Electronics Today

INTERNATIONAL JULY 1980

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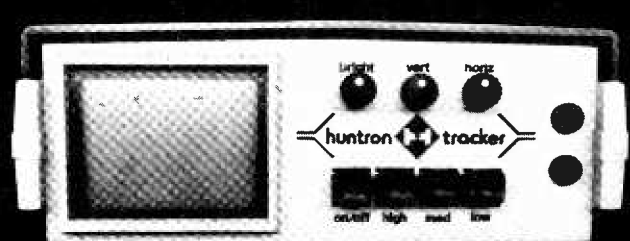

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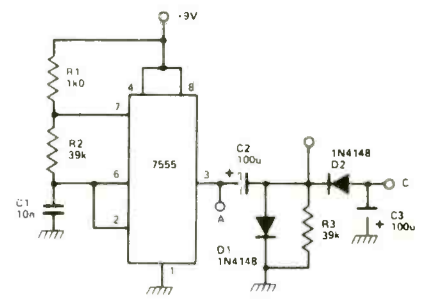
JULY 1980 Vol. 4 No. 7

FEATURES



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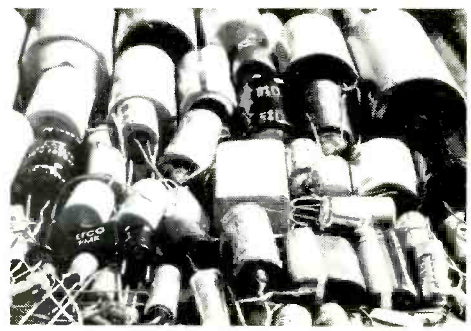

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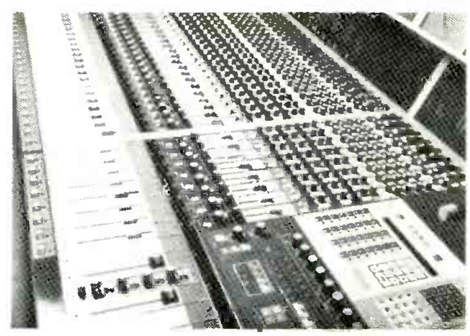

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Cover Photo: Taking this month's cover was quite a procedure. The 'smoke' effect was produced by pouring boiling water over dry ice and 'pouring' the condensation down a slope. Thanks are due to Martin Craig of the Toy Shop, 62 Cumberland Street, Toronto, for the loan of Robots.

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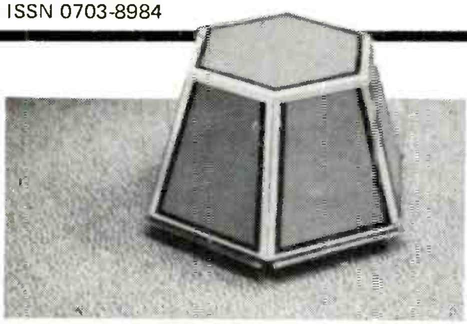

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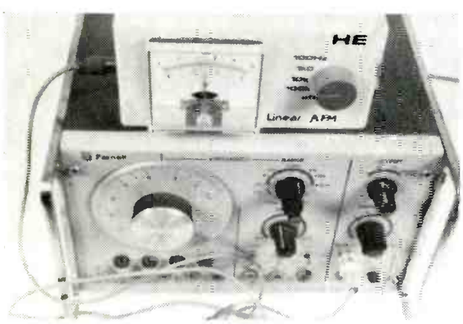

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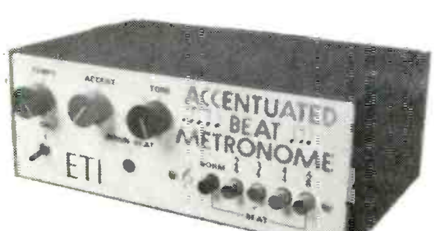

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LIABILITY
Whilst every effort has been made to ensure that all constructional projects referred to in this magazine will operate as indicated efficiently and properly and that all necessary components to manufacture the same are available, no responsibility whatsoever is accepted in respect of the failure for any reason at all of the project to operate efficiently or at all whether due to any fault in design or otherwise and no responsibility is accepted for the failure to obtain component parts in respect of any such project. Further no responsibility is accepted in respect of any injury or damage caused by any fault in the design of any such project as aforesaid.

EDITORIAL QUERIES
Written queries can only be answered when accompanied by a self-addressed, stamped envelope. These must relate to recent articles and not involve the staff in any research. Mark such letters ETI-Query. We cannot answer telephone queries.

BINDERS
For ETI are available for $6.75 including postage and handling. Ontario residents add 7% PST.

SELL ETI
ETI is available for resale by component stores. We can offer a good discount and quite a big bonus, the chances are customers buying the magazine will come back to you to buy their components. Readers having trouble in buying ETI could ask their component store manager to stock the magazine.

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 0.1uF is 100n, 5600pF is 5n6. Other examples are 5.6pF=5p6. 0.5pF=0p5.

Resistors are treated similarly: 1.8M ohms is 1M8, 56k ohms is the same, 4.7k ohms is 4k7, 100 ohms is 100R and 5.6 ohms is 5R6.

PCB SUPPLIERS
The magazine does not supply PCBs but these are available from the following companies. Not all companies supply all boards. Contact these companies direct for ordering information.
B&R Electronics, P.O. Box 6326F, Hamilton, Ontario, L9C 6L9
Spectrum Electronics, Box 4166, Stn 'D', Hamilton, Ontario, L8V 4L5
Wentworth Electronics, R.R. No.1, Waterdown, Ontario L0R 2H0
Danocinths Inc. P.O. Box 261, Westland, MI 48185, USA.
Exceltronix Inc., 319 College St., Toronto, Ontario, M5T 1S2
Arkon Electronics Ltd., 409 Queen St. W., Toronto, Ontario, M5V 2A5.

NEWS

Super Colour In a Desktop Computer

Invitations to press conferences come in on a regular basis to our offices and we usually go as an opportunity to get a firsthand look at new products and to meet the people who send us news releases.

One such event took place at Hewlett Packard's headquarters in Mississauga to introduce the System 45C Desktop Computer.

The system, featuring graphics computation is capable of displaying results in up to 4,913 colours on a cathode ray tube (CRT) display.

The HP Series 9800 System 45C is designed for engineers and scientists who have complex design and analytical problems. It constitutes a complete workstation – with built-in colour graphics CRT display, light pen, operating system, read/write memory, enhanced-BASIC language, keyboard, mass storage system, and thermal line printer – all integrated into a single desktop unit.

The System 45C can solve complex graphics-computation problems and, at the same time, provide three-dimensional representations in solid or wire-frame form. Results can be displayed in vivid colours coded to enhance interpretation of results. The system provides 70 graphics statements, which relieve the user of many programming tasks such as generating geometric figures.

The colour commands allow displaying alphanumerics and lines (vectors) in eight colours; a choice of 4,913 shades of colour are available.

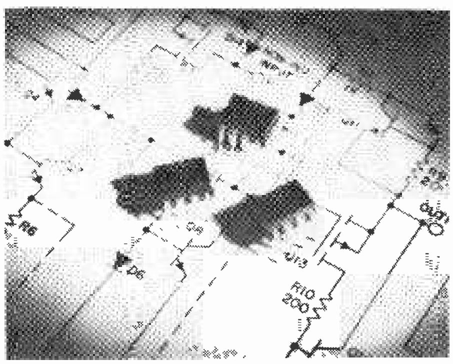
Geometric figures – such as circles, rectangles, regular polygons, and objects represented in matrices – are drawn on the CRT through simple commands. An additional "FILL" parameter quickly adds colour fill to any of the drawn figures. Assigning such computational tasks to the System 45C's firmware relieves the user of writing application routines to accomplish these graphics.

The light pen, supplied as part of the standard System 45C, provides a convenient way for the user to pick, move, and construct objects on the CRT display. Using the light pen, selection of an individual pixel (dot) is possible. A second-order, predictive algorythm (located in firmware) moves the cursor in the direction and speed of the light-pen motion.

The colour of the high resolution CRT makes most colour TVs look sick by comparison. Under darkened conditions the colours came across with intensity that was quite simply staggering. The demo program we watched ran through the various applications with emphasis on the value of colour on data interpretation.

The standard system comes with 187K for a mere $56,801 Cdn. If you're keen on knowing more write to: Inquiries Manager, Hewlett-Packard (Canada) Ltd., 6877 Goreway Drive, Mississauga, Ontario L4V 1M8.

More MOS From RCA



The CA080-series BiMOS operational amplifiers, RCA equivalents of the industry type TL080 BiFET series, have been introduced by RCA Solid State Division. These BiMOS amplifiers offer improved characteristics over the TL080 BiFET devices. The CA080 is an externally phase compensated single amplifier, and the CA082 and CA083 are internally phase compensated dual amplifiers. The CA080, CA081 and CA083 have provisions for external offset nulling.

The CA080-series types feature gate-protected MOS/FET (PMOS) input transistors for high input impedance (10^{12}R typ.) and a wide common-mode input voltage range, and bipolar and MOS output transistors for a wide output voltage swing and high output current capability. Other features include very low input bias and offset currents, low input offset voltage, fast slew rate, a typical unity-gain bandwidth of 5 MHz, and low distortion. All types are direct replacements for the TL080 BiFET series in most applications.

The CA080 types are supplied in a variety of package options, including the 8-lead plastic DIP (Mini-DIP), the 14-lead DIP, the 8-lead TO-5 style, the 8-lead TO-5 style with dual-in-line formed leads (DIL-CAN), and in chip form.

Typical prices are less than $1.00 US in quantities of 100–999.

Further information and copies of the data bulletin may be obtained from RCA Solid State Division, Box 3200, Somerville, NJ 08876.

Cheaper Fiber Optics

All of Morotola's Fiber Optic components have been reduced in price by approximately one third. The price reductions mark the initial transition into the volume production phase of manufacturing, and are expected to accelerate the implementation of fiber optics in equipment designs.

Included in the price reduction are Motorola's latest ferrule emitters and detectors as well as its earlier TO-18 fiber optic components.

You can of course win an evaluation kit of these components absolutely free. Details are in the June 1980 issue on page 43, but hurry, contest closes on the eighteenth of this month.

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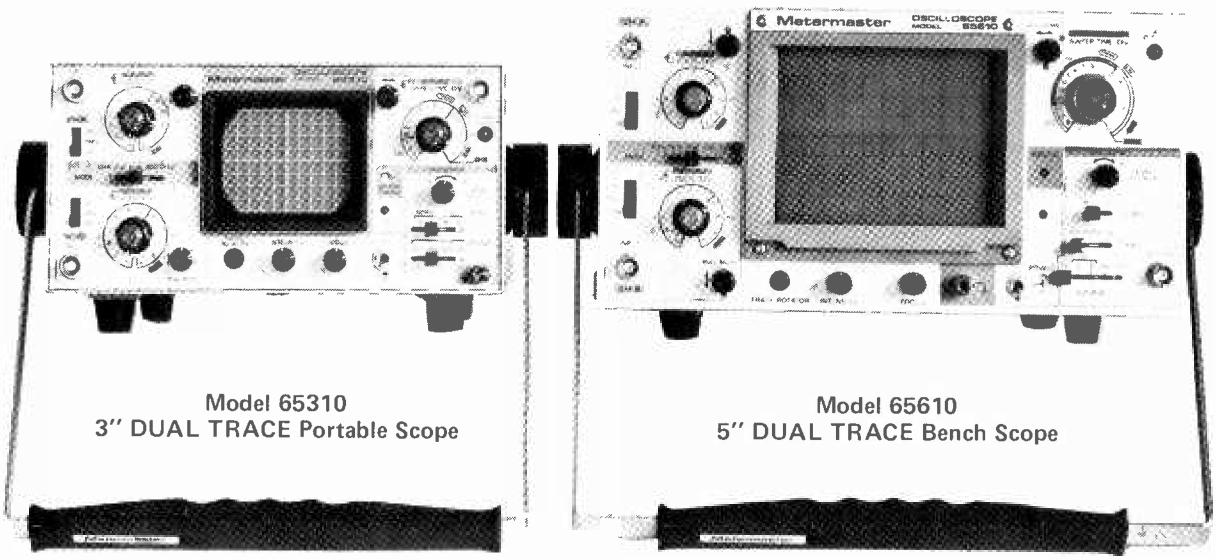

Model 65310
3" DUAL TRACE Portable Scope

Model 65610
5" DUAL TRACE Bench Scope

The Model 65310 is a truly portable, dual trace, 15MHz scope offering battery operation as a standard feature. This is an ideal oscilloscope for the service - man who needs a combination bench and portable instrument. This scope is packed with features:

* Operates from 3 power sources:
  1) Rechargeable NiCad batteries
  2) 120VAC line (also charges batteries)
  3) 11 – 30VDC
* 3" High Brilliance CRT
* Fully Automatic Triggering
* Built-in Calibration Source
* Trace Rotator
* 2mV Vertical Sensitivity
* Operating Modes CH-A, CH-B, Dual, Add/Sub Chop, and X-Y

WEIGHT: 13.5 lbs.
OPTIONAL ACCESSORIES: Combination 1:1 and 10:1 switchable probes(compensated). Priced at $39.00 F.S.T. included.

Vinyl carrying case for Model 65310 only, priced at $62.00 F.S.T. included.

The New METERMASTER Model 65610 scope employs an extremely bright 5" rectangular CRT with internal graticule. External DC operation permits floating measurements. Take a look at the features this scope has to offer:

* Operates from 2 power sources:
  1) 120VAC line
  2) 11.5 – 30 VDC
* Frequency Response 15MHz(-3dB)
* Fully Automatic Triggering
* Built-in Calibration Source
* Trace Rotator
* HF Rejection
* 5mV Vertical Sensitivity
* Operating Modes CH-A, CH-B, Dual, Add/Sub Chop, X-Y, and Z modulation.

WEIGHT: 16 lbs.
OPTIONAL ACCESSORIES: Combination 1:1 and 10:1 switchable probes(compensated) Priced at $39.00 F.S.T. included.

Call one of our offices (below) for a no obligation, free of charge evaluation.

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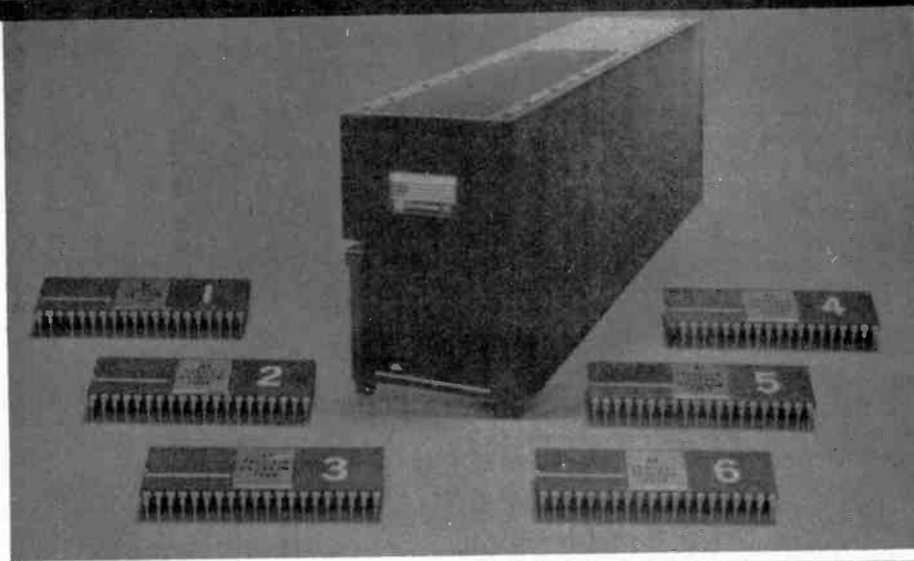
MPU Jet Engines

An aviation fuel savings of 1½% doesn't sound like very much, but when translated into actual figures, it amounts to more than 7,500,000 gallons a year for Pan American World Airways' fleet of 747 Jumbo Jets. That's what Pan Am will be saving when it finishes the installation of Delco Electronics' new Flight Management Systems. The heart of the system is the Flight Management Computer which utilized Motorola's NMOS LSI circuits. In today's dollars, this savings amounts to approximately $5.55 million per year.

Pan Am began installation of the Flight Management Systems in early 1980 on its fleet of 10 Boeing 747 SP's (long range jumbo jet) and on 29 standard size Boeing 747-121 models.

Pan Am's selection of the system containing Motorola LSI circuitry was awarded following a year of flight test and evaluation on a 747 in regular scheduled service. The result showed a fuel efficiency improvement of some 1.5 percent when the FMS was used.

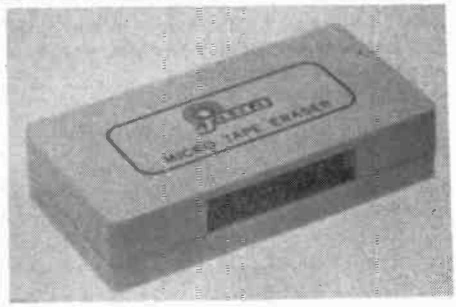
Each Pan Am FMS System is composed of four 'black boxes' – a computer, an alphanumeric control display, a switching unit for electrical hookup, and a unit to monitor engine data.



High Fidelity With Jana

Those wonderful folks who brought you CBs, Jana Kits and components are now plunging into the audio field with a line of no less than eleven record and tape care products.

Additionally look for consumer products such as portable radios, car stereos and speakers, headphones and intercoms bearing the Jana name.



Fuseful Catalogue

Bussmann Manufacturing, St. Louis, have just introduced their new 40 page Small Dimensional Fuse/Holder Catalogue SFB-80.

This new Buss catalogue covers their complete line of fuses/holders for the electronic industry.

Included in this full colour Buss catalogue are complete specifications and blowing curves on fuses and detailed information on fuse blocks and holders.

Bussmann Manufacturing is represented in Canada by Atlas Electronics Limited, 50 Wingold Avenue, Toronto, Ontario M6B 1P7.

Britain To Get CB Plus Garbage Channels

Although in North America and most of Europe we take CB for granted, it has remained illegal in Britain. This has not prevented its use and an estimated 100,000 CB'ers are active using smuggled rigs – even the import and sale of these is prohibited. The level of activity is such that if the skip is reasonable you'll hear the much higher noise level on Channel 14 which is used for calling.

The pressure for legislation has led to almost weekly demonstrations and finally the British Government have said they'll consider it, not on 27 MHz, but 900 MHz. There will be 40 channels but what is interesting is that another 40 channels are to be introduced for other uses such as digital transmission between computers: these are entitled 'Garbage Channels'.

900 MHz may seem a high frequency without much hope of getting out far – but think how small the antennas will be!

Wireless Security

A two-part, ultrasonic security system that uses the existing electrical wiring to sound an alarm has been developed by a company located in Markham, Ontario. The Tellus TSS simply plugs into any electrical outlet. When the Intruder Sensor detects motion, it sends a signal through the existing household wiring. The Receiver/Alarm is activated only when it receives that signal and sounds a loud 105 decibel horn. This principle allows the alarm to be plugged in anywhere, even in your neighbours home if you are going to be away. The Tellus TSS can be used to protect your home, apartment or cottage and any number of sensors or alarms can be used to provide a totally integrated security system.

The product has been designed, engineered and is manufactured totally in Canada, by Tellus Instruments Limited, 91 Esna Park Drive, Unit no. 9, Markham, Ontario L3R 2S2 and is covered with a five year warranty on parts and workmanship.

Expose Yourself

News Digest is a regular feature of ETI Magazine. Manufacturers, dealers and clubs are invited to submit news releases to News Digest, c/o ETI Magazine. Sorry, submissions cannot be returned.

P.M.I. Distributor

Zentronics announces the aquisition of a new product line, Precision Monolithics.

P.M.I. is a manufacturer of high quality precision linear bipolar intergrated circuits. The two principal areas of their product line are operating amplifiers and data conversion products.

Product will be stocked in all eight Zentronics locations.

Write to Zentronics, 1355 Meyerside Dr., Mississauga, Ontario L5T 1C9.

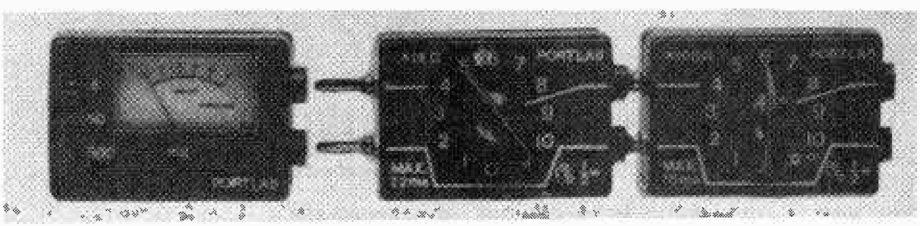
The Last Word

'What will they think of next?', is a well used expression quite unsuitable in the news section of any magazine, but sometimes you have to wonder.

A California (where else?) engineer has developed a solar powered tape recorder that can be imbedded in a tombstone. The idea is to activate the appropriate button and you can hear the last words of whoever is resting six feet below you. (Oh, I'm sorry, we're you eating breakfast?)

According to the inventor, Stanley Zelazny, the 'Memorial Audio Reproduction System' has been well received. The device can also be used in historical monuments to give visitors a short history lesson. Alternatively it can be used as a warning device in potentially dangerous unattended installations.

If you're really interested you can write to Miracles In Motion, 10630½ Valley Spring Lane, Toluca Lake, CA 91602. ●



Novel R Box(es)

A flexible resistor substitution system has been introduced by Electronic Industrials.

The system consists of a series of seven single decade resistance boxes that can be 'daisy chained', to produce values of up to 1,111,111 ohms. The modular concept allows the user to break up the set to be used in several applications simultaneously.

Additional accessories include a series ammeter and also a zener substitution box.

Write to Electronic Industrials Company, P.O. Box 458, Downsview, Ontario M3M 3A8.

Looking Back

Already inquiries are flooding in on our Click Eliminator project. Here are a few answers.

The parts list only makes mention of resistors for right hand channel. You will also need C101-106 (identical to C1 to C6), RV 101 (identical to RV1) and ICs 101-103 (you get the idea).

The TL083 is a Texas Instruments chip available from Active Components for $1.30 US. You can also get the LF 356 from them, but shop around, it's fairly widely available.

The TDA1022 BBD is the real problem in this project. At this writing there are 29 units in Canada and delivery times are approximately 8 weeks. We have been assured that Philips Electronics can obtain more stock should the need arise. This IC can be ordered through any Philips distributor.

FEATURE

CMOS 555 APPLICATIONS

Tim Orr brings you the result of bipolar versus CMOS in the 555 league.

THE BIPOLAR 555 timer has been around for many years, but there is now a CMOS version that has some very significant design improvements. The two devices are functionally very similar, being interchangeable in most applications. The operation of the 555 is very simple, (Fig.1). It consists of a pair of comparators that operate at ⅓ and ⅔ of the supply voltage, this being set up by a resistor chain. These comparators set and reset a flip flop which in turn drives the output stage. A second output is available which is an electronic switch, (Discharge) to ground. Other features include access to the resistor chain via the control voltage pin and an extra reset input to the flip flop. This simple network readily lends itself to all sorts of oscillators and timer circuits.

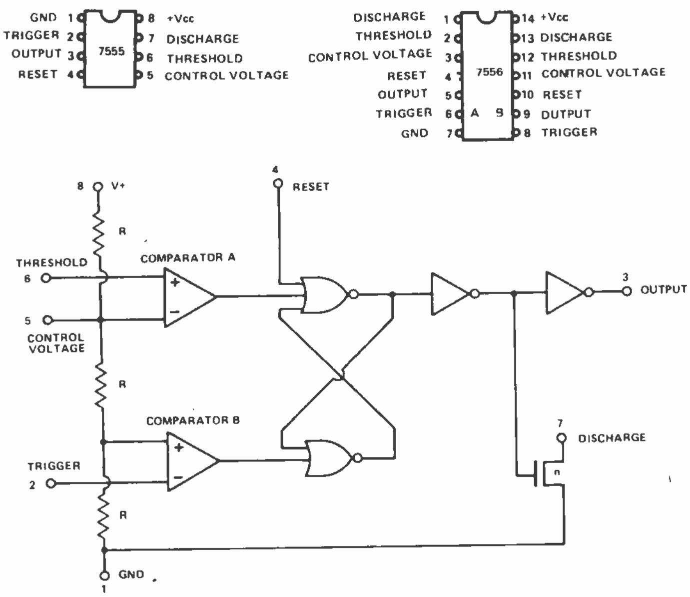


Fig. 1. The pin-out and internal configuration of the CMOS 555.

The bipolar 555 has a few parameters that can make it difficult to use, but which have been improved in the CMOS version, (Fig.2.). The bipolar quiescent supply current is generally about 10 mA which negates their use in small battery units. The CMOS version consumes a mere 120 ua.

PARAMETER	CM 7555	BIPOLAR 555C
QUIESCENT CURRENT Vcc +15V	TYPICAL 120uA	TYPICAL 10mA
INPUT CURRENT TRIGGER	50pA	0u5A
THRESHOLD	50pA	0u1A
RESET	100pA	0m1A
MAX. OPERATING FREQUENCY	500kHz	500kHz
POWER SUPPLY RANGE	2 → 18V	4VS → 16V
PEAK SUPPLY CURRENT TRANSIENT	10mA	370mA
RISE AND FALL TIME AT OUTPUT	40nS	100nS

Fig. 2. A comparison between the Bipolar and CMOS version of the 555.

Also the CMOS inputs are very high impedance having input currents down in the pico amp region. Another major improvement is the reduction in the power supply current transient during an output transmission. The bipolar is very noisy in this respect and can often be the cause of lots of 'funnies' in nearby circuits.

The CMOS 555 is a low power high input impedance device that should be used where low current consumption is at a premium. The following circuits illustrate some possible uses of the device.

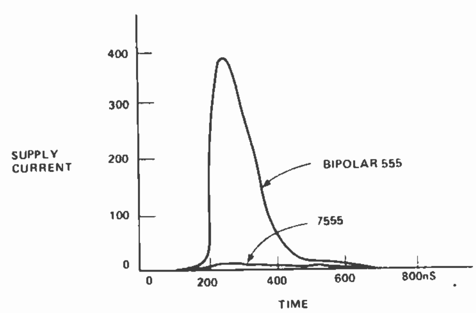


Fig. 3. The CMOS 555 displays an impressive reduction in supply current transient during an output transmission.

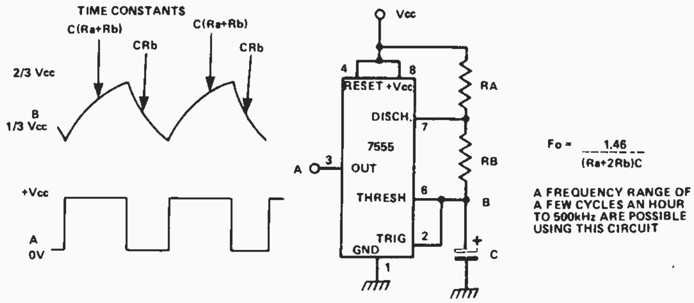


Fig. 4 (above) A simple oscillator can be constructed using two resistors and a capacitor. Due to the high input impedance of the CMOS device, resistor values up to 100M may be used. The operation is as follows. Capacitor C is charged up via Ra and Rb and so rises with a time constant of C(Ra+Rb). When the voltage B reaches ⅔ Vcc, the threshold hold comparator goes high causing the output (pin 3) to be set low. Also the discharge FET (pin 7) is turned on. This discharges the capacitor via Rb with a time constant of CRb, until the voltage B reaches ⅓ Vcc.

This causes the trigger comparator to go low which sets the output high and turns off the discharge FET. Thus, the voltage B oscillates between ⅓ and ⅔Vcc. The waveform is asymmetric but due to the nature of its generation its frequency is virtually invarient with regards to supply voltage changes. It is possible to generate a sawtooth waveform by reducing Rb to a short circuit. This causes the reset time to be very fast, of the order of a few microseconds. However, there is a propagation delay through the device from the trigger comparator to the output which causes the discharging waveform to overshoot the ⅓Vcc limit, thus making the waveform at B larger. This will cause the oscillation frequency to be lower than calculated. To maintain the calculated frequency, the discharge period should be 5 uS seconds or longer.

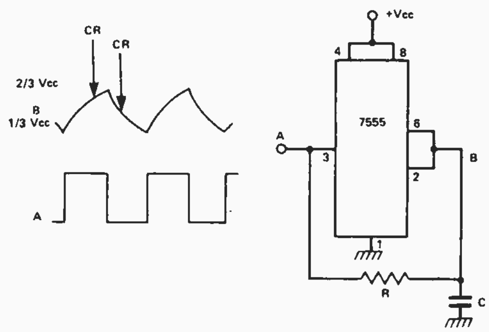


Fig. 5 (above) This oscillator has a symmetrical output because the charge and discharge paths are the same and the portion of the exponential cruve that is used is symmetrical. Note that in this circuit, the discharge pin (7) is available to do other jobs, such as drive a LED or some other device. The timing resistor R should be kept relatively high (above 10k) to prevent loading of the output.

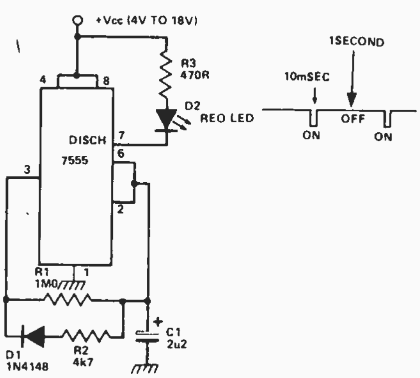


Fig. 6 (above) This circuit is an oscillator that has a wide mark to space ratio. It is OFF for approximately 1 second and then turns ON for about 10 mS. During this latter period the LED is turned on by the discharge FET. The long OFF period is generated by the R1, C1 time constant, whereas the short ON period is produced by D1 (which is forward biased) and R2, C1. The average current consumption is relatively low. If the unit were powered from a 9 V battery, then the current would be 120 uA for the ICM 7555 and an average of 140 uA for the LED, making 260 uA total. This would give a lifetime of a few months for a 9V which would be extended by lengthening the OFF period (increase R1) and reducing the LED current (increase R3).

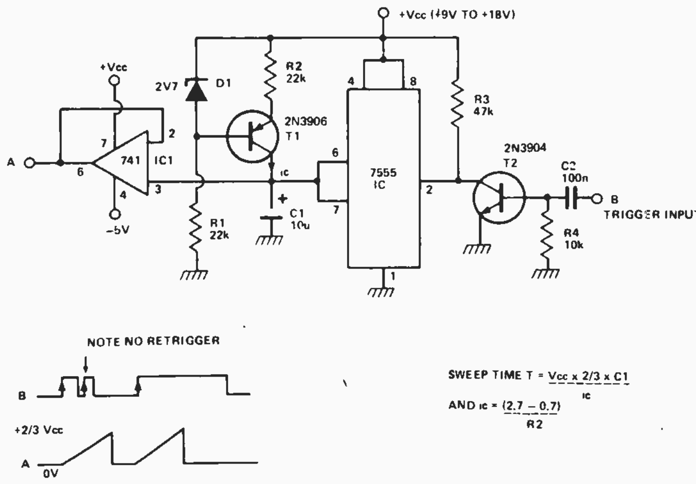


Fig. 7 (above) The 7555 is used to initiate and terminate a triggered sweep. Normally the discharge FET (pin 7) is ON and so C1 is shorted to ground. When a trigger is applied to the input, the collector of Q2 momentarily goes low which sets pin 7 of the 7555 in its OFF condition. Q1, R1, R2 and D1 form a current generator that drives C1. Once the discharge FET has been turned OFF, the voltage on C1 rises linearly. When this voltage reaches + ⅔ Vcc, the threshold comparator sets the discharge FET into its ON state and so C1 is shorted to ground. IC1 is used to buffer the voltage on C1. The sweep generator is not retriggerable and is only initiated on fast positive going inputs. To vary the sweep rate, alter C1 and or R2.

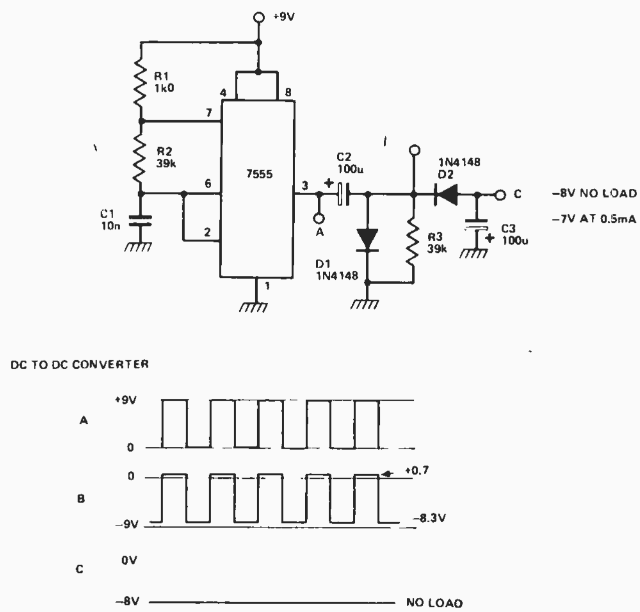
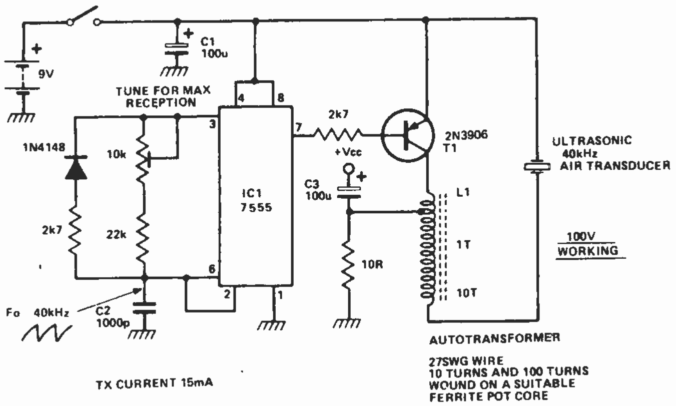


Fig. 8 (above) A DC to DC converter can be constructed from an oscillator and a diode charge pump. The 7555 forms a high frequency square wave oscillator. The squarewave from pin 3 is AC coupled via C2 to the charge pump. The voltage on the negative side of C2 is prevented from going more than 0V7 positive by D1 and so the square wave on this side of the capacitor biases itself so that it moves from +0V7 to —8V3. D2 charges up C3 on the negative excursion of this waveform and so a negative rail of about —8 V is generated. The current that can be taken from this rail is rather low, being determined by the oscillation frequency and C2. Generally DC to DC converters have a poor transfer efficiency.



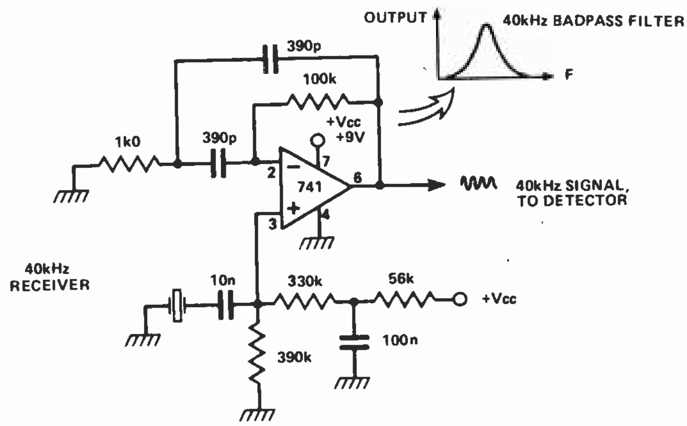


Fig. 9 (above) The 7555 can be used as the driving oscillator in an ultrasonic remote control system. The oscillator generates a thin pulse about 2.5 uS long at the natural resonant frequency of the transducer. This short pulse is used to turn on a transistor (Q1) which drives an auto transformer with a 10 to 1 step up ratio. The output of the transformer is connected to the transducer and when the oscillation frequency is correct a 100 V peak to peak sine wave will be produced at this point. The transducer is usually a crystal with a high impedance and so a high operating voltage is required to produce any power output. The receiver is a 40 kHz bandpass filter. This will amplify any audio signals at this frequency, which can then be sent to a detector circuit.

