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FEATURES
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- Keypress and keypress output
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$89.95

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100WATT $49.95ppd
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TX-80 DOT MATRIX PRINTER

Now an affordable 150 cps dot matrix tractor feed printer can be bought in Canada for the unheard of price of $995.00. Easily attaches to Apple II, TRS-80, PET, etc. through readily available interface options. Write for details.

TX—80, Parallel Interface $995.00

FORT//80

FORT//80© is here at an affordable price. A fast, resident Fortran compiler. Produces directly executable, highly condensed machine code for the 8080, (will run on Z80 and 8085). Runs on any CPM© system.

- Direct IO to 8080 ports
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- Made in Canada

Send now for a full data sheet and sample program.
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FORT//80 . . . . **$99.00**
MANUAL ONLY [APPLIES TO BUY] **$20.00**
DATA SHEET AND SAMPLE PGM . . . . **NC**

VIDEO TERMINAL KIT

DISPLAY: 64 char per line x 16 line per frame
DISPLAY: of 5x7 dot matrix, 64 ASCII char
VERT SYNC: 60 Hz XTAL controlled
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I/O: Parallel port to ASCII keyboard +20ma current loop +RS232
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POWER: 5v 1A CS + +12VDC for RS232

RE6416 . . . . . **$169.95**
LOWER CASE OPTION . . . **$16.95**
POWER SUPPLY OPTION . . . **$16.95**
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0K	$269.00	4MHz. 0K	$325.00
16K	$369.00	16K	$465.00
32K	$469.00	32K	$585.00
48K	$569.00	48K	$705.00
64K	$669.00	64K	$825.00

All data on request

MEMOREX 550

Now you can buy a full sized 8" disc drive fully IBM compatible at a reasonable price in Canada. Ask for a data sheet as there is not enough space here to do justice to this high quality unit.

MEMOREX 550 DRIVE **$650.00**

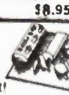
PARTS

8 position DIP Switches $1.50
S-100 Connectors, Solder Tail . . $4.95
Wire Wrap . . $5.95
DB—25 Plug $4.95
Quad Joy Stick $9.95

VIDEO MODULATOR KIT

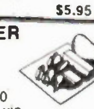
Converts any TV to video monitor. Super stable, tunable over ch. 4-6. Runs on 5-15V, accepts std. video signal. Best unit on the market!
Complete kit, VD-1 $8.95

SUPER SLEUTH



A super sensitive amplifier which will pick up a pin drop at 15 feet! Great for monitoring baby's room or as general purpose amplifier. Full 2 W rms output, runs on 6 to 15 volts, uses 8-45 ohm speaker.
Complete kit, BN-9 $5.95

TONE DECODER



A complete tone decoder on a single PC board. Features: 400-5000 Hz adjustable range via 20 turn pot, voltage regulation, 567 IC. Useful for touch-tone decoding, tone burst detection, FSK, etc. Can also be used as a stable tone encoder. Runs on 5 to 12 volts.
Complete kit, TD-1 $5.95

SIREN KIT

Produces upward and downward wail characteristic of a police siren. 5 W peak audio output, runs on 3-15 volts, uses 3-45 ohm speaker.
Complete kit, SM-3 $3.95

WHISPER LIGHT KIT

An interesting kit, small mike picks up sounds and converts them to light. The louder the sound the brighter the light. Completely self-contained, includes mike, runs on 110VAC, controls up to 300 watts.
Complete kit, WL-1 **$8.95**

LED BLINKY KIT

A great attention getter which alternately flashes 2 jumbo LEDs. Use for name badges, buttons, warning panel lights, anything! Runs on 3 to 15 volts.
Complete kit, BL-1 $2.95

COLOR ORGAN/MUSIC LIGHTS

See music come alive! 3 different lights flicker with music. One light for lows, one for the mid-range and one for the highs. Each channel individually adjustable, and drives up to 300W. Great for parties, band music, nite clubs and more.
Complete kit, ML-1 **$11.95**

FM WIRELESS MIKE KIT

Transmits up to 300' to any FM broadcast radio, uses any type of mike. Runs on 3 to 9V. Type FM-2 has added sensitive mike preamp stage.
FM-1 kit $3.95 FM-2 kit $4.95

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New from National Semi. #LM3914. Drives 10 LED directly for making bar graphs, audio power meters, analog meters, LED oscilloscopes, etc. Units can be stacked for more LED's. A SUPER VERSATILE AND truly remarkable IC. Just out!
SPECIAL PRICE: $4.95—Includes 12 page spec. sheet.

10 Mini Bar LED's. $2.00

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INCORPORATING **ELECTRONIC WORKSHOP**

PROJECTS

FEATURES

NEWS & COLUMNS

INFO & MISCELLANEOUS

THIS MONTH'S COVER. Poor old Rasmus. Just when he thought he'd mastered that stupid racer, Graham modified it to do bigger and better things. I guess the world just isn't safe for your average cat anymore. Article on page 33.

Sharp Electronics

A hand-held, planning computer with 37 alphanumeric memories and 38 alarms for personal programming of future business appointments and reminders of airplane and automobile reservations, phone calls to make and entertainment plans is being marketed by SHARP ELECTRONICS OF CANADA LTD.

Available from Sharp calculator dealers across Canada at a suggested retail price of $139.95, the EL-6200 offers a wide variety of scheduling functions.

A dot matrix liquid crystal display enables users to enter every letter of the English alphabet. Symbols representing travel by plane or car, telephone calls, entertainment and meetings, as well as numbers can also be entered. Appointments can be programmed for up to one year with alarms that will sound at the pre-programmed time and date. The machine also functions as an electronic memo pad for storing important dates and phone numbers for immediate recall.

In addition, the EL-6200 also operates as a 10-digit calculator with clock features. It has a pre-programmed 200-year perpetual calendar and displays the hour/minute/second and year/month/date with A.M./P.M. settings.

Other features include an independently accessible four-key memory for later recall and use in multiplication, division, subtraction and addition and a one-touch per cent key. Sharp's Memory Safe Guard protects all stored information even when the power is off. Horizontally configured, the EL-6200's keys are arranged in the easy-to-use typewriter keyboard arrangement. The machine operates on silver oxide batteries for approximately 1,000 hours. An automatic-off function conserves battery power by automatically turning off the unit when it is not used for about 10 minutes.

Lookout! It's Captain Zilog

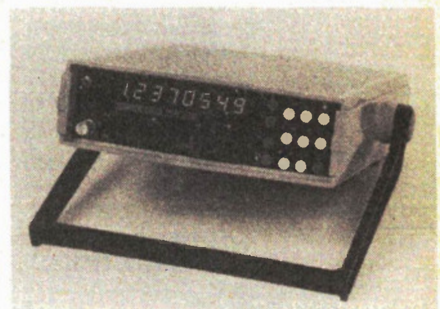
A nifty little comic book from Zilog crossed our collective desks recently. In gut-wrenching drama and four colours this twenty page gem describes how mild mannered Nick Stacey turns into Captain Zilog, defeats Dr. Diabolicus, and saves the world, all this with the aid of his trusty Z8000 microprocessor.

We understand there is a limited quantity of Captain Zilog posters available (with technical data on the Z8000). Write to Bill Galarneau, 10460 Bubb Road, Cupertino, CA 95014.

Universal Counter

A counter with a variety of applications is available from Gladstone Electronic Supply Co. The Greenwich Instruments Model ct 120 Universal Counter/Timer can serve as an event counter, frequency counter, period, time and frequency ratio measurements. Frequency measurements up to 120 MHz are possible as well as time measurements from 100 ns to 10s.

For more information contact Howard Gladstone, Gladstone Electronic Supply Co. 1736 Avenue Rd, Toronto, Ont. M5M 3Y7.



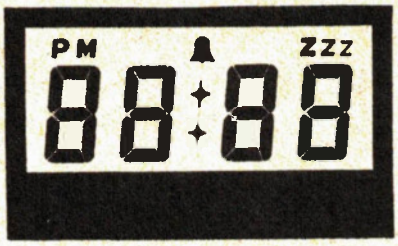
Motorola LCD's

A number of clock and instrument displays have been added to Motorola's growing line of liquid crystal displays. Most displays come with a choice of polarizer configuration, which is identified by a two-digit suffix to the series number.

Write to Motorola Semiconductor Products Inc., P.O. Box 20924, Phoenix, AZ 85036.

MLC412 Series

MLC406 Series

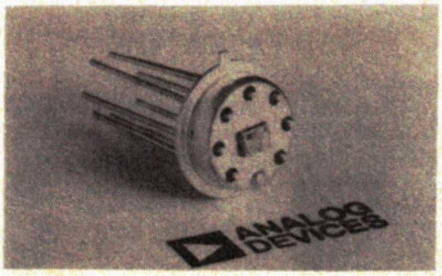


Precision BIFET Op Amp

A precision BiFET operational amplifier which features a slew rate of 13V/us, typical, 8 V/us, minimum, in combination with guaranteed warmed-up input bias current of 25pA, maximum, has been introduced by Analog Devices. The AD544 also features low noise of 2uV peak-to-peak over 0.1 to 10Hz, low quiescent current of 2.5mA, maximum, low input offset voltage of 0.5mV, maximum, and minimum open loop gain of 50,000 (RL-2K).

Input offset voltage drift is available as low as 5uV/°C, maximum, The AD544 settles to +0.01% in 3us, making the device applicable to an output buffer for fast digital-to-analog converters.

Packaged in a TO-99 metal can, the device is available from stock and 10uV/°C, maximum, respectively. The J version sells for $2.50 in 100's with input offset voltage and input offset voltage drift of 2.0mV, maximum, and 20uV/°C, maximum, respectively, and input bias current of 50pA, maximum, warmed up.



Write to: Tracan Electronics Corp., 1200 Aerowood Dr., Unit 46, Mississauga, Ont. L4W 2S7.

Calendar Dates

Strong sales pressure is encouraging medical practitioners to use computers in all aspects of their work, such as record keeping and even diagnosis. Everyone concerned with how computers will affect the practice of medicine should know about the two medical computing courses that Human Computing Resources Corporation is offering early in 1980, at the Academy of Medicine, 288 Bloor West, Toronto.

The Computer-Aided Physician's Office (April 26 and 30) will enable the private practitioner to evaluate the real clinical effectiveness of small computer systems and their potential to reduce or contain costs.

The Frontiers of Medical Computing (March 14 and 15) explains recent advances in medical information systems in an institutional context.

Each course is approved for 16 hours Study Credit by The College of Family Physicians of Canada.

Each course is two days long. Registrants may attend both days, or choose one or the other day. The cost is $225 per day or $400 for two days.

For more information, call Mary Anne Carswell at 416-922-1937.

New Stuff In Canada

Zentronics has been appointed as a franchised distributor for Mostek manufacturers of development tools, memory, microprocessors and telecom products and for Murata manufacturers of capacitors, potentiometers, resistor networks and ceramic piezoelectric filters.

Future has added two new manufacturers to their present series of products.

Magnecraft manufactures a broad line of relays, including general purpose, power, telephone, cradle, low profile miniature and reed types.

In addition Future is now stocking the Centronics line of printers. Centronics is a major supplier to the computer industry with a complete line of serial dot matrix printers, line printers, data communications printers and non-impact printers.

Future has four outlets across Canada. Their head office is at 5647 Ferrier St., Montreal, Que. H4P 2K5.

SPEAKER KIT WAREHOUSE SALE!

Two 15"—200 Watts RMS ea. System

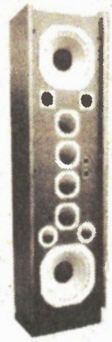
- 20"W, 55"H, 16"D

$169.00 ea.

Kit—A101 ✱
- Two 15" Woofer
- Two 5" Midrange
- Two 2x5 Horn Tweeter
- Cross over net work (L.C.)
- Terminal, Plan Wire

Rings & meshes are optional at $25.00 ea.

Two 12"—200 Watts RMS ea. System



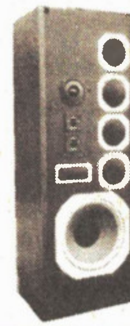
- 18"W, 64"H, 12"D

$159.00 ea.

Kit—A102 ✱
- Two 12" Woofer
- Four 5" Midrange
- Two 3" Tweeter
- Two 3½" Horn Tweeter
- Cross over net work (L.C.)
- Terminal, Plan Wire

Rings & meshes and controls are optional at $35.00 ea.

15"—150 Watts RMS ea. System



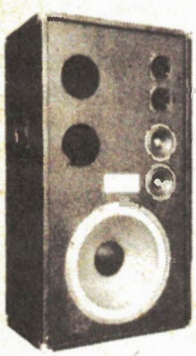
- 20"W, 46"H, 16"D

$112.00 ea.

Kit—A103 ✱
- One 15" Woofer
- Four 5" Midrange
- One 1" Dome Tweeter
- One 2X5 Horn Tweeter
- Cross over net work (L.C.)
- Terminal, Plan Wire

Rings & meshes are optional at $25.00 ea.

15"—300 Watts RMS ea. System



- 21"W, 39"H, 15"D

$149.00 ea.

Kit—A104 ✱
- One 15" Woofer
- Two 5" Midrange
- Two 3½" Horn Tweeter
- Cross over net work (L.C.)
- Terminal, Plan.

12"—150 Watts RMS ea. System

- 18"W, 30"H, 14"D

$89.00 ea.

Kit—A105 ✱
- One 12" Woofer
- One 5" Midrange
- One 3½" Horn Tweeter
- Cross over net work (L.C.)
- Terminal, Wire, Plan

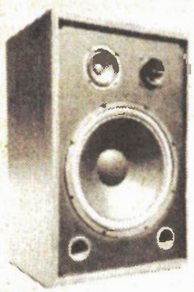
15"—150 Watts RMS ea. System

- 18"W, 32"H, 16"D

$99.00 ea.

Kit—A106 ✱
- One 15" Woofer
- One 5" Midrange
- One 1" Open Dome Tweeter
- One 3½" Horn Tweeter
- One high range Control
- Cross over net work (L.C.)
- Terminal, Plan Wire

15"—100 Watts RMS ea. System

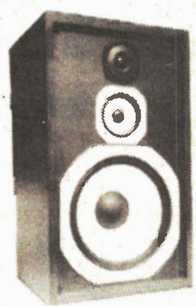


- 18"W, 28"H, 15"D

$79.00 ea.

Kit—A107 ✱
- One 15" Woofer
- One 5" midrange
- One 3½" Horn Tweeter
- Cross over net work (L.C.)
- Terminal, Plan Wire

12"—100 Watts RMS ea. System



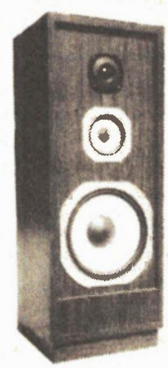
- 15"W, 25"H, 12"D

$60.00 ea.

Kit—A108 ✱
- One 12" Woofer
- One 5" Midrange
- One 1" Dome Tweeter
- Cross over net work (L.C.)
- Terminal, Plan Wire

Rings are optional at $7.00 ea.

10"—60 Watts RMS ea. System



- 15"W, 25"H, 12"D

$49.00 ea.

Kit—A109 ✱
- One 10" Woofer
- One 5" Midrange
- One 3" Phenotic Tweeter
- Cross over net work (L.C.)
- Terminal, Plan Wire

✱ Enclosure (Box) Not Included

WOOFER

15", 54 oz, 200 Watts $69.95
15", 30 oz, 100 Watts $49.95
15", 20 oz, 80 Watts $42.95
12", 30 oz,150 Watts. $44.95
12", 28 oz, 100 Watts $42.95
12", 20 oz, 80 Watts $34.95
12", 30 oz, 60 Watts $29.95
10", 16 oz, 60 Watts $27.95
8", 18 oz, 80 Watts, ... $29.95
8", 10 oz, 30 Watts. $14.95

MIDRANGE

5", 10 oz. 150 Watts $17.95
5", 7 oz, 100 Watts, ... $10.95
5", 5.3 oz, 60 Watts $7.95
5", 2 oz, 30 Watts. $5.95

TWEETER

2x6" PIEZO HORN $24.95
2x5" PIEZO HORN $16.95
3.5" PIEZO HORN $14.95
2.5" PIEZO HORN $9.95
1" Dome, Philips, 80 W $14.95
1" Dome, Philips, 40 W $10.95
3 Way Cross Over Network. 80 Watts $8.95

3 Way Crossover Network. 150 Watts $19.95
Hi Control (L Pad) $4.95
Midrange Control (L Pad) $4.95
6.2 mH Sub Woofer Coil $14.95
Push Button Terminal $1.00
12" Trim Ring. $4.95
10" Trim Ring $3.95
8" Trim Ring $3.50
5" Trim Ring $2.50
* 3 Channel Light Chaser Kit 450 Watts $19.95

Add 5% for postage and handling. Add 7% Sales Tax (Ontario Residents). Prices are subject to change without notice.
*Enclosure (Box) is not included in all kits.

KYLL ELECTRONICS LTD. 4544 DUFFERIN ST., UNIT 19, DOWNSVIEW, ONTARIO. M3H 5R9 (416) 633-2332

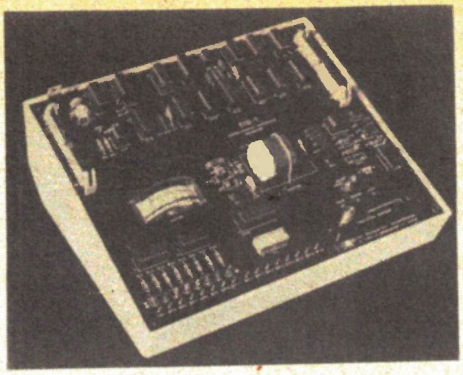
KYLL Electronics LTD.
4544 Dufferin St.
Unit No. 19, Downsview
633-2332

(1 Block S. of Finch)
Rear of Carpet Outlet
TUES., WED., SAT. 10-6
THURS., FRI. 10-9
CLOSED SUN., MON.

Micro-Trainer

A trainer for demonstrating the principles of analog interfacing with a microcomputer is now available from E&L Instruments, Inc. The EID-1 Experimental Interface Designer can be connected directly to E&L's MMD-1 or MMD-2 training and design microcomputers, and is readily adaptable for use with other 8080-based microcomputers.

With the EID-1, I/0 signals representing such variables as light intensity, speed, temperature and position can be provided or simulated by built-in components including a photocell, temperature sensor, dc meter, slide potentiometer, and dc motor. Analog signals converted to digital input can be displayed via LED digital readout. Digital signals can be generated using an on-board 8-position DIP switch. Computer output can be converted to analog signals for meter display or motor speed control. The on-board A/D and D/A converters can also be used to bring in or send out control voltages directly on breadboarding terminals.



The EID-1 is available assembled, or in kit form.

Contact: Frank Gregorio, E&L Instruments Inc., 61 First Street, Derby, CT 06418.

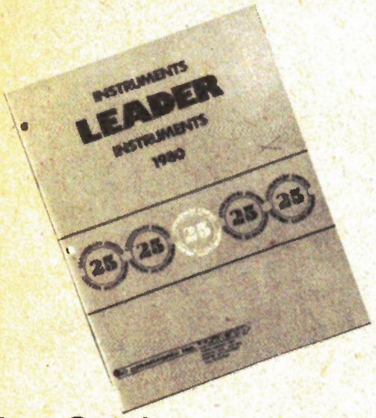
Cable, Closer To Home

Canadian Cablesystems Limited, Canada's largest cable operator has been granted C.R.T.C. approval to test two-way cable television in London, Ontario.

Phase III, a two-way interactive communication system, could eventually offer cable T.V. subscribers a number of services that until now have not been feasible. The London experiment provides 175 households with home terminals to test the following four services; opinion polling, smoke alarms, T.V. surveys and technical monitoring.

The first two-way cable T.V. program in Canada was aired on Cablecast (Channel 13) from 7:00 p.m. to 8:30 p.m. on Monday, December 17, 1979. The home terminals allow subscribers to respond to questions simply by pressing a button. Viewer feedback is immediately relayed to a computer at the cable T.V. facilities and the results are displayed on the television screen within 30 seconds.

Two-way cable television offers many advantages to the subscriber. The computerized smoke detector system provides security and protection at low cost. By monitoring cable signal levels, the maintenance and reliability of service and the quality of picture are greatly improved. Through the recording of television viewing patterns, subscribers will have a means of expressing their program preferences.



New Catalogue

Leader's 25th anniversary catalogue of test equipment is now available. It includes a wide range of scopes, generators, meters and more. The new catalogue is available from Omnitronix Ltd, Leader's Canadian representative for five years.

Expose Yourself

News digest is a regular feature of ETI Magazine. Manufacturers, dealers, clubs and government agencies are invited to submit news releases for possible inclusion. Submissions, or questions about material, should be sent to: News Digest, c/o ETI Magazine Unit 6, 25 Overlea Blvd., Toronto, Ontario, M4H 1B1.

Audio products news will be directed to Audio Today's product department, and similarly Shortwave news will appear in Shortwave World. Sorry, submissions cannot be returned.

For cost effective capacitance measurement

One C-meter stands out of the darkness— the $165 B&K-PRECISION 820

For about one-third the cost of the most popular digital capacitance meter, you can own five times more measurement capability. The new B&K-PRECISION 820 reads all the way to 1 Farad, in ten ranges. With 0.5% accuracy, the 820 resolves to 0.1pF for a maximum count of 9999.

The 820 keeps on going in freezing cold to blistering 100 degree heat, making it ideal for field use. The bright LED display is easily readable under all lighting conditions. It has the versatility needed for any application and the durability to stay on the job. The 820 can be powered by disposable batteries or optional rechargeable batteries.

Unlike many specialized instruments, the 820 has almost unlimited applications in engineering, production line work, QC, education and field service. First time users are quickly discovering that the number of time-saving applications exceed their original expectations. For example, you can measure unmarked capacitors...Verify capacitor tolerance ...Measure cable capacitance...Select and match capacitors for critical circuit applications...Sample production components for quality assurance...Measure capacitance of complex series-parallel capacitor networks...Set trimmer capacitors to specific amounts of capacity...Check capacitance in switches and other components.

You can start discovering your own applications today by seeing your local distributor for immediate delivery.

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Circle no. 7 on Reader Service Card.

NEWS DIGEST

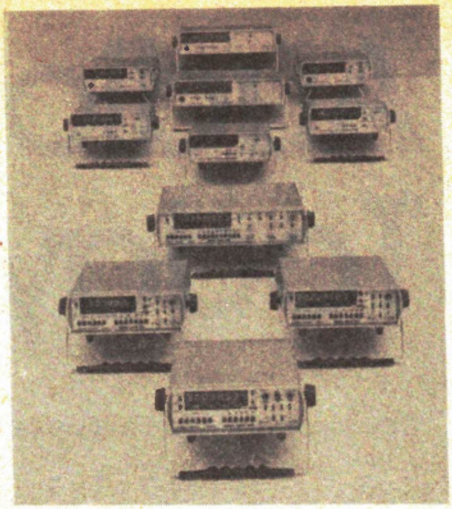
Counter Family

Webster Instruments Ltd. has introduced a new line of 13 counters called the series 99 Hundred, manufactured by Racal-Dana, Inc. Each instrument in the new family is backed by a full two-year warranty with a lifetime guarantee on the Collector Diffusion Isolation (CDI) LSI chip at its heart.

The range of instruments consists of five universal counters and eight frequency counters for bench and systems use. Significant features include .43 inch LED displays, RFI/EMI shielding, GPIB interface and high input overload protection.

The new counter series of 13 instruments are designed and manufactured to international safety standards and to relevant UL, MIL-STD's and IEC specifications.

The 99 Hundred Series universal counter/timers range from an economy version of general bench use to high performance bench and portable models for the most demanding applications. There is a choice of high stability time-bases. The five instruments cover the DC to 1.1GHz frequency range and have better than 10mv input sensitivity.



For more information, please contact: Mr. Roger Webster, Webster Instruments Ltd., 1200 Aerowood Drive, Unit 28. Mississauga, Ontario L4W 2S7.

8080/8085 Pascal

Intel Corporation now offers Pascal-80, the newest high-level language to support 8080 and 8085 microprocessor software development on Intellec microcomputer development systems. The Pascal -80 package is available on flexible diskette.

Pascal-80 is a superset of the standard Pascal devised in 1970 by Professor Nicklaus Wirth of Zurich, Switzerland. Its block-oriented, rigid structure encourages good programming practice, while its high readability helps reduce programming errors.

Whereas the standard Pascal is academically oriented, Intel's Pascal-80 offers extensions that make the language more suitable for commercial and industrial applications.

The Pascal-80 compiler converts the source program into an intermediate p-code which has been optimized for execution speed and to save memory space. The Pascal-80 interpreter then executes this p-code in an interpretive mode.

Now available on both single — and double — density flexible diskettes, the Pascal-80 software package can be ordered as product code MDS-381, and costs $975. US.

Happy Birthday To Us

As of this issue we are three years old. We've come a long way since our first issue in 1977 and we've made a lot of (we hope) friends along the way. We can now boast a readership of some 30 000 Canadians.

Needless to say, we couldn't have done it without you, our readers and our advertisers.

Thank you.

Audio Today

Developments in audio reviewed by Wally Parsons

SO ALRIGHT, already! In December I promised to continue with tube technology next month, (January) but somebody stuck my tubes into a crystal ball, thus giving rise to the Nostradamus effect which appeared in these pages last month.

But now, back to real business.

BASIC TRIODE CHARACTERISTICS

Before proceeding with the design of a basic triode amplifier, we should examine some of the most important characteristics. Three are of primary concern, amplification factor, symbolized by the Greek letter "mu" (u), plate resistance, rp, and transconductance, which is the opposite of resistance, and measured, appropriately enough, in mho's*, which is "ohm's" spelled backwards. Because the quantities are small, we usually encounter micromho's (umho) *Amplification Factor,* is defined as the ratio of change in plate voltage to a change in control-grid voltage in the opposite direction, on the condition that plate current remains unchanged, and any other electrodes (when the unit is not a triode, and in all cases, including the heater) remain unchanged in potential.

Plate Resistance is the resistance of the path between cathode and plate to the flow of electrons, and is the quotient of a small change in plate voltage divided by the corresponding change in plate current. It is measured in ohms.

Transconductance is the quotient of a small change in plate current divided by a small change in voltage on the control grid under condition that all other voltages remain constant. It therefore combines plate resistance and Amplification Factor in one term, and is, in fact, equal to the quotient of the latter divided by the former. The symbol is "Gm" sometimes gm. You"ll notice that this term also appears in connection with field effect transistors, which are also voltage controlled, and has the same meaning.

These characteristics are dynamic and are useful, as we shall see, in calculating performance characteristics of circuits, and determining tube plate voltage and any grid voltage a performance from a particular circuit.

In addition, we have *static characteristics,* shown in graph form as either a plate family of curves, in which plate voltage is plotted against plate current for a variety of grid voltages, and transfer characteristics in which plate current is plotted against grid voltage for a variety of plate voltages. Although it's seldom done, it is quite possible to combine the two with a load, so that a load line transfer characteristic is created. It's a technique I like very much because it gives a visual representation of stage behaviour and an instant "feel" for the circuit. We'll be dealing with this later.

Fig 1a shows a plate family of curves for a typical, hypothetical triode. Notice that by plotting a line to intersect any plate voltage and any grid voltage a particular value of plate current results. Moving up or down the plate voltage line to intersect different grid voltages shows changes in plate current. Also moving along any grid voltage line to a different plate voltage results in a change of plate current. This differs considerably from transistor curves in which changes in collector voltage results in negligible change in collector current. You can also see that by plotting a vertical line corresponding to plate voltage, it is possible to obtain a transfer curve. In other words, one graph can be plotted from the other, as in Fig. 1b.

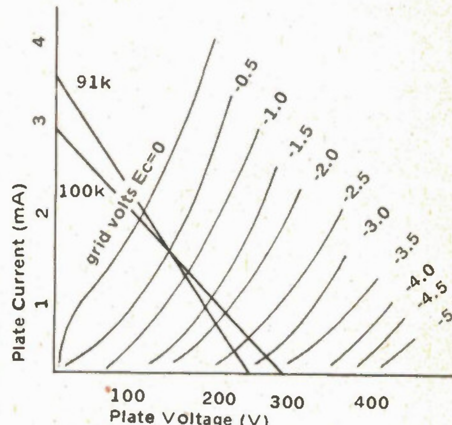


Fig. 1a

BASIC TRIODE CIRCUIT

Fig 2 shows a real life, practical resistance-capacitance (RC), coupled trode voltage amplifier with cathode bias.

Because we are interested in fidelity of reproduction we should set the operating conditions for minimum distortion.

Since this is a voltage amplifier, we require high voltage gain, rather than maximum power output. Let us assume a supply voltage available of 300 V. If signal conditions are such that no current is drawn through the load, there will be no voltage drop, and the plate voltage will then be 300 V. The maximum possible current which can be drawn through this resistor is defined by Ohm's Law and equals the

*The mho has since been replaced by the SI unit, the Siemen (the S). ed.

supply voltage divided by the resistance. If this load resistance is 100 k, then maximum possible current is equal to Eb/RL= 300/100000= 3 mA. Draw a line from the intersection of 300V and O mA, and the intersection of O V and 3 mA. This is the static load line. Now to set the operating point, that is, grid bias.

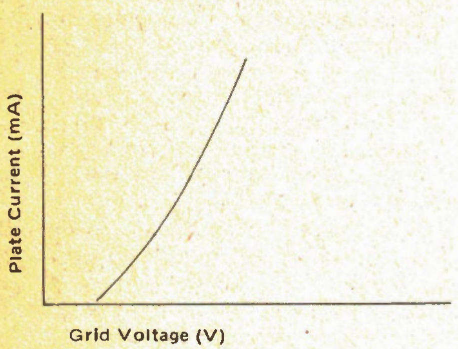


Fig. 1b

Common practice is to set bias at some value about half-way between O V and cutt-off, but I prefer to use a load line transfer characteristic. To do this, arrange a graph with the grid pattern co-ordinates plotted as in fig. 1b. On the load line record the plate voltage-plate current where the load line intersects each grid voltage, and transfer this to the corresponding co-ordinates on the transfer curve graph. Connect the resulting dots to produce a transfer curve. If maximum signal handling is not required,examine the transfer curve and note the straightest portion, and the corresponding grid voltages at the extremes. Find a value exactly halfway between them. This is the desired voltage. Note the maximum and minimum plate voltages obtained at these points. The difference between them is the peak-to-peak output voltage. If this is inadequate you may have to accept excursions into the curved region of the transfer curve, try a different value of load, or, more likely, increase the supply voltage, noting that the maximum plate voltage shown in the tube manual as actual plate-to-cathode voltage, not supply voltage. If you opt for non-linear operation, remember that if you operate into the curve at one end of the line only, the resulting distortion is largely even harmonics, which are cancelled in a push-pull circuit. So far, we've ignored Rg, the grid resistor of the following stage, (which may actually be something else, such as the input resistance of a volume control), tone control circuit, etc). Since it is in parallel with the output, it is also in parallel with RL, and so the real dynamic RL is actually the parallel combination of RL and Rg. If Rg is 1 M, then RL becomes;

$$R_L = \frac{1}{1/100000 + 1/1000000}$$

=90909

=91k

A load line for this value must now be drawn, only this time it must intersect the selected bias point and the DC load line at the same point. Most books on the subject show a rather complicated way of doing this, but there is a short cut so simple as to belie belief. If you erect a load line for any one value of load using a variety of supply voltages, they will all be parallel to each other. Naturally! The line follows Ohm's law. So, if you simply draw a load line using our new value of 91 k, using, say, the supply voltage of 300 V, you have only to move it over a little until it intersects the desired point on the grid voltage curve. At this time it would be wise to draw a transfer curve for the new load value and check for linearity.

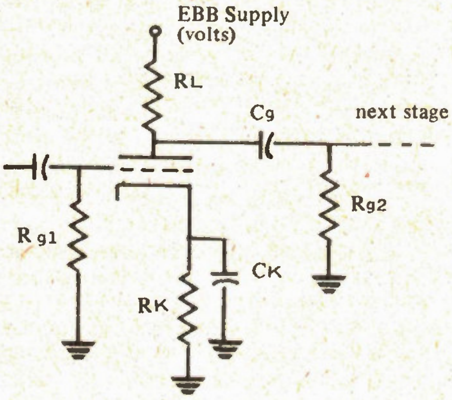


Fig. 2 RC coupled triode stage.

At this time it might be instructive to check the gain of our stage. This can be calculated from either of the following formulae;

$$A = \frac{uR_L}{R_L + rp}$$

where, A =stage gain

R_L=actual load

or

$$A = \frac{gm \times rp \times R_L}{(rp + R_L) \times 10^6}$$

R_L and rp are in ohms, gm is in umhos.

BIASING

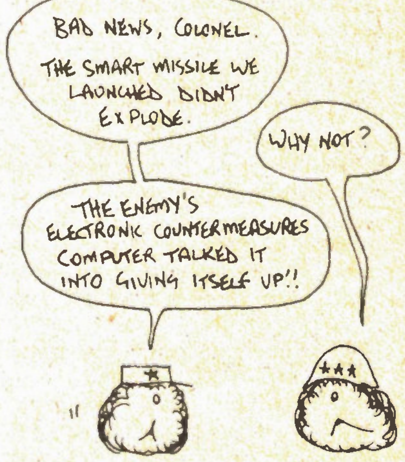
Now that we know how much bias we want, how do we get it? In the circuit shown it is obtained from the voltage drop across cathode resistor R_K. Since bias is the potential on the grid with respect to the cathode, it makes no difference if we make the grid x-volts negative with respect to the cathode (ground referenced) or make the cathode x-volts positive with respect to the grid (also ground referenced). Since no DC flows through the grid resistor, it is at the same potential as ground, that is, zero volts.

The value of R_K is calculated using Ohm's Law: RK = EG/Ib where R_K is the cathode resistor, Eg is the value of bias voltage, and Ib is the cathode current, which, for a triode, equals plate current at Eg. Note that plate voltage is actually measured between plate and cathode, so the actual plate voltage is equal to plate-to-ground voltage minus cathode to ground voltage. With power circuits this bias may be quite substantial and therefore result in a significant change in plate voltage, but in this type of stage the cathode voltage is usually under 10 V, and can ordinarily be ignored for practical purposes.

REFERENCE SOURCES

Of all the tube manuals ever printed, by far the very best, in my opinion, are the RCA Receiving Tube Manual, RC-30, and the RCA Transmitting Tube Manual, TT-5. Both are extremely comprehensive, in terms of the quantity and kind of data, as are their various transistor and integrated circuit publications. Readers seriously interested in pursuing tube design further are urged to obtain these manuals.

And if you do so before next month you'll be able to get ahead of the class, when we look at power amplifier tubes and circuits.



Audio Today Products

Audio developments reviewed by ETI's Contributing Audio Editor Wally Parsons.

STANTON 881S PICKUP

It's been well over a year since a reviewed the first pickup to use a CD-4 derived stylus assembly, the Stanton 681EEES. Shortly after I received Stanton's latest top model, and now their Calibration standard, the 881S.

I stated in the earlier review that I felt that this was the direction in which stylus design should move. I still hold to this position, but a year of working with it, plus exposure to other peoples version of this approach, as well as private correspondence with those involved in such design has introduced some caveats.

A LITTLE HISTORY

The most commonly used stylii during the days of the 78's was really a pointed needle, usually made of thorn, steel, sometimes plated with a material such as chromium. Such a point literally rode on the bottom of the groove, and depended on the abrasives compounded with the shellac material to grind the point into something sort of conforming to the groove shape.

This wouldn't do for LP's, however, so we quickly acquired the stylus, a conical device whose tip was rounded like the tip of a ball-point pen, and with an arc of .001", or 1 mil. Various materials were used, such as osmium, iridium, tungsten, even platinum, but eventually the diamond became standard with all quality pickups.

Unfortunately, this conical tip could not trace high frequency, high velocity modulations whose curvature was less than that of the stylus, yet reducing stylus tip radius increased contact pressure and wear.

In the early sixties the bi-radial tip was introduced. Elliptical in cross-section, it provided for a small curvature at the sides to follow groove modulation, yet a large side-to-side dimension and large curvature at the bottom to allow it to ride up in the groove. At the same time, contact was spread slightly up the stylus which still allowed a low unit pressure.

Tracking force is recommended as 1 gram, with a low of ¾ gram, and a high of 1¼ gram. In fact, at the lowest pressure it was capable of tracking most ordinary pressings, but with complex material, "hot" cuttings, and some of the super discs, I found the higher figure to be more reliable. At this pressure, frequency response matched that at 1 gram, but at ¾ gram there was a slight rise above 15kHz. In any case, it's usually good practice to operate closer to the maximum recommended range, and it's a practice I adhere to with all pickups.

IN USE

I am not quite prepared to describe the 881S as the best pickup I've ever heard. I doubt that I'd say that about any pickup. There are some which will handle some material better, or will track at lighter forces, etc., but of all the units I've heard over the past year, the 881S is one of about three pickups which I would consider if I could only have one.

Percussion instruments, particularly well recorded jazz cymbals have an immediacy and tingle and presence which only a few moving coil units can match, and massed choral works reveal a separation of voices and a stability of imaging which has to be heard to be believed. Even punk rock records brought over by friends actually have words which can be heard and identified. And if you think the sound of punk is offensive, wait until you hear the lyrics. Yecch! It is one of the few pickups which can reproduce a piano realistically, and extract the resinous sonority of a cello, without adding harshness to orchestral string ensemble work, and yet the touch of wiriness inherent in these instruments is not lost.

