Build These Projects:
Model Train Controller
Curve Tracer
Versatility: Here’s why B&K-PRECISION’s new DMMs offer more

Selecting a DMM isn’t simply a matter of looking for the highest accuracy. It’s a more complex process of deciding what features and performance characteristics you need, to do as many different jobs as you’re likely to encounter. In short, versatility is just as important as accuracy!

The new 2830 digital multimeter from B&K-PRECISION has all the popular features you’d expect to find on a 3½ digit lab DMM, but it also offers some very uncommon features. Because a DMM may be used under poor lighting conditions or in a very bright environment, the 2830 uses bright, high-efficiency 0.43” high LED digits. The readability of this premium display is unmatched by other readout devices.

The 2830 is also one of the very few DMM’s available with a 10 ohms range, capable of .01 ohm resolution. This range offers the user accurate resistance measurement of switch and point contacts, or motor or coil condition. AC and DC current measurement capability extends from 100 nA to 20 amps without the need for external plug-in shunts. For voltage measurement, the 2830 can resolve as little as 100 µV. For maximum versatility in resistance measurement, selectable high-/low-power ohms permits resistance measurement with or without forward biasing semiconductor junctions.

The unit is housed in an attractive rugged cabinet which features a combination tilt stand/handle. Options include a battery pack for field use and a carrying case.

B&K-PRECISION’s 2810 DMM offers many of the features of the 2830 but in a more compact package and at a substantially lower price. Features include 100 µV, .01 ohm resolution; high-/low-power ohms; autozeroing; high immunity to RF interference and complete portability.

Free DMM Selection Guide

A new B&K-PRECISION DMM selection guide is now available. This full-color brochure details features, applications and specifications. It also includes details of a new probe that turns any DMM into a digital thermometer. Send for your free copy today!
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RCA Fall Preview

Recently we were invited to view RCA's Fall line colour televisions and VCRs. To us, one TV set looks much the same as the other.

Of great interest however, was a new portable VCR.

RCA's portable VCR system consists of three elements - a portable deck, tuner/timer module and auxiliary power supply. The VDP150 portable deck measures 11-1/4" deep by 10-1/16" wide and weighs 14.3 pounds, including the battery. Low power consumption of 8 watts in the unit helps extend the VDP150's camera — recording capabilities up to 11/2 hours. All functions are controlled by solenoid switches and a micro-processor.

The tuner/timer module, TDP1000, features electronic tuning and 4-hour off-air recording capability when connected to a matching VDP150 portable. Battery-charging circuitry, which keeps the portable ready for action at all times, is also housed in the TDP1000. A timer that can be pre-set up to 24 hours in advance allows unattended recording.

The third element in the SelectaVision portable system is the PDP500, an accessory containing AC power supply and battery — charger combination.

Featured with VDP150 was RCA's top of the line colour video camera.

The CC004 colour camera from RCA has F1.8, 6:1 motorized lens and electronic viewfinder. The latter's 1.5 inch monochrome screen also serves as a monitor to permit a review of tapes immediately after shooting. Weight? About 6 pounds, approximately 50 per cent lighter than last year's comparable RCA model.

Prices should be available in early December.

Memory Mapped ADC

An 8-bit A/D converter which is claimed to perform a full-accuracy conversion in 15 us and can be connected directly to a microprocessor bus and addressed as random-access memory is available from Analog Devices. The AD7574 CMOS is priced from $5.00 in quantities of 1,000.

The AD7574 acts as a memory mapped peripheral and at the user's option may be interfaced like static RAM, ROM, or slow-memory. For example, in the static RAM mode, a conversion is started by executing a memory WRITE to the AD7574. A data read is performed by executing a memory READ to the AD7574. The AD7574 uses control input signals CS, RD and BUSY which are readily available in all microcomputer memory systems.

Applications include avionics, instrumentation and automated process control.

For Sales Engineering Information, please contact Don Travers, Analog Devices Semiconductor, 829 Woburn Street, Wilmington, Massachusetts 01887. Telephone: 617/935-5565.