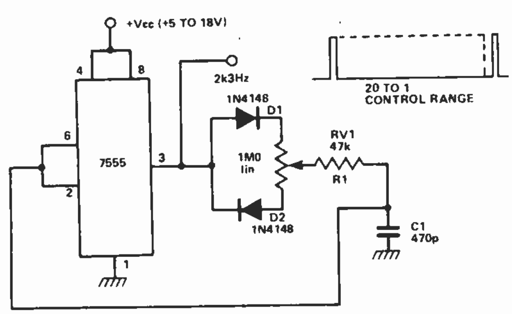


Fig. 10 (above) This oscillator allows the mark space ratio at pin 3 to be varied from 1 to 20, to 20 to 1, by using two feedback routes. When pin 3 is high, C1 is charged via D1, part of RV1 and R1. When it is low, C1 is charged via D2, the other part of RV1 and R1. Thus the position of the RV1 wiper determines the ratio of the charge and discharge periods. The oscillation frequency is slightly dependent on this ratio.

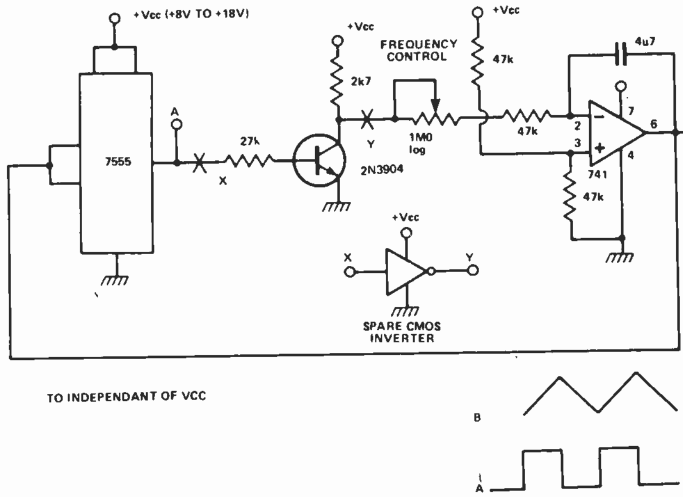


Fig. 11 (above) By making a loop out of a 7555, an inverter and an integrator, a triangle/square wave oscillator is produced. To operate well at high frequencies (up to 40 kHz) a CMOS inverter should be used to replace the transistor inverter. The op amp provides a low impedance triangle output, the frequency of which may be controlled with the 1M log pot.

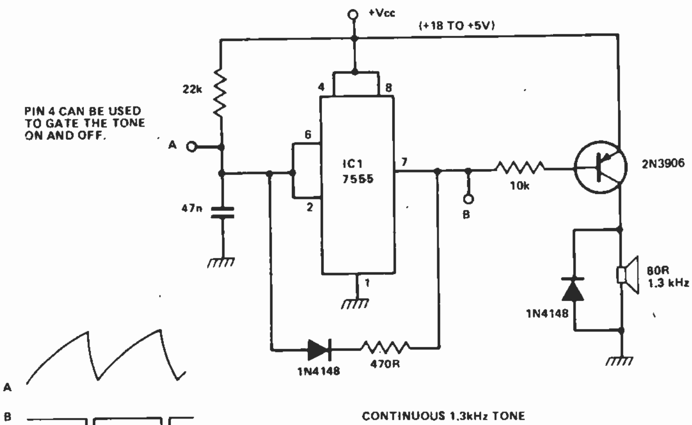


Fig. 12 (above) The 7555 can be used to generate an acoustic tone. The oscillator is set to run at 1k3Hz which has a low period of about 15 nS and a high period of about 755 nS. During the low period the transistor is turned ON and so the loudspeaker is connected across the power supply and sinks at about 100 mA (for a 9 V supply). This gives it a 'kick' on every cycle of the oscillation. As the transistor is only on for 15 out of every 770 nS the average current through the speaker is quite small, being about 1.95 mA. Therefore, the total current consumed by the whole system is only about 2.5 mA (at 9 V), and yet the 20 mW output signal is quite audible.

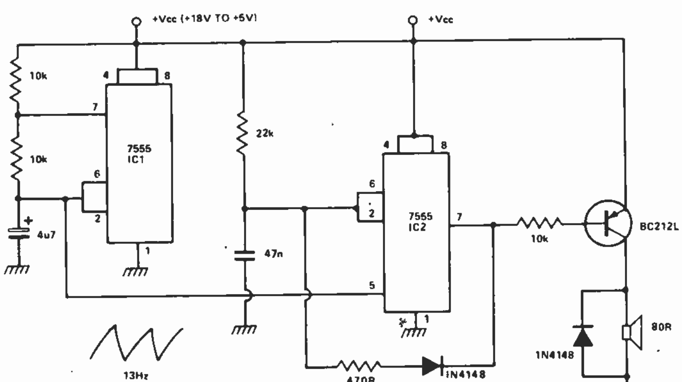


Fig. 13. See next page.

Fig. 13. A warbling tone can be generated by using two oscillators. The warble is produced by IC1 which generates a 13 Hz wave form that is used to frequency modulate the tone generator as described in the previous example. Pin 5 of a 7555 is connected to the + ⅔ Vcc tap on the resistor ladder. By tying it to a 'warble' waveform, frequency modulation of the final output tone is produced. A 7556 could be used instead of two 7555's.

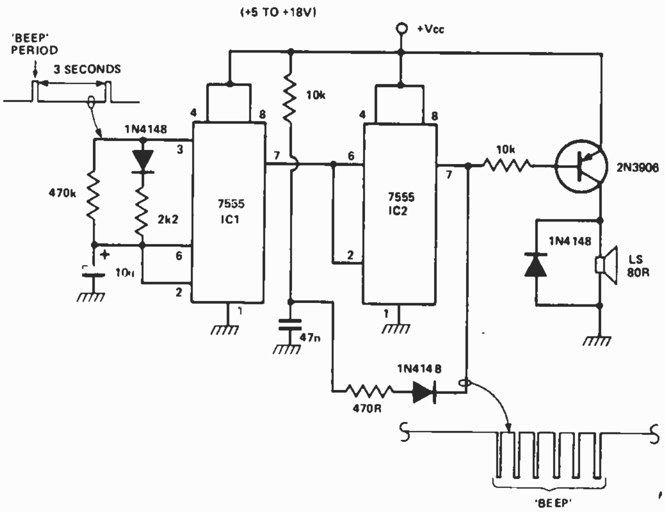


Fig. 14 (above) The police and other emergency services use a repeating high frequency 'beep' on their radio networks. This doesn't interfere with the normal radio traffic and allows the listener to be certain that he is still tuned in correctly to that channel. The circuit generates a similar 'beep' and yet consumes only a couple of milliamps. IC1 is a slow oscillator (3 second period) with a large mark/space ratio. The discharge FET is on for most of the time and only goes OFF for about 15 milliseconds in every 3 seconds. This FET is connected to the tone generator in such a manner that when the FET is ON the tone generator is inhibited. When the FET goes OFF the generator produces a burst of 3 kHz oscillations which are heard as a 'beep'.

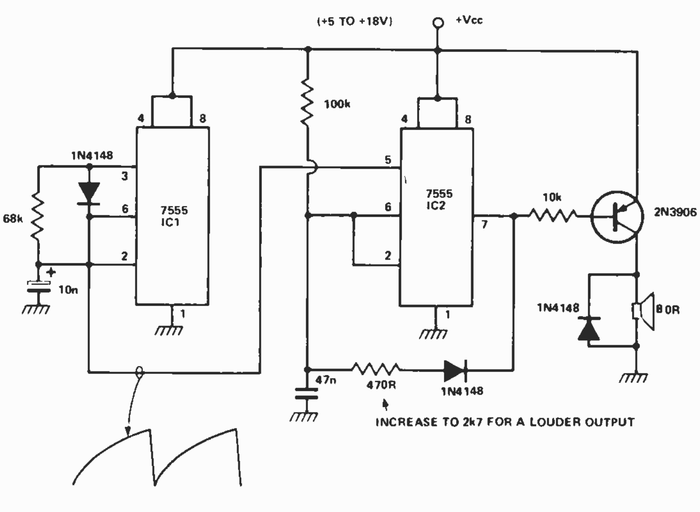


Fig. 15 (above) The last type of sound generator to be described is a simple siren. IC1 generates a sawtooth waveform which is used to frequency modulate, via pin 5, the tone generator (IC2). As the sawtooth voltage rises (with a period of 1 S) so does the tone generator frequency.

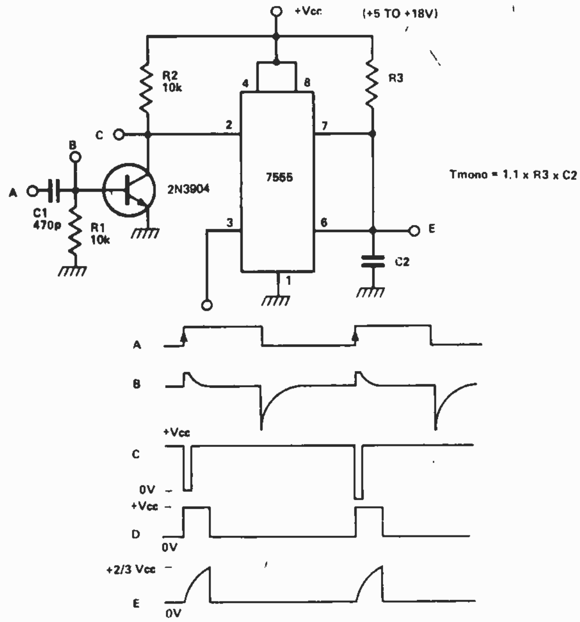


Fig. 16 (above) The 7555 can be made into a monostable, although some problems may occur in its use. A negative going pulse on the trigger input (pin 2) can be used to start the monostable period. It is important that this pulse goes high again before the end of the monostable period, or else it may prolong the period. To this end an AC coupled transistor inverter has been used so that a rising positive signal will initiate the event. Initially C2 is discharged to ground. When pin 2 is taken low, the discharge FET is set to be OFF and so the voltage at E rises with a time constant of C2, R3. When this voltage reaches + ⅔ Vcc, the discharge FET is turned ON, C2 is discharged to ground and the monostable period is finished. During this period the 7555 produces a high output at pin 3.

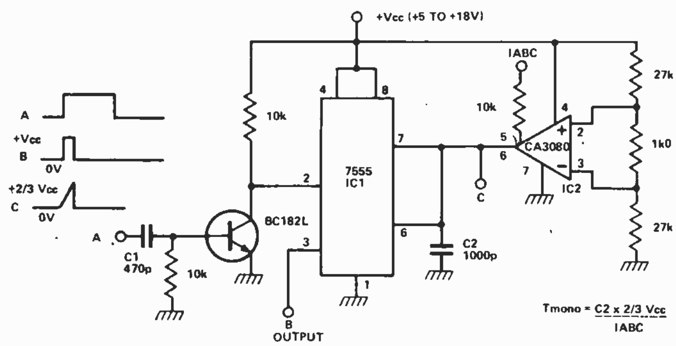
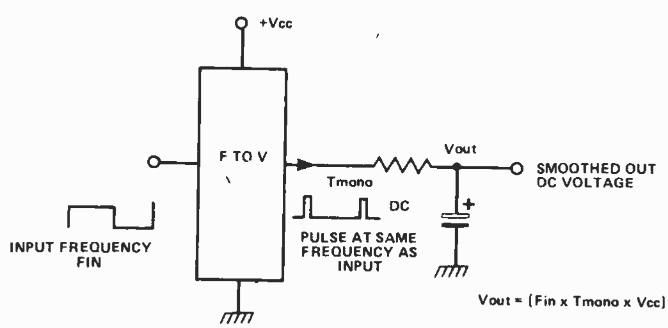


Fig. 17 (above) The previous circuit has been modified. The timing resistor has been replaced with a programmed current source, IC2. Whatever current is put into pin 5 of the CA 3080 (the I_{ABC} current) will appear at its output. This will linearly charge up C2 when the FET switch is turned OFF. The monostable action will be the same as in the previous example. The monostable period is linearly proportional to the I_{ABC} current so by programming this current the period is controlled.



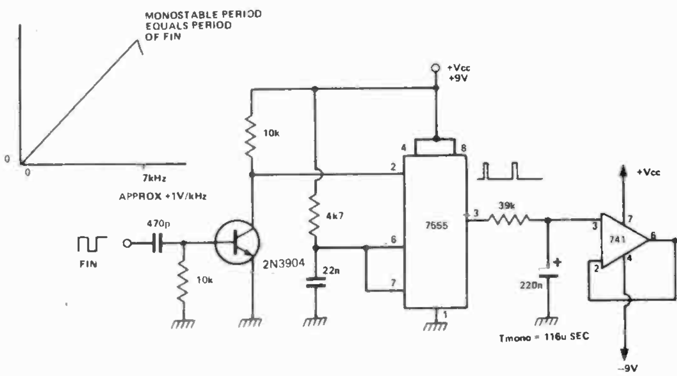
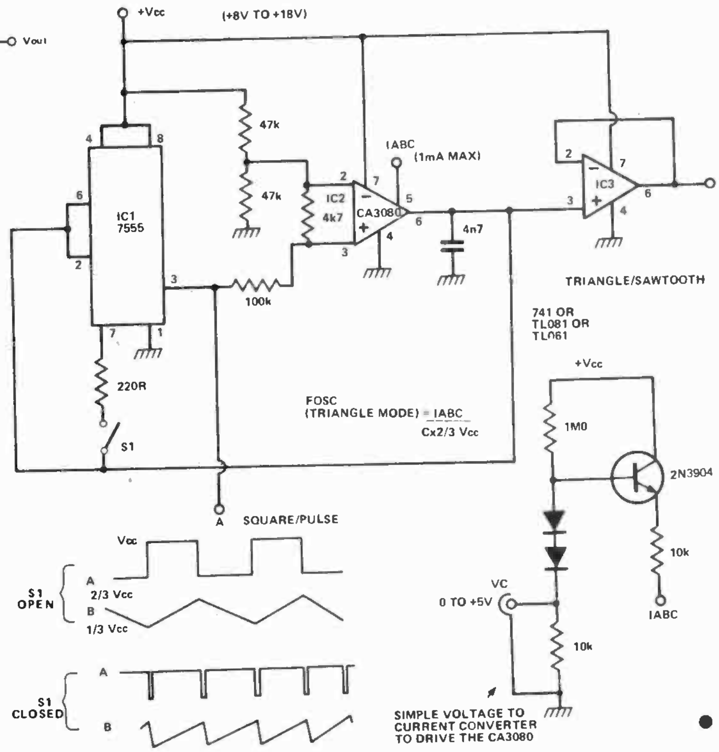


Fig. 18 (above) The monostable can be used to linearly convert a frequency into a voltage. The pulses at the output pin of the 7555 in this circuit are fixed in length but occur at the fundamental frequency of the input signal. Thus the average equivalent DC voltage of these pulses will be linearly proportional to their frequency. This averaging can be performed very simply with a CR low pass filter. This filter determines the response time of the circuit and the ripple. A long time constant will have little ripple and respond slowly and vice versa. Care must be taken to not exceed the range of the monostable. When the period of monostable exceeds that of the input signal, the circuit will miss every other period and will drop its apparent output by an octave.

Fig. 19 (right) IC1 and 2 form a triangle/squarewave oscillator. IC2 is a non-inverting, programmable rate integrator and its output ramps up and down between the ⅓ and ⅔ Vcc limits set by IC1. The rate at which the integrator ramps up and down and hence the oscillation frequency, is determined by the I_{ABC} current. Because the input impedance of IC1 is so high, it is possible to directly connect the timing capacitor to it, without any unwanted loading effects. This circuit has excellent high frequency performance producing good quality triangle wave forms at 40 kHz. The circuit can also produce very low frequency signals by making C a 100n tantalum and I_{ABC} a current of say, 1 nA. This oscillator would then have a period of 800 seconds. IC3 is used to buffer the triangle to the outside world. If a 741 is used, then the waveform will become asymmetrical at low I_{ABC} currents (below 1 uA) due to the input bias current needed to run a 741. A TL081 has very little input current and so could be used for both low I_{ABC} currents and high frequency performance. If low power is needed, then a TL061 (200 uA quiescent) could be used.

By closing switch S1, the oscillator will produce a sawtooth waveform and a pulse. ●

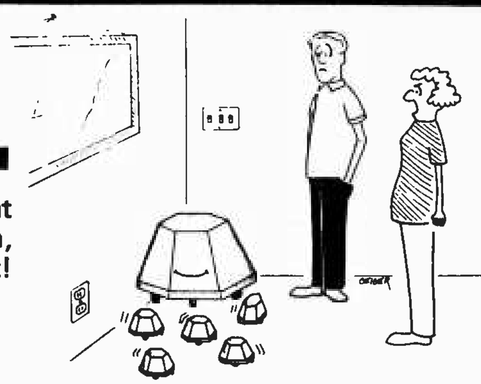


●

PROJECT

HEBOT

'A chicken in every pot and a Hebot in every garage', that's the motto at ETI these days. Combining economy and efficiency, form and function, we present a realistic, revolutionary and robust robot to terrify your cat!



'I told you not to leave it out overnight!'

Since earliest times man has had a fascination for robots in some form or another. Along with their pursuits for the Philosopher's Stone and matter transmutation, some medieval alchemists tried their hand at creating life.

These early attempts were more practices in wizardry (or fraud) than anything else. It wasn't until much later that writers and dreamers thought of mechanical men in the service of humanity. Of course everyone knows the term robot originally came from Câpek's play 'Rossum's Universal Robot', a story of the 'perfect' servant.

Since that time, the idea of robots has taken firm hold in people's minds. Robots are the ultimate servant, unselfish, totally obedient and reliable. On the other hand, robots may well lead to the ultimate destruction of mankind as we know it.

Numerous theories have been advanced to explain man's fascination with his mechinaical counterpart. It has been suggested that the human race is simply one step in some evolutionary process (aren't robots a superior form of person?). Another theory is that by making robots, man is trying to play God; proving his own power of creation. Then of course, the economic value of a successful general purpose robot is beyond measure.

Enough rambling.

The basic mechanics (apart from the cover) are shown here including the drive motors and wheels

Enter ETI

Whatever our motivation might have been, we at ETI feel that the home robot is long overdue. Hebot is probably the most versatile robot project offered to date.

ETI has co-operated with Remcon Limited, one of Britain's foremost manufactures of remote control equipment, to produce a classy chassis we feel will become a standard for many years to come.

The cornerstone of the design is a hexagonal aluminum chassis pan which carries the micro-drive units, batteries, sensors and PCBs on which are mounted the electronic components. We tried a number of different collision sensors and discovered, as Edison used to put it, an awful lot of ways NOT to do it. Our prototype features microswitches whose lever arms have been extended with pre-formed lenghts of piano wire. However, the production kits from Remcon feature sensors mounted integrally with the chassis pan. Another point worthy of note is our use of a plexiglass cover for the prototype. The production kit features a pre-formed three piece aluminum cover as the plexiglass version costs more than all the other components put together.

The microdrive units feature a fully enclosed gearbox and five pole motor with the drive wheel mounted on a steel shaft integral with the gearbox. Typical motor drive current is around 150mA giving between one and two hour's life from 450mAH capacity nicad cells (AA size). The chassis can turn on its own axis and will carry a payload of up to five pounds of weight. Previously published robot designs in other magazines have been let down by poor mechanical design or the use of difficult to obtain or reproduce electronic components. The precision engineered design from Remcon which has resulted from our consultation with them removes one of the main pitfalls of any project of this type.

Superlative

If Hebot's chassis is good (which it certainly is), then words cannot do justice to the electronic design. Though composed of largely conventional circuit elements, the circuit represents a breakthrough in systematic design facilitating development and operation.

The novel feature of this system is the separation of executive and control signals. In a maximal system, up to eight pairs of motor control signals may be present simultaneously with Hebot 'choosing' between them according to the state of 'priority' input sense lines. a possible arrangement might be

7	
6	**external control**
5	
4	
3	**'avoid' manoeuvres**
2	**tracking**
1	**searching**
0	**random walk**

Level seven has highest priority and zero lowest priority. Assuming Hebot was not under external control and was neither tracking nor searching then a random walk would be executed. Following any colision, priority sense input three would become active and Hebot would manoeuvre himself out of trouble before returning control to level zero; random walk. Of course, there is nothing special about the control signals chosen and any group of signals could be assigned priorities and connected to the appropriate inputs. Control levels may vary between +5 V (full forward and -5 V(full reverse) with intermediate voltages giving variable speed and zero volts halting the machine.

We are presenting Hebot in two parts. The first part (this one) concerns forward motion, manoeuvres and other forms of control, the second part will detail the implementation of the Hebot system as well as a battery charger and loop drive circuit.

Hebot is a flexible, open-ended project whose scope is limited only by your resources of imagination, skill, time and (inevitably) money. Accordingly, the schedule may be changed to accommodate design developments and should in any case be used only as a springboard for your own ideas.

Construction

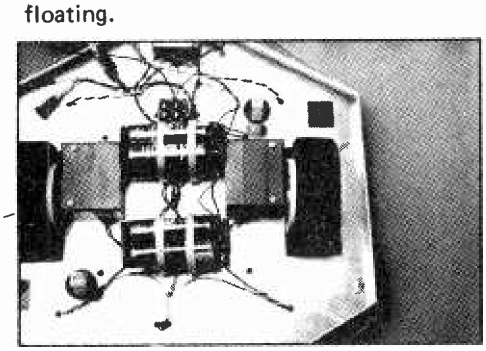
The chassis, aluminum cover and mechanical components are available from Remcon. The electronic components are mounted on one PCB which is supported from the chassis pan by plastic 'click-fit' pillars.

The use of Remcon chassis is recommended though not absolutely necessary. The motor drive circuitry would probably work well with a track drive vehicle or anything else that uses two motors for locomotion and steering.

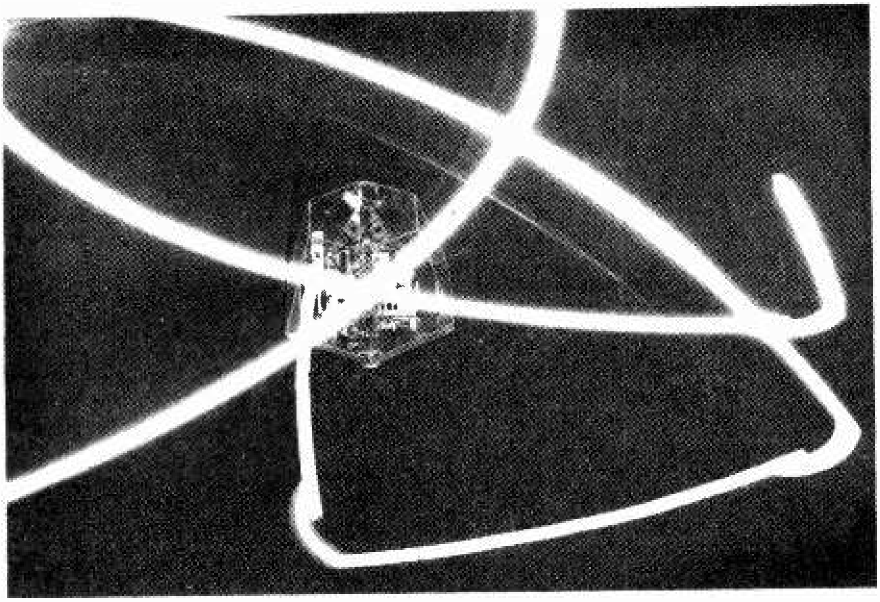
There are a large number of wire links on the PCB which MUST be soldered into place first as many of them pass beneath components, we suggest you use no. 22 swg. wire for this.

Integrated circuit sockets are recommended for the IC's and normal CMOS precautions should be observed to avoid destruction of the chips by static charges. Flying leads are used to interconnect someof the IC's and should be soldered into place after the other components have been mounted but before inserting the chips. It is impossible to give precise constructional details for this project which ideally will be developed by the constructor. However, you should find out photos helpful.

If, initially, only four inputs are required then IC5 may be omitted. Uncommited inputs of IC3 should be tied low (to the -5 V rail) and not left floating.



How we installed our batteries.



A bit of photographic trickery shows Hebot in its random walk mode. A light has been fitted and the unit photographed with a time exposure followed by a flash to show its final position.

The chassis comes with holes for mounting the batteries between the drive motors. We used 8 AA nicad cells held down with rubber bands, alternatively you may wish to use cable ties.

Hardwired Intelligence

Hebot's major virtue is its flexibility, which can only be fully realized with a complete understanding of the circuitry involved. To this end, we strongly recommend you read the 'How It Works' section thoroughly.

Essentially there are two major sections to Hebot's electronics: the various motor control circuits and actual priority encoding circuitry. The avoidance circuitry is on the first board. This requires four inputs, one from each collision sensor. A 'collision' is detected by grounding the appropriate input. The circuitry on the second board described here is mostly concerned with searching and driving towards a light (phototropism) and tracking a cable by detecting an AC energising signal. The details of operation of these circuits will be dealt with fully next month.

Each motor control circuit has three outputs, two for motor control and one 'executive' signal. With the circuits described in this article, Hebot has the capability to follow a light beam, magnetic loop, avoid obstacles, and perform search manoeuvres.

To program Hebot, decide which levels you want to assign to which control circuit. Then, simply connect the two control leads to the appropriate inputs on IC5 or IC4 and executive signal to the appropriate input of IC3. Then ground all unused inputs on IC3.

The manner in which you make the connections is up to you. Sockets may be employed, or alternatively connections can be made in Veropins or Vector flea clips. The latter method isn't as klugy as it sounds, connections can be quickly changed with a soldering iron.

More Capabilities

The rest of the circuitry enables Hebot to perform a random walk, generate a short tone and respond to loud noises. 'Random walk is something of a misnomer as Hebot actually executes a series of spirals, enabling him to 'look around' his environment. The circuit which generates this motion is very simple and quite elegant consisting of a single op-amp connected as a conventional astable oscillator. To operate, all you need to do is connect pin 10, IC3 to plus 5 V and connect pins A, B to pins 1, 12, IC4 (X O Y, O). It does not matter whether A or B goes to pin 1 or 12. This only affects the direction of the spiral motion.

We have also given Hebot a voice. The circuitry around IC5 accomplishes this. IC5 is a 555 timer connected as an astable oscillator whose output is gated on and off by driving the reset input via transistors Q6, 7. Whenever input pin Y is driven to plus 5 V, a short tone is produced. If you connect pin Y to the 'avoid' output on the other board, Hebot will emit a surprised squeak following each collision.

The other 555 is used with Q5 to detect sounds. Hebot can be made sensitive to loud noises by adjustment of RV3. Any sufficiently loud noise will cause the 555 output (pin X) to rise from minus to plus five volts for about one second. Pin X may be connected to any of the inputs of IC3 (only one connection to each input though!) to make Hebot select control from any X, Y set of inputs. If pin X were connected to input '7' (pin 4, IC3 board one) and X7 (pin 4, IC5) were connected to plus 5 V with Y7 (pin 11, IC5) connected to minus 5 V then Hebot would execute a spin following each loud noise. Note that in this case, the avoid manoeuvre circuitry would be inoperative as level

Next Month

What we've presented so far should keep you thinking for awhile. Next month we'll present loop drive circuitry and a suitable charger. ●

HOW IT WORKS

Circuit operation may be most easily understood by considering the operation of three units separately; the motor servo amp, signal multiplexer and manoeuvre logic. Power for all three is derived from two five volt batteries. If the voltage seems strange, it is because each battery is made from four nickel-cadmium (nicad) cells each having a nominal voltage of 1.25 volts. You do not have to use nicads, ordinary AA dry cells will power the circuit quite happily though battery life will be restricted to a couple of hours' operation or less.

The integrated circuits are powered from plus and minus five volts giving an effective voltage of ten volts. The junction of the batteries (0V) is used only as a bias point for the non-inverting inputs of IC1 and IC2 and as a return for the motors.

Servo Amplifiers

The servo amplifiers formed around IC1 and IC2 could hardly be simpler. Each op-amp functions in a standard inverting amplifier configuration with a gain of one (ie the output voltage equals the input voltage but is of opposite polarity). Transistors Q4, 5 and Q6, 7 function as complementary emitter followers and supply the motor drive current; about 150mA. IC1 and IC2 deserve a special mention. These chips are BIMOS op-amps and feature CMOS output stages enabling the output to swing very close to the supply rails, very important in this application. Ordinary 741 op-amps could be used but would have a very limited and unequal output voltage swing giving low motor drive and loss of torque. The 3130 is a high speed uncompensated device and capacitors C1, 2 are essential to prevent high frequency oscillation which would cause excessive dissipation in the semiconductors and could result in overheating in the motors. Using the circuit shown and our PCB no problems should be experienced.

Motor Control

Control voltages are applied to the servo amps via input resistors R1 and R2. If you follow the connections from these resistors, you will see that they disappear mysteriously into IC4 and IC5. In fact these chips do not alter the control voltages passing through them at all. They are simply multiplexers; an electronic rotary switch used to select control signals. Each chip functions like a four-way two pole switch whose 'position' is determined by the state of three control lines at pins 6, 9, 10. The binary 'address' on pins 9 and 10 selects one pair of four pairs of inputs. The most significant address line from IC3 is used to select either IC4 or IC5 by driving the 'enable' inputs of those chips.

As this signal is inverted by Q1 before being passed on to IC5, only one chip is enabled at any time. The disabled chip behaves as though it were a disconnected switch and exhibits a very high resistance between all inputs and outputs. This arrangement enables any pair of eight possible pairs of control signals to be selected according to the control signals from IC3 and used to drive the servo amps.

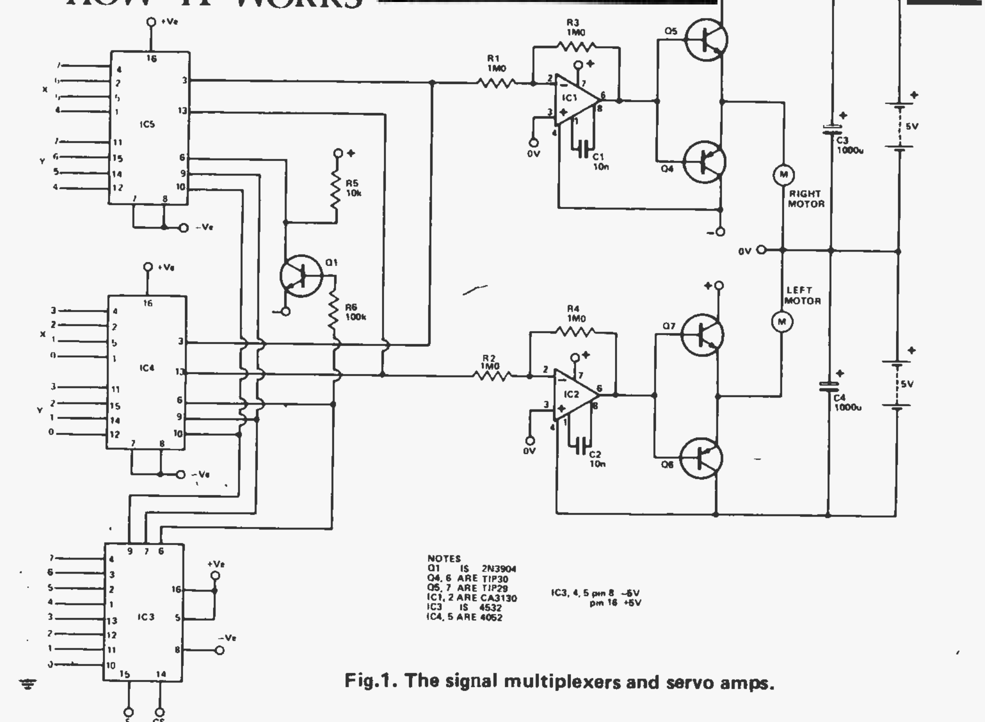


Fig.1. The signal multiplexers and servo amps.

IC3 is an eight-input priority encoder. The operation of the chip is quite straightforward. There are eight individual inputs and a single 'enable' input (pin 5) which is tied high to enable the chip. The eight input lines should be held normally low. When any input is asserted high (ie connected to +5V), the group select (GS) output goes high, enable (E) output goes low and the binary address of the selected input appears on pins 9 (lsb), 7, 6 (msb). For example if input '3' (pin 13) is asserted high then 110 will appear on pins 9, 7, 6. However, if – while '3' is still high – '5' is also asserted high then the address output will change to 101 as five has a higher priority than three and the inputs corresponding to that number will be connected to the servo amp by multiplexer IC5. In this way, the motors are controlled by signals from one set of inputs until a higher priority line becomes active at IC3 when the address will change and another set of inputs will be selected.

For example, let input '2' (pin 12, IC3) be

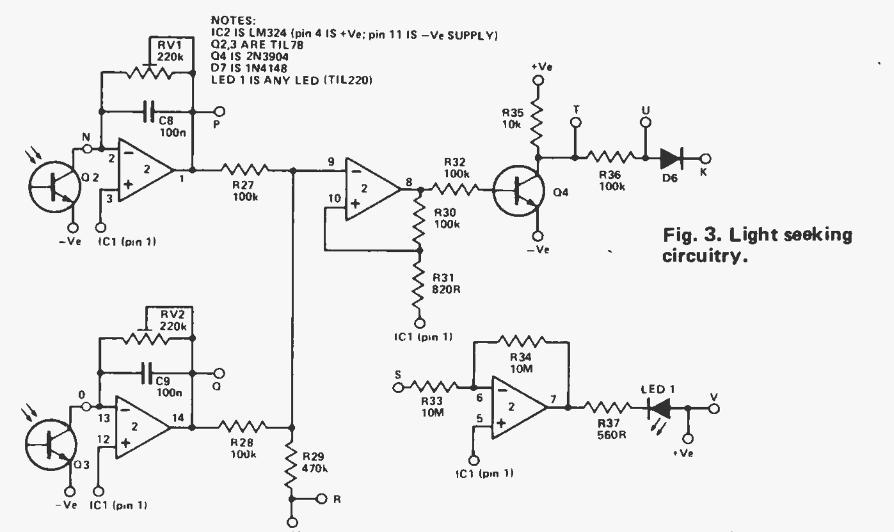


Fig. 3. Light seeking circuitry.

