resistor of Q4. The fall in voltage is dependent upon the proximity and/or size of the metal near the search coil.

It is necessary to ensure that the DC voltage fed to the next stage is clean and R12 and C9 act as a filter to remove any residual AC even if this is at low frequencies.

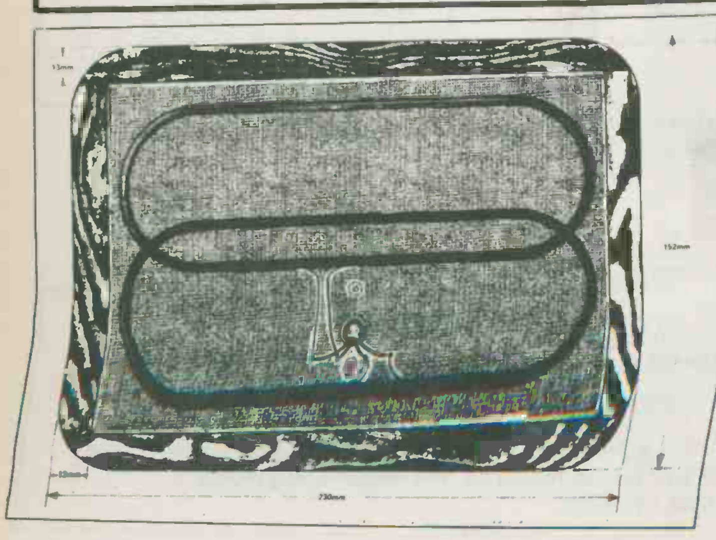
IC2 (the next but one stage) is a voltage controlled oscillator — but to operate this so that metal is indicated by a rising note, rather than a falling one, the voltage at the junction of C9 and R12 has to be inverted and this is achieved by IC1: in "no-metal" conditions, there is about 2 V at the output of this op-amp which rises when metal is near. This stage quickly saturates to give about 7 V at pin 6. IC1 has unity gain.

IC2 is a voltage controlled oscillator. In "no-metal" conditions it gives about 70 Hz which rises to 500 Hz when metal is present, diode D3 gives a rapid recharge to C1 and affects the mark/space ratio of the p-put which results in lower battery cogive a tion. R20 and C12 can be alterefdencies if different range of audio desired.

The output is taken to a volume control and fed to the LM380 audio power amplifier which in turn feeds the speaker.

The levels of signal around Q2,3,4 are all dependent upon transistor gain, temperature and supply voltage, but this doesn't matter because the level control RV1 is adjusted until Q4 just begins to conduct.

Current drain for the complete circuit is in the order of 50 mA.



The search coil. This is L1 and L2 which are made from two coils originally wound on a 140 mm former and then squeezed into the shapes shown.

Winding The Coils

The search head is the key to the whole operation; be prepared to spend some time experimenting.

The housing of the coils is not important; a rectangular shape is used for ease of construction. The coils L1 and L2 should be sandwiched between two pieces of hardboard or plywood separated by two pieces of wood about 6 mm thick.

To wind the coils, you'll need a cylinder about 140 mm (5½ inches) in diameter. Using 32 swg enamelled copper wire, trap one end onto the former with tape and wind 40 turns as close together as possible. Remove the coil and wrap tape around it at intervals to keep it from spreading.

Two identical coils are required. They should be glued into the housing as shown in the drawing.

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Motor Controller Project

PROJECT

Electric drills, saws, grinders, food blenders etc., all benefit from having some sort of control over their speed. Simple electric motor speed controllers, while proving speed control, have limited ability to maintain motor speed constant over widely varying loads. This project overcomes the limitations of these simple units and, despite its simplicity and low cost, is remarkably effective.

By Jonathan Scott

JUDGING BY users' remarks on the shortcomings of speed controllers on a variety of electrically driven appliances, and from much personal experience and observation, there is a *considerable need* for a well-designed speed controller for use with electric drills, grinders, saws, food blenders and other appliances driven by 'universal' electric motors.

The more expensive power drills now come with a variable control built into the trigger. Food blenders come *festooned* with an array of buttons marked with a ludicrous range of words with every synonym from 'mix' to 'masticate' represented!

These gadgets all have a severe limitation, namely, that they really only have voltage controllers, not speed controllers, for the motor in the unit. They vary the speed but provide little or no feedback speed control.

In the case of the power drill with a speed control in the trigger, the operator is in a position to adjust the trigger continuously in response to variations in the speed of the shaft, thus effectively becoming part of a feedback loop and serving as the speed *regulating* element.

The variable speed function of these latest drills is really not designed to allow the slow steady pace needed for delicate or laborious jobs, but to allow the unit to act as an electric screwdriver, when fitted with the appropriate bit, where constant speed is not necessary.

Blenders, however, are items which you typically want to turn on and add more and more ingredients (adding more load) as the process progresses. What happens? The blender slows down as the load increases and it's real pain to have to keep adjusting it. If you're not careful, or in too much of a hurry, you can stall the motor quite easily.

Older electric drills and most high rpm grinder never had any sort of variable speed adjustment, electrical or mechanical. Grinders fitted with a special 'pad' wheel are used for building, too. But you have to be quite deft, otherwise it's easy to buff right through the undercoat of a painted object because of the ferocity of the thing.

If you need to drill a particularly tough substance with an older drill, then you have to be prepared to wear out the fine, sharp drill tip very quickly.

So, there is a distinct requirement for some device which can be placed between the appliance plug and the power that can be used to not only *set* the motor speed, but to *regulate* it as well.

The perils of simplicity

There seems to be fundamentally three degrees of complexity in the way one can design these circuits, each with advantages and disadvantages. All techniques employ some method of sensing the motor back-emf and adjusting the power delivered to keep the back-emf relatively constant.

For the sake of attaching 'handles' to each fundamental technique, I shall dub them — the *crude/economical* method, the *refined/economical* method and the *complex/ultimate* method.

For this project I have chosen the middle course for reasons which will become apparent shortly.

The crude/economical method is the simplest and for that reason has an extraordinary advantage in that it has a low parts count. This sort of circuit requires a diode or two, a pot, a couple of resistors and little else apart from the SCR switching element (see Figure 1). Now, it is hard to beat this sort of economy, but such circuits have a few annoying limitations.

Firstly, they will not usually drive anything but the most sensitive SCRs because they deliver very low gate currents.

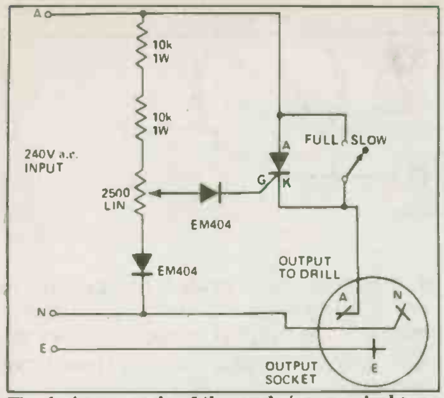


Fig. 1. An example of the crude/economical type of motor speed controller. This is the circuit of the ETI Speed Controller.

Secondly some component values can be critical, resulting in touchy or erratic response if tolerances are a bit out or the unit is driving an unusual motor. Lastly, the lack of an amplifying element in the feedback means that the speed regulation, while being above normal for a universal motor, is nowhere near perfect and the speed does drop under load.

To separate the two further types of controller requires a reasonable familiarity with what goes on when controlling a universal electric motor, so I will discuss the technique I have used in this project now and then go on to the explanation of further refinement.

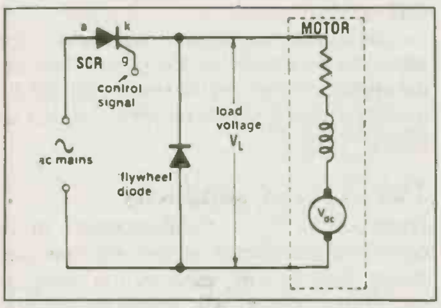


Fig. 2. Fundamental circuit elements of the controller used in this project. Note that V_{dc} is the back-emf of the motor.

Controller technique

A universal electric motor appears as a resistance, an inductance and a voltage source in series. The elements of the phase control system I have used — an SCR and a 'flywheel diode' — are connected as shown in Figure 2.

The voltage across the motor terminals during operation of this circuit will appear something like that shown in Figure 3. (Note that the vertical axis is not to scale.)

Considering the cycle from the peak onwards, let us examine the reason behind the appearance of each part of the waveform.

Say that, at some speed setting, the SCR is fired into conduction at about the 100° point of each positive half cycle. The load voltage jumps to a value very nearly equal to the mains voltage at that point (less the small drop across the SCR) and follows the mains cycle variation until the end of that half cycle (i.e. at the 180° point).

Thus, the point between 0° and 180°, of the positive half cycle, where the SCR fires, defines how much voltage is delivered to the load (the motor). Varying the delay before firing provides a means of varying the power delivered to the motor. This is known as phase control, for clearly obvious reasons.

At the point where the mains voltage falls below the back-emf voltage of the motor you would expect the current through the motor to become zero and the SCR to turn off. But, this is not quite the case as the load is not purely resistive. The inductive component of the motor forces its terminal voltage negative in an attempt to maintain motor current, and indeed, the load voltage would follow the mains negative for some way if it were not for the diode connected across the motor terminals.

This diode conducts as the motor voltage goes beyond about 0.7 volts negative and carries the 'flywheel' current from the motor's inductance, generated by the collapsing magnetic field, allowing the SCR to isolate.

The flywheel current persists until the energy stored in the motor's windings is exhausted. This takes typically two to five milliseconds.

Were the diode not there, a large negative-going pulse would result. This, in itself, is not a bad thing, but it is easy to block this and reduce the net dissipation in the SCR, allowing it to control a larger device for the same ratings and prevents the need to make the controller circuitry more complex to resist the negative-going voltage.

At any rate, some way into the negative supply half cycle, the inductance ceases to be the dominating voltage source within the motor and the back-emf becomes evident.

As you may see from the diagram, the motor voltage rises to a level defined by the apparent dc source within the motor equivalent circuit. (The 'back-emf generator'). This voltage is a result of residual magnetism in the metal of the armature and field coils and the relative motion of these two elements.

The actual back-emf developed depends on a number of factors, a major one being speed so it is a good representation of the motor's instantaneous speed.

There is some noise evident on the back-emf voltage, it is not a smooth dc level. This noise is partly due to commutation hash (high frequency spikes) and partly due to different amounts of residual magnetism in different armature segments etc. However, the noise is not sufficient to obscure the speed signal, or back-emf.

In a typical universal electric motor the back-emf would average around 10 volts at full rpm. The control circuitry in the controller looks at this dc signal and varies the point at which the SCR fires, increasing the delay if the motor attempts to speed up under decreasing load, or decreasing the delay if the motor attempts to slow down under increasing load.

The Perils Of Complexity

It turns out that, in the case of most motors, a very satisfactory degree of speed regulation can be achieved with only a hint of hunting detectable at *very* low speeds. This is most fortunate as it means that one does not require to advance to the next step of complexity, namely using the third technique mentioned earlier — the *complex/ultimate* circuitry with its own compensating system incorporated to guarantee the stability of the system under *all* conditions, despite large loop gain.

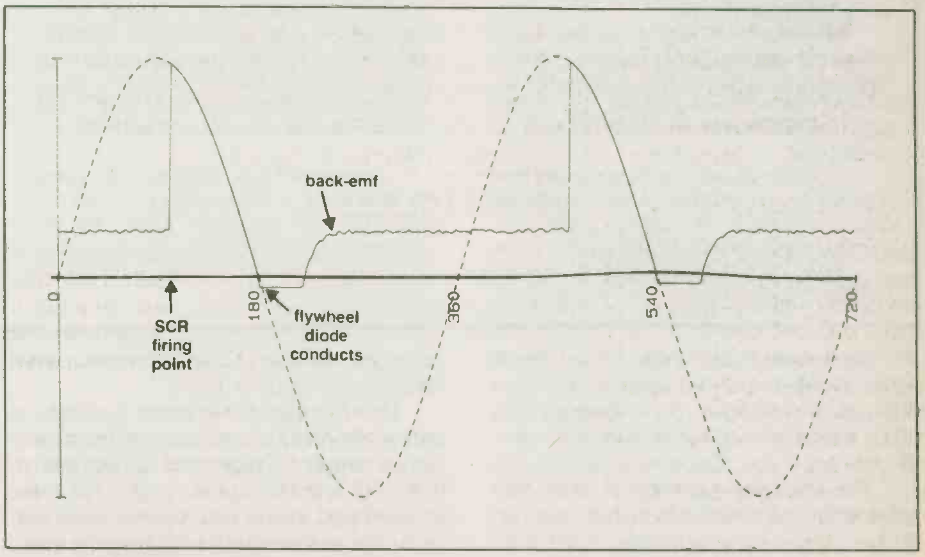


Fig. 3 Waveform of the voltage across the motor when using the ETI speed controller. (Vertical axis not to scale). The dashed line shows the power line input waveform.

HOW IT WORKS

The speed of an appliance's motor attached to the project, is controlled by applying the mains voltage to it at a set point of the mains positive half cycles, as seen in Figure 3. This is done by turning an SCR on at the appropriate point in the cycle. Turning on the SCR earlier in the cycle applies more voltage, increasing the speed, while turning the SCR on later applies less voltage, decreasing the speed.

The SCR (SCR1) is 'fired' by applying a positive pulse to its gate. This is effected by IC1, an optically-coupled triac driver containing a LED coupled to pins 1 and 2 and a bi-i rectional optically-operated 'switch' coupled to pins 4 and 6. When the LED in IC1 is off, the switch is off. When the LED is turned on, the switch conducts. If pin 4 is positive with respect to pin 6, it will forward-conduct from pin 4 to pin 6, and vice-versa if pin 6 is positive with respect to pin 4. So that only positive-going pulses are applied to the gate of SCR1, D3 ensures that the switch in IC1 can only conduct during mains positive half cycles.

Resistor R6 simply limits the current through IC1 pins 4 and 6, while R10 prevents false triggering of SCR1 due to small leakage currents.

The control electronics consists of Q1, Q2, PUT1, IC1, RV1 and associated components. The 'flywheel' diode is D6. Power supply for the control electronics is derived by a half-wave rectifier from the mains input. This consists of D2, R2 and C1. This supply is regulated by ZD1, a 33 V zener, R2 providing current limiting. C1 is charged up during the mains positive half cycles and substantially holds its charge during the negative half cycles.

The SPEED control, RV1 is part of a potential divider — R3/RV1/R4. The wiper of RV1 sets a reference level on the emitter of Q1. This can be anywhere between about 4 V and 15 V (with respect to the neutral line), depending on the setting of RV1.

Now, let us see what happens from the point where the mains positive half cycles crosses through the zero point, going negative, at 180°, assuming SCR1 has been fired during the preceding half cycle.

Referring to Figure 3, as the mains crosses through zero, going negative, D6 (the flywheel diode) will conduct, holding the active (A) load terminal at about -0.6 V. The SCR then becomes reverse biased and ceases conducting.

Capacitor C3 will have been charged to a certain voltage (via R12/R13), but will now be discharged via D5. Any charge on capacitor C2 will be discharged via D4/D1/R1.

Diode D6 remains conducting until the inductive backlash of the motor (as explained in the text) dissipates. The voltage at the load active terminal (with respect to the neutral line) then rises to the back-emf level. D5 is now reverse biased, allowing C3 to charge again via R12/R13 until it reaches the level of the back-emf +0.6 V (D5's forward conduction voltage). Small positive-going 'spikes' on the back-emf level are ignored (momentarily reverse biasing D5) due to the time constant of R12/R13 and C3. This prevents erratic control circuit operation due to this noise. Nevertheless, small fluctuations are still present in the negative peak level held by C3.

Transistor Q2 is forward biased by the voltage drop across R12. The collector of Q2 sources charging current to C2, but this is held discharged via D4/D1/R1 until the mains negative half cycle crosses the zero point and the next positive half cycle begins. When it does, and D1/D4 are reverse biased, C2 will commence charging at a rate determined by the collector current of Q2.

The programmable unijunction transistor (PUT1) has its gate held at about 4 V (with respect to the neutral line) by the potential divider of R7-R8. When C2 charges to 0.6 V above this level, the PUT will 'fire', delivering a current pulse to the LED in IC1. This will operate the switch in IC1 and SCR1 will fire.

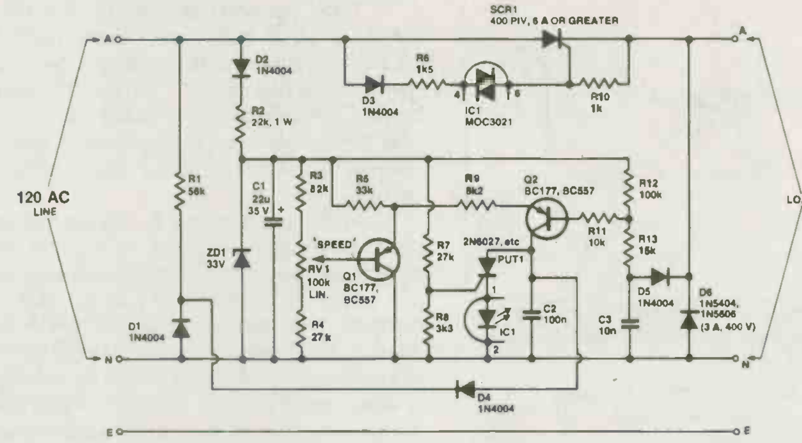
The rate at which C2 charges, determines at what point in the cycle the PUT and thus the SCR will be fired. There are two mechanisms for determining the rate at which C2 charges, and thus the point in the cycle at which SCR1 is fired.

Firstly, a reference level is set at the emitter of Q1 by the setting of RV1, the speed control. The collector-emitter current of Q2 will depend on the value of the voltage at this point and the value of R9, assuming the base voltage is held constant. Thus, varying RV1 varies the charging rate of C2, setting the point at which SCR1 fires.

Secondly, the base current of Q2 varies (and thus the collector current) depending on the voltage drop across R12. If the back-emf of the appliance motor falls, such as with an increase in motor loading, the voltage held on C3 will decrease (pulled down by D5 conducting current through the load) until it reaches the new value of the back-emf plus 0.6 V (D5 forward drop). This will increase the voltage drop across R12 and thus increase the base and collector current of Q2. Thus, C2 will charge more rapidly each mains positive half cycle, firing the PUT and SCR1 earlier in the cycle. This applies more power to the motor so that its speed is maintained.

If the back-emf rises, such as it would from a decrease in motor loading, the voltage on C3 will rise and the voltage drop across R12 will decrease, decreasing the collector current of Q2. Thus, C2 in this case will charge more slowly, causing the SCR to fire later in the cycle. This will reduce power to the motor so that the set speed is maintained.

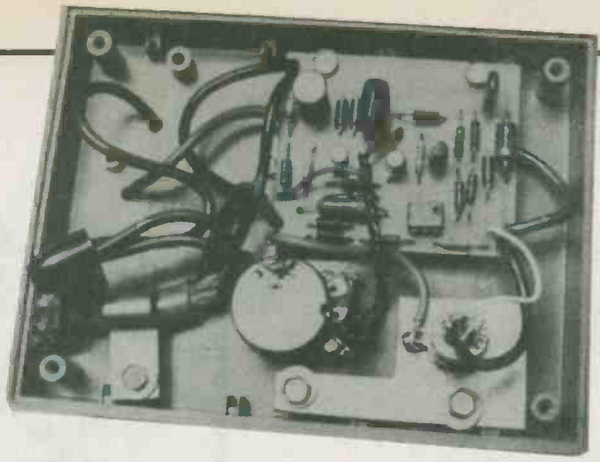
The function of R11 is simply to limit the currents in Q2 during those parts of the cycle when Q2 is not responding to the back-emf signal.



The reason that this type of circuitry is to be avoided, for the applications considered in the introduction to this article, is that it would require a great deal more electronics (and cost!). This would basically entail a mechanism capable of smoothly holding the back-emf signal so it could be further processed, which means some kind of sample-and-hold gate plus some synchronizing signal. Once isolated, the signal is easily dealt with, but the process is much more complex than the simple instantaneous method employed in Fig. 1.

One further refinement in a complex/ultimate controller may occur to the astute reader: namely, having the circuit capable of using the full 360° (or very nearly) of the mains supply cycle. The systems described so far, all assume that an SCR will be used to control the current delivered and not a triac. Hence, at most, only 180° of the mains cycle is available as the SCR must remain in a blocking state during the negative half cycle. Although a triac would permit use of the negative cycles, as would full-wave rectifying the mains before applying it to the SCR, these methods have one problem.

The sensing of speed, so that the speed may be regulated, requires access to the back-emf voltage, blanked immediately after a current zero. Hence, any attempt to employ near-continuous power application



Inside. Construction is quite straightforward — but take heed of the safety precautions mentioned in the text! Note that in use there may be a slight 'dead band' at either end of the speed control rotation where nothing happens.

would be hampered by the inductive 'backlash' concealing the motor's true back-emf value. Any such system would have to be capable of operating in a mode which left only every fourth or sixth half cycle unemployed for the purpose of 'getting at' the back-emf for speed sensing.

While possible, this would not only require considerable circuitry, but would also tend to impart some roughness to the torque delivered. Hence, such methods are well abandoned for the applications for which the controller has been designed. It is a realm of circuit complexity which returns benefits only with physically large machines.

Back To The Project

The controller has been deisnged to be a good compromise between the crude/economical and complex/ultimate controller. Speed can be set from full rpm on no load (at 'half power') down to less than one-tenth normal. This is lower than you're ever likely to need. On low speeds and without any load there is a tendency for motors to 'hunt' about the set speed, power being applied in detectable jerks. But, even when only a light load is applied, this has the effect of damping the control loop, improving the control and smoothing out the variations.

The torque characteristics of the circuit are excellent, until you approach the 180° limit of the cycle — which is, in any case, *way* beyond what you will need in common situations.

A good 'worst case' example is that of making houmous, a particularly thick and pasty (tasty, too!) dip in a blender. Initially, the mixture is oily, but as the blending proceeds it changes to a very glutinous consistency and blenders invariably begin to labour agonizingly at this point. With the controller in control — no problems!

Construction

Safety is a major consideration in a project such as this. Choosing a box in which to house the components has to be done carefully because the project will be used in a work environment, and is likely to encounter more than the usual amount of rough treatment.

I chose a strong, but not brittle, plastic case which comes in two halves, secured by recessed self-tapping screws that set into plastic pillars in the bottom half of the case.

Shape is unimportant, along with size, just so long as all the components can be fitted with ease and the box is not overlay large. If you choose a box with a metal fascia or panel, make sure this is *securely* grounded. If you can, get a box which provides internal posts to which the pc board and SCR mount can be secured with self-tapping screws so that no metal parts attached to these can protrude through the exterior of the case. If you must use a case that doesn't meet this requirement, secure 'the workings' with nylon nuts and bolts. All this is for your own protection.

The potentiometer used was of the conventional type, having a metal case, bushing and shaft. I grounded the pot. case, as shown in the wiring and overlay diagram. If possible, it would be an even better idea to obtain a pot. with a plastic bushing and shaft.

The mains cable *must* be firmly secured with either a clamp-type grommet where it enters the case, or with an ordinary grommet followed by a cable clamp. I used both a clamp-type grommet and a cable clamp, for good measure. (*That's probably overdoing it, but, please yourself — Ed.*)

Best place to start assembling the project is by drilling the few necessary holes in the box. If you are making a direct copy of the prototype, then positioning of the major components is clear from the internal photograph. If you're using a different box, then arrange the major components first and determine where you have to drill holes. Don't crowd the parts against one another. Use the blank pc board as a template for marking its mounting hold positions.

If you're using an SCR type that is not in a stud-mount package, then you'll have to arrange a suitable mount for it. I used a C220D type in a stud-mount, screwing it to a small piece of aluminum which also serves as a heatsink of sorts. SCR dissipation is small, so this heatsink/mount need only be small.

PARTS LIST

Resistors (all ½W, 5% unless noted)

R1	56k
R2	22k, 1W
R3	82k
R4	27k
R5	33k
R6	1k5
R7	27k
R8	3k3
R9	8k2
R10	1k
R11	10k
R12	100k
R13	15k
RV1	100k/A linear pot.

Capacitors

C1	22u/35 V RB electrolytic
C2	100n
C3	10n

Semiconductors

D1-D5	1N4004, EM410 etc.
D6	1N5404, 1N5606 etc.
IC1	MOC3021 triac opto-isolator
PUT1	2N6027, D13T1 etc.
Q1,Q2	2N3905
SCR1	any type, 400 PIV/6A or greater

Miscellaneous

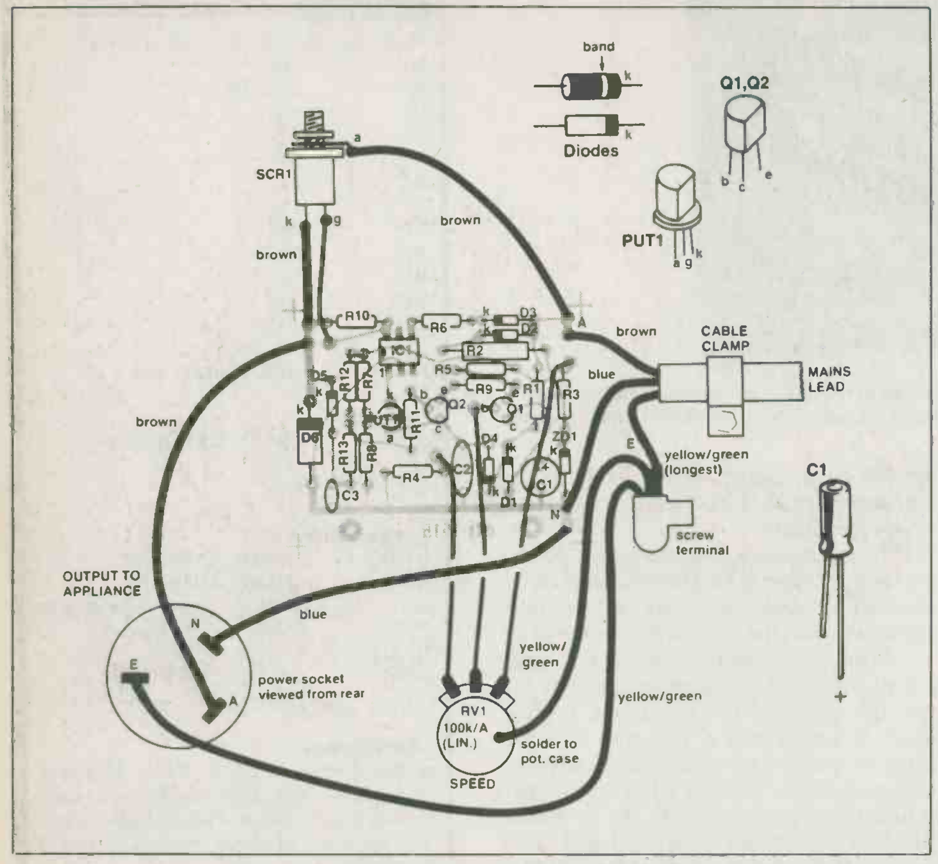
pc board; case — 135 × 100 × 38 mm or similar size to suit; 3-pin panel-mount mains socket; mains cable and plug; small scrap of aluminum, self-tapping screws; screw terminal block; etc.