But perhaps the most surprising quality is bass reproduction. Surprising, because we usually think of speakers are being the limiting link the chain in this respect. But the 881S will reproduce pedal organ with a fullness, and the "rolling" quality which gets on some discs, a bass drum boom which has that ring of authenticity which is obviously not an added colouration, and even the punch of a disco kick drum with an ease which I don't believe can be matched by any other pickup. To appreciate this fully, obviously, requires a first rate speaker, yet even on the small kitchen extensions I have this quality is apparent.

Stereo imaging may not seem as wide and "spacey" as with some other pickups, including Stanton's own 681EEES. But it is still capable of an image wider than speaker placement, and it is a firm, solid image. Instruments do not wander, and their locations can be identified.

Now for the catch. All long contact stylii contact the groove along a line parallel to the stylus axis. Groove modulation lateral components also have such an alignment. Consequently, such a stylus is sensitive to misalignment, which will impair high frequency tracking. It's not always enough to ensure that the stylus is vertical when viewed from the side, because many recordings are cut with a slight tilt to the cutter. The relationship is similar to that between tape and head azimuth. Moreover, badly warped records will upset alignment.

Should you buy it? If you're the sort of person who can't be bothered taking the time to set up an arm and pickup properly, then any pickup selling at nearly $200.00 would be a waste of money. Same thing if you use a record changer (shudder) or one of the semi-automatics with no provision for adjusting anything but tracking force and anti-skating. If your record library goes way back and/or contains many discs if questionable quality, and you can have only one pickup, don't buy.

Ideally, this is suited to the person with a quality arm such as the new SME, Hadcock, etc, or a quality integrated unit who either buys only the best technical quality discs, or can interchange other pickups more suitable to problem discs, for the azimuth problems I mentioned. The only type of stylus which is not critical in this respect is the spherical, and Stanton does not make one available, although they do market a stylus for mono LPs.

They do, however, market a 0.7 mil stylus for the 681A and it can be used in the 681EEES body. Therefore, if you cannot interchange pickups, that would be a better choice.

One pleasant surprise: I recently acquired an Edith Piaf 78 in mint condition, unplayed. Noting that the contact radii are specified as .0028", almost the same as a 78 stylus, I decided to play it. Works beautifully. I don't think I'd recommend this as a routine practice unless you get a spare stylus for the purpose, but it's certainly worth considering when taping clean discs. Anyway, Stanton also sells a 78 Stylus.

Contact Tri-Tel Associates, 105 Sparks Ave., Willowdale, Ont. M2H 2S5. And mention ETI.

The CD-4 disc, however with modulations as high as 50 kHz, was too much for this. So the side curvature was made even smaller and the frontal cross-section became a broad arc whose radius became more complex, and spread the contact in a line up the side of the stylus.

Stanton used such a design in their model 780/4DQ, and later modified it for the 681EEES.

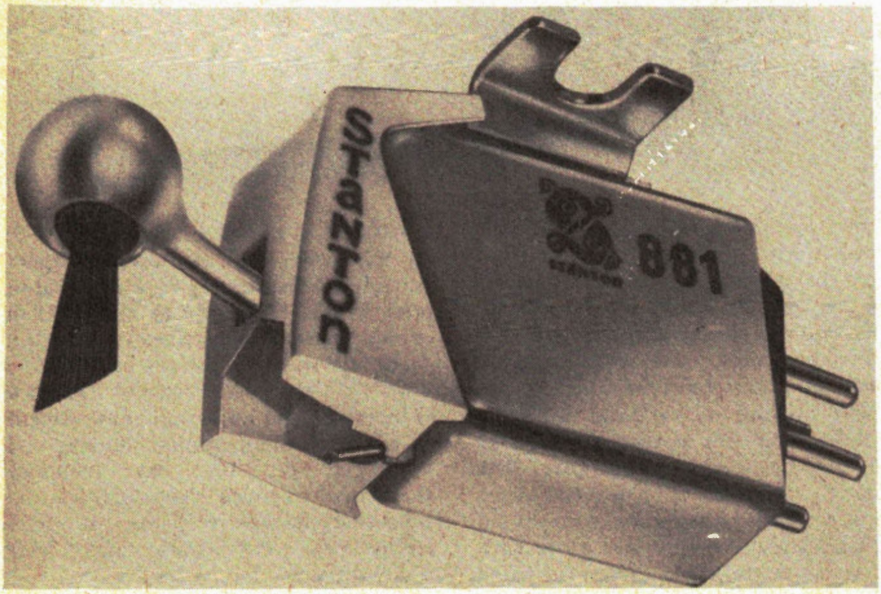
ENTER A NEW DESIGN

Up to this time, Stanton pickups used a moving iron transduction principle, in which a tube of high permeability material was attached to the end of the stylus cantilever, and suspended between a magnet and a set of coils. Stylus movement altered the flux into the coils producing a signal.

The 881S replaces the tube with a super small high energy magnet, which allows very low mass without sacrificing output voltage. A newly-designed suspension system improves rotational stability, and reduces displacement parallel to the cantilever axis. This is a common cause of shifting vertical tracking angle, loss of high frequency channel separation, and distortion.

One frequent cause of difficulty in the use of previous Stanton products was the requirement of working with a lower load capacitance than most other manufacturers used. While most pickups required around 400p to 500p load, Stanton was specifying 275. Consequently, many installations would load most other pickups properly, but the excessive capacitance produced a peak in response between 10 kHz and 15 kHz. With the 881S there has been no change in philosophy. However, the rest of the world seems to be coming around to the same way of thinking, with the result that it will match a larger number of preamps. Performance is still highly dependent on proper termination, though, and it would be worthwhile for the prospective user to make every effort to provide it. Turntable arms should be equipped with low capacitance cables, and any loading capacitors in the preamp removed. Then, if necessary add capacitance to come up to the desired value. In any case, it works better with too little rather than too much. Performance specifications claim a response to 25 kHz. I was only able to measure to 20 kHz, but, with proper loading, it matched the calibration sheet which came with the unit. Output level is specified as 4.9 mV at 5.5 cm/s and channel balance within 1 dB at 1 kHz. The best test record on hand is only accurate to 2 dB, but the pickup confirmed it, so there is no quarrel in this regard.

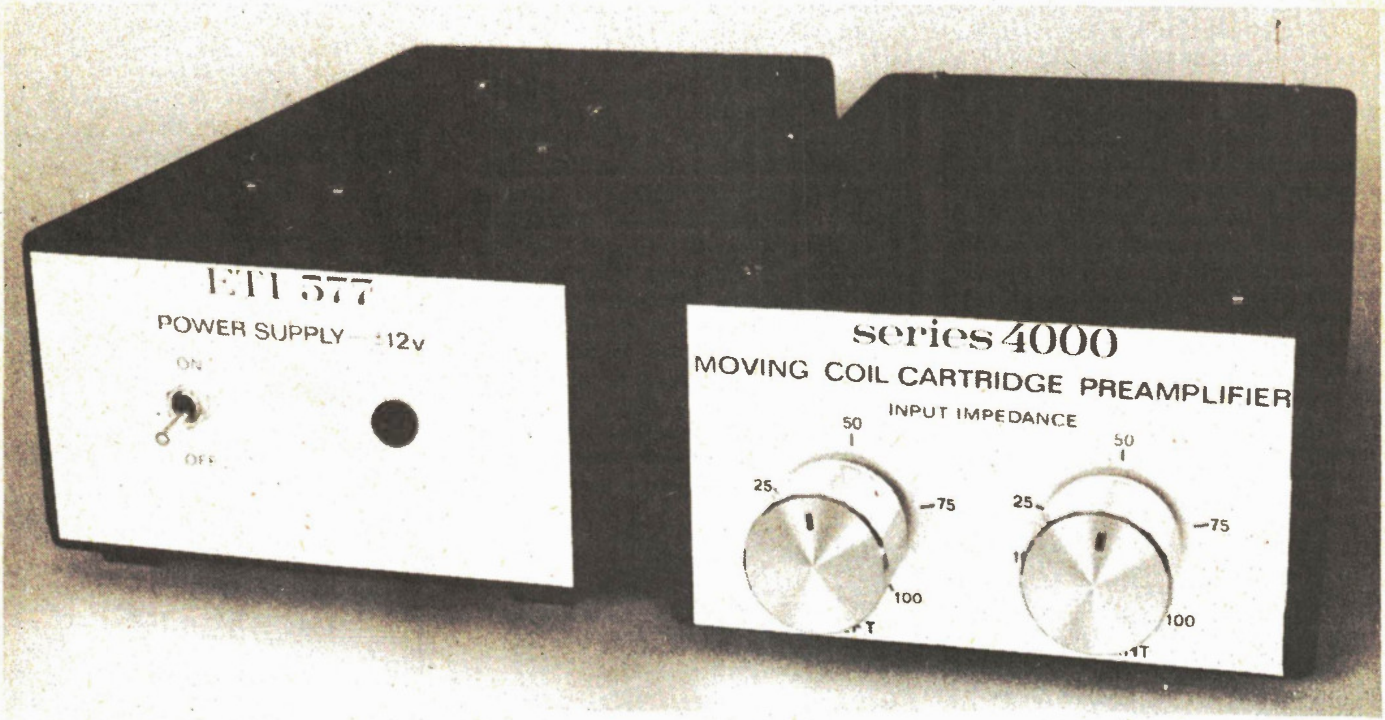
The CD-4 disc, however, with modulations as high as 50kHz, was too much for this. So the side curvature was made even smaller, and the frontal cross-section became a broad arc whose radius became more complex, and spread the contact in a line up the side of the stylus.



Series 4000 Moving Coil Preamp

Designed to complement our popular Series 4000 stereo amplifier, this project features performance equal to, or better than, top quality commercial preamps currently available.

DAVID TILBROOK



OVER THE LAST several years there has been a dramatic increase in the number of moving coil cartridges released. The design of this type of cartridge results in a number of advantages over the more usual phono cartridge which works on a moving magnet principle.

Modulations on the wall of the record are tracked with a diamond stylus attached to a long arm called a cantilever. In the moving-magnet cartridge a small magnet is attached to the cantilever so that stylus movement causes movement of the magnet. Two pick-up coils are mounted close to the magnet so that the windings of the coils intersect the lines of magnetic flux from the magnet. As the stylus moves the magnetic flux seen by the pick-up coils varies in direct proportion to the stylus movement, and small electrical signals are generated in the coils.

The moving-coil cartridge works in a similar way but inverts the roles of the pick-up coils and magnet. The magnet assembly is held stationary while the pick-up coils are mounted on the cantilever assembly and move with the stylus modulations (hence the name 'moving coil').

The pick-up coils are reduced drastically in size and weight compared to the coils used in moving magnet cartridges. This results in a total cantilever weight that is much smaller than in the typical moving magnet cartridge. Since the weight is greatly reduced the ability of the stylus to react to transients is increased and an overall improvement in signal accuracy results. Moving coil cartridges generally have superior frequency response characteristics and improved phase response at high frequencies. But they also have disadvantages.

The small pick-up coils have a very low impedance resulting in much lower

SPECIFICATIONS

Gain	28 dB (x 25 approx).
Frequency response	29 Hz to 48 kHz ±1 dB.
Input impedance	Adjustable 3.3 to 100 ohms.
Noise	Total equivalent input noise 0.3 nV√Hz. Over a 20 kHz noise bandwidth—42nV. Signal-to noise ratio, with respect to an input level of 150 μV: -71dB.
Total Harmonic distortion	With respect to an input level of 0.2mV, unmeasurable (below noise). Calculated to be 0.0015% (see text). Rising to 0.015% for a 30 mV input signal at 1 kHz.
Channel separation	Better than 61 dB.
Input overload margin	better than 80 dB.

signal levels than available from normal phono cartridges. In fact, the voltages present on the typical moving-coil cartridge at a recording velocity of 10 cm/sec can be in the order of 150 μV! This is generally insufficient to drive an amplifier to anything like full power. Furthermore, since the output level is some 30 dB below that expected by the amplifier then a great reduction in the signal-to-noise ratio will result. An amplifier with a short circuit signal to noise ratio of 80 dB for example, which is quite a good figure, will end up with a signal noise ratio of about 50 dB — which is distinctly *bad*.

The internal impedance of moving-coil cartridges is around 5 ohms and to achieve the low recommended load impedance required it is clearly not satisfactory to simply load down the input of the average phono input with a resistor since this does nothing to overcome the signal-to-noise ratio problems.

The solution to these problems is to insert some voltage gain between the output of the cartridge and the phono input. This can be done in two ways. Firstly, it is possible to use a transformer to boost the voltages up to the desired level and they are capable of very good results. But, transformers are still limited in transient performance and noise. To obtain the necessary voltage gain the turns ratio must be relatively high. Since the impedance ratio is related to the square of the turns ratio, the output impedance must, of necessity, be high also — usually around 30 k for a 50 Ω input impedance. This is substantially higher than the output impedance of normal phono cartridges and degrades the noise figure of the phono input stage. A solution to this is to use a pre-preamplifier instead of a transformer to achieve the necessary voltage gain.

PREAMP REQUIREMENTS

Preamplifiers have their disadvantages also. The biggest problem by far is the design of an extremely low noise input stage with the correct input impedance to load the cartridge according to the manufacturers' recommendations. The distortion must be kept to a minimum and the frequency response should be as flat as possible. These design goals are not unique to a moving coil cartridge preamplifier but they are difficult to achieve owing to the very low output voltage of the moving coil cartridge.

The required low input impedance can be achieved in several ways. Firstly, we can make the input stage a common base configuration. In this type of circuit the input is connected to the emitter of the transistor so that the input impedance is determined by the emitter resistor in parallel with the base-emitter junction of the input transistor, which can be quite low. However, this does not solve the problem of input stage noise.

The other possibility, and the one I elected to use in this design, is common emitter configuration. The impedance of the base-emitter junction of a bipolar transistor is a function of the amount of current flowing in the emitter of the transistor. This will be largely determined by the collector current and not by the base current, which will contribute only a small amount of the total emitter current. A study of base-emitter turn-on characteristics shows that the impedance of the base-emitter junction is approximately equal to:

$$\frac{26\beta}{I_e\,(\text{mA})}$$

where 'β' is the small signal current gain of the transistor.
and 'I_e' is the current in the emitter of the transistor in mA.

So, to reduce the input impedance of the first stage it is simply necessary to increase the emitter current. But this increases the current density in the input transistors, increasing the noise generated by the input stage.

To understand why this happens it is necessary to look more closely at the causes of noise.

NOISE

There are two main sources of noise in transistors: shot noise and l/f noise. Shot noise is the main cause of noise at middle and high frequencies and is generated when an electron attempts to cross a potential barrier. It is therefore directly related to the amount of charge flowing in the device. More specifically, it is given by the equation:

$$\overline{I_s^2} = 2qi_{dc}B\ (\text{amps})^2$$

(mean shot noise current)

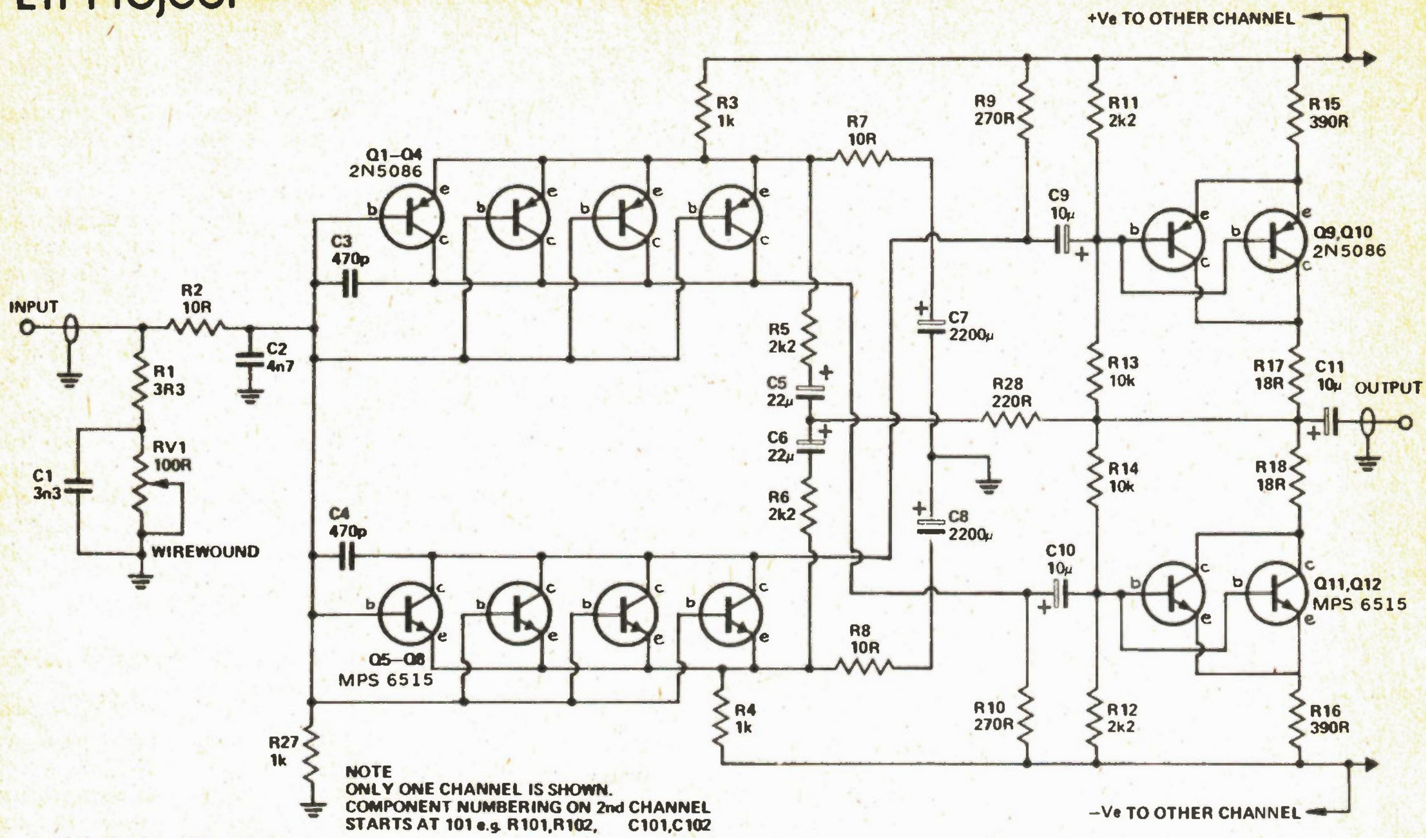
where 'q' is the charge of an electron, in coulombs
'i_{dc}' is the dc current in amps
and 'B' is the noise bandwidth in Hz.

1/f noise has a random amplitude like shot noise but its spectral density has a 1/f characteristic. This means that the noise amplitude increases as frequency decreases and becomes the dominant source of noise at low frequencies. As with shot noise, its equation reveals that it is directly related to the current flowing in the transistor.

$$\overline{I_f^2} = K\frac{(I_{dc})^a}{f}B$$

where 'I_{dc}' is the dc current in amps.
'K' and a are constants that are a function of the particular device
'f' is the frequency in Hz
and 'B' is the noise bandwidth.
Notice that as I_{dc} is increased, so too is the 1/f noise (I_f^2)

It is clear from this that, in order to keep noise generated by shot and l/f noise to a minimum, it is necessary to keep the current density in the input stage low. But, as we saw earlier, to obtain the necessary low input impedance we have to increase the emitter current. The solution to this is to use several transistors in parallel to form the input device. This decreases the current density in each of the transistors since the necessary emitter current can be shared by all of the input devices. It also places the impedances of the base-emitter junctions in parallel, further decreasing the input impedance of the first stage. Furthermore, since each transistor is a completely independent noise generator their noise voltage will tend to reduce each other (a process too complex to examine in detail here).



HOW IT WORKS

The input stage consists of Q1 to Q8 plus associated circuitry. Q1 to Q4 and Q5 to Q8 are in parallel to reduce the current density providing a low input impedance stage having very low noise. A detailed account of how this works is given in the text.

Capacitor C1 and C2 fix the upper frequency roll-off characteristics as well as shunting the input with the desired load capacitance for the moving-coil cartridge. The configuration of R1 and R2, C1 and C2 was found to give the best loading for a variety of moving-coil cartridges.

The potentiometer RV1 allows the input impedance to be variéd over the range most commonly recommended by cartridge manufacturers.

Negative feedback is applied via the network consisting of R28, capacitors C5 and C6 and resistors R5 and R6. Some degenerative feedback for the input stage is applied to the first stage by the emitter resistors R7 and R8. Capacitors C9 and C10 are coupling capacitors to the second stage while bias for this stage is determined by R11, R12, R13 and R14.

The power supply consists of a series regulator Q13 and Q14. The potential dividers R21/R23 and R22/R24 divide the voltage present at the output of the regulator and drive the transistors Q15 and Q16, and the LEDs. The transistor base-emitter junction in series with the LED will drop 0.6 + 1.65 volts. Therefore, whenever the voltage present at the centre of the potential divider tries to increase above 2.3 volts the transistor increasingly, conducts decreasing drive to the pass transistors Q13 and Q14.

This is a relatively low noise regulator since the voltage reference is LED and not a zener diode which is a noisy device. Resistors R19 and R20, together with capacitors C12 and C13 form 6 dB per octave low-pass filters on the supply rails to further reduce noise that may be generated by the regulated supply. . .

This configuration works very well and the noise levels of this preamplifier rival any of the commercially available units.

To see just how difficult it is to obtain a satisfactory signal to noise ratio at these signal levels it is necessary to look at another form of noise called 'thermal noise'. This is caused by the agitation of charged particles in any conductor due to their temperature. Every passive component will generate thermal noise and short of dunking the whole thing in liquid helium to cool it off, there is simply no way of getting rid of it. Thermal noise is given by the equation:

$$\overline{e_R^{\,2}} = 4kTRB \text{ volts}^2$$

where 'T' is the temperature in degrees Kelvin (K).
'R' is the value of the resistance.
'B' is the noise bandwidth
'k' is Boltzmans constant, equal to 1.38×10^{-23} W-sec/K.

From this equation we can calculate the theoretical noise that will be generated by the moving coil cartridge itself. This clearly is the absolute lowest noise figure that is possible with the input stage generating no noise of its own (which is very unlikely!).

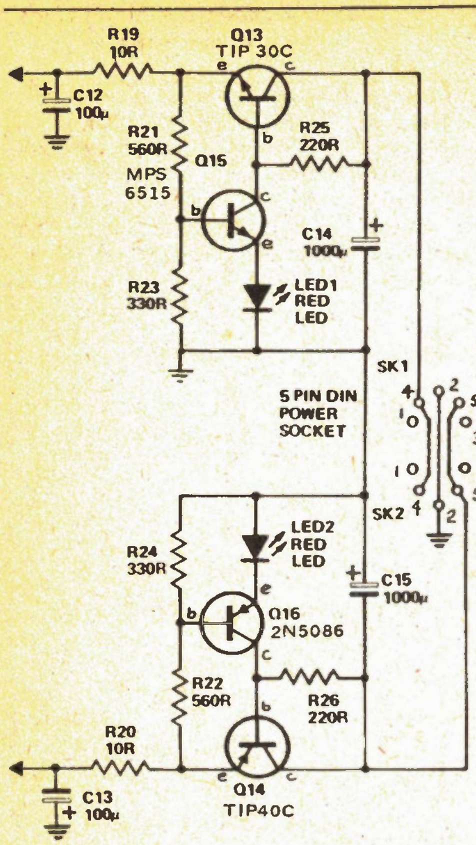
If we let the temperature of the transistor be 300 Kelvin (i.e.: mean atmospheric temperature) and the noise bandwidth be 20 kHz (the hi-fi audio band), then since the dc resistance of the cartridge is about 5 ohms the equation becomes:

$$\overline{e_R^{\,2}} = 4 \times (1.38 \times 10^{-23}) \times 300 \times 5 \times (20 \times 10^3)$$

Therefore $\overline{e_R} = 4.07 \times 10^{-8}$ volts or 41 nV.

So, the thermal noise of the cartridge itself is 41 nV.

Actually, this calculation is not quite right since the noise bandwidth is defined as having a 'brick wall' response. An amplifier with 3 dB point of 20 kHz that is falling at a rate of 6 dB per octave will actually have a noise bandwidth much greater than 20 kHz. Furthermore, if we want to be able to quote noise figures to enable comparison between different input stages, it is valuable to quote noise voltages independently of noise bandwidth. This can be done quite easily by dividing the noise voltage by the square root of the bandwidth. The dimensions of this new figure will be "volts per root Hz",



and our result for the thermal noise of a moving coil cartridge becomes:

$$\frac{41}{\sqrt{20\,000}}\ \text{nV}/\sqrt{\text{Hz}}$$

or 0.29 nV/√Hz

Now, if we are aiming at a signal to noise ratio of 70 dB with respect to a signal voltage of 150 nV (0.15 mV), which is the expected signal level at a recording velocity of 10 cm/sec., then the equivalent input noise of the amplifier will be given by the equation:

$$-70 = 20\log\left(\frac{N}{0.15\text{x}10^{-3}}\right)$$

and is equal to 0.33 nV/√Hz.

The necessary equivalent input noise is in the same order of magnitude as the noise being generated by the cartridge itself!

Designing an input stage with this sort of noise isn't easy, especially when it is considered that the noise generated by even the quietest transistor is in the order of several nV/√Hz for usable emitter current. This is substantially worse than the requirement.

PERFORMANCE FEATURES

The total equivalent input noise of this unit was measured at 0.3 nV/√Hz. With respect to a noise bandwidth of 20 kHz, this corresponds to an input noise of 42 nV, giving a signal to noise ratio with respect to an input signal of 150 nV (0.15 mV) of 71 dB. At this level, the noise generated by the cartridge itself will be one of the dominant noise sources.

The circuit uses a symmetrical configuration with NPN and PNP transistors set up in such a way that asymmetrical distortions tend to cancel. Normally distortion products are generated differently for positive and negative signal excursions and this tends to produce second harmonic distortion products. The configuration used in this circuit results in very low second and third harmonic distortion. This has enabled a total harmonic distortion figure of around 0.0015% to be obtained.

The problem with quoting distortion figures of this order is that they are too low to be measured directly, being well hidden under the noise level. The only way a figure can be obtained is to remove the overall negative feedback, measure the distortion and then divide by the gain difference when the feedback is reapplied. Unfortunately, feedback does not affect all the distortion products equally, but the figure is still meaningful.

Another advantage of the symmetrical design of the input stage is that it does away with the need for an input capacitor. This is a definite advantage when dealing with low input impedances since the value of the capacitor would have had to be very large to obtain a flat frequency response at low frequencies.

The signal voltages present in the preamplifier are naturally extremely low and for this reason the power supply has been kept as a separate unit to reduce the possibility of 50 Hz induction from the power transformer.

A voltage regulator supplies the necessary ±6 volts. As it is critical to achieve low noise it is important that the regulator does not put noise onto the supply rails which would degrade the noise performance of the unit. Normally the voltage reference used for regulators of this type is a zener diode but, as the zener is reverse biased, it generates a comparatively large amount of noise. In this design an LED was used as the voltage reference. A red LED operated in the forward-biased mode drops a constant 1.65 volts and generates very little noise.

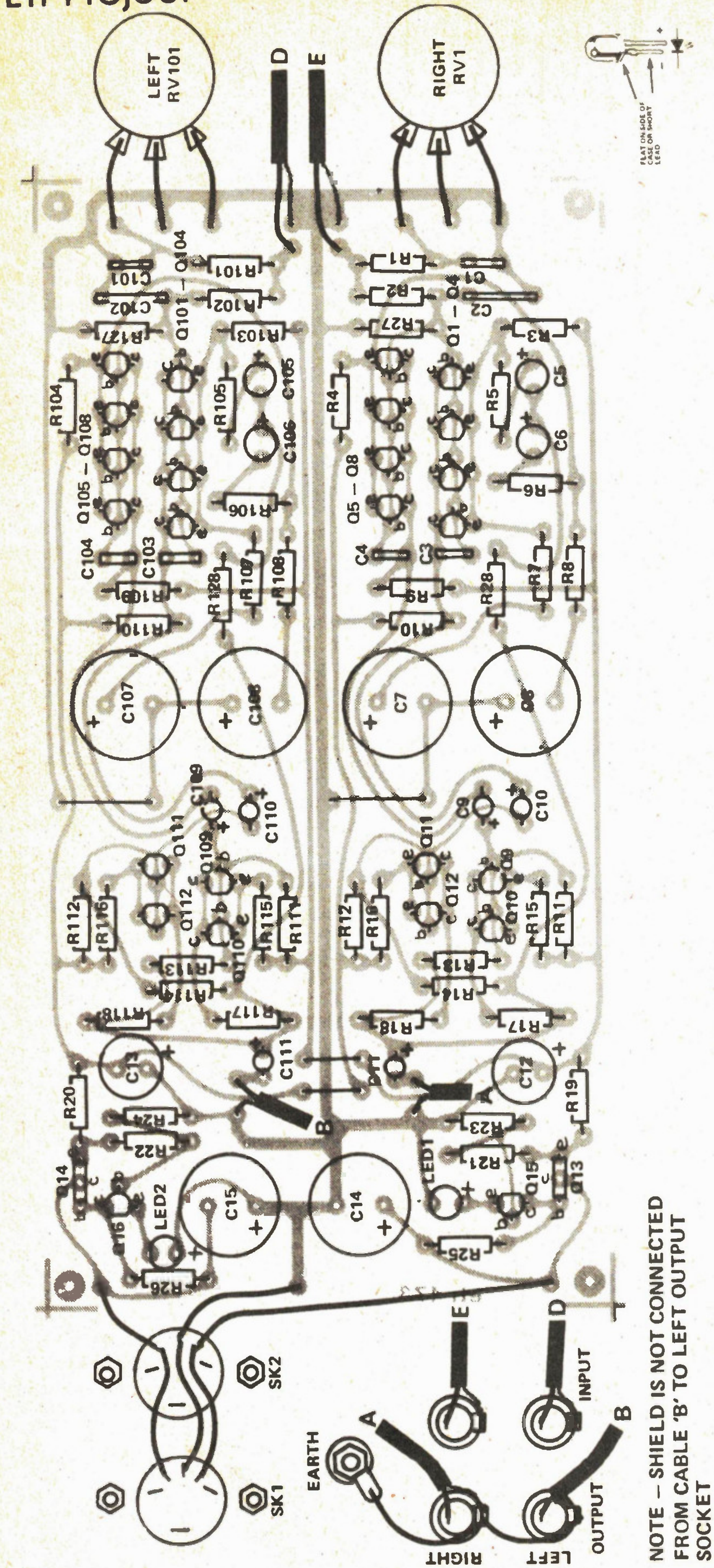
CONSTRUCTION

Construction is relatively straightforward since most components are on the mounted pc board. Other construction methods are possible but performance may not match that of our prototype.

Mount the resistors and capacitors first, followed by the transistors. Since there are quite a few transistors on the board placed close to each other, don't make the mistake I did and get them mixed up! Cut the necessary lengths of shielded cables and solder them onto the board keeping the ends as short as possible. Solder the necessary lengths of hookup cable to the board and after checking all components mount the board in the chassis.

I used a diecast aluminum box and quite frankly wish I hadn't. The shielding to external magnetic fields really isn't good enough. I found I had to be careful where the preamp was placed or it would pick up hum from the magnetic field produced by the power amp's transformer. Use a steel box if you can, if not, just be careful where it is placed.

Once the board is mounted in the chassis, the pots and rear panel hardware can be mounted and the wiring completed according to the wiring layout diagram shown. Here again I came unstuck. The first system I used to ground the shielded cables caused a monumental hum loop (and I still don't really understand why!). The final method tried is shown in the wiring diagram and this works very well. The shielded cables coming from the outputs on the board have only one of their shields connected to the output RCA sockets which are wired together and connected to the chassis at the ground terminal. This type of terminal is supplied with the necessary hardware to insulate them from the chassis. In this case however, we want the terminal to connect firmly to the case to provide the necessary ground connection. It is important that the RCA sockets be insulated from the case and that the ground connection made to them is according to the wiring diagram. If the unit is going to be used with the recommended power supply there should be no hum problems. This power supply, ETI 557, is described later in this issue. It is wired so that the O volt line is not connected to the chassis of the power supply. This is important, otherwise a hum loop around the units' line grounds will result. If you wish to use a power supply other than the 577 then it will be necessary to ensure that the O volt line from the supply does not connect to the power supply chassis. Do not 'cure' the problem by disconnecting the ground wire at the 120 volt plug as this will remove any ground connection from the power



supply chassis. This is not only dangerous, it's illegal.

POWERING UP

Before turning the unit on make a final check of the board. Check the orientation of the transistors, electrolytic and tantalum capacitors and the LEDs. If all is right, turn down the volume control completely and switch the power supply on. The LEDs in the

PARTS LIST

RESISTORS all ½W, 5%

R1, R101	3R3
R2, R102	10R
R3, R4, R103, R104	1k
R5, R6, R105, R106	2k2
R7, R8, R107, R108	10R
R9, R10, R109, R110	270R
R11, R12, R111, R112	2k2
R13, R14, R113, R114	10k
R15, R16, R115, R116	390R
R17, R18, R117, R118	18R
R19, R20	10R
R21, R22	560R
R23, R24	330R
R25, R26	220R
R27, R127	1k
R28, R128	220R

CAPACITORS

C1, C101	3n3 ceramic
C2, C102	4n7 ceramic
C3, C4, C103, C104	470p ceramic
C5, C6, C105, C106	22μF 16V tantalum
C7, C8, C107, C108	2200μF 25V electro
C9–C11, C109–C111	10μF 16V tantalum
C12, C13	100μF 25V electro
C14, C15	1000μF 25V electro

TRANSISTORS

Q1–Q4, Q101–Q104	2N5086
Q5–Q8, Q105–Q108	MPS 6515
Q9, Q10, Q109, Q110	2N5086
Q11, Q12, Q111, Q112	MPS 6515
Q13	TIP 29C
Q14	TIP 30C
Q15	MPS 6515
Q16	2N5086

LED1, LED2	standard red LED

POTENTIOMETERS

RV1, RV101	100R wirewound linear

MISCELLANEOUS

SK1, SK2 . . . 5 Pin DIN socket
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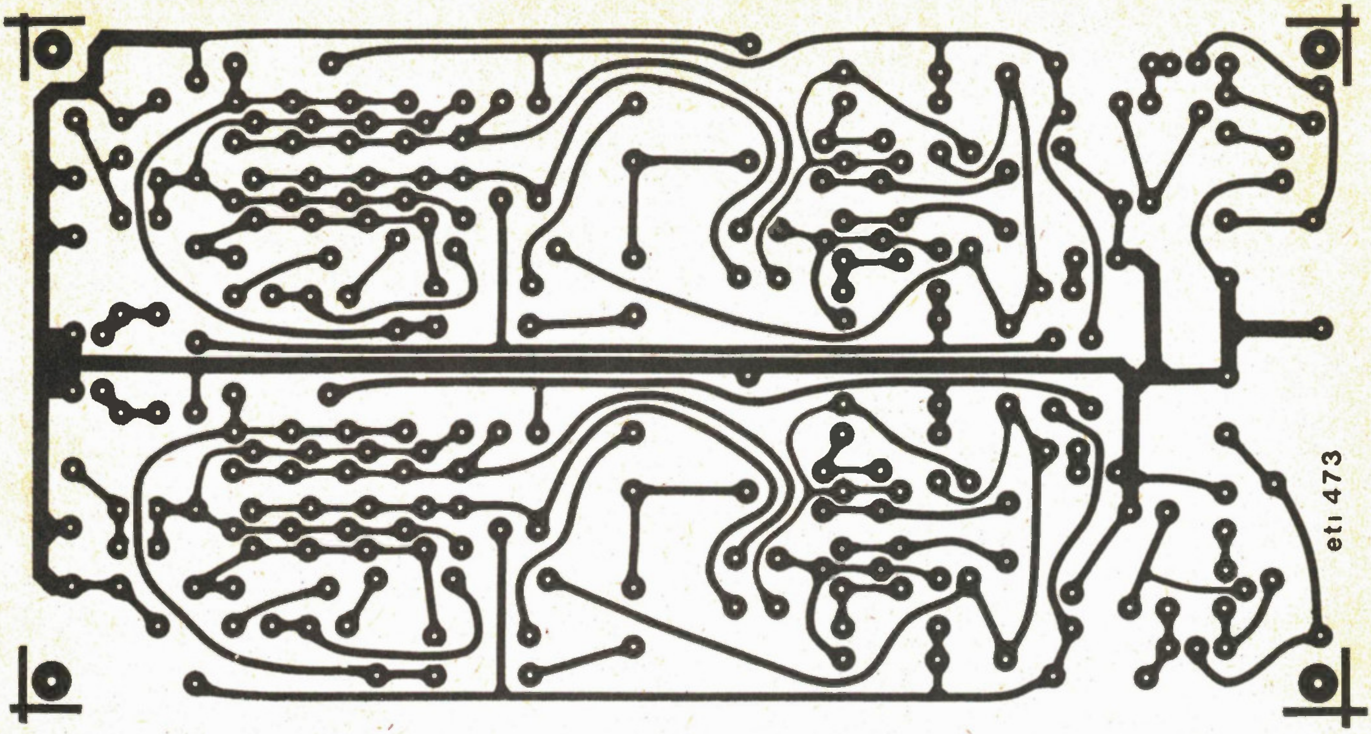
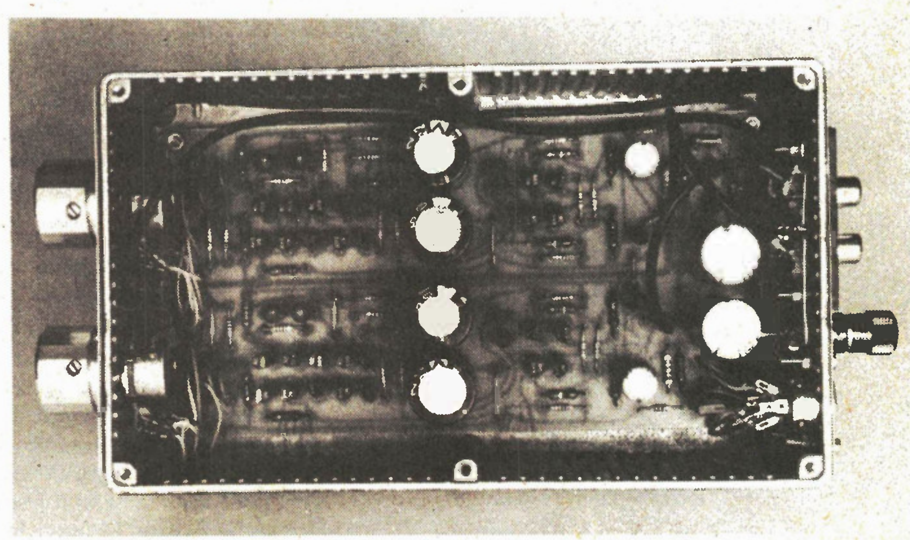


preamp's regulator should come on immediately. I used standard RCA to RCA cables from the output of the preamp to the phono input and had some trouble with hum induction into the leads. Fortunately, we had been sent a set of Audio-Technica type AT620 cables for evaluation several days before and these cured the problem completely.