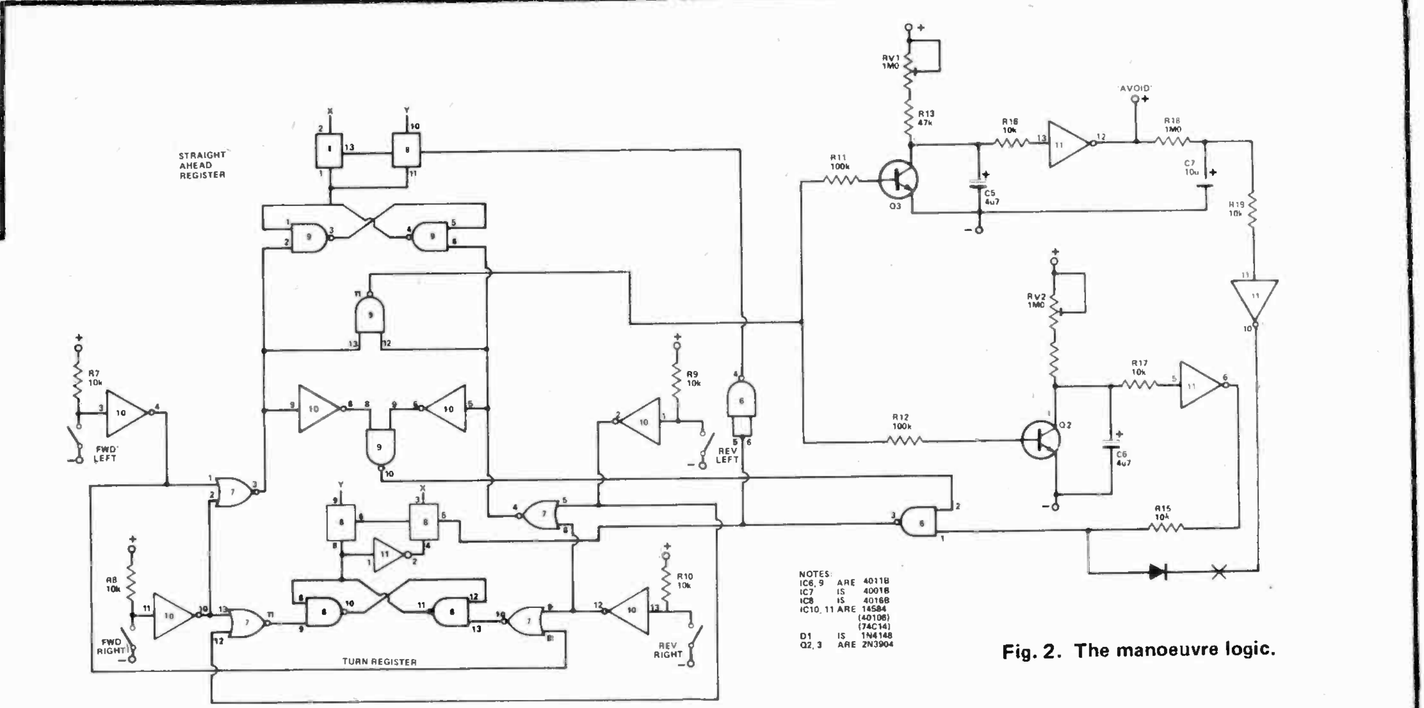


Fig. 2. The manoeuvre logic.

connected to +5V. Motor control inputs 2X and 2Y (pins 2, 15, IC4) are connected to +5V via 560k resistors to give a slow forward speed. Following any collision, a signal from the manoeuvre circuitry asserts input '3' (pin 13, IC3) high and motor control inputs 3X and 3Y are selected. The X and Y outputs (pins 2, 3 and 9, 10, IC8) from the manoeuvre circuitry are connected to inputs 3X and 3Y and these signals are used to steer Hebot out of trouble. Following the manoeuvre, control is returned to the next lowest priority level which is currently high; in this case level 2 – slow forward.

Manoeuvre Logic

The manoeuvre logic has four inputs, one for each sensor, and three outputs; two motor control signals and 'avoid' (pin 12, IC11) which goes active (high) for a certain period determined by adjustment of RV1 following any collision. It is this signal which applied to IC3 causes Hebot to select control by the manoeuvre circuitry.

The sensor inputs use 40106 hex Schmitt to add an extra degree of noise immunity to the system.

Following any collision, pin 11, IC9 goes high causing capacitors C5, 6 to be discharged via transistors Q3, 2 and monostable timing periods to be initiated.

The overall manoeuvre time is adjusted by RV1 while RV2 sets the duration of straight motion before a turn is executed. If RV1 is first set then adjustment of RV2 will alter the degree of turn. Hebot chooses forward or reverse and the direction of turn by examining internal registers which 'remember' which sensor signalled a collision.

There are two registers to control manoeuver information, 'straight ahead' and 'turn'. These are made from parts of IC9 ('straight ahead') and IC6 ('turn') which form bistable set/reset flip flops. For straight ahead control, the output is applied to motors via two 4016 CMOS switches (IC8).

In the case of the 'turn' register, one switch is fed directly from the register while the other receives an inverted signal. In this fashion signals of opposite voltage are applied to the motors and Hebot turns.

The 'turn' and 'straight ahead' signals are enabled by control pulses from monostable timing circuit. These are kept out of phase from each other to prevent the outputs from conflicting.

If there are 'too many' collisions within a certain period then pin 10, IC11 will go low. This output may be optionally connected to pin 1, IC6 where it will cause Hebot to execute a turn immediately following a collision without any straight motion. The usefulness of this strategy will depend on the settings of RV1, 2 which may be optimised for different obstacles. The circuitry has been designed to enable a flexible and versatile system to be developed and there may be many changes which can be made to adapt Hebot's behaviour to this environment.

The Second Board

All the circuitry on this board is powered from the plus and minus five volt supply. Although the junction of the batteries (0 V) is available, an artificial 0 V is generated onboard by R2, 3, C2 and appears at pin 1, IC1. The op-amp is connected as a voltage follower and merely provides a low impedance output to drive other circuitry. This feature enables the board to be operated from a single supply ensuring a more flexible system and also allows the remaining opamps to operate normally even if the one side of the supply is abnormally low.

The 'random walk' is produced by driving the servo-amps with signals from an astable oscillator formed by components R4, 5, 6, C1 and one of IC1's amplifiers. The outputs are taken from C1 and the junction of R5, 6 and appear at A and B. Resistors R1, 7 protect the diode networks inside the CMOS multiplexer chips IC4, 5 to which these outputs will be connected. Note that the bottom of R6 goes to pin 1, IC1; effectively 0 V.

Wire Tracking

The remaining two amps in IC1 and all of IC3 together form the wire tracking circuitry enabling the Hebot to follow a cable back to its nest by detecting an AC signal. There are two identical input stages whose outputs are pins 7, 8, IC1. An AC signal from the sensor coils is coupled to the inputs (pins 6, 9, IC1) by capacitor Cx or directly. Each amplifier operates as a current-to-voltage converter and produces an alternating voltage output. The detection stages are identical. The signal at pin 8, IC1 is coupled via C3 to rectifiers D1, 3 and charges C5 producing a DC voltage which is proportional to the strength of the input signal from the sensor coils. This voltage varies between -5V and approximately +1V and appears at pins E, F where it should be coupled to pins G, H. Two of the amps in IC3 are used with resistors R16, 17, 18, 19 to convert the output voltages from C5, 6 to signals swinging between 0 V and +3.5 V suitable for driving the motors forward via the multiplexers and servo amps. The signals appear at pins I (X) and J (Y).

Hebot needs to know whether there is any useful signal at these outputs and this is accomplished by measuring the average voltage across capacitors C5, 6. This signal appears at pin 14, IC3. When it rises above about 0.7 V (measured with respect to Q1 emitter) transistor Q1 is biased 'on ' and the voltage at its collector will fall towards -5V. This signal is input to the Schmitt trigger (pin 9, IC3) and appears inverted at pin M. An identical signal appears at pin L. However, this output may be disabled by pulling pin K to -5 volts. Resistors R25, 26 and capacitor C7 provide a bias voltage for the Schmitt trigger.

Phototropism

The circuitry around IC2 enables Hebot to detect and steer towards a source of light. The two input stages are identical. A current flows through Q2 which is proportional to the incident light. This is converted to a voltage which varies between 0 V and +3.5 V and is output at pin 1, IC2 (pin P). The output from Q3 appears at pin Q.

The output levels at P (X) and Q (Y) are suitable for driving the motors forward via the multiplexers and servo-amps. Resistors R27, 28, 29 form a potential divider which drives the Schmitt trigger (input pin 9, IC2) whose output is normally 'high' (at about +3.5 V). When the average voltage at P, Q rises above about 0.5 volts, ie when Hebot sees light, the output of the Schmitt trigger goes 'low' (to

HOW IT WORKS

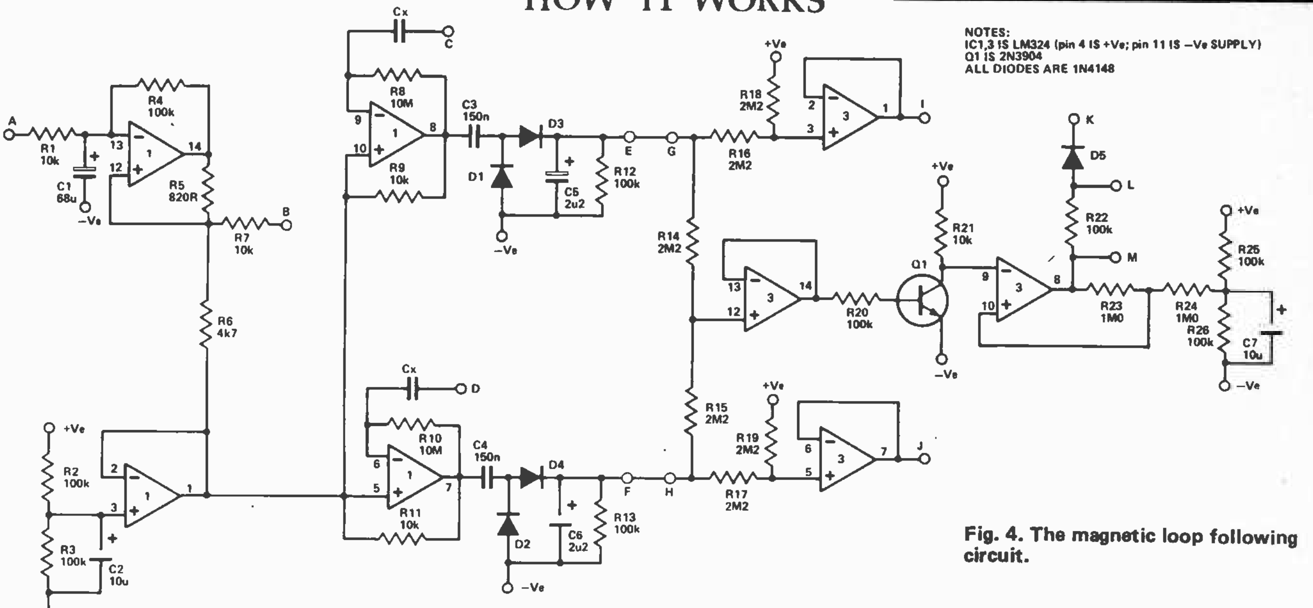


Fig. 4. The magnetic loop following circuit.

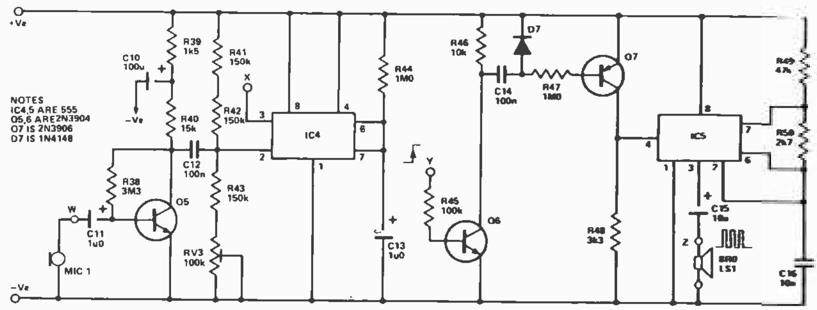


Fig. 5. Sound seeking and speaking.

about -5 volts) biasing off Q4 and causing the voltage at its collector (pin T) to rise from -5 V to +5 V. This signal is repeated at pin U but may be disabled by pulling K to -5 volts.

On Board Test Facility

The remaining section of IC2 may be used to give a visual indication of operation of other parts of the circuit. It is connected as a conventional inverting amplifier with an input resistance of ten million ohms.

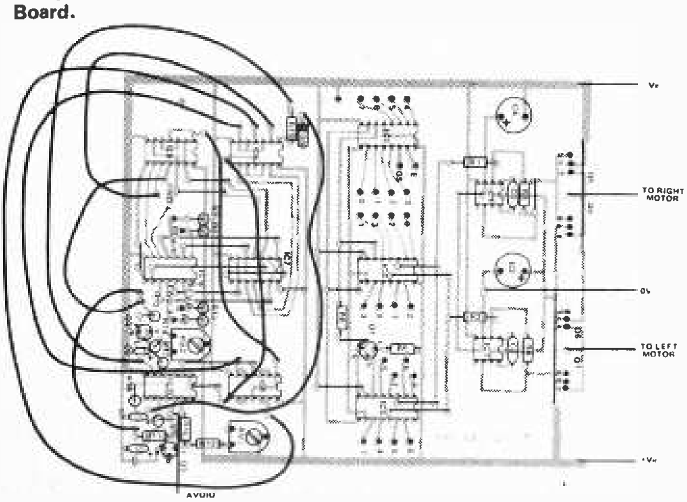
With the input (pin S) disconnected, the LED will glow at medium brilliance. Connecting pin S to pin V will cause it to glow brightly indicating a positive input, while connecting a negative input (pin R) will extinguish the LED (this input should be tied to the negative rail when not in use).

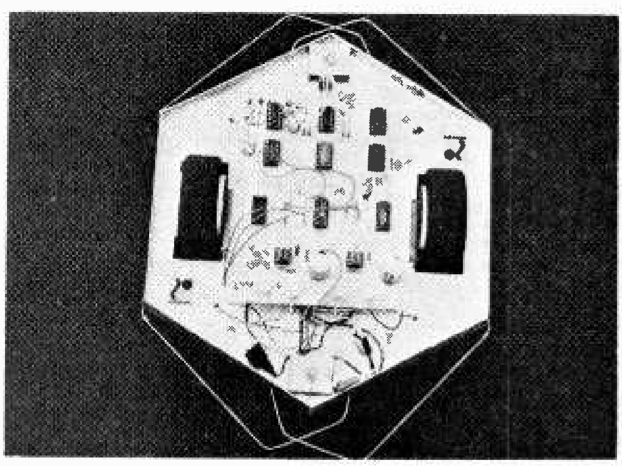
Sound Generation & Dectection

Integrated circuits IC4, 5 enable Hebot to detect and generate sound. Both devices are 555 timers. IC4 will produce a positive output at pin X of monostable period determined by R44, C13 (about one second with the values shown) when triggered by a sound at the microphone, MIC1. The sensitivity of the circuit is set by adjustment of RV3. The trigger input of the chip (pin 2, IC4) is normally held above the trigger voltage of one-third of the supply voltage by bias resistors R41, 42, RV3. Any sound picked up by the microphone produces an alternating voltage at Q5 collector which is coupled to the trigger by C12. A loud noise will produce a signal of sufficient amplitude to trigger IC4. The output signal (pin X) could be used to throw Hebot into reverse, a spin, or just stop him in his tracks.

IC5 produces a short burst of sound each time input Y is taken from -5 volts to +5 volts. Each positive transition of this input causes Q6 collector to go low to -5 volts. This signal, coupled to Q7 by C14, R47 causes the reset input (pin 4, IC5) to be pulled to +5 volts enabling the oscillator to produce a short tone burst. Any digital signal may be input to pin Y. If 'avoid' (pin 12, IC11 board one) is connected, a tone will be produced each time Hebot encounters an obstacle. The loudspeaker is AC coupled to IC5 to avoid excessive current flow. The frequency can be changed by adjustment of R49 or C16.

The pc overlay for the Manoeuvre and Control Board.





PARTS LIST

Options Board

RESISTORS (all ¼W 5%)

R1, 7, 9, 11, 21, 35, 46	10k
R2, 3, 4, 12, 13, 20, 22, 25, 26	
27, 28, 30, 32, 36, 45	100k
R5, 31	820R
R6	4k7
R8, 10, 33, 34	10M
R14, 15, 16, 17, 18, 19	2M2
R23, 24, 44, 47	1M0
R29	470k
R37	560R
R38	3M3
R39	1k5
R40	15k
R41, 42, 43	150k
R48	3k3
R49	47k
R50	2k7

POTENTIOMETERS

RV1, 2	220k
RV3	100k

CAPACITORS

C1	68u tantalum
C2, 7	10u tantalum
C3, 4	150n polyester
C5, 6	2u2 tantalum
C8, 9, 12, 14	100n polyester
C10	100u tantalum
C11	1u0 electrolytic
C13	1u0 tantalum
C15	10u electrolytic

SEMICONDUCTORS

Q1, 4, 5, 6	2N3904
Q2, 3	NPN Phototransistor (TIL 78)
Q7	2N3906
D1 thru D7	all 1N4148
IC1, 2, 3	LM324
IC4, 5	555

MISCELLANEOUS

MIC1	any microphone (crystal or balanced armature inserts work well)
LS1	any loudspeaker (we used an 8ohm 1½inch loudspeaker)
PCB, IC sockets, terminal pins	
LED1	any LED (we used TIL 220)

Manoeuvre and Control Board

RESISTORS (all ¼W 5%)

R1, 2, 3, 4, 18	1M0
R5, 7, 8, 9, 10	
15, 16, 17, 19	10k
R6, 11, 12	100k
R13, 14	47k

POTENTIOMETERS

RV1, 2	1M0 preset

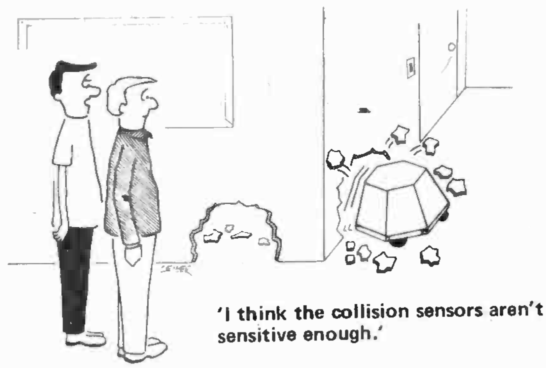
CAPACITORS

C1, 2	10n polyester
C3, 4	1,000u electrolytic
C5, 6	4u7 tantalum
C7	10u tantalum

SEMICONDUCTORS

Q1, 2, 3	2N3904
Q4, 6	TIP 30
Q5, 7	TIP 29
D1	1N4148
IC1, 2	CA3130
IC3	4532B
IC4, 5	4052B
IC6, 9	4011B
IC7	4001B
IC8	4016B
IC10, 11	14584 (40106, 74C14)

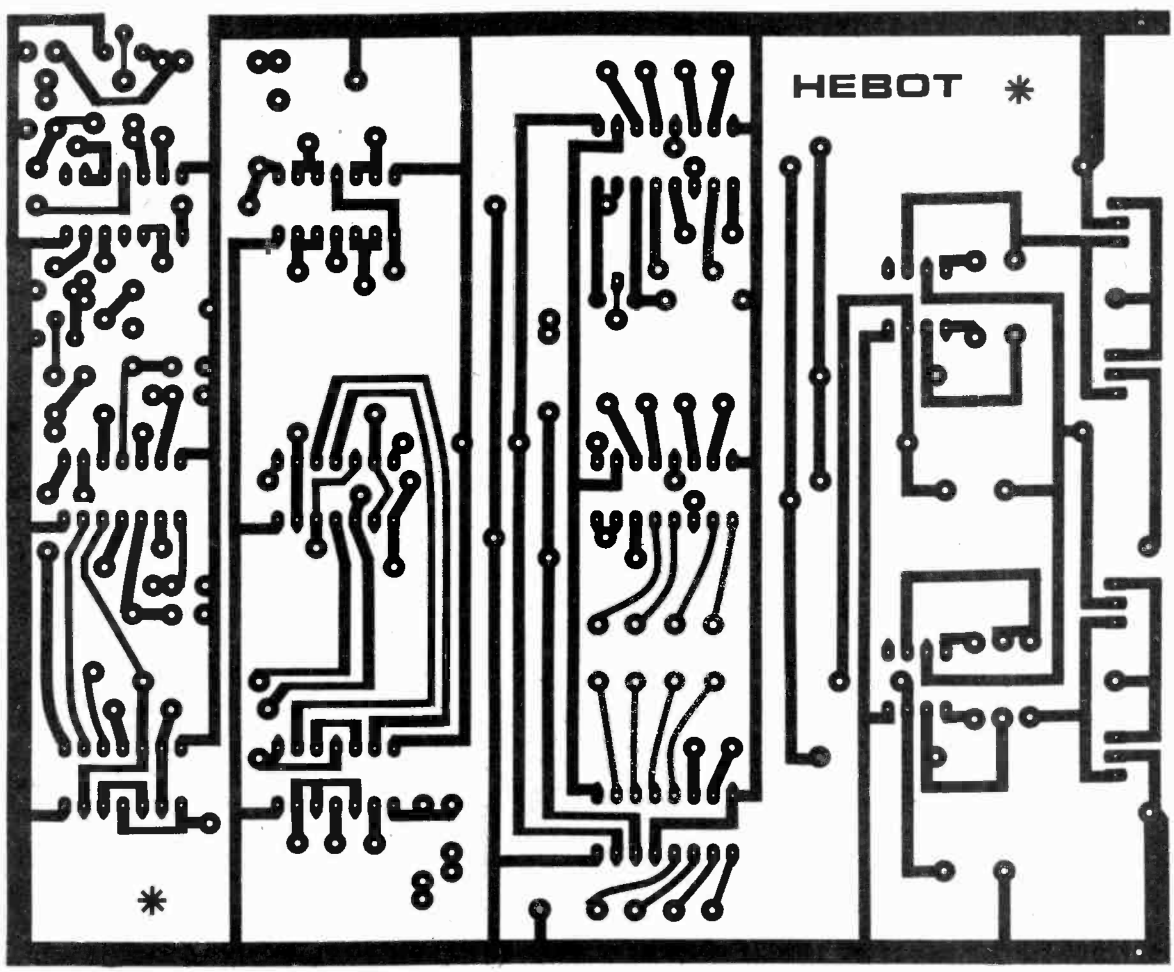
All CMOS must be 'B' series.

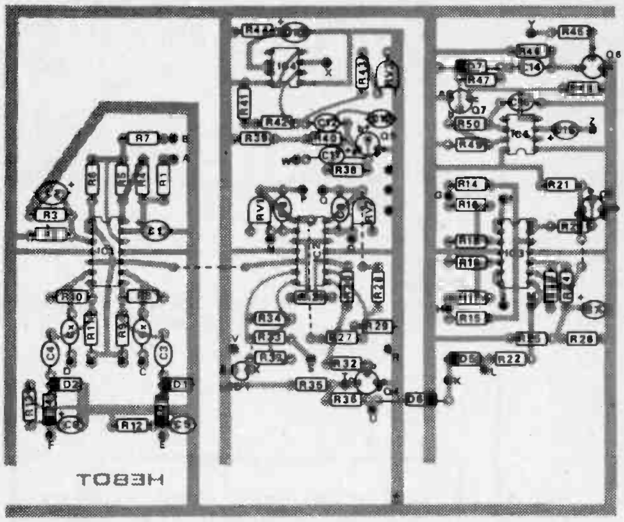


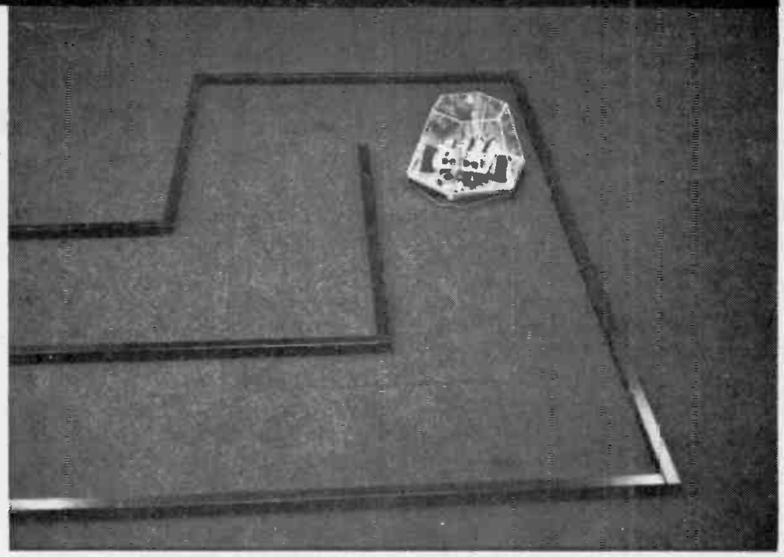
'I think the collision sensors aren't sensitive enough.'

At the time this issue went to press, the details of Hebot chassis manufacture have not been finalized. Look for full information in next month's issue.

The Options Board PC layout



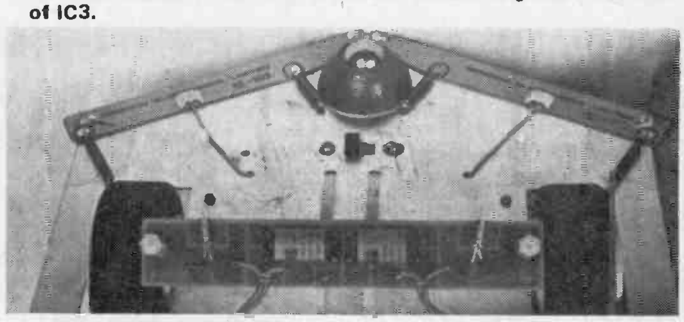




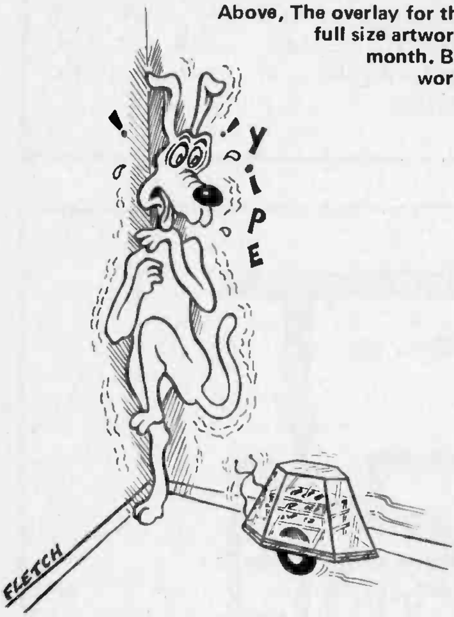
Above, The overlay for the options board, full size artwork to follow next month. Below left, Hebot works just as well on cats!

How we constructed our Hebot maze. Anything will work such as 2 x 4 wood or 1" square steel tubing (expensive! We know).

The connections to IC3 and IC4. Note the shorting link at the side of IC3.



Our pickup coils and photosensors mounted conveniently on one pcb.



Service News

The sort of Korean electronics assembly line on which your TV may have been made.

David Van Ihinger returns from Korea with some impressions of a service industry that is virtually non-existent.

YOUR NEWS reporter has taken to the Orient to see how the other half of the world lives. Here we are in Seoul, the capital city of South Korea, where a good many of the electronic products we use in Canada originate.

I visited Seoul, the capital, and Pusan, a seacoast city: population of these citites just about equals that of the whole of Canada! Both cities are veritable beehives of activity, with shops crowded together, row on row, street on street. No space is wasted. Aside from arteries, streets are narrow, with pedestrians sharing with push-carts, bicycles, cabs and trucks, the very precious space left for them between the endless faces of storefronts. Even the back lanes become shopping malls, jammed both sides with temporary and permanent shops, vying with the merchants out front for passing trade, offering fast foods, fruit, fountain pens, fish, French perfume, fresh water, fancy clothes, fiery flavoured delicacies, furniture, films, frilly lace, footwear, exotic females and other fabulous paraphenalia. The quality of merchant and merchandising is exceptionally high, particularly towards the central areas — the competition being so fierce. Although there are a few department-type stores, upwards of ten stories high, the bulk of businesses appear to reside in shops averaging about ten feet wide and not much deeper. This leads to smaller inventories, less variety and tighter specialization down to a very few name brands, extremely efficient layout and display — total area usage as there is absolutely no room for waste. It seems that every nook and cranny fronting to any form of pedestrian traffic is plugged with an enterprise, shoe shine stand, candy stall, sandal sales, cigarette lighters, sweet things, sour things, soft drinks, much resembling the CNE midway on its busiest day. Most shops in Seoul are open from early morning to late at night, 365 days a year!

Getting It All Fixed

Now, what about service? Getting information on TV and electronic service was most difficult. Sales people were not ready to admit that their product would ever require service, and no one could actually point your reporter to a genuine (by Canadian standards) service shop. Original factory replacement parts are very scarce, even impossible to obtain, particularly imports. Substitutions are possible, but time-consuming and often requiring circuit alterations. Circuit manuals, data parts lists, service tips, and factory-recommended modifications are virtually non-existent. What service is provided by the local merchant is either on a carry-in basis or home service on foot, in central areas. I saw a new refrigerator being loaded on a push-cart, the favorite delivery vehicle.

Average house call $6.00 (equivalent Canadian cost of living to money value), plus parts. I did not see any colour test equipment, not even a oscilloscope. It appears as though the service industry in this country has not kept pace with sales and that replacement of the product is their answer. I could not locate any service association.

TV broadcasts are only in black and white — channels 7, 9 & 11. Antenna requirements are quite simple, the most common antenna appearing to be a small 5 element yagi, broadly tuned across the three channels. Although the American forces also broadcast on channel 2, very few antennas include it in their design. This channel of course uses English.

Anyone owning a colour set has to rely on video recorders or reception from Japan. There are quite a few vertically-polarized UHF heads, equipped with mast amplifiers, pointing towards Japan. The high cost of this reception equipment is written off by dividing its cost among neighbour-subscribers, a practice not particularly approved by the authorities, but somewhat resembling a form of bootleg cable system. If legitimate cable systems do exist, no one could tell me. Some hotels in Seoul are equipped with excellent master antenna systems, covering not only regular broadcasts, but some print-outs as well. This may have been CATV, however no one could confirm it one way or the other.

Sports programmes are a favourite of the Korean audience.

Stations broadcast a lot of reruns of American movies and old programs, sound dubbed in Korean very cleverly — so cleverly it is hard to believe that Kojak ever spoke English! I must admit, it is oddly humorous to view and listen.

My overall impression of TV in Korea was of disappointment, particularly from the point of view of a service technician. It surely demonstrated to me what can happen to an industry that is not organized.

Announcements

Electronics Technicians Association, International Inc. Annual Meeting: July 11th & 12th at Iowa State University, Ames, Iowa. Contact: Ron Crow, D.E.T. (515) 294-5060, or Dick Glass, C.E.T. (317) 241-7783.

International Society of Certified Electronics Technicians (ISCET) announce release of a free booklet "Careers in the Electronics Industry" available from 2708 West Berry, Fort Worth, Texas 76109, self addressed envelope.

NESDA/ISCET Electronics Service Convention and trade show August 18-23 at the Galt House, Louisville, Kentucky.

Technicians wishing to take C.E.T. exams may obtain a booklet by writing to ISCET at 2708 West Berry, Forth Worth, Texas 76109.

Thanks to VEA Reporter for the plug. We'll try to warm up those arctic masses before we send them on down to you, next year.●

CAPACITORS

Are you in a dilemma over dielectrics? or just confused by capacitors? then read on. Richard Maybury takes a look at the often ignored subject of the dielectric material in fixed capacitors.

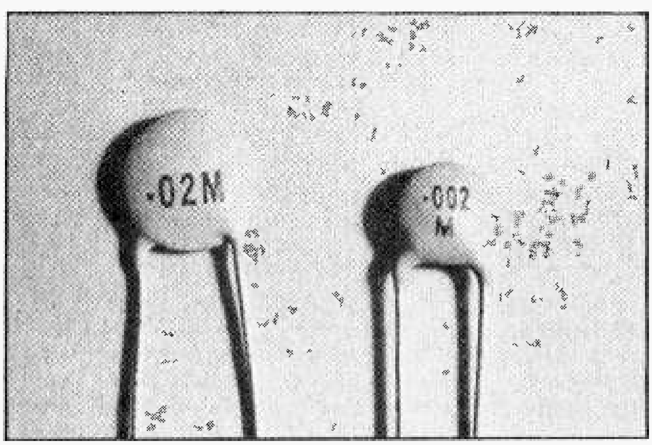
FIRSTLY WE SHOULD EXPLAIN that this article is not intended to be an in-depth study of the workings of the capacitor, that has been done so many times before, usually punctuated by complicated formulae. This article is designed to give an insight into the construction of capacitors, with particular reference to their dielectric material (more of which later).

From our point of view (the capacitor users) the ideal capacitor will be physically small with as great a range of capacitance as possible. Any leakage (current paths across the plates) should be minimal. This capacitor should ideally be stable with regard to both capacitance and leakage, under as many adverse conditions as possible. It should be able to operate with a large variation of applied AC and DC potentials, current and frequency, enjoy a long and healthy life and cost next to nothing.

Faced with all these constraints the poor old capacitor manufacturer may well be seen burying his head in his hands in despair, but compromise to the rescue, the ideal capacitor does not exist as such — but you can bet your boots there's one available for the application you have in mind.

Let's take a look at the (almost limitless) choice on the market, and to what use they can be best put.

The first capacitors were possibly just two plates of metal placed close to each other, the insulating material being air. (On a historical note if you've read Erich Von Dannikens *"Chariots of the Gods"* you may be convinced otherwise. Apparently in the old testament there are instructions for building an Ark (a kind of altar) you were required to construct a wooden box, lined on the inside and outside with gold leaf, anyone touching this sacred shrine would be struck down by lightning; we'll leave you to draw you own conclusions about the suitability of wood as a dielectric!).



A couple of miniature ceramic capacitors the value is stamped on the side, often a major source of confusion.

Air spacing is the oldest and simplest type of capacitor, it can still of course be found today, namely the variable capacitors. We won't dwell too long on this just long enough in fact to point out that the measurement of dielectric quality uses air as the standard, air has a dielectric value of 1 (a polystyrene capacitor has a dielectric value of 2.5 at 50 Hz, so you can see that apart from its use as the standard it's not too clever as a dielectric material).

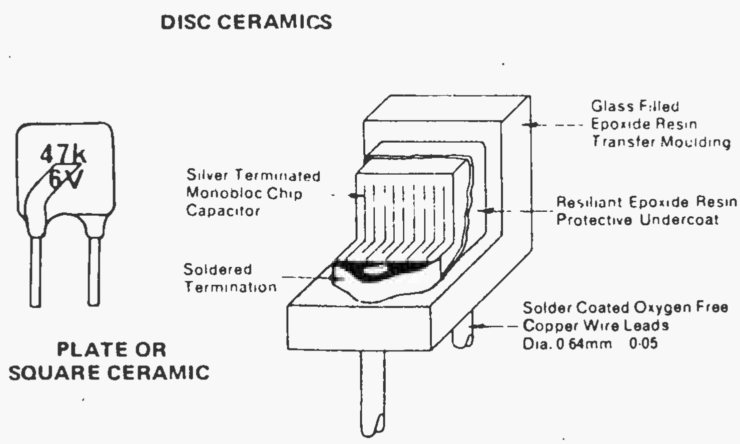


Fig. 1. Cut-away diagram showing construction of Ceramic Capacitors.

Far and away the most common type of capacitor in use today is the Ceramic capacitor

The Ceramic Capacitor

The ceramic capacitor is available in several physical shapes, and two distinct grades: *low Permittivity* (low-K) and *high Permittivity* (high-K). Both types are physically small (small compared to other types of capacitor), both are relatively fragile physically but there the similarity ends.

High-K ceramics suffer large non-linear changes of value with temperature and strength of applied AC/DC fields (the capacitance will decrease as the voltage rises) the value will also change with frequency (up to 20% in the 1 kHz-10 MHz range).