Just bolt the SCR to the heatsink without any insulator, and use some thermal compound to improve thermal contact between the body of the device and the heatsink. REMEMBER — the heatsink will be at MAINS POTENTIAL, so make sure when mounting it that no securing bolts protrude through the case or use nylon nuts and bolts.

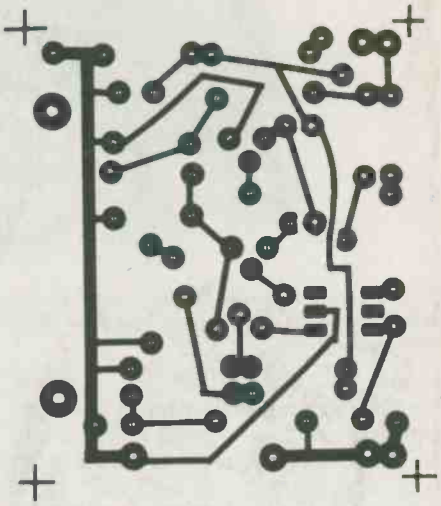
I mounted the SCR separately to the pc board so that a wide range of SCR types and packages could be readily accommodated, from the stud-mount C220D I used in the prototype, to small 6 A-rated, flange-mount plastic pack devices.

It is difficult to specify a 'load rating' for the project in terms of the SCR's characteristics, because of motor surge current characteristics and the range of motor ratings in appliances. A 6 A-rated SCR will happily handle an appliance rated to draw a nominal 2 A under 'normal' load. The C220D used in the prototype will reliably handle an appliance rated at four to five amps, right up to full revs setting under almost-stalled-rotor conditions.

Before attaching the 3-pin panel-mount mains outlet socket to the outside of the case, attach *colour-coded* wires to its terminals and thread these through the holes drilled for them in the case. Take care that



Overlay and wiring diagram. Follow this to assemble the pc board and wiring up of the external components.



you get the active (A), neutral (N) and ground (G) wires correct. Use wire from a short length of stripped-down mains flex.

When attaching the power cable, cut back the sheath so as to expose some 150 mm of the three wires to provide connections later. Make sure the cable is very firmly secured.

Mount the potentiometer using nuts on *both sides* of the case panel and lock the bushing tight so that there's no possibility of the pot. body coming loose and being rotated when the knob is turned.

Assemble the pc board next, according to the overlay diagram. You'll find it easier to solder the diodes in place first, followed by the resistors, capacitors and the rest of the semiconductors. As usual, watch the orientation of all the semiconductors and the electrolytic capacitor (C1).

Having done that check it. Make an especially careful examination of the soldering as diagnosis of problems will be dangerous and/or difficult later, because the board operates 'live'. In other words, if you are going to make only one project work first time this year, make it this one.

Attach the three wires that go to the potentiometer. Better colour code or mark these in some way to avoid confusion and wiring errors. Make sure they're long enough. Ordinary hookup wire will do for these. An ordinary piece of hookup wire can also be used for the lead to the SCR gate. The leads to the SCR anode and cathode carry mains potential and load current and should be wired using mains-rated wire. Get it from some stripped-down mains flex, like before.

Now wire up the mains input cable and the mains outlet socket to the pc board, then check it.

Note that the ground wire on the mains input cable should be longer than the active and neutral wires. Should the mains cable come adrift, the ground wire would then be the last to break.

The Try Out

When you're satisfied that the project is correctly together, it's time for a try-out. Just plug in your drill, blender, or whatever into the outlet socket, set the speed pot. a bit up from minimum, plug the controller into the mains, and switch on. See that the appliance's motor rotates at some low speed. Advance the speed control and see that the motor speed increases, as expected. If nothing's happening at this stage, switch off, unplug everything, and go over your wiring (this assumes you *know* the appliance works).

If that works, then try applying a load with the motor set at some convenient speed and see that the controller maintains the motor speed. If not, you've got troubles on the pc board and you'd better unplug everything and go over it.

If you are using the unit with an unusual motor, where the inertia of the armature may be greatly different to that expected by this circuit, you can vary the gain of the feedback amplifier by simply changing the value of R9. This can be varied between a minimum of about 150 ohms and a maximum of 22k.

Thus, if the motor hunts excessively (especially at low speed settings), R9 may be increased from the 8k2 value shown, reducing feedback loop gain and restoring stability at a small price in speed constancy. If the reverse is the case, you can acquire tighter regulation by reducing R9 — but check that hunting is kept to a minimum.

Finally, several words of caution are in order. The power bursts which are applied to the motor by the SCR switching and the control system variations with the motor armature running at low speed, applies a lot of stress to the motor's brushes and armature windings, so the controller should not be used in applications where it's not really necessary. Wear from the controller's use is unlikely to significantly shorten the life of an appliance, but it is never good practice to strain a mechanical device unnecessarily.

In addition, many appliance motors, particularly drills, employ a small cooling fan on the armature. The cooling effect of the fan is reduced, and extended periods of operation at low speeds should thus be avoided. **ETI**

A Look at the Sinclair's QL

A giant step forward . . . or a leap in the dark?

CLIVE SINCLAIR, British designer of the ZX-80/81/Spectrum computers, and now Sir Clive, is about to have another go at capturing the lion's share of the micro market. Sales of the Spectrum (never released in Canada) were excellent, and Sir Clive expects to do the same with his new QL (for Quantum Leap).

The QL retails for 399 pounds sterling, between $800 and $900 Canadian. North American release is planned for the fall, but production shortages may mean delays.

As pointed out at its launch, there is no other computer offering anything like the power of the QL at anything near the price; the inclusion of four useful and well designed programs is a nice touch, and a sensible precaution against one of the most serious threats to a new computer — lack of software support. This is a marketing lesson which Sinclair has learned thoroughly but which others absorb only at great cost.

But then marketing is largely what Sinclair Research Ltd. are all about. The method is easily grasped, if not so readily followed by companies with less nerve. Somehow Sinclair manage to make and sell tomorrow's computer today, at yesterday's price. It is a leap-frogging process that reverses the normal procedure by which marketing-men take surveys to determine what the public wants, and then produce what they think the public needs. It is a technique (which has worked so far) whereby a new and innovative produce creates its own market: after all, was there really a demand for a small inexpensive home computer until Sinclair released the ZX80? The QL may well follow the same pattern.

The QL is very carefully positioned to bridge the gap (if there is one) between home and business computer users: on the one hand it is cheap enough to compete with the Acorn/BBC, Commodore 64 and the like, but also powerful enough (at least potentially) to compete with Apple, CBM and even the IBM PC. Yet Sinclair candidly admit that although they see the QL primarily as a business machine, they have no idea what uses the QL will ultimately find in the hands of the target 3.5 million users world wide. In other words having created a supply, they earnestly hope that demand will follow!

Certainly the QL has features to attract interest from all sections of the computer-buying public, and promises to be an interesting machine to explore.

Inside Story

The specification of the QL is worth considering in detail. The main processor is Motorola's MC68008, the baby of the 68000 family but nevertheless a most powerful CPU. It has a 32-bit internal structure and is fully compatible with 68000 code. The 20-bit wide address bus can directly access 1M byte of memory (or memory-mapped I/O), but the most attractive feature to Sinclair must have been its 8-bit data bus, which means the 68008 can be operated with standard byte-wide memories and support chips.

As well as the 68008 the QL includes an Intel 8049 8-bit CPU with 2K ROM and 128 bytes of RAM on the chip. This handles the keyboard, sound generation and the RS232C receive function. In addition, two custom chips are employed: one is dedicated to memory management and the display, while the other looks after the two microdrives, the local area network and RS232C transmission. A real-time clock is also included, maintained by a back-up battery — a most useful facility which, in the age of digital watches, is inexplicably missing from most computers.

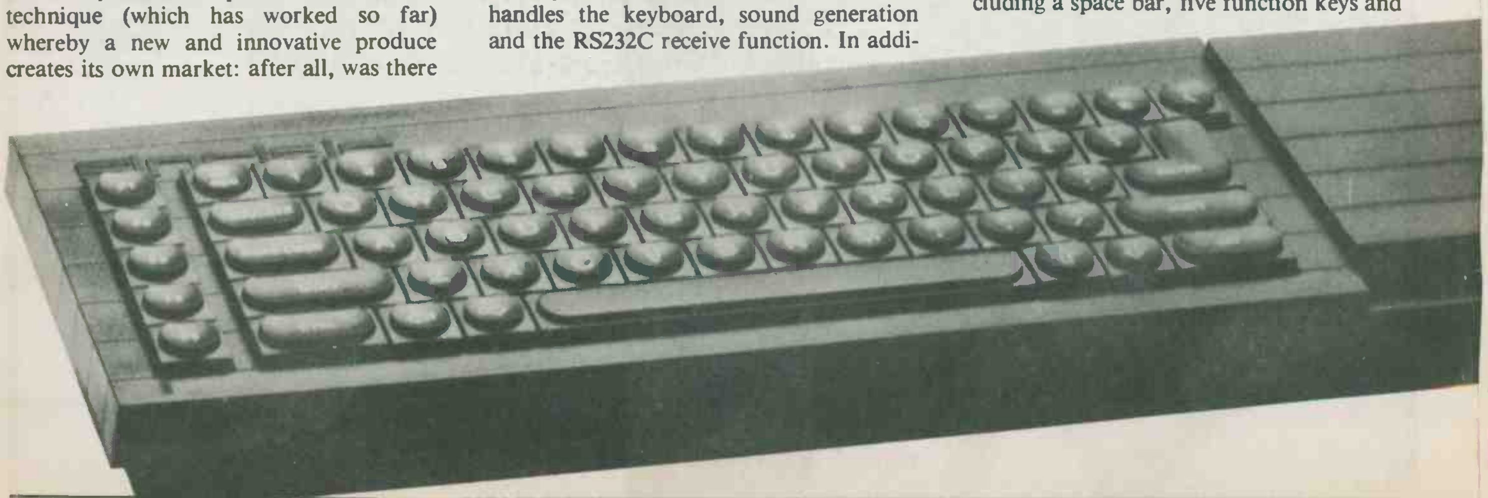
Internal RAM stacks up at a fairly massive 128K, of which 9K is free to the user; an 0.5 Mbyte expansion board is promised, which will take total RAM to 640K! The 32K ROM contains the new QDOS operating system, which promises to be very interesting, and an enhanced version of Sinclair BASIC, dubbed SuperBASIC.

QDOS is described as " . . . a single user multi-tasking, time-sliced system. . ." and was developed to take advantage of the power of the 68008 CPU. Multi-tasking (the ability to handle several jobs simultaneously) allows the QL to run several programs at once, each with an independent screen window — a feature normally available only on far more expensive computers.

SuperBASIC offers several improvements over the old Sinclair BASIC. For a start it incorporates the structured PROCedure format used by BBC BASIC; it is also said to be user-extendable and to run at a constant speed, so that program execution time does not depend on the length of the routine. Other features include easy interfacing to machine code, and access to the QDS operating system.

In And Out

The QL's keyboard has a full sized QWERTY layout with sixty-five keys including a space bar, five function keys and



four separate cursor controls. It is, apparently and a last, a proper keyboard!

Two microdrive units are built in, and a further six can be daisy-chained onto the expansion socket. However, these must be QL Microdrives; those made for Spectrum cannot be used, though the cassettes themselves are compatible if formatted for the QL.

A port at one end of the computer accepts ROM cartridges up to 32K in capacity, but once more ZX ROM cartridges are not suitable.

The QL offers alternative display outputs. Best quality is obtained from the Monitor port, which will drive either an RGB or a monochrome monitor. Two graphics resolution modes are available: 512 x 256 pixels with a choice of four colours (red, green, black, white, plus a 'stipple' feature) or 256 x 256 with a palette of eight colours. Normal character format on a monitor display is 25 rows x 85 columns.

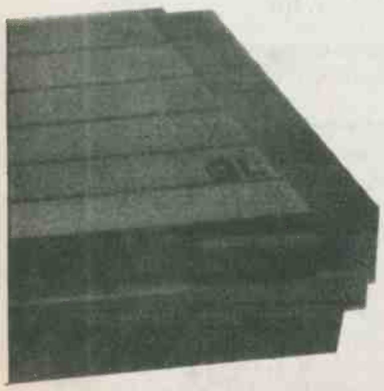
The UHF TV output display modes are similar, but the use of the stipple feature is not recommended and the character format is typically forty six characters, depending on software.

Other features built into the QL include a local area network (QLAN) providing a link-up for up to sixty-four QLs or Spectrums, two RC232C ports and two joystick ports.

Onwards And Outwards

In addition to the 0.5 Mbyte memory expansion, an interesting list of peripherals and extensions is planned for the QL. The most important of these are the 68000 assembler, the analogue/digital interface, Winchester (hard disc) interface, modem and the parallel printer interface.

Finally there is the manual. A preview copy was released to interested journalists at the press launch, and while it would be unfair to criticise it at this stage it is plainly incomplete, with large sections either missing or very skimpy; one hopes that the final style is less opaque than that of the draft version. Bad documentation is unforgivable and a sin which infuriates reviewers and often leads to unfavourable comment on the computer itself.



Software

The 'software suite' supplied with the QL was written and licensed from Psion and consists of four integrated programs: QL Abacus, a spreadsheet; Archive, a data management/filing system; Easel, a graphics design program; and Quill, a wordprocessor.

All four are supplied on Microdrive cassettes and make extensive use of the QDOS operating systems, capability for separate screen windows. At the top of the screen is a Control window, which at all times displays a list of current options available, to the user; few lines of the screen to show information about the work in progress; and the Display window, a large area across the middle of the screen, shows the work.

The screen format is identical in all four programs, as is the command structure, so the learning curve for the complete suite is likely to be quite short. In addition data is transportable from one program to another so that, for example, business graphics can be generated from data imported from the spreadsheet.

Many other tasty features are listed in the documentation, including many found only on up-market business computers, so the indications are that the QL software suit will be a joy and a delight to use — Murphy's Law permitting.

Paper Tigers

Lest readers begin to think that the QL is all things bright and beautiful, a flawless example of computing engineering unmatched by any other, it has to be said that the QL does have a few shortcomings. Indeed the sceptics have already compiled a list of them.

The most serious criticism is the complete lack of a facility found on every computer in the QL's price range . . . a cassette interface (it's worth mentioning that a floppy disc interface is missing, too).

The implication of this is that cheap software is unlikely to be available for some time, because blank Microdrive cassettes currently cost around $15.00 at retail prices, and the medium is not suitable for high speed duplication either. Taking a slightly longer view, though, it will probably not be too long before add-on cassette and/or floppy interfaces are available. Another possibility is that software houses will go for ROM-based programs, though this development must wait on the release of the 68000 assembler.

The Microdrive system itself is not yet proven to the satisfaction of many buyers. However the QL Microdrives may prove more efficient than those made for the Spectrum; according to the provisional manual, QDS routinely stores as many files as possible in spare memory, reducing wear and tear on the tape and greatly increasing access time. And the 0.5M byte RAM pack provides a very substantial amount of spare memory! Another serious albeit temporary problem; is the lack of a parallel printer interface.

The remaining criticism of the QL (so far) have about them a faint aroma of sour grapes. Complaints have been made about the use of the 68008; its data bus is only 8-bits wide rather than 16, so it will be only a quarter as fast as the 68000 because it has to perform four times as many fetches; and with a clock speed of only 7.5MHz and QL will be slower than some of the faster 8-bit computers. Well, I wouldn't bet on it.

In fact both the 68000 and the 68008 fetch instruction in pairs of bytes (words), so there is not all that much difference between them, and Motorola data shows that on a 'quick sort' bench-mark test the 68008 clocks in only 10 milliseconds slower (30%) than the 68000 CPU running with a memory management unit. And at first appearances, the 68008 instruction set looks extremely powerful and compact (a point made several times by Motorola in comparing their 68000 family CPUs with other 16-bit processors), so machine code programs should run very quickly on the QL.

The remaining criticism to date concerns the choice — or rather the lack of choice — of colours in high resolution graphics mode. This criticism is relevant only to dedicated games-players, and even so its ultimate strength will depend on the effectiveness of the stipple feature in producing shades and tones.

Of course there will undoubtedly be other valid criticisms of the QL (it would be too much to expect any computer to be perfect) and these will show themselves when review models become available. Then experience will tell whether or not the QL lives up to its specification. The QL will not win kudos for the missing cassette interface, but this is not an insoluble problem: where Sinclair leads, others tend to follow, and if fast performance is any guide the QL and its add-ons will be every bit as successful as earlier Sinclair computers. **ETI**

Coping with Components Part 2

This month we conclude our series on component identification with a look at capacitors.

Capacitors

A CONSIDERABLE variety of capacitor types are now available to the hobbyist, and most people will have a junkbox with many capacitors which are of unknown types, or carry strange markings indicating the values. The tables given here should identify most of the values, and the text and illustrations, the type of capacitor. It is important to select the correct type of capacitor for the job, as although there is some overlap in many applications, each variety has particular attributes which will make it more suitable for some purposes than others.

All capacitors are, of course, able to store electrical energy and consist of two parallel conducting surfaces separated by another material, which is an insulator, and known as the dielectric. The cheapest such dielectric is air, although the hobbyist will normally only meet this in variable capacitors (see later). The commonest dielectrics in fixed capacitors are mica, ceramics, paper, plastic and less commonly, oil, with other materials sometimes being used.

As DC current cannot flow through a capacitor, they are often used to separate DC and AC signals within a circuit. Nor does AC current actually flow through the capacitor — the movement of electrons from one electrode to the other only gives this appearance.

The amount of electrical energy which can be stored depends on the value of the capacitor, and the dielectric material used in its construction will determine the relative size for a particular value. A vacuum is used as a reference for the 'dielectric constant' with a value of 1 — higher vlaues give the amount of energy stored per unit/volume as a ratio to this reference. Most plastic dielectrics such as polyester and polycarbonate have constants of around 3, mica around 6, and tantalum about 11. One material, barium titanate has a dielectric constant up to 15,000 and is used in the dielectric of many ceramic types to achieve the very high capacitance/volume ratios in low voltages.

Temperature stability is often important, and especially in RF oscillator circuits, attention must be paid to this characteristic. It is usually expressed in parts per million (ppm) per degree Centigrade temperature change, and may be zero, positive, or negative.

The tolerance against the marked value of any capacitor will depend on its construction — in the case of electrolytic types, this may be as much as -20/+80% in any unit. However, this is usually not a problem in electrolytic applications, but should be kept in mind if the value has been calculated for any applications. In the opposite direction, mica types are available with tolerances of 1 or 2%, but of much lower capacitance value.

Paper Capacitors

Common some years ago, these have tended to be less frequently used. They are constructed by winding alternating strips of metal foil and paper into a roll with leads attached, or inserted into each end, then impregnating with wax or a synthetic material, before environmental protection by means of an outer encapsulation.

The method above gives a capacitor with appreciable inductance — this can be reduced by a slight variation in the method of winding the layers when the foils are wound, so that they can be crushed together at the end and the complete end is then soldered to the wire lead.

These capacitors are best in voltage work, although the fact that paper will easily absorb moisture can lead to problems — the insulation resistance disappears quickly. Audio work was a common application at one time, but plastic based types are now normally used to their smaller size and better electrical characteristics.

Table 2
Capacitor Markings

Polyester capacitors have the same coding as resistors with first significant figure of value at the top of the capacitor. An additional band at the end will indicate the working voltage: brown = 100 V, red = 250 V, yellow = 400 V.

Ceramic capacitors are usually marked with their value in figures (the old band markings have virtually disappeared) i.e., 22p = 22pF or 2p2 = 2pF2.

The "**n**" system is also frequently met where if the "n" precedes the figure, it is a multiplier of i.e., n22 = 220pF; or if it follows the figures, it is a multiplier of 1000: i.e., 10n = 10,000pF, 220n = 220,000 pF. Note that:

1500pF = .0015uF = 1n5

Also, another method is two significant figures plus multipler to the power of 10, i.e.,:

104 = 100,000pF (100n or 0uF1)
102 = 1,000pF (1n or 0uF001)

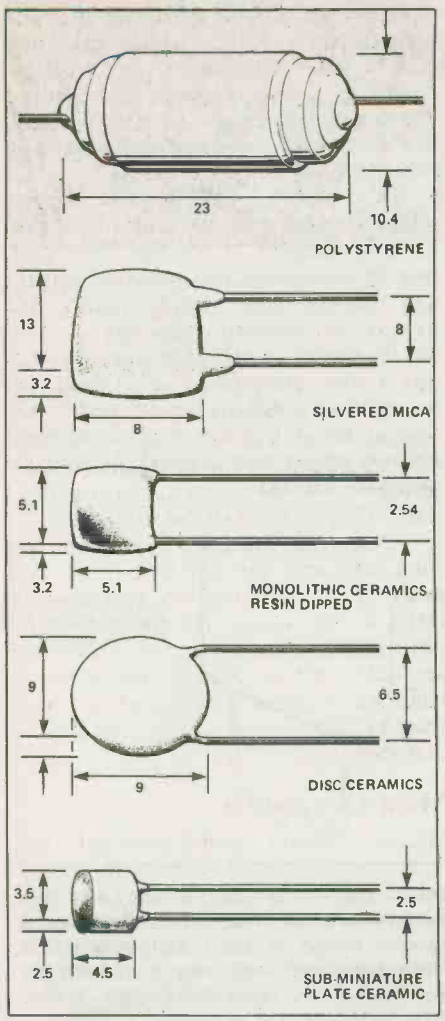
Mica Capacitors

Mica is a natural mineral (although synthetic mica is now made) normally found ind in granite rock formations, and has the advantage of being totally inert, and a good insulator. It is also extremely stable (although it does absorb moisture) making this material excellent for high stability work, with a temperature coefficient not exceeding ±100 ppm, and it is capable of passing high RF currents.

Mica capacitors are constructed by assembling alternating sheets of mica and foil, with the foil overlapping the mica sheets at each end. Alternating foils are then wrapped together and leads attached to opposite sides, covering the whole assembly with a dipping of epoxy resin, or a moulding to prevent water contamination. Tolerance specifications vary from ±20 to ±1%. In the 1% ranges, capacities up to 50pF are often alternatively specified as ±0pF5, due to the practical difficulties in obtaining ±1% at low values.

A particular variety of mica capacitors, normally referred to as 'silver mica' are widely used in RF oscillator circuits, due to their excellent stability. The construction is different to the normal mica, as a thin film of silver is formed on each side of the mica sheet to act as electrodes, before impregnation, lead attachment and epoxy-encapsulation. Temperature coefficients are around +30-50 ppm.

Where the leads inductance would be a problem, a specially cased version is available without leads where the layers are sandwiched between metal clamps.



Polystyrene capacitors offer high insulation resistance with good electrical properties.

Mica capacitors are used where high stability is required.

Ceramic capacitors are available in a number of different forms, each suited to a particular application.

N.B.: All dimensions in millimeters. All capacitor sizes vary according to the value; those shown are typical of each type.

These can be soldered directly to a printed circuit board, and are often used in VHF/UHF RF transmitter applications ('UNELCO' type).

Ceramic Capacitors

For a variety of case sizes, and confusing markings, it is difficult to beat the ceramic capacitor, probably most familiar in its round disc form. They are widely used in decoupling applications and at RF, as they have low series inductance, and in nearly all low capacity (up to about 0uF1) non-critical applications. The dielectric material is normally an inorganic ceramic compound, with the higher capacitance types using one, or a mixture, of the higher dielectric constant substances such as barium titanate, mentioned earlier.

Silvered electrodes are formed on each side of the dielectric to which leads are attached, prior to covering with an epoxy coating for protection.

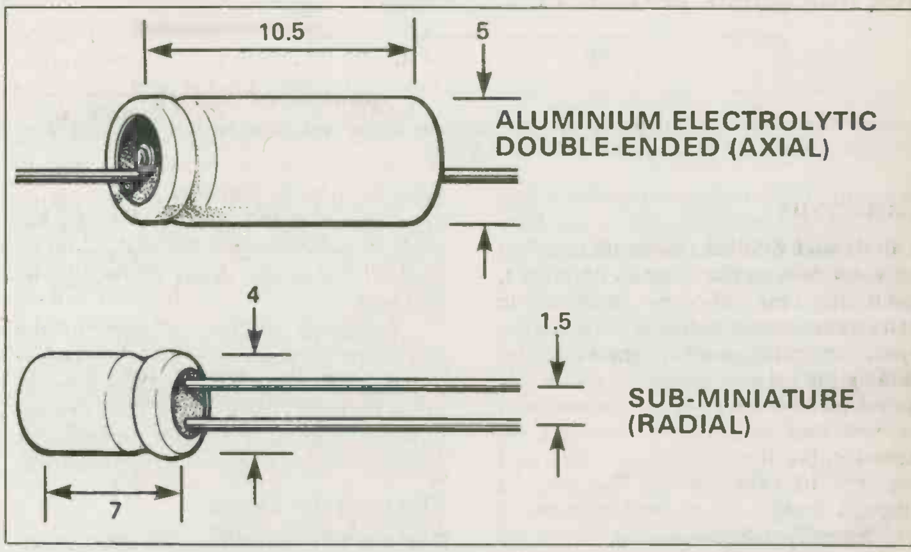
These high volume/capacitance ratio types are often referred to as medium or high K types (K being the dielectric constant) and have a number of disadvantages over the lower value type (up to about 400pF) which use lower K materials. Their temperature coefficients are extremely high (tens of percent in some cases), and the capacitance is affected by the level and type of voltage (AC/DC) present. Although they are both excellent for decoupling in solid state circuits both for logic and RF, they have no place in RF frequency determining applications. Tolerances are often in the 20/+80% region.

When selecting a ceramic capacitor for RF decoupling purposes, use values of .01uF for use up to about 15MHz; .0047uF to about 80MHz; .0022uF up to 120MHz; and 100pF (.001uF) to around 400MHz.

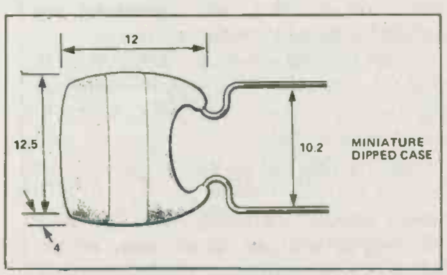
The smaller values have much more predictable temperature coefficients and good stability, and are available in temperature coefficient groupings. The variation is from ±30 to ±1000 ppm, in groups, and as the change is linear, they have considerable use for temperature compensation in oscillator circuits. The case is often rectangular or square (with a thin cross-section) and a colour top identifies the grouping — these are often referred to as plaquette types. Tolerance groupings can be as low as 2%.