Perhaps I am biased, but the sound quality of this preamp is extremely good! Using a Nakamichi MC1000 cartridge, this preamp showed distinct improvement over the transformer I was using previously. There is an openness that never existed before and the bass end showed a great improvement being firmer and much more defined. I trust you'll be as satisfied with your project as I have been.



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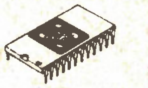

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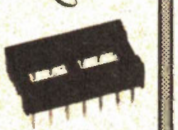

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Egg Timer

Jonathan Scott is generally otherwise occupied while his breakfast eggs are on the boil — or so he tells us. "Having to get up in the morning is tedious enough without having to keep your eyes peeled for when the egg timer runs out", he says. An interesting argument, and an interesting solution. . .

OKAY, so you've *got* an egg timer. Odds on it's nothing like this one!

Conventional egg timers — the coloured-granules-in-a-three-minute-hour-glass variety — do their job efficiently, but silently. You have to watch them to see when your egg is ready. Either you stand and stare at it for the duration or you need sharp wits to instinctively 'know' when the time's up. Lack of audible indication on conventional egg timers is a consequence of inadequate design. Lack of sharp wits in the morning is a consequence of soft living.

This project tackles the first problem, the second is up to you!

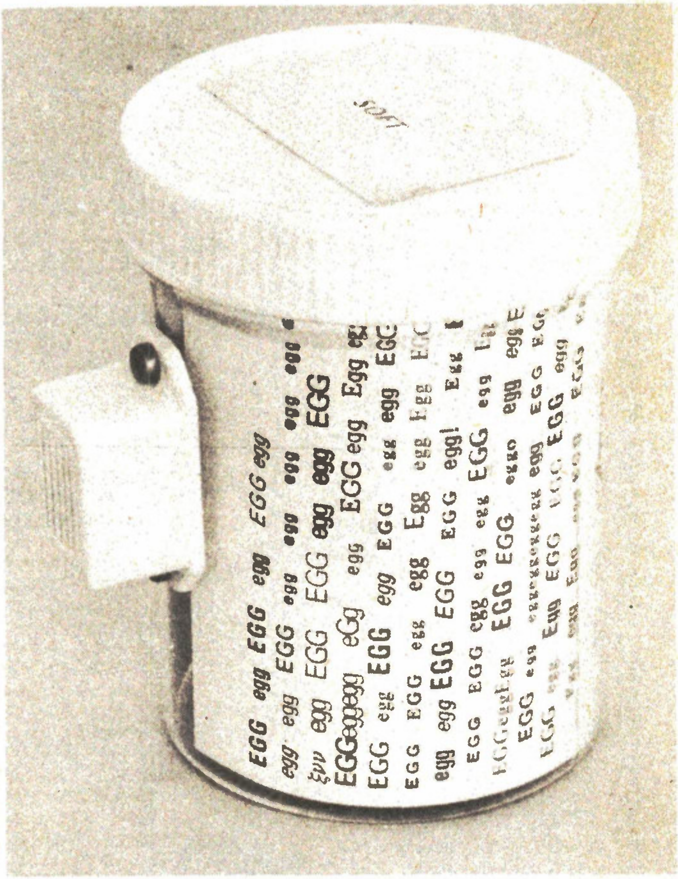
FEATURES

Conventional egg timers (even electronic ones we've seen) lack the option of 'hard' or 'soft' timing. Even if the electronic ones have an audible indication, they have the disadvantage of including an on/off switch.

This egg timer project includes the hard/soft option, does not include an on/off switch and 'bleats' when your egg is ready. We could have had it go 'cluck, cluck' or even 'cock-a-doodle-doo', but considered this a little *too* corny, and besides, it complicated the project unnecessarily!

Operation is very simple. First, you pick it up and shake it — the device lets you know with a soft bleep when it's been shaken enough. You then put it down on one end. Which end depends on whether you want a long time period (for a hard egg) or a shorter period (for — you guessed it — a runny one). After the appropriate period has elapsed the timer will issue a one second-long bleat and turn itself off until shaken awake again.

Has it got a microprocessor inside?



The egg timer is 'set' by giving it a few good shakes and setting it down on one end. The ends are labelled 'hard' and 'soft' — according to how you like your egg, you set it down on either one end or the other. An on/off switch is unnecessary.

No, it's all done with one CMOS IC, a couple of transistors and a dollar's worth of mercury switch.

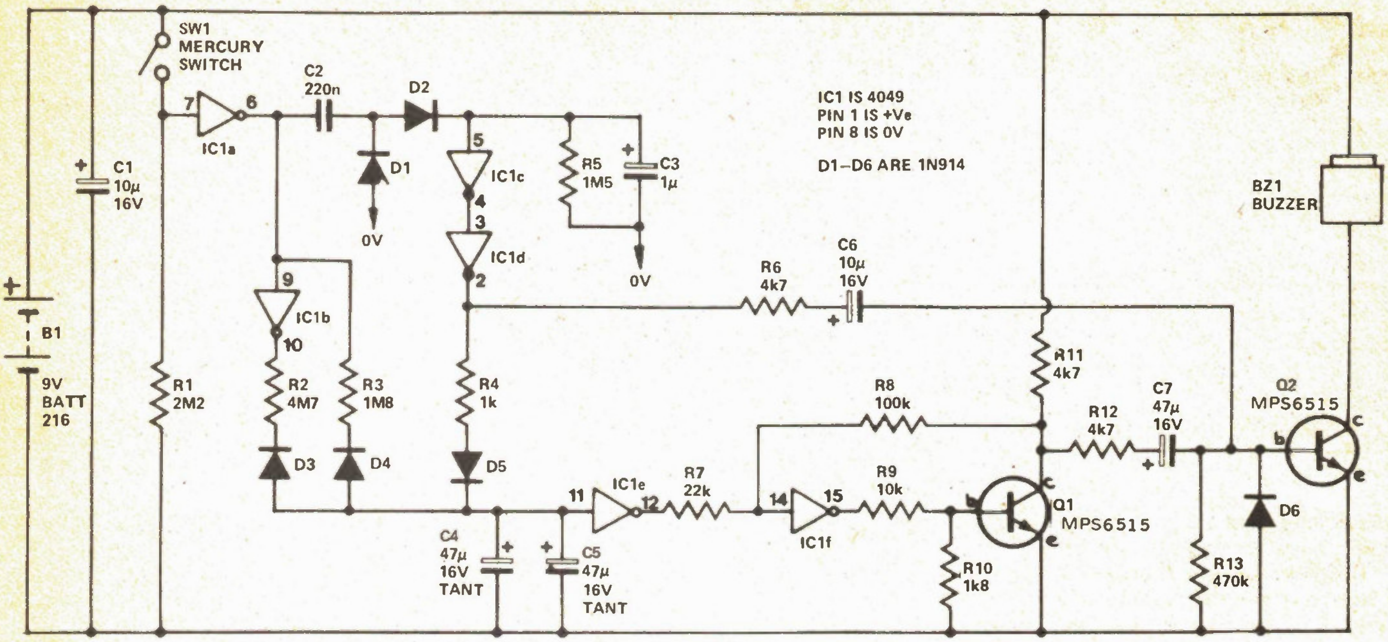
CONSTRUCTION

The project is best constructed on the printed circuit board designed for it. Be sure to get the IC, transistor and diodes correctly oriented when inserting the components in the board. Take care also with the electrolytic capacitors

Carefully follow the overlay diagram and you should experience little difficulty.

The choice of a housing for the project depends a little on your kitchen decor — select a container that's large enough to enclose the pc board and battery though. We've used a plastic jar and a salt shaker as examples.

However, that plastic ornamental



One CMOS IC, two transistors and a handful of components make up this timer. No on/off switch is necessary.

emu's egg that Aunt Aggie gave you for Easter may do just as well – assuming it will stand securely on either end (. . . maybe that's not such a good idea after all).

The buzzer may be mounted either onto the outside of the container or on the inside. The latter will result in a loss of volume though. A few holes in the case will allow the buzzer to be heard better if you wish to mount it inside.

The whole assembly should be packed in the container chosen using sponge rubber scraps – it has to stand a lot of shake, rattle and roll.

When you do this, make sure that the metal case of the battery does not come in contact with the copper side of the pc board.

ADJUSTMENTS

If you like your eggs super hard – or perhaps extremely runny, or even somewhere between these extremes, the time periods may be changed by altering the value of R2 or R3 – one will alter the softness of the 'hard' egg, the other the density of the 'soft' egg. See 'How it Works' for an eggsplanation of the circuit operation (these puns will have to stop . . . Ed.).

HOW IT WORKS

The timing period is initiated by shaking the egg timer. Initially, C3, C4 and C5 are discharged and both transistors are biased off. IC1a is a buffer whose output is high when SW1 is open and low when it is closed. Shaking the timer will therefore cause an alternating voltage to appear on the output of IC1a. C2, C3, D1 and D2 form a rectifying network which charges C3 using this output of IC1a. Once C3 has charged past the threshold voltage of IC1c (indicating that the timer has been shaken), two things will happen: Firstly, C6/R6 will pass current to turn-on Q2 and thus the buzzer, to indicate that it has been shaken enough. Secondly, C4 and C5 start charging via D5 and R4. When C4 and C5 have charged to the threshold voltage of the Schmidt trigger formed by IC1f and Q1, Q1 will turn on and terminate the bleep.

Meanwhile, C3 will have discharged through R5 (assuming you're not still shaking the thing) and IC1c and IC1d will have reverted to their original state.

C4 and C5 will then discharge via either R2/D3 or R3/D4, depending on whether SW1 is closed or open. This is the really clever part. SW1 is now only used to start the timing period but, depending on which end of the device is uppermost during that timing period SW1 will either be open or closed and either R2 or R3 will determine the length of the period.

When C4/C5 have discharged sufficiently, Q1 will switch off, charging C6 via the base of Q2, causing the final one-second beep.

Not bad for one CMOS IC, eh?

PARTS LIST

Resistors all ¼W 5%

R1	2M2
R2	4M7
R3	1M8
R4	1k
R5	1M5
R6	4k7
R7	22k
R8	100k
R9	10k
R10	1k8
R11, R12	4k7
R13	470k

Capacitors

C1	10μ 16V electro
C2	220n greencap
C3	1μ 16V electro
C4	47μ 16V tant
C5	47μ 16V tant
C6	10μ 16V electro
C7	47μ 16V electro

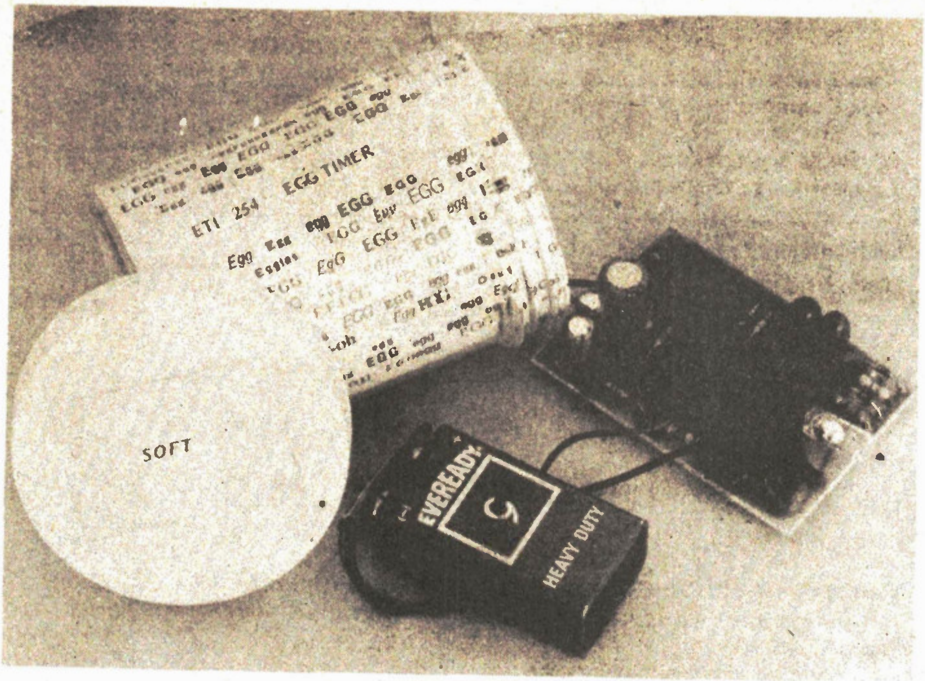
Semiconductors

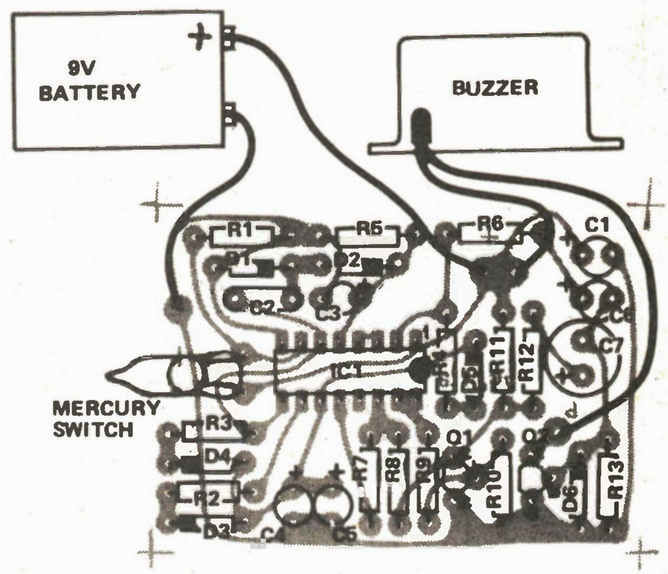
D1-D6	IN914 or sim
Q1, Q2	MPS6515
IC1	4049

Miscellaneous

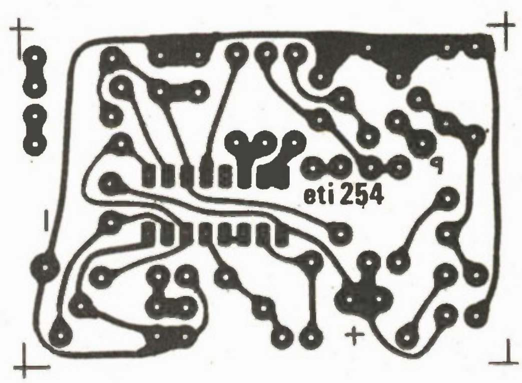
B1	9 volt, battery
BZ1	piezo electric buzzer
SW1	Mercury switch

Suitable container, battery clip, packing material, ETI 254 pcb.



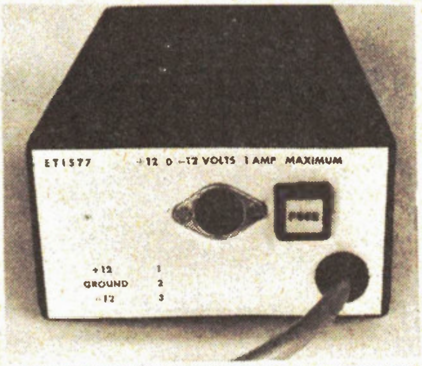


Printed circuit board overlay. (overLAY?). Take care with the orientation of the diodes and electrolytic capacitors.



General Purpose Power Supply

Whilst this supply was designed specifically to power the Series 4000 moving—coil cartridge preamp it should find application in many electronic projects.



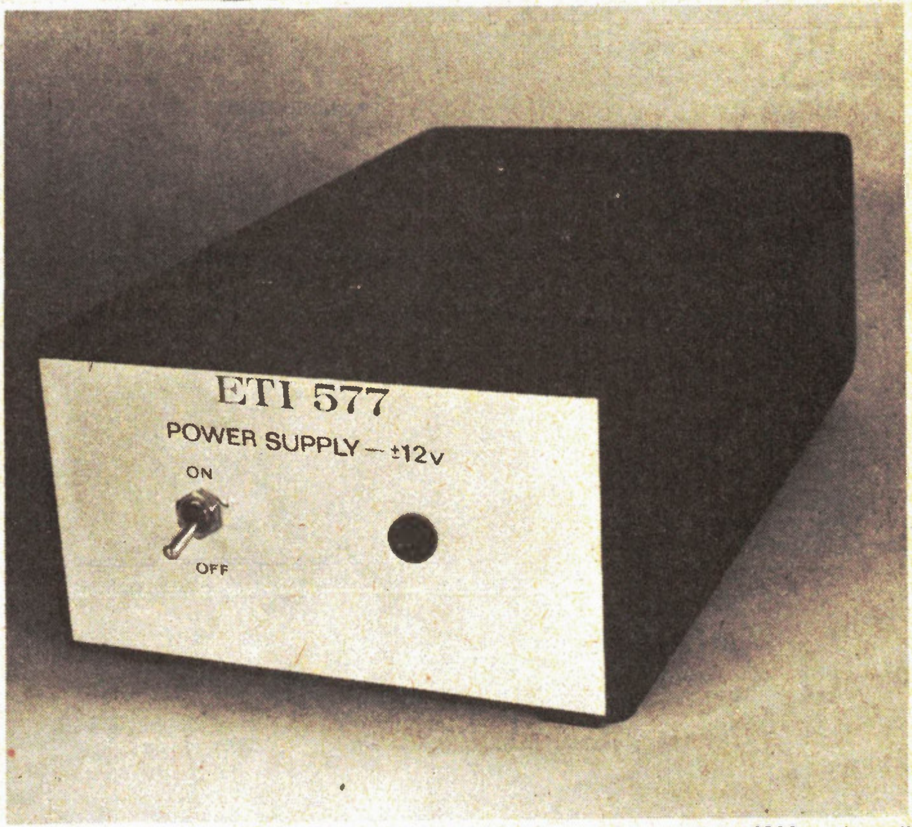
Rear view of the power supply

THIS POWER SUPPLY provides the +/-12 volts needed by the Series 4000 moving coil cartridge preamplifier. We intend designing a range of hi-fi system 'add-ons' like the M.C. preamp and rather than have a power supply in each unit they will be powered from this supply. This decreases the cost of building the units and just as importantly removes the major source of hum from within the chassis.

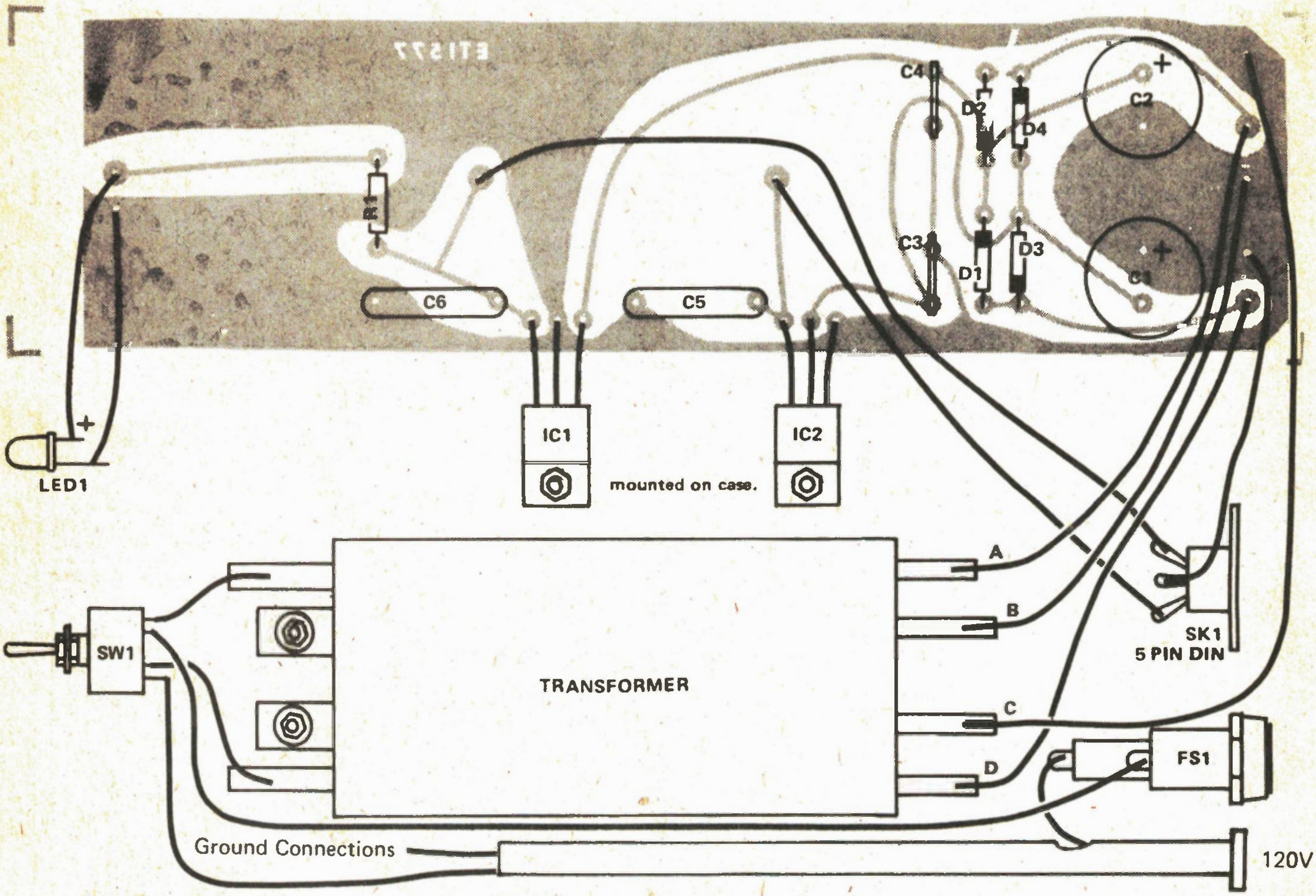
The supply delivers positive and negative 12V dc at 1A while the IC series regulators provide short circuit and temperature protection. These regulators have a tendency to oscillate at around 3 MHz and for this reason must have their output pins bypassed to ground through an appropriate capacitor. If they are allowed to oscillate the device quickly overheats and its thermal protection cuts in.

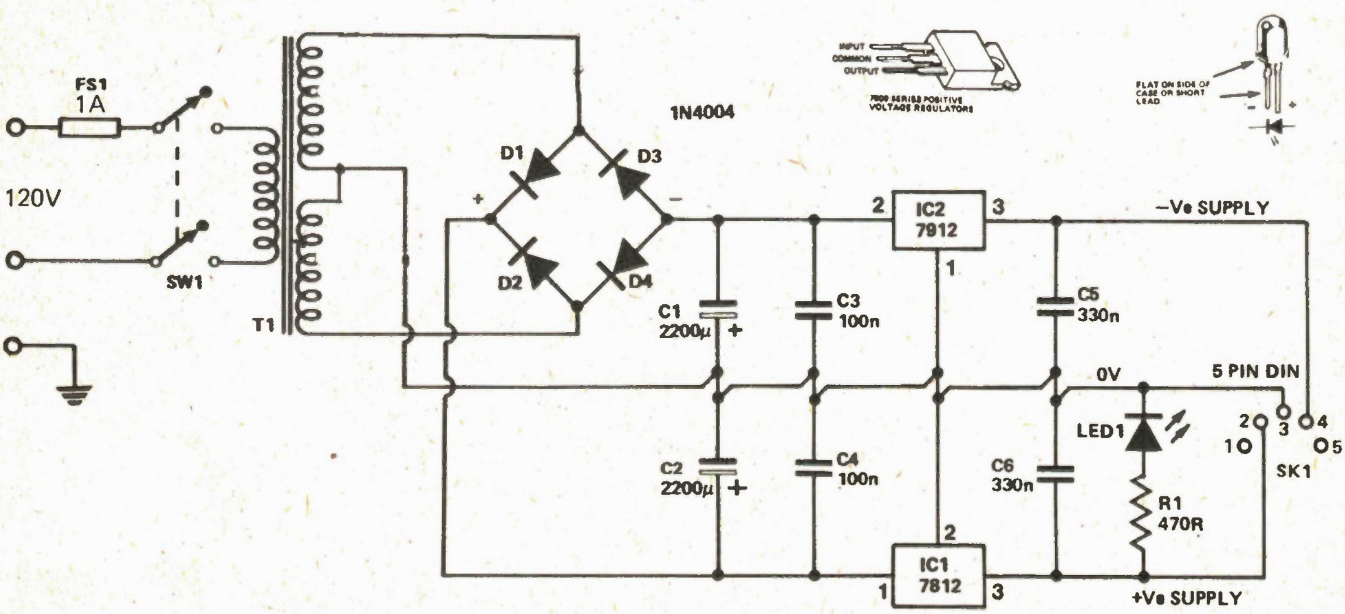
The regulators are mounted onto the chassis which acts as a heat sink. If the recommended power transformer is used, the voltage after rectification is approximately 17 volts. The regulators must drop 5 volts at a worst-case current of one amp, so they are dissipating a maximum of five watts which is well within their ratings.

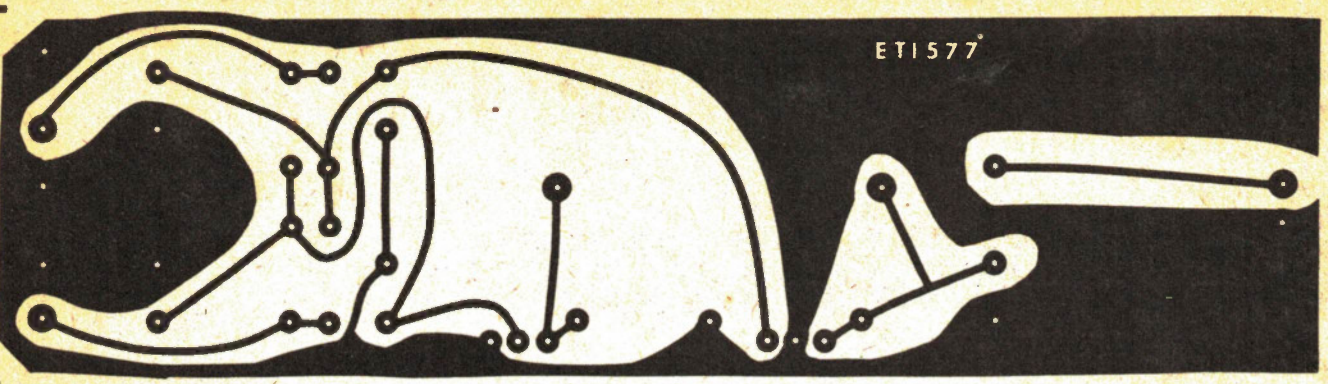
Assembly of the pc board is not difficult as it has relatively few components. If you are using the same box we did it is easier to solder pc board pins onto the board, slot the board into place, bolting the regulators down, and then make the necessary wiring interconnections. Both regulators must be insulated from the case using the appropriate mounting hardware. The case of these regulators is connected to pin 2. For the 7812 this is the ground connection, and accidental connection to case will cause a hum loop when the unit is connected to the moving coil cartridge pre-amp. In the 7912, pin 2 is the input to the regulator and as such has 17 volts directly from the bridge rectifier connected to it. Accidental connection of this to ground will probably damage the rectifier diodes, so check with a multimeter that the case of this regulator is well insul-



Our prototype was housed in a diecast box to match that used for our Series 4000 moving-coil cartridge preamp, although any suitable box may be used if the power supply is intended for another application.


ETI577
C4
C2
D2
D4
R1
C3
D3
D1
C1
C6
C5
IC1
IC2
LED1
mounted on case.
TRANSFORMER
A
B
C
D
SW1
SK1
5 PIN DIN
FS1
Ground Connections
120V


FS1
1A
120V
SW1
T1
1N4004
D1
D3
D2
D4
IC2
7912
IC1
7812
−Ve SUPPLY
+Ve SUPPLY
C1
2200μ
C2
2200μ
C3
100n
C4
100n
C5
330n
C6
330n
0V
5 PIN DIN
LED1
R1
470R
SK1
INPUT
COMMON
OUTPUT
FLAT ON SIDE OF CASE OR SHORT LEAD



ated from the chassis before powering up.

The LED is mounted onto the front panel with a standard LED mounting grommet and connected to the board by two short lengths of hook-up cable.

Make absolutely certain that all 120 volt connections are secure and that the line cable ground lead is connected to chassis as shown in the wiring diagram. The line cord must be secured to the chassis, either with a clamp-type grommet where it enters the box or with a cable clamp on the inside.

Before applying power to the unit make a final check of the board and all connections to the power transformer. Check the 120 volt connections and ensure that the regulators are satisfactorily insulated from the chassis. If all is correct, turn the power supply on. The LED on the front panel should come on immediately. Check the voltage present on the output DIN socket which should be very close to 12 volts (certainly within 0.25 V). Make sure the positive and negative supply connections terminate on the correct DIN socket pins.

HOW IT WORKS

Line 120VAC is applied to the primary of the transformer via a 1A fuse. The transformer secondary consists of two 15 V windings with tappings at 12 V. The 12 V tapping of one is joined to the O V of the other — this junction (effectively a centre-tap) forming the O Volt rail.

A bridge rectifier D1-D4 rectifies the ac voltage from the transformer and supplies around 17 volts to the inputs of the regulator ICs. Capacitors C1-C4 filter the input to the regulators while C5 and C6 ensure high frequency stability of the regulators.

The IC regulators provide a stable, regulated output very close to the specified 12 Vdc and can supply up to one amp of dc current. Overload and thermal protection is provided internally on the IC chip. These regulators are convenient, inexpensive and require the minimum number of components.

PARTS LIST

Resistors — all ½W, 5%
R1 . . . . 470R

Capacitors
C1, C2 . . . . . 2200µF 25V electro
C3, C4 . . . . . 100n greencap
C5, C6 . . . . . 330n greencap

Semiconductors
D1–D4. . . . 1N4004, or sim
LED1. . . . . . Red led, TIL220R or sim
IC1 . . . . 7812 or LM340-12 voltage regulator (positive)
IC2 . . . . 7912 or LM320-12 voltage regulator (negative)

Miscellaneous
T1. . . . . transformer, 15V-0-15V, 1.3 amps
SW1. . . . . . . DPDT switch
F1. . . . . 1A, 3AG type fuse
SK1. . . . . . . Chassis mounting 5 pin DIN socket

Chassis mounting 3AG fuse holder, 5 pin DIN plug, Diecast aluminum box 190 x 60 x 110 mm.

Get Going On Radioteletype

For the avid communications enthusiast radioteletype RTTY can offer an extra 'fillip' to hobby pursuits. Radio amateurs have been exploring this communications mode increasingly in recent years as have a small band of shortwave enthusiasts. Join the gang — it's easier than you think! An excellent design from our Australian Office.

Tom Moffat
VK2TM

THIS IS the first of a short series of articles covering the construction of a complete radioteletype system. Designed for easy home construction in self-completing stages, the project modules use commonly available components and will enable you to build a complete receiving and transmitting system, centred around the Teletype Corporation Model 15 machine readily available from surplus sources.

Construction is modular, so after each stage is finished you have something that works. Each succeeding stage allows the system to do more, until the system is complete. Modules to be described are a *demodulator, modulator with cassette interface, regenerator/ speed converter, input filter*, and a *tuning oscilloscope*.

Ready? Lets get started.

The teleprinter is a clattering old bucket of bolts, or one of the finest machines ever devised by man — depending on your point of view!

They've been around for years, sending and receiving telegrams, churning out wire service news copy, and doing a myriad other jobs where it's necessary for written material to be sent from one place to another quickly.

As newer (quieter and faster) machines come into service, many old ones are finding their way into amateur hands. Most of these are Teletype Model 15s and Creed Model 7s. Although considered useless in commercial circles, these machines are ideal for two-way communication on the amateur bands, as well as a bit of eavesdropping on HF news and telex circuits. In Australia the teletype Model 15 is much more common than the Creed, so this series concentrates on the Teletype, although similar principles apply to the Creed.

THE LOOP

The correct current to operate the selector magnets is around 60 mA. A quick Ohms law calculation will show that this current will flow with 12 volts across them. Many teletype converter construction articles show the magnets working from 12 V pulses, but it can be mathematically shown that this arrangement results in 40% distortion.

Here's why — the selector magnets are really two big inductors in series, and as we know, inductors oppose the flow of current. With 12 V applied it takes about 8 ms, or 40% of a pulse length, before the current builds up enough to close the magnets. The solution is to hit the magnets with a higher voltage so that the current builds up faster. But, a higher voltage causes more than 60 mA to flow, so a series resistor is required.

If a loop voltage of around 150 is used, the time for full current to build up in the selector magnets falls to around 1% of a pulse length. When the loop circuit first closes the full 150 V appears across the magnets because the inductor looks like an open circuit until current begins flowing. As current begins to flow the voltage across the magnets drops, the voltage across the series resistor then rises until a stable condition of 60 mA is reached. So, the loop voltage should be as high as possible. The limiting factor is the maximum voltage the switching transistor in the receiving converter will take. Voltage regulation is not important so a very simple loop supply circuit will suffice.

The transformer should be able to supply 60 mA continuously, and stay cold to the touch. The loop resistor will dissipate about 10 watts, so a resistor of about 2k5 ohms, 25 watts would be ideal. Some provision must be made for adjusting the resistance to set the loop current to 50 mA.

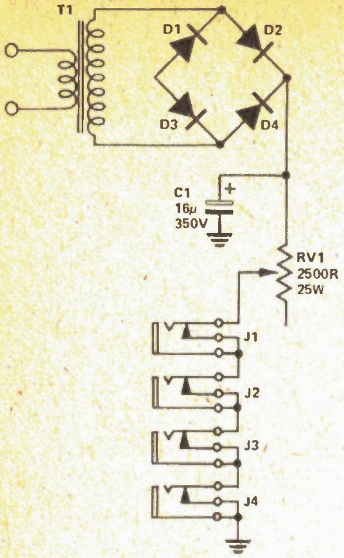
Once the machine is going, have a good fiddle with it, learn all its tricks. And perhaps now is a good time to learn to type!

RECEIVING CONVERTER

Now that you've got your teletype machine running on 'local loop' it's time to get it doing something useful, other than talking to itself. This section describes a receiving converter that takes the audio tones coming from a receiver and converts them into a series of dc pulses to drive the printer magnets.

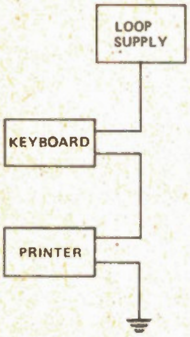
First, a look at the nature of the teletype signal:

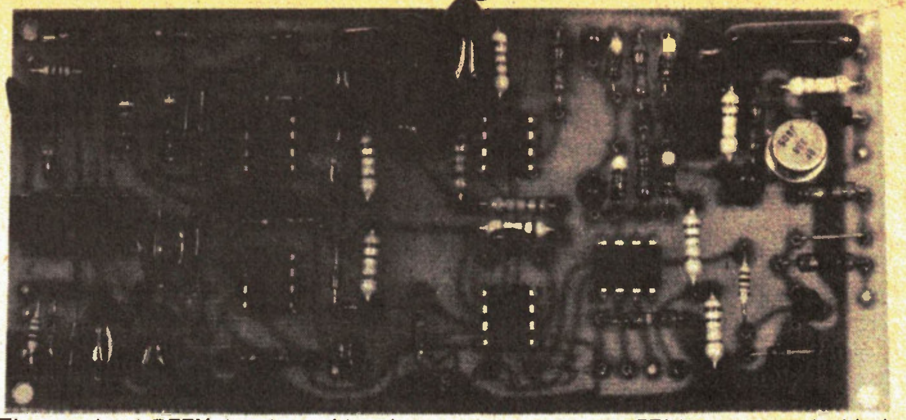
Pulses from the sending machine are arranged to frequency-shift key an HF transmitter so that during 'mark' a constant carrier of some frequency is transmitted. During 'space' the carrier swings higher or lower in frequency by an amount known as the 'shift'. Amateur stations normally transmit 170 Hz shift, and commercial stations transmit 440 or 850 Hz shift, although 170 Hz is sometimes seen. The narrower shifts are usually considered better as the two frequencies, being closer together, are less affected by selective fading. But, the equipment used to receive narrow shift must be more precise to pick one frequency out from the other.



LOOP SUPPLY

The transformer, T1, has a 125 Vac secondary rated at 250 mA. The diodes are 400 PIV types or a bridge. The jacks, J1 - 4, are shorting type 'phone jacks (insulated from case). To check out your machine, connect the 'bits' as shown below.