As High-K types are none too stable they find applications only in non-critical positions ie. DC blocking, by-passing and de-coupling but these account for a very high proportion of all uses.

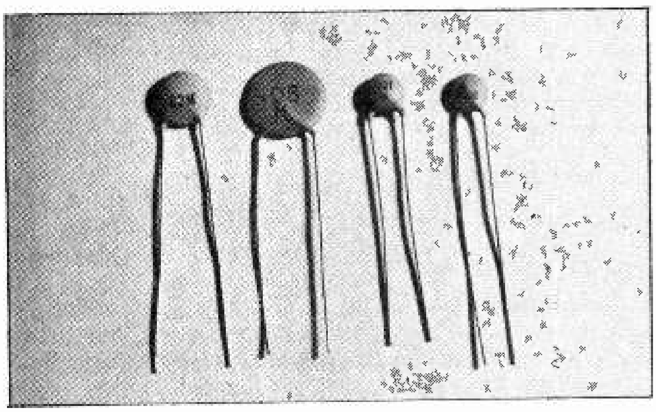
Just a small selection of the multitude of capacitors available to the amateur market.

Low-k Ceramics

These are the opposite of High-K types in many respects, low-loss, good temperature stability and wide frequency and voltage ranges. In some cases they are deliberately manufactured to be temperature conscious for thermal compensation in temperature sensitive equipment.

Ceramic capacitors are made in a variety of styles (see Fig 1), their shape often affects the frequency range, e.g. tubular ceramic operate up to about 50 MHz, disc or plate to 100 MHz, feed through to 500 MHz, and button ceramic to 1000 MHz.

Because of the simplicity of their construction the capacitance range of ceramics is usually towards the low end (one or two picofarads (pF) upwards). The construction is often nothing more than a round disc of ceramic material, the two faces coated with a metallic film to which the connecting wires are attached. The capacitance will depend upon the thickness of the disc and cross-sectional area of the metal coating. The resulting device is then dipped into a variety of coating materials to offer a degree of protection.



Four 'low k' ceramic capacitors.

Plastic Film Capacitors

There are three main types of plastic-film capacitors: Polystyrene, Polyester and Polycarbonate.

Polystyrene is probably the most common at the moment.

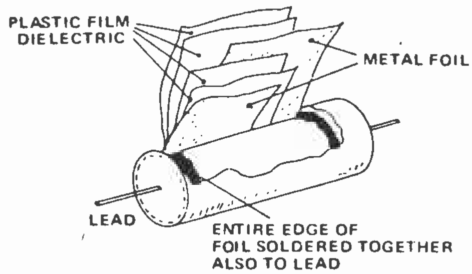
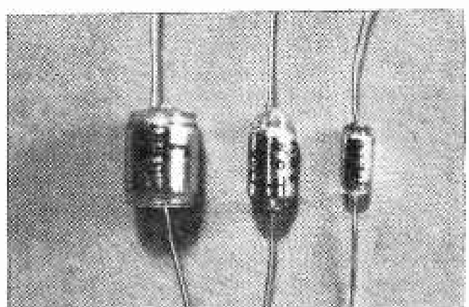


Fig. 2. Method of forming Polystyrene capacitors, note that entire edge of rolled foil is connected to the lead-outs.

Polystrene

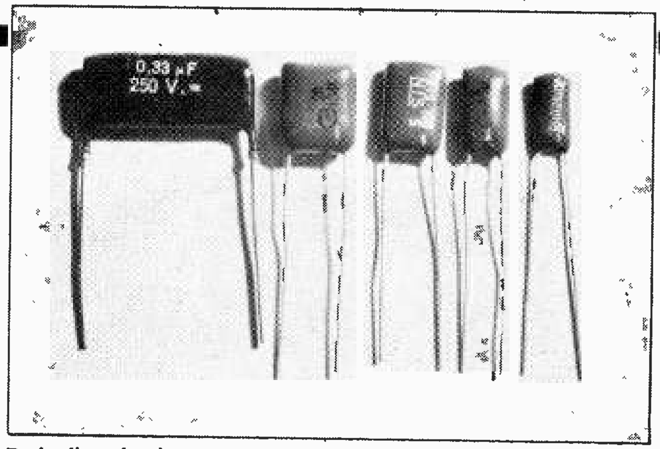
This type of plastic-film capacitor is constructed using interleaved sheets of polystrene film and metal (usually aluminium) foil, the beginning of the roll is staggered to enable the leads to be attached (see Fig. 2). In certain applications, instead of a separate foil layer a thin coating of metal is deposited onto the plastic film directly (this technique applies equally to polyester and polycarbonate types). The resulting sandwich of plastic and metal foil is rolled tightly into a tubular shape (this tube may then be flattened to suit a rectangular encapsulation which gives greater edge-on component packing density).



Polystyrene capacitors, easily destroyed by excess heat.

Electrically the polystyrene capacitor has average-to-good characteristics, the voltage range can extend to 650 V, they find many applications in tuned circuits, coupling frequencies of up to 100 MHz. The higher values (10nF and above) can be used for by-pass etc.

The polystyrene capacitor does have one or two drawbacks; it's extremely sensitive to heat, not in the sense of capacitance changes but physically, they melt very easily! They are also sensitive to attack from a wide variety of solvents and greases, so a great deal of care should be taken with polystyrene capacitors, firstly when soldering and secondly in their application to ensure they do not come in contact with harmful chemicals.



Resin dipped polyester capacitors.

Polyester and Polycarbonate

Polyester capacitors can be examined along with Mylar, Melinex and polypropelene materials, they all have basically the same dielectric properties, they all, however have superior electrical characteristics to polystyrene, particularly in the case of Polycarbonate capacitors. All of the plastic-film capacitors (apart from polystyrene) have excellent resistance to attack from corrosive or solvent chemicals.

Polycarbonate in particular seems to have become a definite favourite among digital equipment manufacturers, possibly due to their very high tolerance rating. They are usually a lot smaller physically, for a given voltage rating, than other plastic-film capacitors.

One last property of plastic-film capacitors is the ability of some types to 'self-repair'; these are metallized-film capacitor. In the event of an arc jumping through the dielectric film (it will never be completely impervious) the area around the arc will vapourise thus clearing the fault, and reducing the possibility of another arc. This does not happen on any other type of capacitor, a dead short will usually result after such an arc.

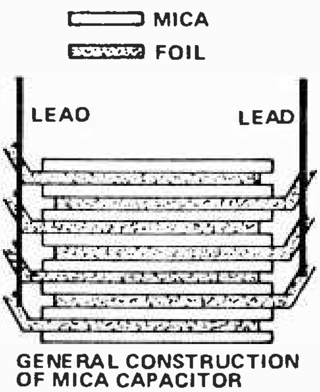


Fig. 3. Construction of Mica capacitors, the entire assembly is then dipped into a bath of fluid coating to ensure a hermetic seal, and prevent ingress of harmful chemicals.

Mica and Paper

Both these types of capacitor were once popular but now have largely disappeared from the amateur electronics scene; they do however have specialised properties that ensures their continued manufacture.

Mica

Mica is a natural mineral which can be cut into very thin slices; a variety of methods are used in their manufacture (Fig. 3). Moulded Mica types are made from layers of Mica, interleaved with metal film, the range of capacitance of this type is about 10pF-100nF.

Silver Mica capacitors are noted for their very high stability and are often used in oscillators and filters. They are usually quoted as 5% tolerance or better and have a value range of 5-3300pF.

Metal-clad Mica types are used in high power RF circuits.

Button Mica capacitors exhibit low inductance and are mostly constructed in stand-off or feedthrough style, the main applications being in UHF circuits. Finally there are Dipped Mica types; these are dipped in a resin coating at below atmospheric pressure, and used where reliability is the prime concern; values range from 10pF to 100nF.

Paper

Paper capacitors are rarely seen these days except where high voltage AC and DC currents are to be found; in these situations paper is just about the best dielectric.

The method of construction is similar to the plastic-film type of capacitor, but instead of plastic the dielectric consists of a layer of impregnated paper, the substance used for the impregnation can be one of several natural oils, waxes or synthetic resins.

As in the plastic-film types, the construction can be by one of two methods: metal foil or metallized film. Unlike other types zinc is often used instead of aluminium. The use of zinc usually results in a device considerably smaller than an aluminium type. The voltage range of paper capacitors is considerably larger than that of most other types, often extending up to 4 kV.

Encapsulation of paper types usually consists of a thin coating of synthetic resin or metal cannister.

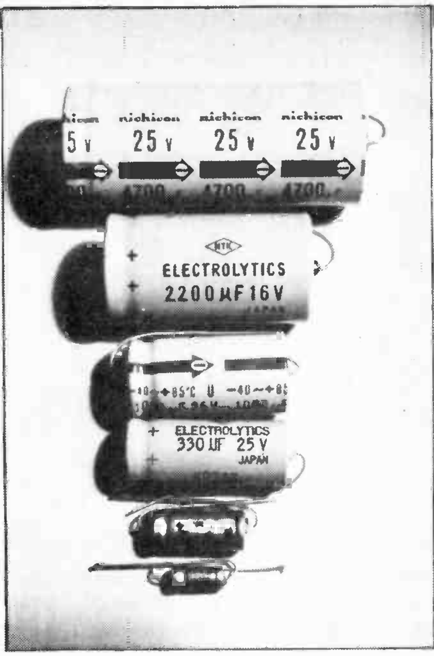
Electrolytic Capacitors

The difficulty of producing large value capacitors is highlighted by the electrolytic, it is at best a compromise, for example the tolerance is often quoted as −20+100% or −50+100%!

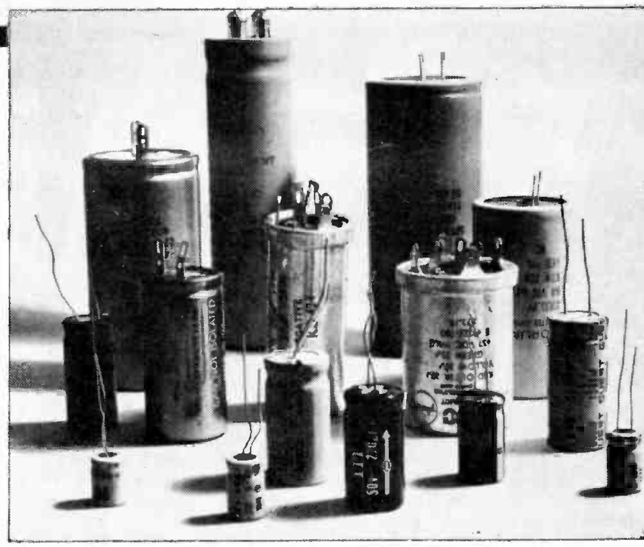
Electrolytics fall into three distinct groups, the conventional type, most often encased in a metal cannister, the non-polarised electrolytic, usually a little larger than a capacitor of the same value, and finally the Tantalum, a fairly recent newcomer to the capacitor field.

(At this point it must be said that there are several other types of capacitor we have not dealt with. It is very unlikely that they will be encountered by the average amateur, however it might be an idea to take a look at them in a future article.)

Getting back to the electrolytic capacitor, we'll deal with the most common type first, the metal foil type.



A selection of tubular metal-foil electrolytics, voltage is usually proportional to physical size.



Some 'power' electrolytics in the background, tags are usually used instead of leads.

Metal Foil Electrolytics

Electrolytic capacitors consist basically of two aluminium foils interleaved with an absorbant paper, and wound tightly into a cylinder. Contacts are provided by tabs of aluminium attached to the foils. The winding is impregnated with an electrolyte and housed in a suitable container, usually an aluminium can, which is hermetically sealed (see Fig. 4).

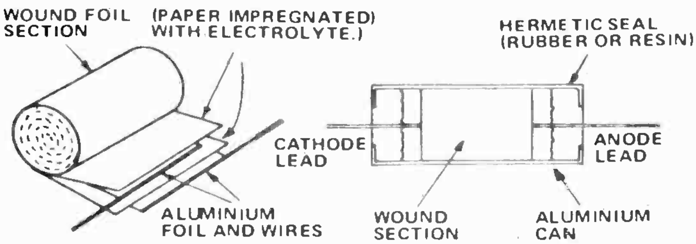
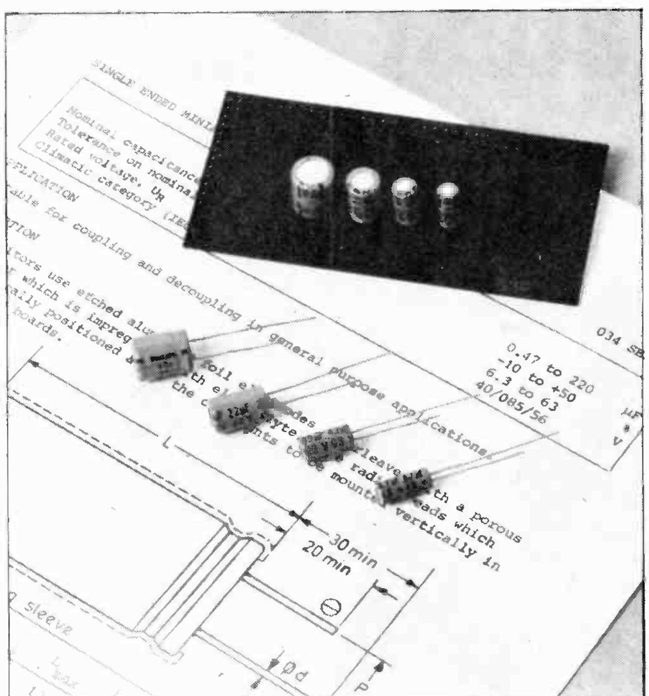


Fig. 4. Electrolytic capacitors, use a similar method of construction to Polystyrene capacitors, note that the start if the roll is staggered to enable the lead-outs to be attached.

A dielectric layer is 'formed' electrolytically on the surface of one aluminium foil which acts as the positive plate or anode, of the capacitor. The electrolyte serves as the second plate of the capacitor and also to repair any flaws in the oxide film when the electrolyte is polarised. The second foil, usually called the cathode, provides contact with the electrolyte. Since this film will have a thin oxide layer, due to natural oxidation, it will also possess very high capacitance. The thinness of the oxide film, and their high breakdown potential, is responsible for the very high capacitance per unit volume and high working voltages of electrolytic capacitors.

Similar to the plain foil type of electrolytic is the Etched foil electrolytic, the aluminium foil on the anode and cathode are chemically etched to increase the surface area and hence the capacity, this results in a physically smaller device but has the disadvantage of not being able to withstand high AC currents, compared with plain foil types.

The capacitance value and leakage both increase with temperature on foil electrolytics, leakage also increases with applied DC voltage, this increase becomes more rapid at voltages above its rated working voltage. This can lead to excessive heat dissipation, and ultimately to its destruction. Most electrolytics are designed to withstand short surges of up to 20% over the rated working voltage.

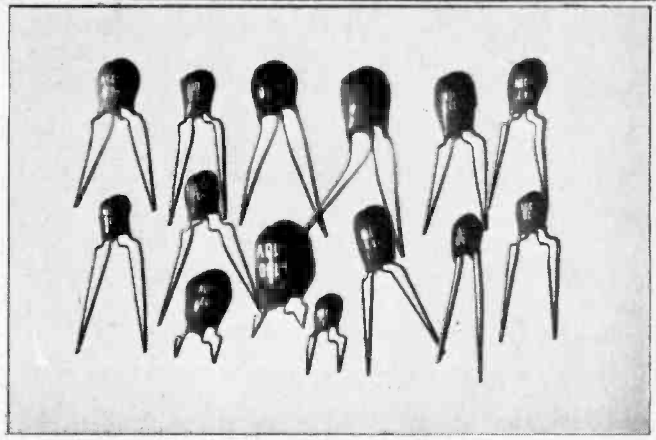


Some new miniature PCB-mounting electrolytics, for greater component density.

Non-Polarised Electrolytics

These capacitors are constructed using several foils in one winding and connected back-to-back. They are usually larger than polarised capacitors of equivalent value since double the foil area is normally required, the

Just some of the multitude of capacitors currently available to the amateur.



Miniature tantalum capacitors, small size, large capacity, but usually low working voltage.

leakage current will often increase as a result. These capacitors are most often used in speaker crossover networks or speaker coupling circuits. Values are obtainable from 1u to 100u.

Tantalum Capacitors

Tantalum oxide is used as the dielectric. This has a much greater permittivity than aluminium oxide resulting in high value capacitance in a relatively small space, they will normally be polarised.

There are three different types of Tantalum capacitor. These are the tantalum foil, similar in construction to ordinary electrolytics. Solid tantalum, this uses manganese dioxide (a semiconductor) as the electrolyte, and a tantalum anode. These are often coated in epoxy resin or a polyester sleeve with epoxy seals. The third type is the wet sintered tantalum, this type is rarely seen other than in specialised applications and can be manufactured to a very high tolerance.

Tantalum capacitors have a much lower voltage rating than electrolytic capacitors, typically 3-100 V for the solid type, up to 125 V for the wet sintered type and up to 450 V for foil tantalums. Tolerance is typically −20% to +50%. Their small size makes them ideal for transistorised applications.●

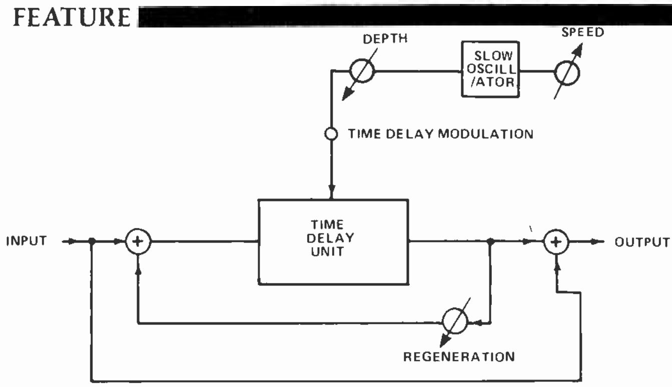
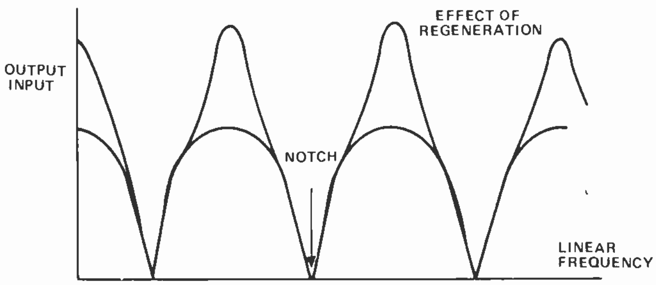


Fig 5. (Above): Flanging and how it is obtained. Below is shown the frequency response of a comb filter.



to the delay time. By applying feedback around the delay line, the comb becomes more peaky and so provides more colouration of the sound. The delay time is slowly modulated and this produces an interesting mobile colouration of the sound. Flanging and phasing are often confused as they are both produced by comb filtering. Flanging uses a time delay and generally has lots of notches, sometimes as many as 50, whereas phasing uses phase delay and usually has only 2 or 3 notches.

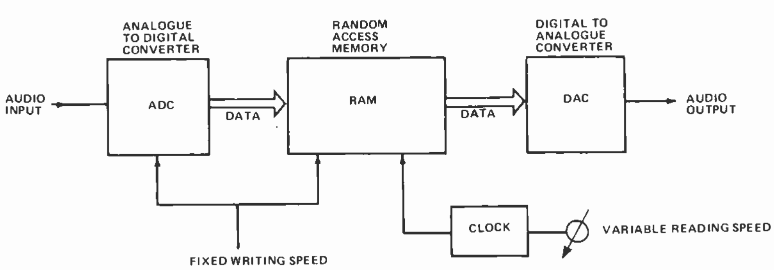


Fig 6. Digital pitch shifting techniques.

Pitch Shifting

It is now possible to transport the pitch of an instrument using a pitch shifting device. The shifting is not perfect, but it is good enough to produce useable harmonies. The operation is as follows. The input signal is converted into a binary code and written into memory. At the same time the memory is read, but at a different speed and this data is converted into the audio output using a DAC. If, say, the reading speed is twice that of the writing speed then the output will be transposed up an octave in pitch. There are many problems to be overcome. First, the output must not be significantly delayed. Second, the time varying information of the output must rapidly track the input, that is,

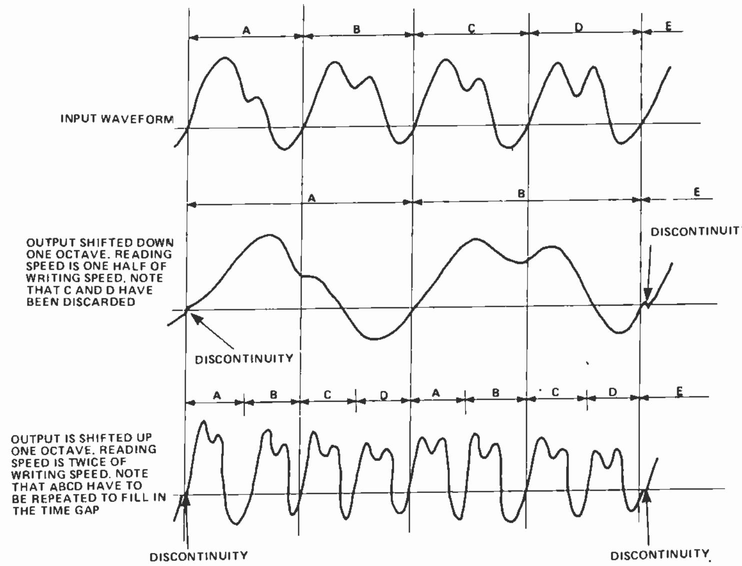


Fig 7. Pitch shifting in practise.

the melody should be the same, but the pitch transposed. To satisfy these conditions the memory size should be relatively small (20 to 40 mS). Take the case of the up transposition of one octave. If the reading speed is twice as fast as the writing speed then each segment of sound will have to be played twice, otherwise gaps would appear. However, when the transposition is down by one octave, then half of the information cannot be read in time and so has to be discarded. Pitch shifting units are usually continuously variable over the range of plus or minus one octave.

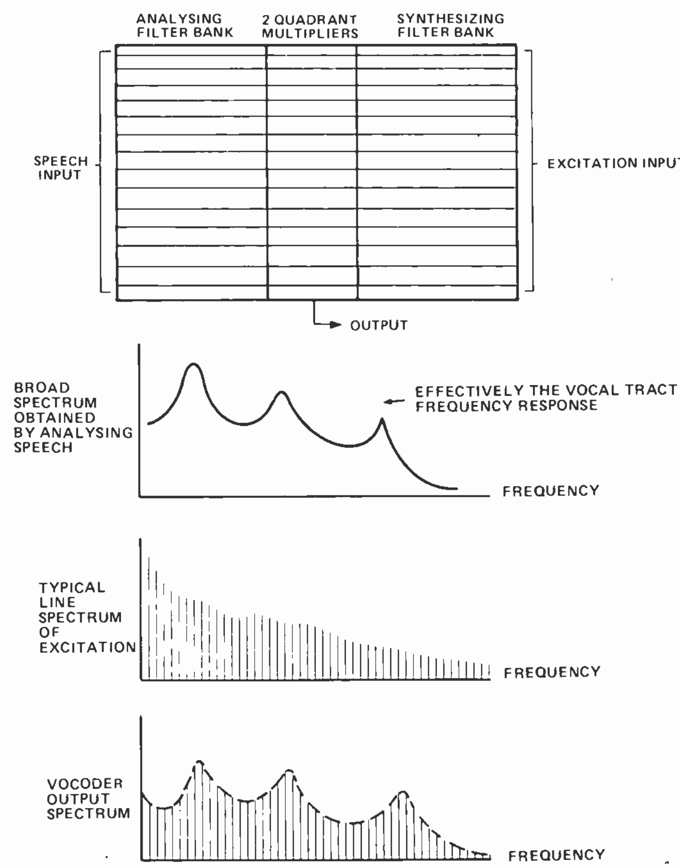
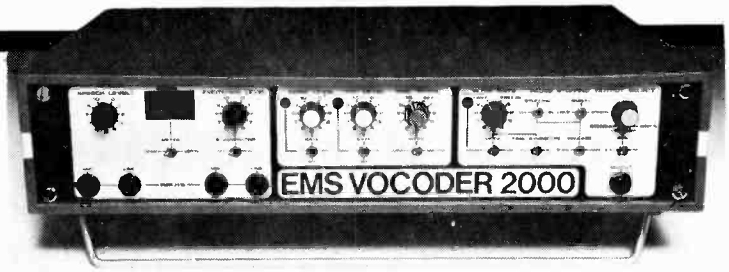


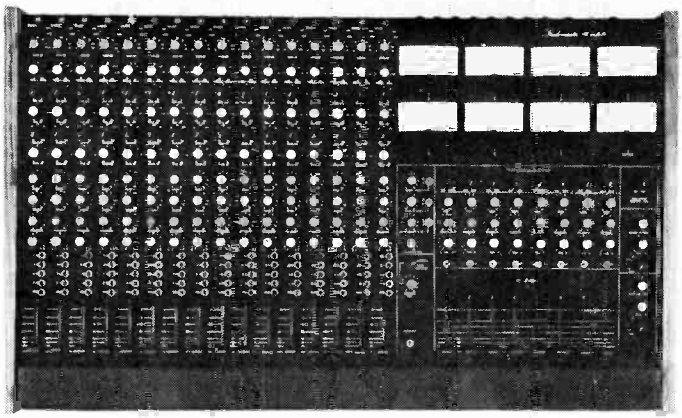
Fig 8. A representation of the Vocoder principle and waveforms expected.

Vocoders

A vocoder is a device for producing a cross product of two sounds. If the two sounds are speech and an electric organ, then the resultant sound output is a talking organ. When we speak we produce a buzz in our vocal chords that is acoustically filtered by our vocal tract. The buzz becomes articulate, it speaks. The vocoder uses a filter bank to analyse the speech so it can determine the time varying frequency response of the vocal tract. It then synthesises a model of this frequency response using a second filter bank plus some multipliers. The excitation signal (the electric organ), is then filtered by this model and so becomes articulate. The vocoder output has the melody and harnonics of the excitation signal, but the time varying broad spectrum (the articulation) of the speech.



Above: the EMS Vocoder 2000, a very popular unit and one which the author helped to design in his days at EMS.



Above: a typical portable mixing unit. This one is produced by Studiomaster and will mix sixteen channels into eight.

Mixers

There is a wide variety of mixers on the market today, ranging in price from $40 to $60,000. Basically, the more you pay, the better the product. A mixer is composed of input and output channels; for example a 16 into 8 device has 16 inputs and 8 outputs. A typical input channel has the following controls. An input gain switch so that low level signals from microphone sources up to high level studio signals can be accomodated. An overload lamp or a VU or PPM is usually provided so that the signal level may be monitored. Next is a tone control section, perhaps consisting of Bass, Middle, Treble and sometimes a few parametric control functions. Many mixers also have an echo send control so that reverb may be added to that channel. A foldback control is often included. This is an internal mixing system so that a few tracks can be grouped together and fed back via head phones to the musicians.

A pan control enables that channel to be sent to either of the left and right output groups. Routing switches are used to connect a particular channel to any output group. A level slider, always at the bottom of the channel allows the operator to fade in and out the sound from that channel? You might get a nasty surprise! You won't if you have got a prefade listen switch. This connects the signal at the top of the slider to some monitoring device, so that the operator can have a sneak listen to a channel before fading it up and perhaps ruining the output.

To produce a controlled mix down the operator will need to be very skilled and possibly he will need ten pairs of hands!●

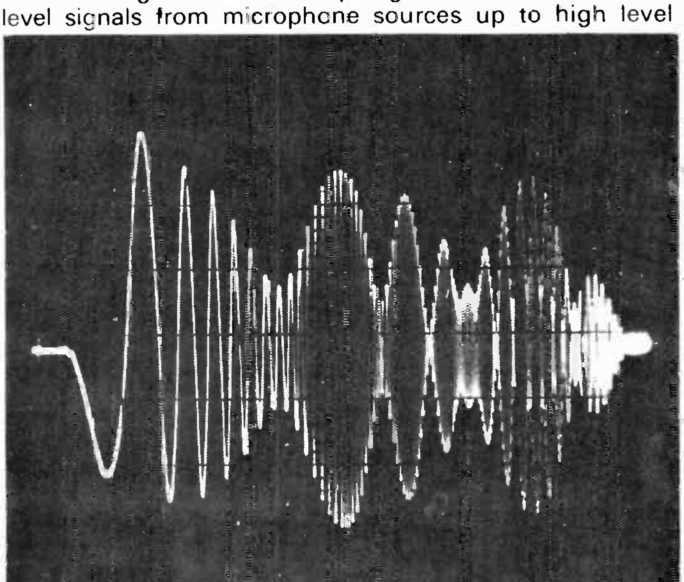
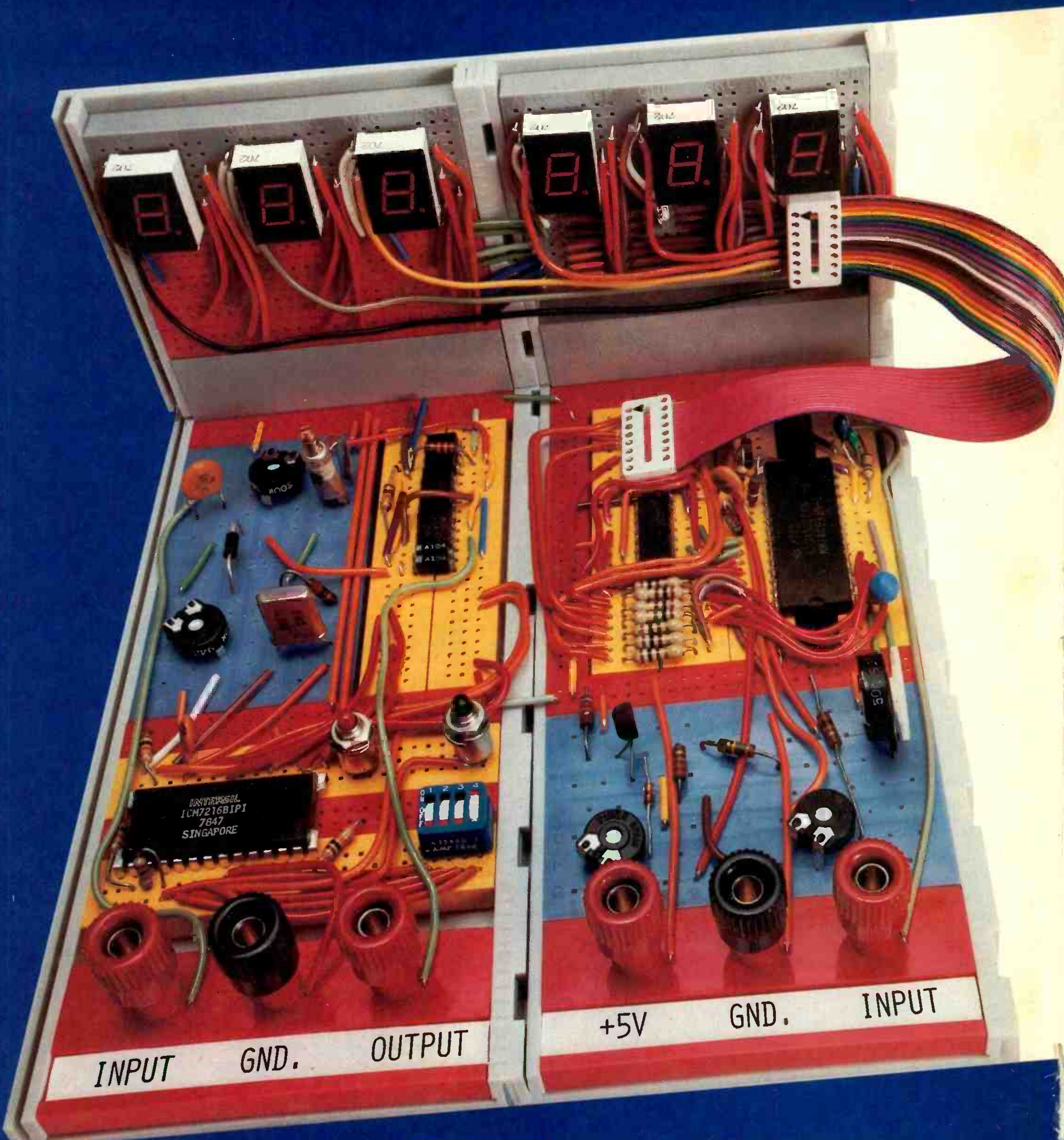


Fig 9. The frequency response of a chorus unti which employs three flanging units without regeneration. The scope picture was obtained using a swept sine wave oscillator set to run the audio band.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COLUMN

Audio Today

Our Audio Editor Wally Parsons is enthusiastic about dbx and explains dynamic range.

New dbx Recording Technology Series
"dbx Model 224 Type II Tape Noise Reduction System, a simulataneous encode/decode system that provides up to a 40 dB increase in useable dynamic range. It is suitable for use with 2-head recorders and provides full monitoring ability with 3-head recorders. The system also features a decoding function for specially encoded dbx Discs, offering full dynamic range and noise-free playback."

dbx Model 21 Disc Decoder
"The dbx Model 21 Disc Decoder can be added to any good home stereo system for decoding the newly introduced dbx Digitally Mastered Full Dynamic Range Recordings, as well as dbx Encoded Discs mastered using analogue master tapes or direct-to-disc recording techniques.

"For the first time, phonograph records can reproduce the full dynamics of a live performance without record surface noise. Use of dbx encode/decode technology allows music to be reproduced with exceptional clarity and realism, against a background of silence — sound that is virtually indistinguishable from that of the master tape from which the dbx recording is made.

"The dbx Model 21 Disc Decoder can be used with any preamp, integrated amplifier or receiver which has a tape monitor function, or it can be connected between the outputs of a preamplifier and the inputs of a power amplifier. Suggested retail price is $189.95."

AUDIO TODAY doesn't usually open with a product news item; such items usually appear under a separate sub-head, as do letters. It's also unusual to reprint a manufacturer's press release verbatim. However, when something exceptional comes along, an exception must be made, and this is it.

Audio News
A word about press releases. Dozens of these come across the various desks at ETI every month. Only a few of these prove newsworthy enough to print, and it's interesting to note that many of the *least* newsworthy are put out by people who think it's cheaper than buying advertising. But even those which are used are usually rewritten, either to tone down the goshwowgeewhizboyoboyoboy tone which is so popular, or to make them literate.

However, in the case of those releases issued by BSR Canada, distributor of dbx products, this hasn't been necessary. Usually, the only reason I rewrite them is either to conserve space, or because I prefer this column to have my own personal stamp.

Notice that dbx does *not* claim that reproduced sound is indistinguishable from the original performance; it is indistinguishable from the master tape. The two are not the same. And that "phonograph records can reproduce the full dynamics of a live perfromance". No promise of magic, no little black box that will deliver the ultimate in fidelity from the $295.95 super-fi purchased at the discount mail-order house. However, the promise is held out that if your *equipment* is capable of delivering a full dynamic range, dbx can supply the goods to be delivered.

The Why and How of it all
Charter members of Professor Parsons' Audio Today Show and Tell Club will recall that in February and March of last year I dealt with the subject of noise and dynamic range.

It should be understood that there are only two real requirements for wide dynamics, from the standpoint of the reproducing chain, that is, from the programme source, e.g. records, to the loudspeaker/listening environment. The system must be capable of developing sufficient acoustic power to match the highest level to be reproduced and at

The dbx Model 21 Disc Encoder may well allow records keep up with modern equipment.

The dbx Model 224.

the same time the noise introduced in the chain must be below audibility at all frequencies.