One of the recent introductions is the monolithic ceramic capacitor, which can give a very high capacitance for a very small size, together with a low AC impedance, making them ideal for high density solid state coupling and decoupling work in logic circuits, although they are more expensive than other ceramics.

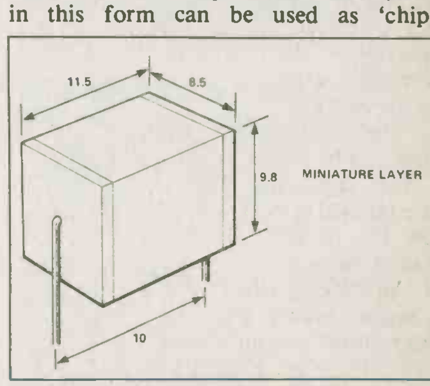
Construction is by sandwiching alternate layers of ceramic compounds and resins and metal electrodes to form a large multi-layer unit. After heat processing, the blocks are cut into small units, the area determining the capacity value, solderable and encapsulations added, and in this form can be used as 'chip'



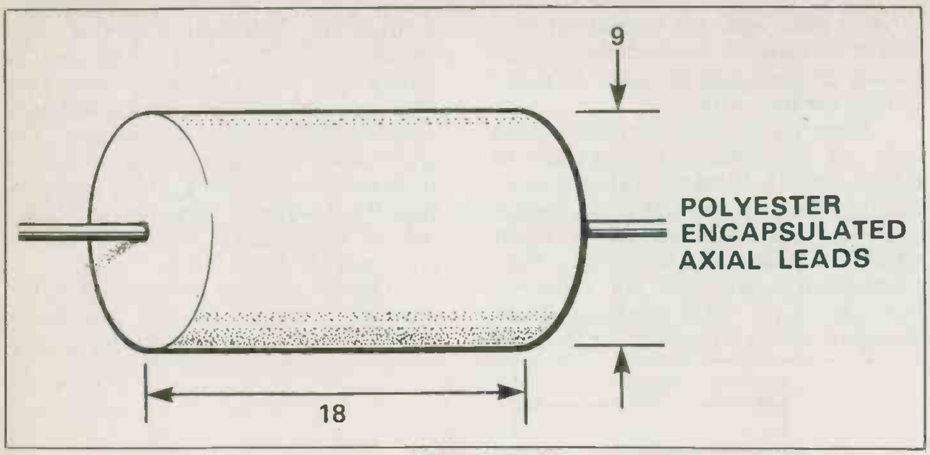
Electrolytic Capacitors: Axial electrolytics (top) are available in values up to 4700uF and at voltage ratings to 450 V. Radial types, either standard of subminiature (shown at bottom), are supplied in more restricted value and voltage ranges, but take less space on a printed circuit board.



Polyester Capacitors: The example shown above is the familiar "C280 Polyester" capacitor. The dimensions are typical for values to 47n.

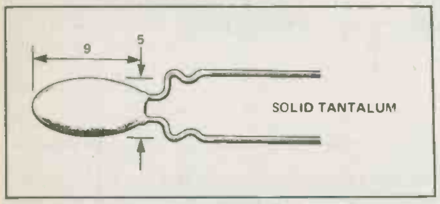


Polyester Capacitors: The box-like, silver coloured capacitors are sometimes referred to in catalogues as "Siemens" type, after the manufacturer.



Polyester Capacitors: Axial polyester types are especially rugged and useful for high temperature environments; working voltages to 400 V DC (200 V AC).

capacitors (with minimal inductance and suited to automatic insertion), or have leads applied plus encapsulation to give a normal style capacitor. Besides the High K type, they can also be obtained in temperature compensating styles and ultra stable forms. Tolerance ranges are similar to the other ceramic types.



Tantalum Electrolytic: Preferred for accuracy in i.e., timing, filter circuits. They have very low leakage currents and good stability, but cannot withstand reverse voltages.

Plastic Film

The most common type is the polyester film capacitor which find wide application in DC circuits. The most familiar type will be the Mullard C280 type, which is also metalized and which look like lozenges, encapsulated in a hard lacquer case. Tolerances are around 10 to 20%, with a high temperature coefficient of about 20%. Construction is similar to that of paper types, with the plastic film replacing the paper.

Polycarbonate types find application in AC circuits as they have a very low power factor (power factor is the ratio of impedance to resistance). The temperature coefficient is very low. If you need to decouple AC mains input lines, this is the type to use.

Polystyrene is an extremely good material for capacitors, as it has excellent stability, and a very slight negative temperature coefficient. The latter property can be put to good use in compensating for the positive temperature coefficient of mica capacitors in oscillator circuits. Care needs to be taken in soldering these, as it is easy to damage the plastic and short out the metal layers as polystyrene will melt at 90 degrees Centigrade. Tolerances down to 1% can be obtained.

Metalized variants of some of the above are common — the plastic film is covered with a few microns thick layer of metal particles, often by vacuum deposition — and produce a higher capacity in a smaller volume. Use for DC applications.

Electrolytic Types

Everyone will be familiar with this type of capacitor, although modern technology has produced many variants under this general title. The major difference between these and the previous types of capacitor, is that we are now dealing with an electro-chemical construction, rather than a passive one. They have many disadvantages, but despite this are widely used in virtually all high (greater than 1 microfarad) capacitance DC applications.

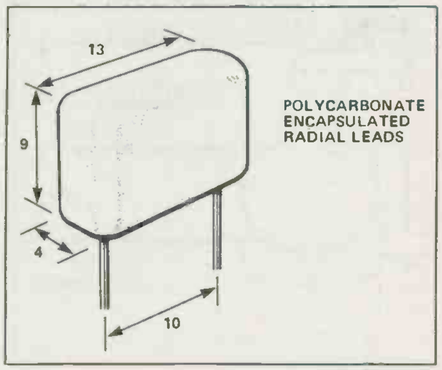
There are two main types of electrolytic capacitors — aluminum and tantalum.

Aluminum Electrolytic

In these, which are the traditional type, two aluminum foils are separated by insulating paper and wound into rolls. These rolls are then impregnated with an electrolyte, and after electrical stabilization, sealed into an aluminum (or sometimes plastic) container.

The normal types are 'polarized' i.e., they have positive and negative terminals. The anode, or positive terminal, is one of the aluminum foils, with a layer of oxide formed on this foil as the dielectric — the oxide is actually formed as DC current is passed through the capacitor. The type of foil used affects the capacitance, with an etched foil providing a greater contacter area with the electrolyte which forms the cathode, and therefore a much greater capacitance over plain foil types. The other foil contacts the electrolyte and connects the outer world. In many cases, the case is also the cathode, and may be covered in a wrap of plastic as insulation. The paper interleaves serve to prevent shorts between the two electrodes, and hold everything in close contact.

It is possible to obtain non-polarized versions, which can be used in AC or audio applications — you can make your own by connecting two polarized capacitors back-to-back. Never apply AC voltages to polarized capacitors — you run the risk of an explosion which can occur if the capacitor is overloaded. If polarized electrolytics are to be used in AF applications, a DC bias must be applied which is greater than the peak AC voltage to prevent damage.



Polycarbonate: The material has better electrical characteristics than polyester and should be used instead, in ore critical situations. A brass-encapsulated axial form is available for super-critical (i.e., high temperature) applications where price is of no concern!

The electrolyte used depends on the application, but it should be able to repair any damage to the oxide film, and also to recombine any gases evolved by DC leakage current. If this does not happen, pressure will built up in the container with obvious results — larger units usually have a pressure relief arrangement to avoid danger.

Electrolytic capacitors have a large DC leakage current compared with other types, and this factor may be important if the capacitor charge is critical, as say in timing circuits. After a period on the shelf not being used, the oxide layer can start to disintegrate and allow a very large leakage current to flow. If full working voltage is applied in this condition, the capacitor can be seriously damaged — it should be reformed first over a period of hours by passing a small current through the capacitor via a 10-15k resistor, until the leakage current has dropped to a low stable value.

Values of electrolytic types vary from 0uF1 to one farad, and the sizes from very small PCB mount types with wire terminations (either axial or radial), to be very large computer grade types (high reliabili-

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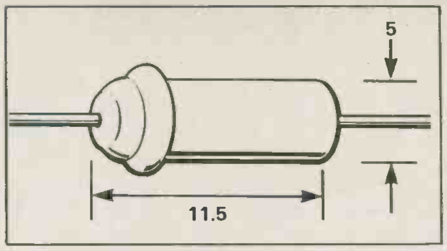
ty), with screw terminals. Working voltages are equally varied from 3 V for high capacity miniature PCB types to 400/600 V for power supply applications. Tolerance groupings are wide — often -20/+80% against nominal marked value.

Tantalum Electrolytic

This material is very popular in the form of tantalum bead capacitors, allowing miniature capacitors which are very stable and have long life — however, most cannot withstand reversed polarity to any extent. The construction of tantalum foil types is similar to that of aluminum types, but using tantalum in place of aluminum. In this case, the size will be similar to an aluminum one.

In wet-slug and solid electrolyte types, the anode is a pellet of masses of tiny tantalum beads partly fused together or a sintered pellet; covering these with a layer of oxide gives a vast increase in capacitance over aluminum types for a given size. The DC leakage current is greatly reduced and there are no shelf life problems; together with the size reduction, these factors make them very popular in high density solid state work, although their cost is appreciably greater. They are very useful for timing circuits.



Polyester: This is a metalized film capacitor used in computer circuits and for professional applications.

Variable Types

These are generally known as 'tuning' capacitors, and are normally air spaced, although vacuum types are available for high power transmitting applications. The evolution of the transistor radio has also brought with it the plastic dielectric variable which offers high capacitance variation in a small, low cost package (sometimes referred to as 'polyvaricons'). Finding the larger high capacitance types is not so easy as it once was, as solid state has virtually eliminated the need for them, but rallies are useful sources if they are needed — otherwise they are expensive to buy new.

The air spaced types are available in a wide variety of sizes, capacitance, and voltage combinations. Multi-section types ganged together are common, and one particular type allows one-half of the gang to increase capacitance as the other half reduces. They are constructed from parallel sets of intermeshed plates, one set of which can rotate. The rotating plates are known as 'rotors' and the fixed plates as 'stators'. They are usually made of aluminum, brass, or copper, and may be silver plated in the last two cases for high frequency applications. The capacitance available is determined by the area of the plates, their number, and the air gap between them.

Varying the shape of the plates as they mesh, is sometimes used to give a logarithmic response to the capacity/rotation curve as an aid to linear calibration curves on analogue tuning dials.

The air gap determines the voltage rating above which arcing will take place between the pces — .015" gap will allow 600 V DC working, while transmitting types may have air gaps as high as 0.25" for 900 V.

Maximum capacitance values vary from a few tens of pF to about 400pF — the minimum capacitance for any unit depends on its construction, and could be around 3 to 5 pF for a 20-40pF maximum, to 20-40 pF for a 360pF version. This minimum unmeshed capacitance has to be taken into account when calculating oscillator or tuning coverages, and also the extra capacitance added by the wiring to the capacitor, usually referred to as 'stray capacitance'.

Trimmer Capacitors

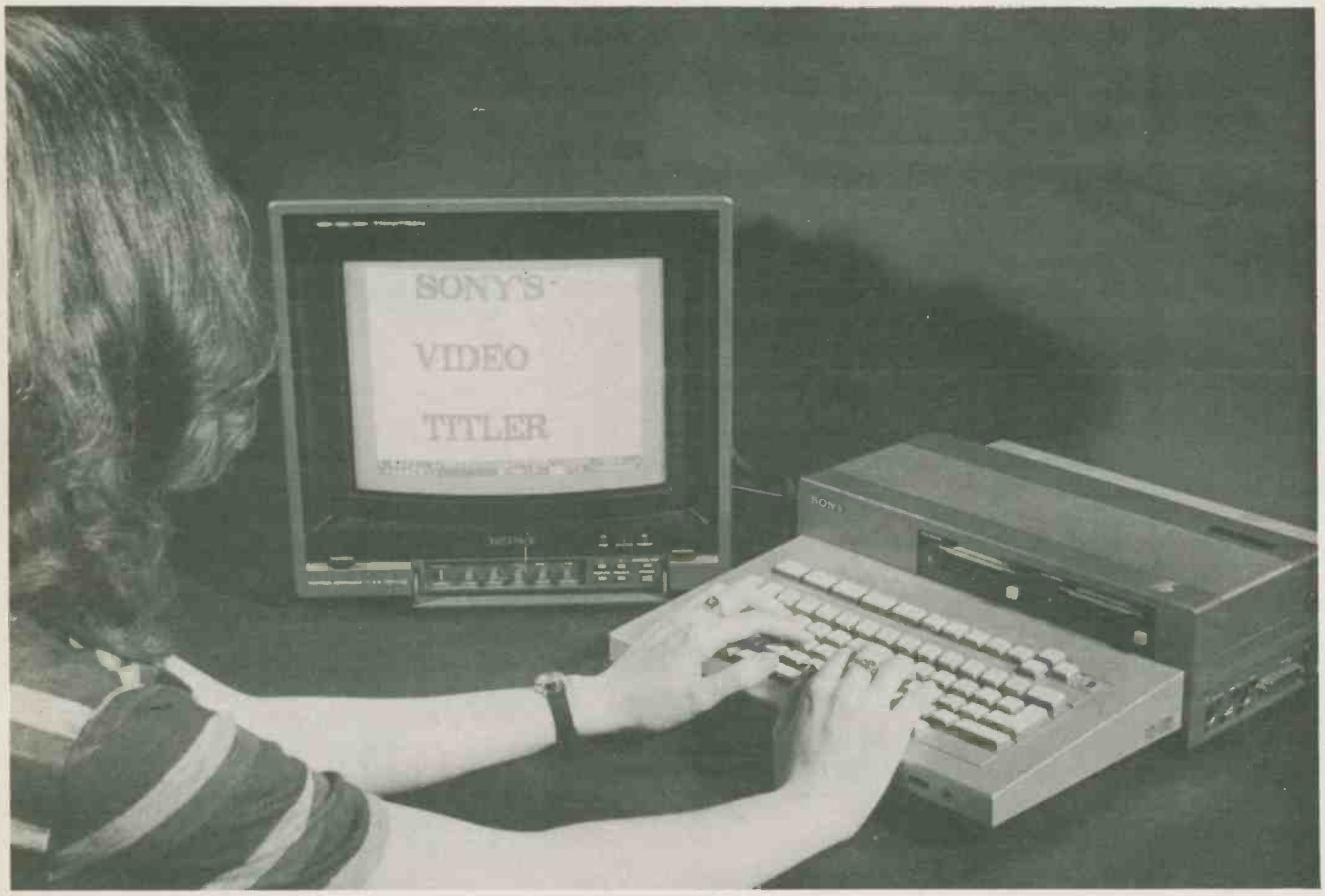
Another area where styles vary immensely. The basic air spaced trimmer is a miniature version of its big brother, with the vanes sometimes cut for a solid slug, rather than made individually as in the largest types. Screwdriver adjustment is normal, rather than via a shaft, and the overall capacitance value is unlikely to be more than 50pF. If higher values are required up to several hundred pF, mica compression trimmers may be used. These consist of two flexible metal plates, between which is a layer of mica. An adjusting screw is inserted through holes in the plates, into a ceramic base — tightening the screw compresses the leaves together, thus varying the capacitance.

Film dielectric trimmers are common now, and give miniature components of high stability — available up to about 60pF maximum.

Ceramic disc trimmers have the advantage of being extremely stable and are available in a wide range of values and sizes — sub-miniature types of only a few mm in diameter can be seen in some watches. Construction is basically a rotor with an area of silver plate on its top surface as one electrode. The other stator plate has a similar plated area, and the two halves are held together by suitable spring pressures. The two mating surfaces are ground very flat for stability. As the rotor is turned, the area of overlapping plate is varied thus altering the capacitnace. Maximum values are about 100pF — the temperature coefficient of these may be several percent of the marked values.

There are, of course, other types of resistor and capacitor which you may come across — however, the preceding encompasses most types, and should help towards a better understanding of the limitations inherent in particular constructions. **ETI**

Sony SMC-70 Review



A new CP/M-based colour computer from the people who brought you go-anywhere-stereo and wristwatch TV.

by Edward Zapletal

WHEN SONY first dropped us a line to let us know that they were sending a micro our way, I thought that my ears were playing tricks on me. Was this the same Sony who have brought us the latest in audio and video gadgetry? You bet your ears it is! Sony's contribution to the ever-growing micro market is the SMC-70 microcomputer, a CP/M based, 8-bit, colour computer.

RAM Charged

At first glance, it looks much like any other micro around. A closer examination reveals a machine which not only runs CP/M, but has some outstanding graphics capabilities as well. The heart of the SMC-70 is the workhorse Z80-A MPU. The 64K bytes of RAM may not seem like much, but considering that on top of this there is an additional 32K bytes of video RAM, 2K of character RAM, 2K of attribute RAM and 2K of Programmable Character Generator RAM (PCG), this should be sufficient for most applications, especially if the disk unit is used. The attribute RAM is used for specifying the colour of characters and symbols, setting the background colour, and inverting between characters and background. As for ROM, there is an ample supply of this as well, 32K bytes. This is comprised of 9K for the System Monitor, 22K for Sony BASIC, and 1K for character font.

From A To Z

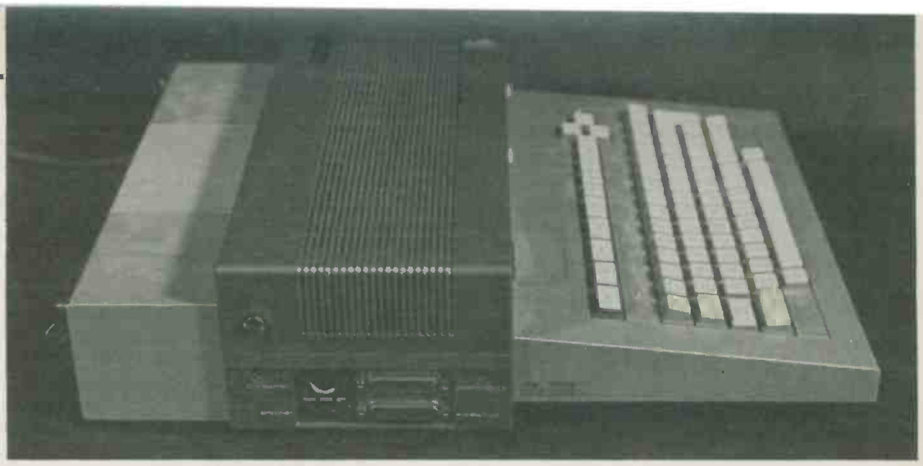
The 72-key QWERTY keyboard is somewhat awkward, but it contains all the necessary buttons for graphics and editing. Next to the space bar there is a very prominent red and white key with an "H" branded on it. At first glance it looks like something one might see on the President's desk in the White House; in reality it is a very useful programmable HELP key which can be used to gain assistance in software such as GRAPHICS EDITOR, GRAFTALK, and certain other applications, including the word processor. The five programmable function keys are the heart and soul of the '70; all the graphics and word processing are controlled quite effectively with these, and once you are used to this system, it's a breeze. There is also full four-way cursoring, as well as HOME, CLR, DEL, and INSERT keys, and the entire keyboard has auto-repeat.

Seeing It In Colour

The SMC's video display is really something, although since it's a Sony you wouldn't expect anything less from the purveyors of BETA and Walkmans. The CRT has three display modes: Character mode, Graphic display, and the Border display, which are superimposed on one another. The Character display is comprised of 8 × 8 dot matrix/character, 80 or 40 char. by 25 lines, and the characters can be programmed in 8 colours. The background colours can be changed and the characters can be inverse or blinking as well. The Graphic mode is broken down into four sub-modes of differing resolution and colour choice: 1) 160 × 100 dots - 16 colours - 4 screen pages; 2) 320 × 200 dots - 16 colours; 3) 640 × 200 dots - 4 colours; 4) 640 × 400 dots in the monochrome mode. The Border display gives a choice of 16 colours. All of this, when displayed through the Sony's KX-1211 HG component TV-RGB monitor, made for a very impressive presentation.

Micro Driving

The SMC-70 which was left with us was accompanied by a dual disk drive unit which accepts the new 3.5 inch, high density mini-disks, which are also in use on the Apple Mac and Lisa computers. This system, developed by Sony, is capable of storing a staggering 1 Megabyte of information on one double-sided, doubled density mini-diskette. Sony supplied us with single-sided single density disks with a capacity of 280K bytes. Also available is a cassette tape storage system, but on a machine such as this, it is highly unlikely that it would be needed for much more than simple programming applications.



CP/M

A comforting thought, when reviewing a new micro, is in knowing that it runs an operating system which is pretty well liked by prit' near everyone. Just pop in the CP/M system disk and you're off to the races. All the normal stuff is there: PIP, STAT, ASM, DUMP, etc. Instead of FORMAT and COPY, Sony uses a utility titled BACKUP, which lumps the two previous ones together into a menu driven utility. The SMC version of CP/M has been extended for colour and graphics applications which are superior in quality to anything on the market of late.

Software

Just as an automobile won't run without some sort of fuel in its tank, a micro is pretty much useless without sufficient supporting software. Aimed at the lower to mid-priced business level, the SMC runs a variety of packages such as: SuperCalc 1 & 2, a complete accounting package, Sony disk BASIC, CB-80 (a souped-up business BASIC for graphics, colour and sound). Data Base Management, Word Processing (WordStar, Letterwriter) with a spelling checker and mailing list option. The really big selling point for the SMC-70, though, is its graphics.

Custom Text

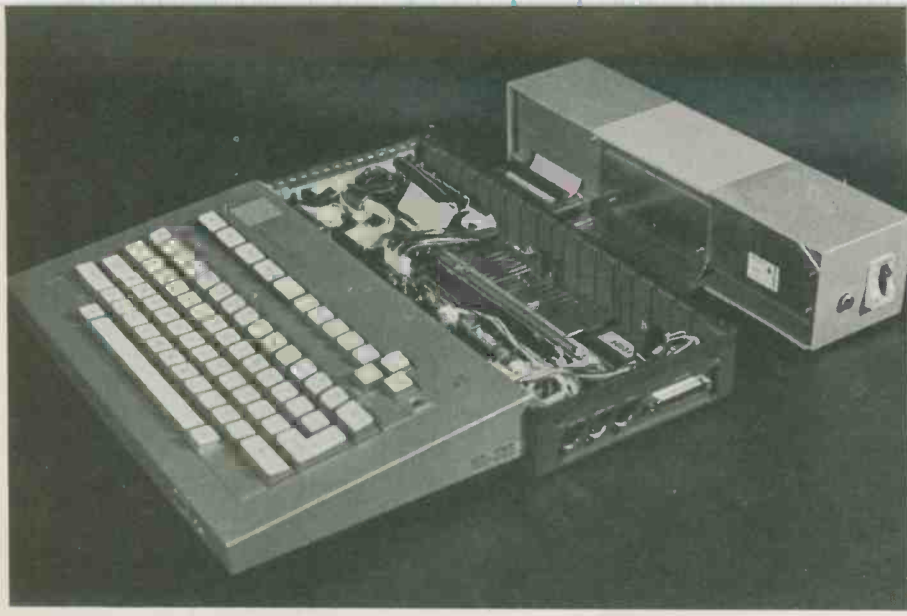
The three packages available are very entertaining and not extremely difficult to learn. The Video Titler package lets you create text in three character sizes, as well as six different type faces in sixteen colours. The text created with the Video Titler can then be superimposed over a video image by interfacing the SMC-70 with a suitable video display system (eg., Sony video disc player and KX-1211 HG component TV). This was demonstrated to me at the recent Computer Fair in Toronto, and the potential for this type of display would seem to lie in the educational, industrial, and tourism sectors, just to name a few.

Disney Anyone?

Graphics Editor is a totally menu-driven package which allows the creation of full colour graphics images from the keyboard or optional graphics tablet. It sports such features as variable "zoom editing." 320 × 200 - 16 colour resolution and superimposition with external video equipment. All graphics are created using the five function keys positioned along the top edge of the keyboard. The commands for drawing, storing, saving, loading, overlaying, etc., are always displayed at the bottom of the screen for easy reference. A data disk supplied by Sony revealed some very colourful likenesses of Disney characters which we could change and tamper with to our heart's content. Concise and meaningful prompts lead you into the various levels of the editor. If at any time you become bogged down, you can always press the panic button (HELP key), which dumps you out to a screen help file and advises you on the correct action to take. So, at this point you think you've lost your treasured graphic creation? Nope, the SMC-70 returns you to where you were when you yelled for help. The one obvious thing which seems to be lacking, at least on a sophisticated graphics machine such as this, is a joystick for moving the cursor around. The Graphics Editor is certainly worth the look if you're thinking of graphic assisted displays for any reason.

Bars and Pies

Generating charts and graphs is usually a chore when the software being used is just not quite good enough. Sony's Graftalk



number of existing Z80 based systems, as well as Sony's reputation as a leading electronics manufacturer, the SMC-70 will probably survive the flooding market. The cost of the SMC-70 can be broken down as follows: Computer $1895, Dual Micro-drive Unit $1495, Printer $1095, Trinitron Component TV KX-1211 HG $1299, RGB and Printer cables $90 each. CP/M and one of either the Word Processor or Data Base Management packages are included. For more information contact: Daryl Duda, Sony Marketing Headquarters, 411 Gordon Baker Rd., Willowdale Ont., M2H 2S6. (416) 499-1414.

package makes it quite simple to enter the data, title the various axes, as well as colour and label desired portions of your work. There is also the capability of using SuperCalc data with Graftalk, as well as data created with Letterwriter, eliminating the need for re-entry of lengthy data files.

End of File

After having explored the SMC-70 for a few days, it would seem that it certainly has a future in the video graphics market. Its one strong point is that it's a CP/M based system which has very good software potential, and very good graphics capabilities which are not found on too many CP/M systems. Its ability to interface with video systems makes it attractive for presentations of all kinds. However, the era of the 8-bit micro would seem to be passing, slowly, but still passing. But given the reliability of CP/M and the

Quick Reference

Mfg:	Sony
Price:	Computer $1895, drives $1495
CPU:	Z80A
RAM:	64K user plus 38K video
Screen:	40 or 80 × 25
Graphics:	320 × 200
Colours:	16
Sound:	Yes
Video:	RGB

ETI

FIRST ISSUE
OCTOBER 1984

Software Now!