Electronic Thermostat

A fully automatic electronic thermostat, Autopace 7, manufactured by Autotronics, Inc., reportedly cuts home heating and air conditioning bills by up to 30%. It could pay for itself in as little as six months, depending on locality and climate. The micro-processor "brain" allows programming of 28 temperature changes per week, or four changes per day, fully controlling central heating and air conditioning systems.

The Autopace 7 replaces most existing four-wire thermostat systems. For remodeling it can be adapted to older two-wire systems by simply replacing the two-wire cable with a four-wire cable. The thermostat operates on 24VAC, 60 Hz as supplied in most heating and air conditioning systems.

The system features a 100% solid-state design with no moving parts and is housed in a molded case. The unit has a three inch LED display for easy readability on time and temperature.

For more information contact: A.C. Simmonds & Sons Limited, 975 Dillingham Road, Pickering, Ontario, L1W 3B2.
**Tenna Car Stereo**

From their Pro series, Tenna offers an IN-DASH Auto Reverse Cassette AM/FM Stereo: Model C-3039AR that supposedly offers the quality of home stereo.

Installation is simplified with fully adjustable shafts and a universal nose size, short (4½") chassis that makes it easy to fit in most cars including foreign models. It features adjustable FM muting, separate front to rear fader and balance controls, dial-in-the-door and selectable end-of-the-program ejector continuous play. It also has tape direction, mono/stereo, local/distance and AM/FM switches plus locking fast-forward and rewind controls.

Reported specifications are Amplifier; 3 Watts per channel minimum RMS at 4 ohms from 40-20,000 Hz @ 1% THD both channels driven. Output Z; 4 ohms. Pre-Amp Output: 100 MV@ 10 K ohms.

Price, $199.95 US. Available from most Tenna Dealers or Tenna Corporation, 19201 Cranwood Pkwy., Cleve, OH 44129.

**Video Terminal**

The Cybernex APL-100 terminal features true overstrikes using a highly legible 9x13 dot character cell and a 1920 character 80 by 24 display with selectable 48 line, 32 character split screen mode which scrolls all 48 lines from bottom right to top left.

Standard features of the APL-100 in both ASCII and APL modes include read and write cursor address, four direction cursor control, page print and printer port on/off control.

The list price of the APL-100 is $1795.00 Canadian, FOB Ottawa, Ontario, Canada, (no taxes included), with delivery beginning in September, 1979.

For full information on the APL-100 terminal or the 6 standard models of video terminals, contact Bruce Douglas, V.P. Marketing, 2183 Dunwin Drive, Mississauga, Ontario, Canada, phone (416) 828-2810 or Wayne Reid in Ottawa, at (613) 741-1540.

**Oaktron ‘Mini Hi Fi Systems’**

Enclosed speaker systems for vans, boats and R/V's have been introduced by Oaktron Industries, Inc. The speaker enclosure is strongly built, with a black leather-look vinyl finish. You get high-style and high-fidelity in a small package. It is supposed to be specially designed to deliver full, rich sound in confined spaces, even the home bookshelf. The enclosure's acoustic grill has a protective inner mesh, and see-through grill screen. With a dual purpose terminal strip for screw or jack connection, the speaker enclosure has dimensions of 10¾" long, by 77/8" wide, and 57/8" deep. The enclosure is available with three different pre-mounted speakers; the model ENST3 three-way system with woofer, midrange, and tweeter, boasts a frequency response of 50 to 19,000 Hz and 25 watts RMS power, with 50 watts peak; the EN69T "Super Power," with up to 90 watts peak power, and the model EN69H "High Compliance" speaker, up to 40 watts peak power.

For further information write to Omnitrone Limited, 2056 Trans Canada, Dorval Quebec, H9P 2M4.

**Function Generator**

The Continental Specialties model 2001 is a complete signal-generating capability at a very affordable price. IC circuitry produces stable low-distortion sine waves (less than 2% THD), fast-rise-and-fall-time square waves (less than 100 nsec), high-linearity triangle waves (better than 1%) and TTL square waves with rise and fall times 25 nsec. Frequency is accurate-sweepable and repeatable-to 5% of dial setting, in 5 ranges from 1 Hz to 100 kHz. Two shortproof 600 ohm outputs are adjustable from 1mV-100mV and 100mV-10VP-P. Variable DC offset control (pushbutton selectable) — provides controlled, variable shifting of the output waveform's center line above or below zero.