Until about 1970, the limiting factor was in the reproducing chain. Bookshelf speakers were quite popular, but were incapable of producing truly high sound levels, and even at their limit required enormous amounts of electrical power. I recall calculating the power required to drive one popular speaker to a sound level of 110 dB, and came up with a figure of 10 kilowatts. But even if such power levels were available, it would have been futile, since continuous operation above 50 watts would have burned it up.

At the same time, a signal to noise ration of 50 dB from a phono preamp was quite remarkable, and seldom achieved, especially with the very low output levels delivered by the better pickups.

In fact, it was standard conventional wisdom up until that time that the phonograph record was superior to any equipment available to reproduce it.

The March of Progress

In the meantime, the availability of high speed high power transistors at a reasonable price and improved circuitry resulted in the introduction of more high performance high power amplifiers. Today it is possible to purchase even a consumer class receiver with 250 watts per channel output, and an 800 watt unit is now available as a basic single channel amplifier. Couple this with a greater understanding of rational speaker design, which has produced more sensitive speakers, and we have the capability of producing truly awesome sound levels.

Similarly, improvements in pickups have produced higher performance levels with, in some cases, greater output levels, coupled with preamps with even lower noise levels than a decade ago.

As a result, the record itself is now the limiting element in the system.

There is a limit to the maximum level which can be cut on a disc. There is also a lower limit to the noise of the groove itself. Even if this were to be negated by some wondrous new material, and cutters of unlimited power handling capability, pickup tracing capability and preamp noise would again become the limiting factors. The laws of diminishing returns are setting in, and it makes sense to try a different approach.

The Solution

In theory, there is a simple answer to all this. Just as frequency response is shaped to utilize better the characteristics of the medium, so can the dynamic characteristics. This is the dbx approach.

Essentially, dbx has compressed the dynamic range during the record process, so that dynamic peaks are below the maximum permissible level, and the lowest levels are above the noise floor. By itself, this might be all right for television and movies, but it's just the opposite of increasing the dynamic range, right? But if we *expand* the dynamic range in an exactly complementary manner on playback, we restore the original dynamics.

To be precise, dbx compresses everything by a factor of two to one and expands it by the same amount. Thus, a 10 dB difference is recorded as 5 dB, then played back at 10 dB again. And an 80 dB difference is recorded as only 40 dB, then expanded to 80 dB again. A 40 dB range can be handled easily by any record manufacturer you can name, while 80 dB is impossible no matter what pains are taken. (see Fig. 1)

Newness?

Of course, compressors/expanders(Companders) are not new. What *is* new is the manner in which it is used. Earlier devices had problems in controlling attack and release time, resulting in peculiarities of reproduction, such as "pumping" effects. What was needed was a *precision* companding system.

The other difference lies in the use of a totally linear companding curve. Common practice in the past has been to use manual compression only on the lower level material, along with automatic limiting on the peaks. Some attempts to compensate for this have met with variable success, depending on how the thresholds and the expansion rates used on playback corresponded to the recording characteristic. Sort of a dynamic counterpart to attempting to equalize manually to an unknown curve, like we did in the early fifties.

This system works. And it works well. Unfortunately, the decoder cannot be used on standard discs, and dbx discs will not reproduce satisfactorily without the decoder.

Whether or not it sets a trend is closely related to the compatibility problem, and how this is handled by the marketing people, as well as dealers and various scribblers. I would like to see it happen.

This is why the next few columns will deal with this subject, and a detailed feature article is in the works.

Stick around, kiddies; this promises to be fun.

Continued on page 63

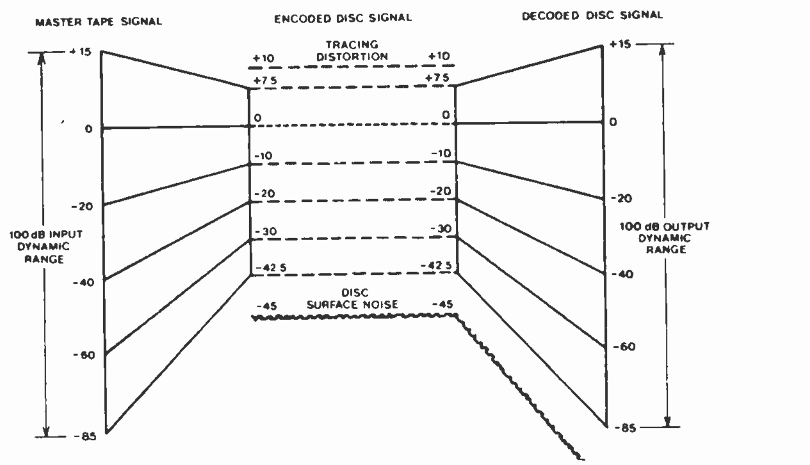

Fig.1. Diagram depicting the combination of signal compression during encoding and expansion during decoding that results in surface noise reduction and dynamic range retention on dbx encoded discs.

FEATURE

THE TESLA CONTROVERSY

It is not doubted today that Tesla's name ranks with the major early researchers into the nature of electricity but some people claim that much of his work has never been made public. We look at his life and career.

BY THE BEGINNING of the 1880s, electrical machines were finding their way into both the commercial and domestic fields. Although the nature of AC was understood, practically all motors and generators were DC. Electricity was becoming accepted and arc-lamps, electric lifts, photo-flood lamps and a wide variety of other devices were appearing.

In 1882 however, a young man Nikola Tesla who had been born in Smijan in what is now Yugoslavia, started to devote his undoubted talents to investigating AC. Tesla had the unusual flair for mental visualisation of highly complex ideas, a virtue shared by Faraday who was also working at that time.

At the end of 1883, Tesla exhibited a working model

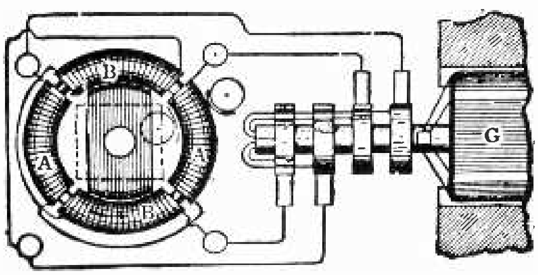

Fig. 1. Diagram used by Tesla in "The Electrician" to explain how a rotating field may be produced by a poly-phase system.

of an AC machine in Paris. (Figure 1 is one of Tesla's own pictures.) He then began a campaign hopefully to persuade the emerging electrical giants, such as the Continental Edison Company, that AC transmission was more efficient than DC and this resulted in a job offer to work with Edison in America. A chance soon came, the repair of DC generators in the ocean-going steamer "Oregon," for him to show his skills.

His work must have been good as he soon became Edison's chief assistant.

A few years later Tesla set up his own laboratory from which he finally reported (in 1888) the electromagnetic rotary field which enabled three-phase power transmission to be implemented. Shortly after this, George Westinghouse, of Westinghouse Electric Co., bought into Tesla's interests and built a hydro-electric system (see Fig. 2) of enormous proportion at Niagara Falls.

Tesla was a man of great generosity. It is said he tore up a contract binding Westinghouse to pay him $12 million — saying that it was more important for the Niagara plant to keep the home-lights burning than for Westinghouse to become bankrupt because of a debt to him.

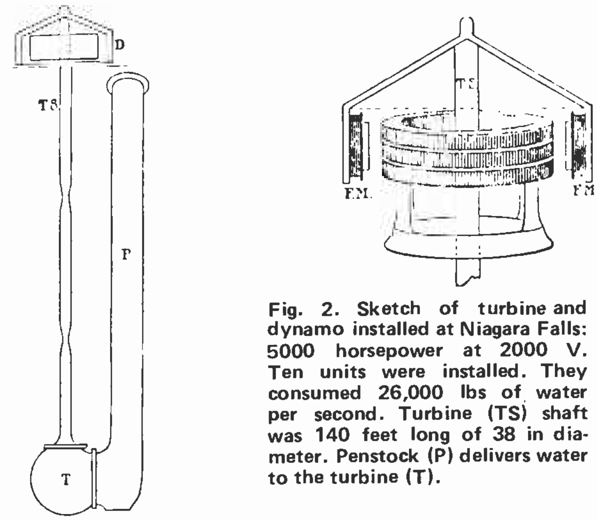

Fig. 2. Sketch of turbine and dynamo installed at Niagara Falls: 5000 horsepower at 2000 V. Ten units were installed. They consumed 26,000 lbs of water per second. Turbine (TS) shaft was 140 feet long of 38 in diameter. Penstock (P) delivers water to the turbine (T).

Tesla and Radio

Notwithstanding his already significant work in power electrical engineering Tesla turned to thoughts of higher frequency (RF) currents — higher by far than the typical 100 Hz limit of power generators of that time.

The pioneers of radio had shown how a spark discharge, produced with an inductor and capacitor (Leyden jars to begin with) was finally proven to be an oscillatory process lying typically in the radio frequency band. Rigs that produced such discharges continued to be developed. The addition of a vibrating bell-like contact or spark-gap discharge arrangements produced a continuous train of discharges. When step-up transformer action was also incorporated, the Tesla coil was formed. (Another name is the Ruhmkorff coil.) Figure 3 is a 1910 Tesla apparatus

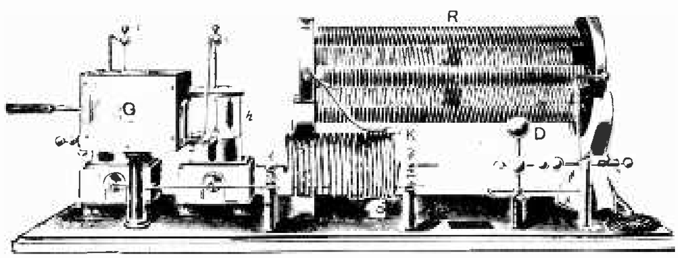

Fig. 3. Modern (at least in 1910) Tesla coil apparatus.

It was the spectacular things Tesla did with his radio frequency extremely high voltage generators that gained him so much fame. At a lecture to the American Institution of Electrical Engineers, given around 1891, he made a memorable impression being reported at the time as

"his work places Tesla among the greatest of our present-day scientists and inventors, such as Edison, Graham Bell and Thomson."

Made His Mark With Sparks

Invitations poured in for his spectacular displays with man-made lightning and RF discharges. His equipment used two kinds of generator.

The first was a 384 pole AC dynamo running at 50 revolutions per minute to give 19.2 kHz. The other was a Ruhmkorff-type induction coil used with a condenser (capacitor) and a spark gap. This produced the then amazing half a million volts at "scores of thousands of cycles per second". It was the latter that impressed his audiences, for Tesla *"brandished flaming swords like an archangel"* — see Fig. 4 (or should it be arc-angel! — Ed).

Fortunately for everybody these RF discharges were

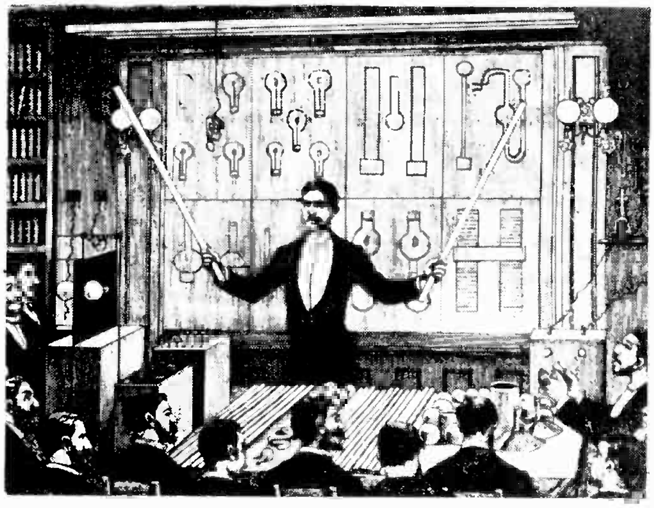

Fig. 4. Tesla amazed the scientific world in 1893 by holding glowing tubes aloft without any electrical connections being made to the tubes.

not lethal but Tesla said when about to try them out for the first time (experimenters were naive to say the least), *"it was as if I were poised to jump from Brooklyn Bridge"*.

Demonstrations included drawing arcs between a string of people, as recorded, Fig. 5, in a contemporary magazine. Another was to make Geissler tubes (glass tubes filled with rarified air but having no electrical contact with external circuits) glow whilst suspended between, but well free of, the poles of high high-voltage transformer.

In his 1899 he built a huge experimental barn at Colorado Springs in Colorado — 30 metres long and 7½ metres wide on top of which was a 25 metre tower supporting a 60 metre mast. At the top was a 1 metre diameter copper ball.

He subsequently proved the earth is electrically charged at a high potential. The Los Angeles Free Press reported visionary ideas not yet exploited — use of the earth's resonance energy and the launching of waves of electrical energy to transmit power to places remote

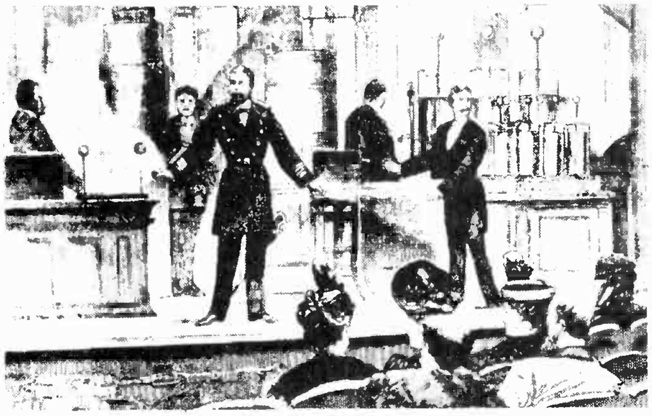

Fig. 5. A contemporary print of Tesla's experiments conducted in Berlin in 1894.

from generators. There was talk of charging the earth to produce tremendous voltages and of terminals to extract it. Tesla is said to have *'lit 200 incandescent lamps at a distance of 26 miles'*. It is said his ideas failed to be exploited by commerce because the transmitted electricity could not be charged for.

Powerful Secret?

Tesla died in 1943, his last work being on the use of cosmic rays as energy sources. The Free Press report claimed that the FBI seized his papers and confiscated all of his reports.

Did Tesla have a unique and powerful secret? He certainly was a visionary, perhaps he did discover something great that is being withheld.

It has been suggested that the Russians have recently found out how his way-out experiments were done and in doing so have tapped some new form of energy. Frankly we doubt if there is any truth in the suppression — or rediscovery — of his work but a lot of people do not agree.

Today he is truly acknowledged. His name is used as the now adopted unit of magnetic field insensity and most laboratories possess Tesla-coils for ionising gas in evacuated tubes.●

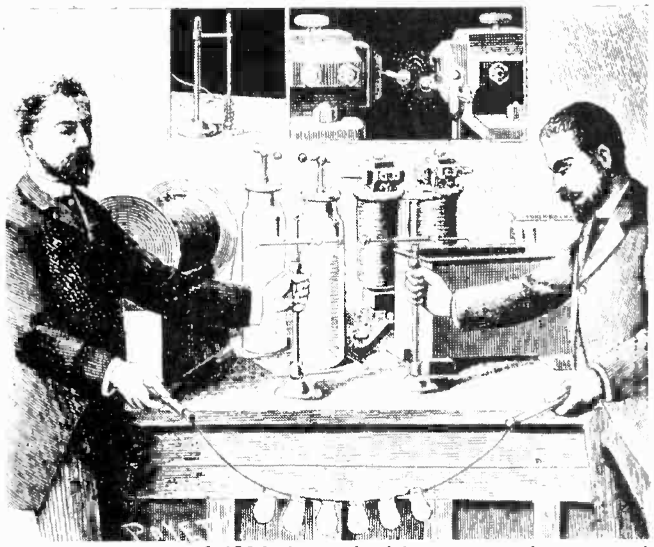

Fig. 6. This print of 1894 shows the laboratory equipment used in Tesla's experiments.

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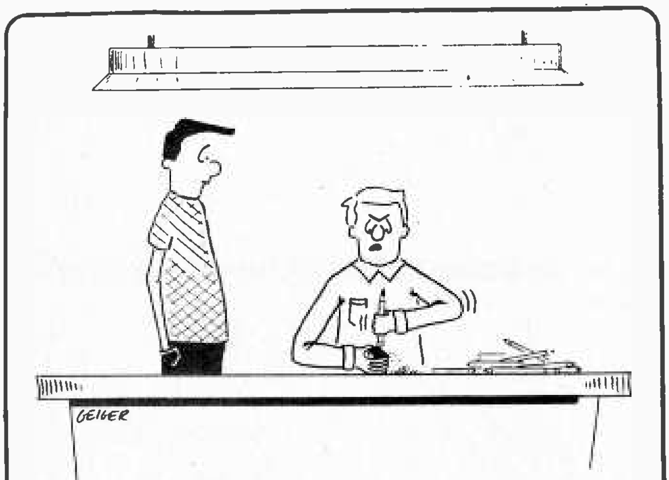
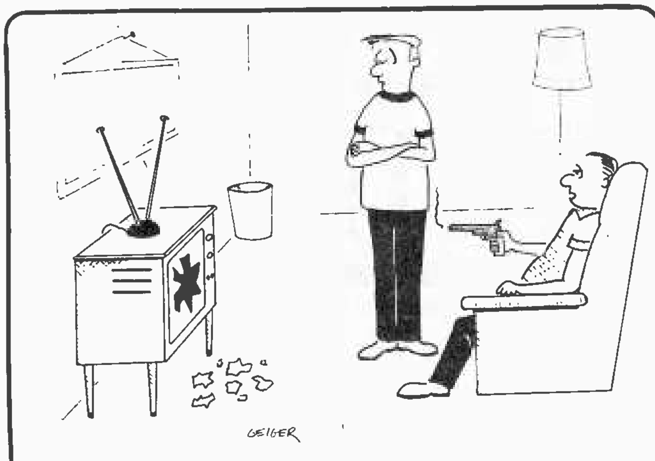
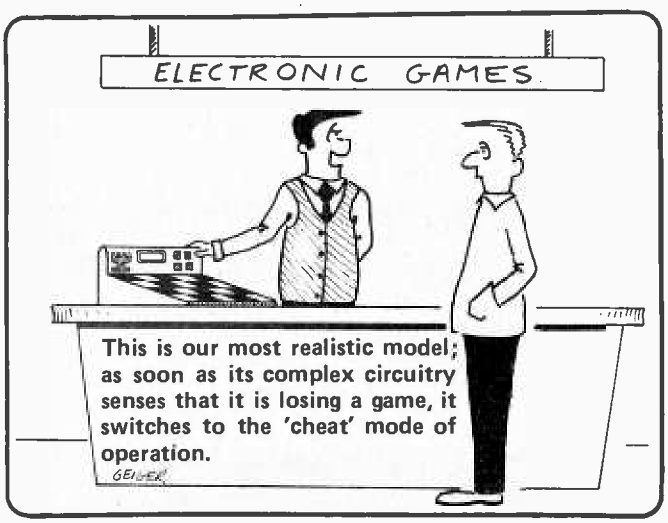


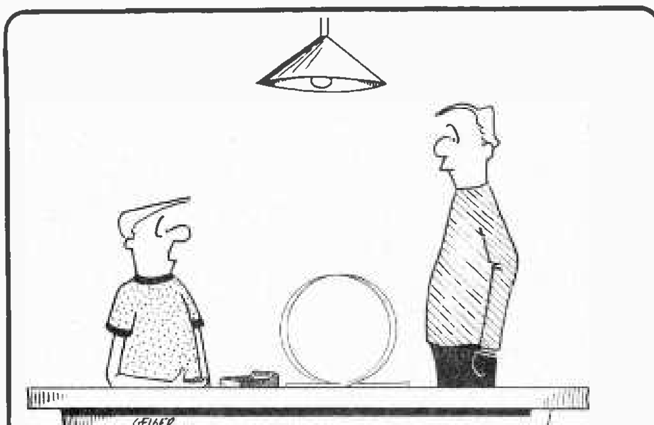
It's supposed to be an erasable memory chip — but I've been at this for over half an hour . . .



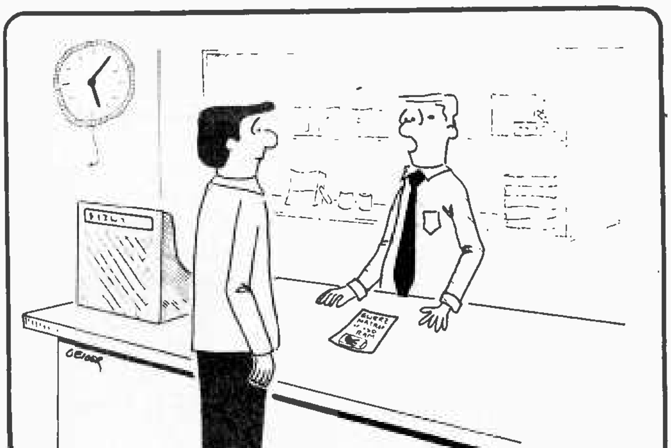
My regular remote control is being repaired, so they gave me this loaner.



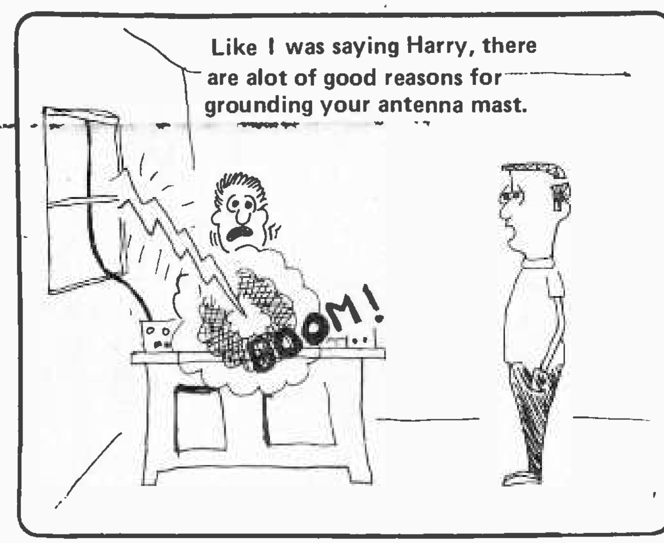
This is our most realistic model; as soon as its complex circuitry senses that it is losing a game, it switches to the 'cheat' mode of operation.



I bought this calculator because it was supposed to be able to execute loops, and so far, I haven't even been able to get it to roll over.



What do you mean, 'Qwerzmatronicisoram' is too long a name for an electronic component — that's just the Acronym.



Like I was saying Harry, there are alot of good reasons for grounding your antenna mast.

PHOTOGRAPHIC TIMER

This project should appeal to the photo enthusiast. Use it to do your enlarger timing

OUR PHOTOGRAPHIC TIMER is a useful project with some unusual features. It has two fully variable ranges, covering 0.9 seconds to 10 seconds and 9 seconds to 100 seconds. The unit has a relay output for turning the enlarger on and off, and is battery powered. Timing periods are initiated by pressing a start switch, and either end automatically at the end of the pre-set timing period, or they can be aborted part way through the timing period by pressing a RESET switch.

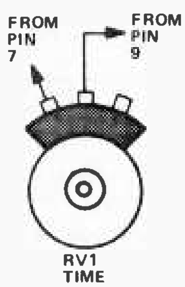
Power Saving

The most unusual feature of the timer is that it consumes power only during the actual timing period. This feature makes it legitimate to use a battery power supply, which in turn increases the unit's versatility by making it fully portable and suitable for use as a general-purpose short — period timer. The unit has a built-in LED (light-emitting diode) that illuminates during the timing periods.

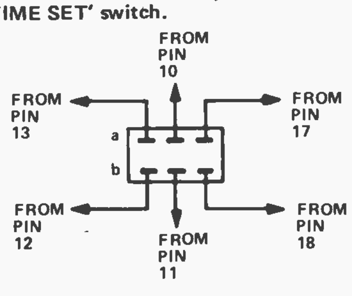
Construction

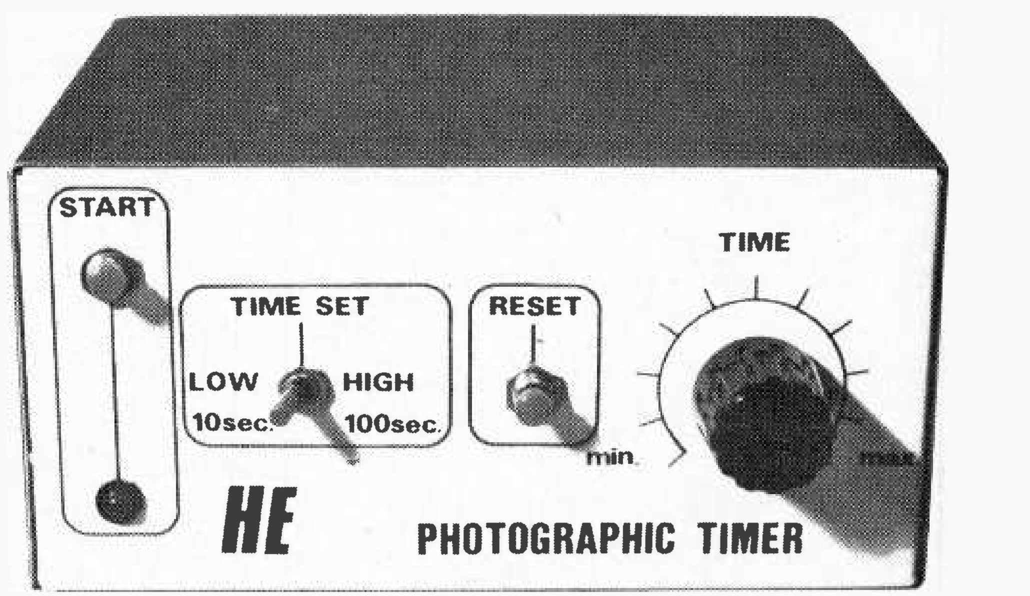
Most of the circuit is built on a PCB, and construction should present no problems if you follow the overlay with care. Be sure to fit the two diodes, the two electrolytic capacitors, the LED and the IC the right way round. Take extra care when doing the interwiring, especially to SW1.

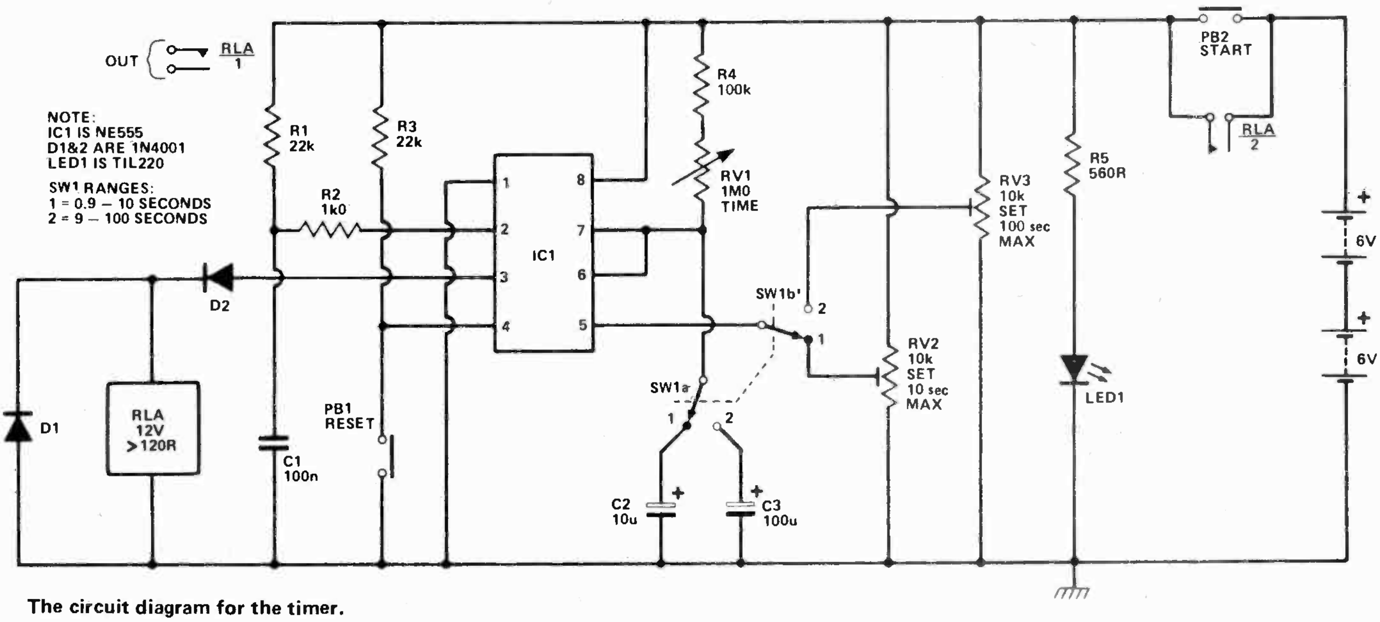
When the construction is complete, double-check all wiring and then give the unit a functional check. Connect the battery supply, press the START switch, and check that the relay and LED operate and turn off again automatically at the end of a pre-set period. The maximum timing period can be pre-set to precisely 10 seconds on range 1 via RV2, and to 100 seconds on range 2 via RV3.●



How to wire the 'TIME' pot the 'TIME SET' switch.







The circuit diagram for the timer.

HOW IT WORKS

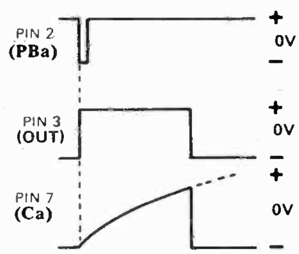
The photographic timer is designed around a simple and inexpensive IC known as the 555 timer. Fig. 1 shows the circuit and waveforms of a simple manually-triggered timer built around this IC. Here, trigger pins 2 and 4 are normally held high by Ra and Rb, and output pin 3 is low. When a brief negative-going trigger pulse is applied to pin 2 of the IC, via the push-button PBa, a timing period is initiated and the pin 3 output terminal immediately goes high and Ca starts to charge towards the positive supply rail voltage via Rc.

After a delay determined by the values of Ca and Rc, the Ca voltage reaches 2/3 of the supply voltage value, and at this point a switching action is initiated within the IC in which output pin 3 switches rapidly to zero volts and Ca is discharged, thus completing the timing cycle. Note that the timing cycle can be aborted part way through, if required, by applying a negative-going pulse (by briefly closing PBb) to pin 4 of the IC.

Our photographic timer is a modified version of the basic Fig. 1 circuit. Look now at the full circuit diagram of our timer. Here, the output of the IC is used to drive relay RLA, which has two sets of N.O. (normally-open) contacts: one set of contacts is in series with the circuit's supply leads, and the other set is used to give output control. The circuit's START pulse is derived from the positive supply line via R1 and C1, and the timing periods are determined by the values of C2-C3-RV1-R4, which can be switch-selected via SW1.

The timer operation is initiated by momentarily closing PB2 and thereby briefly connecting the positive supply to the circuit. At the instant that the supply is connected, C1 is discharged. Consequently, trigger pin 2 is held negative relative to the supply line at this instant, and a timing cycle is immediately initiated. As the timing cycle is initiated relay RLA operates and contacts RLA/2 close and bypass switch PB2, thus maintaining the supply connection to the circuit once PB2 is released. At the end of the timing cycle RLA turns off and contacts RLA/2 open, thus breaking the supply connections to the circuit. The circuit thus consumes no current when it is in the STANDBY mode.

Pre-set pots RV2 and RV3 are switch-selected to connect to modulation pin 5 of the IC, and enable timing periods to be varied over a limited range to compensate for variations in the actual values of electrolytic capacitors C2 and C3 and to enable precise maximum timing periods to be obtained.



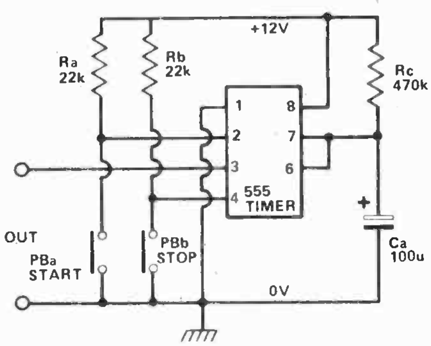
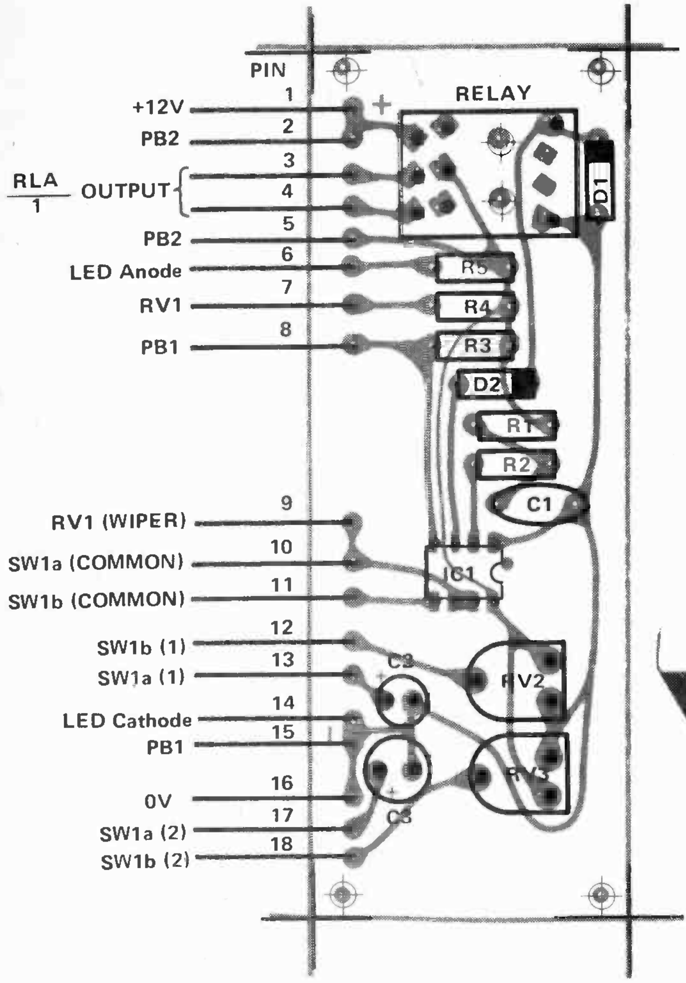
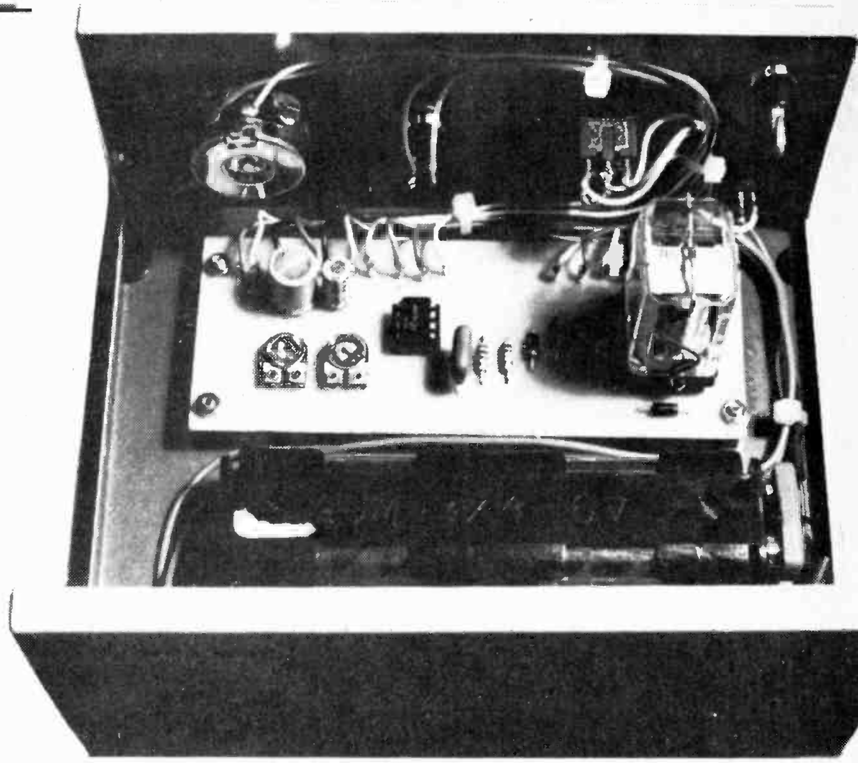
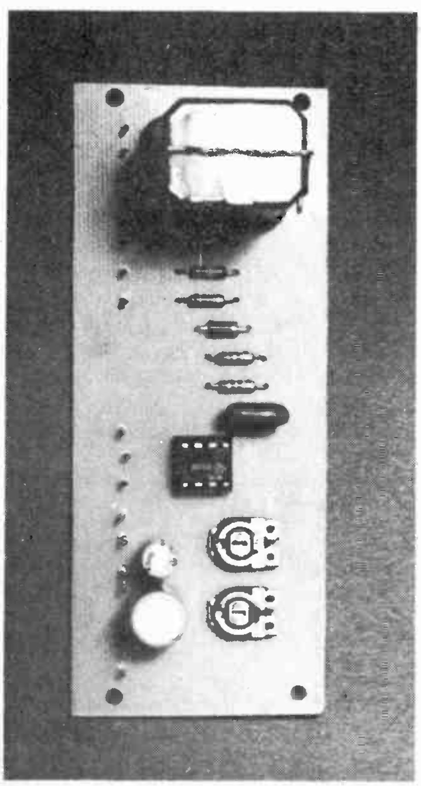


Fig. 1. The waveforms on the left are those produced by the simple circuit on the right.