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Not knowing about software is a multiple edged sword. Not only don't you know what you need; you don't even know what you're missing. It's terribly easy to leap upon the first package that comes within waving distance of your application and then bend your application to suit it.

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Steve Rimmer
Editor,
Software Now!

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First Issue Oct

A New Canadian Publication for the Ultimate Medium

The difference between we humans and the other inhabitants of the planet is our capacity for making tools. Civilization is often measured by its grasp of technology . . . it's through his use of tools that man has come to be able to manipulate his environment.

The computer is the ultimate tool . . . it is, like man himself, unspecific, and thus adaptable to virtually any task. The same computer can be a bookkeeper, a game, an artist's palette, a composer's amanuensis, a word processor or a programmer's development station.

The computer itself is simply a box full of chips. The power of computers lies in the software that runs on them.

Software Now! is the new magazine for people harnessing the power of the microcomputer. In its pages you will find the information which you will need to choose and apply the software that will dedicate your computer to your tasks. It will help you make sense of the miriad of similar software packages, translate the intricate complexities of software claims, understand the watershed breakthroughs in software development . . . and even have a bit of time left over to dematerialize a few aliens.

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Software Now! will be dealing with a broad range of systems and applications, encompassing eight, sixteen and thirty-two bit machines and software as diverse as video games, drafting systems and spreadsheets.

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The key to that software is understanding.

The key to understanding software is Software Now!

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Software Now! is published by Moorshead Publications, which also brings you Computing Now!, Electronics Today, Computers in Education and the Printout newsletter. It has been producing successful magazines in Canada since 1977.

Moorshead Publications is unique in the way it produces magazines. The expertise in applying microcomputers has allowed us to make virtually the entire process of publishing electronic. The editorial in the publications is created on word processing terminals and computer type set. All the financial planning is handled by computer, as is filing and list management. The company also maintains an on line telecommunications computer to communicate with its readers.

The Editor of **Software Now!** is Steve Rimmer, who also edits Computing Now! In the first year of its existence Computing Now! went from a standing start to having over twenty two thousand subscribers, making it Canada's largest consumer microcomputer publication.

Steve has had experience with a wide range of software, from word processors to sophisticated music and graphics packages. He uses a number of computers, including several CP/M based machines, an IBM, an Apple II+, a Commodore and a MacIntosh.

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Features In The Queue

This is some of the editorial we have lined up for the first few issues of Software Now! You can expect it to change a bit . . . new software springs up almost daily, and Software Now! will always feature the most important developments in this dynamic field. Articles being developed during the preparation for the magazine include:

Computer Aided Drafting On a Micro • Techniques in MacPaint • How to choose a Spreadsheet • Apple Software Crate • Getting to the Root of UNIX • The Digital Research Pantry • A Thousand and One Word Processors • IBM's Productivity Family • Can Mac Write? • Professional Software Roundup • Power Programs for the 64 • Approaching the C • Word Processing Support Programs • dBase II Enhancements • Will it Run Multiuser? • Concurrent CP/M •.

Reviews: 10 Base • Mighty Mail • WORD-BASE • Easy Script • Computer Chef • Electronic Circuit Analysis Program • Superex Retailer • MAI Basic Four • The Print Shop • TK!Solver • Microsoft BASIC for the Macintosh • Sundog • Turbo PASCAL for the IBM • AutoCAD • MultiMate • Lexicheck and Word Juggler • Dataflex • Symphony • Omniterm 2 • DB Master • Paint Magic.

In addition to this look for these regular features:

The Library (Our monthly survey of books)
By The Boards (Public domain software)
Arcade (A blast at the latest games)
Short File (A short overview of new releases)

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CalcNow: A real spreadsheet program with many as the new features of programmes costing a small fortune. CalcNow is perfect for those who want to experiment with a spreadsheet and are dying to see how they work. It is far from a toy.

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Poker: Life is not complete without a video game.

Phone Jack: A telecommunications terminal.

The contents of the disks vary depending on the system and additional programs come for some systems: see overleaf for a more complete description.

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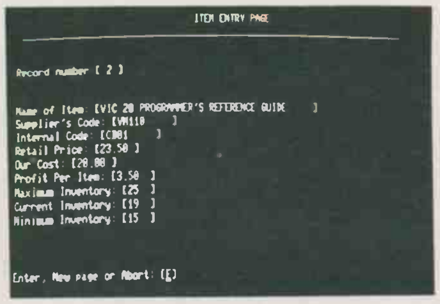

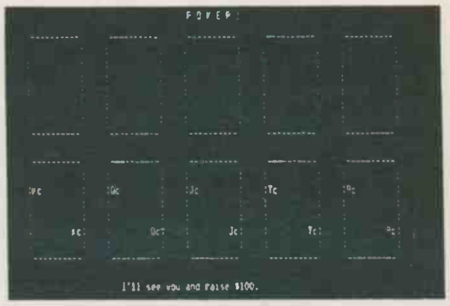

CalcNow

CalcNow is a fully capable spreadsheet package. It can manage a sheet sixteen columns across by twenty six rows deep. It allows for automatic and manual recalculation, full cursor movement, formulae, constants and labels, disk storage of your sheets and a full hard copy reporting function. Its syntax and behavior is very much like that of the popular packages and for models of the size usually used in small business and personal financial planning it's equivalent to professional . . . and very much more expensive . . . spreadsheet packages.

Phone Jack

Most computers have telecommunications hardware built into them . . . it's a shame that they don't all have software available to drive it. This program does basic telecommunications and, while its features do vary a bit from system to system . . . based on what the operating systems allowed us to impliment . . . it does provide for the basic requirements of calling computer bulletin boards and dial up mainframes.

Utility Pack

Most revisions of the disk will also have a choice selection of utility programs. These vary a lot from system to system so it's a bit difficult to describe them all here. However, these are the little routines that make life so much easier when you sit down at the keyboard and switch on.

DataBox

Many commercial data base managers are extremely powerful, extremely expensive and, in fact, grossly over qualified for most tasks. DataBox can handle most of their routine tasks that data base managers are bought for. It is efficient of disk space, reasonably fast and very, very flexible. It can keep track of your files, your stock . . . or even your record collection. It features variable fields, hard copy reporting and flexible search parameters.

Poker!

We wanted to include a game on the disk and, after some deliberation decided that a good dimly lit, smokey card game would fill the bill best. This one simulates five card draw poker in the proper cowboy style. It can deal, draw, call, bet . . . do everything but cheat and pull its six gun on a really bad hand. POKER! features a graphic display of the cards being played.

These programs will vary a bit from system to system . . . the following outlines the formats in which we can supply this software. You will need your own Microsoft compatible suitable BASIC Interpreter (e.g. GWBASIC, BASIC-80, MBASIC, APPLESOFT, RS BASIC, PET BASIC, Microsoft MacIntosh BASIC etc.)

For CP/M* users: CalcNow, DataBox, Poker!, Utility Pack, Phone Jack

For Apple][+ DOS Users: CalcNow, Databox, Poker!, Phone Jack, Utility Pack plus Clef Hanger (An Apple Music Box), Skyhook (a teletype converter) and Fruit Crate (a BBS).

For IBM Users: CalcNow, Databox, Poker!, Utility Pack, Phone Jack plus Bandit (A slot machine simulator)

For MacIntosh Users: CalcNow, Databox, Poker, Phone Jack and Letterhead (a stationary generator).

For Commodore Users: CalcNow, Databox, Poker, Utility Pack and Phone Jack.

For TRS-80 Model III and 4: CalcNow, Databox, Poker

This software is available as a free gift to charter subscribers to Software Now! magazine. To be eligible to receive this disk your subscription order must be at our offices no later than September 30th, 1984.

*Available for Apple CP/M, Osborne single and double densities, Access Matrix, Kaypro II, Lobo max 80, Morrow Micro Decision, Olympia single and double, Superbrain, Systel/Olympia, DEC VT-180, Nelma Persona, Xerox/Cromemco, 3R Avatar, Casio FP-1000, Epson QX-10VD, Attache, Micromate, if800, Sanyo MBC 1000, Televideo, Zorba and on eight inch single sided single density disk.

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TRS	Radio Shack Models 3 & 4
CBM	Commodore Disk formats
ACP	Apple CP/M
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OS2	Osborne Double Sided
AMT	Access Matrix
KAY	Kaypro
LOB	Lobo max 80
MOR	Morrow Micro Decision
OL1	Olympia Single sided
OL2	Olympia Double sided
SBR	Superbrain
SYS	Systel/Olympia
DEC	DEC VT-180
NEL	Nelma Persona
XER	Xerox/Cromenco
3RA	3R Atavar
CAS	Casio FP-1000
EPS	Epson QX-10VD
ATT	Attache
MIC	Micromate
SAN	Sanyo MBC 1000
TEL	Televideo
ZOR	Zorba
IF8	if800
8"	8" Disk Single Sided, Single Density

Machine Language Part 2

In this second part of this series, Bob Bennett looks for implied and immediate addresses on the computer's memory map.

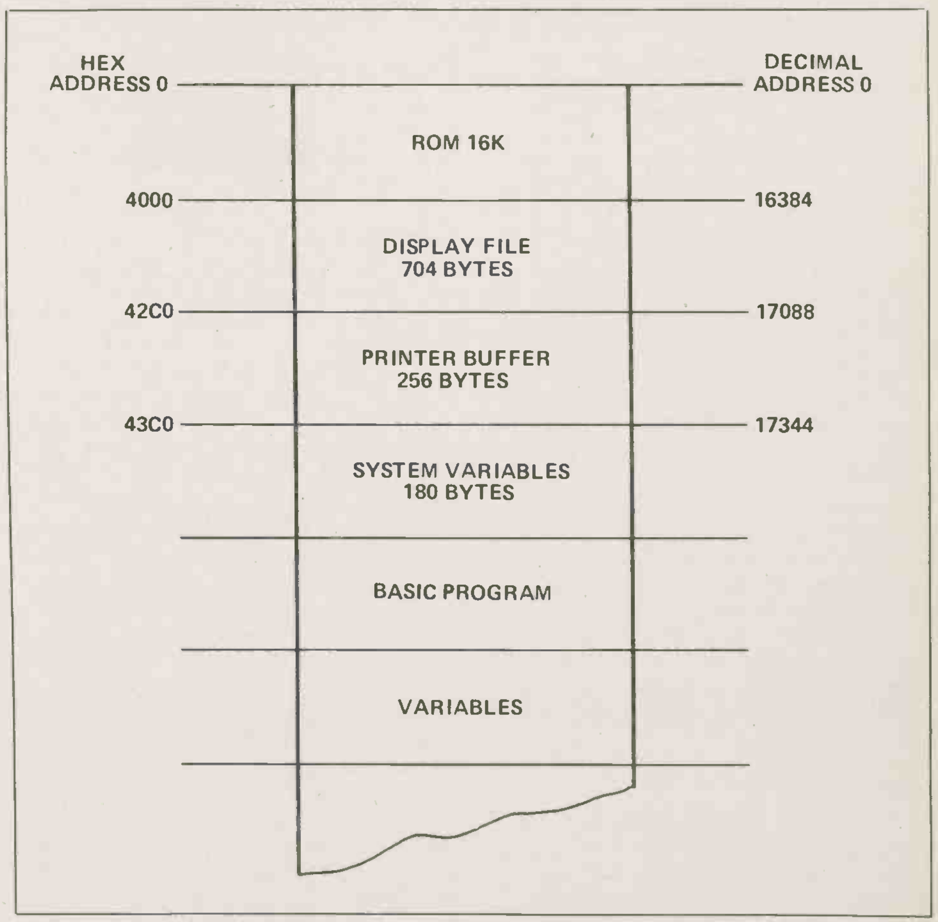

Fig. 5 Portion of generic memory map.

WHEREABOUTS in RAM your machine code program will go depends on the memory structure of your computer. A look at the computer's memory map will show the areas in RAM reserved by the computer for 'housekeeping' duties. These duties consist of keeping tabs on everything that happens while the computer is switched on. Figure 5 shows a portion of a memory map for no computer in particular; how it works is fairly simple, but does require a lengthy explanation.

The *display file* is shown as occupying 704 addresses, each of one byte: these 704 bytes store information relating to the picture on the screen. The working area of the screen in our example consists of 32 columns by 22 rows, and 32 times 22 equals 704. The reason I referred to working area is that there are usually two rows at the bottom of the screen reserved for the input data. As a rule the top left hand corner of the screen is position 0,0, and this is the first address in the display file. Suppose that you printed the letter A in position 0,0: the code for letter A would be stored in address 16384.

The *print buffer* is merely a temporary storage area for data going out to a printer, but this area can often be used by the programmer.

Any good computer handbook has a section devoted to the *system variables,* which are a series of reserved addresses usually given short names. These addresses contain information, dealing with which comprises the major portion of the housekeeping I mentioned before. Each system variable consists of one, two, or very rarely, three or more bytes. If there is only one byte then the address will usually contain a number, the value of which may determine the action to be taken by the computer.

If there are two bytes, then the two consecutive addresses of the system variable themselves hold an address. This is usually the starting address of an area in RAM where a particular variable is stored. For example, when you assign letters or strings as variables, the information relating to those variables is held in an area of memory. If you had a system variable called VARS, this would consist of two bytes, and would hold the starting address of that area.

The area of RAM, from the system variables onwards, is the part that is of primary interest to machine code programmers. As your list of variables is added to, or subtracted from, then the area it occupies can fluctuate. This is true of the area taken up by your BASIC program, as you add or delete lines. Areas in RAM can be reserved for machine code programs, and there is usually plenty of information around telling you how to do it for your particular computer.

How . . .

Once you have found out where to put your program, the next task is to get it there! There is really only one way it can get there, but there are several methods of doing it (that's a bit like saying 'there is only one road to Rome, but there are many means of transportation'). The program is POKEd into addresses, byte by byte. Starting with the first address, and the first byte, the addresses are incremented after each POKE.

If you're not familiar with POKE, it's how you get information into RAM. Consider this example of a direct command, POKE 32000,119 decimal: this means place the decimal number 119 into address 32000. If your computer allows you to use hex direct, then the command could be POKE 32000,77 hex. The complementary command to POKE is PEEK, so, after entering the above example, the instruction PEEK 32000 would cause the number 119 decimal to be printed to the screen. Of course, you can only POKE information in RAM, but you can PEEK at either RAM or ROM.

Probably the most widely used method of entering machine code programs into home micros is with a hex loader. If your micro doesn't support hex direct, then the hex code has to entered as a string, sliced and then converted to decimal before POKEing into the addresses. Otherwise, the decimal conversion can be left out. Another method might use the READ/DATA statements if your computer has them.

Assemblers and compilers can also be used to get your program into memory. Taking the assembler first, this is a program that could either be resident in ROM or loaded in via tape, etc. This will take your assembler language statements and convert them into machine code. Before the program can run, however, the statements are checked for validity, and an opportunity is given to edit the program. A compiler is a program, usually loaded into the computer, which converts a higher level language, such as BASIC, into machine language. If the last two methods have to be loaded in then they do use up memory, which is usually a precious commodity. So how the program gets into the computer is a combination of personal preference and what your computer will support.

What . . .

The instruction set, mentioned last month, is where you will find all the instructions you will use in machine code programing. Ideally they will be in tabular form, giving both decimal and hexadecimal notation, and sometimes you might find the binary form given as well. Also they should include the assembler mnemonics, and the number of bytes per instruction. Those of you with Sinclair micros have everything that you need, apart from the byte count, in the handbook. Because the instruction set for the Z80 is very comprehensive I will be using that for the examples I give. Don't worry if your computer doesn't have a Z80 CPU, the same principles will apply.

Don't Forget The Post Code!

Before very long 16-bit micros will be as common in the home as the eight-bit ones are now, but until then I will be dealing only with the eight-bit variety. Addressing modes are simply a way of getting around the fact that addresses require 16 bits, but our data word is only eight bits long. The first addressing mode I'll explain is the implied because it is the simplest, and only one byte long.

Sometimes known as the register direct, the *implied mode* is so named because the data source and destination are implied in the instruction. For example, to load the B register with the contents of the C register requires the instruction 41 hex in the Z80 set. Here the source is the C register and the destination, the B register; this could be shown as C   B. Incrementing and decrementing registers, and No OPeration and RETurn instructions use the implied mode.

NOP, or no operation, is self explanatory, nothing happens (nothing, that is, except a fractional waste of time). This is a very useful instruction that could be used in a timing loop, or to occupy addresses that you intend to overwrite with data later on in the program. Or perhaps you haven't quite decided what to do in one patch of the program. An approximate number of NOPs will reserve the space for you until you have made up your mind. As for the RETurn, this is perhaps the most important instruction you will use. Without it, in some computers, you could be stuck in an infinite loop. In its simplest form, it can be regarded as an instruction to return to the place from where you were sent — more will be explained later.

All simple register to register transfers use the implied mode, but as an exercise see how many of these instructions you can find in your set. The golden rule is that there is one byte in the whole instruction.

For Your Immediate Attention

The immediate mode is the next easiest addressing mode that you can use. As with the implied, the immediate mode does not involve any addresses, but there are now two bytes per instruction. The instruction 3E hex in the Z80 set means load register A with the number that follows; in the 6502 set the same instruction would be A9 hex. This might have the mnemonic Ld A,n, or M   A, or even MV1 A,D8; note that the names are not CPU instructions; they are just humanised memory aids. That last menmonic sums everything up nicely because it means, move immediate(ly) into A a data byte of eight bits. Other instructions of this type include add n to a particular register or subtract n from a particular register. Again as an exercise, pick out all the immediate mode instructions out of your set.

Now that we have reached two byte instructions, I'd like to clear up a point that seems to confuse newcomers to machine code programming. The idea that the same byte can represent two different things might seem at first glance to be perplexing, but stop and think. Let me take as an example the instruction above, load A with n. This could be written in a Z80 program as 3E,3E (or for the 6502, A9,A9). What happens is that when the computer gets to the first 3E it regards it as an instruction, an instruction to load the byte that follows (which also happens to be 3E) into register A. What the second number stands for is up to you, as the programmer, to decide. It may be just a number you want to manipulate, or it could be the code of a character you want to print to the screen. Whatever, the computer recognized the first 3E (or A9), as an instruction requiring two bytes. After carrying out that instruction, the computer would carry on with the rest of the program from the instruction which came after the second byte. Every instruction belongs to a class that requires one, two, or more bytes for proper execution. It is the programmers responsibility to ensure that the computer starts off in the right place! **ETI**

"It was very expensive, but it's an authentic old crystal set. You can tell, because the digital frequency readout is in Roman Numerals."

6502 Utilities

Even though manufacturers have been producing microprocessors with thirteen digit names for years now, the 6502 is still a programmer's favourite. Three programs are listed below to give your fingers some practice. You'll also learn why the chips in your computer try to crawl out of their sockets at night...

by John Rudzinski

AT around six-thirty in the morning, after watching the obligatory morning cartoons, a select breed of professional worker goes to work in Silicon Valley, U.S.A. Grabbing a quick coffee and a wicker basket, these hard workers trod into the fields to begin their backbreaking occupation.

Chip picking.

In the summer months, the chiptrees blossom. Branches bend with bough-breaking clusters of TTL, op-amps, encoder-decoders, and microprocessors. When ripe, the chips fall — feet earthward — to the ground where the chip-pickers stoop to collect them.

The oddballs on the chiptrees fall upside down, feigning death in hope of escaping unseen under cover of darkness. This is to be expected of the inverting amplifiers, but seems unusual for the TTL... the so-called logic chips.

The favourite fruit of the chiptree, however, is the 6502 microprocessor. Admittedly, it's nothing fancy... what with an eight-bit accumulator, two eight-bit index registers, an eight-bit stack pointer and a sixteen-bit program counter, it's fairly archaic as opposed to some of the monsters that've been skittering out from Intel and MOS Technology these days. Still, it's a remarkably easy chip to both understand *and* program, which is why it remains a favourite today.

Quickies

The three short assembly programs that follow are written for the Apple][+ computer or similar abomination. There's a reason for this... it's the only micro I have.

I used to have a VIC-20, but I'm okay now.

Program One, *Password Protection*, isn't actually a program... it's a subroutine to a program that you have to supply. It might prove useful in a disk pre-boot situation where you don't want Russian spies diddling with your data. When BRUN, it lets potential perpetrators know that your program is protected, and they're to supply a password before anything useful will happen. If, in this case, "BLA-AT", (the sound of an unhappy disk drive) isn't typed in, the program will gleefully erase itself from memory.

Naturally, you're free to replace the password with any six letter word that strikes your fancy. Be careful to BSAVE before you BRUN it... backspaces are considered valid characters as well.

If you've spent hours looking around for a chart to find the hexadecimal equivalents of a number of keyboard characters, you might get a kick out of Program Two. Comprised of 262 bytes, it will inhale a string or strings of up to 255 bytes rattled off the keyboard, ponder the meaning of life for a few moments, then spew out the hex. Before I obtained a sympathetic assembler, I always had to look each character up in a table, then jam them individually into memory to display whatever string I wanted to convince to burn CRT phosphor.

Hitting a Control-C will tell the program you've finished your input unless you type over the 255 character limit. It gets somewhat violent should this happen and lays the hex on you unrequested. You just can't convert a novel to hex with a 262 byte program.

```
:ASM
                 *****************************
                 *
                 *    PASSWORD PROTECTION
                 *
                 *  (C) 1984 - J. RUDZINSKI
                 *
                 *****************************
                 *
                           ORG  $0800
                 *
                 BUF       EQU  $2000
                 CLS       EQU  $FC58
                 GET       EQU  $FD35
                 PRINT     EQU  $FDED
                 C/R       EQU  $FD8E
                 BASIC1    EQU  $E000
                 *
0800: 18         FIND      CLC
0801: 90 2F                BCC  BEGIN
0803: C2 CC C1   PASS      ASC  "BLAAAT"
0809: D4 C8 C9   STR1      ASC  "THIS  PROGRAM PROTECTED."
0820: 8D                   DB   #$8D
0821: 8D                   DB   #$8D
0822: C5 CE D4   STR2      ASC  "ENTER PASSWORD: "
0832: 20 58 FC   BEGIN     JSR  CLS
0835: A2 FF                LDX  #$FF
0837: E8         XLOOP1    INX
0838: E0 29                CPX  #$29
083A: F0 09                BEQ  PASSGET
083C: BD 09 08             LDA  STR1,X
083F: 20 ED FD             JSR  PRINT
0842: 18                   CLC
0843: 90 F2                BCC  XLOOP1
0845: A2 FF      PASSGET   LDX  #$FF
0847: E8         XLOOP2    INX
0848: E0 06                CPX  #$06
084A: F0 2E                BEQ  RIGHT
084C: 20 35 FD             JSR  GET
084F: 48                   PHA
0850: A9 D8                LDA  #$D8
0852: 20 ED FD             JSR  PRINT
0855: 68                   PLA
0856: DD 03 08             CMP  PASS,X
0859: D0 3B                BNE  BYE
085B: 18         AROUND    CLC
085C: 90 E9                BCC  XLOOP2
085E: 8D         STR3      DB   #$8D
085F: D9 CF D3             ASC  "YOUR  PROGRAM STARTS HERE..."
087A: 20 8E FD   RIGHT     JSR  C/R
087D: A0 00                LDY  #$00
087F: CC 95 08             CPY  DATA
0882: D0 18                BNE  WIPE
0884: A2 FF                LDX  #$FF
0886: E8         XLOOP3    INX
0887: E0 1C                CPX  #$1C
0889: F0 09                BEQ  END
088B: BD 5E 08             LDA  STR3,X
088E: 20 ED FD             JSR  PRINT
0891: 18                   CLC
0892: 90 F2                BCC  XLOOP3
0894: 60         END       RTS
0895: 00         DATA      DB   #$00
0896: 8E 95 08   BYE       STX  DATA
0899: 18                   CLC
089A: 90 BF                BCC  AROUND
089C: A9 BF      WIPE      LDA  #$BF
089E: A2 FF                LDX  #$FF
08A0: E8         XLOOP4    INX
08A1: E0 96                CPX  #$96
08A3: F0 06                BEQ  END1
08A5: 9D 00 08             STA  FIND,X
08A8: 18                   CLC
08A9: 90 F5                BCC  XLOOP4
08AB: 4C 00 E0   END1      JMP  BASIC1

--- END ASSEMBLY ---

TOTAL ERRORS: 0
```

My favourite creation is Program Three. Entitled *Subliminal Advertising*, it's the shortest of the three listings at 111 bytes. It's a bit odd in that it appears to simply ask a question and then wait for your input. What it's actually doing is laying in wait for a victim to answer its query. No matter what is typed, one of ETI's sister publications shows up on the screen, one character at a time, in response to each keypress.