For further information contact Len Finkler Ltd., 25 Toro Road, Downsview, Ontario M3J 2A6. Telephone (416) 630-9103 Telex 065-24010

**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.
Fiber Optic Kit
Motorola now has a fiber optic evaluation kit, developed to give designers hands-on experience with the latest state of the art fiber optic components. It will acquaint engineers with the new Motorola ferrule semiconductors and the compatible AMP fiber optic connectors. The kit is called "The Link", and refers to the optical link between the transmitter and receiver of any system — with all of the optical portions needed. The kit includes; a fiber optic infrared source(LED), an integrated detector/preamplifier, a one meter length of fiber optic glass cable, terminated with appropriate matching AMP connectors.

In addition, The Link kit contains detailed data sheets for the Motorola fiber optic ferrule semiconductors and the AMP connectors, design considerations, applications and circuit ideas, and a fiber optic cable selector guide.

Price for the "The Link" kit, in unit quantities, is $99.00 U.S.
Write to Motorola Semiconductor Products, P.O. Box 20912, Phoenix, Arizona 85036

Catalogues
A new B&K-Precision industrial test instrument catalogue, BK-180, featuring more than forty instruments, is now available from Dynascan Corporation. The 44-page catalogue features a broad range of high-quality test instruments for engineering, production line, MRO and other industrial applications. Each catalogue product description includes a detailed specification section and helpful applications information.

B&K-Precision, Dynascan is represented in Canada by Atlas Electronics Limited, 50 Wingold Avenue, Toronto, M6B IP7.

Keithley
Keithley Instruments has a new 87 page catalogue and buyers guide. This catalogue provides complete introduction and selector guides on all their products; digital multimeters, electrometer, picoammeter, nanovoltmeters, etc. There is also a listing of miscellaneous accessories such as rach mount kits, ph adaptors, etc.

For a copy of this catalogue please contact Radionics Limited, 195 Grave Street, Northridge, Ca. 91324.

Attention, Ceres Users
We’ve heard from Ceres that their Ceresist patterns #18, 40,52/1, 52/2 and 75/1 will not be available until mid-January, 1980. In addition, #20 will not be available at all.

To avoid inconvenience, readers are advised not to order these patterns at this time.

Hobby World
The new Hobby World Computer Accessory Catalog #112 contains 16 pages of software, computer boards, systems, printers, semi-conductors, and PC aids designed to meet the needs of the computer enthusiast, novice, and business-person. The catalog discusses each product in great detail. Quantity and club discounts are available. Contact, Ms. Goist, Hobby World Electronics, 19511 Business Center Drive, Northridge, Ca. 91324.

R-ohm
R-Ohm recently announced the availability of a short form catalog for its line of resistors and semiconductors.

This four-page catalog covers R-Ohm’s small signal transistors, switching diodes, carbon film resistors, metal film resistors and resistor arrays. Specifications and performance graphs are included, as well as a list of R-Ohm’s distributors and representatives. R-Ohm Corporation, 16931 Milliken Avenue, P.O. Box 19515, Irvine, CA 92713, (714) 546-7750. Eastern Offices: (312) 843-0404. TWX: 910-595-1701.

New Stock
Longman Sales Inc. (LSI) is now a stocking representative for FMC Semiconductor and offers a complete inventory of power diodes and SCR’s for same day shipment.

Technical assistance is available by contacting Bill McNanny of LSI, Longman Sales Inc.,1715 Meyerside Drive, Unit#1, Mississauga, Ontario, L5T IC5

Dip Sockets
O.K. Machine and Tool Corporation offers a wide range of wire-wrapping Dip Sockets for plug-in packaging of Integrated Circuits. Dual-in-line configurations accommodate virtually all SSI, MSI and LSI devices. Sockets feature gold plated 3-level wire-wrapping pins .025 inches (0,63mm) square on .100 inch (2,54mm) centers. Other features include phosphor bronze leaf spring contacts and black bodies of U.L. recognized glass filled thermoplastic. Available in 14, 16, 24, 36 and 40 pin configurations.