Above left: The overlay for the PCB
Above Right: Inside the box.
Below Left: The PCB with components in place.
Below Right: The PCB foil pattern shown full size.



PARTS LIST

RESISTORS (All 5%, ¼W)

R1	22k
R2	1k
R3	22k
R4	100k
R5	560R

CAPACITORS

C1	100n (0.1uF) polyester, mylar etc.
C2	10u 16V electrolytic, PCB mounting
C3	100u 16V electrolytic, PCB mounting

POTENTIOMETER

RV1	1M0 linear, rotary
RV2, 3	10k preset

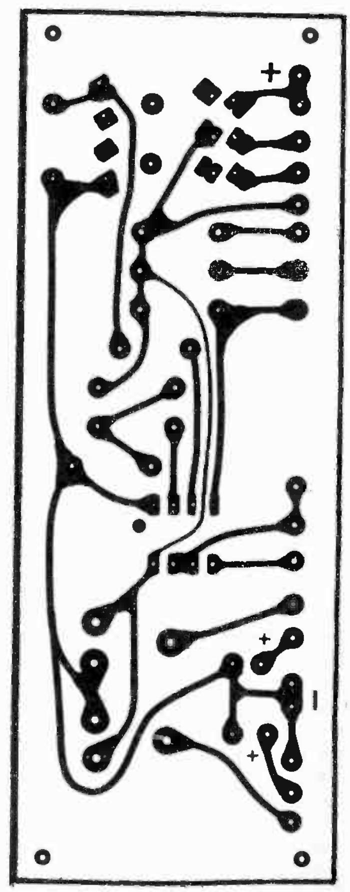
SEMICONDUCTORS

IC1	555 (NE555)
D1, D2	1N4001 silicon diode
LED1	TIL 220

MISCELLANEOUS

SW1	Miniature toggle, two pole, two way
PB1, PB2	Push button switches, push-to-make
Relay	12V coil with minimum resistance of 120R, sub miniature type with at least two 'normally open' contacts (change-over contacts will contain a normally open pair)
PCB	Pattern as shown

Bulgin mains plug and socket, 2-off HP7 4 section battery holders, 8-off HP7 battery. Case to suit.



QRM QRM QRM

Bill Johnson advocates HAPPY FLIERS, agrees with a letter from Vancouver and reports on a court case.

IT SEEMS to me that amateurs in Canada have a distinct advantage over other amateurs around the world — we have not one, but two national organisations to represent our interests to government and the public. Despite the constant bickering and attempts at one-upmanship between the two, amateurs in Canada are taking giant strides ahead at a pace greater than our confreres in other countries. So much so, in fact, that it would seem that someone, somewhere in authority, has our interests at heart, and is doing his utmost to promote them. I wonder who that could be!

For many years, amateur radio led a dark existence. It was a hobby unknown to those who were not in its ranks. Almost a secret society. Over the last few years, however, we have not only gained valuable extra privileges from the government in the form of modes of emission, such as packet radio, but it seems that all government departments recognise the importance of amateur radio as a communications resource. With the new Digital License, we find that amateur radio is not only the resource of hobbyists, but of University researchers also. Our services as communicators are actively sought out by departments who need the extra manpower but can't hire the numbers of skilled people required. Such agencies as the Canadian Coast Guard and Environment Canada have shown interest in recruiting amateurs as assistants to their objectives. We appear to be at the threshold of a new world full of opportunities to serve.

On the subject of public service, there is an organisation in the United States called "H.A.P.P.Y. Flyers", which consists of people who are both amateur radio operators and pilots of small aircraft. Their objects, in co-operation with the Civil Air Patrol, are to use their technical expertise, coupled with their own personal aircraft, to search for and locate downed aircraft. Not only do they do a service to the general public, but their members have developed several high-technology gadgets to aid in the detection and tracking down of radio signals emanating from downed aircraft. As the flyers amongst you will know, an ELT (emergency locator transmitter) is nothing but a battery-operated transmitter that emits a wailing tone when activated by the impact of an aircraft crash. There is no position information transmitted, nor does the transmitter give any directivity information such as a VOR (VHF Omni Range) transmitter gives to guide aircraft on our airways. Location of the transmitter signalling distress is solely by radio direction-finding techniques used by VHF amateurs in the big cities to locate repeater-jammers. The H.A.P.P.Y. Flyers have developed units which they will sell in kit form to anybody who wishes to do direction-finding for either aviation emergency or any other use. The name "H.A.P.P.Y. Flyers", by the way, stands for "Hams And Pilots, Piloting, Yakking." How original!

Since they already have it in the U.S., why don't we have it here? We don't have a civilian air search and rescue organisation here as they do in the U.S., but we don't need it — when an aircraft is lost and ELT is heard, the authorities would be happy to hear from anybody as to its whereabouts. This could be another way to demonstrate amateur radio's superior technology to the public, and having a lot of fun in the meantime. With the Canadian Coast Guard forming an auxiliary which will use amateur communications, it seems a natural little 'extra' to use our direction-finding capabilities to full advantage in this area too. (I would be happy to receive letters from anybody interested in forming an organisation for Canada's HAPPY flyers — just write to me at the ETI office).

Out West

The premier of British Columbia, talking on the Quebec independence issue, once said that B.C. is the only province in Canada that has all the resources, industry, and manpower to 'go it alone' should Confederation fall apart. His words were still ringing in my ears when I received a very interesting letter from an amateur in Vancouver. For several years, new Canadian amateurs have had a hard time extracting the information they need from the various technical manuals available to them. The old standard handbook written by Morton Biback in the early sixties was sadly out-of-date, and no matter how many times it was reprinted, updated, and re-written, it never seemed to keep up with the present state of technology. CARF, with their manual for students, made a valiant attempt, but there was still something missing. With all this as a background, I was delighted to receive a copy of a new study guide now being sold in B.C. The content is easy-to-read, well detailed, and the pace of the lessons are steady and consistent. Drawing are well-done and clear, interspersed generously with the written material.

In his letter Ralph Zbarsky, VE7BTG writes,

". . . we agreed with your statement (Sept. 79 QRM) that something was definitely wrong in the training techniques being used. As a result of this initial meeting, the B.C. Amateur Radio Instructors Group was formed. The group now comprises 31 instructors on a province-wide basis and provides a forum for exchanging instruction techniques, sample lessons, and new ideas relating to both group and individual instruction.

"In addition to meetings, at which we have discussed examination content and format with D.O.C. officials, regular on-the-air sessions have been held to discuss problems and solutions which are monitored by hundreds of hams and S.W.L.s across Canada (judging by the resultant check-ins and letters). The latest examinations have been discussed question by question to assist those instructors who cannot personally attend the meetings.

"As a result of this activity, we believe that a more unified approach to instruction in B.C. has resulted. For the first time, instructors (and students) have a group to which they can turn to for assistance, a group that exists expressly for that purpose, that is not affiliated with either of the two major warring Canadian factions (neither of which appear ready or able to serve this function). Through the support of individuals and clubs, we are able to maintain a post office box mailing address and provide services ranging from a comprehensive list of typical questions that students must be capable of understanding to certificates for successful course completion. As a representative group, we also believe that our representations will have a greater impact on the D.O.C. than will individual approaches (which, of course, we also encourage and support). Anyone wishing further information can contact me or the B.C.A.R.I. at PO Box 35404, Vancouver, B.C. V6M 4G5."

All I can say to that is well done, Ralph!, why can't we do something like that in the rest of Canada?

Amateurs In The Courts

In a Toronto court room, this spring, Murray Crimless, VE3GAD, of Lindsay, Ontario, appeared before the Judge charged with possession of a device capable of detecting radar speed measuring equipment, transmissions contrary to the provincial highway traffic act. Armed with jurisprudence stating radio to a purely Federal matter, and two radio inspectors for expert testimony, Murray was all set to plead NOT GUILTY with determination to win the case, even if it meant spending more than the thousands of dollars that he already had tied up in the case.

You will all be glad to hear that Murray got off, but the outcome was more the work of a policeman not showing up than the legal arguments of Murray's lawyer, Lorne Jackson, VE3CXT. The judge dismissed the case for lack of evidence, and ordered the radar detector, (which had been seized at the time of the alleged offence) returned to Murray. This presented a problem, however, when the police refused to allow Murray to transport the device home in his car, since the transportation of these devices except in a factory-sealed carton is also illegal in a motor vehicle. All was resolved when somebody phoned 'downtown' and got special permission. The 'radar detector', incidentally, was a unit that Murray had built from a kit in true amateur spirit many years ago, and was being used, in conjuction with a microwave transmitter in the car, in some collision-avoidance experiments that he was legitimately performing under his amateur license from the Feds. It's enough to make you fed up, isn't it?

QRM letters are welcome from any reader who has an opinion to render, whether licensed amateur or not. ●

Write to:—
QRM Letters
ETI Canada,
Unit 6,
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73 de Bill VE3APZ

PROJECT

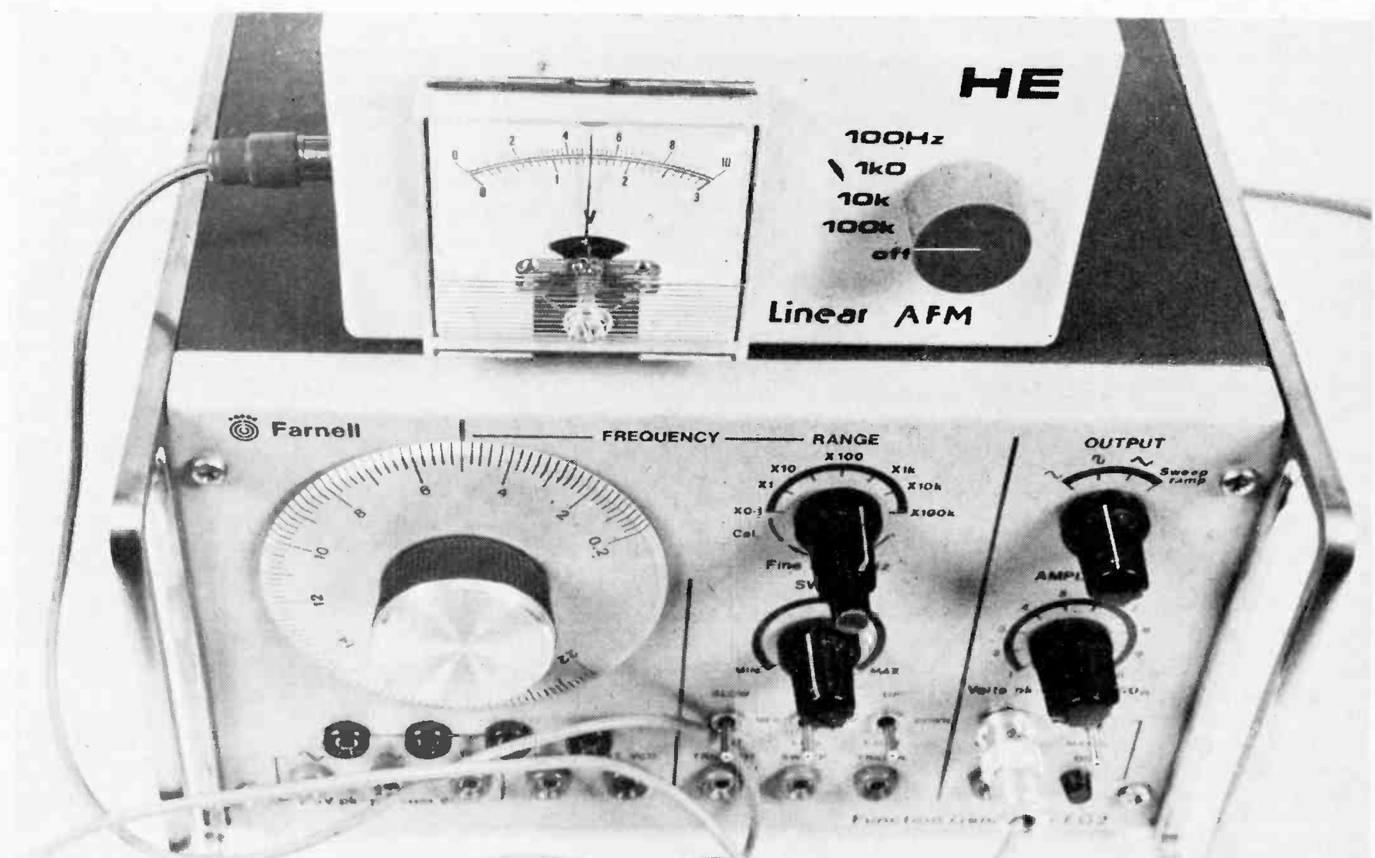
ANALOGUE AUDIO FREQUENCY METER

Get in tune with the modern age. . . economical testgear made to measure.

THIS LINEAR SCALE AFM will enable you to resolve frequencies from 10Hz to 100kHz in four decade ranges. It is low in cost yet high in performance. Accuracy is unaffected by the waveshape of the input signal and the unit is sensitive to input levels down to about 200 mV. The input circuit features a protection diode network and the maximum safe input voltage is effectively limited by the rating of the coupling capacitor C1. The unit operates from a single 9 volt battery and current drain is low giving a useful life from a 9V battery or equivalent source.

Cheap Chips

Only two relatively cheap chips are used; a 3140 bi-MOS op-amp which performs signal pre-amplification and conditioning, driving an ordinary 555 timer configured in the monostable mode. Timing components are selected by a five position range control which also



Calibrating the Audio Analogue Frequency Meter against the workshop signal generator. For those without any test equipment an alternative method is outlined in the text.

functions as the power switch. Only a handful of other components are required and accuracy, after calibration, is determined by four fixed resistors.

Construction

Construction may take many forms. However, use of a PCB aids assembly and reduces any chance of error. Our design is highly recommended. In any event, all leads should be kept as short as possible to avoid stray coupling; keeping signal input leads away from the 555 for example.

Construction should proceed in the usual order. Insert the IC holders first, followed by the passive components; resistors and capacitors, paying close attention to the orientation of the polarised components. Finally insert the diodes and plug the IC's into their sockets. Pin one is indicated by an indent at the top of the package or a dot by the pin itself. Note that the signal 'low' input is separate from the 0V line.

Calibration and Use

Calibration of the instrument is very straightforward owing to the high input impedance. With the unit switched to the 100Hz range, touch the input with your finger. There will generally be enough stray power field to provide an adequate signal. This should cause a deflection on the meter and RV1 can be adjusted until a reading of 60 Hz is obtained.

HOW IT WORKS

The input signal is applied to C1. R1, D1 and 2 provide protection against high input levels. IC1 is a high input impedance op-amp configured as a Schmitt trigger with R5, 6 setting the hysterisis. C2, R2, 3 provide a mid-voltage bias source.

The output of IC1 consists of a train of square waves at the same frequency as the input signal. This triggers the 555 timer which produces a monostable pulse of period determined by selection of range resistor, R9 through R12 at the output pin 3 from each negative excursion. The trigger pulse must be shorter than the output pulse and differentiating network C3, R7, 8 is used to accomplish this.

To avoid inaccuracies owing to falling battery voltage, the output of IC2 is clamped at 5 V6 by ZD1 and the meter is driven via current limiting network RV1, R14. A 5 V6 zener is chosen as it has a low temperature coefficient. This means that its voltage exhibits little change per degree change in temperature. The reason for this is that the negative and positive temperature coefficients of the zener and avalanche effects almost cancel out in 'zener'diodes of this voltage.

The only possible source of trouble worth mention may be failure of the 555 to trigger at all. This could be caused by the value of C3 being too small. Trouble from this source is unlikely. However, C3 should be as small in value as possible consistent with reliable triggering.

Current pulses from IC2 are averaged in the meter whose deflection indicates the input frequency. To allow for variations in component tolerances, full scale deflection corresponds to about a 75% duty cycle. C5 is a supply decoupling component.

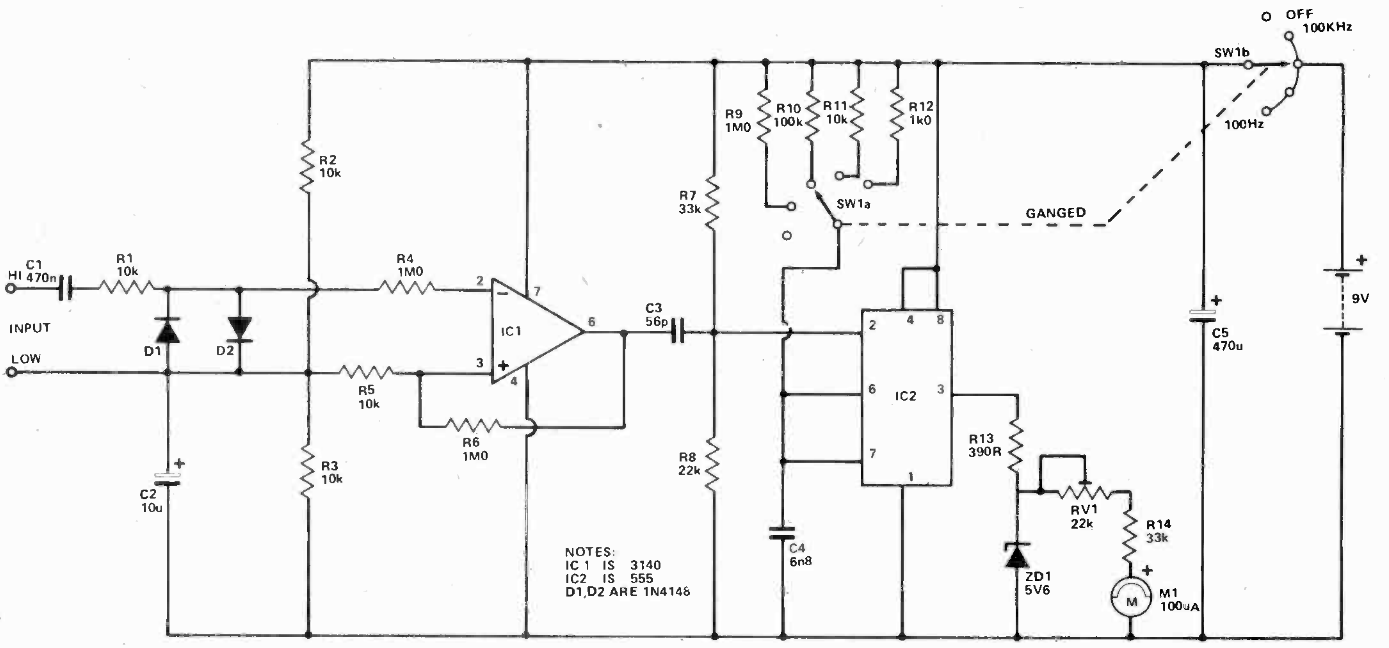
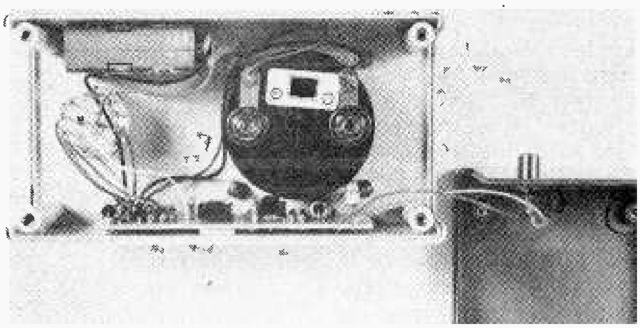


Fig. 1. Circuit diagram of the Analogue Frequency Meter.

Of course if a signal generator of known accuracy is available, you can set up the unit on any desired range. However, the technique described above will enable useful results to be obtained. A feature of the instrument is that only one range need be calibrated; the others falling into line automatically.

In use, select the highest range (100 kHz), this automatically applies power to the unit, then connect the unknown input signal. The reading can be noted and a lower range selected if required. This is to avoid spurious readings which can be obtained on the lower ranges owing to retriggering of the 555 by high frequency input signals. There are no other adjustments to make so all you need now is something whose frequency you can measure. ●



Inside view of our prototype.

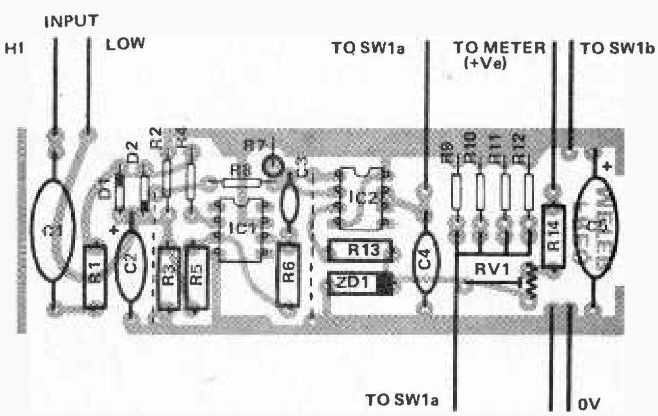
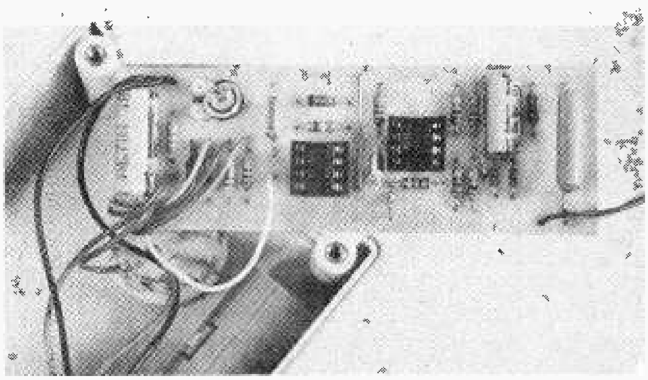


Fig. 3. The component overlay on the PCB.

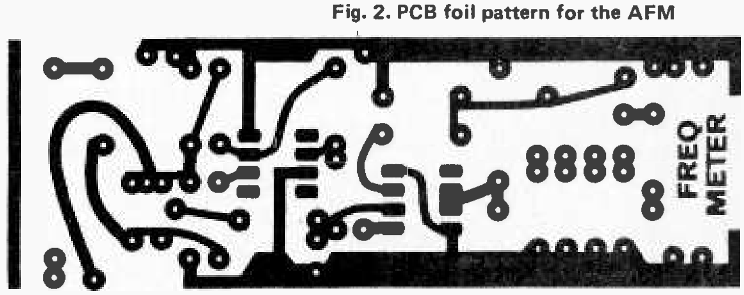


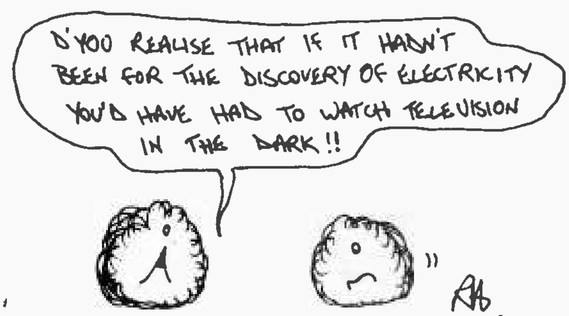
PARTS LIST

RESISTORS (all ¼W, 5%)

R1, 2, 3, 5, 11	10k
R4, 6, 9	1M
R7, 14	33k
R8	22k
R10	100k
R12	1k
R13	390R
POTENTIOMETER	
RV1	22k preset
CAPACITORS	
C1	470n polyester
C2	10μ tantalum
C3	56p polystyrene
C4	6n8 polyester
C5	470μ electrolytic
SEMICONDUCTORS	
IC1	3140
IC2	555
D1, 2	1N4148
ZD1	5 V6
MISCELLANEOUS	
Meter	100 μA FSD
SW1	2 pole 5 way
PCB	case to suit

Fig. 2. PCB foil pattern for the AFM





WHAT'S ON

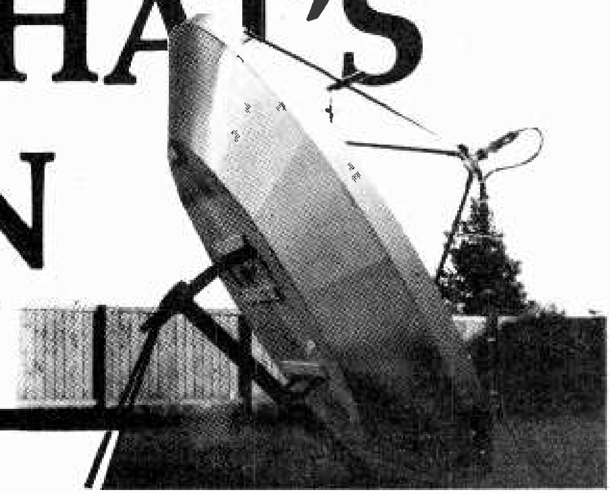


Fig.1. A view of NORSAT's dish antenna.

Steve Rimmer reviews a Canadian Satellite System.

Elementary, My Dear Holmes

I WOKE UP this morning to the sound of the Fugs being played through my guitar amp with the reverb turned up and the tremolo going full blast. It was not pleasant. You probably don't know what exactly a Fug is, even in the singular and cannot thus imagine what sort of manifest horror is racked upon the human brain by finding a bunch, three in fact, crawling around the inner ear, trolling for consciousness, at seven AM. Suffice it to say that if you met one in the subway, he would be attonal, obscene, about fifteen years out of date and, I suspect, probably out of work. Mid sixties East cost protest drug rock? Yes indeed. The song I arose to was called CCD. You may, if you wish, ponder the meaning of those initials, or research them, if you're really into nostalgia, in the delete bin.

"I thought I hid that album," I recall thinking to myself. I discovered the dog sleeping in my drawer again.

I may have mentioned my acquaintance, Max. He comes over, now and then, to groove. I hadn't heard that word used since I hid the Fugs album. Grooving is the process of eating food (mine), occupying space (mine), experiencing technology (mine) and trying out possibly illegal substances on the dog (his and mind: his stone, my dog . . which probably explains why it was sleeping among my socks). When I got down to the studio, Max was sitting in a bean bag chair, which he must have brought with him, stroking a kitten. Every piece of equipment in the room was on. The stereo was playing through the synthesizer (which was, in fact producing the tremolo sound) into the amp, all the video monitors were on, displaying different tapes, and there was a Devil's Dungeon game in progress on the computer. Max smiled. He proferred me the cat. "I brought ya this."

I was speechless with gratitude. Or something.

"You gonna buy a satellite soon?" Max inquired.

"Will you take the cat back if I say no?"

"Course not."

"What about if I say yes?" It's all a foolish discourse. You can't buy satellite systems in second hand shops or flea markets, the haunts of the financially inopportune.

"I had an idea how you could shoot one down, if ya want." Max said seriously. You can't really tell if he's grinning through his beard.

"Listen, hit me next week. I gotta do the column." Max understood this. He always reads the column. Fortunately, I get two copies of the magazine, so I usually get a chance to see it too.

"Elementary, my dear Holmes" he said, and left.

It only struck me much later that this had been a pun, and a rather vile one. I turned everything off and started trying to figure out which of several viscously bubbling topics to throw the eye of a newt into and transform into a couple of thousand words.

What eventually decided me was the last stack of mail I got (see; you do have a say in things). The most frequent question I've encountered to date dealt with satellites: notably, where to purchase downlink hardware from. It seems like it's about time for another satellite bit, and this would be a useful area to cover in some depth. This month, we're going to look at NORSAT SYSTEMS. If you've been considering buying a satellite system, this may be just what you need.

And I can send Max over to your place next time.

Norsat

Readers who spend their nights tunnelling through ETI's back pages may have noticed an ad for NORSAT SYSTEMS (P.O. Box 232, Surrey B.C. V3T 4W8). As far as I can tell, to date, these folks are the only Canadian based supplier of home satellite ground station equipment. To be sure, considering the duty and shipping charges involved in importing equipment from the States, this is the cheapest way to go. Furthermore, as the equipment supplied by NORSAT is of a Canadian design, it appears to be better able to withstand our novel climatic variations. The dish antenna, (Fig.1) for example, is claimed to be able to emerge unscathed from 100 mile an hour breezes. Those are real miles. Smaller dishes are available if you wish to convert to metric.

NORSAT has available both plans and complete kits.

The dish antennas are sold in three bits, these being the reflector proper, the feed (which sits on the dish) and the mount, which takes up the space between the dish and the ground. The dish is supplied in pieces . . . fourteen big ones, the segments, or "ribs" of the reflectors, and a somewhat larger number of smaller ones, which will get lost, unless you're careful. Small pieces usually do. When it's all put together, it is twelve feet (or 3.7 meters, if you want to be difficult) in diameter. The actual reflector surface is aluminum, supported by a fairly simple plywood structure. The plywood doesn't come with the kit, as the cost of shipping it would exceed the actual worth of the material.

The plans alone go for about a hundred dollars, and the kit of pre-cut pieces for about a thousand. This is a bit like a twenty thousand dollar Rolls; a great price, but it's still a lot of bread. If you elect to buy just the plans, NORSAT estimates that you can buy the materials (and do the cutting yourself) for about three hundred.

Judging by some photographs that NORSAT enclosed. (Fig. 2) dealing with the bringing to life of one of these marvelous metal frisbees, any mad fool with a hammer and a three car garage could get the dish together. But do check out that garage. It's not just any door that will pass a twelve foot dish .. and no matter how you turn the thing, it's still twelve feet across. If you really get stuck, you can make it 3.7 meters.

The feed system for the dish is available only in an assembled form, mostly because it could not be built to the necessary tolerances as a kit. It is, in fact, not even built by NORSAT, although it uses NORSAT's design, but rather, by a firm which specializes in these things. All this precision goes for a mere $168.00.

The final component of the antenna proper is the mounting structure. This is a bit of a grey area for a number of reasons. The exact nature of what one uses as a mount will be determined by a number of factors, such as, what kind of meteorology is likely to impose itself up the dish, whether or not the antenna is to be steerable, and so forth. Furthermore, the mount is physically huge, and made of relatively inexpensive materials. As such, NORSAT does not sell a kit of parts, but only plans for this component, for twenty- eight dollars.

The specifications of the dish will probably be qite meaningless to anyone who does not chance to be a microwave engineer, but, then, probably no more so than the specs of a stereo. If nothing else, they are good for party banter and comparison. The minimum gain at 3.7 GHz is 40.8, rising to 41.9 at 4.2 GHz. The noise temperature at 40^{o} is less than 25^{o} K. Judging by what I've been told (relatively little), I think this is pretty good.

The ouput of the feed is type CPR-229G. If you've taken apart a DEW line station recently, you probably have one of these in a drawer somewhere.

The important part of a satellite system is actually the receiver, to some degree. The antenna has to be properly designed, stable and of sufficient gain to be sure, and, from a theoretical point of view, the receiver could be quite klugy. With respect to some of the articles that have been running in a few of the U.S. technical magazines of late, one could, it seems, get together a simple receiver (sort of) that would get useable pictures. However, producing a system that one could actually watch without going mad retuning and adjusting, and one that can make full use of a good antenna by being able to check out everything that's "up there", requires somewhat more expertise. To a greater degree than the dish antenna, which is acually just a relatively simple bit of mechanical work, receivers for personal systems are a somewhat new frontier. Until a few years ago, no one was trying to design low cost instruments to do this job, because the only people who needed groundlink sets were quite prepared to pay top dollar for them. Thus it is that, while several fairly good antennas are available, the choice of receivers is considerably more limited. NORSAT's CTC-2001 (Fig. 3) is, apparently, among the more highly regarded designs in this area. The price . . . a mind searing, wallet shattering $29.45 . . . no no, pardon me, that's $2945.00 . . . is actually a few hundred dollars below the landed cost of the American competition. Once again, the splendor of the savings is overshadowed by the sheer magnitude of that which remains to be spent.

The receiver is housed in a 19" (not available in metric) rack mounted case, which looks to be about 5¼" high. It is capable of being tuned to any of the up to twenty-four satellite downlink frequencies. The front panel contains a very complete system to monitor what the internal wizzbangs are up to, consisting of a switchable meter to deal with signal levels or tuning lock, plus fourteen status LEDs. There is also a headphone jack to monitor received sound before it heads out to the stereo for amplification. The system also contains a regulated power supply to send out to the dish and fire up the feed mounted low noise amplifier.

The aforementioned internal wizzbangs of the set live on modular, plug in cards, to facilitate servicing.

For some of us, twenty-five hundred dollars would certainly mean no beer this weekend, and, possibly, selling the front lawn to a sod farm. However, there are those who have large limits on their Visa cards, and will want to guild the silicon lilly. For these depraved, and obviously grossly overpayed oil company executives, there are options available for the receiver.

Option number one is the installation of an improved discriminator. See why all the circuitry is modular? This improvement will reduce the noise, or "sparklies" seen in a picture when the antenna and low noise amp are just about out at their limit. In fact, it will be of some benefit even in a larger system, as it reduces the noise generated by the receiver itself, thus "quieting" down the picture a bit. At seventy- two dollars, it's well worth it.

If you are a bit confused as to what a discriminator has to do with video quality, remember that satellite down-

Fig.2. NORSAT antenna under construction.

links have the picture component modulated FM, to get a useable signal-to-noise ratio over the extremely high loss transmission path.

The second option is a VHF modulator, which bounces both the demodulated video and audio down to a standard broadcast TV channel, so you can see uncut Carson shows on your very own 1958 round screen Zenith, instead of popping for a proper monitor.

As with all modulators used in this way, there is some degradation of picture quality when a broadcast TV is used, as opposed to a direct feed monitor.

The audio on the WESTAR satellites is somewhat different from that on SATCOM, and the other "birds", and as such, cannot be demodulated by the demodulator that comes with the receiver. This is very sad, especially if there happens to be something on WESTAR you want to hear as well as watch. To cheer you up, I should tell you that behind option number three there is a brand new second audio subcarrier demodulator. It plug' into the receiver along with the existing circuit, and can be switched in from the front panel when needed. Isn't that amazing? It costs $104.00. Still amazing, but not quite as much.