The public has a right to know.

```
:ASM
                 *************************
                 *
                 * STRING INPUT AND HEX
                 *
                 *     CONVERSION
                 *
                 *************************
                 *
                            ORG  $0800
                 *
                 BUF        EQU  $2000
                 CLS        EQU  $FC58
                 GET        EQU  $FD35
                 ?HEX       EQU  $FDDA
                 PRINT      EQU  $FDED
                 C/R        EQU  $FD8E
0800: 4C 22 08              JMP  BEGIN
0803: C5 CE D4   STR1       ASC  "ENTER STRING. HIT ^C WHEN DONE."
0822: 20 58 FC   BEGIN      JSR  CLS
0825: A0 FF                 LDY  #$FF
0827: C8         YLOOP1     INY
0828: C0 1F                 CPY  #$1F
082A: F0 09                 BEQ  ENTER
082C: B9 03 08              LDA  STR1,Y
082F: 20 ED FD              JSR  PRINT
0832: 18                    CLC
0833: 90 F2                 BCC  YLOOP1
0835: 20 8E FD   ENTER      JSR  C/R
0838: 20 8E FD              JSR  C/R
083B: A2 FF                 LDX  #$FF
083D: E8         XLOOP1     INX
083E: E0 FF                 CPX  #$FF
0840: F0 25                 BEQ  ?STRING
0842: 20 35 FD   GRAB       JSR  GET
0845: A8                    TAY
0846: C0 83                 CPY  #$83
0848: F0 10                 BEQ  ?STRING
084A: C0 88                 CPY  #$88
084C: F0 09                 BEQ  BKSPACE
084E: 9D 00 20              STA  BUF,X
0851: 20 ED FD              JSR  PRINT
0854: 18                    CLC
0855: 90 E6                 BCC  XLOOP1
0857: 20 ED FD   BKSPACE    JSR  PRINT
085A: A9 A0                 LDA  #$A0
085C: 20 ED FD              JSR  PRINT
085F: A9 88                 LDA  #$88
0861: 20 ED FD              JSR  PRINT
0864: 18                    CLC
0865: 90 DB                 BCC  GRAB
0867: 8A         ?STRING    TXA
0868: 48                    PHA
0869: 20 8E FD              JSR  C/R
086C: 20 8E FD              JSR  C/R
086F: 18                    CLC
0870: 90 10                 BCC  NOTE
0872: C1 CE C4   STR2       ASC  "AND   NOW, IN HEX:"
0882: A0 FF      NOTE       LDY  #$FF
0884: C8         YLOOP2     INY
0885: C0 11                 CPY  #$11
0887: F0 09                 BEQ  CONVERT
0889: B9 72 08              LDA  STR2,Y
088C: 20 ED FD              JSR  PRINT
088F: 18                    CLC
0890: 90 F2                 BCC  YLOOP2
0892: 20 8E FD   CONVERT    JSR  C/R
0895: 20 8E FD              JSR  C/R
0898: 18                    CLC
0899: 90 01                 BCC  SKIP
089B: 00         DATA       BRK
089C: 68         SKIP       PLA
089D: 8D 9B 08              STA  DATA
08A0: A2 FF                 LDX  #$FF
08A2: E8         XLOOP2     INX
08A3: EC 9B 08              CPX  DATA
08A6: F0 0E                 BEQ  END
08A8: BD 00 20              LDA  BUF,X
08AB: 20 DA FD              JSR  ?HEX
08AE: A9 A0                 LDA  #$A0
08B0: 20 ED FD              JSR  PRINT
08B3: 18                    CLC
D8B4: 90 EC                 BCC  XLOOP2
08B6: 18         END        CLC
08B7: 90 0D                 BCC  CHOICE
08B9: CD CF D2   STR3       ASC  "MORE? (Y/N): "
08C6: 20 8E FD   CHOICE     JSR  C/R
08C9: 20 8E FD              JSR  C/R
08CC: A2 FF                 LDX  #$FF
08CE: E8         XLOOP3     INX
08CF: E0 0D                 CPX  #$DD
08D1: F0 09                 BEQ  YESNO
08D3: BD B9 D8              LDA  STR3,X
08D6: 20 ED FD              JSR  PRINT
08D9: 18                    CLC
D8DA: 9D F2                 BCC  XLOOP3
08DC: 20 35 FD   YESNO      JSR  GET
08DF: AA                    TAX
08E0: E0 D9                 CPX  #$D9
08E2: D0 15                 BNE  BYE
08E4: A9 D9                 LDA  #$D9
08E6: 20 ED FD              JSR  PRINT
08E9: A9 C5                 LDA  #$C5
08EB: 20 ED FD              JSR  PRINT
08EE: A9 D3                 LDA  #$D3
08F0: 20 ED FD              JSR  PRINT
08F3: 20 8E FD              JSR  C/R
08F6: 4C 22 D8              JMP  BEGIN
08F9: A9 CE      BYE        LDA  #$CE
08FB: 20 ED FD              JSR  PRINT
08FE: A9 CF                 LDA  #$CF
0900: 20 ED FD              JSR  PRINT
0903: 60                    RTS
0904: 00                    BRK
0905: 00                    BRK
--- END ASSEMBLY ---
TOTAL ERRORS: 0
262 BYTES GENERATED THIS ASSEMBLY
```

```
:ASM
                 *******************************
                 *
                 * SUBLIMINAL ADVERTISING
                 *
                 * (C) 1984 - J. RUDZINSKI
                 *
                 *******************************
                 *
                            ORG  $0800
                 CLS        EQU  $FC58
                 GET        EQU  $FD35
                 PRINT      EQU  $FDED
                 C/R        EQU  $FD8E
                 *
                 *
0800: 20 58 FC              JSR  CLS
0803: 18                    CLC
0804: 90 2A                 BCC  QUERY
0806: D7 C8 C1   STR1       ASC  "WHAT IS YOUR FAVORITE COMPUTING"
0825: 8D                    DB   #$8D
0826: CD C1 C7              ASC  "MAGAZINE? "
0830: A2 FF      QUERY      LDX  #$FF
0832: E8         XLOOP1     INX
0833: E0 2A                 CPX  #$2A
0835: F0 21                 BEQ  ANS
0837: BD 06 08              LDA  STR1,X
083A: 20 ED FD              JSR  PRINT
083D: 18                    CLC
083E: 90 F2                 BCC  XLOOP1
0840: C3 CF CD   STR2       ASC  "COMPUTING NOW! MAGAZINE."
0858: A2 FF      ANS        LDX  #$FF
085A: E8         XLOOP2     INX
085B: E0 18                 CPX  #$18
085D: F0 0C                 BEQ  END
085F: 20 35 FD              JSR  GET
0862: BD 40 08              LDA  STR2,X
0865: 20 ED FD              JSR  PRINT
0868: 18                    CLC
0869: 90 EF                 BCC  XLOOP2
086B: 20 8E FD   END        JSR  C/R
086E: 60                    RTS

--- END ASSEMBLY ---

TOTAL ERRORS: 0

111 BYTES GENERATED THIS ASSEMBLY
```

Escape

Night falls with a hushed thud, and the crickets rub their legs together in anticipation. The pickers have gone home to their respective basement apartments and the lights in the deserted factory hum endlessly to an absentee audience.

Crawling out from under a dandelion carcass, a 74LS02 stretches its fourteen silvery legs, peers carefully through the grass, then:

The gunshot report cracks through the still air, and the newly-ventilated chip does an inspired airdance before landing at the feet of the poacher.

"Poor little runt," he muses, dropping the deceased into a sack full of its brethern.

He lifts the sack over his shoulder and begins his walk home. It's been a good haul. There'll be chips with the fish tonight.

ETI

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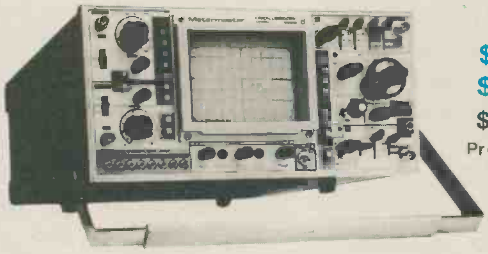

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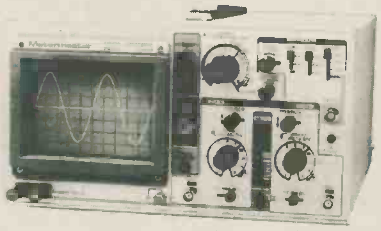

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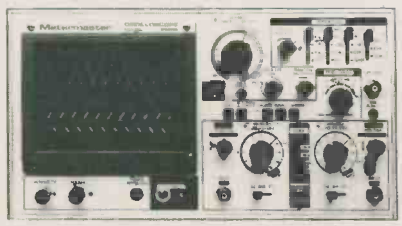

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CIRCUIT IDEAS

Camera Remote Control

The infra-red remote controller gives the freedom to shoot photos from a distance, even from the other side of a window.

MANY of the more recent cameras to come onto the market have provision for an electric remote release, with the camera either being triggered directly or via an autowinder/motordrive. This type of release simply consists of a twin cable with a push button switch at one end and a plug at the other to match the camera or winder. The switch activates either the electronic shutter or an actuator in the winder. This method gives excellent reliability, but it still requires a long cable to carry the signal to the camera. This can be undesirable for some types of photography, and the cable also makes an excellent trip-wire!

For many purposes it is better to use a wire-less method of control, such as an infra-red or ultrasonic system. The latter offers slightly greater range, but infra-red systems have the advantage of operating quite well through a window, so that the camera equipment outside the house can be operated from within. The camera control system described here is of the infra-red type, operates reliably over a range of at least 6 metres, and is at least equal in this respect to the air release which it was designed to replace. It has mainly been used with a Pentax LX camera plus autowinder, but it also worked well when tried with a Minolta XD7 (which is triggered directly), and it should work with any camera which has an electric release facility. The prototype has been built as a single channel system, but the equipment could easily be modified for multichannel use with multi-camera set-ups, as will be explained in greater detail later.

The System

The block diagram of Figure 1 shows the arrangement used in this remote control system, as it is not practical to use a high output power from the receiver. A simple DC system is consequently impractical, as the signal received from the transmitter would often be swamped by the ambient infra-red level. Instead, an AC system is used, with the transmitter providing an amplitude modulated beam. The infra-red signal is generated using a special type of light emitting diode, and this is driven from an audio oscillator via a buffer stage which provides the fairly high drive current required. This gives a crude form of modulation with the LED simply being switched from fully on to fully off, but for this application nothing more complex is needed.

The audio frequency output from the diode is not likely to be very large in practice, and would typically only be a few tens of microvolts. A high gain amplifier is therefore used to boost this signal to a high enough level to operate the following stage, which is a Phase Locked Loop tone decoder. This circuit has an electronic switch at its output, and this is turned on if an input signal at a frequency within its narrow locking range is received. The transmitter is adjusted so that its operating frequency is at the centre of the locking range, where the PLL decoder is most sensitive.

There are two reasons for the use of a PLL decoder in the circuit; one is simply that it gives almost total immunity to spurious triggering by electrical interference or noise. A second advantage is that it enables two remote control systems to be used side-by-side without one also activating the other — provided the two operate on slightly different frequencies that is.

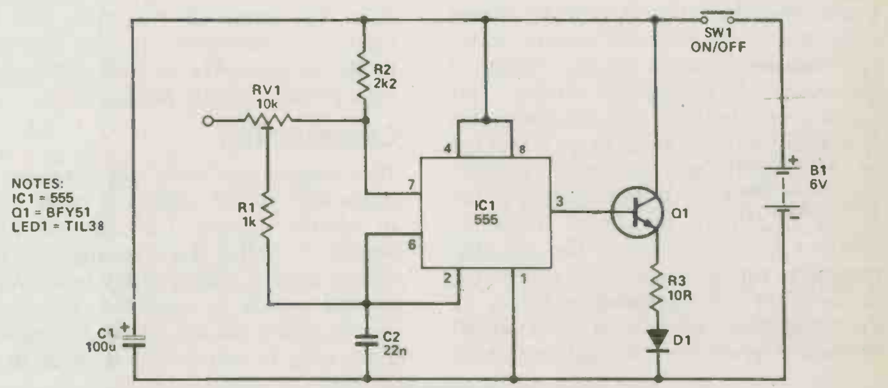


Fig. 2. The circuit diagram of the transmitter stage.

Another special type of diode is used at the receiver to produce an electrical signal from the received infra-red pulses. This is a large photodiode that gives good sensitivity, and although the diode itself is sensitive to a large part of the light spectrum, an integral infra-red filter removes light outside the infra-red range. This prevents strong light in the visible part of the spectrum from saturating the diode and preventing the system from operating properly.

A monostable multivibrator is used as the next stage of the receiver, triggered by the output switch of the PLL tone decoder; the monostable drives a VMOS switching transistor which in turn controls the camera. The monostable is used to ensure that the VMOS switch is activated for a long enough time to operate the shutter,

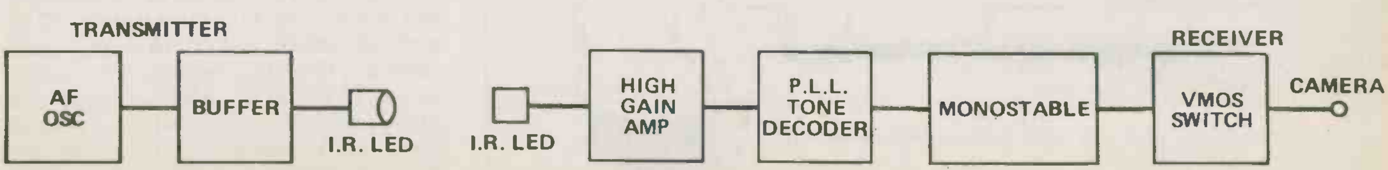


Fig. 1. A block diagram of the whole remote control system.

even if only a brief input signal is received. This helps to give more reliable operation if the system is used at virtually its maximum range.

Transmitter Circuit

Figure 2 shows the circuit diagram of the transmitter, based on a 555 astable oscillator. This gives a roughly squarewave signal, with RV1 used to trim the output to the appropriate frequency (around 5 kHz). The output stage of the 555 is barely able to provide sufficient output current to drive infra-red emitter D1 at the required current of around 150 milliamps, so Q1 is used as an emitter follower buffer stage to give more reliable and consistent results. Operating push-button on/off switch SW1 supplies power to the transmitter and activates the camera.

Receiver Circuit

The receiver unit is a little more complex, as can be seen from the circuit diagram of Figure 3. D2 is the infra-red photo diode· this can be used as a photovoltaic cell, producing an output voltage which is roughly proportional to the received infra-red intensity; however, slightly higher sensitivity is obtained by using it in a potential divider circuit. Here its reverse resistance varies with the received infra-red intensity, giving a varying voltage at the output of the divider circuit. This signal is coupled by C4 to the input of a high gain amplifier which uses Q2 and Q3 as straighforward common emitter amplifiers. C5 rolls-off the response of the first amplifier in the radio frequency range to prevent instability. The coupling capacitors can have quite low values due to the fairly high operating frequency of the transmitter; this helps to filter out 60 Hz hum received from AC lighting which

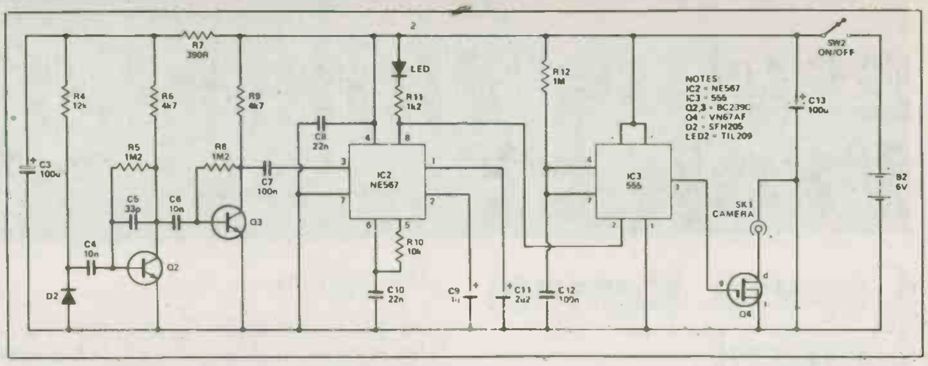


Fig. 3. The circuit diagram of the receiver stage.

could otherwise drive the amplifier into clipping and desensitize the circuit to the signal from the transmitter.

An NE567 (IC2) is used in the tone decoder, R11 and D3 form the collector load for its output transistor, and LED1 lights up when the tone decoder is activated. This is useful when adjusting the frequency control of the transmitter, and it also helps when setting-up the equipment ready for use.

The negative output signal from the tone decoder is used to trigger IC3, which is a 555 used in the standard monostable multivibrator configuration. Q4 is the VMOS output transistor, driven direct from the output of IC3; note that the camera or autowinder must be connected to SK1 so that Q4 is fed with signal of the right polarity (centre pin positive).

Construction

The connection from the camera or autowinder to the receiver is made using an electric release for the particular camera or winder you are using, and this remote control unit *can only be used if a suitable release is available.* The push-button switch on the release is removed and a plug to match SK1 is fitted in its place. With the camera or winder connected to SK1 (and switched on where appropriate), a multimeter set to a fairly high DC volts range can be used to determine the polarity of the voltage on SK1 so that this can be correctly wired to the printed circuit board.

Like the transmitter unit, the receiver is powered from four 1.5 V cells. As it is likely that the unit will be left running for long periods, NiCad rechargeable cells are probably the most practical power source, but primary cells can be used if preferred.

Adjustment

RV1 is given the correct setting by trial and error. With the output of the transmitter aimed at D2 in the receiver from a short distance away, it should be possible to get LED1 to light up by adjusting RV1. If not, switch off both units at once and thoroughly recheck them for errors. Once LED1 can be made to light up, it is a matter of gradually moving the two units further apart and readjusting RV1, as necessary, to keep LED1 lit. This is continued until the maximum range of about seven metres is achieved.

Remember that the unit can only function properly if the infra-red radiation from the transmitter has a transparent path to D2 at the receiver. The unit is quite directional, mainly due to the built-in lens of D1, and the output of the transmitter needs to be aimed reasonably accurately at the receiver, especially when the system is used at something approaching its maximum range.

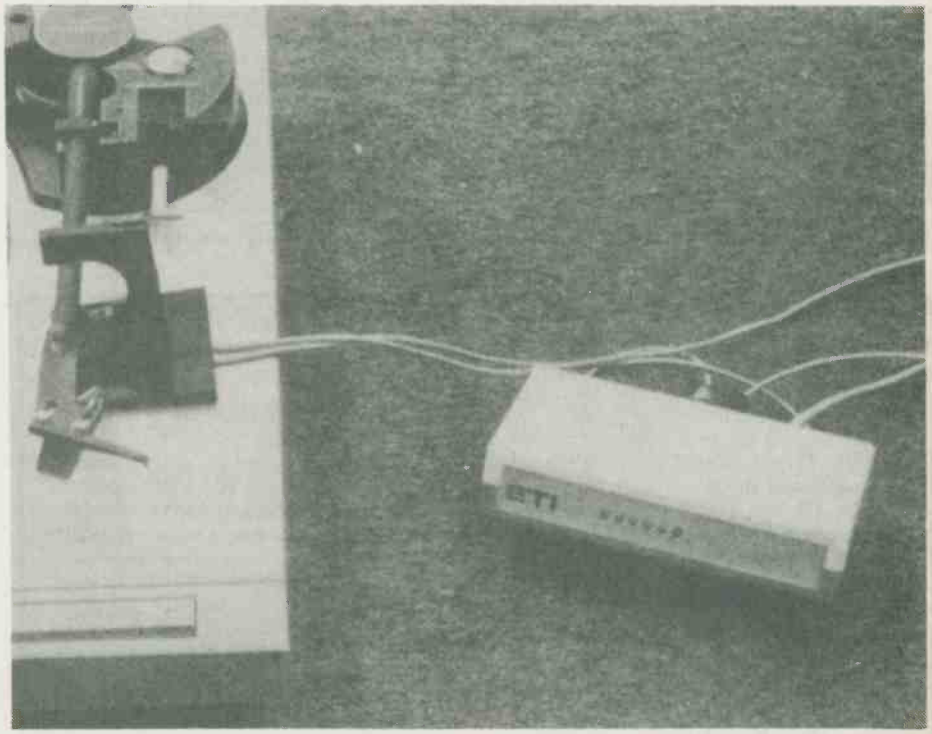
If it is necessary to control two or three cameras, a separate receiver unit for each one must be used. However, C10 in each unit must be given a slightly different value (15nF, 22nF, and 33nF are suitable). A separate transmitter circuit can be used for each receiver, housed in a single case and powered from the same battery. C2 in each transmitter would have the same value as C10 in the receiver unit it is to activate. It would be possible to have a single transmitter circuit with a switched operating frequency, but this would not give the option of firing two or three cameras simultaneously. **ETI**

"Special this week only – our Jacketed Wire comes with two pairs of pants."

Stylus Timer Project

PROJECT

Do you play your records with a smoothly-contoured, precision-engineered, highly-polished stylus — or a worn-out nail? Check your playing hours with the ETI Stylus Timer. Design and development by Phil Walker.



FOR modern styli and cartridge combinations, the life of the stylus may run to many hundreds or even thousands of hours before replacement is necessary. The trouble is that even at five hours each and every day (which is quite a lot) it will take over six months to accumulate 1,000 hours playing time. If you are like us, you could easily forget whether you changed the old nail last week or last year, quite apart from knowing how long it has been used since then.

Don't worry, help is at hand — this device is designed to measure the total number of hours your stylus has been in use since you last changed it and give some indication of that measurement.

The device has six LEDs which, in the basic configuration, change every 167 hours, totalling 1,000 hours. This could be used to indicate that a check on stylus condition would be carried out either at home or by your local dealer. When the last one comes on it will stay on until the device is reset (assuming the power is on).

As mentioned above, the basic design allows for 167 hours per step, the last one occurring after 1,000 hours. This can be modified to 330, 400, 830, or even 1,700 hours per step giving replacement times of up to 10,000 hours for the very lightest equipment (or Scrooges), or 83 hours per step if your equipment is a little heavier than some or you want to keep your stylus in tip-top condition all the time.

In order to eliminate dependence on mains supplies when the equipment is not in use, the device contains a rechargeable battery which provides the microamp or so needed to keep the CMOS devices active. Also, the LED display is turned off when not required to conserve battery power. To prevent accidents, the reset facility is disabled when the device is on standby.

Designs Discussed

The circuit uses standard CMOS integrated circuits for most functions in order to keep the standby power as small as possible. This enables us to use a 8V4 rechargeable Ni-cad battery ensuring that with intermittent use the device should operate almost indefinitely. (In fact a normal dry-cell 9V battery will give a very long life but may not like the charging current flowing into it via R7).

The power for the LED display and the timing signal for the logic are taken from the AC input. This is any 60 Hz voltage source giving between 12 and 20 V at about 50 mA. For preference this supply should be switched with the turntable or equipment mains supply.

The first method of detecting stylus use we considered involved detecting the presence of a music signal from the pickup. However, if the signal was tapped off after the RIAA preamp, we realized the project couldn't be built by readers who lacked the confidence to muck about inside their expensive commercial hi-fi. On the other hand, putting the project between the deck and the preamp would lead to the knotty design problem of not degrading the pickup performance. Thus we opted for a mechanical solution, but adventurous readers may care to adapt this project for their own needs. Note that we CANNOT give any technical advice if you do try it.

The circuit operates by detecting when the tone arm is away from its rest position and then allowing the rest of the circuit to count at 60 or 120 Hz. The 60 or 120 Hz is divided by about 72 million in order to driver the final counter at one pulse every 167 hours. The already decoded outputs of this device (IC5) are used by the output drive (IC6) to power the display.

The final counter (IC5) has ten decoded outputs of which only the first six are used. These control IC6 and thus the display. When the sixth output of IC5 goes high, it disables the counter chain causing the sixth LED to remain on indefinitely.

IC6 contains six inverting buffers which have three-state outputs. This facility is used to switch off the LEDs and conserve power.

A transistor (Q2) was used in the standby battery circuit so that when operating from the AC input, the supply voltage to the ICs was a little different to that when operating from battery alone.

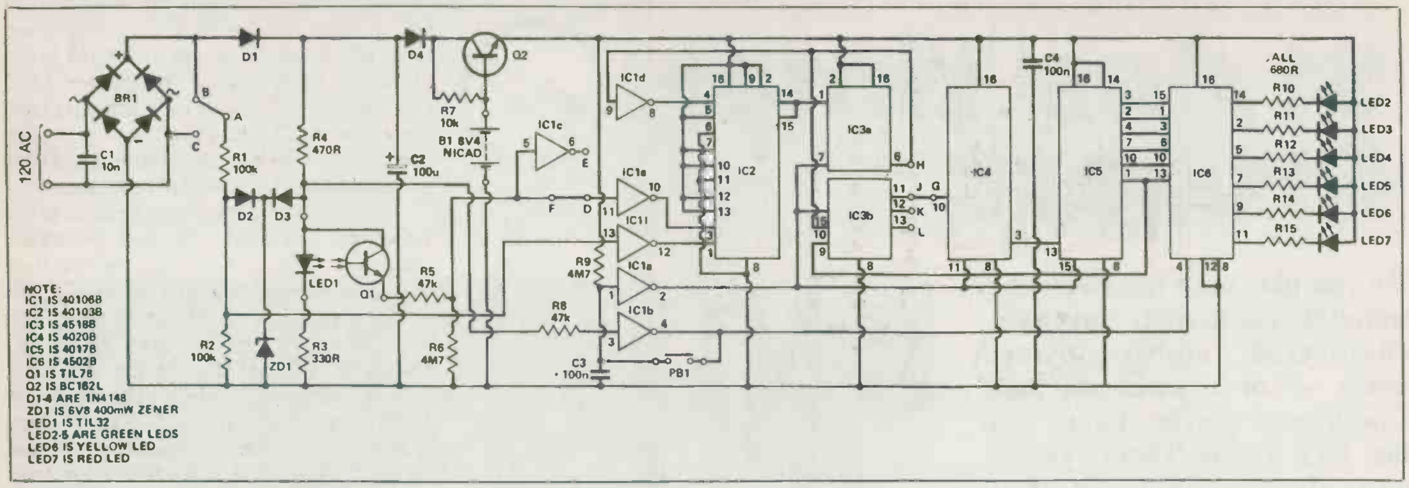


Fig. 1. Circuit diagram of the ETI Stylus Timer. The various lettered links are used to select the timing period (see text).

HOW IT WORKS

The 60 Hz power input is rectified by BR1 and charges C2 via D1. Q2 and R7 form a simple voltage regulator using the battery B1 as a reference. If there is no AC input, then D6 isolates the rectifier circuitry from Q2 and B1 supplies the very small bias current needed to keep the CMOS devices active via the base-emitter junction of Q2.

R4, D3 and ZD1 form a moderately stable voltage for the optical sensor and an input to the power detection circuitry IC1b. The output from the optical sensor (LED1 and Q1) is taken via R5 and R6 to IC1e either directly or via IC1c. This allows the circuit to operate with either an open or blocked light path as required.

Depending on the position of link A-B or A-C a 60 or 120 Hz signal will be applied to IC1f. The voltage of this signal is limited to R1, R2, D2 and ZD1 to prevent damage to IC1.

IC2 is connected such that it divides by 220 or 219 as determined by the input from IC1d. This is accomplished by the device loading its internal eight bit counter with the binary number on its inputs each time it reaches a count of zero. In this case the most significant seven bits are wired to 1101101X = 218_{10} while the least signficant bit (X) is switched between 0 and 1. The output from this stage drives IC3, a dual decade divider. The Q4 output from IC3a controls the division ratio of IC2 as outlined above. As the Q4 output is only high for two clock periods out of 10, the effective division ratio of IC2 is:

$$8/10 \times 220 + 2/10 \times 219 = 219.8$$

IC3b is used to divide by 2 in the standard circuit and then drives IC4 which does the rest of the division required (a factor of 2^{14} or 16384) to give a one cycle in 167 hours signal.

IC5 is a decade counter with 10 decoded outputs. Each output is high for one clock period of the 167 hour input signal (or longer if counting is suspended). Only the first six outputs are used to drive IC6 and the sixth output also inhibits IC3b to prevent further counting. IC6 is a hex buffer with three-state outputs which have a fairly high impedence state by a signal on pin 4. This facility is used to prevent the LED display taking current while the AC supply is off.

The reset switch PB1 is connected in an unusual place so that it can only pull the input to IC1a low when the power sense circuit indicates that the AC supply is present. When operated, the reset circuit applies a high logic level to the reset inputs of IC's 3, 4 and 5 for about a second. IC2 is not reset and will cause an error of two or four seconds in the timing, but in a hundred hours or so, this is not significant.

Also the LED voltage can be stabilized at the correct value. The configuration allows the battery to be trickle-charged from the same supply.