The completed RTTY decoder — this unit was constructed in the ETI lab. and tested with the kind assistance of Widge Lowe VK2ZWL. It compares very well with other popular units.

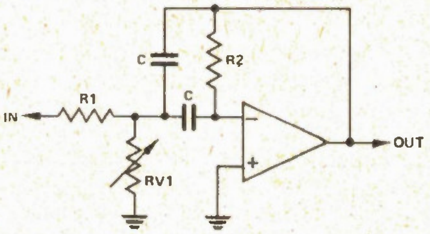


Figure 2: **General circuit of the active filters used in the decoder.**

This converter allows the copy of any shift from about 10 Hz to 1000 Hz, by simply setting a front panel control. It will operate alone, or as part of a more elaborate system. For stand-alone operation it needs a +12 and −12 volt supply, an audio input from an SSB receiver, and a connection into the loop supply. When used with the regenerator/speed converter to be described later, a jumper on the board is removed and logic-level signals are taken from the collector of Q1. The regenerated signals are fed back into the base of the loop switch transistor Q2. The converter gives a very good account of itself in received error-rate tests against some of the more popular 'ready-made' designs, mostly because of the type of filters used.

THE FILTERS

The received signal emerges from an SSB receiver as a pair of audio tones, by convention 2125 and 2295 Hz for 170 Hz shift. Either tone can represent the mark condition. In amateur RTTY service the mark tone is the higher one, although 'upside-down' signals are sometimes found. This converter can take them either way and squirt them out the right way around, selected by the flip of a switch.

Many older converter designs use passive filters, using toroidal inductors and capacitors, to detect the audio tones and turn them into dc voltages for the logic circuitry. Two problems arise. Once the filters are tuned there's no easy way to change their frequencies for different shifts. As well, they're

THE TELETYPE MODEL 15

IF YOU'VE recently acquired a Model 15, chances are it's older than you are. Many were built during the second World War, so they've been in continuous use for nearly 40 years. But they were built to last, like a fine watch, and in amateur service they'll probably go another 40 years! Your Model 15 will probably be in going condition, although 'stiff' if it's been in storage any length of time.

To get the machine up and running, you'll need a 115 Vac supply for the motor (step-down transformer) and a loop supply, described elsewhere. Before applying power, make these few visual checks. First, the power cord. If it's rubber it's probably rotten. Replace it. There are probably two other cords with telephone plugs on them. Check their condition also.

Next, remove the machine cover by first pulling off the paper crank on the left hand side and lifting the case straight up. Check for any bits of string or wire used to hold the works in place during transport. Also check for any packing material that may be inside . . . one machine I know of had been packed in wood shavings, the innards were full of them, all nicely glued in place with oil!

Remove the typing unit by unscrewing the three or four large knurled screws holding it to the base. Lift it straight up and set it aside. Inspect the keyboard mechanism and motor assembly for foreign matter. When all looks well, replace the typing unit.

Make these electrical checks using an ohmmeter. Check across the power cord . . . it should show a few ohms resistance with the on/off switch (on the right side of the machine) on; it should look wide open with the switch off. Check each side of the power cord to the machine base. Any leakage foreshadows potential shocks, which the teletype is capable of delivering with considerable efficiency!

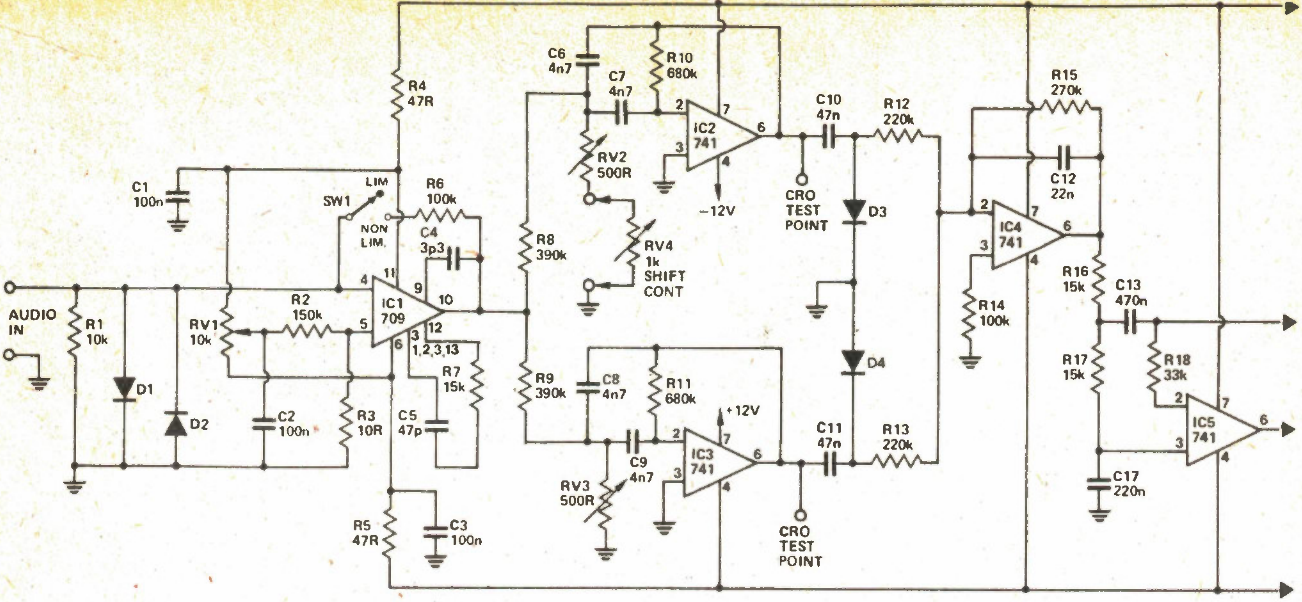
Now check the other two cords. One should show about 200 ohms from tip to sleeve, this is the receive line. The other should show a short. This is the send circuit.

To the left of the keyboard is a hole containing two levers, one on top of the other. The top one is the 'break' key; the other is the send/receive switch. Press down the break key and the transmit line should go open. Check both send and receive cords for leakage to earth. They should be clear; if not you've probably got some leaky capacitors somewhere or some oil has dripped into the circuitry. If the machine passes all these checks it's time to power it up.

The Smoke Test

First, apply 115 Vac to the power cord and switch on the motor. The machine should 'run open' with the innards rotating and the typing head jumping up and down. There should be no grinding noises. If there are find out where they're coming from before proceeding. Also, check between the machine base and a good ground for any voltage . . . there will probably be some indication due to insulation leakage. If it's not very highground the machine base, and leave it earthed from now on.

With the machine turned off insert the send and receive plugs in any two loop supply jacks. Adjust the loop resistor for 60 ma, measured with a milliameter plugged into one of the remaining jacks. Now turn on the power. The machine should remain still, with only the motor and main drive shaft running. Carefully observe the area around the drive shaft, watching for smoke,



usually set up to have equal Q, so with the same Q and different centre frequencies the bandwidths will be different. The bandwidth of a filter affects the shape of the detected pulse – the narrower the bandwidth the more rounded the square pulse becomes.

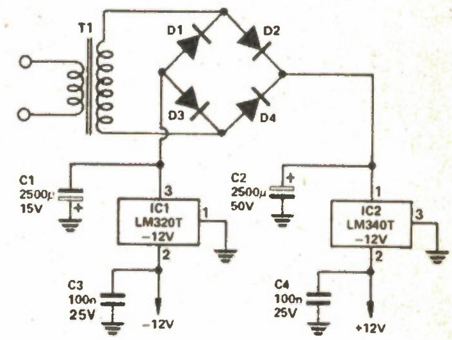
This converter uses constant bandwidth active filters. Obviously, with constant bandwidth, their Qs will be different but who cares?, it's the bandwidth that counts.

The general circuit is shown in Figure 2. Resistor R1 mainly affects the gain of the filter, which in our case is set for slightly less than one. Resistor R2 affects the bandwidth. This is set for 100Hz as a compromise between easy copy of very narrow shifts and the amount of receiver tuning required to keep the signal within the filter passbands. Resistor RV1 affects the frequency only, so by varying RV1 you can tune the centre frequency wherever you want while maintaining a bandwidth of 100Hz.

In this coverter, both filters are identical, tuned by trim pots to 2295 Hz. But the lower frequency filter has another pot in series (the shift control) so its frequency can be pulled down to the lower tone of 2125 Hz, or whatever.

CONSTRUCTION

Once the board is etched and drilled, insert the component in the usual way, starting with the smallest. Try to get the resistors running all the same way to make the diodes, tantalum capacitors, IC's etc, are the right way around. PC board pins are handy for external connections.



There is a jumper on the power rail near the top of the board that must be installed. For stand-alone operation the top of R26 must be connected to the +12 V supply and a jumper inserted between the collector of Q1 and Q2's base resistor, R27. Connect + and – 12 volts and earth to the appropriate

ominous smells, or squeaking noises. There is a slipping clutch that prevents the machine from turning over; if it is dried up or too tight the resulting friction will cause smoke.

Operate the keys, and the machine should print. Run the machine for about ten minutes, then disconnect the power, remove the case, and feel the motor. It should not be uncomfortably hot. If it is, the machine is putting too much strain on it, or the motor itself is stiff and surgery is required.

Lubrication

It's probably a good idea to lubricate the entire machine, starting with the motor. Even if it doesn't run hot it's good for the peace of mind to know the motor is clean and properly greased.

Remove and disassemble the motor, noting exactly how it comes apart so it will go back together easily. There are two possible motor versions — syncronous and series governed — but there's nothing special about them mechanically. Just be sure the brushes, commutator, and bearings are all cleaned and in good condition. Although the Teletype Corporation specifies a special grease for the motor and gears, Golden Fleece Duralith 2A is suitable.

With the motor reassembled and back in position, dab some grease on the large gears in the drive chain and then switch the machine on. The gears should run freely without any backlash. This can be adjusted by shifting the motor around on its mounts.

Next comes the machine itself. Pour some light machine oil into a small bottle cap and fashion an oiling tool from a piece of number 22 wire. Dip the wire end into the bottle cap — the amount of oil it retains is the correct amount for each oiling point. Touch a drop of oil to each moving part. Oil everything in this way, in both printer and keyboard. The felt washers in the clutch assembly should be saturated. Wipe up any drips, and make sure no oil gets on any electrical contacts, especially those in the keyboard.

Adjustment

The only adjustments that should be attempted by the amateur new to teletype are machine speed and range setting. If there are other problems, it would be best to seek out the help of an experienced teletype repairman or at least another amateur who is more familiar with such things. If your machine has a series governed motor, you now have to decide what speed to set it on. If it has a syncronous motor, you're stuck with whatever speed it came with, unless you change the motor and gears.

The series governed motor has a drum on the back marked with black and white stripes around its perimeter. At the back of the drum are two slip rings and a slot with a rubber tyre protruding through it. The rubber tyre is the speed adjustment. The standard operating speed for amateur use is 45.45 bauds, or 60 words a minute. Most commercial circuits (or at least the ones you'll be able to copy) run at 50 bauds, or 66 words a minute. The machine speed must be syncronized to the transmitter speed or the machine will print garble.

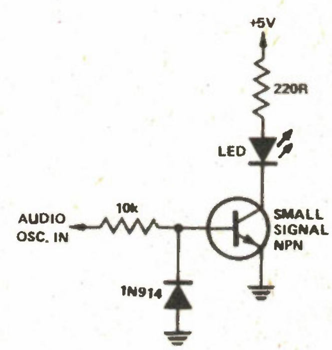
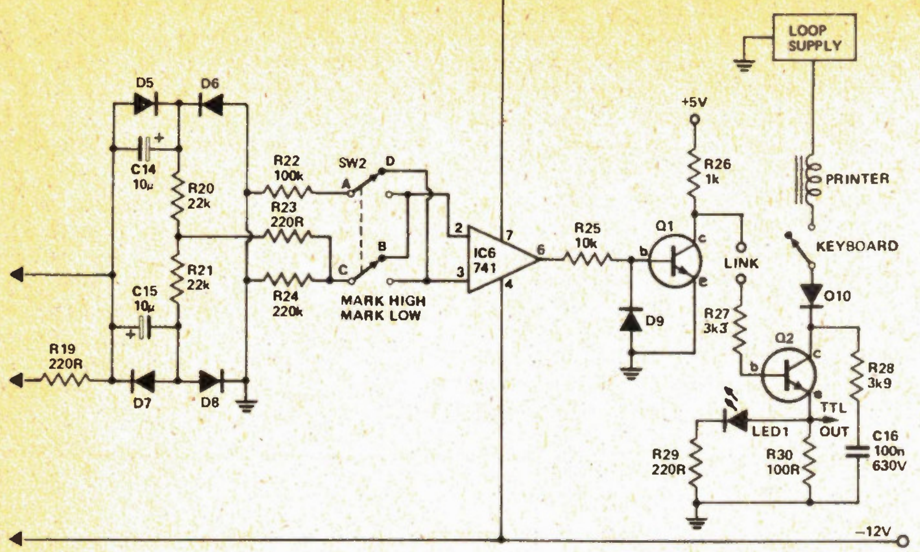
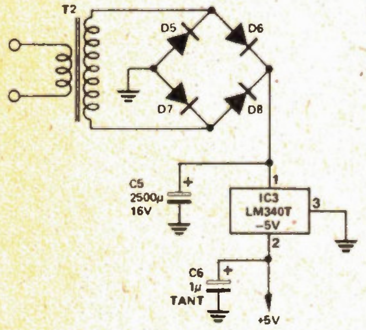


Figure 1. **Circuit of a simple stroboscope that may be used to adjust the machine's speed.**





The two circuits at left show the system power supply. The complete system requires +12, -12 and +5 volts. Design is conventional using three -terminal regulators, the two transformers were used as they were in hand although a single one would be better.

T1 – 12.6-0-12.6 Vac; T2 – 6.3-0-6.3 Vac; both 250 mA D1 – D8 : 100 PIV, 1A diodes or two bridges.

points, and connect the 'loop' output to the bottom of J4 in the loop supply. A small switch connected across the loop line to the converter will allow the loop to be closed for local testing while the converter is switched off.

ALIGNMENT

Equipment required: CRO*(best) VTVM (second best) and an audio oscillator. For absolute accuracy a frequency counter would be a help.

Begin by shorting the audio input to the converter. Attach the CRO to pin 10 of IC1 and adjust RV1 for a noise trace centred about zero volts. If a VTVM is used adjust for zero volts. It will jump around a bit so go for an average.

* an oscilloscope in Canada (ed)

HOW IT WORKS

IC1 is either a hard limiter or a buffer amplifier, depending on whether R6 is switched in. IC2 and IC3 are the mark and space filters. Their outputs are rectified by D3 and D4 and then combined into a dc level that swings high and low with the teletype pulses. IC4 and IC5 form a low pass filter that restricts transitions from the filters to the 50 baud rate or less. It effectively reduces the noise bandwidth of the system. D5-D8 and associated components are a circuit to cancel some bias distortion caused by selective fading. They average the mark and space transitions and set one side of the comparator half way between them. IC6 is the comparator, which squares the swinging waveform from the anti-distortion circuit. It's inputs can be reversed by a switch to allow 'upside-down' copy.

Q1 is a TTL/CMDS 5 V logic driver, which can also be used with +12 V to drive the loop switch directly. Q2 is the loop driver, requiring +12/0 V logic levels. The components in its collector circuit smooth out inductive kicks from the printer magnets. When loop current is flowing Q2's emitter is pulled up to +5 V; this voltage follows both received signals and keyboard signals and so becomes the logic signal to drive the modulator. The LED indicates the flow of loop current.

Next, connect the oscillator to the audio input and set it exactly for 2295 Hz. Adjust the shift control for minimum resistance. Connect the CRO or VTVM to pin 6 of IC3 and adjust RV3 for maximum indication. Now observe pin 6 of IC2 and adjust RV2 for maximum. Set the oscillator to 2125 Hz, and adjust the shift control for maximum indication from IC2. Now set the oscillator back to 2295

If the motor is badly off speed, probably because the governor has been fiddled with, you can set it roughly on speed in the following manner:

Starting from the left of the page, hold down the space bar, causing the machine to send continuous spaces. It should take about ten seconds before the 'end of line' bell rings. For the fine adjustment a stroboscope is required, and one can be made up quite easily by connecting a red LED directly to a square wave audio signal generator. Most generators have enough output to drive the LED directly; if yours doesn't, use a transistor driver as shown in Figure 1. Set the generator frequency to about 5 Hz and the LED should pulse on and off. Set the output to pulse the LED as brightly as possible without blowing it up (have another LED handy just in case).

Tape the LED to the machine so that it shines on the stripes painted on the motor governor. Now set the oscillator frequency to 350.4 Hz for 45 baud operation, or 384.76 Hz for 50 bauds. With the room darkened observe the stripes, which should be stationary when the speed is correct.

You'll have to turn off the machine and rotate the rubber tyre in the governor to make the adjustment. Many machines have a lever that can be pressed against the tyre when it's running to change the speed, but most of these short out the slip ring assembly, resulting in much sparking and electric shocks. So it's best to do it the slow way, by hand.

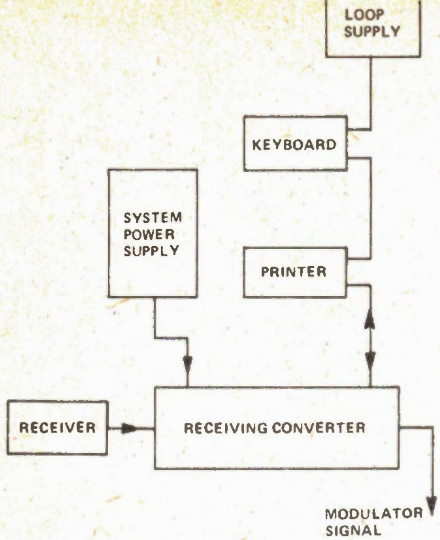
Rangefinder

Proper adjustment of the rangefinder depends on having a received signal available, known to be of good quality and on speed. You may have to wait until your receiving converter is built or you can borrow someone else's Model 15 or a tape transmitter to supply the signal. The rangefinder sets the receiving mechanism to allow the best possible copy.

The teletype signal is made up of a series of seven pulses. The first pulse, called the start pulse, is always a space (no current flowing in the loop). The next five pulses carry the code representing the character being transmitted. The last pulse is the stop pulse, and is always a mark (current flowing). The first six pulses are all the same length, 22 ms for 45 bauds, and 20 ms for 50 bauds. The stop pulse is about 50 percent longer. The start and stop pulses are necessary to synchronize the sending and receiving machines. The machine samples only about 20 percent of each code pulse to determine the character being received. The purpose of the rangefinder is to 'orient' the sampling period earlier or later in the code pulses with respect to the start pulse. The pulses themselves may become shortened or lengthened or displaced forward or backward in time, because of transmission conditions.

The rangefinder control is a locking knob attached to a pointer that can be moved along a scale from 0 to 120. The markings represent percentage of code pulse length. To adjust the rangefinder, start the machine copying RY's repeated, as these represent the most frequent mark-space transitions. Move the rangefinder first up the scale until the signal garbles, and then down the scale to the garble point. Note the readings and set the pointer half way between them, locking it off. If no signal is available, set it to 50, it will probably work.

A perfect machine will copy signals while the rangefinder is moved from about 10 to 90. If the range is considerably less, it indicates transmission conditions have mangled the signal, or the machine needs internal adjustments. If the range is displaced up or down the scale from a symmetrical position, it means the sending and receiving machines are not running at the same speed.



The system as it stands.

Hz and switch on the teletype. Operate the MARK HIGH/MARK LOW switch until the machine runs idle in the closed condition. Label this switch position as 'MARK HIGH'. Slowly move the oscillator frequency down to 2125 Hz. The loop should snap open, hopefully half way between the two frequencies. Switch everything off and feel the loop switch transistor Q2. It should be absolutely cold. If it feels warm (or hot) it means the gain is probably down a bit and it's not being switched all the way on. In this case change the base resistor R27 to a lower value until it does run cold.

You must now do a quick calibration of the shift control. With the CRO or VTVM connected to pin 6 of IC2, set the oscillator first for 2125 Hz and tune the shift control for maximum output. Label this position '170'. Set the oscillator for 1855 Hz and tune the shift again. Mark this spot '440'. Set the oscillator for 1445 Hz and tune again. Mark this position '850'.

IC1 can be run as either a hard limiter or a straight-through amplifier, in which case its gain is reduced by switching in R6 to provide negative feedback. It's normally used as a limiter except when there is an interfering signal. In a hard limiter the strongest signal always wins, so if it's not the signal you want, the limiter must be disabled. The 'non-limit' function must be set up to match the signal level from a particular receiver. This is done by tuning in a signal that reads about S9 on the meter and then selecting R6 so IC1's output (pin 10) is just below clipping. The limiting level can be made variable by using a pot (about 1M) in place of the fixed resistor. Be sure to retain the switch to take the pot completely out of circuit when hard limiting is desired.

With the alignment complete and the receiver connected to the converter it's now time to give it a try.

If an oscilloscope is available, an aid to station tuning can be obtained by obtaining a lissajous pattern on the screen. Connect the CRO 'x' and 'y' inputs to the test points on the pc board. The pattern should appear as two flattened ovals at right angles to one another when a station is correctly tuned.

PARTS LIST

RESISTORS all ½W, 5%

R1	10k
R2	150k
R3	10R
R4, R5	47R
R6	100k - see text
R7	15k
R8, R9	390k
R10, R11	680k
R12, R13	220k
R14	100k
R15	270k
R16, R17	15k
R18	33k
R19	220R
R20, R21	22k
R22	100k
R23, R24	220k
R25	10k
R26	1k
R27	3k3
R28	3k9
R29	220R
R30	100R

POTENTIOMETERS

RV1	10k min trim pot
RV2, RV3	500R min trim pot
RV4	1k linear pot

CAPACITORS

C1–C3	100n ceramic
C4	3p3 ceramic
C5	47p ceramic
C6–C9	4n7 greencap
C10, C11	47n greencap
C12	22n greencap
C13	470n greencap
C14, C15	10µ 16V tantalum
C16	100n 630V greencap
C17	220n greencap

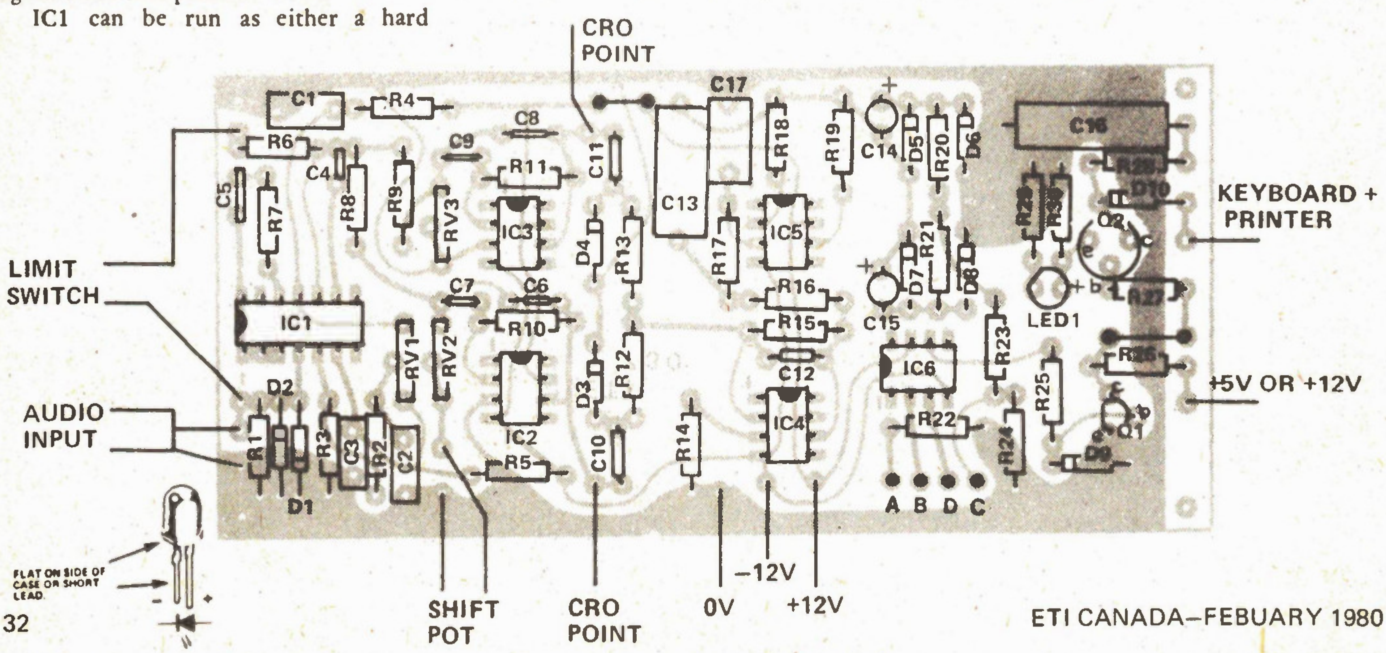
SEMICONDUCTORS

D1–D4	IN914, or similar
D5–D8	1N34 or similar
D9	IN914 or similar
D10	IN4004, or similar
Q1	2N3904
Q2	MPS A42 or similar 300V VCE transistor
LED1	TIL220R Red led or similar
IC1	709 or 741 (if 741 used delete R7, C4, C5 - see text)
IC2–IC6	741

MISCELLANEOUS

SW1	SPST min toggle
SW2	DPDT min toggle

Box to suit, ETI 730 pc board.



Simple Radio Control

If Santa gave you an R.C. model for Christmas, you may only be scraping the surface of its potential. Graham Wideman describes some neat tricks.

APPREHENSIVELY I APPROACHED the cashier, guardedly clutching my purchase, hoping to be able to escape the store without drawing stares or comments. Such was not to be my fortune as the eager young fellow seized upon this opportunity for embarrassment.

"Buying it for yourself or 'for a friend'?", he snickered.

"Er, for a friend.", I whispered.

"Yes, I bought one 'for a friend' just last week", he intimated.

Thus consoled, and my wallet suitably relieved, I stole away from the counter, and hurried from the store.

Hardly able to wait to open my new acquisition, I sped back home. There, int the privacy of my own living room I was finally safely alone with my Radio Controlled Formula-1 Racing Car...

NEW WAVE R/C MODELS

As you may have noticed, a large crop of radio controlled model cars have sprung up in the last year, and no doubt have been especially popular this last Christmas. The more sophisticated among them sell for $30 to $35 and include functions such as forward, reverse, turn left, turn right.

This represents three functions. That is to say the car normally proceeds straight forward, and the control unit is either off, or emits one of three control signals to command the car to execute one of the other 3 functions.

As a side note we might add that this collection of functions is far superior "play value" compared to the "one function" forward or reverse'n'turn models available at very low prices.

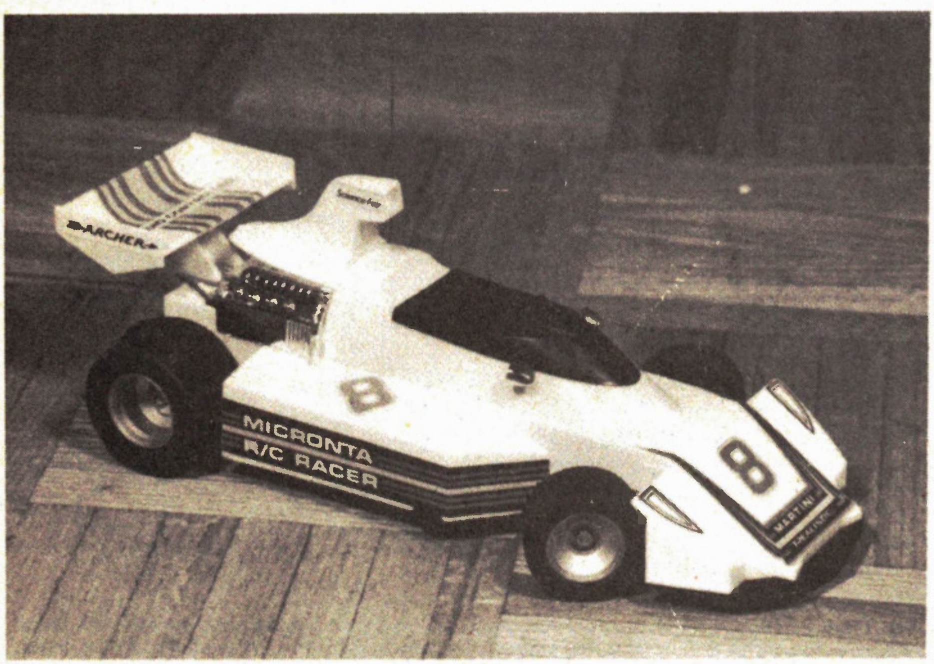


Fig.1 Typical inexpensive RC model. We got this one from Radio Shack.

MODIFY OR CANNIBALIZE

Our aim in this article is to first give some ideas for the creative experimenter to modify his existing model for greater control flexibility. Then, if you're bored with that, how about using the guts out of you RC car to control something you want to make, such as a boat, remote camera control or what-have-you? Where else can you get a complete RC outfit for just $30?

We should point out that the experiments and modifications outlined apply to the particular model we have, a Micronta - Radio Shack car, but the principles will apply generally.

SOME NON—DESTRUCTIVE EXPERIMENTS

First, let's determine how the control box sends control signals to the car. A look on the back of the transmitter shows that it operates in the 27 MHz radio control bands, conveniently (for us) located between the CB channels. What we need to know is how "control information" is "encoded" on that signal. So, get out a cheap (ie. not very selective) walkie talkie and listen while you activate those controls.

The results you'll hear are different audio tones for each of the control messages. Perhaps a high one for "Reverse", low for "Right" and medium for "Left". You can even control the car by whistling the appropriate tone into the walkie-talkie while transmitting!

OK, so we've got a block diagram of the system - (figure 2).

Immediately several possibilities have probably crossed your mind:

— What about **two** control tones at once?

— Increase range using walkie-talkie transmitter?

— Is it possible to get finer control over speed and steering somehow?

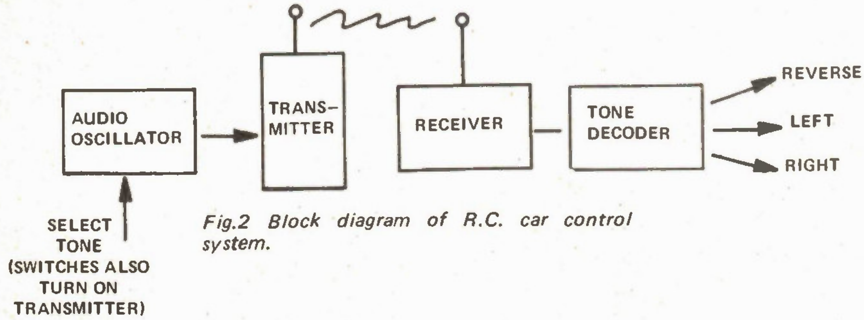


Fig.2 Block diagram of R.C. car control system.

TWO FUNCTIONS TOGETHER

In most cases, it is not possible to operate two controls at once. That is to say, the car will not reverse and turn at the same time. Obviously this would require two tones to be present, and listening on the walkie-talkie will quickly tell you that only one tone comes out at a time. Further investigation on our model showed that this was due to only one oscillator being use, its frequency changed by switching timing capacitors.

So, it remains for the user to add his own extra oscillator for, say, the reverse function, so as to provide two tones (figure 3).

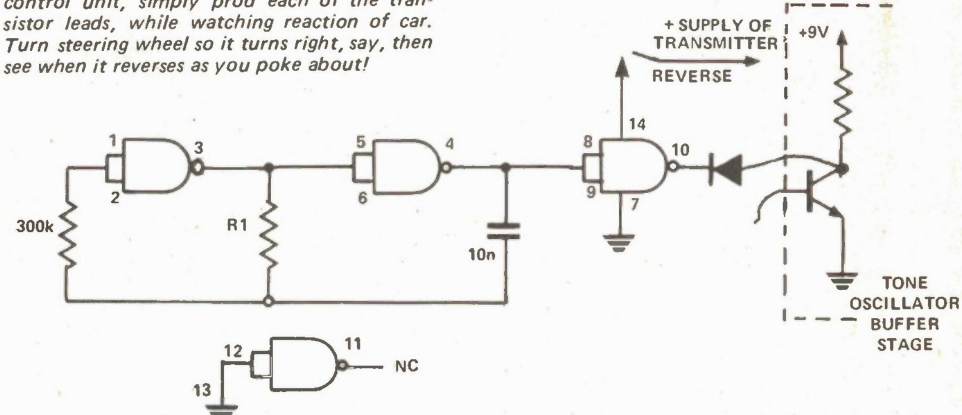


Fig.3 Example showing how to add two functions by using separate 'reverse' oscillator.
Choose R1 as follows: start with 150k, reduce to make tone higher, increase to make tone lower. (You can monitor output (pin 10) on oscilloscope, use audio tracer, or even feed it into your home stereo, so you can set the tone to match that from walkie talkie when control "REVERSE" activated.)
To find the correct point to connect to in control unit, simply prod each of the transistor leads, while watching reaction of car. Turn steering wheel so it turns right, say, then see when it reverses as you poke about!

WALKIE TALKIE POWER INCREASES RANGE

This one is pretty much up to you. Most reasonable walkie-talkies put out 100mw or so, and this will improve range somewhat. You'll have to arrange how the control oscillator modulates the walkie-talkie transmitter. To stay legal you should also exchange the transmitter crystal for the R.C. Control, with the one in the walkie-talkie transmitter.

PROPORTIONAL CONTROL

A few hours of "study" with your radio control model will lead you to the conclusion that the control "subtlety" leaves something to be desired. You can only steer straight, full right or full left for example.

With practice you can "jiggle" the steering wheel to make the car's front wheels turn only part way, but it's a nuisance. What you are doing is rudimentary "pulse proportional control". That is to say, if you turn the wheel full right so that the control oscillator is on all the time, the car's wheels will be full right. If you jiggle the wheel right so that the control oscillator is on say 50% of the time, the car's wheels will turn half right, and so on.

Naturally, we'd like a circuit to do this, to save on the wrist adtion. Figure 4 outlines such a circuit. It assumes 9V supply, and that present left and right switches are switched to the plus supply.

Speed can be dealt with similarly, except that here you would be dealing with alternating forward and reverse, not a particularly good situation. You could just disconnect reverse, and have adjustable forward speed only. This isn't bad for big open racing areas.

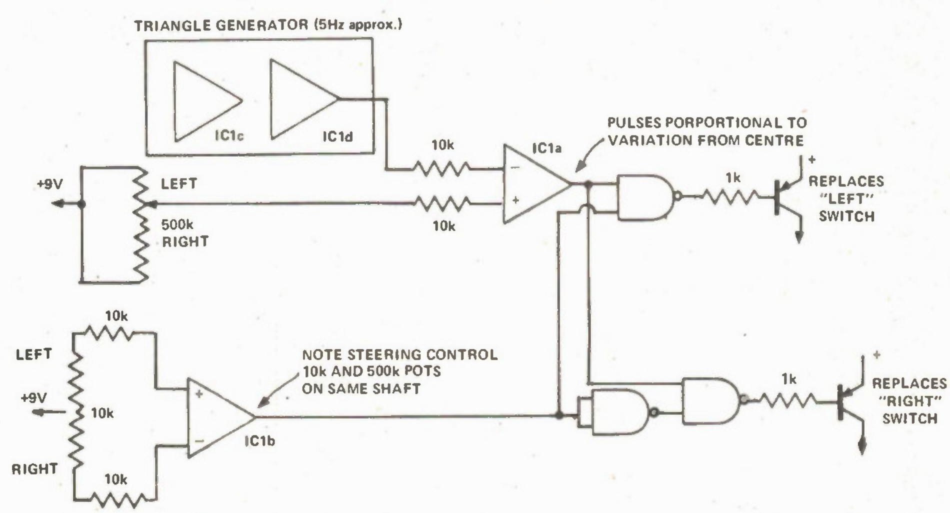


Fig.4 Proportional steering control. "Op Amps" are four sections of LM3900. See National's Appplication Notes (available at Radio Shack) for how to build triangle generator. NAND gates are CMOS 4011 (A or B)

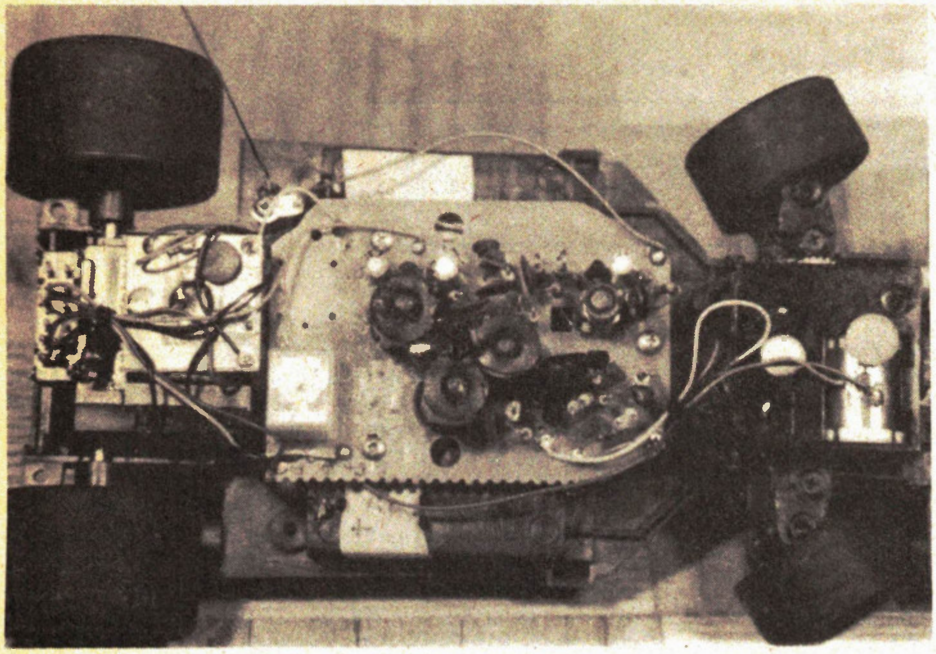


Fig. 5 Undoing a few screws reveals some very simple circuitry.