Option four is a walnut cabinet, at $98.00. This may be the point to dig out the saw and take apart the book shelves.

Option five is a gas. It's a key lock power switch. For why? "It is particularly useful to censor childrens viewing of pay TV R and X rated movies." Now, I can understand the thinking behind this, and it's probably a good thought. It will either keep the kids away from the tube when there are blue flicks about . . . or teach them a useful trade . . . like locksmithing.

The final option makes use of the design of the receiver's front end, which employs a voltage controlled oscillator, as opposed to just a direct drive tuning capacitor. Because the tuning is accomplished via a DC voltage, a remote tuning control can be plugged into the back of the set. Stations can thereupon be selected from ones chairside. If you could arrange to be fed intravenously, you'd never have to get up again. At $137.00, this is most expensive of the options, and, I feel, is the least useful. If you are too stoned to get up and change the channel, you are too stoned to care what is on the screen.

As before, I'm not sure that the specifications for the receiver will be of much practical use, as few of us are really capable of fully understanding them in light of the application to which the system will be put. On top of this, there are few other sets to compare it to. However, recognizing that without numbers, pocket calculators would never have been invented (and then where would we be?), I'll lay a few of the more interesting digits upon you. In all cases, the receiver conforms to the various standards for frequencies and subcarriers used by the satellites, including the WESTAR sound channel, with the appropriate option.

The RF Noise figure is 13 dB maximum. The FM threshold is 9.5 dB with the standard discriminator, and 8.5 with option one. The video bandwidth extends to 6 MHz with a 52 dB signal to noise ratio. For comparison, a home VCR at normal speed has 43 dB signal to noise. The audio bandwidth is 45 Hz to 15 KHz, at up to plus 10 dBm into 600 ohms. The headphone jack accepts normal 8 ohm cans.

In addition to all this hardware, NORSAT also supplies a "Site Co-ordination/Performance Study", to keep you from locating your antenna at the bottom of a well, or other equally unsuitable place. The cost of this service is $25.00.

The Law

An lastly, the law. I was talking with Charlie Pitts, of Spacecoast research, a Florida based distributor of TVRO downlink hardware, several weeks ago. Spacecoast feels that it could offer more of its products to we poor frostbitten gnomes North of the invisible line, but for the duty and postage. To this end, the company is seriously considering a Canadian manufacturing facility. Charlie was up here on a "fact finding" safari, investigating, among other things, the possible existence of any legal hassles dealing with private satellite system owners. I think he garnered more questions than answers. The only really official word on broadcasting in Canada is the Department of Communications, who were fuzzy at best. They have only one related document, which, upon labourious unpacking (and spreading out all over the floor), revealed to us both that it misses the

mark altogether. Subsequent forays into this never-never land of paper marsh gas monsters have given me no further insights into the question.

To date, the powers that be seem to be ignoring the private owners of satellite equipment. This may be, in part, because there are very few of them. Then, too, they are not actually hurting any of the program owners, as none of the American services, HBO, STAR CHANNEL, and so forth, could be had and paid for in the usual way in Canada. Then, too, there are individuals like David Brough who use satellite transmissions to provide ersatz network programming to remote areas of the country where the CBC fears to tread . . . even though it has a mandate to do so.

The fact is, though, that things are very loose in the legal aspects of satellites. I recall an international statute that states that anybody can receive any material transmitted over the (public) airwaves, provided he does not communicate what he has received to any third party. This seems to relate more or less to short wave transmissions, but, technically, it also seems to cover satellite downlinks. Presumably, then, one could use the material provided one didn't set up a cable system with it, sell tapes of it, or, to be sticky, discuss what was on the tube last night on the way into work.

I think that this is becoming an increasingly important question, as more and more Canadians start sinking the family jewels into downlinks. While it is probably beyond all humans and most lesser dieties to get the laws changed, it would be nice to know where we all stand, especially if some fellow in a red suit with bowed legs appears at the door bearing a tool box and an evil grin.

I hope that someone out there, possibly in some branch of the legal profession, or a neighbour thereof, knows something concrete about this important question. Or, perhaps you have an opinion, or some blinding insight into further ramifications of the problem. If you checked yes beside any of the above, feel free to grasp any one of your sixty-four Crayola crayons firmly in the termination of any suitable extremity and write in. If it's in English, or relatively legible sanskrit, we'll print it. Maybe.

Switching Off

That moment has come again, when we must all grasp our volume controls between our fingers and turn ourselves off, shrinking rapidly down into a single, rapidly fading white dot, and vanish, ultimately, from the screen. One day we shall no doubt weary of this, and shrug off this slug tuned, high Q coil, putting our collective foot through our respective screens . . if we do it in unison, who knows . . . the shock might kill Mork and Mindy once and for all. Listen, the risk is great, but consider the prize if we succeed!

Next month's column will contain many words, some beginning with capital letters, and will undoubtedly deal with something related, however distantly, to video . . . unless, of course, it does not. I think that pretty well covers most of the possibilities. Until then,

Stay Tuned.●

What's On? **Table I**

If you are still trying to talk yourself into filling in the pool and putting up an antenna, you may be interested in the current "TV Guide" for RCA's SATCOM F1 "bird", at present, the most interesting resident of the outer reaches.

Channel Number	Program Source
1	KTVU-Independent Station originating in San Francisco.
2	PTL-Religious programming.
3	WGN-Independent Station originating in Chicago.
4	A Victim of Murphy's Law (Broken & Not in Service).
5	Warner Brothers "Star Channel"-Uninterrupted Movies.
6	WTBS-Independent ("Super") Station originating in Atlanta.
7	ESPN-All Sports Network-(Incessant Howard Cosellniks).
8	CBN-Religious programming.
9	Alternates between Madison Square Gardens transmissions and a new service called C-SPAN.
10	SHOWTIME-A Pay TV Network (West Coast Version).
11	NICKELODEON-A "second service" of Warner Brothers STAR CHANNEL.
12	SHOWTIME (East Cost Version).
13	TRINITY Religious programming.
14	RCA Owned-used for various purposes.
15	Not yet occupied.
16	FANFARE-Another Sports Channel
17	WOR.
18	SIN-Spanish International Network.
19	Not yet occupied
20	HOME BOX OFFICE-At present, a spare channel.
21	SOUTHERN SATELLITE SYSTEMS-Pay TV.
22	HOME BOX OFFICE Uninterrupted movies -(West Coast Version).
23	HOME BOX OFFICE Take 2-(HBO Second service).
24	HOME BOX OFFICE (East Coast Version).

TEACHER'S TOPICS

Have you ever wondered why the word 'Decibels' seems to crop up everywhere in the electronics field? Ian Sinclair explains both the origins and the usage.

LOOK UP THE REFERENCE BOOKS, and they'll tell you that Alexander Graham Bell invented the telephone. He did, true enough, but what he was *trying* to invent was a deaf-aid, and it just happened that the microphone and earpiece he came up with were a lot more suitable for a telephone than for the deaf. The point is that Bell was very interested in ears and hearing, which is how a unit called the bel came about. One tenth of a bel is called a decibel, and it's this unit whose name seems to crop up everywhere in electronics.

Why? Well, it happens that the end result of a lot of electronic gadgets is something you hear or see, and Bell's work on the telephone led to a very important discovery about the way we hear sounds. A telephone microphone converts sound waves into electrical signals. Now electrical signals are waves that we can measure, and even a hundred years ago we could measure the power of electrical signals, so that converting sound waves into electrical signals is a very convenient way of measuring the power of sound waves. Bell carried out some measurements, and made the rather surprising discovery that two sounds of the same pitch, one with twice as much power as the other, did not sound so very different to the ear. Quite certainly, one didn't sound twice as loud as the other.

Ring of Confidence

It's not so surprising when we use modern equipment to make measurements on the sounds around us. The softest sound we can just hear (those of us of the generation before discos, that is); has a power of about one millionth of a millionth (10^{-12}) of a watt on each square metre of surface. The loudest sound our ears can stand (Concorde at three yards, or a disco at 20 feet) sends out something like 10 watts per square metre. Now there's a huge ratio between these two quantities, some ten million millions, a darn sight more than the ratio of sizes of an elephant to a flea, and no instrument can be devised which can handle the full range. How does the ear cope, then? The answer is that the output of signals which the ear sends to the brain isn't proportional to the power of the signals arriving at the ear, but to the logarithm of the sound power.

Remember your logs? The logarithm of ten is 1, the logarithm of 100 is 2, and the log of 1 000 is just 3. For these numbers which are powers of ten (ten multiplied by itself several times), the log is equal to the number of zeros which follow the 1.

The other feature of logs which made them so useful in the days before pocket calculators (that's given my age away!) is that multiplying and dividing numbers can be done simply by adding or subtracting the logs of the numbers. For example, the ratio 1 000/10=100 can be worked out by taking the logarithms 3 (log of 1 000) and 1 (log of 10), and subtracting, to give 2 (log of 100. You wouldn't use logs for such a simple one as that, but it did make more complicated multiplications and divisions a lot easier.

Logs and Watts

To measure how the ear reacts to sound, then, we take the log of a ratio of powers. We need two measurements of powers to form a ratio, though, so that we have to choose some standard to compare all other power measurement to. In electronics we take 1 mW (one milliwatt, which is one thousandth of a watt) as the standard power, though acoustical engineers sometimes use the threshold of hearing, 10^{-12} W/square metre as their starting point. When someone says that a sound is 95 decibels, then, you need to know from which power level this is being measured.

When we measure some quantity of power, we find the ratio of that power to one milliwatt, then find the logarithm of the ratio, and the result is the number of bels. A lot of measurements in electronics are power ratios to start with, such as the ratio of power out of an amplifier to the power in (power gain) and we can change these ratios into bels by taking the log. For example, a power ratio of 50 000 works out at 4.699 bels.

The bel is rather a large unit, so for convenience we use its smaller brother, the decibel. A decibel is one tenth of a bel (is a decimal a tenth of a mal, and what does that make a decision?), so that 4.699 bels are 46.99, 50 as near as maybe, decibels. As it happens, the ratio of power corresponding to one decibel is just about the smallest difference the ear can detect. As a formula, then, the decibel ratio is:

$$\text{db} = 10 \log (\text{power ratio})$$

Now, strictly speaking, decibels should be used just for this job of power ratio measurement, and nothing else, but the idea is so useful that decibel ratios are used even when what we are measuring is *not* a power ratio. One very common use (or misuse) is to compare signal voltages rather than powers, and when this is done, the formula is changed to:

$$\text{db} = 20 \log (\text{voltage ratio})$$

Why 20? Well, the reason is that when we have a voltage V across a resistance R, the power is given by V^2/R, voltage squared divided by resistance. Squaring any quantity can be carried out by multiplying the log of the quantity by two, so that the voltage ratio is converted into 'decibels' and then multiplied by two, giving the 20 in the formula. Strictly speaking, this use of decibels is justified only when the voltages are measured across the same value of resistance, such as when we compare the output of an amplifier at two different frequencies.

DECIBELS TO VOLTAGE GAIN

To use the table, split up the decibel figures into tens and units (100 is ten tens) look up the tens figure in the left-hand column, and the units figure in the top row. The intersection gives the voltage ratio which corresponds to the db figure. For example, 26 decibels is 19.9 times.

Units / Tens	1	2	3	4	5	6	7	8	9	10
0	1.12	1.26	1.41	1.48	1.78	1.99	2.24	2.51	2.81	3.16
1	3.55	3.98	4.47	5.01	5.62	6.31	7.08	7.94	8.91	10.0

2 Numbers in this row are 10 times the numbers in the first row
3 Numbers in this row are 10 times the numbers in the second row
4 Numbers in this row are 100 times the numbers in the first row
5 Numbers in this row are 100 times the numbers in the second row
6 Numbers in this row are 1,000 times the numbers in the first row
7 Numbers in this row are 1,000 times the numbers in the second row
8 Numbers in this row are 10,000 times the numbers in the first row
9 Numbers in this row are 10,000 times the numbers in the second row
10 Numbers in this row are 100,000 times the numbers in the first row

Voltage is so much easier to measure directly, using an oscilloscope, than power that we're stuck with 'voltage' decibels for good now.

Pocket Decibels

If you carry a pocket calculator which has a log key, then working out decibels is easy — you work out the ratio of powers or voltages, press the log key, then multiply by ten for power ratios and twenty for voltage ratios. A few calculators even have a db key, so that a ratio of voltages can be converted directly. If you haven't a calculator, orit hasn't a log key, try the tables shown in Fig. 1, which give voltage/decibel conversions as quickly and accurately as you're likely to need. Remember that a decibel out either way is hardly noticeable●

VOLTAGE GAIN TO DECIBELS

To use the table, convert the gain to a number (less than ten) and power of ten. For example, a gain of 52,000 is 5.2 x 10,000, and a gain of 652 is 6.52 x 100. Look up each part of this number in the table, and add. For example, 5.2 is, from the table, 14.3, and 10,000 is 80db. Adding these gives 94.3 db. One place of decimals of voltage gain is enough, because the difference in decibels is very small.

Gain	0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1	0	.82	1.48	2.28	2.92	3.52	4.08	4.60	5.12	5.56db
2	6.02	6.44	6.84	7.22	7.60	7.96	8.30	8.42	8.94	9.24db
3	9.54	9.82	10.1	10.4	10.6	10.9	11.1	11.4	11.6	11.8db
4	12.0	12.2	12.5	12.7	12.9	13.1	13.2	13.4	13.6	13.8db
5	13.9	14.0	14.3	14.5	14.6	14.8	14.9	15.1	15.3	15.4db
6	15.6	15.7	15.8	15.9	16.1	16.3	16.4	16.5	16.6	16.8db
7	16.9	17.0	17.1	17.3	17.4	17.5	17.6	17.7	17.8	17.9db
8	18.1	18.2	18.3	18.4	18.5	18.6	18.7	18.8	18.9	19.0db
9	19.1	19.2	19.3	19.4	19.5	19.5	19.6	19.7	19.8	19.9db

Powers of ten:

10	20 db	10,000	80 db
100	40 db	100,000	100 db
1,000	60 db	1000,000	120 db

PROJECT

METRONOME

For any up and coming musician a sense of timing is of great importance (something not easily acquired by most of us). The ETI Metronome will at least keep you in strict tempo and save the physical efforts of tapping your feet to keep in time.

THE TEMPO RANGE of the instrument is variable over the 10:1 range of approximately 300 to 30 beats per minute via RV1, and thus fully spans the musical tempo range of Largo (40 beats per minute) to Presto (208 beats per minute). The tempo range can be adjusted, if required, by changing the value of C1. Increasing the C1 value lowers the whole range, and decreasing C1 raises the range.

Music To Your Ears

RV1 can be calibrated in terms of conventional musical tempo names by using a watch with a second hand to compare the number of metronome beats per minute against the information in the following table:

Tempo Name	Tempo Span Beats/Min	Mid range Tempo Beats/Min
Largo	40-60	**50**
Larghetto	60-66	**63**
Adagio	66-76	**71**
Andante	76-108	**92**
Moderato	108-120	**114**
Allegro	120-168	**144**
Presto	168-208	**188**

The instrument can be used as either a normal metronome, or as an accentuated beat metronome. Our design allows for four basic rhythmic patterns in the time signatures of 2-4, 3-4, 4-4, and 6-8.

The tone of the non-accentuated beats is variable via RV4, that of the accentuated beat via RV3, and the beat length via RV2.

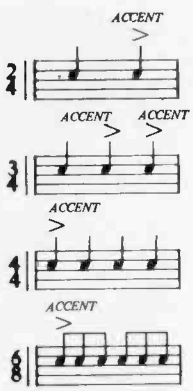


Fig. 1. The accented beat of the bar.

Construction

Construction of the metronome should not pose any special problems providing the overlay is followed carefully and correct orientation of all electrolytic capacitors and diodes is observed.

The type of switch used is a matter of personal choice; either a bank of interlocking push button switches, as used on our prototype, or a rotary switch may be employed, this being the cheaper.

The switch assembly is mounted directly onto the front panel with stand off pillars to give the correct recessed depth, all interwiring to each switch is taken via a six-way socket.

After checking that all is well the setting up procedure may now be carried out.

Calibration

Setting up the metronome is quite straightforward. Rotate RV2 (located on the rear panel) fully anti-clockwise, then select the normal mode of operation. Switch on the

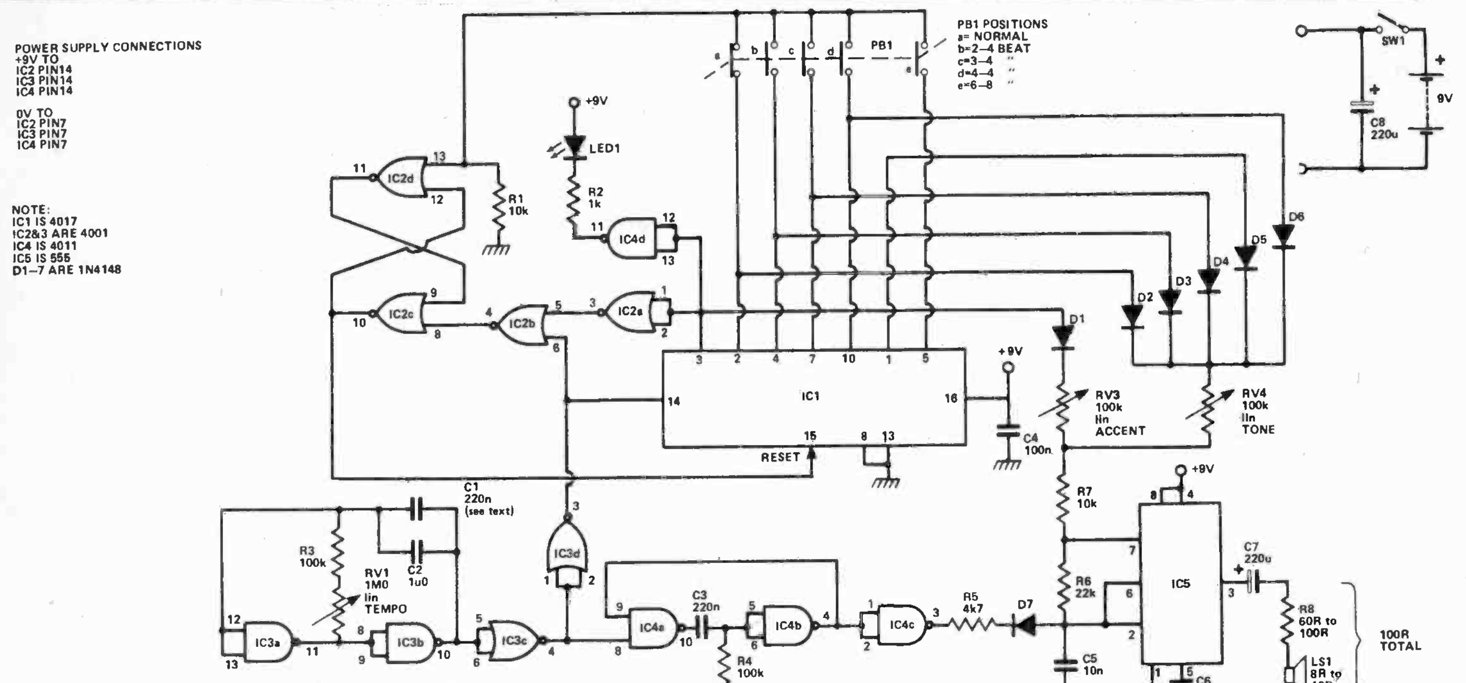


Fig.2. Circuit diagram of the metronome.

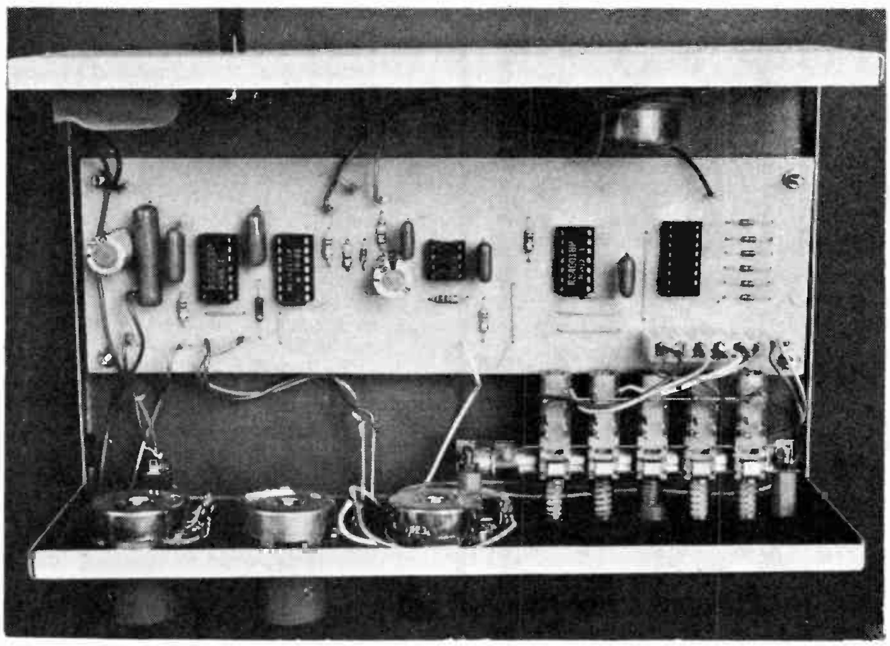
PARTS LIST

RESISTORS	
R1, R7	10k
R2	1k
R3, R4	100k
R5	4k7
R6	22k
POTS	
RV1	1MO Lin
RV2	1MO preset (knob operation)
RV3, RV4	100k Lin
CAPACITORS	
C1, C3	220n polyester
C2	1uo polyester
C4, C6	100n polyester
C5	10n polyester
C7, C8	220u elect
SEMICONDUCTORS	
IC1	4017
IC2, IC3	4001
IC4	4011
IC5	NE555
LED 1, 0.2in dia	D1-D7, 1N 4148

MISCELLANEOUS

PB1—5 poslt change over push button, (interlocking action). Rotary switch may

40R Loudspeaker 2½in dia.
SPST miniature toggle.



Internal view of metronome showing PCB layout and connections of the front panel.

unit — the down beat LED should be permanently on and a steady tone heard from the loudspeaker.

For the accentuated beat to fall on the correct note of each bar, an approximate setting for the accent and tone controls should be adjusted as follows:
(set tempo according to time signature used)

Beat	Accent	Tone
2/4	Fully clockwise	Fully anti-clockwise
3/4	Fully anti-clockwise	Fully clockwise
4/4	Fully clockwise	Fully anti-clockwise
6/8	Midway	Fully anti-clockwise

That just about completes the construction and calibration for the unit.

Hopefully our metronome will serve it's purpose as you acquire your sense of rhythm, even to the more complex arrangements that will follow.●

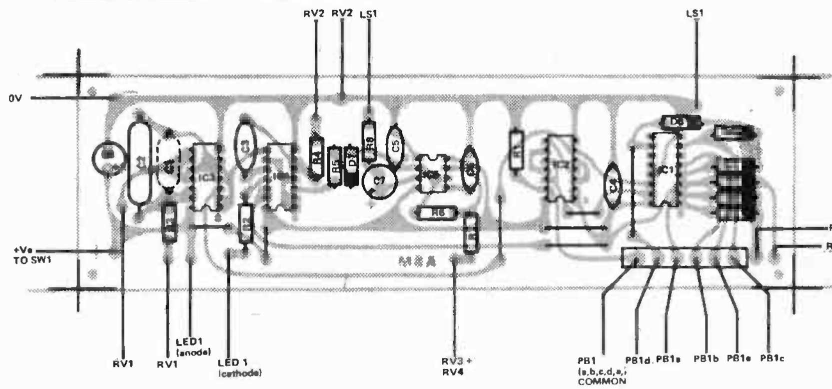
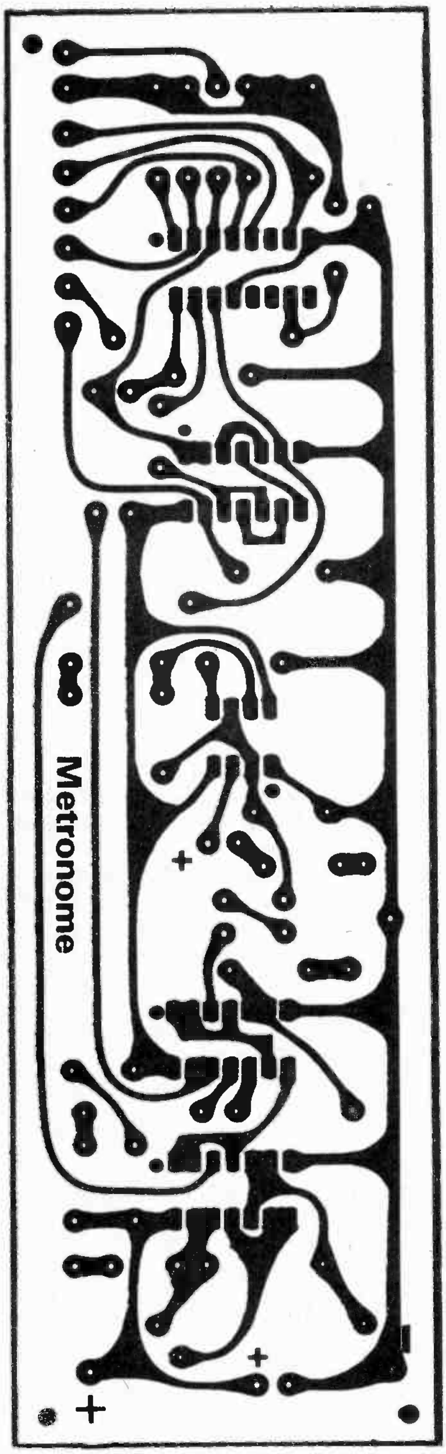


Fig.3. Component overlay.



The full size PCB layout

HOW IT WORKS

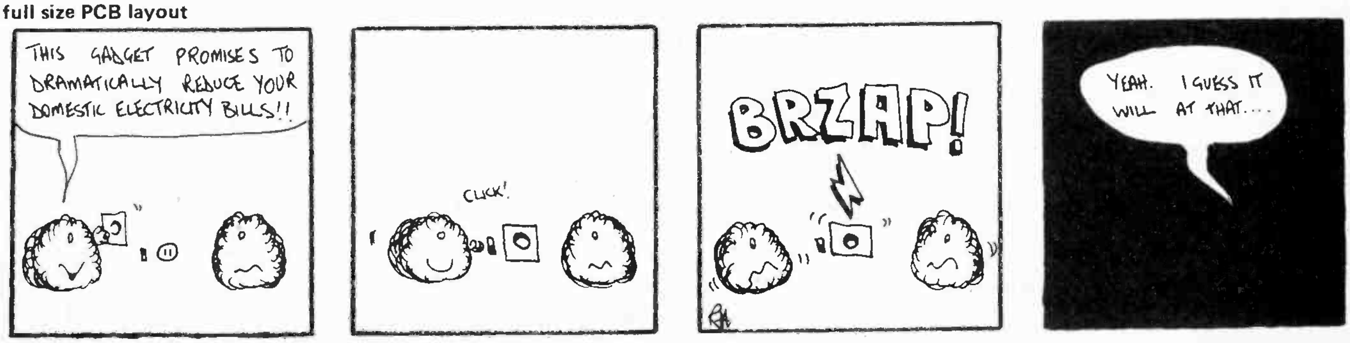
IC3a and IC3b form the Tempo generator, and are wired as a free-running astable multivibrator with it's operating frequency variable over the approximate range 30 to 3000 cycles per minute via RV1: the range of the generator can be adjusted to cover this precise range, if required, by adjusting the value of C1.

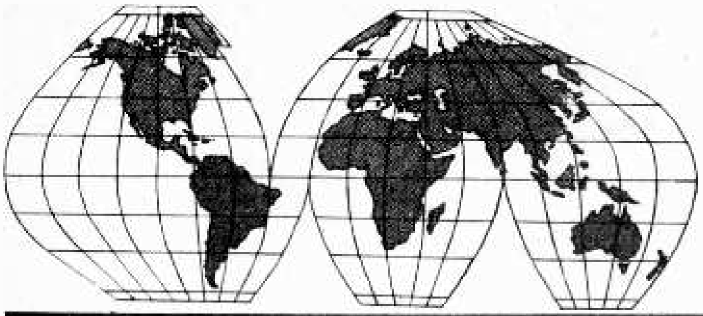
The output of the Tempo generator is used to clock counter IC1 via buffer gates IC3c and IC3d, and simultaneously to trigger a monostable multivibrator or pulse generator that is formed from IC4a and IC4b. The output of this monostable is used to gate on the circuit's tone generator, which is built around IC5, via inverting buffer stage IC4c and via R5 and D7.

The frequency of the IC5 tone generator is controlled by either RV3 or RV4, which are selected via gate diodes D1 to D6 from the output of the IC1 counter. When the unit is used as a normal metronome the tone is controlled by RV3 only, and the circuit generates a brief 'tick' or 'tock' tone (depending on the setting of RV3) each time the tempo generator completes an operating cycle. The duration of this tone is variable via RV2.

IC1 is a 4017 decade counter with ten decoded outputs. Output '0' is used to control the ACCENT of the IC5 tone generator via D1 and RV3, and also to activate beat-indicating LED via IC4d, and outputs '1' to '5' are used to control the TONE via D2-D6 and RV4. Outputs '1', '2', '3', '4', or '6', are used to control the counting model of IC1 via SW1 and a logic network designed around IC2. This network causes the counter to reset after each clock cycle which the unit is used in the normal metronome mode, or after each alternate cycle in the 2-4 beat mode, or after every third cycle in the 3-4 mode, or after every fourth cycle in the 4-4 mode, or after every sixth cycle in the 6-8 mode.

Readers should note that, when the instrument is used in the accentuated beat mode, the apparent or illusory position of the accented note can be shifted to the start or end of a beat sequence by merely altering the relationships of the Tone and Accent frequencies. The sound 'dee-dah-dah' (accent at the start of the beat) is clinically identical with 'dah-dah-dee' :accent at the end of the bat) in a continuously repeating time sequence, although the change of accent position is not necessarily noticeable to the human ear: when frequencies are transposed, however, the latter sound becomes 'dee-dee-dah', and the accent clearly appears to be at the end of the beat.





SHORTWAVE WORLD

John Garner, our Short Wave Editor, takes a look at some receivers.

FOR MANY YEARS Radio Shack stores sold the very popular DX-150 Communications Receiver, followed by the modified versions — the DX-150A, DX-150B and the DX-160. Since these sets were selling for under $200. they were about the only ones affordable for beginner listeners until about five years ago when the Barlow-Wadley loop was invented and used in a number of receivers at a reasonable price. Except for the difficulty of tuning the slide-rule type scale of the DX150 and 160, the sets operated very well. Most of us who at one time owned a DX-150 for a while graduated to a receiver with better tuning controls, such as the Yaesu FRG-7. Sales of the DX-160 soon began to decline and recently Radio Shack took it off the market. However you may still be able to find one in some Radio Shack stores.

The DX200

In April the replacement for the DX-160 appeared in the local Radio Shack store selling for $299. Thanks to the store owners we were able to borrow a new DX-200 for a weekend to do some comparative listening.

The general appearance of the DX-200 is quite attractive. The cabinet is similar to the DX-300 except instead of the digital readout there are two large tuning drums — one for the main tuning and one for the bandspread — reminiscent of the Kenwood R-300.

Main features of the DX-200, as outlined in the Radio Shack Owner's Manual shown in Table I.

Front panel controls on the DX-200 are well placed and these include: BFO Pitch, S-Meter, Antenna Trimmer, AGC Switch, Band Selector (0.15-0.4, 0.52-1.6, 1.6-4.5, 4.5-13, 13-30), Band Spread Tuning Dial, Main tuning Dial, Headphone jack, Calibrator switch, Mode Selector, Volume/Off control, and RF Gain Control.

On the rear panel we have an external speaker jack, the power cord, Ground Screw terminal, Antenna Screw terminal and the Mute screw terminal.

After an afternoon of listening to the DX-200 I have the following observations on its operation. Tuning the receiver is, at best, very awkward. Tuning is accomplished by setting the main tuning dial, calibrating with the 500 kHz marker, setting the main dial on a red indicator mark and then setting the band spread. You should then be able to read the correct frequency. However in practice this is not quite so. After finding Radio Moscow on 12010 kHz on the other sets we had operating — Yaesu FRG-7 and FRG-7000, Panasonic RF-2800 and a Radio Shack DX302 — in a matter of seconds, I then proceeded to try this same frequency on the DX-200. I finally found it after a number of minutes of searching and the dial read 11880. This is just not good enough for any serious shortwave listener. The audio quality was very good. Selectivity and Sensitivity of the set were quite acceptable.

I believe that for a receiver selling for $300. the tuning method should be more accurate and simplified. Since this set would be for the newcomer to the shortwave listening hobby I think he would deserve something better.

In conclusion I must say I cannot recommend this receiver for any serious listening.

Radio Shack's DX 302

In the early 1970s Radio Shack introduced the SX-190, a direct frequency readout receiver that was very popular for a while. The set required a number of crystals and also suffered a few problems. When Yaesu introduced the direct readout FRG-7 the market for the SX-190 virtually disappeared and Radio Shack began to look for a replacement for it. This resulted in the DX-300 which came on the market in 1979, after very much advance publicity which sounded very good. We were all waiting anxiously for the first appearance of the DX-300. Unfortunately the first sets to appear on the market suffered many problems and changes were hurriedly made by Radio Shack. Those who bought the original sets were returning them to stores for refunds or modifications to make them operable. Finally by the end of 1979, Radio Shack stopped producing the DX-300.

Table I, DX200

Features

FREQUENCY COVERAGE - 150 to 400 kilohertz and 520 kilohertz to 30 Megahertz.
Large, easy to read frequency display dials for both main tuning and band spread.
-Fast and slow AGC selector.
-Variable BFO Pitch for reception of CW and SSB signals.
-Antenna trimmer matches your antenna to the frequency band you're listening to.
-Five element ceramic filter for outstanding selectivity (freedom from adjacent channel interference).
-Dual MOS FETs in the critical RF and mixing stages eliminate cross modulation and RF distortion.
-All solid state circuitry provides maximum efficiency with minimum noise.
-Integrated circuit audio amplifier for high intelligibility.
-500 kilohertz marker for calibration of main tuning and band spread.
-Standby switch and rear panel MUTE contact for use in HAM installations.
-External speaker jack.
-Band Spread dial electronically expands frequency on 10 shortwave bands, 15 HAM bands and the CB band.