Construction

The construction of the main unit is straightforward if a little fiddly on account of its small size. Assemble the components onto the PCB including the three links but excluding LED 2-7. Place the assembled PCB in the bottom of the box and align it over the wider spaced fixing holes with C2 next to the space for the battery. Mark the positions for the LEDs on the front panel and the jack sockets and PB1 on the back panel. Also mark a position for the power cable grommet. Drill all these holes in sizes to fit your components.

Wire up the switch and sockets. The common connection from R4 on the board should go to the sleeve connections on the jack sockets to prevent accidental short circuits via the panel. The LEDs should now have their leads bent so that they will go into the board while the LED body protrudes through the panel. Finally connect the battery connector and the AC power lead. The latter should be a twin lead shielded cable terminated in a three pin DIN plug or similar to pick up the supply.

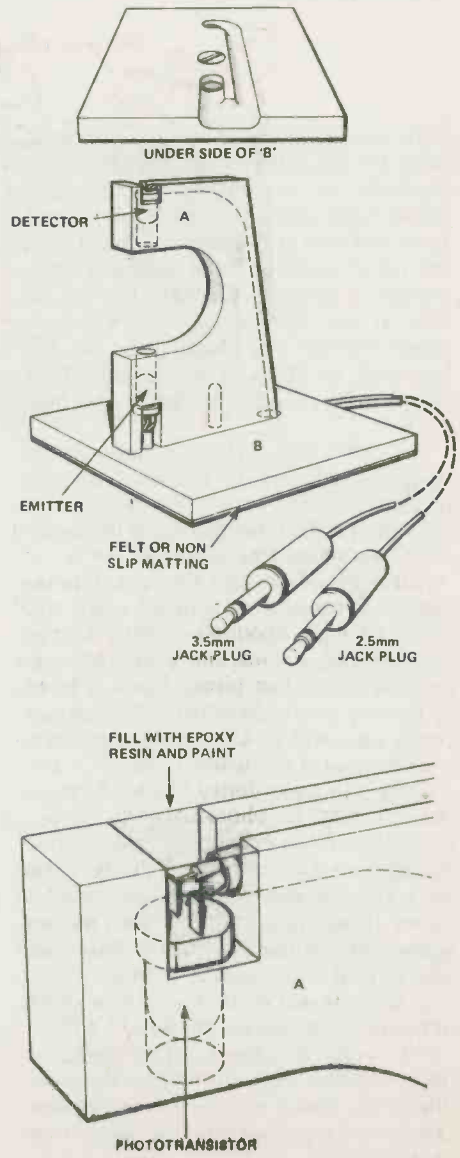


Fig. 2. Constructional details of our sensor. Using different sized jack plugs will prevent incorrect connection.

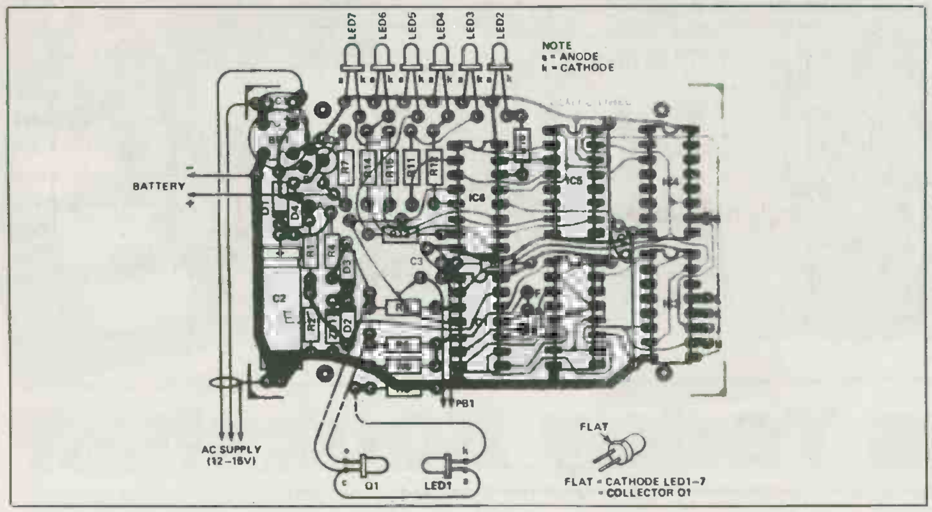
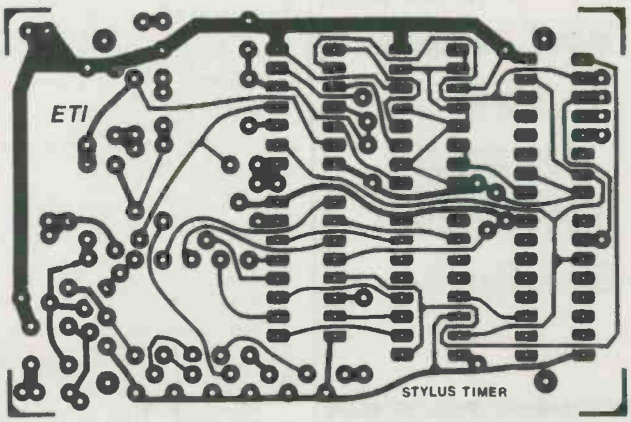


Fig. 3. Component overlay.



The Sensor

The purpose of the sensor housing is to hold the emitter and receiver in line and exclude some of the ambient light. Our sensor was constructed from an offcut of black Plexiglas about 90 × 55 × 55 mm). A U-shaped slot was cut out of the longer side of the smaller piece; then a hole was drilled in the thickness of the material in both legs of the U to take the optical devices and hold them in line. The back edge of the U was slotted to take the shielded wire from the phototransistor.

Three holes were drilled along the centre line of the other piece of Plexiglas; two to take wires and one to take a mounting screw. The underside of the base piece was channelled out using a rasp attachment in a hobbyist drill to conceal the wires.

The sensor device is mounted in the top hole to reduce the amount of ambient light reaching it. The screened wire from the phototransistor is run along the slot in the plastic and down the hole in the base. The slot can be filled with resin and painted when finished.

If a small three-way connector can be obtained, this could be used in place of the two jacks and a single length of shielded cable would suffice to connect the sensor.

Power Supply

The AC power supply is very simple and consists of a small transformer, fuse, neon indicator and three pin DIN socket mounted in a small box. Construction is very straightforward and, if the specified box is used, most small 6 VA transformers will fit onto the moulded pillars in the box, obviating the need for external screws.

Use and Modifications

To use the stylus timer, the sensor should be positioned so that the tone arm interrupts the light beam when it is in the rest position. Make sure that it does not foul the arm at any time if you have any sort of automatic control.

If possible, the AC power supply for the device should be obtained from your system. Anything from 12 to 15 V AC may be used without modification. Up to 25 V may be used, but R4 and R7 should then be 1k0 1 W and 27k respectively. If the supply is greater than 25 V, one side of any available supply is grounded, or if you prefer not to tamper with your system, then use the simple power supply described.

With the sensor in position and a suitable AC supply connected, press the reset button on the unit. The first green LED should light and stay lit for 167 hours of playing time, followed by the next LED until the red LED lights to indicate replacement overdue. If the power supply is switched off at any time, the accumulated time is stored until the power is restored.

Other time intervals can be used in the device by changing the link positions. Changing A-B to A-C doubles the time period. Changing G-J to G-K or G-L increases the interval by 2½ or 5 respectively while changing it to G-H halves it, although it will not stop on the last count as before. In some of these other positions the intervals between the lighting of each LED may not be as regular as before (especially G-K). If it is desired to have counting enabled when the light path is obstructed, then link D-F should be changed to D-E.

PARTS LIST

Resistors (all ¼W, 5%)

R1,2	100k
R3	330R
R4	470R
R5,8	47k
R6,9	4M7
R7	10k
R10-15	680R

Capacitors

C1	10n ceramic
C2	100u 40 V axial electrolytic
C3,4	100n ceramic

Semiconductors

IC1	40106B
IC2	40103B
IC3	4518B
IC4	4020B
IC5	4017B
IC6	4502B
Q1	TIL78 IR receiver
Q2	BC182L, 2N3904, etc.
D1-4	1N4148
ZD1	6V8 400 mW zener
BR1	50 V, 1 A bridge rectifier
LED1	TIL32 IR transmitter
LED2-5	2 mm green LED
LED6	2 mm yellow LED
LED7	2 mm red LED

Miscellaneous

PB1	subminiature push-button
B1	8V4 Ni-cad

PCB battery clips; case 125 × 65 × 30 mm (Vero 75-2682A); 3.5 and 2.5 mm jack plugs and sockets; three pin DIN plug (if required to connect to power unit); thin twin cable; small grommet; 100 × 55 × 6 mm acrylic sheet.

AC Power Unit (If Required)

12 V, 6 VA mains transformer; 100 mA fuse and fuseholder; mains neon; case 125 × 65 × 50 mm (Vero ref. 75-2684B); three pin DIN socket; line cord; grommet; solder tags.

ETI

Electronics Today Bookshelf

Top 10 Electronic Books

Based on sales from Moorshead Publications Book Service

1 **BP73: REMOTE CONTROL PROJECTS** $8.10
OWEN BISHOP
This book is aimed primarily at the electronics enthusiast who wishes to experiment with remote control. Full explanations have been given so that the reader can fully understand how the circuits work and can more easily see how to modify them for other purposes, depending on personal requirements. Not only are radio control systems considered but also infra-red, visible light and ultrasonic systems as are the use of Logic ICs and Pulse position modulation etc.

2 **BP90: AUDIO PROJECTS** $7.60
F.G. RAYER
Covers in detail the construction of a wide range of audio projects. The text has been divided into preamplifiers and mixers, power amplifiers, tone controls and matching and miscellaneous projects.

3 **The GIANT HANDBOOK OF ELECTRONIC CIRCUITS**
TAB No.1300 $27.95
About as twice as thick as the Webster's dictionary, and having many more circuit diagrams, this book is ideal for any experimenter who wants to keep amused for several centuries. If there isn't a circuit for it in here, you should have no difficulty convincing yourself you don't really want to build it.

4 **ELECTRONIC TROUBLESHOOTING HANDBOOK**
AB019 $11.95
This workbench guide can show you how to pinpoint circuit troubles in minutes, how to test anything electronic, and how to get the most out of low cost test equipment. You can use any and all of the time-saving shortcuts to rapidly locate and repair all types of electronic equipment malfunctions.

5 **BP74: ELECTRONIC MUSIC PROJECTS** $7.20
R.A. PENFOLD
Although one of the more recent branches of amateur electronics, electronic music has now become extremely popular and there are many projects which fall into this category. The purpose of this book is to provide the constructor with a number of practical circuits for the less complex items of electronic music equipment, including such things as a Fuzz Box, Waa-Waa Pedal, Sustain Unit, Reverberation and Phaser-Units, Tremelo Generator etc.

6 **BP44: IC 555 PROJECTS** $7.75
E.A. PARR, B.Sc.,C.Eng., M.I.E.E.
Every so often a device appears that is so useful that one wonders how life went on before without it. The 555 timer is such a device. Included in this book are Basic and General Circuits, Motor Car and Model Railway Circuits, Alarms and Noise Makers as well as a section on the 556, 558 and 559 timers.

7 **BP37: 50 PROJECTS USING RELAYS, SCR's & TRIACS** $7.75
F.G.RAYER, T.Eng.(CEI),Assoc.IERE
Relays, silicon controlled rectifiers (SCR's) and bi-directional triodes (TRIACs) have a wide range of applications in electronics today. This book gives tried and practical working circuits which should present the minimum of difficulty for the enthusiast to construct. In most of the circuits there is a wide latitude in component values and types, allowing easy modification of circuits or ready adaptation of them to individual needs.

8 **BP79: RADIO CONTROL FOR BEGINNERS** $6.80
F.G. RAYER, T.Eng.(CEI),Assoc.IERE.
The aim of this book is to act as an introduction to Radio Control for beginners to the hobby. The book will commence by dealing with the conditions that are allowable for such things as frequency and power of transmission. This is followed by a "block" explanation of how control-device and transmitter operate and receiver and actuator(s) produce motion in a model.

Details are then given of actual solid state transmitting equipment which the reader can build. Plain and loaded aerials are then discussed and so is the field-strength meter to help with proper setting up.

The radio receiving equipment is then dealt with which includes a simple receiver and also a crystal controlled superhet. The book ends with the electro-mechanical means of obtaining movement of the controls of the model.

9 **99 TEST EQUIPMENT PROJECTS YOU CAN BUILD**
TAB No.805 $15.95
An excellent source book for the hobbyist who wants to build up his work bench inexpensively. Projects range from a simple signal tracer to a 50MHz frequency counter. There are circuits to measure just about any electrical quantity: voltage, current, capacitance, impedance and more. The variety is endless and includes just about anything you could wish for!

10 **BP76: POWER SUPPLY PROJECTS** $7.75
R.A. PENFOLD
Line power supplies are an essential part of many electronics projects. The purpose of this book is to give a number of power supply designs, including simple unstabilised types, fixed voltage regulated types, and variable voltage stabilised designs, the latter being primarily intended for use as bench supplies for the electronics workshop. The designs provided are all low voltage types for semiconductor circuits.

There are other types of power supply and a number of these are dealt with in the final chapter, including a cassette power supply, Ni-Cad battery charger, voltage step up circuit and a simple inverter.

See order form in this issue.

ELECTRONIC THEORY

ELEMENTS OF ELECTRONICS — AN ON-GOING SERIES
F.A. WILSON, C.G.I.A., C.Eng.,
BP62: BOOK 1. The Simple Electronic Circuit and Components $8.45
BP63: BOOK 2. Alternating Current Theory $8.45
BP64: BOOK 3. Semiconductor Technology $8.45
BP77: BOOK 4. Microprocessing Systems And Circuits $11.70
BP89: BOOK 5. Communication $11.70
The aim of this series of books can be stated quite simply — it is to provide an inexpensive introduction to modern electronics so that the reader will start on the right road by thoroughly understanding the fundamental principles involved.

Although written especially for readers with no more than ordinary arithmetical skills, the use of mathematics is not avoided, and all the mathematics required is taught as the reader progresses.

Each book is a complete treatise of a particular branch of the subject and, therefore, can be used on its own with one proviso, that the later books do not duplicate material from their predecessors, thus a working knowledge of the subjects covered by the earlier books is assumed.

BOOK 1: This book contains all the fundamental theory necessary to lead to a full understanding of the simple electronic circuit and its main components.

BOOK 2: This book continues with alternating current theory without which there can be no comprehension of speech, music, radio, television or even the electricity utilities.

BOOK 3: Follows on semiconductor technology, leading up to transistors and integrated circuits.

BOOK 4: A complete description of the internal workings of microprocessor.

BOOK 5: A book covering the whole communication scene.

PH247: DIGITAL TECHNIQUES $19.95
Covers logic circuits, Boolean Algebra, flip-flops, registers, combinational logic circuitry, and digital design.

PROJECTS

BP48: ELECTRONIC PROJECTS FOR BEGINNERS $7.75
F.G. RAYER, T.Eng.(CEI), Assoc.IERE
Another book written by the very experienced author — Mr. F.G. Rayer — and in it the newcomer to electronics, will find a wide range of easily made projects. Also, there are a considerable number of actual component and wiring layouts, to aid the beginner.

Furthermore, a number of projects have been arranged so that they can be constructed without any need for soldering and, thus, avoid the need for a soldering iron.

Also, many of the later projects can be built along the lines as those in the 'No Soldering' section so this may considerably increase the scope of projects which the newcomer can build and use.

221: 28 TESTED TRANSISTOR PROJECTS
R.TORRENS $5.00
Mr. Richard Torrens is a well experienced electronics development engineer and has designed, developed, built and tested the many useful and interesting circuits included in this book. The projects themselves can be split down into simpler building blocks, which are shown separated by boxes in the circuits for ease of description, and also to enable any reader who wishes to combine boxes from different projects to realise ideas of his own.

BP71: ELECTRONIC HOUSEHOLD PROJECTS $7.20
R. A. PENFOLD
Some of the most useful and popular electronic construction projects are those that can be used in or around the home. The circuits range from such things as '2 Tone Door Buzzer', Intercom, through Smoke or Gas Detectors to Baby and Freezer Alarms.

Electronics Today Bookshelf

BP49: POPULAR ELECTRONIC PROJECTS $7.75
R.A. PENFOLD
Includes a collection of the most popular types of circuits and projects which, we feel sure, will provide a number of designs to interest most electronics constructors. The projects selected cover a very wide range and are divided into four basic types: Radio Projects, Audio Projects, Household Projects and Test Equipment.

BP94: ELECTRONIC PROJECTS FOR CARS AND BOATS
R.A. PENFOLD $7.60
Projects, fifteen in all, which use a 12V supply are the basis of this book. Included are projects on Windscreen Wiper Control, Courtesy Light Delay, Battery Monitor, Cassette Power Supply, Lights Timer, Vehicle Immobiliser, Gas and Smoke Alarm, Depth Warning and Shaver Inverter.

BP95: MODEL RAILWAY PROJECTS $7.60
Electronic projects for model railways are fairly recent and have made possible an amazing degree of realism. The projects covered include controllers, signals and sound effects: striboard layouts are provided for each project.

BP93: ELECTRONIC TIMER PROJECTS $7.60
F.G. RAYER
Windscreen wiper delay, darkroom timer and metronome projects are included. Some of the more complex circuits are made up from simpler sub-circuits which are dealt with individually.

BP113: 30 Solderless Breadboard Projects-Book 2
R.A. Penfold $8.85
A companion to BP107. Describes a variety of projects that can be built on plug-in breadboards using CMOS logic IC's. Each project contains a schematic, parts list and operational notes.

BP104: Electronic Science Projects
Owen Bishop $8.85
Contains 12 electronic projects with a strong scientific flavour. Includes Simple Colour Temperature Meter, Infra-Red Laser, Electronic clock regulated by a resonating spring, a 'Scope with a solid state display, pH meter and electrocardiograph.

BP110: HOW TO GET YOUR ELECTRONIC PROJECTS WORKING $7.60
R.A. PENFOLD
We have all built circuits from magazines and books only to find that they did not work correctly, or at all, when first switched on. The aim of this book is to help the reader overcome just these problems by indicating how and where to start looking for many of the common faults that can occur when building up projects.

BP84: DIGITAL IC PROJECTS $7.60
F.G. RAYER, T.Eng.(CEI),Assoc.IERE
This book contains both simple and more advanced projects and it is hoped that these will be found of help to the reader developing a knowledge of the workings of digital circuits. To help the newcomer to the hobby the author has included a number of board layouts and wiring diagrams. Also the more ambitious projects can be built and tested section by section and this should help avoid or correct faults that could otherwise be troublesome. An ideal book for both beginner and more advanced enthusiast alike.

BP67: COUNTER DRIVER AND NUMERAL DISPLAY PROJECTS $7.05
F.G. RAYER, T.Eng.(CEI), Assoc. IERE
Numeral indicating devices have come very much to the forefront in recent years and will, undoubtedly, find increasing applications in all sorts of equipment. With present day integrated circuits, it is easy to count, divide and display numerically the electrical pulses obtained from a great range of driver circuits.

In this book many applications and projects using various types of numeral displays, popular counter and driver IC's etc. are considered.

BP99: MINI — MATRIX BOARD PROJECTS $7.60
R.A. PENFOLD
Twenty useful projects which can all be built on a 24 x 10 hole matrix board with copper strips. Includes Doorbuzzer, Low-voltage Alarm, AM Radio, Signal Generator, Projector Timer, Guitar Headphone Amp, Transistor Checker and more.

BP103: MULTI-CIRCUIT BOARD PROJECTS $7.60
R.A. PENFOLD
This book allows the reader to build 21 fairly simple electronic projects, all of which may be constructed on the same printed circuit board. Wherever possible, the same components have been used in each design so that with a relatively small number of components and hence low cost, it is possible to make any one of the projects or by re-using the components and P.C.B. all of the projects.

BP107: 30 SOLDERLESS BREADBOARD PROJECTS — BOOK 1 $8.85
R.A. PENFOLD
A "Solderless Breadboard" is simply a special board on which electronic circuits can be built and tested. The components used are just plugged in and unplugged as desired. The 30 projects featured in this book have been specially designed to be built on a "Verobloc" breadboard. Wherever possible the components used are common to several projects, hence with only a modest number of reasonably inexpensive components it is possible to build, in turn, every project shown.

BP106: MODERN OP-AMP PROJECTS $7.60
R.A. PENFOLD
Features a wide range of constructional projects which make use of op-amps including low-noise, low distortion, ultra-high input impedance, high slew-rate and high output current types.

CIRCUITS

How to Design Electronic Projects
BP127 $8.95
Although information on standard circuit blocks is available, there is less information on combing these circuit parts together. This title does just that. Practical examples are used and each is analysed to show what each does and how to apply this to other designs.

Audio Amplifier Construction
BP122 $8.95
A wide circuits is given, from low noise microphone and tape head preamps to a 100W MOSFET type. There is also the circuit for 12V bridge amp giving 18W. Circuit board or stripboard layout are included. Most of the circuits are well within the capabilities for even those with limited experience.

Electronic Circuits for Model Railways
BP213 $4.50
Lots of circuits including three types of controllers including one with simulated inertia and one with high power. Signalling and lighting systems are discussed at length and the superession of RF interference. There are also 4 "steam whistle" and "chuffer" circuits.

BP80: POPULAR ELECTRONIC CIRCUITS — BOOK 1 $7.75
R.A. PENFOLD
Another book by the very popular author, Mr. R.A. Penfold, who has designed and developed a large number of various circuits. These are grouped under the following general headings; Audio Circuits, Radio Circuits, Test Gear Circuits, Music Project Circuits, Household Project Circuits and Miscellaneous Circuits.

BP98: POPULAR ELECTRONIC CIRCUITS, BOOK 2 $8.85
R.A. PENFOLD
70 plus circuits based on modern components aimed at those with some experience.

BP39: 50 (FET) FIELD EFFECT TRANSISTOR PROJECTS $6.75
F.G. RAYER, T.Eng.(CEI),Assoc.IERE
Field effect transistors (FETs), find application in a wide variety of circuits. The projects described here include radio frequency amplifiers and converters, test equipment and receiver aids, tuners, receivers, mixers and tone controls, as well as various miscellaneous devices which are useful in the home.

This book contains something of particular interest for every class of enthusiast — short wave listener, radio amateur, experimenter or audio devotee.

BP87: SIMPLE L.E.D. CIRCUITS $5.40
R.N. SOAR
Since it first appeared in 1977, Mr. R.N. Soar's book has proved very popular. The author has developed a further range of circuits and these are included in Book 2. Projects include a Transistor Tester, Various Voltage Regulators, Testers and so on.

BP42: 50 SIMPLE L.E.D. CIRCUITS $3.05
R.N. SOAR
The author of this book, Mr. R.N. Soar, has compiled 50 interesting and useful circuits and applications, covering many different branches of electronics, using one of the most inexpensive and freely available components — the Light Emitting Diode (L.E.D.). A useful book for the library of both beginner and more advanced enthusiast alike.

THE ACTIVE FILTER HANDBOOK
TAB No.1133 $13.95
Whatever your field — computing, communications, audio, electronic music or whatever — you will find this book the ideal reference for active filter design.

The book introduces filters and their uses. The basic math is discussed so that the reader can tell where all design equations come from. The book also presents many practical circuits including a graphic equalizer, computer tape interface and more.

MASTER HANDBOOK OF 1001 PRACTICAL CIRCUITS
TAB No.800 $19.95
MASTER HANDBOOK OF 1001 MORE PRACTICAL CIRCUITS
TAB No.804 $23.95
Here are transistor and IC circuits for just about any application you might have. An ideal source book for the engineer, technician or hobbyist. Circuits are classified according to function, and all sections appear in alphabetical order.

BP88: HOW TO USE OP AMPS $8.85
E.A. PARR
A designer's guide covering several op amps, serving as a source book of circuits and a reference book for design calculations. The approach has been made as non-mathematical as possible.

BP65: SINGLE IC PROJECTS $6.05
R.A.PENFOLD
There is now a vast range of ICs available to the amateur market, the majority of which are not necessarily designed for use in a single application and can offer unlimited possibilities. All the projects contained in this book are simple to construct and are based on a single IC. A few projects employ one or two transistors in addition to an IC but in most cases the IC is the only active device used.

BP117: PRACTICAL ELECTRONIC BUILDING BLOCKS BOOK 1 $7.60
Virtually any electronic circuit will be found to consist of a number of distinct stages when analysed. Some circuits inevitably have unusual stages using specialised circuitry, but in most cases circuits are built up from building blocks of standard types.

This book is designed to aid electronics enthusiasts who like to experiment with circuits and produce their own projects rather than simply follow published project designs.

The circuits for a number of useful building blocks are included in this book. Where relevant, details of how to change the parameters of each circuit are given so that they can easily be modified to suit individual requirements.

223: 50 PROJECTS USING IC CA3130 $5.00
R.A.PENFOLD
In this book, the author has designed and developed a number of interesting and useful projects which are divided into five general categories: I — Audio Projects II — R.F. Projects III — Test Equipment IV — Household Projects V — Miscellaneous Projects.

224: 50 CMOS IC PROJECTS $3.75
R.A. PENFOLD
CMOS IC's are probably the most versatile range of digital devices for use by the amateur enthusiast. They are suitable for an extraordinary wide range of applications and are also some of the most inexpensive and easily available types of IC.

Mr. R.A. Penfold has designed and developed a number of interesting and useful projects which are divided into four general categories: I — Multivibrators II — Amplifiers and Oscillators III — Trigger Devices IV — Special Devices.

THE MASTER IC COOKBOOK
TAB No.1199 $17.95
If you've ever tried to find specs for a so called 'standard' chip, then you'll appreciate this book. C.L. Hallmark has compiled specs and pinout for most types of ICs that you'd ever want to use.

BP118: PRACTICAL ELECTRONIC BUILDING BLOCKS - Book 2
R.A. PENFOLD $7.60
This sequel to BP117 is written to help the reader create and experiment with his own circuits by combining standard type circuit building blocks. Circuits concerned with generating signals were covered in Book 1, this one deals with processing signals. Amplifiers and filters account for most of the book but comparators, Schmitt triggers and other circuits are covered.

BP24: 50 PROJECTS USING IC741 $3.75
RUDI & UWE REDMER
This book, originally published in Germany by TOPP, has achieved phenomenal sales on the Continent and Babani decided, in view of the fact that the integrated circuit used in this book is inexpensive to buy, to make this unique book available to the English speaking reader. Translated from the original German with copious notes, data and circuitry, a "must" for everyone whatever their interest in electronics.

BP83: VMOS PROJECTS $7.70
R.A. PENFOLD
Although modern bipolar power transistors give excellent results in a wide range of applications, they are not without their drawbacks or limitations. This book will primarily be concerned with VMOS power FETs although power MOSFETs will be dealt with in the chapter on audio circuits. A number of varied and interesting projects are covered under the main headings of: Audio Circuits, Sound Generator Circuits, DC Control Circuits and Signal Control Circuits.