INSIDE

These new inexpensive RC models must be the product of the latest IC technology bringing prices down etc., right? Imagine our surprise upon opening our car and finding all-transistor circuitry (figure 5). (Well at least they don't take time to warm up!)

The transmitter control section contains a transistor audio oscillator with one inductor and three (switch selected) capacitors. The receiver-decoder contains three sharply tuned audio filters each using an L-C circuit for detecting the incoming control tones. Each of the decoder "channels" then feeds an output stage, which we are now interested to know about, so that we can use them for our own purposes. Figure 6 explains the forward/reverse circuitry.

The steering circuitry is a little more complex, but none-the-less useable. it's described in figure 7.

The easiest ways to use these units for other than what they were intended, is to use them pretty well as-is, or add relays. Those more adventurous readers will no doubt see their way to adding forest of transistors and IC's for special purposes. The details given here should prove enough to get started.

CAUTION!

We must warn you that the radio control systems discussed here are not the most sensitive or selective. The transmitter has limited range, and the receiver can be upset by nearby CB or other radio control activity. So please consider these factors when entrusting your time and dollars to such a communications link.

If these considerations are observed, we are sure you will be able to come up with many useful and fun applications for this inexpensive approach to radio control. It certainly should not be beyond even the person with little or no test equipment to adapt the system we inspected to a small boat for example. We would however advise against model airplane use!

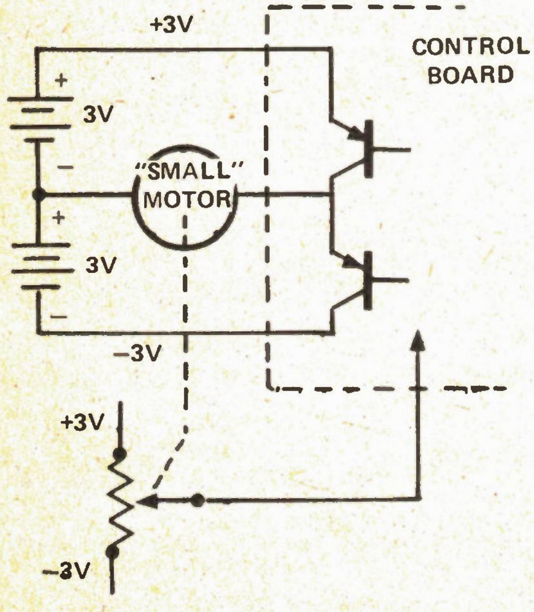
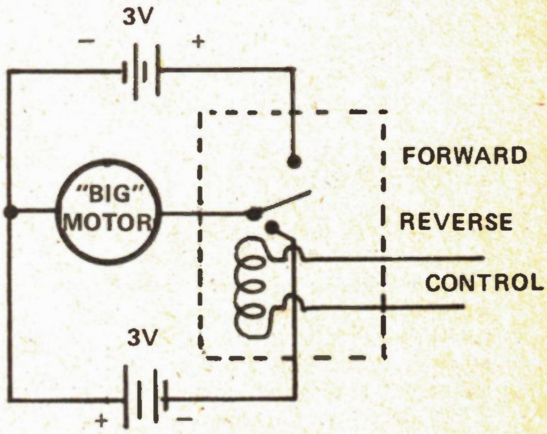


Fig.6 Forward/Reverse drive.
The forward/reverse circuit has a relay to control motor direction. This ofcourse is easy to use for whatever you want. A higher current capacitiy relay might be substituted, or this small relay could turn on or off a larger relay. (notice that if you are still enamoured with the car as it is, you could trade in reverse for super fast forward on 6V!)

Fig.7 The steering circuit is similar to forward/reverse circuit, except transistors switch power polarity applied to motor which drives steering, and also rotates small potentiometer. The signal from the pot wiper returns to control board to tell transistors to turn off at limit of travel, and also to enable control board to return steering to centre (straight ahead) when "driver" relaeses steering wheel.
This kind of control is directly useful in other model steering applications, or you could disperse with the pot and have the transistors control one or two small relays.



Gain Control

Tim Orr continues his occasional series of circuits, methods and explanations with a detailed look at how gain can be controlled by another electronic signal, be it squarewave, sinewave or voice signal. This leads to some interesting circuits — from ducks to filters!

THERE ARE MANY cases in signal processing where the control of the gain is necessary. Some common examples are automatic volume controls in cassette recorders and in the IF sections of radio receivers. Also in professional audio equipment there is a whole range of compressor, expander, limiter and noise gate devices which find great use in recording and broadcast studios. Maybe you have wondered how the volume of the music drops when the DJ starts to talk and then fades up again when he stops. This process known as voice over or "ducking", uses *voltage control of gain.*

Noise reduction systems such as dolby and dbx employ voltage controlled amplifiers. Synthesisers and sound processors obtain effects such as ring modulation, automatic panning, frequency shifting, dynamic filtering, tremolo and envelope shaping also by the use of this technique.

GAINING GAIN

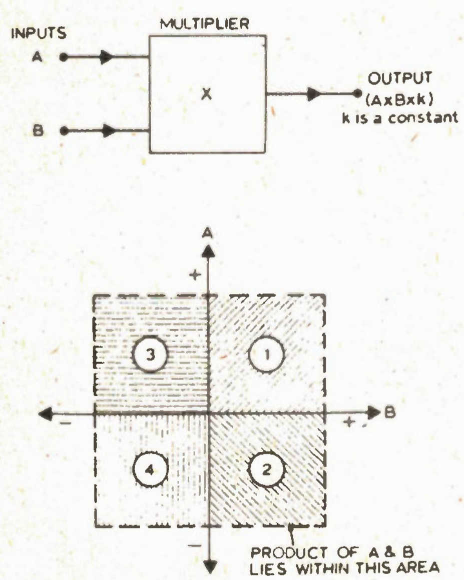
There is a wide variety of methods which can be used to obtain the gain control. This can be anything from constructing the variable gain element yourself from basic parts, to buying ICs or modules designed specifically to solve your particular problem. Generally the solution is some sort of compromise, because unfortunately the problem of making high performance controlled gain cells (multipliers), is rather difficult and therefore the ICs tend to be rather expensive.

However with a bit of care a cost effective solution can usually be produced.

A good example is the AGC in a transistor radio. The transistors in the IF section have an h_{fe} that varies widely with collector current. Thus, by sticking three transistors in series it is possible to vary their overall gain by about 40 dB, (x 100), merely by controlling their collector currents. The AGC stops the audio output of the radio from varying as the radio reception conditions alter.

ELECTRONIC MULTIPLIERS

When it is required to control the level of one signal with that of another, an electronic multiplier is used. This process is analogous to arithmetic multiplication. If input A is positive, fig. 1, and input B is positive, then the product (the output), will also be positive. If A goes negative then



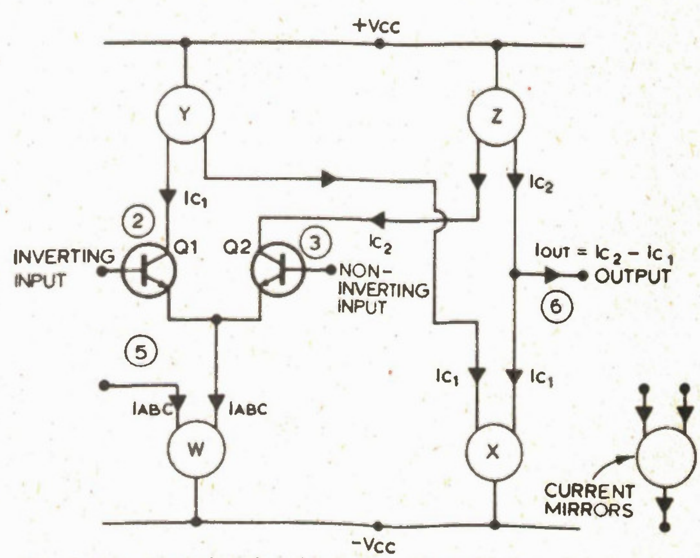


Fig. 1, left: the principle behind electronic multipliers. The graph shows the possible outputs for a variety of combinations of input polarities.

Fig. 2, above: internal workings of a CA3080, an Operational Tranconductance Amplifier.

the product will be negative. If both A and B are negative then the product will be positive thus preserving the arithmetic rules.

If A and B are limited to be only one sign each then the multiplier is known as a one quadrant multiplier. This is the product can only be in one quadrant. If A can be both +ve and -ve, and B only of one sign then the multiplier is known as a two quadrant multiplier. This is what is called an amplitude modulator. The audio signal which is bipolar is A and the control voltage is B.

If A and B can be both +ve and -ve, the product can lie anywhere in the four quadrants and hence the multiplier is known as a four quadrant multiplier. This type of device is found in frequency shifters and ring modulators.

CA3080 – AN OTA !

The CA3080 is a two quadrant multiplier, or to give it its full title, it is an Operational Transconductance Amplifier. It has a differential input and a single quadrant current input known as I_{ABC} , (amplifier bias current), fig. 2. The differential transistor pair is used to steer the I_{ABC} current between the two transistors Q2. There is a region where the input differential voltage is linearly proportional to the percentage of current steered between the two transistors. This voltage region is fairly small, being about 20 mV, but using the CA3080 in this area then a reasonably linear 2 quadrant multiplier can be obtained.

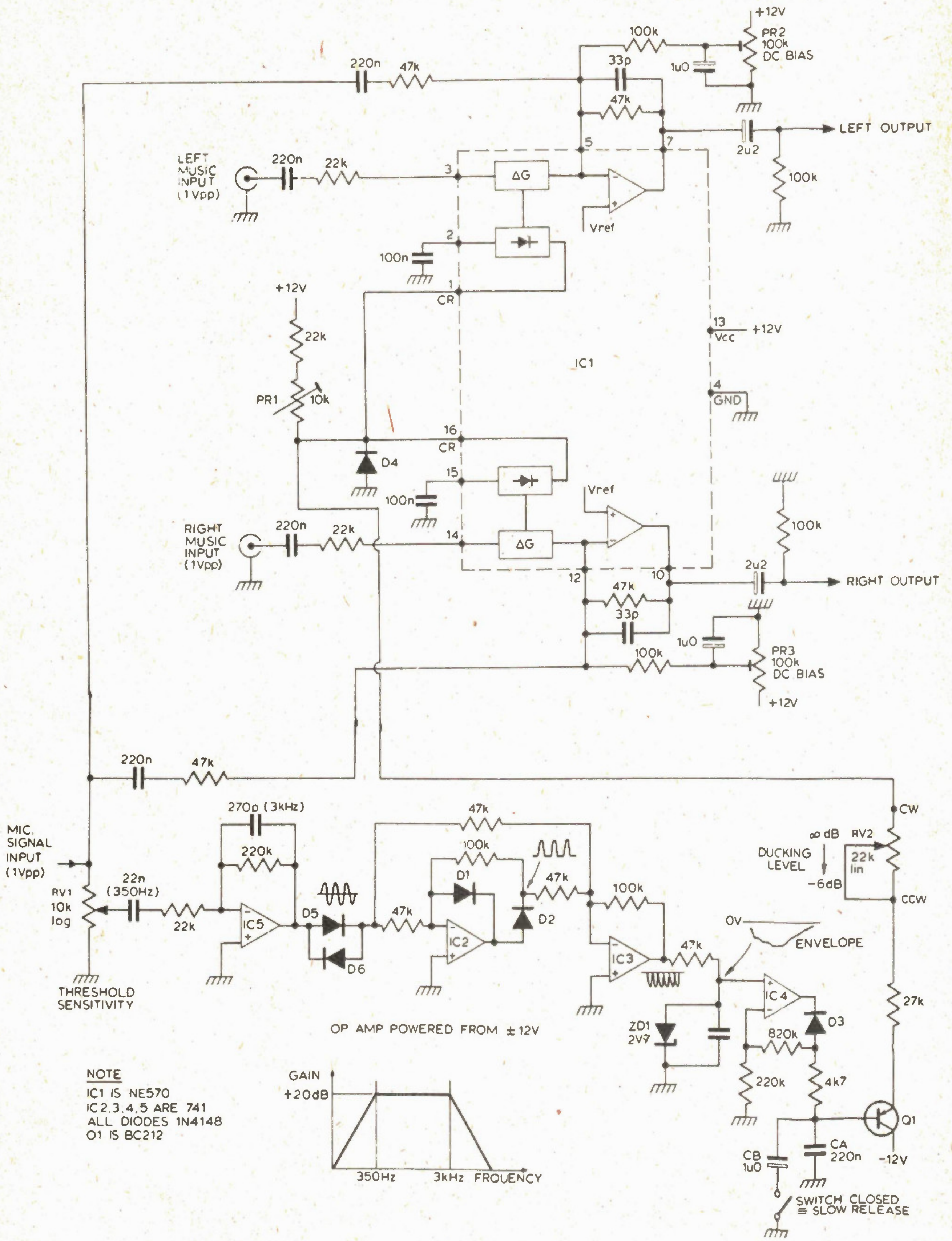
What has happened is that the I_{ABC} current has been multiplied by the input voltage. The produce is the difference between the two collector currents. This difference is extracted by the use of mirrors, current mirrors that is. The current mirrors can be attached to either the +ve or the -ve supply rail.

A current mirror has two input terminals, whatever current flows into one flows into the other – hence the term 'current mirror'.

What we want to do is take the difference between the collector currents of Q1 and Q2. I_{C1} is reflected from mirror Y and then from mirror X and then appears at the output. I_{C2} is reflected from mirror Z and then appears at the output. The two currents are subtracted from each other and the output current is thus ($I_{C2} - I_{C1}$), which is the product of $I_{ABC} \times V_m \times K$, where K is a constant. Note that the I_{ABC} current is also reflected from a current mirror on the negative rail.

The CA3080 is a low cost two quadrant multiplier and can be used to perform a wide variety of multiplication functions. The linearity of the device holds true for I_{ABC} variations of over three decades. When using this device keep I_{ABC} below 0.5 mA.

Stereo Voice Over (Ducking) Circuit for Disco Unit



NOTE
IC1 IS NE570
IC2,3,4,5 ARE 741
ALL DIODES 1N4148
Q1 IS BC212

The circuit operation is as follows. The microphone signal comes via VR1. This pot sets the sensitivity of the circuit to the microphone signal. If it is too sensitive the unit will be 'ducking' every time the DJ breathes. IC5 is an amplifier and filter. The filter has been specifically tailored to fit the characteristics of speech, thus making the ducking unit less sensitive to spurious noise. IC2, 3 forms a precision full wave rectifier, the output of which is low pass filtered and then fed to IC4. This wave form is the envelope of the microphone input signal.

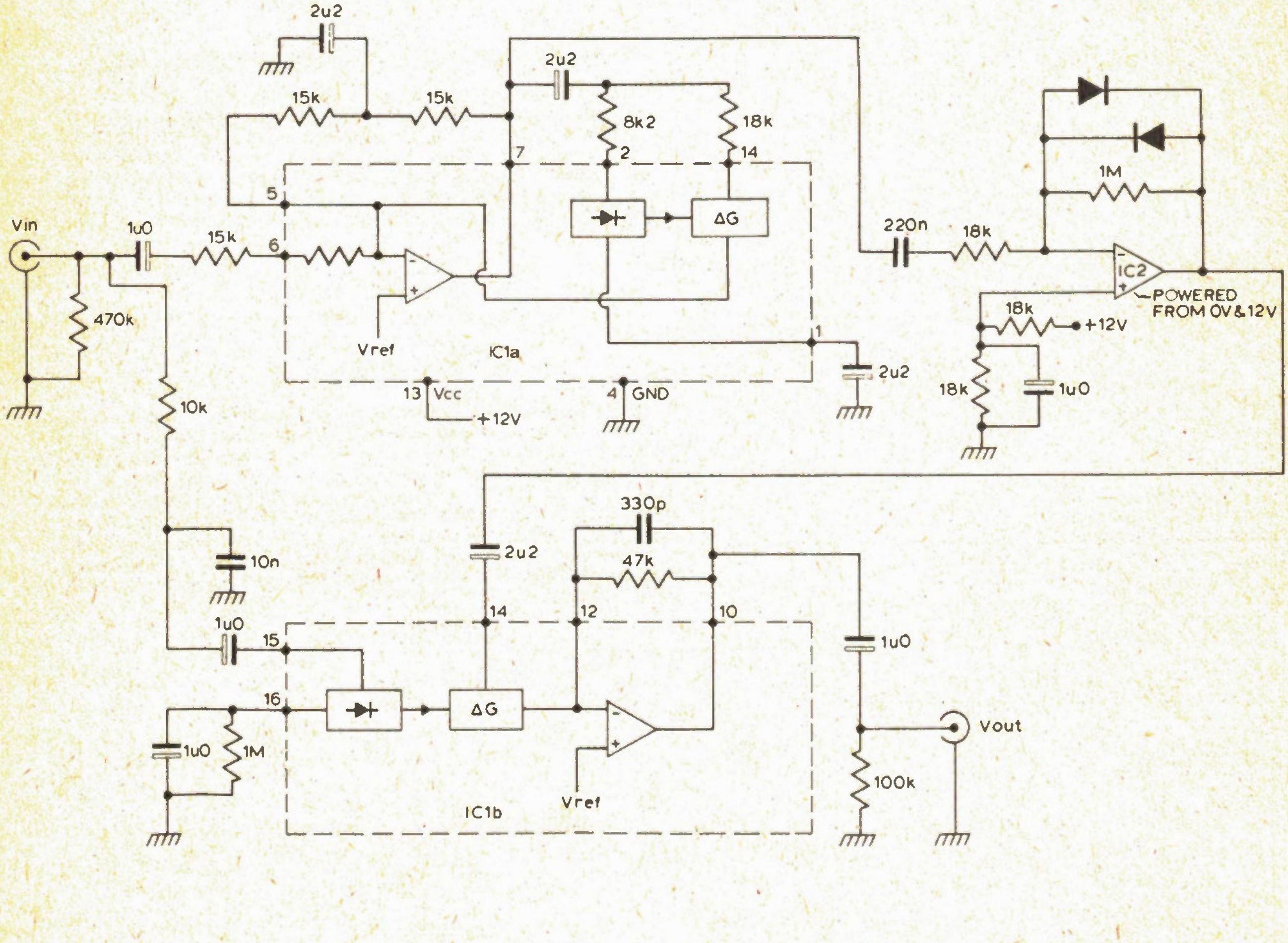
IC4 is a peak, negative going, voltage detector with a gain of x 5. When the DJ begins to speak, IC4 goes negative and in doing so pulls the base of G 1 negative. When the DJ stops speaking the base of G 1 rises back towards O V with a time constant determined by CA or CA + CB.

This is the release time and it controls the speed with which the faded down music comes back to full volume. G 1 is an emitter follower and is job is to rob current from the gain cells in the NE570.

This current sets the volume of the two music channels. When the base of G 1 is pulled down to the negative rail, the amount of robbed current is maximum, and when no current flows into pins 1 and 16 of the NE570 and all of it flows into g 1, then both nusic channels are turned off.

To set up PR1, put a large signal into the microphone channel, set RV2 so that it is a short circuit and then adjust PR1 so that the two music channels just close off. PR2 and PR3 should be adjusted so that pins 7 and 10 Of the NE570 are both +6 V.

Clever Fuzz Box



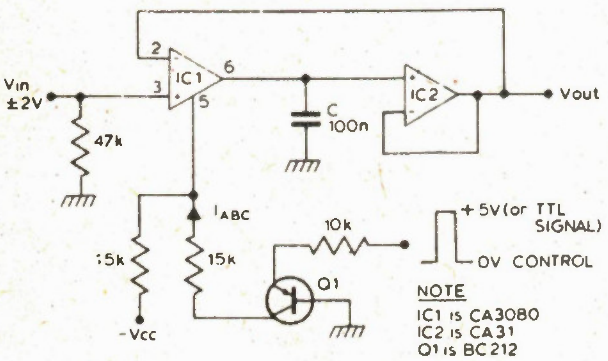
Fuzz boxes are used by guitarists to produce harmonic distortion and sustain. If you want to produce only the distortion, but to retain the original envelope of the signal then this is the circuit for you.

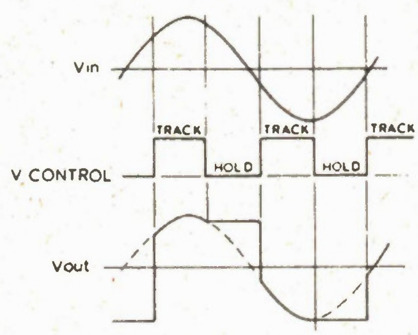
IC1 is a 2:1 compressor as described previosuly. This produces a relatively high level signal which then drives IC2, which is a x 50 amplifier with diode clamping. IC2 produces the distorted (fuzz) found. This is then fed into the IC3 gain cell, the output of which drives the op amp. This gain cell is driven by the rectified original signal (low pass filtered at 1k5 Hz), so that the distorted sound is given the envelope characteristics of the original sound.

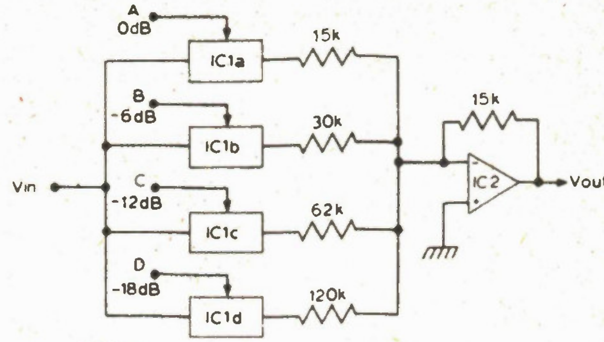
If a fuzz sustain sound is required rather than a dynamic fuzz then IC3 could be modified (by the inclusion of a clamped high gain amplifier driving pin 15) so that it acts as a low level expander. This will squelch the noise at the end of the fuzz period.

Track and Hold

In this example the CA3080 is used as a current controlled switch. When the control voltage is high, I_{ABC} is maximum, (0.44 mA) and the OTA gain is maximum. The voltage at pin 2 of IC1 adjusts itself so that it is the same as that on pin 3, this being due to the 100 per cent feedback via the high input impedance voltage follower IC2. When the control voltage is 0V, I_{ABC} is zero and hence the gain of the OTA is zero. Therefore no current comes out of its output and so the voltage at the output of IC2 remains frozen (Hold mode). The maximum differential input voltage is 5 V and this must not be exceeded. The capacitor C should be selected to suit the speed of the operation.







0 ≡ -6V
1 ≡ +6V

A	B	C	D	GAIN
1	0	0	0	0dB
0	1	0	0	-6dB
0	0	1	0	-12dB
0	0	0	1	-18dB

POWERED BY ±6V

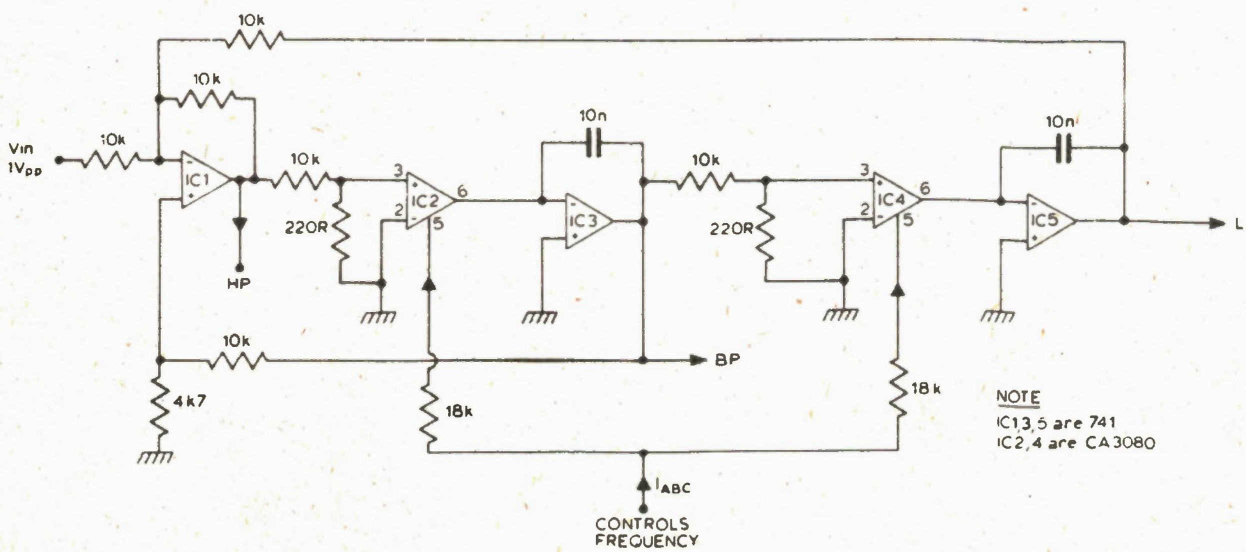
NOTE
IC1 is 4016
IC2 is 741

Voltage Controlled (Switched) Attenuator

The CD4016 is a quad analogue transmission gate. That is, it is a quad voltage controlled switch. When the control is high the switch is ON, having an effective resistance of about 400R. When the control is low the switch is off and ot looks like a 100M resistor. Thus by using 4016 switches it is possible to 'Switch' the voltage gain of an amplifier. The resistors in this example are selected to give 6 dB changes in gain.

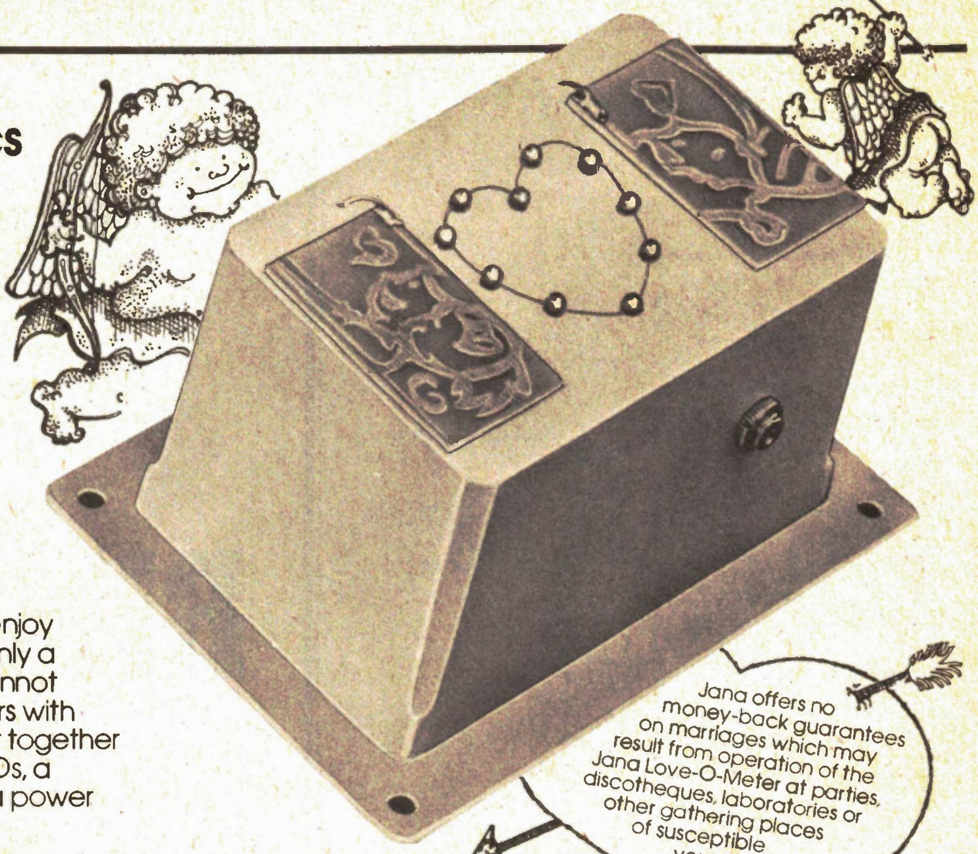
Filter

A state variable filter produces three outputs: highpass, bandpass, and lowpass. It is thus a very versatile filter structure, even more so if the resonant frequency can be varied. This frequency is linearly proportional to the gain of the two integrators in the filter. Two CA3080's, (IC2, 4) have been used to provide the variable gain, the resonant frequency being proportional to the current I_{ABC}. Using 741 op amps for IC3 a control range of 100 to 1, (resonant frequency) can be obtained. If CA3140's are used instead of 741's then this range can be extended to nearly 10,000 to 1.



Love-o-Meter

Another Jana Quality Kit



Learn Electronics (and how to play cupid) with this clever and entertaining Jana Kit.

Build a Jana Love-O-Meter and take it to a party. When you reveal who the Great Lovers are, the party will suddenly become very exciting! Some of your friends may enjoy Love-O-Meter but say it's only a hilarious game. Yet they cannot dispute its electronic powers with one who knows how to put together 7 transistors, 6 diodes, 10 LEDs, a capacitor, 15 resistors and a power jack.

You can achieve all that by following the clear, step-by-step plans provided by Jana. All you need to add to the Love-O-Meter kit and its glass PCBoard (optional extra) are a pencil soldering iron, screwdriver, needle nose pliers and a bit of your time and interest. Batteries or power adapter are extra, but the plastic package serves as case for your finished product.

If anybody asks about what makes the LED display light up, you can give a technical answer: conductivity from one touch plate through the boy and the girl to the other touch plate. Or you can merely smile and wink. Though learning electronics is sometimes a solitary task, your Jana Love-O-Meter can provide both the learning and the solution to your loneliness. Consider it a micro-miniature computer dating machine, a transistorized "Match Maker". And lots of fun!

See your hobby electronics dealer for dozens of useful and educational Jana kits.

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2. Battery Operated Fluorescent Light
3. Bug Shoo
4. Code Oscillator
5. Crystal Radio
7. Curiosity Box II
8. Dally Lighter
9. Decision Maker
10. Fish Caller
11. Hi Power 12V DC Flasher
12. Photo Electric Night Light
15. O-20V Power Supply
16. Single Channel Color Organ
17. Electronic Siren
18. Shimmer Strobe Light
19. Tone Generator
20. 5 Transistor 1 Watt Amplifier
22. Xenon Strobe
23. LJ 12016A Color Organ
24. Loudmouth Siren
25. Roulette Wheel
26. Electronic Sheet Game
27. Electronic Dice
28. Super Roulette
29. FM Mini Broadcaster
33. Love-O-Meter

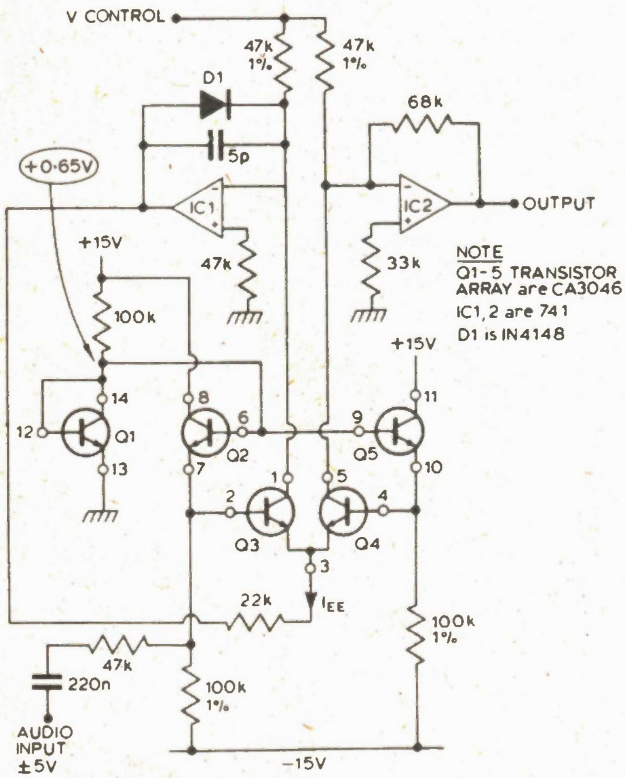
Circle no. 14 on Reader Service Card.

Jana

INDUSTRIAL ELECTRONICS

1777 Ellice Avenue, Winnipeg, Manitoba R3H 0W5

VCA Using CA3046 Array



The CA3046 is an array of 5 transistors which are all well matched and relatively cheap. Q3, 4 forms the differential transistor pair, IC1 controls the current and IC2 extracts the differential output current and turns it into an output voltage. The audio input is inserted into the base of Q3 but also connected to this node is the emitter of Q2. Q2 and Q5 serve to predistort the input signal, but they distort the signal the opposite way to which the multiplier distorts it. This is known as distortion cancelling, and it allows a larger signal level to be applied to the multiplier for the same percentage of distortion at the output. The larger input signal allows a higher signal to noise ratio to be obtained. Transistor Q1 is used to bias the bases of Q2, 5 to a suitable operating region.

THE KING

TOWER'S INTERNATIONAL TRANSISTOR GUIDE is now available from ETI. We are proud to be able to bring you this "bible" of transistor data. It contains data on over 13000 transistor types, 2Ns, 2SCs, European and "replacement" types. Information includes polarity, material, package and lead info, maximum ratings for VCB, VCE, VEB, IC, TJ, P, minimum FT, HFE, typical use, manufacturer and suggested equivalents.

To order use the card in this issue, or mail the coupon below to: TOWER'S, Electronics Today Magazine, Unit 6, 25 Overlea Blvd, Toronto, Ontario, M4H 1B1.

OK ETI – I don't want to be in the dark about transistor specs any longer – send me the KING. Here's my $8.50 plus 90¢ for postage and handling. (That's $9.40 if your calculator battery is dead.)

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Signature ____________________

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(see our ad in Jan ETI)

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A MOTOROLA D-3 KIT
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Draw Date: Feb. 29, 1980

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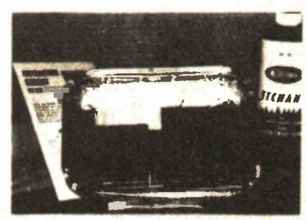
Circle no. 12 on Reader Service Card.

FINGERS TO DONUTS

KIT 850 NEW

Photo-Etch Kit for Printed Circuits with Positive Acting Resist



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KIT 850 is a complete kit using a photographic method to produce professional quality printed circuits. Artwork made on clear mylar film may be exposed directly on the sensitized boards to produce an image. No reversal is necessary. Kit 850 contains one 3x4½" and one 4x6" single-sided sensitized boards, developer, exposure glass, clamps, etchant, trays and instruction sheet. Also included is a 4x6" clear mylar, and a combination of pressure sensitive 16, 24 and 40 pin IC pads, donuts, tape and one etch resist pen with which to make artwork. KIT 850 IS COMPLETE INCLUDING A U.V. LIGHT SOURCE.

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Dorval, Quebec H9P 2N4
Telephone: (514) 683-6993

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SHORTWAVE WORLD

THE NOVEMBER ISSUE of ETI carried an article on Shortwave Clubs. Each of the clubs mentioned in that article have excellent monthly news bulletins which will be found very useful to the SWL/DXer in keeping up to date on the current situation in the short wave world. This month I will be telling you about some books and other non-periodical publications that you will find very useful in the pursuit of the great hobby of short wave listening.

Prices quoted from United States addresses are in US dollars.

Check your local book store for availability of some of these books or order from the address given. All of these books are meant to help you get more out of the hobby of shortwave listening. Good reading.

CORRECTION

In the listing of clubs in the November issue it was incorrectly stated that ANARC was founded in 1974. Actually ANARC (Association of North American Radio Clubs) is fifteen years old, having been founded in the summer of 1964.

Until next month 73 and good listening

A few of the wide range of books available to the shortwave listener.

WORLD RADIO TV HANDBOOK — Published annually in Denmark, the WRTH is the DXer's Bible. Schedules, frequencies, countries, programming, shortwave, medium wave, FM, TV call-signs, addresses, transmitter powers, beam antenna bearings, geographical locations, relay stations, slogans, interval signals, feature programs, home service and regional transmissions — all this and much more is packed into this unusual SWL book. Countries are listed in alphabetical order by continents. Also included are feature articles by experienced DXers around the world on various shortwave and medium wave topics. The 1980 edition is the 34th. It is usually available in January or February and the cost is $14.95. Available from Heathkit, Gilfer, or SWL Guide.

WORLD DX GUIDE — Published in 1978 by the publishers of the World Radio TV Handbook, this book covers just about everything pertaining to the hobby. 28 chapters on DXing, maps, tables, charts, information on propagation, interference, ionospheric behaviour, SW, MW, and TV antennas, SSB reception, plus the best articles published in "How To Listen To The World. Especially recommended for new comers to the hobby. Available from Gilfer for $8.75.

SWLs AND DXers GUIDE — Published by Canadian S-W-L International, this mimeographed book contains much helpful information for the beginner listener. How to write a reception report, addresses of foreign SW stations, propagation and how it affects listening, things to look for in a receiver, using a tape recorder to aid in your listening, articles by a newcomer on some of the frustrations in getting started, and much more. Available from Canadian S-W-L International, P.O. Box 142, Thunder Bay, Ontario, P7C 4V5 for $3.00.