Specifications

Semiconductor Complement -	4 IC's, 13 transistors, 16 diodes and 6 LEDs.	
Receiving System -	Single Conversion.	
Frequency coverage -	0.15 - 0.40 MHz (150 - 400 kHz)	
	0.52 - 1.6 MHz (520 - 1600 kHz)	
	1.6 - 4.5 MHz	
	4.5 - 13 MHz	
	13 - 30 MHz	
Reception Mode -	AM, SSB, CW	
Antenna Impedance -	Lo-Z for 50 ohms antenna and Hi-Z for long wire antenna.	
Sensitivity (AM) -	250 kHz	1 uV
	1 MHz	1 uV
	2.5 MHz	1 uV
	7 MHz	1 uV
	21 MHz	1 uV
Image Ratio -	250 kHz	55 dB
	1 MHz	40 dB
	2.5 MHz	40 dB
	7 MHz	30 dB
	21 MHz	15 dB
Selectivity -	-6 dB	4 kHz
	-40 dB	6 kHz
I.F. -	455 kHz	
Signal-to-Noise Ratio -	45 dB at 7 MHz, 1 mV	
AGC (at 7 MHz) -	10 dB change in output for 80 dB change in input.	
RF Gain Control Range -	80 dB at 7 MHz	
BFO Pitch Range -	± 3 kHz.	
Fidelity Response (AM) -	300 Hz	-4 dB
	2 kHz	-8 dB
	(1 kHz = 0dB 50 mW)	
Audio output -	1.5 watts, 10% THD	
THD - (at 7 MHz, 1 mV)	3 % at 30% modulation	
	5% at 80% modulation	
Hum & Noise -	Speaker output at minimum volumn — 3 mV	
	Headphone output at minimum volume — 0.3 mV	
Calibrator accuracy -	500 kHz - 20 ppm	
Power Requirement -	AC 120 V, 60 Hz	
Dimensions -	145 mm high, 360 mm wide, 220 mm deep	
Weight -	4.1 kilograms	
Price -	$299.95 Canadian.	

In April our local Radio Shack store received their first DX-302, the replacement model for the DX-300 and we were given this set for an afternoon of tuning in the bands.

The overall appearance of the DX-302 is identical to the DX-300 with a couple of slight changes in wording of controls. Performance has been improved considerably. Selectivity is much better and the problem with the Megahertz tuning knob whereby a station could be heard one thousand kilohertz above its proper location seems to have been eliminated in the shortwave range. I did notice this problem still exists on the medium wave band, that is our three local AM stations on 580, 800 and 1230 also appeared on 1580, 1800 and 2230 kilohertz (exactly 1 MHz higher).

The BFO pitch control was able to bring in good crisp SSB and CW signals. Stability of the digital display is very good. I only noticed a drift of 1 kilohertz on a very few occasions during our listening experiment. Audio quality is also quite good.

The Owner's Manual for this set as well as for the DX-200 include several pages of information for the newcomer including some shortwave stations' frequencies (although much of this information is outdated). The manual points out the main features of the DX-302, shown in Table 2

The DX 302 from Radio Shack. John Garner rates this one very highly.

Table II, DX-302

Features

- Quartz-controlled frequency synthesizer.
- Continuous frequency coverage from 10 kilohertz to 30 Megahertz.
- Large digital frequency display.
- Triple conversion circuitry.
- 6 element and 9 element ceramic filters provide outstanding selectivity (freedom from adjacent channel interference).
- Dual MOS FET in the critical mixer stage (freedom from cross-modulation and undesired RF distortion).
- All silicon solid state circuitry for maximum circuit efficiency with minimum noise.
- Audio power IC provides high intelligibility sound.
- AC or DC negative ground operation. If the AC power should fail an automatic circuit switches over to the battery power with no interruption of sound.

Specifications

Semi-conductor Complement - 1 LSI C-MOS Frequency Counter IC, 3 Integrated Circuits, 39 transistors, 32 diodes, 5 7-segment LED displays, 6 LEDs and 1 thermistor.

Receiving System -		Quartz controlled synthesizer, triple conversion.	
Frequency coverage -		10 kHz to 30 MHz continuous.	
Preselector bands -		0.01 - 0.15 MHz (10 - 150 kHz)	
		0.15 - 0.5 MHz (150 - 500 kHz)	
		0.5 - 1.6 MHz (500 - 1600 kHz)	
		1.6 - 4.5 MHz	
		4.5 - 12 MHz	
		12 - 30 MHz	
Frequency Display -		Digital read-out in five 7 segment LEDs, 3/8" high.	
Sensitivity - (for 10 dB Signal-to-Noise Ratio)	AM	50 kHz	30 uV
		300 kHz	2 uV
		900 kHz	1 uV
		3.1 MHz	0.5 uV
		7.1 MHz	0.5 uV
		15.1 MHz	0.5 uV
		28.1 MHz	0.5 uV
	SSB	50 kHz	15 uV
		300 kHz	1 uV
		900 kHz	0.5 uV
		3.1 MHz	0.3 uV
		7.1 MHz	0.3 uV
		15.1 MHz	0.3 uV
		28.1 MHz	0.3 uV
Image Ratio -		100 kHz	70 dB
		300 kHz	70 dB
		900 kHz	70 dB
		3.1 MHz	60 dB
		7.1 MHz	60 dB
		15.1 MHz	60 dB
		28.1 MHz	60 dB
Selectivity -		-6 dB	-60 dB
	Wide	3.5 kHz	6.0 kHz
	Narrow	2.5 kHz	4.0 kHz
Reception Modes -		AM, USB, LSB, CW	
IF -	1st	55.5 - 54.5 MHz	
	2nd	3 - 2 MHz	
	3rd	455 kHz	
Beat Frequency -		455 kHz ± 1.5 kHz	
BFO Pitch -		± 1 kHz	
Frequency Stability -		Within 1 kHz per hour after 60 minutes warm-up. Within 2 kHz during 10 minutes after initial turn on.	
Audio Output -		(8 ohms) 1.5 watts maximum.	
Antenna Impedance -		50 ohms for coax connector. Hi-Z for long wire.	
Power Requirements -		AC: 120 volts, 60 Hz (220/240 volts, 50 Hz for European/Australian models), 15 watts. DC: 8 'C' cells or external 12 volts negative ground only, 8 watts max.	
Oimensions -		146 mm high, 362 mm wide, 252 mm deep.	
Weight -		6 kilograms.	
Price -		$499.95 Canadian.	

Front panel controls consist of signal strength and battery meter, preselector tune and dial, preselector band switch, attenuator switch (used to attenuate strong local signals), a light switch (when using batteries this will save on batteries — it is also used to check battery condition), Selectivity switch for narrow or wide, BFO Pitch for best reception of SSB and CW, Digital Frequency Readout, Speaker, a jack for headphones, Mode switch, Volume/Off control, RF Gain control to adjust sensitivity of the receiver, and the main tuning — the outer knob for the desired MHz range and the inner knob for precise kHz tuning.

On the rear panel are two cord wrapping posts for portable or battery operation, battery compartment, the external speaker jack, key jack, tape output jack, coax antenna connector, antenna screw terminal, ground screw terminal and a mute screw terminal. The power cord comes out of the back and is equipped with a three prong plug. A 12 volt jack and fuse are also on the rear panel.

Two antennas are included with the DX-302 — one is a back-of-the-set telecopic antenna which is handy for portable use — the other is a 10 meter long wire which can be used as a temporary antenna away from your normal listening post.

After an afternoon of listening to the DX-302 I can say that this receiver is a great improvement over the DX-300 and for $500. it is well worth the money. It's nice to see Radio Shack taking the trouble to design this new receiver to replace the problem-riddled DX-300.

Thanks to Radio Shack for the use of the DX-200 and DX-302 and thanks also to Roy Stokes, Nandor Petrov, Marc and Bill Butuk for joining with me in this comparative listening test.

Kenwood R-1000

This is another receiver that has come on the market since the October Shortwave Receiver Survey. I haven't had a chance to listen to an R-1000 yet but from all indications, after a few minor growing pains were corrected by Kenwood, this appears to be another good receiver at a reasonable price.

Grant Manning of Radio West had this to say about the R-1000 . . .

"Introducing a great new all-brand communications receiver from a proven leader in amateur radio manufacturing! The R-1000 tunes from 200 kHz to 30 MHz continuous, with both analog and digital frequency readout. An easily programmed digital clock is built-in and will turn your receiver and recorder on and off by simply "punching in" the times you desire. The blue-green digital readout frequency display doubles as the clock display by the use of a front panel switch.

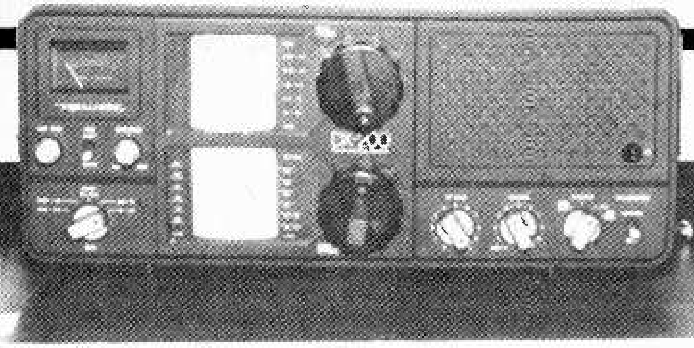
"This set has one of the best "front ends" seen here in recent years, immune to cross-modulation and overloading. Additionally, it has very clean audio!"

The R-1000 specifications are shown in Table 3.

Radio West, 3417 Purer Road, Escondido, CA 92025, USA offer a modified R-1000 with improved Selectivity for $445. US. This of course, does not include the exchange rate on the Canadian dollar and any import duties.

A 20 page catalog is available from Radio West at the above address. This catalog lists a number of receivers, both stock and modified by Radio West, and accessories for the shortwave listener. When writing them, mention ETI.

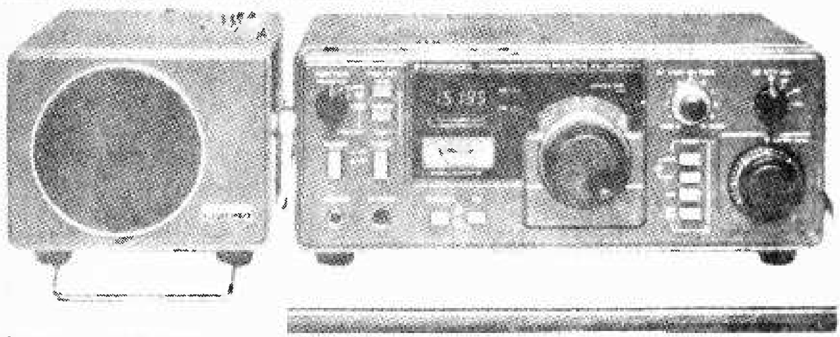
Next month I will return with some more tropical band information. Until then, 73 and good listening.●



The Radio Shack DX 200.

Table III, R1000

Frequency Range	200 kHz to 30 MHz.
Modes of Operation -	AM, SSB, CW
Stability -	within 300 Hz during any 30 minute period after warm-up
Selectivity -	AM Wide 12 kHz @ -6 dB, 25 kHz @ -50 dB; AM Narrow 6 kHz @ -6 dB, 18 kHz @ -50 dB, SSB/CW 2.7 kHz @ -6 dB, 5 kHz @ -50 dB
Sensitivity -	200 kHz to 2 MHz - SSB 5 uV, AM 50 uV; 2 MHz to 30 MHz - SSB 0.5 uV, AM 5 uV (S + N / N 10 dB or more)
Output Impedance	4 to 16 ohms, external speaker or headphone
Power Requirements -	100/120/220/240/ V AC, 50/60 Hz at 1.5 Watts.
Dimensions -	300 mm wide, 115 mm high, 218 mm deep
Weight -	5.5 kilograms
Price -	Approximately $650. Canadian



The Kenwood R-1000, shown here with the optional SP-1000 speaker.

Continued from page 40

AudioToday Letters

Case Of The Missing Speaker, And Other Tales

I have two 65 Watt speakers but I have only got a Simpson Sears 12 Watt amplifier. The problem is that the cheap amplifier cannot bring out the sound. I am interested in getting information on ILP modules to finish my stereo system. I do not know the proper size amplifier for two 65 Watt speakers or the pre-amp or whatever else is needed. Information on the equipment would be appreciated.

I also have a Peavy amplifier, 200 Watts RMS. The speaker is gone. It's a Session 400. The amplifier output requirement is for 4 ohms, and has output for two speakers. Hope you would have information on maybe, SRO Altec speakers with the required wattage.

This amplifier has high range and a good speaker is required.

I don't know Oaktron speakers but that 300 Watt speaker interests me.

B.H., Liverpool, N.S.

The question is, where did the speaker go? Does it have any friends it might have confided in? Did it run off to Vancouver? Or even Toronto! Quick, chief, signal the Dynamic Duo. Speakerman has struck again.

I've never heard of Session speakers. If you mean a Celestion Ditton 400, I've no references to that model. If that's it, contact Rocelco Inc., at 1669 Flint Road, Downsview Ont., M3J 2H7.

For information on ALTEC, contact Altec Lansing of Canada, Ltd., 151 Carlingview Drive, Rexdale, Ontario M9W 5E7.

I can't lay my hands on the relevant literature at the moment, but, unless I'm mistaken, the SRO Line is a professional line by Shure. If that's what you want, contact A.C. Simmonds & Sons, 975 Dillingham Road, Pickering, Ontario L1W 3B2.

Oaktron is available from Omnitronix Ltd., 2056 Trans Canada Highway, Dorval, Quebec H9P 2N4.

ILP Modules are distributed by Audiex Electronics, 1736 Avenue Road, Suite B, Toronto, Ontario M5M 2N4.

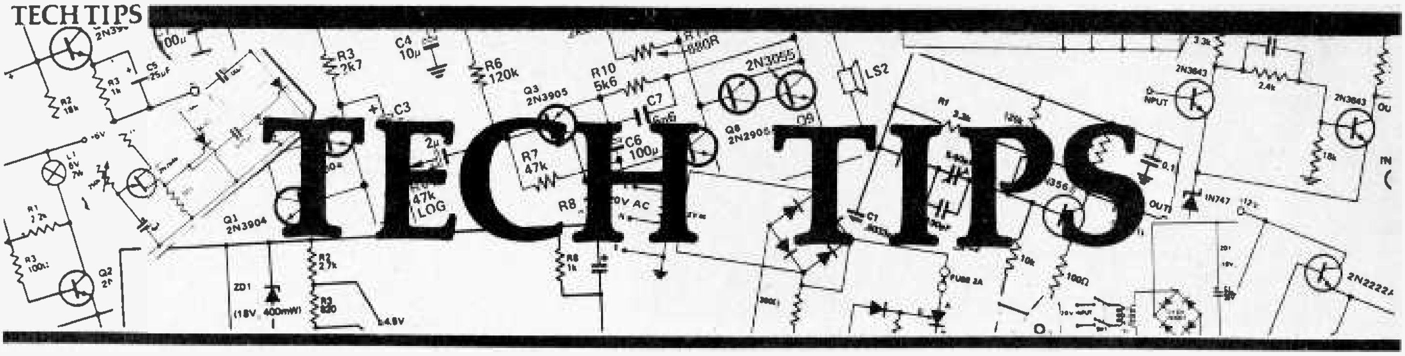
Several of the above are also on bingo cards in some issues of ETI, but if you want specifics on particular products it might be best to write.

I really wish manufacturers would stop describing their speakers in terms of wattage rating. It's a meaningless term by itself and says absolutely nothing about the product, although perhaps a great deal about the manufacturer or the pointy-headed types in the advertising agency.

Generally speaking, you don't *need* 65 Watts for a so-called 65 Watt speaker, but this might be the maximum continuous power it can handle, or it might be a recommended amplifier, or anything. If you want to use them commercially, I wouldn't use more than 65 to 100 Watts, but for home use, assuming normal levels, rather than trying to run a radio station without a transmitter, even 200 Watts might be quite safe. More important in determining what you *need* is the *sensitivity* of the speaker. Generally speaking, I prefer some degree of overpower, to reduce the chances of tweeter burnout (tell you why in a later column) and, for records, an infrasonic filter to protect against overload due to record warp. This is especially important with vented speakers.

I've never heard of a Peavy, but if it's a 200 Watts mono, or 200 Watts per channel stereo, the 4 ohm figure is probably a minimum load. That might also be the impedance at which its power is rated. You can go to a higher impedance such as 8 ohms, or even two in parallel, as long as the total is not less than 4 ohms, but the higher impedance will give lower maximum power. It should not affect the sound level, if we disregard speaker sensitivity. Of course, if it's 100 Watts total (both channels) 4 ohms, that means 100 Watts per channel, and maybe 50 Watts per channel into 8 ohms. If that figure is with both channels driven, fine, but if not, you may have to derate to 35 Watts per channel. This assumes we mean RMS. If peak power is used for rating, make that closer to 20 Watts.

Numbers can be fun.●



Simple Cassette Interface

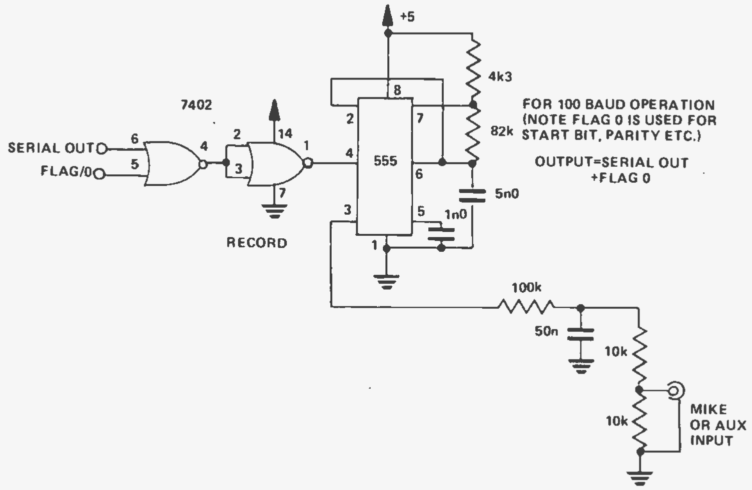
Elmer Bulman

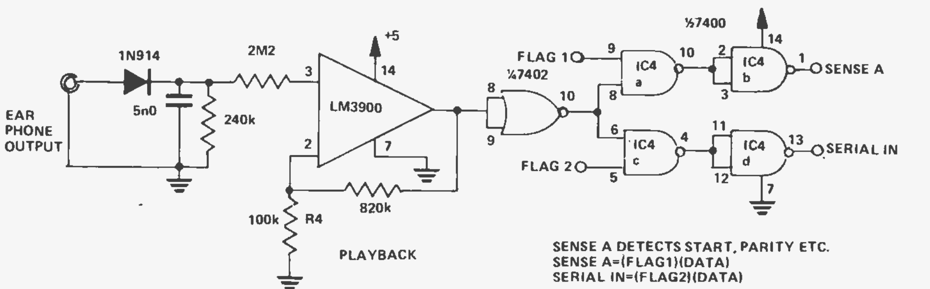
When your programs develop to the length that it becomes a chore to re-enter on a key board, these circuits will tide you over until you can afford something more elaborate in software storage.

The record circuit provides a burst for a one and silence for a zero. The input gating provides software control, the 555 provides the burst and the output circuit shapes the square wave to a triangle wave at a level suitable for the recorder input.

The playback circuit consists of rectification and precise filtering for the input to the Schmitt Trigger. The output of the 3900 is then gated for software control.

The burst frequency (555) will depend on the quality of the recorder available to the user. The higher the frequency you can retrieve the better. To determine a suitable baud rate simply allow a minimum of ten cycles in the burst. Needless to say your start bits must be high and the remainder is software.



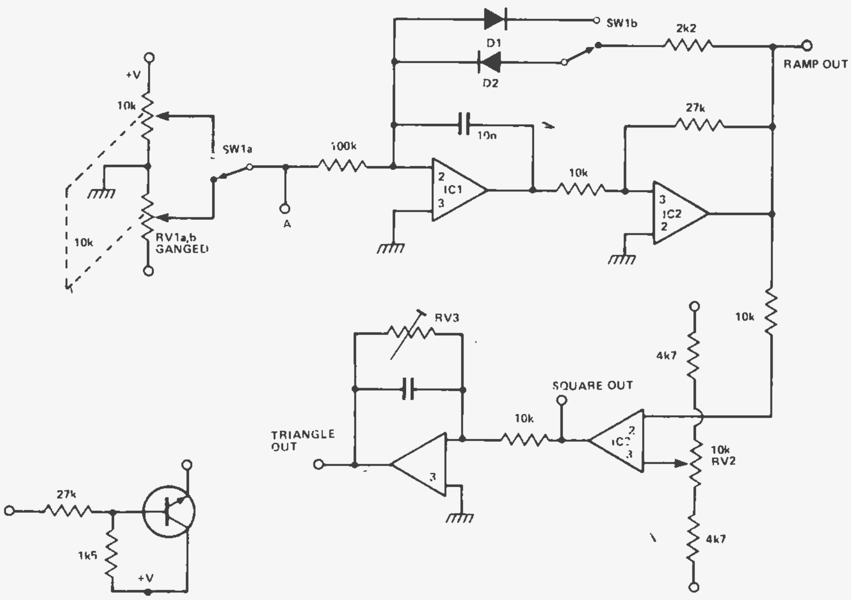


Function Generator

J. S. Paterson

IC1 is an integrator which, along with IC2, etc, forms a voltage controlled ramp oscillator, the frequency of which is set by RV1. S1 and diodes D1, 2 control the direction of the ramp. The output of IC2 is taken to IC3, which is a comparator providing a square output at pin 6. RV2 provides control of symmetry. Lastly, this square wave is fed to an integrator, which gives a triangular waveform. If the control voltage is applied via the circuit in Fig. 2 the frequency will vary logarithmically with voltage — useful for synthesizers.

With RV1 slider grounded, a ramp can be fed into the circuit at point A, so the oscillator will sweep through its range — useful for testing filters, etc.



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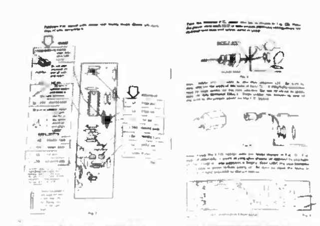
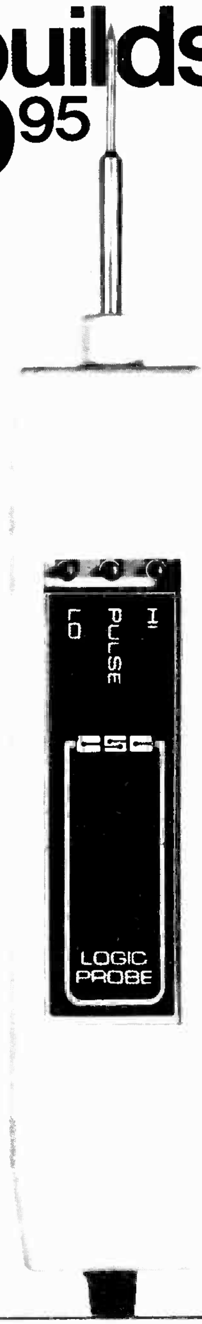


Complete, easy-to-follow instructions help make this a one-night project.



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GSR Meter

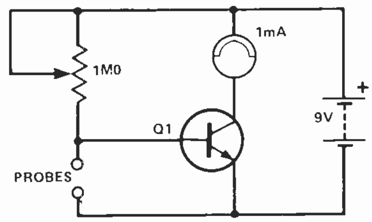
D.Chivers

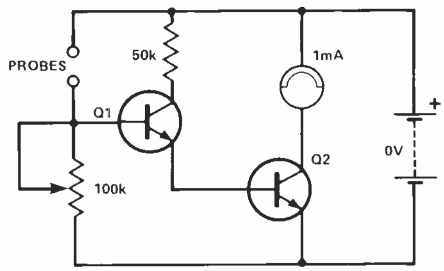
The galvanic skin response meter is probably the easiest both to construct and to use. Fig.1 uses a single 2N3704 - incidentally, the meter used was simply the 1mA range of a multimeter. While the circuit shown had the required sensitivity, it was not selective enough and under all sorts of stresses and strains the needle refused to budge from a set position. The darlington pair configuration of Fig.2 greatly increases sensitivity and the 100k pot will bring the reading down to a usable level — without this, the current passing through the meter would be about 30mA. This modified circuit proved to be amply selective.

For use as probes, silver foil taped onto the tips of the first and second fingers proved to work well, though for more permanent use steel gauze is recommended. Naturally the hand must be kept as steady as possible during experiments.

First experiments proved highly successful; the meter needle drifted at first and frequent use of the sensitivity control was required, but after a few minutes the needle stabilised.

Since the needle responds to stress within the body or mind, it is easy to make it move; talking, thinking hard or biting a finger all cause the needle to move up, making it go back down by





NOTE:
Q1-2: 2N3704 OR SIMILAR

removing the factor causing the stress. Moving the needle below its mean value was far more difficult especially while watching the meter and actually trying to relax — in fact to start with this actually caused tension. The easiest way to do this is to simply close the eyes and relax, while an observer takes note of the results. On opening the eyes the reading would jump up to what it had been before relaxation commenced.

This circuit will of course function as a lie detector but since stress is caused by any question the results are not too reliable and certainly of no significance.

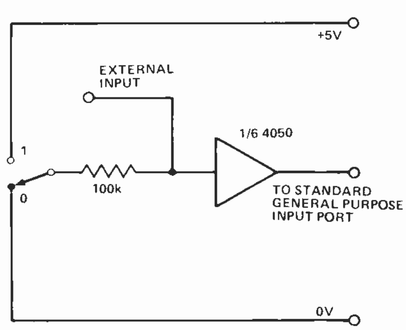
An unexpected use for the circuit of Fig.1 is that of a transistor tester. If a fixed value resistor of about 2M2 is used in place of the pot the gain of the transistor may quickly be tested; FSD= approx. hfe 250. For NPN transistors, polarity of the meter and battery must be reversed.

Tech-Tips is an ideas forum and is not aimed at the beginner; we regret that we cannot answer queries on these items. We do not build up these circuits prior to publication.

ETI is happy to consider circuits or ideas submitted by readers; all items used will be paid for. Drawings should be as clear as possible and the text should be preferrably typed. Anything submitted should not be subject to copyright. Items for consideration should be sent to the Editor.

External Input For Micros

P. F. Tilsley



This simple circuit provides a micro with an 8 bit switch/external signal input port. The state of the switches controls the byte read by the micro, but any totem pole TTL signal applied to the external input socket over-rides the signal from the corresponding switch. The value of the resistor is not as critical. The circuit is shown for only one bit.

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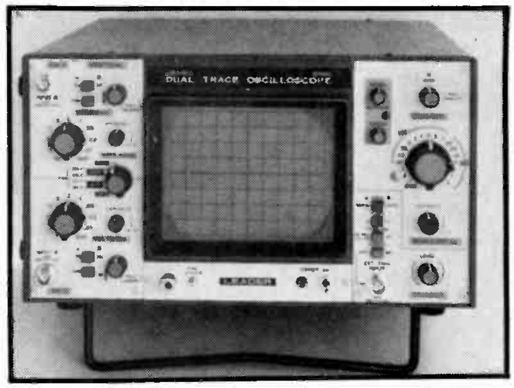
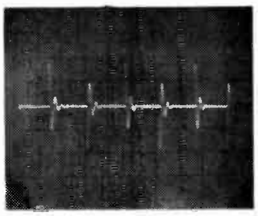


When a magazine like ETI and a company like Omnitronix get together, you never know what might happen!

To celebrate their tenth anniversary Omnitronix is putting a Leader 'scope up for grabs. Flushed with the excitement of our last two contests, we at ETI couldn't pass up the chance to throw another.

This scope is no lightweight either. The LBO 514 is a 10 MHz, dual trace oscilloscope. Minimum vertical sensitivity is 1 mV/DIV. Maximum sweep speed is .5 us/DIV and the instrument is capable of all modes of triggering, including chopped and alternate modes. The LBO 514 retails for $895.00, some lucky ETI reader will get one free!

Now to the contest. In order to ensure that the most deserving person wins, we have put together an exercise in waveform analysis. The scope traces shown below at left are the result of 1 kHz square wave being put through one of the simple circuits at right. That's all! Additionally, you might want to know that the square wave had an amplitude of 10 Vpp and came from a 600 R source. Those values however are not really necessary. When you've got the right picture with the right schematic, fill in the form and send it in to us.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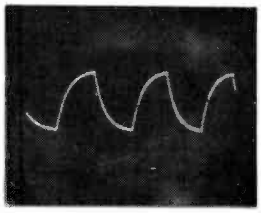
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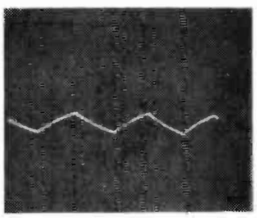
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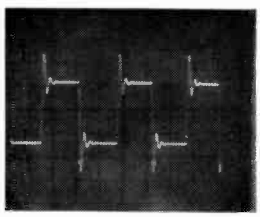
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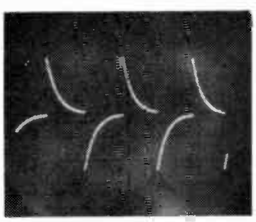
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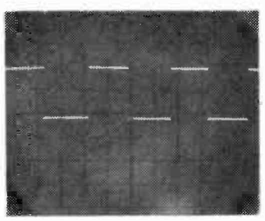
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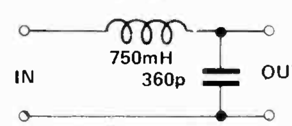

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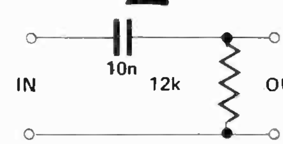

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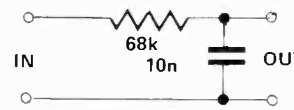

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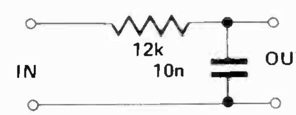

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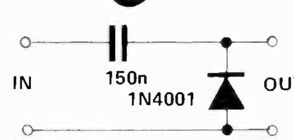

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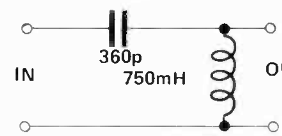

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When you have determined your answers, enter them, along with your name, address and phone number in the appropriate spaces on this form. Mail the entry form to:

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The first three correct (or closest) answers drawn, win.

Readers not wishing to cut up their magazines may submit their entry on a photostat or hand drawn copy of this form, but only one entry per person. Multiple entries will be disqualified.

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All entries become the property of Omnitronix Limited.

Contest closes August 15th, 1980.

Editor's decision is final.

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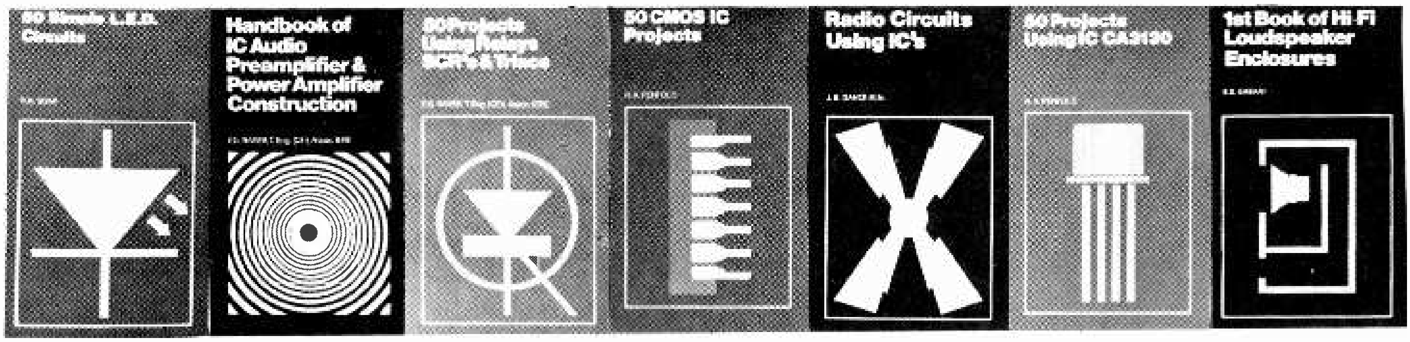

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■ Every so often a device appears that is so useful than one wonders how life went on before without it. The 555 timer is such a device.
■ It was first manufactured by Signetics, but is now manufactured by almost every semiconductor manufacturer and is inexpensive and very easily obtainable.
■ 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.
■ An invaluable addition to the library of all those interested in Electronics

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52 Projects Using IC741 — BP24

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■ This unique book, originally published in Germany, shows fifty-two different projects that can be simply constructed using only the IC741 and a few discrete components
■ An invaluable addition to the library of all those interested in electronics

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■ The vast majority of people who start up "Mobile Discos" know very little about their equipment or even what to buy Many people have wasted a "small fortune" on poor, unnecessary or badly matched apparatus.
■ The aim of this book is to give you enough information to enable you to have a better understanding of many aspects of "disco" gear
■ The approach adopted is to assume the reader has no knowledge and starts with the fundamentals, hopefully the explanations given are simplified enough for almost anyone to understand but please not that this is by no means the full story.
■ The book is divided into six parts — Basic Electricity, Audio, Ancillary Equipment, Cables and Plugs, Loudspeakers, Lighting Equipment and the information has been considerably sub-divided for quick and easy reference.

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■ 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
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■ It will be found that in general the actual F.E.T. used is not critical and many suitable types will perform satisfactorily The F.E.T. is a low-noise, high gain device with many uses, and the dual gate F.E.T. is of particular use for mixer and other applications
■ This book contains something of particular interest for every class of enthusiast — shortwave listener, radio amateur, experimenter or audio devotee
■ A valuable addition to the library of all electronic enthusiasts.

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■ Included in this book are a collection of the most popular types of projects which, we feel sure, will provide many designs to interest all electronics enthusiasts.
■ All the circuits utilise modern, inexpensive and freely available components
■ The 27 projects selected cover a very wide range and are divided into four basic areas Radio Projects, Audio Projects, Household Projects and Test Instruments
■ An interesting addition to the library of both the beginner and more advanced constructor

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It is possible with relatively simple apparatus to create complete compositions using electronic and sometimes non-electronic musical sources.
■ This book sets out to show how Electronic Music can be made at home with the simplest and most inexpensive equipment It describes how the sounds are generated and how these may be recorded to build up the final composition
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■ The purpose of this book is to introduce the LM3900 to the Technician, Experimenter and Hobbyist It provides the groundwork for both simple and more advanced uses and is considerable more than just a collection of simple circuits or projects.
■ The LM3900 is different from conventional 'Op-Amps', it can be used for many of the usual applications as well as many new ones. It is one of the most versatile, inexpensive and freely available devices on the market today
■ The book is divided into six basic sections —
Introduction
Audio Applications
Simple Linear Applications
Simple Digital Applications
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■ 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.).
■ Also includes circuits for the 707 Common Anode Display
■ A useful book for the library of both beginner and more advanced enthusiast alike.
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■ This book is written by the very experienced and popular author Mr F.G Rayer who deals with the subject in four parts
Part I Understanding Audio IC's
Part II Preamplifiers, Mixers and Tone Controls
Part III Power Amplifiers and Supplies
Part IV Hybrid Circuits
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50 Projects Using Relays SCR's & Triacs — BP37

■ Relays, silicon controlled rectifiers (SCR's) and bi-directional triodes (TRIACs) have a wide range of applications in electronics today. These may extend over the whole field of motor control, dimming and heat control, delayed, timing and light sensitive circuits and include warning devices, various novelties, light modulators, priority indicators, excess voltage breakers etc
■ In this book, the very experienced and popular author — Mr F G Rayer — has given tried and practical working circuits which should present the minimum of difficulty for the enthusiast to construct
■ In most circuits there is a wide latitude in component values and types, allowing easy modification of circuits or ready adaption of them to individual needs
■ An ideal book for both beginner and advanced enthusiast alike.

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50 Projects Using IC CA3130 — No.223

■ The CA 3130 is currently one of the more advanced operational amplifiers that is available to the home constructor This means that it is often capable of a higher level of performance than many other devices and that it often needs fewer ancillary components.
■ In this book Mr R A Penfold 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
■ An ideal book for both the beginner and more advanced enthusiast alike

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■ In this book the newcomer to electronics will find a wide range of easily made projects, many complete with actual component and wiring layouts 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
■ This book which is written by the very experienced author Mr F G. Rayer is divided into four sections —
1 "No Soldering" Projects
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4 Power Supplies
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