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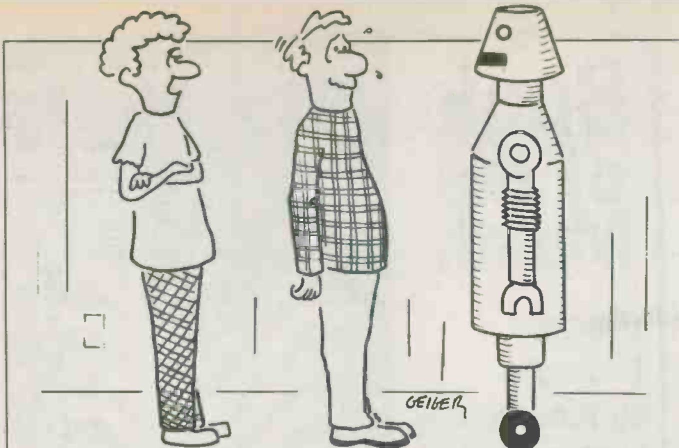

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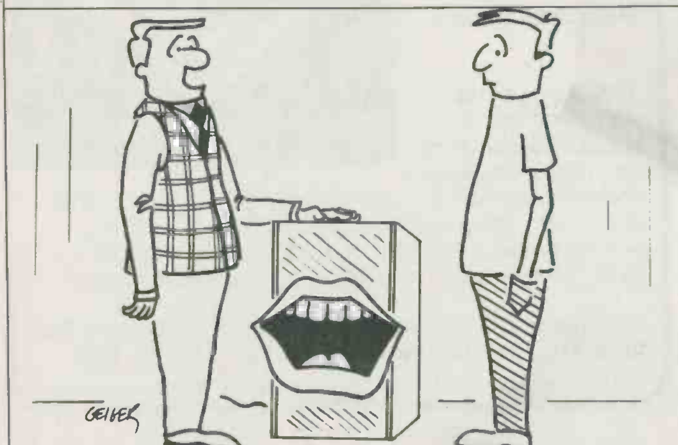

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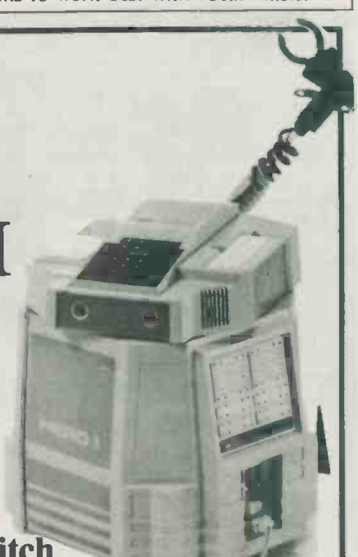

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Timing long periods has always been a problem because of the high leakage characteristics of the timing capacitor. This is no longer true. The XR-2240 IC is a programmable timer capable of producing ultra-long time delays without sacrificing accuracy.

THIS IC CAN generate time delays from microseconds up to five days, and with a little ingenuity can generate a delay of a couple of years! A functional block diagram of the IC is shown in Figure 1.

The circuit consists of an internal timebase generator, a programmable 8-bit counter and a control flip-flop. The time delay at the output is set by an external CR network and can be any period from 1.CR to 255.CR. Herein lies the secret. The CR timebase generator can be set to give a very accurate short period, and binary multiples of this short period are then programmed and taken from the output. Each output is capable of sinking approximately 5 mA of load current.

The features of the IC are:

1. Timing from microseconds to days.
2. Programmable delays: 1.CR to 255.CR
3. Wide supply voltage range: 4 V to 15 V
4. TTL compatible inputs and outputs
5. High accuracy: 0.5%
6. Excellent temperature stability
7. Period T = C × R

Circuit Operation

The timing cycle is initiated by a positive-going pulse on pin 11. This trigger pulse performs three functions:

1. Activates the timebase generator
2. Enables the counter
3. Sets all counter outputs to the *low* state

The timebase generator produces timing pulses with a period, T, equal to 1.CR. These clock pulses are counted by the binary counter inside the IC and the timing period is complete when a positive-going pulse is applied to pin 10 (i.e., the circuit is reset). In most applications, one or more of the output terminals are connected back to the reset input. The circuit will commence timing when the trigger pulse is applied, and automatically reset on the completion of the timing period.

Remember, the outputs are normally high and are set to low when timing is initiated, returning again to the high level on completion of the timing period.

DESIGNER'S Notebook

Super Timer — The XR-2240

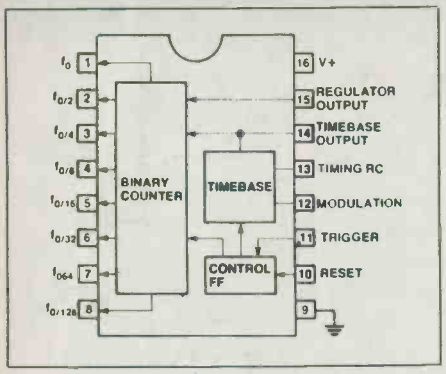

Fig. 1. Functional block diagram of the XR-2240.

Circuit Construction

The binary outputs, pins 1 to 8, are open collector and can be connected together to a common pull-up resistor. The output of the timer will be low as long as any one output is low. In this manner the time delays associated with each output can be added by simply connecting them together to a common bus. The outputs can be used individually or wired together.

For example, the output at pin 4 is 8 $\times$ CR = 8T. If pins 4 and 3 are connected together, the output will become 12 $\times$ CR = 12T.

Figure 3 shows the actual connections for a practical circuit. When the power is applied with no trigger or reset inputs, the circuit sets up to the initial state of all outputs high. Once triggered, the circuit is totally immune to any additional trigger inputs until the timing period is completed, or a reset pulse is applied.

Choice of Timing Components

Once a signal timing period, T, is

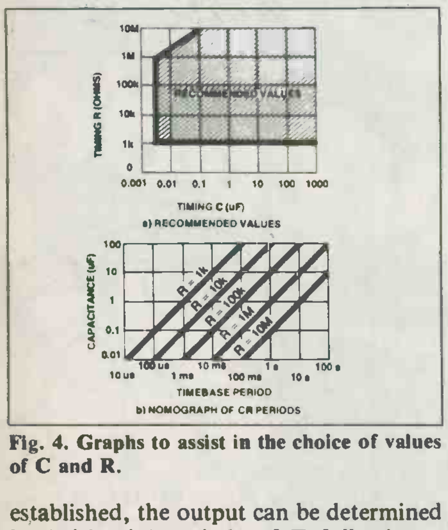

Fig. 4. Graphs to assist in the choice of values of C and R.

established, the output can be determined by 'wiring-in' periods of T following a binary progression. However, the procedure may have to be reversed when a certain accurate output period is required.

For example, if a timing period of 6 hours 30 seconds is required, first convert the time to seconds:

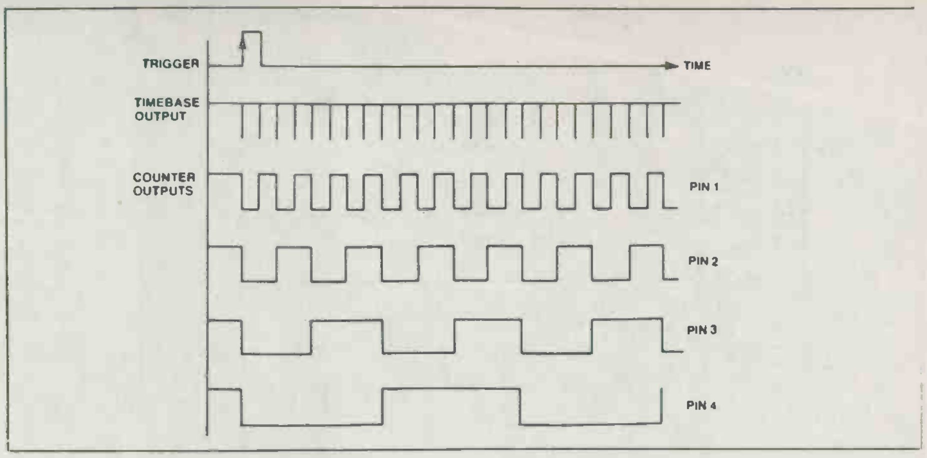

Fig. 2. Output waveforms and timing diagram.

$= 6 \times 60 \times 60 + 30$
$= 21630$ seconds.

The maximum number of timing periods available with one IC is:

$(1+2+4+8+16+32+64+128)T = 255$ T. Therefore the period of T can be calculated:

$T = 21630/255$
$= 84.82$ seconds

With a low-loss capacitor (such as tantalum) as one timing component, R can be calculated. If C = 100 uF:

$T = CR$

Therefore:

$R = T/C$
$= 84.82/(100 \times 10^{-6})$
$= 848.24$ kilohms

This can be tailored precisely for very accurate timing with a resistive network or potentiometer, or simply rounded off to 850k.

Figure 4 shows two graphs which will assist you in choosing:

1. The recommended range of timing component values.
2. The time period, (T), up to 100 seconds, to be expected from combinations of C and R values.

An example of output periods to be expected using a 100 uF capactior (tantalum) and 1M resistor as the timing components is shown in Table 1.

The type of circuit operation discussed to this point has been monostable i.e.,

T = CR = 100 μF x 1 M = 100 seconds	Period of Output
T	100 secs = 1.7 min
2T	200 secs = 3.3 min
4T	400 secs = 6.7 min
8T	800 secs = 13.3 min
16T	1600 secs = 26.7 min
32T	3200 secs = 53.3 min
64T	6400 secs = 1.8 hours
128T	12800 secs = 3.6 hours
255T	25500 secs = 7.1 hours

Table 1. Example of accurate time available using the XR-2240.

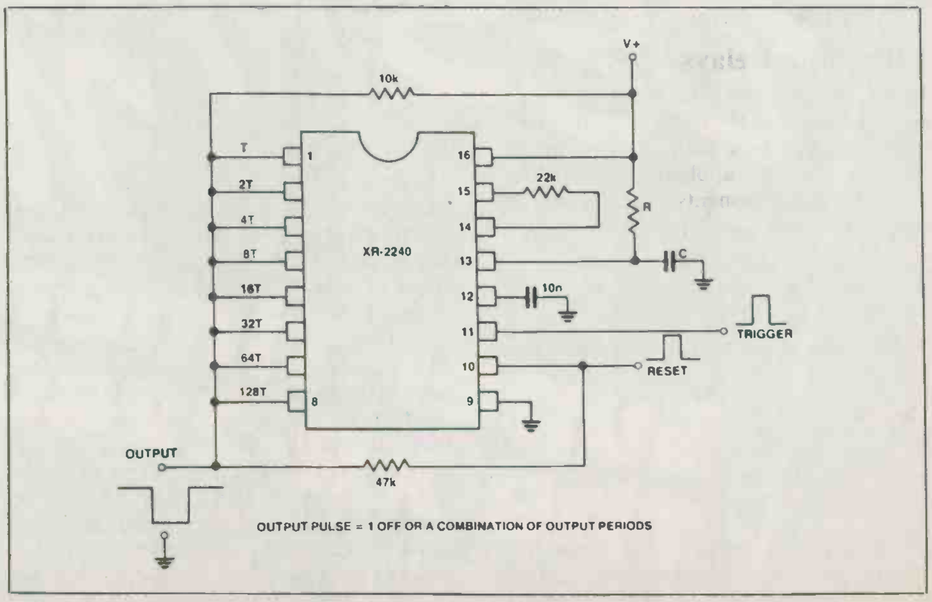

Fig. 3. Connections for a practical circuit.

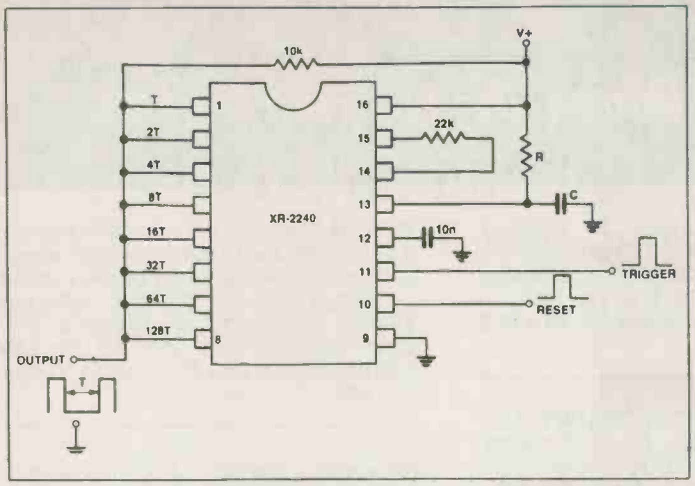

Fig. 5. Astable operation under control of external trigger and reset controls.

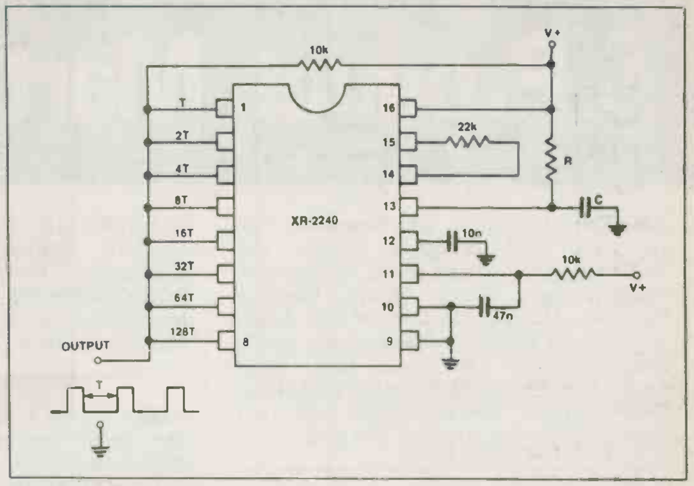

Fig. 6. Free-running circuit.

the output goes low on triggering, stays low for the timing period and returns to a high level. It will not time again until it is retriggered. An XR-2240 can also be used in a free-running or astable mode.

Astable Operation

To operate in this mode, the reset line to pin 10 is disconnected from the output.

Figure 5 shows an astable circuit under the control of the external trigger and reset signals. It will start timing when an external trigger pulse is applied, and will not stop until a reset pulse is applied.

Alternatively, the circuit can be made truly free running. The circuit in Figure 6 self-tirggers automatically when the power is switched on, and continues to operate in its free running mode indefinitely.

When the timer is used in this mode, each counter output can be used individually as synchronized oscillators, or they can be connected together to provide complex pulse patterns.

Ultra-long Delays

In some applications, delays of four days may be required. This is particularly useful in electronic farming for controlling the rate of supplementary feeding. The timing components required can be calculated thus:

4 days = 96 hours
= 5760 minutes
= 345,600 secs.

Maximum number of T combinations = 255

Therefore:

T = 345600/255
= 1355.3 secs
= 22.6 minutes

Incidentally, 20 minutes is about the longest time recommended for 1.CR as anything beyond this suffers from leakage problems.

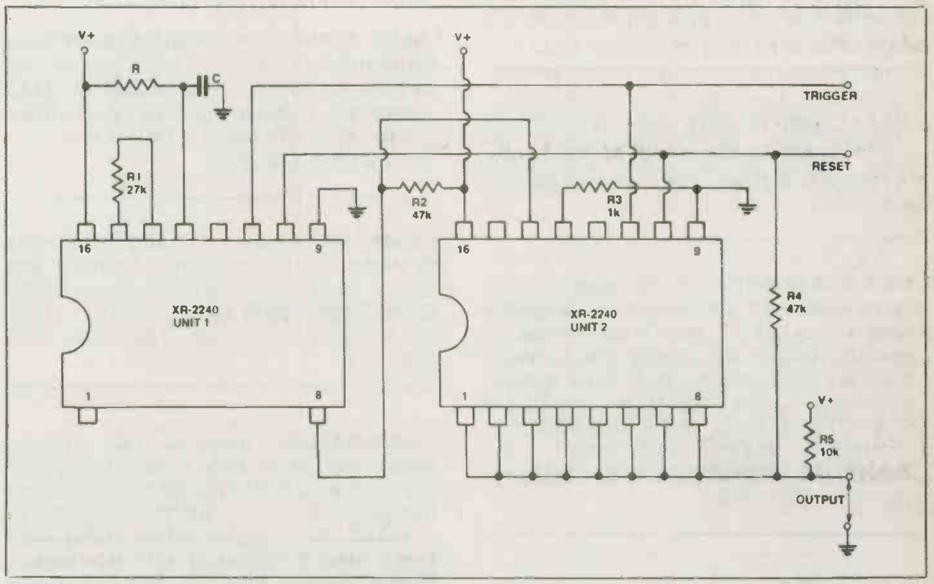

Fig. 7. Cascaded XR-2240s.

T = CR
if C = 500 uF (low leakage)
R = T/C
= 1355.3/(500 × 10^{-6})
= 2M7

Two XR-2240 ICs can be cascaded to generate extremely long time delays. When used in this format, the reset and trigger terminals of the ICs are tied together and the timebase of unit 2 disabled as shown in Figure 7.

The output is normally high. When a positive-going trigger pulse is applied, the output goes low and stays in the low state for $(256)^2$ = 65,536 periods of the timbase oscillator. Therefore, the totaly timing period of two cascaded units can be from 256.CR to 65,536.CR. The output is available in 256 discrete steps by selectively connecting one or a combination of the outputs from unit 2 to the output bus.

With T = 20 minutes an example of an ultra-long delay can be given.

CR = T = 20 mins.
65,536T = 1,310,720 min.
= 21,845 hours
= 910 days
= 2.5 years!

This article highlights the use of an XR-2240 as a precision timer. Other application suggestions are:

1. Sequential timing
2. Binary pattern generation
3. Frequency synthesis
4. Pulse counting or summing
5. A/D conversion
6. Digital sample and hold

Further information on the IC can be obtained from Exar Integrated Systems or their agents (Active Component Sales).

This article was made possible by the courtesy of Exar Integrated Systems. Data was taken from their publication 'XR-2240/2340 Programmable Timer Counter.'

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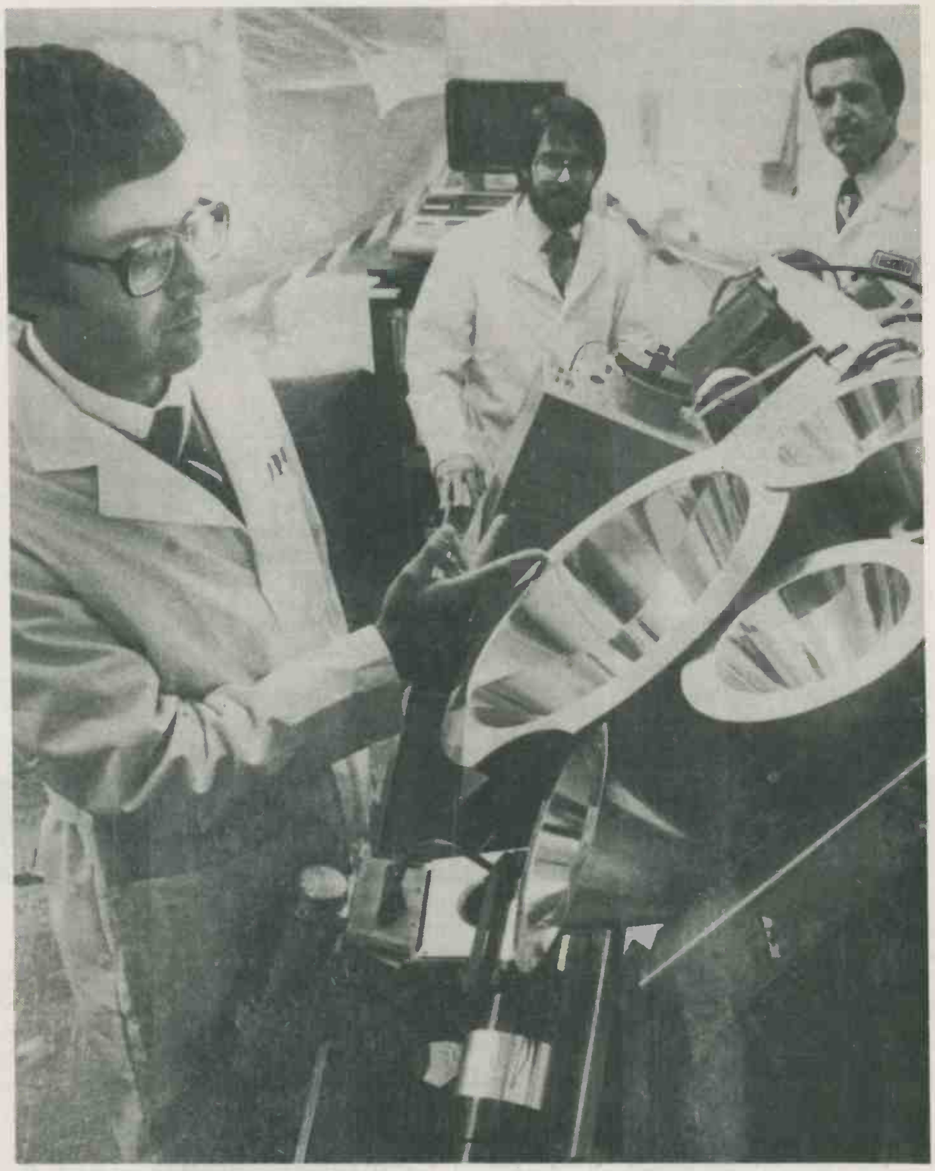
VLFs and the Magnetosphere

A process of wave interaction in the magnetosphere can amplify very low frequencies.

by Roger Allan



Part of the SEEP experiment carried aboard the S 81-1 satellite. Circular objects in the foreground are thermal radiators, used as part of the cooling system for the electron sensors which must operate at low temperatures for best sensitivities.

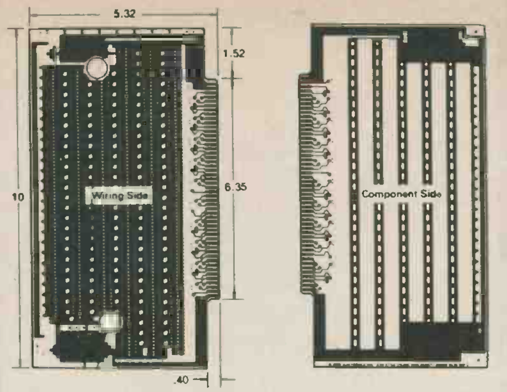
THE PROCESS of dumping electrons from the magnetosphere into the ionosphere goes on all the time and is a mechanism that helps maintain the equilibrium of the radiation belts, particularly the Van Allen belts, which surround the earth. The dumping process is due to natural processes and transmitted waves from the ground. Very often, high-power transmitters induce over half of the wave energy that exists in the magnetosphere. This process, known as field/effect/wave interaction results in the deflection of free electrons from the magnetosphere down into the ionosphere in a process identical to that caused by sunspot activity. When the freed electrons enter the ionosphere they create a miniature aurora borealis — small light emissions — that can be detected. In addition, it is felt that X-rays are released which should be discernable.

For some years, scientists have believed theoretical calculations which indicated that such ground based generation of Very Low Frequency (VLF) radio waves could result in these waves not only being transmitted thousands of kilometers but also amplified by the dumping process.

Acting under the sponsorship of the U.S. Office of Naval Research, Lockheed Palo Alto Research Labortory and Stanford University recently released the results of an experiment, known as SEEP (Stimulated Emission of Energetic Particles), which indicates that such a process in fact takes place, and further, that the amplification produced by the dumping process increases power factors by between 1,000 and 10,000 times (30-40 db).

The discoveries of this research program could lead to the improvement of radio communication by using magnetic field lines to capture and amplify VLF radio waves by utilizing that very large volume of space surrounding the earth that up until now hasn't been fully explored for its communication potential. Further, it provides a basis for improved minimization of deleterious heavy sunspot activity throughout the world.

Essentially, the experiment used a 1-Mw U.S. Navy VLF transmitter at Cutler, Main, Annapolis, Maryland and Jim Creek, Washington (used to communicate with submarines), and a 4 kw transmitter operated by Stanford University for the National Science Foundation at Siple, Antarctica, along with detectors mounted on the S 81-1 satellite — part of the USAF Space Test Program. Further, other satellites, specifically the Dynamics Explorer 1 and the International Sun-Earth Explorer flying at a higher altitude than the S 81-1, also carried VLF receivers to measure the intensity, frequency and



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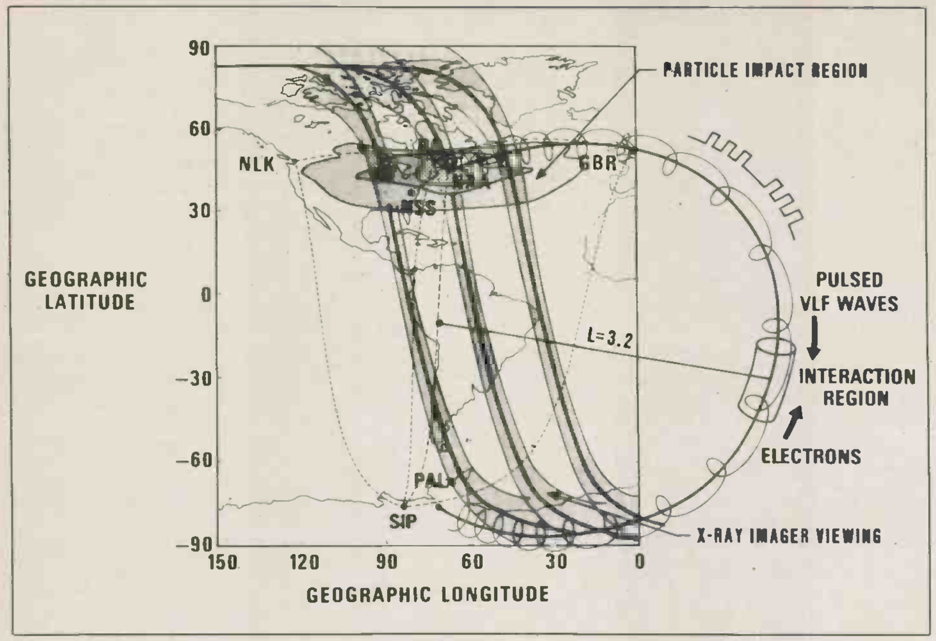
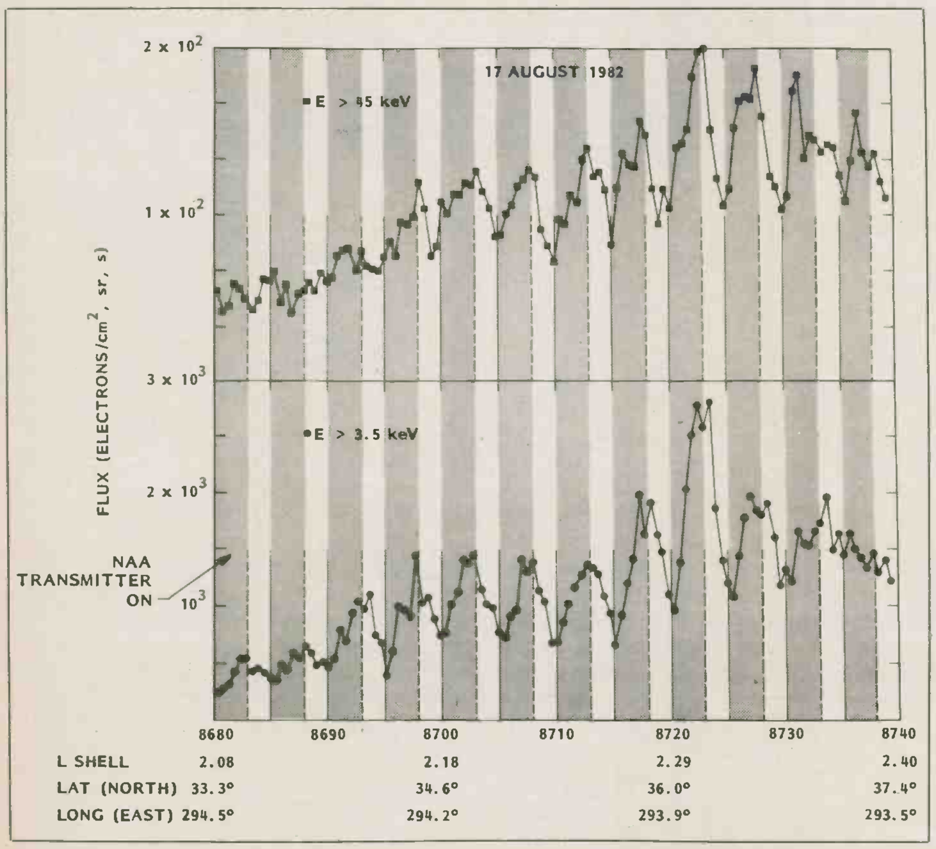


Location of high-power VLF Transmitters used in the SEEP experiment, along with a schematic representation of the interaction between pulse-coded very low frequency waves and the electrons spiralling around a magnetic field line connecting the Earth's northern and southern hemispheres. The high-power transmitters were turned on when the satellite was traversing regions (shaded areas) through which the displaced electrons moved. The interaction region marked in the diagram is at an altitude of approximately 8,500 km.