THE COMPLETE SHORTWAVE LISTENERS HANDBOOK — I always feel a little hesitant when I hear any book called complete. However this is one book that is as complete as you can expect in one volume. Written by Hank Bennett who has had many years of SWL experience and who has written hundreds of articles on the subject in newspaper and magazine columns as well as in club bulletins. Some of the contents include; Introduction to Shortwave Listening, Terminology, Radio Receivers, Antennas Frequencies, Propagation, Reception by Continental Areas and Frequencies, Amateur Radio, CB Radio, FM DXing, Utility Stations, Logbooks, Reporting and Verification, Time and Standard Frequency Stations, Card Swapping, Radio Clubs, WDX Callsigns and Awards. Available from SWL Guide. Price $6.95.

SHORTWAVE LISTENER'S GUIDE — by Charles Woodruff. This 144 page book makes things even easier for international shortwave broadcast listeners. Three convenient formats simplify schedule information into quick, easy-to-use tabulation. One list has all shortwave broadcasters listed by country - with information on call signs, station announcements and slogans, interval signals, what frequencies are most likely to be used and at what time. Another list is arranged by frequency, and another by country and city. There is also a list of News broadcasts. Available from Gilfer for $5.45.

SHORTWAVE LISTENERS HANDBOOK — All new SWLs should have this to help them understand and get more enjoyment out of the hobby. Covers receivers, antennas, propagation, operating procedures, and much more. Available from SWL Guide. The price is $4.90.

GUIDE TO DXing FOR BEGINNER DXers — Written by Bob Padula, this revised and updated edition runs to 32 pages with over 30,000 words. This article is designed for the beginner DXer, or for the older DXer returning to the hobby after some years absence. Details on how to compile a reception report, use of the spectrum, verifications, how to identify languages, as well as ways to keep DX records. It also contains sections on antennas, receivers, reporting hints, frequency selection, propagation and the DXer's Code of Ethics. Available from the Australian DX Club for US $3.00 airmail or US $2.00 seamail.

DXing ACCORDING TO NASWA — This 136 page book covers the many facets of shortwave. It answers hundreds of questions for both beginners and advanced DXers. Also included is the NASWA Country list. Offset printing, 5½" x 8½". Available from NASWA for $4.00.

BROCHURE FOR NEW DXers — (in French) Those who understand French may order this booklet from Club Ondes Courtes Du Quebec for 50¢.

BETTER SHORTWAVE RECEPTION — This popular general information book is now thoroughly revised, with new illustrations and many pages of new material. Contains information not available in other books. Available from SWL Guide. The price is $4.95.

UNDERSTANDING & USING RADIO COMMUNICATIONS RECEIVERS — Semi-technical approach to help you

Newcomers to any hobby have a hard time getting info. This month, John Graner surveys his private library and lists some good SW reading.

which will aid the serious DXer in choosing the best time to tune in. The service predicts DX conditions for the various bands on a day-to-day-basis with surprisingly high accuracy. Also included are tips on short-skip, sunspot activity, ionospheric storms, and unusual band openings. Mailed first class. Trial 2 month subscription is $5.00. Yearly subscription is $24.00 from Gilfer.

SUNRISE-SUNSET — This 16 page booklet covers over 250 sites around the world with a computerized list of sunrise and sunset times. Available from SPEEDX for $1.00.

get the most out of your present receiver, or aid in selecting a new receiver. 192 pages, 75 illustrations. Available from SWL Guide. Price is $3.95.

THE WORLD IN MY EARS — The first part of this book is an autobiography by Arthur Cushen, a very well-known DXer from New Zealand who is blind. The second half of the book is a general summary of the hobby, particularly in relation to the New Zealand listener. There are many photographs throughout the book. Available for US $15.95 (bank draft or international money order) from Arthur T. Cushen, 212 Earn St., Enwood, Invercargill, New Zealand.

FROM SEMAPHORE TO SATELLITE — History of Communications — Over 350 pictures and 344 pages depict the invention, development and usage of radio, radar, telegraphy, television, and facsimile from the 18th century to the 1970's. Engrossing reading. Issued by the International Telecommunications Union (ITU) in Geneva, Switzerland, on the occasion of its centenary. Available for $11.95 from Gilfer.

QSL ADDRESS BOOK — This book by Gerry Dexter lists addresses for over 800 shortwave stations as well as names of verification signers. There is a grading system to help you to see how long it might take to get your QSL. Also covers report writing, mailing, follow-ups. The author is well qualified in this subject having verified over 1000 shortwave stations in more than 200 countries. Available from Gilfer for $4.75.

THE ANTENNA CONSTRUCTION HANDBOOK — A very valuable and practical book to help you get the best from your receiver by connecting a good antenna. This book spells out how to design, cut and build antennas to capture the last microvolt of signal. Mathematical formulas are eliminated and the emphasis is on the practical. 230 pages. Available from Gilfer for $6.45.

ANTENNA HANDBOOK — Although written primarily for the radio amateur, this new book gives enormous detail on all types of antennas, (beam, long wire, dipoles, and much more) without tedious math but with a lot of practical ideas and construction plans, tables, etc. $6.95 from Gilfer.

SIMPLE, LOW COST WIRE ANTENNAS — Also meant primarily for the amateur operator but also very helpful to the advanced DXer who wants the ultimate in antenna design. Excellent on theory and construction. 192 pages. Available from SWL Guide for $4.95.

THE SHORTWAVE PROPAGATION HANDBOOK — Two leading authorities on propagation, George Jacobs and Theodore J. Cohen, have teamed up to produce this definitive work on a fascinating subject which affects all of us who listen to shortwave radio. Propagation is explained in simple language so the average reader can understand and produce his own propagation data in conjunction with the information from WWV. Available from Gilfer for $7.50.

MAIL-A-PROP — This is a bi-weekly shortwave propagation newsletter

INTERNATIONAL LISTENING GUIDE — This 16 page booklet is published four times a year in March, May, September and November. It contains a listing of broadcasts in English in the shortwave bands listed by time. Also included is a summary of news broadcasts in English. The price for a year is US $9.00 from Bernd Friedewald, Merianstr. 2, 3588 Homberg, German Federal Republic.

TROPICAL BANDS SURVEY — The Danish Shortwave Clubs International produce this 28 page guide each summer. Included is information monitored around the world on stations operating in the 60, 90 and 120 meter bands. Times and frequencies of broadcasts from the islands of Indonesia, Papua New Guinea, Africa, India, the Caribbean and South America. Available from Gilfer for $3.00.

80- METER DXing — Written for Hams but useful for those who listen to the 60 and 90 meter bands. This book explains propagation on the low frequencies, black-outs (magnetic and ionospheric disturbances) and the gray-line phenomenon. $4.50 from Gilfer.

INDONESIAN SURVEY — SWBC 1979 — A complete survey of all SWBC stations in this interesting country, currently on the air. James Young has compiled this listing from over a dozen sources, in frequency order with station names, location, powers, dual frequencies, complete addresses, verification signers, language, QSL policies, etc. Available from James Young, Box 576, Wrightwood, CA 92397 USA for $4.00.

BROADCASTING IN FRENCH INDO-CHINA — An eight page booklet with illustrations of QSLs and schedules of stations in Cambodia, Laos and Vietnam by Adrian Petersen. Included in a short history of the development of radio in this part of the world. Available from Australian DX Club for 8 IRCs airmail.

BROADCASTING IN SOUTH ASIA — Another booklet by Adrian Petersen on stations in India, Pakistan, Bangladesh, Nepal and other South Asia countries. 24 pages for 8 IRCs from Australian DX Club.

BURMA AND NEPAL REVISITED — A one page article by Adrian Petersen tracing the history of broadcasting in these two countries. Current schedules of the countries are also included. From Australian DX Club for 4 IRCs airmail.

BROADCASTING IN HONG KONG — Another one pager by Adrian Petersen on Hong Kong Radio History. Same price as above item.

INDONESIAN REPORTING GUIDE — A guide on "How to report Indonesia" to secure maximum QSL response. Detailed info on identification of Indo stations with sample reports in the Indonesian language and translations. A good aid in obtaining QSLs from stations that would be otherwise impossible. 8 IRCs from Australian DX Club.

FRENCH REPORTING GUIDE — Similar to the above but for stations broadcasting in the French language. Same price and source as the Indonesian Guide.

A GUIDE TO SOVIET BROADCASTING — Covers Russian language identification, station charts and lists, and Soviet map. 40 pages, offset printing. Available from SPEEDX for $1.25.

DXing THE USSR — Discusses Soviet broadcasting structure, plus data on Home Service broadcasts, with a summary of verification policies of stations in the USSR. 16 pages for 8 IRCs from Australian DX Club.

GERMAN DXing IN THE YEARS 1931-33 — A 36 page book with skeds and loggings from this era. Available from Rainer Pinkau, Radio News, P.O. Box 902, D-3400 Goettingen, West Germany (Pinkau) for 7 IRCs.

DXing LATIN AMERICA — An Introduction to the fascinating hobby of DXing Latin America, this is a 2-page article by Bob Padula, going through, country by country with languages used, how to identify stations, best times to listen, etc. Available from Australian DX Club for 4 IRCs airmail.

DXing BRAZIL — An article dealing with Brazilian stations by Bob Padula, it deals mainly with Brazilian stations as heard in Australia. 4 IRCs from the Australian DX Club.

VoA RELAY BASES — Adrian Petersen outlines the history and development of the Voice of America and its relays sites around the world. This is a sixteen page booklet plus four pages of updated material. 8 IRCs from the Australian DX Club.

AUSTRALIA CALLS THE WORLD — This article, written by Bob Padula and Russell James traces the history of Australian Shortwave from its early years up to the end of the second World War. Illustrated with pictures of early transmitters and personalities. 8 IRCs from the Australian DX Club.

SPEEDX UTILITY GUIDE — Covers PTP, Coast Guard, LW, Military, VOLMET, time stations, spy stations, embassy stations, voice mirrors, etc. Contains report forms, frequencies and addresses. 240 pages. Available from SPEEDX for $6.95.

LIST OF TIME SIGNAL STATIONS — This handy booklet tells you everything you've wanted to know about time signal stations around the world. It includes frequencies, hours of operation, and formats used. Diagrams of the various types of time ticks are included. Available for $2.25 from Gilfer.

CONFIDENTIAL FREQUENCY LIST — This 104 page book covers approximately 4500 stations operating between the broadcast bands such as fixed, Coastal, Embassy, FAX, Military, Aeronautical, Time Signals, VOLMET, Weather, Press, Feeders, INTERPOL, CW traffic, etc. Power (if known) and pertinent remarks about hours and schedules are given. Available from Gilfer for $6.95.

GUIDE TO RTTY FREQUENCIES — Lists about 2500 teletype stations around the world and how to identify RTTY transmissions in Arabic and Russian, how to read weather codes, where they originate, and what areas they cover. Listing includes frequency, call signs, location, power, speed shift, whether it's running normal upright or inverted, news service and schedules. Most of the information is otherwise unavailable. $8.95 from Gilfer.

REVIEW OF INTERNATIONAL BROADCASTING — This is a monthly publication edited by well-known SWL/DXer Glenn Hauser. Listeners comments on stations' programming are stated. Useful lists of such things as DX programs, news programs, English broadcasts to North America, etc. are included from time to time. Available from Glenn Hauser, University Radio WUOT, Knoxville, TN 37916 USA. Sample copies are $1.00. A one year subscription is $12.00.

NOTES — IRCs are International Reply Coupons which are available from the Post Office.

Addresses of above sources which are not included in the text follow:

Gilfer Shortwave, Box 239, Park Ridge, NJ 07656 USA

SWL Guide, 414 Newcastle Road, Syracuse NY 13219 USA

Australian DX Club, P.O. Box 54, Melton, South Victoria 3338, Australia

NASWA, P.O. Box 13, Liberty, Indiana 47353 USA

Club Ondes Courtes du Quebec, 3420 Chemin Ste-Foy, App. 5, Sainte-Foy, Quebec G1X 1S6.

SPEEDX, P.O. Box E, Elsinore, CA 92330 USA.

QRM QRM QRM

Bill Johnson tells how one ham was instrumental in the making of a VHF alternative to ARRL CW transmissions.

CODE PRACTICE HAS always been one of the most important things that a budding amateur has to persistently do in order to succeed, not only at passing the examination, but also the many contacts on the air that require CW.

The ARRL has always been the only steady, reliable source of CW practise in North America. Its signals on 75 and 40 metres have been, at the best, hard to copy here in Ontario, with the quality of equipment that is generally owned by the beginning amateur.

So, when two metres became a readily-available means of communication, it was a natural for code practice. The only problem, for those studying in the early seventies, was the lack of two metre repeaters that could be turned over completely to code practice for the required time every night. At the time when code practice on two was first suggested to the RSO, there were only three repeaters in the Toronto area, and the only one with the required range was VE3RPT - which nobody wanted to lose to code practice for an hour every evening.

So, nothing was done for many years. Nothing, that is, until the efforts of one man, with the support of his local club, changed the situation around. That man is Lloyd Ferns, VE3BZF, and the club involved was the Kitchener-Waterloo Amateur Radio Club. This is the story of how nightly code practise came to Ontario.

In September, 1975, John Riddell, VE3AMZ, reported to the KWARC that the Kitchener-Stratford FM Association had voted in favour of transmitting nightly code practice on their repeater, VE3KSR. There was much discussion pro and con, and the idea did not receive much response that night. Lloyd Ferns, long an advocate of sending code practice in Ontario, felt that code sent on 2 metres would be of little value.

Fate works in many ways, however, and slowly, through circumstances beyond his control, things slowly fell into place at Lloyd's QTH. Lloyd purchased a Multi 2000, which contained an audio oscillator which produces modulated CW in the FM mode. When Dick Smith, VE3EIE, of Orangeville, was leaving for the Maritimes, he sold Lloyd his model 19 Teleprinter.

At this point, Lloyd remembered an article in QST describing a simple way to produce perfect code using a teletype machine, a paper tape, and a polar relay. A subsequent search revealed all the details in QST for November, 1969.

Using the letters Z,M, and T, properly-spaced code can be produced. Paper tapes can be generated, edited, and reviewed before being played on the air. Editing is as easy as snipping out the bad parts of the paper tape and replacing them with good ones. When perfect, the tapes are fed through the reader, which feeds the bipolar relay, thus activating the tone heard from the transmitter.

Several experimental transmissions were made, and adjustments were necesary to adjust the transmitted tone and remove the annoying key clicks. After many conventional filters were employed with poor results, Lloyd threw away the books and tried some brute force filtering with 5 Henries and 50 uF across the relay.

Success was finally achieved, and on November 9, 1975, perfect code was transmitted via VE3KSR at Baden, which has a normal range of 80 km. Practise was sent nightly, except on Mondays (Club net night), at speeds of 5, 7.5, and 10 w.p.m., beginning at 7 p.m. every night. From this point on, code practice was sent nightly for the rest of the winter, also on VE3TTY in Toronto.

The sessions on VE3TTY meant more work for Lloyd. He had to do one session at 7 for KSR and the second at 7.30 for TTY. A Swan VHF amplifier was added to the station to relieve the Multi 2000 on the one hour plus transmissions.

In the spring of 1977, fate took a hand once again when a commercial communications company asked for permission to erect a 200-foot tower on Lloyd's property. The user wanted to erect a 45 MHz side-mounted antenna, leaving the top clear for Lloyd's two-metre antenna. Naturally, Lloyd said yes, and soon found himself dwarfed by an antenna system as high as those on the CN tower.

His problems were not over, however, as he found out one day when a bolt of lightning hit the Sinclair Rapier antenna, melting it and doing severe damage to the wall receptacles in the shack, melting the ground pin right off the repeater AC cord. This strike caused much consultation with Sinclair Radio Labs, who recommended a SRL 224 antenna, giving 6dB gain over a dipole. This antenna can take a direct lightning strike since it is at DC ground. After installation of this antenna and much grounding at the site, Lloyd was back on the air. Proof of the pudding was very certainly in the eating in this case, as the security afforded by the new precautions was demonstrated when Lloyd and a visitor were lifted from their chairs by another direct hit, this time with no damage to the station.

One problem that Lloyd found was

that he was tied to his operating chair for hundreds of evenings at a time. This situation has been alleviated now with the advent of the VE3RSO repeater, located at his site. Now, other clubs can feed the network with CW on the input to the repeater, and it can be copied by anyone on the output of RSO or any of the other two metre repeaters that repeat the output of RSO.

Although other individuals and organisations have helped Lloyd, specifically KWARC and the RSO, his story is one of great self-sacrifice for the benefit of the amateur community. His story is one which makes everybody aware of the great strides forward we can make, not as members of organisations, but as individual amateurs.

QRM LETTERS

Dear Bill,

Readers of your column who are hams and who enjoy home-brewing (of the digital logic variety) would no doubt be interested in an up-date on CCW (Coherent CW) as described in a two-part article in CQ magazine June and July 1977. I have heard very little about it other than the comment in RTTY news by Larry Walrod, VE7BRK, that it could be used to advantage in RTTY.

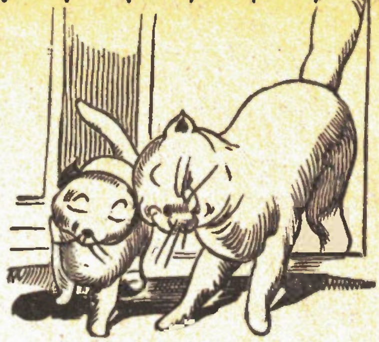
It would be to the credit of the amateur radio fraternity if this improved A1 mode was promoted since it makes efficient use of available radio spectrum and lends itself to high-speed sending and receiving of morse code under microprocessor control. I don't mean as an alternative to packet radio for those who have masses of data to handle. Since so many appear to be using morse keyboards, it would seem a logical step to go CCW and effectively reduce some of the clutter in lower frequencies.

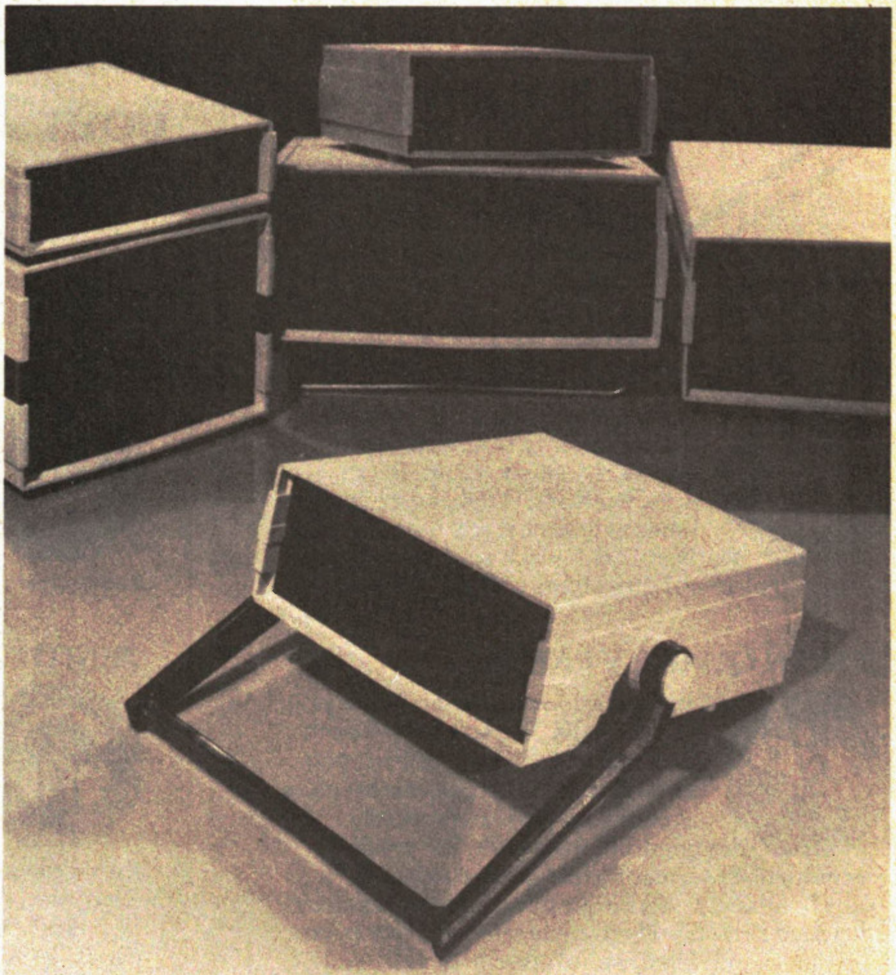
I have enjoyed your column and look forward to reading it each month in ETI.

Regards,
L.A. (Bill) Veit, VE3BWV

Send your letters to:
QRM LETTERS,
ETI Canada,
Unit 6,
25 Overlea Blvd.,
Toronto, Ontario, M4H 1B1

73 till next month,
Bill VE3APZ





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AFTER A FEW YEARS of close association with electrical equipment, one tends to become less concerned about dangers from electrical shock and other sources. Safety precautions become second nature, and the tendency to repair faulty equipment is more reflex than conscious. It's very easy to forget that a large percentage of Canadians are unaware of the dangers of consumer electronic equipment.

The Ontario Television Electronic Association (OTEA), appears to be aware of this. The following, by Hank Steenhuysen, is taken for The Voice Of OTEA.

"In a meeting with members of the Department of Consumer Relations, about a year ago, the problem of safety of electronic equipment popped up.

" I expressed the thought that aside from rip-offs or poor workmanship by incompetent operators, the consumer should be alerted to the fact that an improperly serviced T.V. set or Stereo could become a fire-hazard and a potential killer.

"The manufacturers go through a hassle to get their products C.S.A. approved, but after the product is marketed, anyone can defy the safety precautions.

"To my surprise I discovered a total lack of comprehension on their part. After explaining the purpose of special safety-components in newer types of T.V. sets, marked in special shaded areas in technical manuals and the fire-hazard the set could become if they are replaced by components with a different safety rating, they became quite interested.

"At the same time I explained how dangerous a live-chassis can be if certain insulating boards are left off in the back, or antenna terminals are "hot". Not to speak of the increase of X-ray radiation by a wild running H.V.-stage.

"Then I started to wonder how many of us, the insiders, really take safety seriously. The fact that you don't read of too many accidents in the newspapers does not mean that the potential danger is not always there.

"The OTEA has decided to alert the public to this dangerous state of affairs, by newspaper advertising or any other means open to us.

"Needless to say that we expect every member of OTEA to become extremely safety conscious, if he is not already so inclined. We, as OTEA members, must work for the safety of the public and force the whole industry to follow suit. We have been hammering away at the incompetents and at poor service practices, let us now as OTEA members show the way.

" Our motto from now on is:
Be sure, be safe, Be Protected.

"The following procedures of safety are adopted by the OTEA and may be amended in the future.

1. Measure High Voltage (CRT Anode) and adjust, if necessary, to manufacturer's specifications.
2. Check lead-dress, component placement and dress, pinched wires, etc.
3. Look for jumpered fuses, circuit breakers, and wrong values of same. (It is realized that there are limitations in this direction, for example, fuses are often enclosed or inaccessible).
4. Check ohms resistance between external cabinet metal and power input. Repeat for antenna terminals to power input. Less than megohms calls for attention.
5. Check power cord for cracks, breaks, improper joints and ends. Replace defective or burnt interlocks with correct replacements.
6. Use correct safe components where required.
7. Consult manufactures' precautions concerning all above items.
8. Replace all insulating barriers, grommets, fish-papers and other original-equipment safeguards."

MUSINGS

It's true that any piece of consumer electronic equipment represents a potential threat, but does this really apply to modern sets?

All consumer equipment manufactured or imported in Canada is subject to very stringent CSA regulations. This alone pretty much guarantees that new sets are safe. Furthermore, most brands now carry extended service warranties. This implies a higher level of reliability.

Most manufacturers require that servicemen (er, persons) use certified replacement parts. This applies to all parts of the set and in the case of the HV section, it's probably critical for proper performance.

Short of all technicians carrying a radiation measuring device, I seriously doubt it worth anyone's while to take the back off every set just to make sure everything is hunky-dory. Most appliances and electronic gear will function properly *unless* somebody fiddles with it. I speak from personal experience from as far back as 13 years old). Make sure you leave a set in as good as or better than new condition.

BUT PUBLIC AWARENESS IS STILL IMPORTANT

People don't think about safety unless they are actually threatened. How many people simply won't notice frayed electrical cords? In fact many people cause loose connections by yanking a plug by the cord.

Another frequently overlooked danger is radiation leakage from microwave ovens. While these appliances probably have adequate interlocks, leakages can occur if the door is bent or warped, or if the seals are damaged.

There's the classic story of the rich lady who had washed her toy poodle and put him in the microwave "only for a second" to dry him off.

Also, just recently in Southern California, a restaurant operator removed the door from his microwave and defeated all the interlocks. Leaving the oven running continuously, he instructed the waitresses to place dishes directly in the cavity with their hands. He was stopped eventually, but not before one girl had to have her hand and lower arm amputated to prevent the spread of cancer.

Public awareness is very important. As the "technical class" of our society we should make public awareness a public service, on our part.

NEXT MONTH

A rather short Service News this month. This is because Dick is away on holiday and I'm discovering that his are very large shoes to fill. Next month David Van Ihinger takes control. You may remember Dave from the T.V. Antenna article in August, 1979.

Oh, well as Dick would say...

All the best

John Van Lierde

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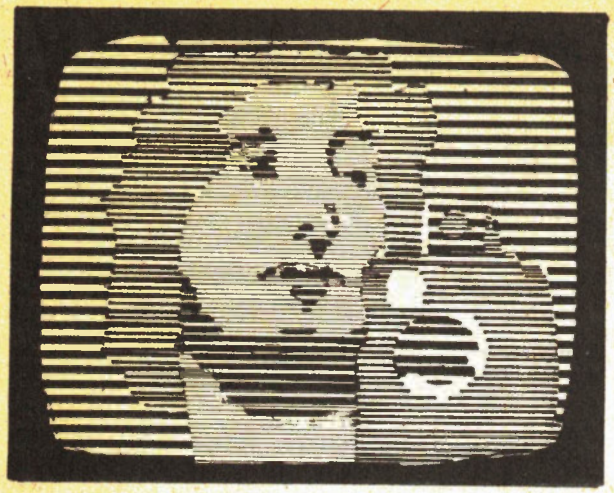

WHAT'S ON

Resident video freak, Steve Rimmer, presents the theory of vidicon operation and offers some hints on tune and adjustment.

VIDEO SURGERY

MOST IMMORTALS, sheep and nerds would never conceive of fiddling with the guts of video equipment. For them, BRITENESS, VOL., and TUNE are the limits of their tamperings with the dark, immortal arts.

The true video buff, however, will have the cover plates off his toys within minutes of getting home.

I am assuming, of course, you have all followed my advice and immediately purchased a video camera as detailed in last month's column (it doesn't work, right?). Read on and I will detail how to make your best all better.

INSIDE

Before the transistors start flying, it might be worth while having a detailed look at just what goes on inside a camera. In fact, especially in the area of the cameras we'll be looking at, the circuitry involved is astoundingly simple. The first camera I built got along quite nicely with only six tubes, including the pickup. Commercially built eyes are not much more complex. The biggest fuzzy area involved is in dealing with the Vidicon pickup tube itself.

The circuitry of a black and white vidicon camera is very much like that of the monitor into which the signal it produces is fed. The central element, the vidicon, has many similarities to a CRT. It produces an electron beam, which is made to scan a raster by electromagnetically deflecting it, so the tube is encased in a yoke much like that of a conventional picture tube. In most cases, the vertical scan rate, sixty hertz, will be triggered from the mains under normal operation ... although some cameras have provision for external sync, so that everything will wind up in phase with some other video signal. The horizontal scan rate may be crystal controlled, a free running, and hopefully stable, oscillator, or phase locked in some way to the vertical. Depending upon the particular method of producing this signal, the frequency may not be exactly 15.750 Kilohertz. In the Philips EL 8000 shown, for instance, it is 15.625. This is not a terribly important difference, as video monitors, television receivers and video tape recorders are generally capable of adjusting themselves to fairly wide tolerances in scanning rates

The timebase oscillators which produce the horizontal and vertical pulse chains drive two essentially similar output stages. Inasmuch as the B++ for the vidicon tube is only a few hundred volts, no voltages are derived from the horizontal scan, as would be the case for a picture tube. However, because the yoke coils represent fairly hefty inductances, the outputs have to do some "counterwaveshaping". They give the pulses the impression that they've seen equally large capacitive effects, so that when they reach the deflection coils, they wind up producing linear scanning voltages. While this type of arrangement can never equal the linearity inherent in the electrostatic deflection found in, for example, an oscilloscope tube (or some other types of camera tubes), deviations of less than two percent can be arrived at with proper adjustments. This is really pretty good; if New York City could keep the deviation rate down to less than two percent, I'm sure they'd all be quite pleased with themselves.

(Besides which, the monitor upon which the image from a camera is eventually shown will have electromagnetic scanning, also inherently a bit non-linear. If all the tolerances work out, perhaps they'll compensate for each other.)

With the beam of the vidicon scanning in a proper raster pattern, and a visual image directed upon the face, or target, of the tube, video will emerge. Very, very little video. When it's really blasting away, the average tube will kick out about sixty millivolts of signal. Thus, the output of the tube is immediately directed to the input of a high gain, wide band, low noise amplifier. The first stage of the amp must have a very high input impedance, lest it load the signal down to the point where it gives up and goes home. Since this isn't remarkably easy to do with bipolar transistors ... which are generally a bit nasty around tubes ... this first stage will usually either be a FET, or, if the camera dates back to the dim and distant past before suitable FETs roamed the planet, it might well be a small triode tube. From this point on, the video hits some more gain. Somewhere along the line, vertical and horizontal sync pulses are added to it, as provided by the timebase generators of a couple of paragraphs ago. When everything is at a reasonable level it finds its way to a follower stage, producing one volt of signal across seventy five ohms, and promptly goes wandering merrily out of the camera. In some cases, as well as being released in the form of raw video, the signal at this point may also toddle on to fire up an RF modulator, providing an input for standard, tuner type TVs.

Because, as we shall come to grips with momentarily, the beam current of the vidicon varies with the incident light of a scene, it is quite simple to build a circuit which "knows" how much illumination is available and adjust the video signal level accordingly. Since

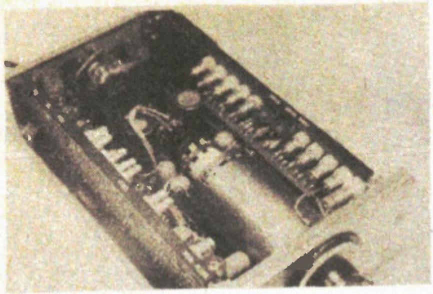

Fig. 1 Inside the Philips EL8000 CCTV camera

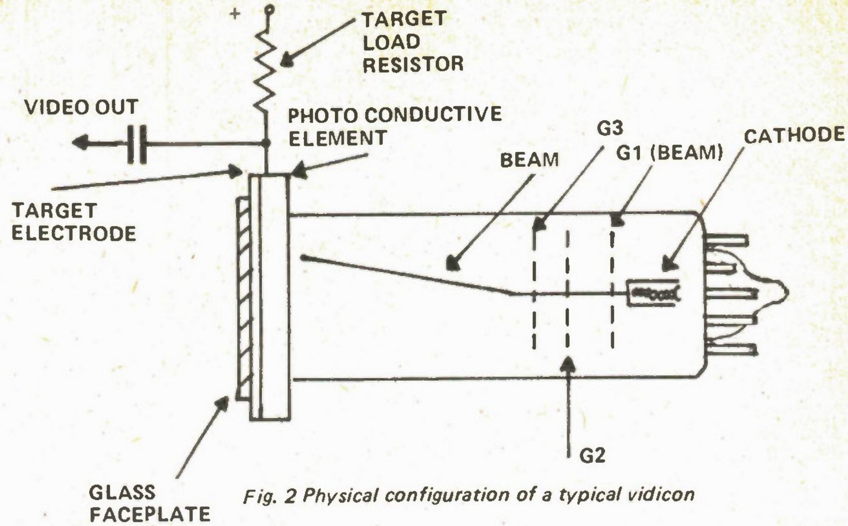

Fig. 2 Physical configuration of a typical vidicon

the contrast range of a pickup tube is not nearly that of photographic film, the system is quite intolerant of even fairly inconsequential sounding errors in exposure. Thus, almost all vidicon cameras are equipped with an ALC circuit of this type to keep things within reasonable limits. The range of control of the ALC can be as little as one to a couple of hundred, or as much as one to a million.

If the circuitry of a TV camera seems fairly undemanding, it might be a bit easier to understand, under several acts of Murphy's Law, why the vidicon tube itself is so ugly and complicated. The following simplified breakdown of its operation is provided largely for the sake of completeness. There is really no practical value in causing smoke to roll from the ears in order to fully grasp the intricacies of the nasty thing. It is usually sufficient to know that if the appropriate voltages are applied to the pins, and some proscribed incantations are muttered in its hearing, signals will come popping out.

Now, listen carefully. There'll be a quiz afterwards.

Refering to the diagram of the vidicon tube, we notice that up front is a thing called the target, which consists of a transperantly thin metal electrode. Behind this is, in essence, a large matrix of very tiny photoresistors pointing backwards from the target plate. Now, if the target is placed at a positive potential, and an image is focussed on it, the voltages on the back ends of the resistors will be proportional to the illumination falling on them. In effect, the pattern of light falling on the face of the target will have been converted to a pattern of voltages on the back of it.

When the electron beam comes a-scanning, it sequentially connects each resistor, at its back end, to the cathode of the tube, which is near ground potential. When the illumination on a resistor is low, its resistance is very high, so this grounding causes relatively little current to flow through the tube. If, on the other hand, the illumination is high, and the resistance drops, the beam current will increase. Since the target voltage is coming through a fixed, external resistor, a voltage proportional to the instantaneous illumination on the target, as the beam scanns it, i.e., a video signal, will be developed across it.

Or something like that.

The resistor through which the target gets its voltage is not, in fact, a fixed element, but, rather, a pot, so that the target voltage can be varied. In this way, the sensitivity of the tube can be altered. The higher the target potential, the "faster", or more sensitive, the tube becomes. However, the photoresistors in the target assembly are not ideal devices, and, as the target voltage is increased, the little fellows begin to pass proportionatly more "dark current", or current which does not reflect any incident illumination. This will, eventually, manifest itself as a glowing around the perimeter of the picture, which looks a little silly, and proclaims to all and sundry that the target adjustment has been adjusted a bit too far.

While we're into adjustments, it will also be noticed that the voltage on the first grid of the vidicon is also variable... it's controlled by the beam current pot, suggesting it has something to do with the electrons streaming off the cathode. It is a fairly innocuous little control. If the beam current is too high the photoresistors get highly uptight and go non-linear, distorting the picture's grey scale. If it is too low, they do pretty much the same thing in the opposite direction. Needless to say, there is usually an optimum setting for this one somewhere in the middle.

The third, and, often most confusing adjustment associated with the vidicon is the focus. You see, TV cameras have two focusses. There's the mechanical focus, and the electrical focus. The mechanical focus is, in fact, often broken down into coarse focus, which moved the vidicon tube back and forth, and fine focus, which adjusts the lens. With mechanical focussing any scene, no matter how distant, can be focussed on the face-plate of the tube. There is, quite obviously, no optimum setting for mechanical focus; it is changed to suit whatever is going on in front of the camera. Electrical focus has nothing to do with light. It focusses the electron beam of the vidicon tube on the faceplate, just like one might focus the beam of an oscilloscope, so that the raster lines are sharp. Thus, if either focus is out of focus the resultant picture will look blurred. However, it must be kept in mind that once properly focussed, the electrical focus does not require any periodic fiddling, because it has nothing to do with the distance of the subject from the camera.

TUNING UP

For purposes of this discussion, you should have a somewhat functional camera. Troubleshooting is best done with a service manual, and, rather than try to generalize one into a few paragraphs ... with lines like "if you camera has a line cord, plug it in. If not, refer to the next page where we'll deal with gopher and treadmill generators." ... it might be best to skip right along to the final adjustments. These aren't all that complicated, but most manuals seem to leave them out.

All hoping for a wave of simple factory service, me thinks.

Place a test pattern card infront of your camera and focus it, using the lens, as best you can. If you haven't got a test pattern, as may well be the case ... many authorities do not consider these things to be among the prerequisites of human existence ...use the back cover of this magazine. You might want to memorize the rest of the instructions first, or make sure you can read with your head sideways.

Somewhere in the camera will be a screwdriver adjustable type pot (occasionally mounted on the rear panel) to set the electrical focus. With the lens focussed as best it can be, adjust this control for the sharpest picture.

If the lens will not focus on objects past ten or twenty feet, even with the lens set to infinity, you may have to slide the vidicon tube or the whole deflection assembly, as the case may be, a bit closer to the lens.

Next, adjust the beam current for best picture resolution and a good grey scale.

If the horizontal and vertical scanning amplitudes seem to be set correctly, that is, if you are not getting an old border around the perimeter of your picture, indicating a recent overscanning, or very gritty resolution even at optimum beam, indicating underscanning, don't touch these pots. Aim the camera at a perpendicular circle and adjust the horizontal and vertical linearity controls so that it looks round on the screen. These pots may be found to be a bit interactive with the amplitude settings, so some fiddling may become necessary to get everything running normally.

It is essential that the scanning of the camera be properly adjusted before it is used for an extended period of time, lest the tube be burned in a pattern that will, at a later date, mar the picture.

The target voltage will probably be found to have been set quite high, especially if the camera was used in surveillance work, where sensitivity is much more important than attractive pictures. As such, you may wish to drop it down a bit until the edge flare discussed earlier goes away. A simple way to do this is to aim the camera at a uniform grey, or neutral coloured, surface and adjust the target voltage until the screen is fairly monotone from centre to edge.

If the camera has an RF modulator, it can be adjusted by tuning in a broadcast TV station on a standard television, and fine tuning the set until it is as clear as possible. Now, connect the RF output of the camera to the set and adjust the tuning of the modulator until the picture comes in properly on the TV. As a rule, most single channel modulators are tuned to channel 3.

USING IT

There are only a few simple precautions to observe when using a vidicon camera. First of all, don't point it at bright lights for extended period as this will permanently burn the vidicon tube. The same holds true for shiny objects reflecting bright lights. Short exposure to bright objects will leave temporary burns on the tube surface, which will fade away in a few moments.

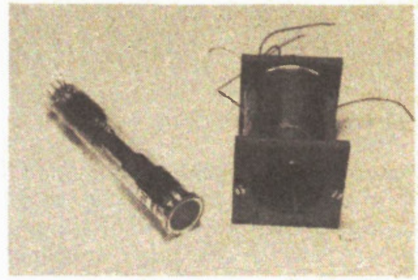

Fig. 3 Vidicon tube and focus coil.

Most vidicons will not enjoy being used at angles in excess of 45°, as this would cause bits of material loose in the tube to fall onto the photoconductive surface, causing the marks we've discussed earlier. As such, pointing the camera directly at unclad bodies, as seen from a top tall buildings should be avoided. Use a mirror.

The camera should not be subjected to excessive mechanical shocks, vibration, heat, cold, or flattening by a pile driver for all the usual reasons.

It will be found that, if the camera is focussed on a scene in which one area is significantly brighter than another, such as the interior of a room in which there is a sunny window, the ALC will cause the image to be properly exposed for the brighter area, leaving the rest of the picture black. Some control of this can be achieved with careful adjustment of the lens iris, but, in most cases, this is something that has to be lived with.

In future columns, we'll have a look at some of the techniques involved in properly using a TV camera, so as not to make your home movies look like Eraserhead.

Next month for me is December. For you, it's March. I don't know what I'm going to do in November; I can't even imagine what I'm going to be up to as far away as next year. Therefore, I will refrain from any prognostication as to the nature of next month's column ... to date, I've not managed to get a great number of these predictions right anyway. However, if you have any questions about video or the true meaning of life, do feel free to write. Until next month, stay tuned.

Practical Guide To Triacs Part III

Our final article in this three part series explains how Triacs are used in zero-voltage switching circuits — and includes circuits for the control of large heating loads.

Zero voltage switching is a method of varying the power applied to a load by switching line voltage on and off only at the zero crossing points of the sinusoidal waveform.

The technique virtually eliminates the problems of rfi associated with phase control of large resistive loads.

The difference between phase control and zero voltage switching is illustrated in Fig. 27, where the upper waveform shows phase control, whilst the lower waveform shows zero voltage switching.

Zero voltage switching can only be used for applications in which the controlled load is capable of averaging bursts of complete half-cycles. Thus the response time of the load must be long compared with the period of the switching cycle, for it is quite possible that at low power settings, short bursts of say, twenty to thirty half-cycles may be applied at ten second intervals. Thus the method is acceptable for the control of loads such as heating elements, but out of the question for light dimming.

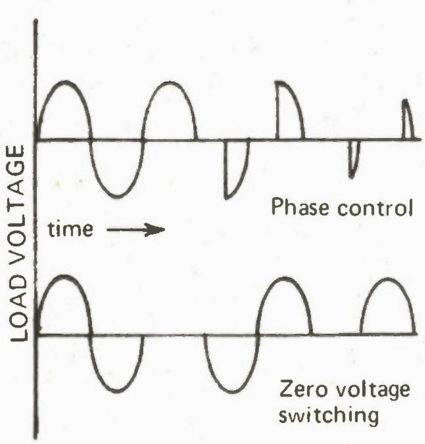

Fig. 27

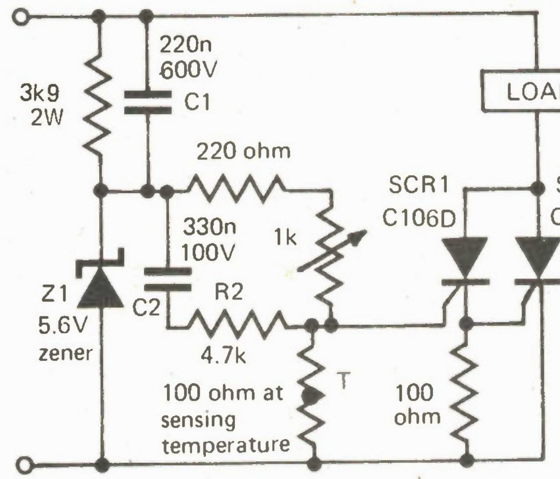

Fig. 28

Fig. 28. Simple half-wave zero-voltage switching circuit, maximum load is determined by choice of SCR2.

HALF WAVE CONTROL

A very simple yet effective zero voltage switching is shown in Fig.28. This circuit provides half-wave control only, but is very satisfactory for commercial applications where the heating elements can be designed to suit.

The circuit is extremely stable and unaffected by quite large variations in line voltage and ambient temperature. The response time depends upon the characteristics of the thermistor which is used — times of one to two seconds are typical. The sensing differential is around ¼°F at normal ambient temperature.

The Zener diode Z1 forms a voltage pedestal of 5.6 volts nominal amplitude by clipping the incoming positive half-cycle of mains voltage. This pedestal is differentiated by R2, C2 and associated resistors to form a pedestal of reduced amplitude with a pulse superimposed on top of the pedestal (Fig.29). This waveform is applied to the gate of SCR1. The capacitor C1, which is connected in parallel with R1, provides a leading phase shift to the pedestal so that SCR1 is triggered into conduction by the peak of the positive decaying pulse which is superimposed on the pedestal. It does this at the beginning of the positive going half-cycle of line voltage appearing at the anodes of both SCRs.

Fig. 29. Basic waveform associated with circuit of Fig. 28.

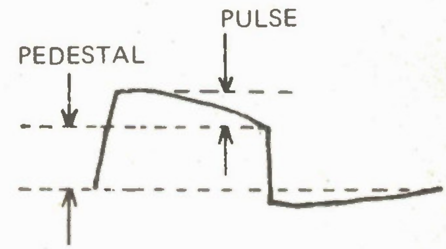

Fig. 29

The thermistor controls the amplitude of the pedestal and thus provides a semi-proportional control with a small temperature differential.

The lock-in configuration of SCR1 and SCR2 reduces the effects of ambient temperature variations. The cost of this circuit is very low compared to a phase control circuit of the same power handling capacity as no rfi components are required

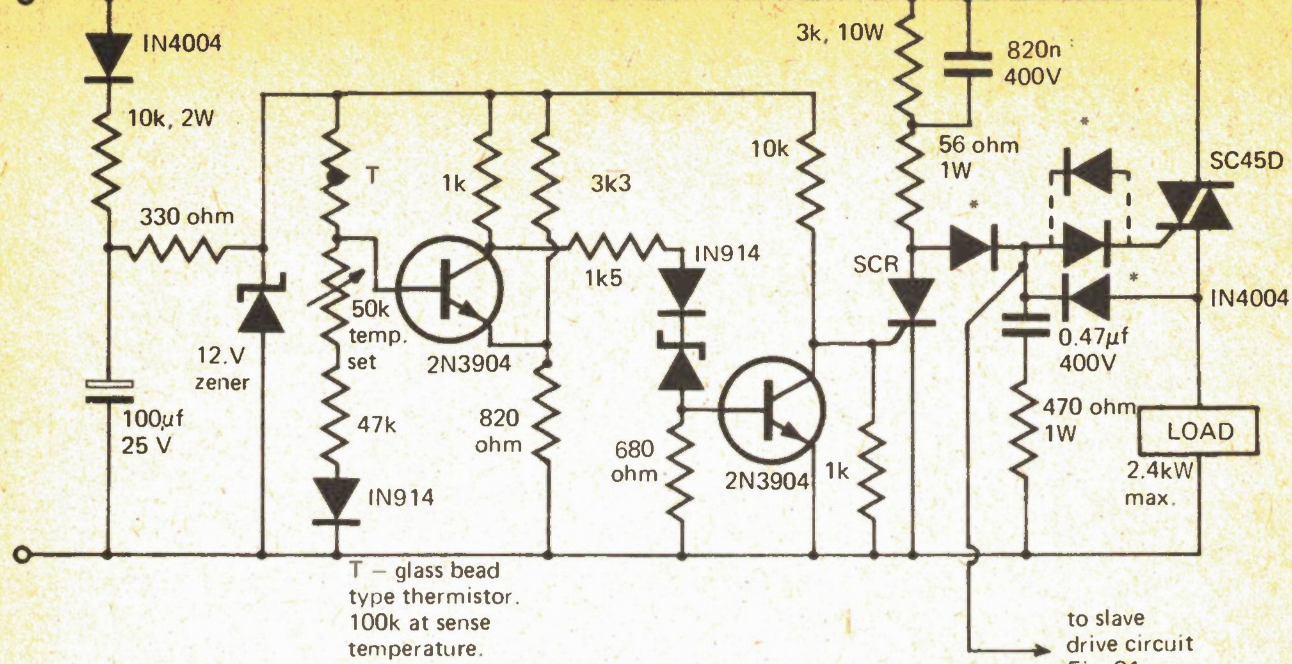

Fig. 30. This circuit can control loads of a size determined only by the rating of the Triac. The slave circuit shown in Fig. 31. can be driven by the output of this circuit if required.

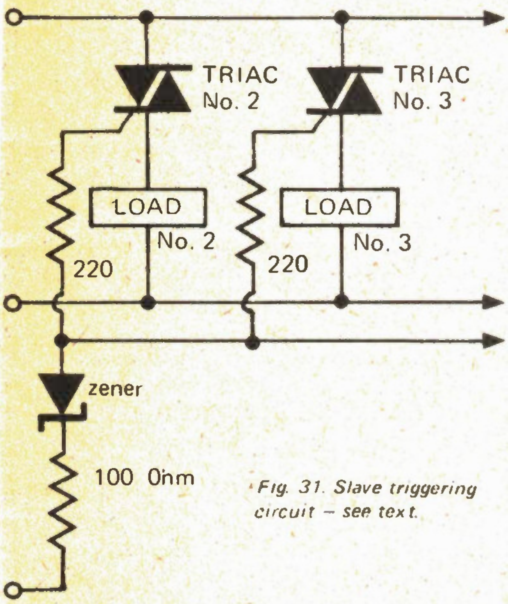

Fig. 31. Slave triggering circuit – see text.

FULL WAVE CONTROL

The circuit shown in Fig.30 will provide full-wave control of heating loads of almost any size. The triggering circuit will drive Triacs of any size from 1 amp up to 125 amps. In addition almost any number of additional Triacs can be slave driven by the main triggering circuit. (The slave triggering circuit is shown in Fig. 31).

The differential of this circuit is approximately ± 1/6°C. This circuit has a semi-proportional action, and is suitable for applications where large amounts of power have to be controlled accurately and at low cost.

INTEGRATED CIRCUIT CONTROL

A number of companies have produced integrated circuits specifically for zero voltage switching applications. These ICs permit circuit and operational techniques which would otherwise require an unrealistic quantity of discrete components.

Two examples of zero voltage switching ICs are the PA424 and the Fairchild UA742 TRIGAC. There are many more available.

Although outwardly similar, the two ICs are not interchangable – however to some limited extent their functions are the same.

When used with only a few passive components, plus a thermistor, the ICs, (a), develop their own dc power supply, (b), differentially detect sensor unbalance, (c), detect zero voltage crossing point and (d), produce the required Triac triggering pulse.

A simplified version of the PA 424 device is shown in Fig.32. The input section is a differential amplifier consisting of transistor Q1 and Q2. A balanced pair of resistors R1 and R2 form the internal arm of a resistance bridge.

The external arm of this bridge consists of the temperature sensing thermistor and the 'set temperature' potentiometer.

BASIC CONNECTIONS

When the PA 424 is used in the basic Triac triggering connection shown in Fig. 33, the external resistor Rs provides power to drive the circuit and also supplies line voltage zero crossing information.

During the negative half-cycle, diode D1 (Fig. 32) conducts, and external capacitor Cs is charged. This capacitor provides power to drive the circuit during the remainder of the cycle.

As the line voltage goes through zero, the current through Rs also goes through zero, and if required by the sensing circuit the zero crossing detector puts out a triggering pulse. This pulse has sufficient energy to fire practically any suitable Triac.

In essence the Triac is triggered when the resistance of the sensing element Ra falls below the resistance of the 'set temperature' potentiometer Rb. For optimum sensitivity the resistance of the sensing element should be around 5k at 'set' temperature.

The circuit's operation is not limited to temperature control – the input sensor could equally well be a photo-diode, pressure transducer, strain gauge, or any other type of sensing element that has a resistive output in the required range (500 ohms to 50k).

FAIL SAFE OPERATION

Both the PA 424 and the TRIGAC ICs can be used in sophisticated applications. One example of this is fail-safe' operation of heating loads.

In many control systems the failure (short or open circuit) of a thermistor or resistance thermometer can cause a dangerous condition. For instance a heating control with a normal negative temperature coefficient thermistor would interpret shorted thermistor leads as a very high sensed temperature and would react by cutting off the power.

However if the thermistor were to go open circuit (and this is not uncommon) the control system would see this as a low temperature and full power would be applied continuously to the load. In this case an 'open circuit' thermistor detector is required to protect the system against this condition.

A circuit which will achieve this is shown in Fig.34. It is also possible to protect circuits against 'short circuit' failure of positive temperature coefficient thermistors.

Zero voltage switching can be used in conjunction with proportional control circuits for both single and three phase loads. However the circuitry required is fairly complex and outside the scope of an article of this type.

TRIACS — FAULT FINDING

By far the greatest cause of failure is overloading. It cannot be stressed too strongly that a Triac, like most semi-conductor devices, is destroyed instantaneously by a short circuit placed across its output.

An almost infallible indication of an overloaded Triac is that gate control will have been lost, and the Triac is 'on' all the time. Checking this is quite simple, just unsolder any lead connected to the Triac's gate, and, if the Triac is still switched 'on' then the unit has lost gate control.

Before replacing the Triac, check with an ohmeter to make sure that the load is not shorted out. When the circuit is again in operation, monitor the line current for a time to check that it is within the Triac's designed rating. In particular remember that large incandescent lights have a very heavy inrush current and this may exceed the Triac's short term overload capability. (This is generally five to ten times full rated load for one half-cycle of the input waveform).

The other extreme of failure is when a Triac circuit will not trigger at all. This is generally a failure of the triggering circuit rather than the Triac.

The first obvious check is to establish that there is in fact line voltage across the Triac. Assuming that voltage is there, a very simple check is to connect a resistor (150 ohms to 1k) between the case and the gate. This should trigger the Triac into full conduction.

If the Triac is triggered into conduction, then the fault lies in the triggering circuits; if the Triac does not trigger, then the Triac is faulty.

Finally, don't test Triacs with a Megger.

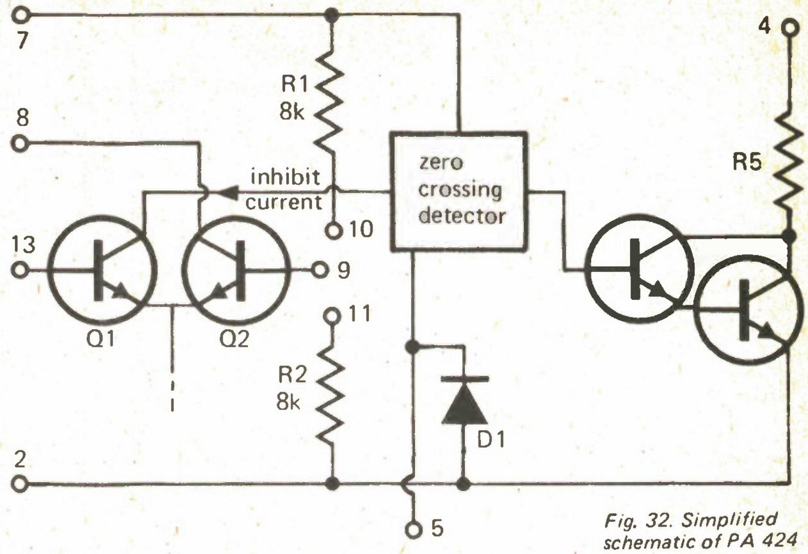

Fig. 32. Simplified schematic of PA 424 integrated circuit.

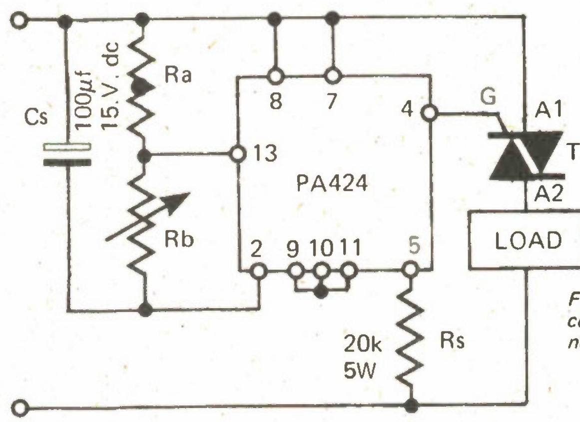

Fig. 33. Basic temperature control circuit uses PA 424, note Triac connections.

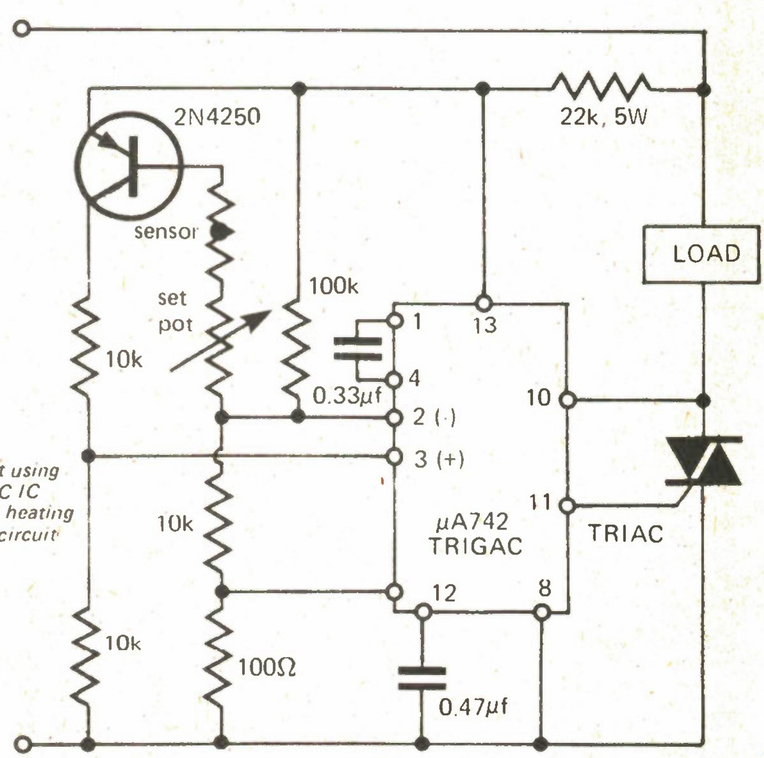

Fig. 34. This circuit using a Fairchild TRIGAC IC senses and protects heating loads against open circuit thermistors.

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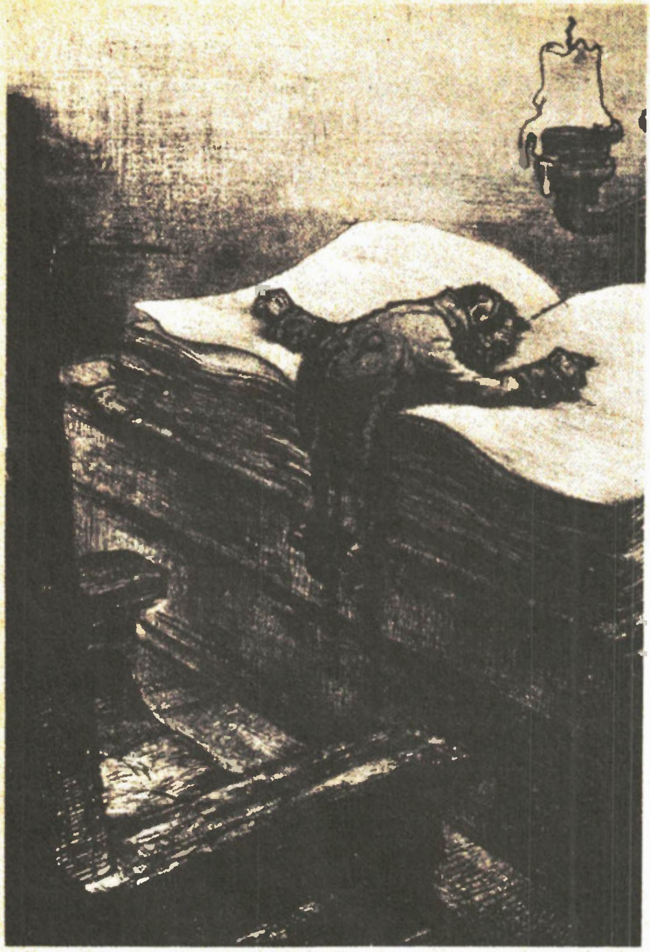

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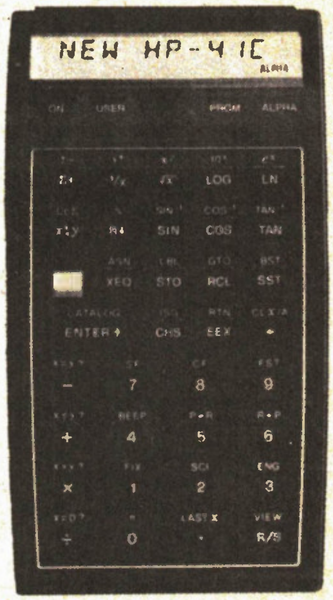
HP 41C Review



It looks deceptively like a calculator, but much, much more hides beneath that wily keyboard.

A 'personal calculating system' with the power of a personal computer for an amazing price

IN WRITING THIS ARTICLE, I am acutely aware that my personal enthusiasm is going to show right through it to the point where the reader may well suspect me of bias! The only answer I have to this is that, once you have read the article, or better still – seen the machine, you will be just as biased as I am.

When Hewlett-Packard released the HP-67 and 97 programmable calculators I decided that they had reached the ultimate in pocket calculator power. Surely, I reasoned, no-one could use more portable computing power – for anything more complex than these calculators could handle, a personal computer, though less portable, would be a better solution.

Well, I was wrong.

With the release of the HP-41C, Hewlett-Packard have introduced a pocket calculator which is more powerful than many personal computers. The key to the power of the machine is its ability to manipulate and display alphanumeric characters. This means that it can display and understand letters and punctuation marks as well as numbers.

In appearance, the HP-41C is similar to most current pocket calculators. The keyboard looks rather like previous HP calculators with a few curious additions – the letters of the alphabet from A to Z plus =, ?, :, space and , (comma) are printed on the front of most keys, and there are some new functions like XEQ and ASN. The display is a liquid crystal 16-segment type with 12 character positions, which also displays the current trigonometric mode and other status indicators.

ALPHA OPERATION

The use of alphanumerics means that the keyboard of the HP-41C is remarkably uncluttered for such a powerful machine. For example, take the method for calculating the standard deviation of a group of data. As on previous HP machines, the data is accumulated using the Σ+ key, but there is no 's' key to return the standard deviation. Instead the XEQ key is depressed, followed by the ALPHA key, then the letters S, D, E, V are entered into the display. Finally, the ALPHA key is depressed once more to return the machine to its normal mode; this acts like a carriage return on a computer, and the calculator accepts the command, returning the result of the standard deviation calculation in the display.

One hundred and thirty functions are crammed into the machine in this way, without making the keyboard so complex as to be unusable. In case you forget the functions that are available, the CATALOG command will sequentially list all the function names in the display to remind you. In fact, the machine maintains three catalogues, one of the programs the user has entered into the machine, one of the programs contained in Application Module ROMs and peripherals plugged into the machine, and one of the built-in functions of the machine itself.

The alpha capabilities of the machine are not the only new thing about it. At the top of the case there are four multi-pin sockets which are in fact I/O ports. Into these you can plug various optional extras, including extra RAM, ROM in the form of Application Module software, a magnetic card reader, a printer (with plotting capabilities), and a soon-to-be-released bar code reader.

SYSTEM EXPANSION

RAM first. The basic calculator has 441 bytes of storage in CMOS RAM which can be allocated to program steps or storage registers as necessary. Each storage register takes up seven bytes, while program steps may take one,two, or three bytes. Alphanumeric characters occupy one byte each. This means that the calculator can be set up with 63 data registers or approximately 200 to 400 lines of program memory, or any combination in between.

If that isn't enough, extra memory can be added, in 448 byte blocks, to a maximum of four memory modules. This will give up to 319 memory registers or 1000 to 2000 lines of program storage. If that's not enough, you need a computer not a calculator! The RAM in the memory modules is also CMOS and will retain its contents as long as it is plugged into the calculator.

The plug-in ROM Application Modules contain up to 8 Kbytes of software – that is, somewhere between 4000 and 8000 lines of program maximum! A wide range of Application Pacs will be made available, similar to those for the HP-67 calculator. These will include Circuit Analysis, Mathematics, Aviation, Statistics, Stress Analysis, Games Navigation and several other titles.

PERIPHERAL POWER

In peripherals, the HP-41C sets a whole new standard. The most important for many users is the printer, which offers a wide range of facilities. Like that on the HP-97, it can print results of numeric calculations, as well as intermediate results. However, it can also print letters and punctuation, both upper and lower case, from a special register in the calculator. If that's not sophisticated enough, it can also print user-created graphics characters, and automatically perform high-resolution plotting, with automatic scaling of units! All the power of the printer comes from its built-in microprocessor and driving software.

The printer ROM contains 24 programs with names like BLDSPEC, PRBUF, and PRSTK. These can be run from the HP-41C using the XEQ and ALPHA keys, but if the programs don't perform in quite the manner required for your application they can be downloaded into the calculator RAM and then modified to suit. Thus, the plot programs can be altered to print histograms, for example.

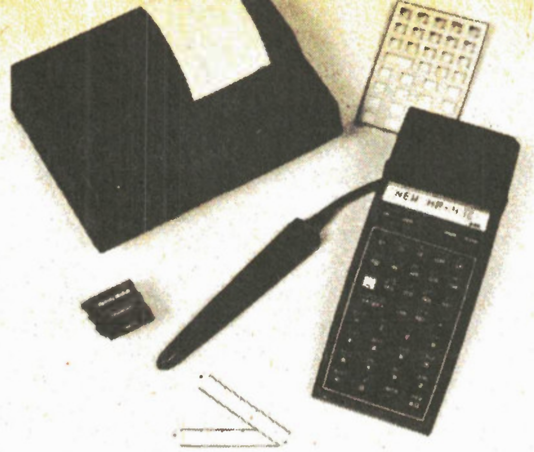
For those who are likely to have a collection of long programs which cannot all fit into the calculator at one time, or for current HP-67 or 97 owners, the magnetic card reader is a useful accessory. Occupying one I/O port, the card reader slips neatly onto the top of the calculator, and is, like the printer, an intelligent peripheral. Part of the philosophy of the HP-41C is that the user should only have to pay for those facilities which he requires, and so the basic calculator does not contain any of the peripherals' intelligence.

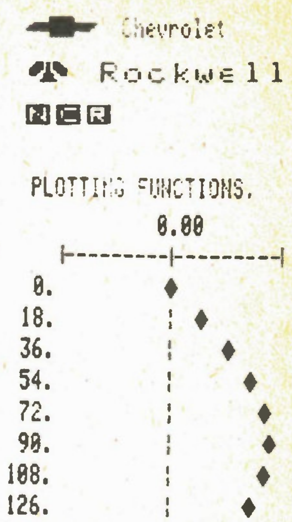
The HP-41C card reader is intelligent, and will prompt the user for the next card side to be inserted in a multi-card sequence; for example 'READY FOR 3 OF 7'. It doesn't matter in which order the cards are inserted, the card reader will recognise and store them in the correct area of memory.

For insertion of program lines when editing, the HP-41C unpacks lines of program code, leaving gaps between them. When a program is loaded, there will be a pause while the calculator re-packs the program memory in the densest possible configuration, and the display will show the prompt 'PACKING' to let the user know what is going on.

To maintain compatability with the earlier HP-67 and 97, the card reader is able to read HP-67 program cards and translate HP-67 keycodes like f P≷S, which don't make sense to the HP-41C, into calls to subroutines stored in the card reader which execute the desired function.

The card reader also offers some new functions, such as the ability to record a card which cannot subsequently be listed or modified by the user, only run. Previously write-protected cards can also be overwritten. Again, all the intelligence to perform these functions has been built into the card reader – effectively making the calculator into a mini distributed-intelligence system.





ABOVE: The HP-41C with printer and assorted peripherals. RIGHT: At top are examples of the special character capabilities, while beneath is portion of a sine plot.

THE CALCULATOR ITSELF

Even disregarding the power of its peripherals, the HP-41C is an immensely sophisticated calculator. The use of an alphanumeric display enables the calculator to 'prompt' the user; for example, when the STO key is pressed, the word 'STO' appears in the display, followed by two dashes to indicate that a two digit register number is required. Once the two digits are supplied, the display returns to the previous value in the X register.

Two new instructions replace the old DSZ (decrement and skip on zero) and ISZ (increment . .) instructions. The ISG (increment and skip if greater) and DSE (decrement and skip if equal) instructions permit the user to increment a register by a selectable increment (not just one), and test against a selectable value (not just zero). This gives a capability similar to the FOR . . NEXT loop in BASIC.

Labelling in programs is rather more sophisticated than in previous calculators. Labels A to J, a to e and 00 to 99 are local labels, while all the rest are global. This means that a GTO D instruction in the currently executing program will not jump to a LBL D in another program, causing a crash. However a GTO M will search right through program memory, not just the running program, allowing one to call subroutines in other programs, or exit from the running program.

The way the HP-41C searches for labels in memory is interesting. While previous HP calculators would search onwards through program memory following a GTO label instruction, the HP-41C operates somewhat differently. Branches to labels 00 through 14 are handled as relative branches within plus or minus 112 bytes of the GTO instructions. Labels 15 through 99 occupy twice as much space in program memory (two bytes), but the calculator remembers the location of these labels regardless of their location in a program.

Alpha labels are handled in a completely different way. The calculator maintains the Alpha labels as a linked list; each alpha label also contains the address of the next alpha label. The calculator then can search extremely quickly for labels.

Design a calculator

A unique facility of the HP-41C is the USER mode, in which built-in functions, routines or even programs can be accessed through a single key stroke. In fact, any key on the calculator can be given a different meaning from that in the normal mode, by using the ASN (assign) function. Thus, a statistician who calculates a lot of standard deviations would find that keying in XEQ, ALPHA, S, D, E, V, ALPHA is a bit tedious, but he could reassign the SIN and COS keys, which he might never use, to stand for mean and standard deviation.

There are 56 flags in the HP-41C, some of which have predefined functions, such as indicating whether a printer is attached to the calculator. Special instructions enable a flag to be automatically cleared after test, and five of the flags are continuously indicated in the display, so you can see their state. For the ones which aren't displayed, the calculator lets you test a flag, returning a display of YES or NO.

ODD FUNCTIONS

Built into the calculator is an audio beeper, which has ten programmable tones. These are primarily intended for audio alarm of error conditions, but I dare say they could be programmed to play a tune!

Complete control of the display format is possible. The calculator can be set to display numbers with commas between the thousands and a decimal point before the decimal fraction. Or, by setting a flag, it can display numbers with points between the thousands and a comma before the decimal fraction, in the European style. The calculator is set to the correct mode by the shipping department before being delivered to the customer – that's the kind of attention to detail that keeps HP customers coming back for more!

The display does not always display the contents of the X register, but can be set in VIEW mode and then used to examine the contents of the stack, the alpha register, or any memory register, without disturbing the contents of the stack.

An OFF instruction lets a running program turn the calculator off to conserve the batteries (alkaline cells give up to a year's option), while an ON instruction disables the automatic power-down facility which would otherwise switch the calculator off if it is not used for ten minutes or so.

All the usual functions of a programmable calculator are there, of course, including the relational tests, factorial, logs, trig, percentages, rectangular/Polar conversions, and so on. Interestingly, particularly in view of the alpha capability of the calculator, HP have brought back the octal/decimal functions of the HP-65, rather than hex, which would be more popular, as well as a showpiece for the alphanumeric display.

Also, in the interest of improved accuracy, there are two new log functions – exp(X-1), and ln(X+1), which would probably never be used from the keyboard, but can improve the accuracy of programs considerably.

WHATEVER NEXT?

If after considering all this, you are feeling somewhat shell-shocked, as I am, you might like to consider what might be in the offing as accessories for the HP-41C.

For a start, HP have annouced there will be a light wand bar code reader for the HP-41C. This means that they will be able to publish software in the form of bar code, and from the beginning of 1980, their User Solution Books will include bar code to save the user keying in long programs.

However, it is interesting to conjecture what else might be under development, as yet unannounced, to match the HP-41C. Since the machine is byte oriented, it is possible (even probable?) that HP might introduce a parallel interface for the calculator to allow data acquisition. This would make the machine suitable for applications now being met by the HP-97S, a modified HP-97 with BCD input and bit output. Perhaps to match this there might be a clock or timer module.

Teachers' Topics

Everyday, we get letters asking for help with ETI projects. 80% of these letters should never have been written. In the first part of an open ended series, John Van Lierde tells you how to track down those elusive parts.

STOCKING UP

EVERY MONTH, thousands of ETI readers, like yourself, pick up our magazine and drool over the three or four projects we present. Then, after a few months perusal you might eventuallly psych yourself into building something, and therein lies the rub. Getting the parts.

There are two classifications of project components, basic, and esoteric. The former are easy to get, the latter are somewhat more difficult to find, and may well turn you away from any project you could otherwise successfully complete.

THE BASICS

Basics include such things as resistors, capacitors, diodes, some transistors, transformers and so on.

You can get used resistors and capacitors from TV sets and old pc boards, but this doesn't always produce worthwhile parts. There are always a large number of surplus package deals available today. These invariably offer good value, but look out! They rarely contain most often used component values (such as 1k or 1n's). In addition, resistors with their leads cut to 5mm for pc installations are very limited in their usefulness.

You can supply 90% of you parts needs by looking at the past years worth of ETIs. Make a list of most frequently used components, and then check out the ads in this magazine. Your list might look like this;

- *10 ea, most commonly used EIA resistor and capacitor values (¼ W carbon composition resistors. 100V ceramic capacitors, 35V electrolytics).*
- *20, 100 PIV 1A rectifier diodes (IN4002 or equiv.).*
- *5 ea, 2N3904, 2N3906 small signal NPN & PNP transitors.*
- *1 ea, TIP29, 2N3055 NPN and TIP30, 2955 PNP power tansistors.*
- *1 ea, most commonly used 4000, 7400 series ICs.*
- *1 ea, commonly used linear ICs, (741, 301, 380 etc.), 555 timer, 7800 series voltage regulators, etc.*
- *IC sockets, perf board, 2lb. solder (60-40 rosin core), 6-32 & 4-40 hardware, etc.*

This of course is only a suggested listing but you get the idea. It could get expensive, but can pay for itself whenever you breadboard a circuit idea or decide to build a few of someone's one million and one simple 555 projects.

GETTING THE ODDBALLS

You just bought the September, 1985 issue of ETI and you've fallen in love with the ETI 2001 Lunar Landing Computer and Stereo Control Centre on page 549. One problem, where do you get a Afghanistan Scientific Supply HOL65A931 KMOS IC in a SLIP package?

Whatever reasons you might have for tackling a project, you're going to have the same supply problems as any electronic manufacturer in Canada. You will have to track down your own sources.

You would eventually find you HOL65A931, but there are scientific ways of going about it.

First consider what you know about the part. If you know who the manufacturer is, you've got it made. If you don't, you can make an educated guess from the format of the component identification. For example, a device name using an SN prefix would probably be from Texas instruments. Maintaining a large stock of catalogues is good for this approach. Remember also that a large number of ICs are second sourced by other manufacturers, so keep your eyes open.

If you have trouble finding who stocks a particular brand of components, more research is in order.

CHECKING THE MARKET

Assuming your normal suppliers don't pan out, it's time to do some real sleuthing.

Starting with the name of the manufacturer, your next step is to find out who's the prime distributor in Canada. You can do this one of several ways.

Check your stock of catalogues (good ones are Future, Saynor, RAE, and so on) and see if they stock that brand. If they don't have the particular component you want, they should be able to order it from the distributor.

Write directly to the manufacturer and ask for advice on finding sources. They will either give you a list of distributors in Canada or the address of their prime distributor. If the former, pick the distributor closest to you, if the latter, write for a distributor closest to you.

For most applications, however, your first step should be to check indexes and buyers guides. There are many types available, but among the most useful are CEE's Annual Buying Guide and Directory and McGraw-Hill's Electronics Buyers Guide.

The ABG&D is certainly a good starting point. It provides comprehensive cross references of international manufacturers, Canadian distributors, products and services. It is published quarterly, but one issue should be more than adequate for your needs.

EBG is a considerably more expensive book and you would do well to try and find a library copy. This is an excellent last resort source in that it gives the addresses and international subsidiaries for every US manufacturers currently in business. You know the rest once you know the address.

DOING IT RIGHT

It's a wise idea to maintain a binder of all your researches. Keep a record of addresses, names and any correspondence you have. You never know when you may want to deal with that company again.

For some large companies (like RCA) the address you wrote to is not the one that replied. Make a note of the return address and use it in future correspondence. This ensures your letter goes where it's supposed to and reduces delays in getting your reply.

Finally, never throw out a catalogue unless you have a more recent version. If nothing else, catalogues have useful technical data you can use for substituting components.