Example of Modulated Electron Beams

modulation timing of the transmitted waves above the interaction region — with such data being recorded at Siple and Palmer Antarctica, and Roberval Quebec, to correlate the data.

The transmitters were modulated in ten different on-off patterns, and evidence was sought in the output of cooled silicon detectors on board the S 81-1 while it was in low orbit of approximately 250 kilometers while the satellite was passing under a region exposed to interactions initiated by one of the four ground stations. Analysis shows that, for example, using a 3-sec on, 2-sec off format results in a 32 db increase in power, the amplification being due to the magnetosphere.

In addition to the particle detectors, the S 81-1 also carried an airglow photometer and X-ray mapping spectrometer to record expected side effects resulting from collisions between the displaced electrons and the constituents of the atmosphere. No data was generated in this part of the experiment due to an apparent lack of sensistivity on the part of the equipment.

While the experiment was deemed a success, several questions remain, such as why amplification seems to occur only at certain times, and how the waves penetrate the ionosphere and enter the magnetosphere. These sorts of questions may be answered by two follow up experiments. The first, involving what was originally known as the Waves in Space Plasmas (WISP) instrument, now known as the RPDP (Particle Interactions Recoverable Plasma Diagnostic Package), is currently under development by the Centre for Research in Experimental Space Science (CRESS) at York University in Toronto. Expected to be launched on the Shuttle as part of the Spacelab 6 mission in 1986 or 87, it will be used to study the effect of radio waves in the frequency of 0.3 MHz to 30 MHz on the Earth's ionosphere and magnetosphere. A second experiment, also under development by CRESS for the same Spacelab 6 mission, known as the Energetic Ion Mass Spectrometer (EIMS), may also answer some of these questions. It will allow scientists from the Herzeberg Institute of Astrophysics in Ottawa to investigate the properties of charged ions and molecules in the earth's atmosphere. By taking advantage of the large weight carrying capacity of the Shuttle, EIMS will have a sensitivity and precision far superior to those of previous space-borne instruments. It will be used to measure the composition and energy distribution of ion species occurring naturally in the magnetosphere as well as tracer ions injected as a result of other NASA experiments. **ETI**

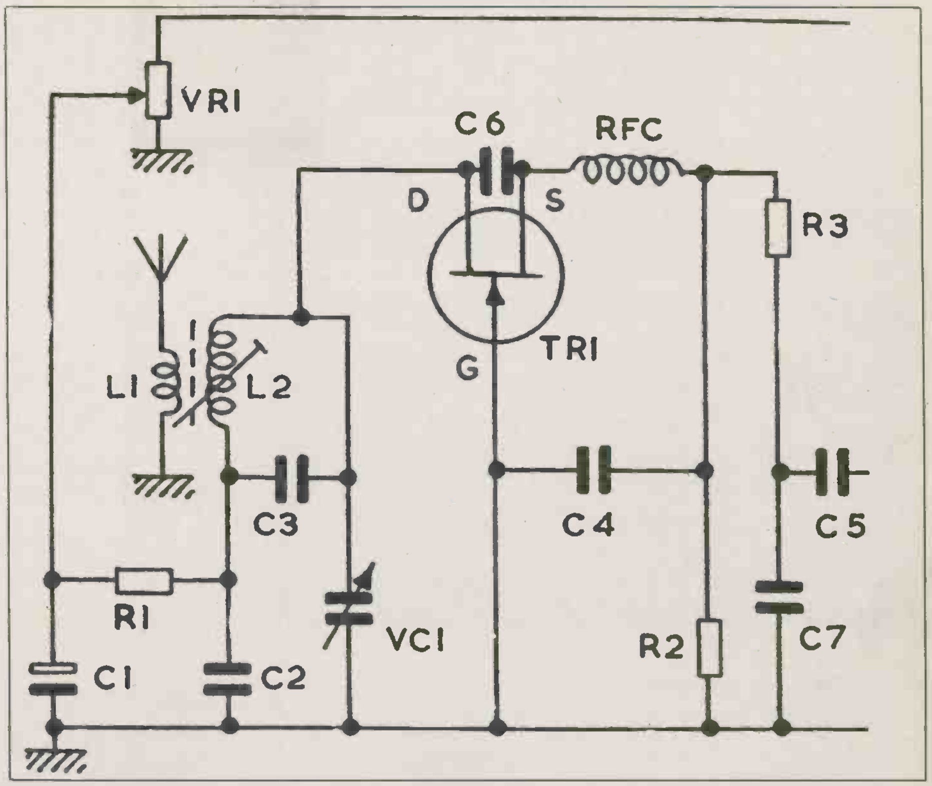
Armstrong

Few of us are aware of the enormous contribution Edwin Armstrong made to the development of radio. Sadly, like many famous inventors, he was bedevilled by legal wrangling over his patents.

THERE'S A VERY hallowed place in radio history not far outside New York City. After you escape from the confusion of Kennedy Airport, you cross the George Washington Bridge and take the green and pleasant Palisades Parkway, which points you towards upper NY State. Not far out, yet in wild, forested country, you'll see a transmitting aerial. Ask, and you'll be told that it is Edwin Armstrong's radio station.

Edwin Armstrong was born in Manhattan, New York, in 1890. His folks were well-to-do: his father a publisher, his mother a former schoolteacher, and between them they fostered in their son a fascination for the mechanical and electrical gadgets with which he was constantly surrounded. The turn of the century in New York was the age of the inventor. A steady stream of inventions were being registered at the US Patent Office, and each was eagerly seized on to be marketed and advertised. In many ways it was an inventor's paradise, but as many were to find out, the paradise had a few traps in it. Young Edwin caught the mood and at the age of 14, decided that he would be an inventor. The newest thing around was radio, and it was this field that Edwin chose, surrounding himself with coils and crystals, earphones and morse keys.

We know very little of what he did in those days, because like many inventors, he was shy and secretive. The next milestone in his career was his entry to Columbia University to study science and engineering — and to chalk his name on the list of radio pioneers long before his studies were complete. Radio at the time (about 1910) had very limited uses, mainly because of the very low sensitivity of receivers. Lee de Forest had just invented his Audion, a three electrode tube of the type we now call a triode, and this permitted some amplification of the feeble signals from a tuned circuit. At university, Armstrong, was able to lay his hands on one of the first of these tubes, and to start making use of it. Within a few months, he had made one of the major discoveries in radio, that of positive feed back.



A modern FET superregenerative receiver similar in operation to Armstrong's circuitry. VR1 controls the regenerative effect, increasing the gain by using positive feedback.

First Milestone — Regeneration

The idea was simple enough. The primitive tube had a very low gain at radio frequencies. Armstrong hit on the idea of feeding the signal back to be amplified again, and he called the idea regeneration. A regeneration receiver was hundreds of times more sensitive than the average receiver of the day, so that Armstrong's invention was undoubtedly one of the milestones in radio progress. It was immensely successful and every radio, from then on, with any pretensions to sensitivity, incorporated regeneration. Armstrong himself had already found out that excessive positive feedback could cause oscillation, and so paved the way for all electronic radio transmitters to replace the crude spark-coil or alternator types which were then used.

It could have, and should have, been the moment of his greatest triumph, but it was soured in a way that was to haunt him for the rest of his life. His patents were challenged by de Forest, and the judges and lawyers, ignorant of the principles involved, ruled that Armstrong's patents were invalid. To its great credit, the scientific community never accepted the legal judgement, and recognised Armstrong with every honour they could bestow. Many inventors from that day on, however, have regarded patent rights as a playground for lawyers and have preferred to get in first with the manufacturing of an invention rather than trust to their ability to profit from licensing agreements.

Second Milestone — The Superheterodyne

At the outbreak of war in 1914, Armstrong was appointed to the US Army Signal Corps to research into improved radio communications. Details of his work are not easy to obtain even now, because of the secrecy which surrounded the 'back-room boys', but one invention of this period is outstanding, and will probably remain so as long as radio is used. Until then, all radio receivers were either crystal sets, using no radio frequency amplification, or tuned radio frequency (TRF) receivers which used coils and capacitors to tune each amplifying stage to the frequency which was being received. TRF receivers are useful up to a point, but they have great

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disadvantages when large amounts of gain are needed. One disadvantage is that the tuning of each circuit has to be changed whenever a different frequency is wanted. Another is that even very small amounts of signal, if fed back from the output to the input, can make the receiver oscillate and so radiate interference. All this was solved by Armstrong's invention of the superheterodyne (superhet) receiver.

In a superhet receiver, each incoming frequency is tuned, amplified and then converted to an intermediate frequency (IF) by mixing it with a signal from an oscillator. The same IF is used no matter what the input frequency on that particular range happens to be. Tuning becomes easier because there are fewer variable tuned circuits, feedback is less of a menance because the signal which is most likely to feedback (the IF) is not at the same frequency as the input. It's difficult nowdays to imagine radio without superhet receivers: from the pocket transistor radio right through to the mighty radar receiver, all use Armstrong's superhet principle.

This work earned Armstrong more than fame. During the 1914-18 war, he had met David Sarnoff, founder of the Radio Corporation of America. (Armstrong had, in fact, married Sarnoff's secretary). Sarnoff was utterly convinced of the entertainment possibilities of radio, and he bought many of Armstrong's patent rights. In the early twenties, the sudden blossoming of radio as an entertainment medium meant a boom in radio manufacture, and made Armstrong a dollar millionaire because of the royalties which were paid by radio manufacturers.

Third Milestone — Frequency Modulation

Despite his new wealth Edwin Armstrong remained withdrawn, and continued to work at Columbia University. His theme now was the elimination of radio interference, a topic which was to occupy him to the day he died. His work was fruitful: in 1933 he took out patents on the frequency modulation system — FM. The idea of modulating the frequency rather than the amplitude of a radio wave makes it possible to design receivers which are completely insensitive to the amplitude modulation caused by interference. At the time, though, only the Army Signal Corps really saw the usefulness of FM. Armstrong found himself with an uphill struggle to convince even his friends that his new system was capable of providing broadcasting of a quality totally unknown at the time. He began the construction of an FM transmitting station, using his own personal wealth. It swallowed over $300,000 and was completed in 1939 — just in time for the wartime economy drive to make it out of the question to operate the station, or for manufacturers to switch to making FM receivers. Frequency modulation was to prove its value in World War II, however, and once again, Armstrong worked in military research projects.

After the war, FM started to be accepted slowly. The problem was mainly cost, and what boosted sales more than anything else was the new craze for hi-fi which suddenly brought in its wake an appreciation of better quality radio broadcasting. These could have been the days of triumph for Armstrong, but the nightmare which had haunted him from his early years was to recur. Once again, his patents were challenged in the courts, and he was put under the strain of trying to prove technical points to an audience of people who were technically ignorant and antipathetic to the quiet unassuming inventor. To add to his worries, his vast expenditure on FM was not yielding him any return, and in 1954, with his fortune spent and his brilliant invention being tossed about the courts by lawyers, Edwin Armstrong committed suicide.

He left behind him a monument as vast as any man can ever hope for. Every radio receiver and every FM transmitter in the world is the result of Edwin Armstrong's patient and little-publicised achievements. Only his name deserves to be better known. ETI

continued from page 10

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The first equation processor ever developed for personal computers, TK!Solver® , has been made more useful for architects, building designers and construction engineers. Software Arts, creator of the VisiCalc® and TK!Solver programs, is now offering a TK!SolverPack™ for Building Design and Construction. For people who use equations, formulas and modeling for analysis, design and planning, TK!Solver is a tool that saves time and increases efficiency by solving equations automatically. The program features a unique backsolving capability, which allows users to solve for any variable in an equation without reformatting the problem. In addition, TK!Solver performs iterative and list solving, produces tables and graphs, contains an automatic unit conversion feature, and has 15 models for solving design problems in residential construction.

2.78 MB for Apple

Data Technology has announced an Apple-compatible disk drive using the new Kodak 2.78 megabyte drive. It uses special 5¼ inch floppy disks at about $15-$20 each; one of these replaces about 25 of the 126K Apple disks. The drive will also read standard floppies. It's available in single, dual, or single-plus-hard disk. The single drive lists at $1,295 U.S. Contact Data Technology, 2775 Northwestern Parkway, Santa Clara, CA 95051 (408) 496-0434.

Circle No. 48 on Reader Service Card.

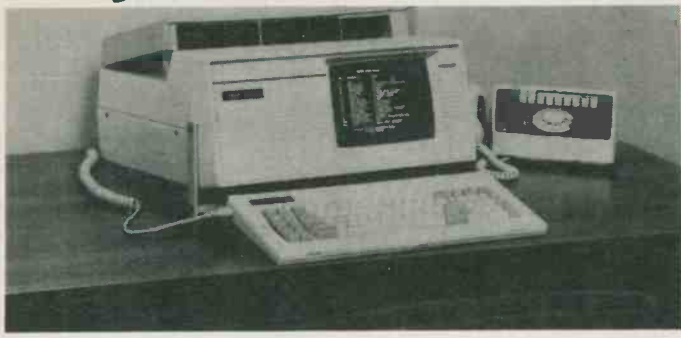
Looking for another source of wire and cable? Amecan Industries stock audio cable, station wire, communications cables, various hookup wires, high voltage cables, cords and more. They have an outlet in Montreal at 4747 Bourg St., St. Laurent, Que. H4T 1H9, and outlets in Mississauga and Edmonton.

Circle No. 49 on Reader Service Card.

The Honourable Donald Johnston, Minister of State for Science and Technology and for Economic and Regional Development and Minister responsible for Space Policy (his friends call him 'Don') has announced a 38% increase in the Space Expenditure Plan to $446 million over the next two years. Electronics manufacturers will no doubt profit from the budget increase.

Zenith has introduced new stereo colour television products designed for consumers to receive TV broadcasts with stereo sound and bilingual audio. Features include: 25-inch diagonal console colour TV sets with built-in stereo/-second-language adaptor; and 19- and 13-inch diagonal colour TV sets with built-in second-language decoders.

for your information



Heath Portable

The IBM-compatible Heath HS-161 Portable PC is available in single or dual 5.25-inch floppy disk drive configurations with each drive having a storage capacity of 360 kilobytes. Both versions are available in either kit form or fully assembled. All have 128 kilobytes of RAM memory that's expandable to 320 kilobytes on the main memory board and to 640 kilobytes by an added memory expansion board. All HS-161's have two RS-232C serial ports, one Centronics-compatible parallel port, color monitor output, four open IBM-compatible expansion slots and a built-in 9-inch amber monitor with an eight level "gray scale" feature. Contact: Heath Co., 1020 Islington Ave., Dept. 3100, Toronto, Ont. M8Z 5Z3.

Circle No. 47 on Reader Service Card.

Electrical Testing Instruments Ltd., announces a solid state dielectric strength tester. The Model HVA-2.5/100C is housed in a portable aluminum case and is used in production, acceptance, design and repair testing of all types of equipment requiring CSA, ASTM, NEMA, UL and IEEE testing standards. The features of this instrument are solid state transient free switching in zero crossing, breakdown and leakage indication, secondary metering of test voltage and positive manual reset on breakdown. The HVA-2.5/100C has been designed for use as a simple tool for dielectric strength, "HIPOT" or breakdown testing of all electrical or electronic equipment and appliances. Contact them at 3015 Kennedy Rd., Unit 12, Scarborough, Ont., M1V 1E7 (416) 292-8181.

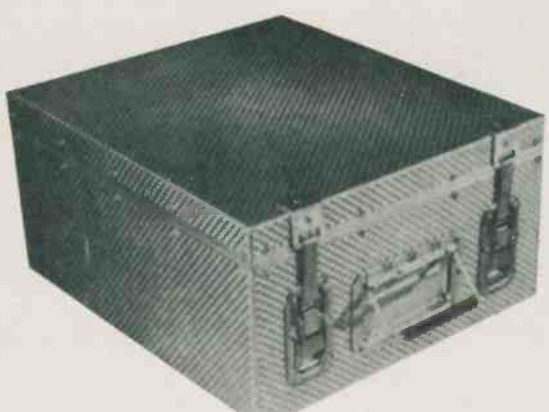
Circle No. 45 on Reader Service Card.

Boy, I wish somebody had coaxial connectors that would just twist on to shielded cable and eliminate those tiresome crimping pliers. They do? B&L Coaxial Connections, 50 Silver Star Blvd., Unit 209, Scarborough, Ont., M1V 3L3 (416) 292-3906, has them all over. Ask for the BNC/TNC line of twist-on connectors.

Circle No. 46 on Reader Service Card.

If any ETI staff member gets up suddenly from a chair, the static spark makes eight computers immediately erase their disks. Data Accessories Corp. Ltd., of 209 Wicksteed Avenue, Toronto, Ont., M4G 2C1 (416) 423-4070, is offering a Computer Care Centre kit; the cleaning fluid included is said to leave an anti-static film on the computer and its surroundings. We must order several cases.

Circle No. 35 on Reader Service Card.



Custom Strongboxes

If you need protection for portable test gear, computers, cameras, musical instruments, etc., North American Strongbox will custom-build a shockproof, waterproof aluminum box to suit your needs. Various shock-absorbing linings are chosen to optimise the required protection. Contact them at 43 Britain St., Toronto, Ont. M5A 1R7 (416) 364-8447.

Circle No. 44 on Reader Service Card.

Circle No. 15 on Reader Service Card

Screen Photos

Systems for producing presentation-quality instant color photographic hard copy have been announced by Polaroid Canada Inc. The hard copy system features a recorder for personal and small business computers. Called the Palette computer image recorder, the new system makes Polaroid 35mm Autoprocess color slides and 3¼ x 4¼-inch instant color prints of color or black and white computer graphics. Contact: Communications Dept., 350 Carlingview Dr., Rexdale, Ontario (416) 675-3680.

Circle No. 43 on Reader Service Card.

Computer Regulator

For sensitive electronic equipment requiring single-phase, 208 V output, an expanded line of hardwired Micro/Minicomputer Regulators featuring a new 208 V output in addition to standard 120-240 V outputs, is now available from Sola Electric, a unit of General Signal. For use primarily with mid-size computer installations, the new Micro/Mini models are available in 60 Hz designs rated for 500 VA to 15000 VA loads. Among these, 7.5 kVA, 10 kVA and 15 kVA Micro/Mini units will also accept 208 V input. Contact Sola Electric, 377 Evans Ave., Etobicoke, Ontario (416)255-6465.

Circle No. 42 on Reader Service Card.

The new Gladstone Electronics Spring/Summer catalogue is obtainable free of charge from 1736 Avenue Road, Toronto, Ont. M5M 3Y7 (416) 787-1448. It includes CB, a new Sinclair computer, robot kits, software, hardware, etc.

Circle No. 41 on Reader Service Card.

High speed MOSFETS

A new family of small signal Mosfets is now available from Ferranti Semiconductors. This ZVN33 transistor series has been designed with extremely compact geometry to permit switching times under 10 nanoseconds. As a result, these devices are ideally suited to applications such as telecommunication switching circuits and other designs requiring superfast switching. Noted specifications are breakdown voltages — 20 to 200V, low thresholds (VGSth) — 2.4V max, and input capacitances as low as 35pf. Available in the hi-rel E-Line (TO-92) and TO-39 packages, the ZVN33 Mosfets are priced at 30¢ each in 1K quantities. Leadtime is 4-6 weeks. For additional information, contact Ferranti Semiconductors, 87 Modular Avenue, Commack, NY 11725; (516) 543-6200.

Circle No. 40 on Reader Service Card.

Looking for a wide range of indicator lights, LEDs, and so forth? Len Finkler and Co., 80 Alexdon Rd., Downsview, Ont. M3J 2B4 offer their comprehensive 44-page technical guide and catalogue, "The Source for Indicator Lights."

Circle No. 39 on Reader Service Card.

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Circle No. 30 on Reader Service Card

Series 600 Preamplifiers

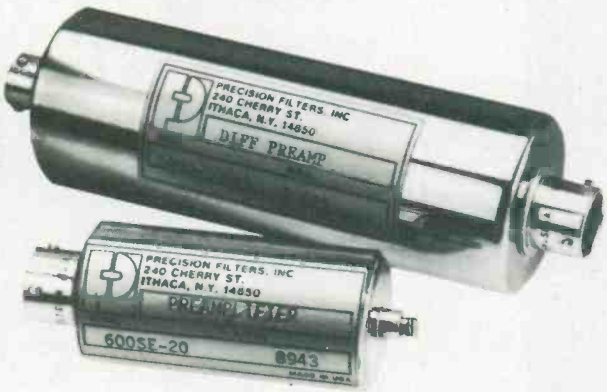
According to Precision Filters Inc., their Series 600 high input impedance, differential preamplifiers feature "excellent" low noise and common mode rejection performance over a frequency response range of 0.5 Hz to 500 kHz. These preamplifiers are available in single-ended and differential versions. Standard fixed gains of 0,10,20,30 and 40 dB or switched gains are available; gain deviation with power supply and temperature changes is typically 0.002 dB per volt or per °C respectively.

The Series 600 provides full output of ±10 volts peak to 100 kHz. Full output response is maintained at up to ±15 mA load current, with total freedom from peaking effects with complex loads.

The differential version can operate from ±9 V DC to ±18 V DC power supplies. Single supply versions, positive and negative, are available for supply range of 18 V DC to 36 V DC. Power supply noise rejection is excellent, greater than 80 dB over the entire frequency response range.

For more information, contact Precision Filters Inc., Dept. 600, 640 Cherry Street, Ithaca, NY 14850, (607)277-3350, Telex 646846.

Circle No. 38 on Reader Service Card.

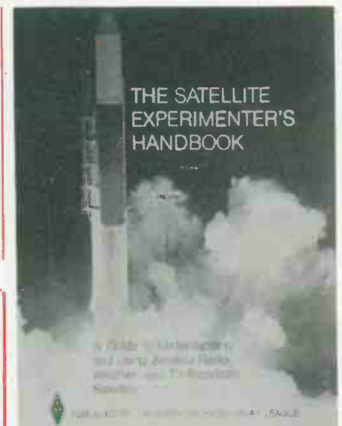


Epson MS-DOS

A new plug-in board that allows the 8-bit Epson QX-10 Personal Business Computer to run 16-bit MS-DOS™ and PC-DOS software is now available. Titled the QX-PC™, this board was developed and manufactured by Titan Technologies of Ann Arbor, Michigan. The QX-PC™ board converts the Z-80 based QX-10 to MS-DOS compatible 16-bit operation. Users can conveniently have access to CP/M™, MS-DOS and Valdocs software all on this same machine. The QX-PC operates at 5 MHz, supporting the graphics, printer and serial port features of the QX-10, making them accessible from MS-DOS. The optional board is available with 192K or 256K bytes of memory. It can be populated to 512K bytes with a separate option card. The 192K version is immediately available through a national network of authorized ZX-10 dealers, with a suggested list price of $1129. Contact Epson Canada Ltd., 21 Progress Court, Unit 18, Scarborough, Ont., M1G 3V4 (416) 431-5588.

Circle No. 37 on Reader Service Card.

This summer, NovAtel Communications of Calgary will begin field trials of Canada's first 800 MHz cellular communications network. A mobile test vehicle will be used to verify system parameters in the seven-cell Calgary test network. Success of the project will no doubt mean the possibility of portable phones in every car before long.



Satellite Book

The American Radio Relay League announces their Satellite Experimenter's Handbook, a collection of information on how to receive and use broadcasts from satellites; these broadcasts include amateur radio, weather, TV, etc. Chapters include orbits, tracking, antennas, and more. Contact: ARRL, 225 Main St., Newington, Connecticut 06111 (203) 666-1541.

Circle No. 36 on Reader Service Card.

The International Maritime Satellite Organization (INMARSAT) has sent letters to the bidders for its new series of satellites, inquiring as to the feasibility of the new satellites carrying 406 MHz transponders, which would be used for relaying distress alerts from satellite radio beacons. The 406 MHz transponder is also being carried on the satellites used in the COSPAS/SARSAT system, a search and rescue system developed by Canada, the United States, France and the Soviet Union, all of which are INMARSAT member countries. The COSPAS/SARSAT satellites have been credited as being instrumental in the saving of more than 180 lives, since the first satellite, a Soviet Cosmos satellite, was launched in June 1982.

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