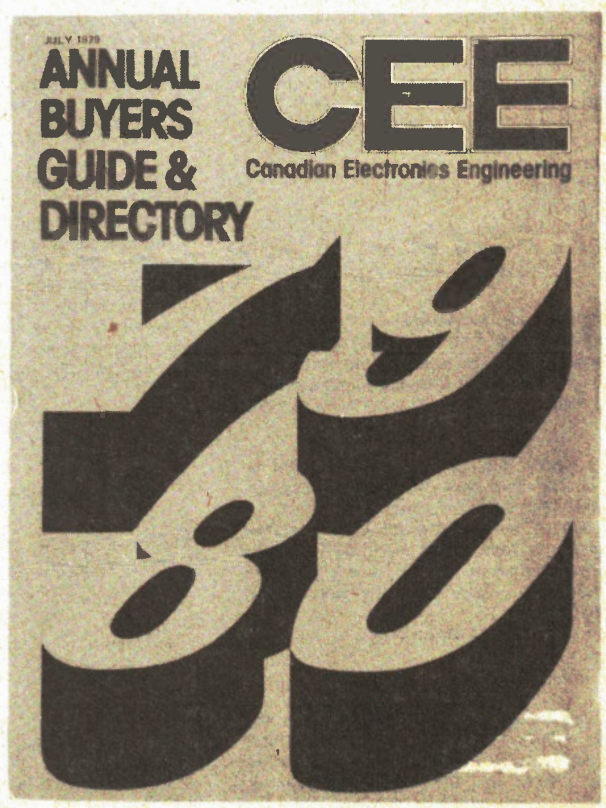
CONCLUSIONS

Gathering the parts for a project is a tedious and time consuming process. Maintaining a stock (some people call it a junkbox) of common components can save you a lot of bother and perhaps even money.

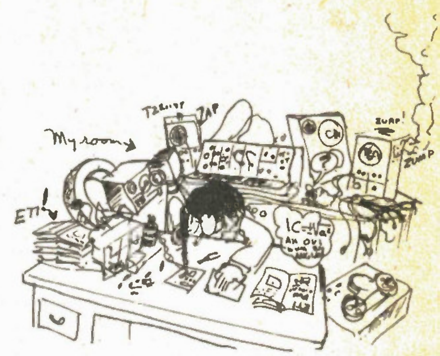
Ordering parts by mail is not a very desirable proposition, especially considering the time and risks involved. A little intelligence and common sense will smooth the way (so will typed letters).

The CEE Annual Buyers Guide and Directory, $3.00 per copy, available from CEE Subscription Dept., Box 9100, Postal Station A, Toronto, Ontario M5W 1V5.

The Electronics Buyers Guide (McGraw-Hill) $30 US per copy (Canada and US), available from Electronics Buyers Guide, 1221 Avenue Of the Americas, New York, NY 10020.



FEEDBACK



A unique look at ETI language critic, Denis L'Esperance, at work.

Questions about our 60W Amplifier and a remark on our first attempts at French text.

I like you very much, as a matter of fact, I ceased to buy a well known U.S. electronic publication and have concentrated on ETI since November 1977. Now, I must say, your Canadian effort has been remarkable. Recently, as I am pleased to see, you even have a bit of French in your publication (Books from Sams). As a good French speaking Quebecois, a lot of which read and buy your publication whether or not we are federalists, I must however complain, I thought someone would tell you, nobody did (apparently).

On page 76 of your November issue, the translation entitled Service Spécial des Livres ETI leaves a lot to be desired. As a matter of fact, it is the typical improper translation of word for word which leaves out the schematic meaning. Some people in Quebec must be chuckling silently after having read these paragraphs. So, being a university graduate, (pretentious types you know), I feel compelled to give you the proper wording, followed by explanations.

My sincere thanks for your attention and appreciation for a really fine magazine.
Denis L'Esperance
Cite des Deux Montagne, Que.,
(B.A. specialise in Communications
Canada Council grant candidate, etc. etc. . . .)

Thanks Denis, we appreciate your comments. It's very hard to tell how we are doing without reader feedback. We have changed the text of the Sam's ad, and in addition managed to get a French Language font so we would'nt have to pen the accents in.

It was a lucky day for me when I went to Edmonton and saw your interesting magazine, which is unobtainable in my town.

I have always been interested in this hobby since I made my first crystal set in 1920, before they started broadcasting. We used to listen to amateurs then. Then came the first station in London 2L0.

I hope this will interest others also.
F.G.Harold (age 79)
Lacombe, Alta.,

I have enjoyed reading your magazine. In the November edition the "60 Watt Amplifier" project puzzles me, because I can not find the transistors TIP141 or TIP146 in the market. I wpuld like it very much if you could find a cross reference transistor for my project.

Dealing with your following passage from your magazine, could you give me some more infor– mation about it.

Adventurous constructors may wish to try adding a second set of Darlington output devices, with their own emitter resistors as per the circuit, connected in parallel with the orginal pair.
V.Choy
Vancouver, B.C.

The TIP141 & 146 (Texas Instruments) are available from Active Components Sales. See their ad in this and previous issues.

Referring to Fig. 1, you can see that collector and base leads are connected directly, and the emitter leads are joined through emitter resistors. The purpose of the emitter resistors is to compensate for differences in base-emitter voltage. This way, one transistor doesn't 'hog' all the current and burn out from thermal runaway. In this case, the emitter resistor is made up from 5 1R resistors in parallel. Mount the additional transistors on the some heatsink as the rest of the amplifier.

Re your interesting article in ETI. Dec. 1979 on Police Radar, you have made no mention of a point which should be looked into.

I refer to the possibility of damage to a person's eyesight when driving on a highway which is fairly well surveyed by these devices. As you probably know, there have been many cases of cataracts of the eye being produced by these high frequencies which are in the radar band. The 10.525 GHz band mentioned is very much

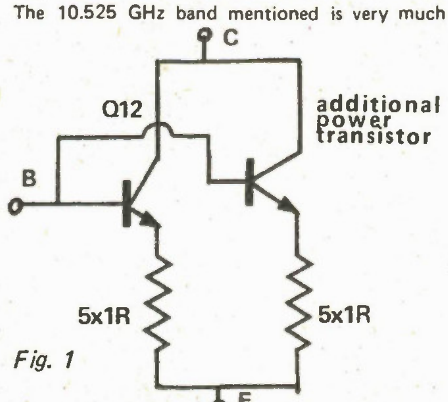


Fig. 1

in this band-wave lenght is 2.85 cms.! A person driving on such a highway and using it constantly on a highway which is radar surveyed pretty constantly could be looking at into the beam, twice a day perhaps. The effect is cumulative and there could be a danger here.

I, of course am not in a position to make any definite statements to the exact amount of radiation required to do any damage. The New Scientist has had several articles - or at least letters in their correspondence columns about this subject, in conjunction with microwave ovens, and I understand that the allowable amount of radiation from these is limited to 10 mW per sq. cm., but some authorities have suggested that this level is to high and should be reduced, so it cannot be lightly dismissed.

Assuming that the beam is fairly well focused, as I asume it is, then the power in the beam might be not inconsiderable, even at a fair distance. Your publication could do a great service if you could get professional advice on this point, and publish it if there is the SLIGHTEST danger from the radar sources at this high frequency.
C.E.Hedley,
Rexdale, Ont.

There are several ways of looking at the problem, but using conservative (I think) approximations, you would have to drive to work for 93 years to achieve the same level of damage as pouring 100mW of microwave energy directly into your eye for 10 minutes. I'm not prepared to defend my calculations, but the order of magnitude is probably correct.

Please send me constructional details & pcb patterns (photocopies) for CCD Phaser (Oct.78) and LCD Thermometer (June 79).
Clairemont,
St. Jean, PQ.

Please send me the following Projects Notes photo copies; Digital Tachometer, LCD Thermometer, AM Tuner, and Digital Wind Meter.
A.Daniak,
London, Ont.

I would like a copy of the ETI Project Light Chaser & Neg (Feb, 79) as well as the Light Show Sequencer (June 79)
P.Prossen,
Moncton, N.B.

WHOA! Hold on! Photo stats are not free. A quick look at the General Information For Readers will tell you that copies of articles are available for $1.00 each (regardless of length) Make sure you mention any updates, mods etc as indicated on Project Chart.

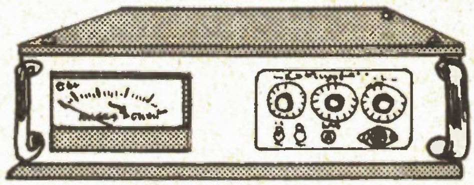
Before you write to us about anything, Study Project Chart and General Information For Readers carefully, you may get your answer much more quickly.

NEXT MONTH

1980 MARCH IN ETI

Biofeedback

More than just a way to get in touch yourself, biofeedback has applications in physiotherapy, rehabilitation medicine and bionics. Tom Benjamin describes current progress.



Electromyogram

A good indication of your state of well being is your level of muscle activity.
Build our Electromyogram and learn more about your body.

Battery Condition Indicator

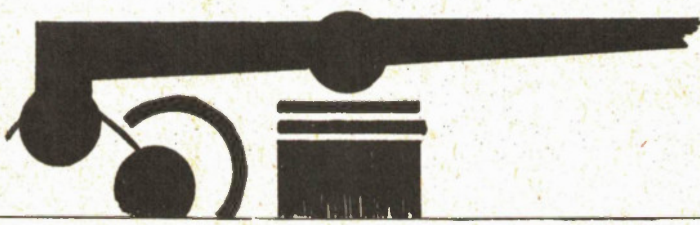
The hardest working component in your cars electrical system is the battery. Next month we'll be giving details on how to build an extremely simple indicator that gives instant, unambiguous readings.

Calcumeter 4100

A scientific calculator and digital multimeter in one package? WOW!
The Calcumeter 4100 is a high quality 3½ digit DMM combined with a micro-processor. John Van Lierde reports on this instrument (assuming we can tear him away!).

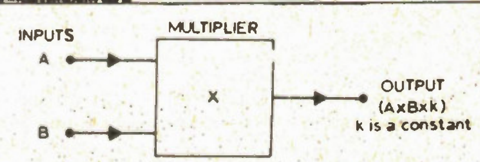
Power Supplies

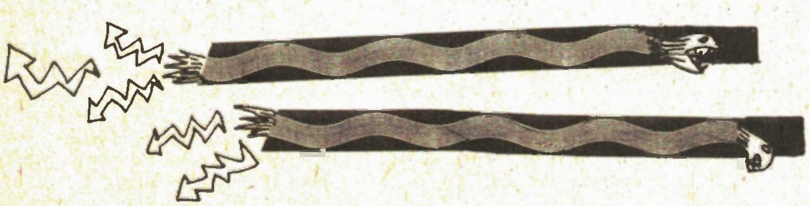
Perhaps the weakest link in any electronic products or project is its power supply. Tim Orr discusses the ins and outs of reliable power supply design.



Gain Control II

Next month we look at some practical applications of voltage controlled amplifiers.

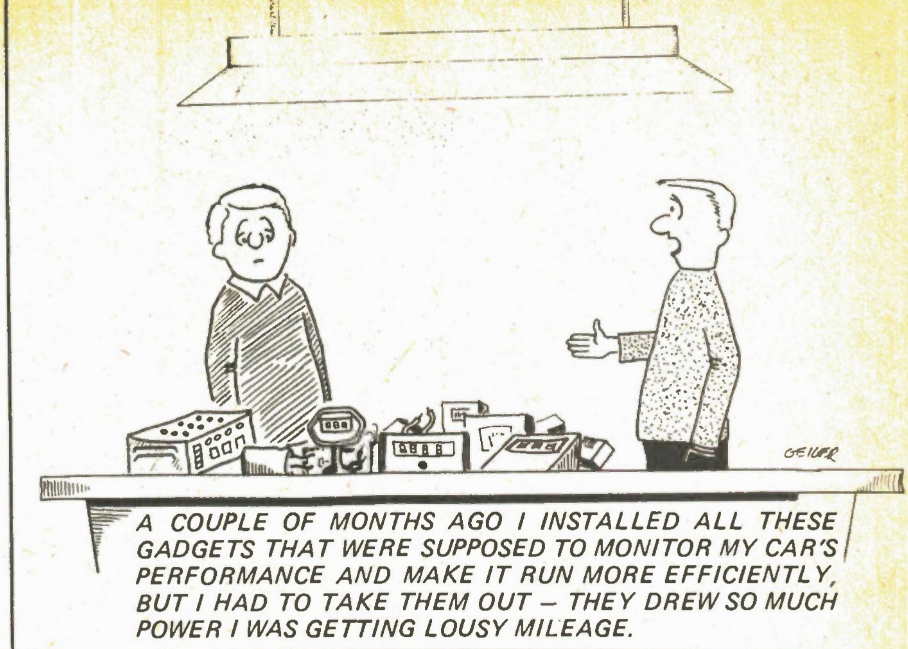


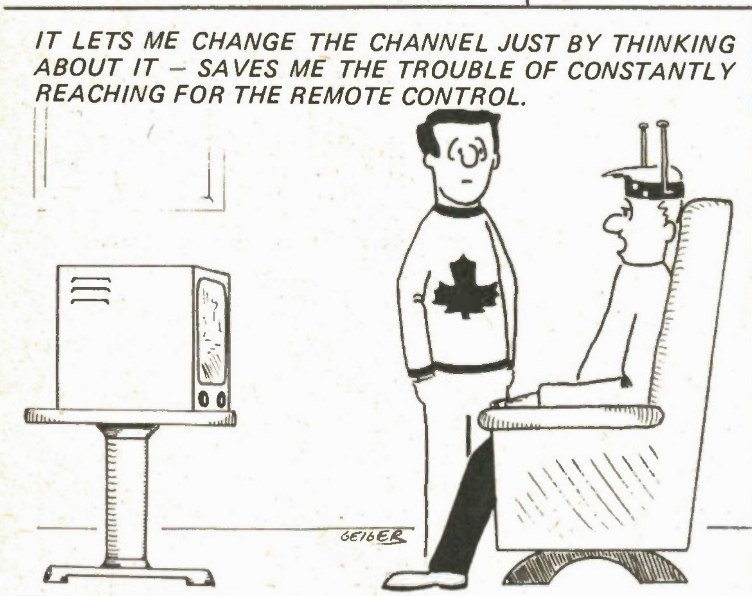


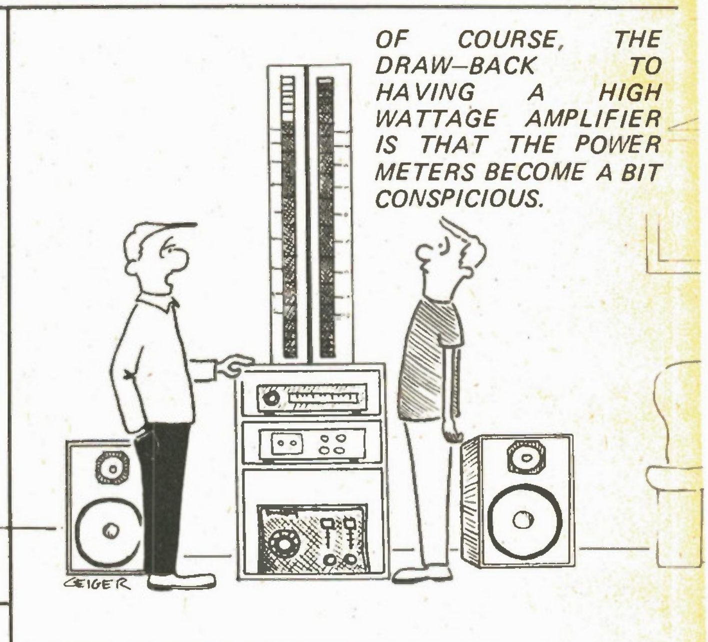
Wire Tracer

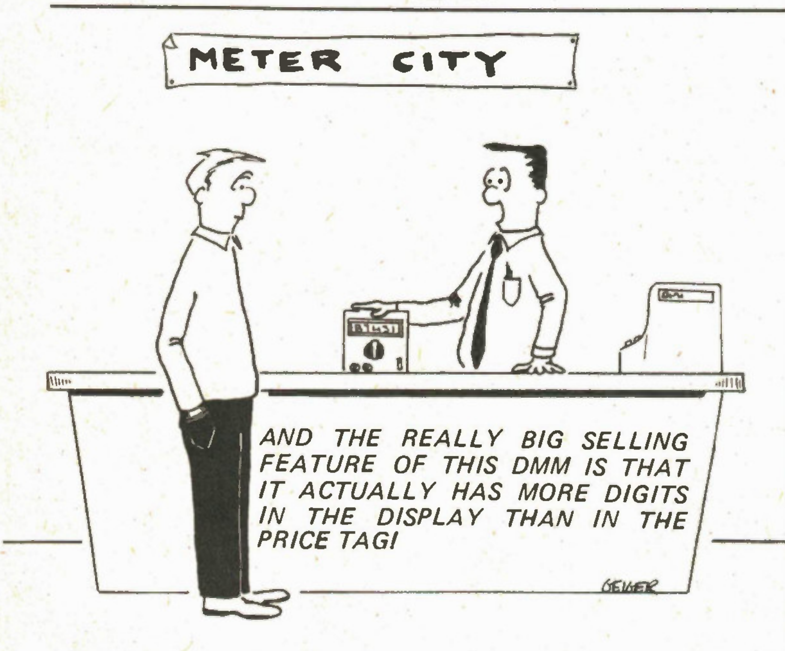
Did you ever drill into a wall and wonder if there was a cable behind it? Our Wire Tracer quickly locates hidden 'live' wires.

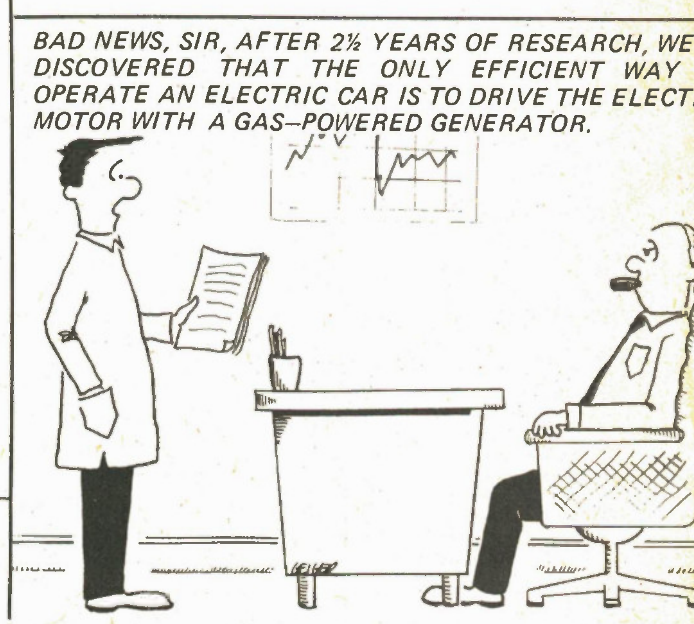
The Fun of Elect-ronics











You can write for Eti

75 cents per word

ETI's not-so-new classified advertising section allows you to reach 30,000 readers nation-wide. For as little as $15 (there's a 20 word minimum) you can promote your business from coast to coast.

WHAT DO YOU DO?

Send us your typewritten or clearly printed words, your permanent address and telephone number, and your money (no cash please). Make your cheque or money order payable to 'ETI Magazine'. We're at Unit 6, 25 Overlea Blvd., Toronto, Ontario M4H 1B1.

WHAT DO WE DO?

We typeset your words (and put the first word and your company name in bold capital letters).

If we get your message by the 14th of the month, it will appear in ETI 1½ months later. For example, if we receive it by November 14th, you (and thousands more) will see it in the January issue.

SATELLITE TELEVISION. Receive entertaining TV stations, movies, sports, and much more directly in your home via satellite. 24 hour programming. We have the latest in advanced technology antenna and receiving systems. Send $7.50, refundable with minimum order, for our catalog of information packages, video receivers, and associated earth station equipment. We are the Canadian originators of home satellite receiving systems. **NORSAT SYSTEMS,** Box 232, Surrey, B.C. V3T 4W8

SPECIAL: $25.00 - Approximately 2500 electronics parts: capacitors - resistors - transistors - hardware - relay - switch - etc. All new material. First quality. Money-back guarantee. Free flyer and sample on request. **SURPLUS ELECTRO QUEBEC,** 2264 Montee Gagnon, Blainville, Quebec, Canada J7E 4H5.

PRINTED CIRCUIT boards from your sketch or artwork. Affordable prices. Also fun kit projects. Free details. **DANOCINTHS INC.** Dept. ETI, Box 261, Westland MI. 48185. U.S.A.

CLASSIFIED

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COMPLETE HOBBY SERVICES. Custom kits and circuit designs. Write for free information. **TEKNIKIT ASSOCIATES** 301 Flora Street, Carleton Place, Ontario, K7C 3M8.

AUDIO KITS now also available at GENERAL ELECTRONICS, 5511 Yonge St., Ont. Class A amp from $58.00. Colour LED VU meter from $26.00. 10 Band Graphic Equalizer $42.00. FREE catalogue: **AUDIOVISION SERVICE,** Box 955, Stn. B, Willowdale, Ont. M2K 2T6.

$1.00 Unusual Canadian and American parts and surplus catalogs. Hundreds of bargains. **ETCO,** Dept 087, 183G Hymus, Pointe Claire, Que.

WSI RADIO – SWL Radios – Ham radios - 18 Sheldon Avenue North, Kitchener, Ontario N2H 3M2. Telephone (519) 579-0536. Write for giant catalog, free of course!! (VE3EHC)

J&J ELECTRONICS LTD., P.O. Box 1437 E, Winnipeg, Manitoba R3C 2Z4. Surplus Semiconductor Specialists. Do you get our bargain flyer? Send $1.00 to receive the current literature and specials and to be placed on the mailing list for future publications.

SPECTRUM ELECTRONICS * Quality pcbs. All orders prepaid. Ont. Res. add 7% PST * Box 4166D, Hamilton, Ont. L8V 4L5 * ETI 594: $1.65 * 141: $6.65 148: $1.40 * 472: $8.05 * 470: $6.30 471: $24.10 * Free price list.

PRINTED circuit boards from stock. No. 594-$1.75; No. 471-$17.95; No. 472-$5.35; No. 141-$7.25; No. 148-$1.75; No. 451-$2.70; U/D counter kit $35.95; Audio Comp kit $22.78; No.470-$5.45. Send cheque, money order, or C.O.D. Post & Pack 50¢. Full list free. **B&R ELECTRONICS,** Box 6326F, Hamilton, Ontario. L9C 6L9

PRINTED CIRCUITS. Quality printed circuit boards for R.&D. and the experimenter from your sketch or negative. **CUSTOM CIRCUITS,** Box 602, Regina, Saskatchewan.

WE SELL SERVICE! Professional repairs to all types of equipment: amateur, commercial, avionics, marine, CB, broadcasting. We stock Japanese transistors! Service Division, **HAMTRADERS** Inc., 18-45 Brisbane Road, Downsview, Ontario. M3J 2K1. 416-661-8800. Telex 065-22234

NEW Store! For the Hobbyist, Ham, Audio, CB'r. **GENERAL ELECTRONICS,** 5511 Yonge St., Willowdale, Ont. 221-6174. Monday, Friday, Saturday: 10:00 am-6:00 pm. Tuesday, Wednesday, Thursday: 10:00 am to 9:00 pm.

ETI Project File

Updates, news, information, ETI gives you project support

PROJECT FILE is our department dealing with information regarding ETI Projects. Each month we will publish the Project Chart, any Project Notes which arise, general Project Constructor's Information, and some Reader's Letters and Questions relating to projects.

PROJECT NOTES

Since this magazine is largely put together by humans, the occasional error manages to slip by us into print. In addition variations in component characteristics and availability occur, and many readers write to us about their experiences in building our projects. This gives us information which could be helpful to other readers. Such information will be published in Project File under Project Notes. (Prior to May 78 it was to be found at the end of News Digest.)

To find out if there are project notes for a project you are interested in, simply refer to Project Chart (see below). If there are project notes listed, they will have appeared in Project File (note, prior to May 78, project notes appeared at the end of News Digest.)

Project notes can be ordered one of two ways. You can order the complete back issue, or you can order a photocopy from the appropriate issue. In either case consult General Information For Readers. If you order a copy of a construction article, specify the issue where the project note can be found and we will include them at no cost. You must specify from which issue those project notes can be found.

PROJECT CHART

This chart is an index to all information available relating to each project we have published in the preceding year. It guides you to where you will find the article itself, and keeps you informed on any notes that come up on a particular project you are interested in. It also gives you an idea of the importance of the notes, in case you do not have the issue refered to on hand.

COMPONENT NOTATIONS 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

PLEASE NOTE: WE CANNOT ANSWER PROJECT QUERIES BY TELEPHONE.

to error and will be widely used sooner or later. ETI has opted for sooner!

Firstly decimal points are dropped and substituted with the multiplier, thus 4.7 uF 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 56k, 4.7k ohms is 4k7, 100 ohms is 100R, 5.6 ohms is 5R6.

KITS, PCBS, AND PARTS

We do not supply parts for our projects, these must be obtained from component suppliers. However, in order to make things easier we cooperate with various companies to enable them to promptly supply kits, printed circuit boards and unusual or hard-to-find parts. Prospective builders should consult the advertisements in ETI for suppliers for current and past projects.

Any company interested in participating in the supply of kits, pcbs or parts should write to us on their letterhead for complete information.

READER'S LETTERS AND QUESTIONS

We obviously cannot troubleshoot the individual reader's projects, by letter or in person, so if you have a query we can only answer it to the extent of clearing up ambiguities, and providing Project Notes where appropriate. If you desire a reply to your letter it must be accompained by a self addressed stamped envelope.

ETI Project Chart

ISSUE DATE	ARTICLE
Nov 78	Cap Meter &Neg.
Nov 78	Stars & Dots
Nov 78	CMOS Preamp & Neg.
Dec 78	Digital Anemometer
Feb 79	Neg
Mar 79	Note:C. D
Dec 78	Tape Noise Elim
Feb 79	Neg
Dec 78	EPROM Programmer
Feb 79	Neg
Jan 79	Log Exp Convert.
Feb 79	Neg
Jan 79	Digital Tach.
Feb 79	Neg
Jan 79	FM Transmitter
Feb 79	Neg
Feb 79	Phasemeter & Neg
Feb 79	SW Radio
Feb 79	Light Chaser & Neg
Mar 79	Tape-Slide Synch
Mar 79	Synth. Sequ.
Mar 79	Tape-Slide Synch
Mar 79	Synth. Sequ.
Mar 79	Dual Dice
Apr 79	Solar Control
Apr 79	Audio Compressor
Apr 79	Wheel of Fortune
May 79	Light Controller
May 79	AM Tuner
May 79	VHF Ant.
June 79	Easy Colour Organ
June 79	LCD Thermometer
June 79	Light Show Seq.

ISSUE DATE	ARTICLE
July 79	Note C
June 79	VHF Ant. 2
June 79	Bip Beacon
July 79	STAC Timer
July 79	Two Octave Organ
July 79	Light Activ. Tacho
Aug 79	Audio Power Meter
Aug 79	Two Octave Organ
Aug 79	Light Act Tacho.
Sept 79	Field Strength Meter
Sept 79	Sound Effects Unit
Sept 79	Digital Wind Meter
Sept 79	Up/Down Counter
Oct 79	Simple Graphic Eq
Oct 79	Digital Dial
Oct 79	Variwiper
Oct 79	Cable Tester
Nov 79	60W Amplifier
Nov 79	Model Train Controller
Nov 79	Curve Tracer
Dec 79	High Performance Stereo Preamp.
Dec 79	Development Timer
Dec 79	Logic Trigger
Jan 80	Guitar Effects Unit;
Jan 80	Series 4000 Stereo Amp.
Jan 80	Logic Probe

PROJECT CHART

This chart is an index to all information available relating to each project we have published in the preceding year. It guides you to where you will find the article itself, and keeps you informed on any notes that come up on a particular project you are interested in. It also gives you an idea of the importance of the notes, in case you do not have the issue refered to on hand.

Canadian Projects Book

Audio Limiter
5W Stereo
Notes N, D May 79
Overled
Bass Enhancer
Modular Disco
G P Preamp
Bal. Mic. Preamp
Ceramic Cartridge Preamp
Mixer & PSU
VU Meter Circuit
Headphone Amp
50W-100W Amp
Note N May 79

Metal Locator
Heart-Rate Monitor
GSR Monitor
Phaser
Fuzz Box
Touch Organ
Mastermind
Double Dice
Reaction Tester
Sound-Light Flash
Burglar Alarm
Injector-Tracer
Digital Voltmeter

Key to Project Notes

C:- PCB or component layout
D:- Circuit diagram
N:- Parts Numbers, Specs
Neg:- Negative of PCB pattern printed
O:- Other
S:- Parts Supply
T:- Text
U:- Update, Improvement, Mods

PCB SUPPLIERS

The following companies currently actively supplying all or some PCBs for ETI projects. Write for complete ordering information.

- B & R Electronics, P.O. Box 6326F, Hamilton, Ontario L9C 6L9
- Spectrum Electronics, P.O. Box 4166, Stn. 'D', Hamilton, Ontario L8V 4L5.
- Wentworth Electronics, RR 1, Waterdown, Ontario L0R 2H0.
- Danocinths Inc., P.O. Box 261, Westland, MI48185, USA.

Simple 60W Power Amplifier Nov 79

Notes on boosting current handling capability. This can be accomplished by inserting an additional power transistor in parallel with each of the two output units.

To do so requires the use of current limiting resistors in each leg to prevent thermal runaway. The extra transistors should be mounted on the same heatsink as Q12, Q13 and Q8.

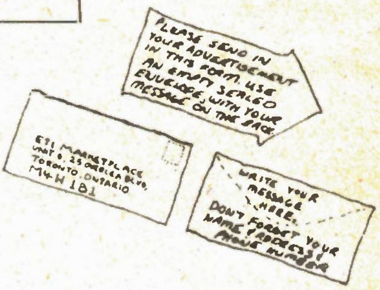
Unfortunately we neglected to make provisions for a ground return from the amplifier module to the power supply. Attaching ground to the pc foil anywhere around the input jack will ensure adequate operation. Do not connect the speaker returns to this point, they go directly to the power supply.

Digital Windmeter Sept 79

Some people are experiencing difficulties in obtaining the SEL 521 seven segment display specified. The Hewlett Packard 5082-7653 should be an adequate subsitute.

ETI MARKET PLACE

FREE PERSONAL ADVERTISING!



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May	February	February
June	March	March
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[redacted]	May	May
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	August	August
	September	September
	October	October
	November	November
	December	December

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X10 Oscilloscope Probes

P100

Specification

Bandwidth:	100 MHz
Rise Time:	3.5 nanoseconds
Input Resistance:	10 MΩ when used with Oscilloscopes with 1MΩ input (Probe resistance 9MΩ ± 1%)
Input Capacity:	9.5 pF when used with oscilloscopes which have 30 pF input capacity.
Compensation Range:	10-60 pF
Working Voltage:	600 Volts D.C (including Pk A.C.)
Cable Length:	1.5 Metres

$33.15

2P150

Specification

Bandwidth:	D.C. to 150 MHz
Risetime:	2.3 nanoseconds
Input Resistance:	10MΩ when used with oscilloscopes with a 1MΩ input. (Probe resistance 9MΩ ± 1%)
Input Capacity:	11.0 pF when used with oscilloscopes which have 30pF input capacity.
Compensation Range:	10-60 pF
Working Voltage:	600 Volts D.C (including Pk A.C.)
Cable Length:	2 Metres

$38.85

3P100

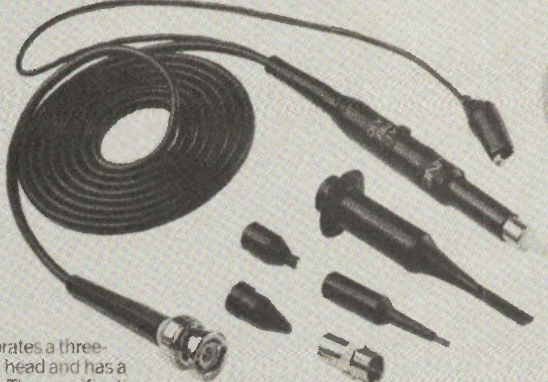
Specification

Bandwidth:	D.C. to 100 MHz
Risetime:	3.5 nanoseconds
Input Resistance:	10MΩ when used with oscilloscopes with 1MΩ input. (Probe resistance 9MΩ ± 1%)
Input Capacity:	13.5 pF when used with oscilloscopes which have 30 pF input capacity.
Compensation Range:	10-60 pF
Working Voltage:	600 Volts D.C. (including Pk A.C.)
Cable Length:	3 Metres

$44.50

SP100 Oscilloscope Probe

$47·35



This passive probe incorporates a three-position slide switch in the head and has a cable length of 1.5 metres. The specification is as follows.

Position x 1

Bandwidth:	D.C. to 10MHz
Input Resistance:	1MΩ (oscilloscope input)
Input Capacity:	40 pF. Plus oscilloscope capacity
Working Voltage:	600 Volts D.C. (including Peak A.C.)
Cable Length:	1.5 Metres

Position Ref.

Probe tip grounded via 9MΩ resistor, oscilloscope input grounded

Position x 10

Bandwidth:	D.C. to 100 MHz
Risetime:	3.5 nanoseconds
Input Resistance:	10MΩ when used with oscilloscopes which have 1MΩ input. (Probe resistance 9MΩ ± 1%)
Input Capacity:	11.5 pF when used with oscilloscopes which have a 30pF input capacity.
Compensation Range:	10-60 pF
Working Voltage:	600 Volts D.C. (including Peak A.C.)

$24.65

1P20
X1 Oscilloscope Probe

Specification

Bandwidth:	D.C. to 20 MHz
Input Resistance:	1MΩ (oscilloscope input)
Input Capacity:	47 pF. Plus oscilloscope input
Working Voltage:	600 Volts D.C. (including Peak A.C.)
Cable Length:	1.5 Metres

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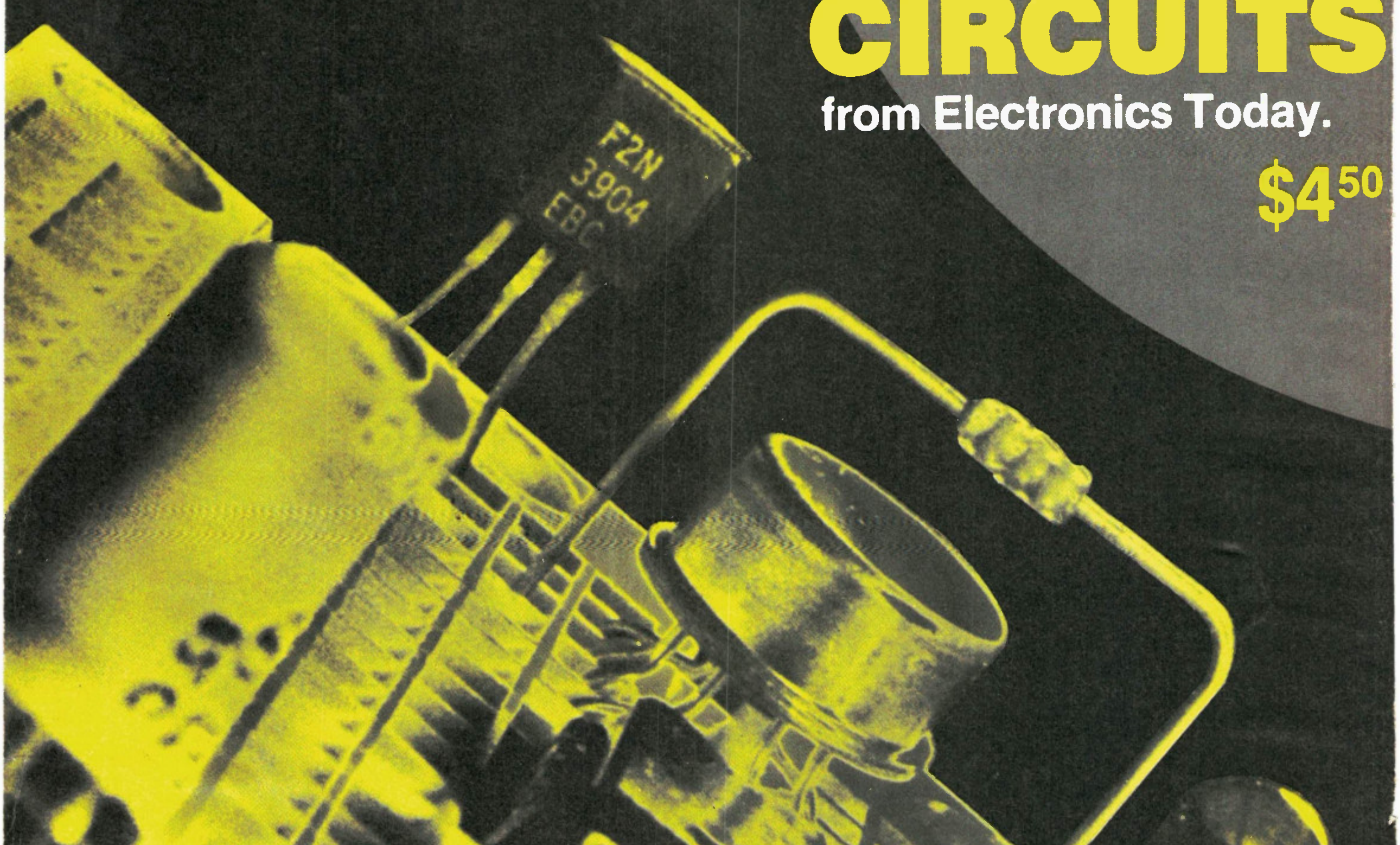

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