For further information please contact Len Finkler Ltd., 25 Toro Road, Downsview, Ontario M3J 2A6 Telephone (416) 630-9103 Telex 065-24010

Test Noise
American Tracer Corp. introduces a new multi-tester by sound. The operator quickly learns the change in tone patterns with the measured parameter. The Traser is in a compact impact resistant lexan case.

The “five-in-one” tester with automatic range switching and protective mechanism allows freedom to concentrate on the tested circuit with indicates resistance form 0-1 meghohm, tone variation AC voltage 300 V to 250 Vrms, Tone variation DC voltage 300V to 40 V, detects mixed AC/DC voltage (complex DC) (for telecommunication systems), tests polarity.

Traser can also be used as a continuity tester with low probe current (500 micro-amps), permitting its use with sensitive components. Retails for $39.95.

For further information contact, H. W. Cowan, P.O. Box 268, Richmond Hill, Ontario L4C 4Y2
What's Under This Heatsink Will Amaze Your Ears!

100W $44.95

55W $29.95

Stereo?
Buy two.

Guitar Amp?
Buy one.

Bi-Amping?
Get a 100W for lows, and a 55W for highs.

Disco?
Buy lots.

You figure it out!

Order Now!
PLEASE USE ORDER FORM ON NEXT PAGE
(Offer closes when stocks run out, or December 5th 1979.)

A WELL KNOWN Canadian manufacturer has decided to discontinue production of their audio power modules, and there are parts for hundreds of these modules left over. ETI has arranged to make kits of these parts available to readers at incredibly low prices. Construction details and schematics come with these kits — all you do is add a power supply, as suggested below. The tools required are just those needed for electronics assembly, and a regular multimeter.

Please order quickly as we can only be sure that we can fill the orders for the first 500 of each module size.

SHIPPING DETAILS: We will ship these units by Canpar where possible, otherwise Certified Mail will be used (we are charging $2 per amp for packing and shipping). Please allow a total of three to four weeks for delivery, after mailing us your order.

SPECIFICATIONS

<table>
<thead>
<tr>
<th>Model</th>
<th>Spec 1</th>
<th>Spec 2</th>
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<tbody>
<tr>
<td>Power out (Into 8 ohms)</td>
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<td>100WRMS</td>
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<tr>
<td>Freq. Response</td>
<td>20 Hz to 20 kHz +/- 1dB</td>
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<td>THD at rated output</td>
<td>0.8%</td>
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<td>IM Distortion</td>
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<td>0.1%</td>
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<tr>
<td>Hum and Noise</td>
<td>80dB below full output</td>
<td>0.1%</td>
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<tr>
<td>Input Impedance</td>
<td>100 kohms</td>
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<tr>
<td>Load Impedance</td>
<td>4 ohms minimum</td>
<td></td>
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<tr>
<td>Sensitivity</td>
<td>1 V for full output</td>
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<tr>
<td>Size (inches...sorry!)</td>
<td>4x4x2</td>
<td>4x4x4</td>
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<tr>
<td>Weight (Pounds...ditto)</td>
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<td>2.5</td>
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<tr>
<td>Power supply required: VDC</td>
<td>+/-38</td>
<td>+/-45</td>
</tr>
<tr>
<td>Amps</td>
<td>2</td>
<td>5</td>
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</tbody>
</table>

PLEASE NOTE: To keep costs down, we are offering these kits ONLY via mail order. The flood of people who came to our office during our last offer was just too much for us!!
ETI Special Offer: Amp Modules

Please use this coupon, or a photocopy thereof.

<table>
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<th>Amount</th>
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<th>No uncount cheques pls</th>
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</table>

| Money Order | □ |
| Charge Card No. | □ |
| Signature | □ |
| SHIPTO: | |
| Name: | |
| Address: | |

| TOTAL REMITTANCE | |

Please send me:

55W Amps at $29.95
100W Amps at $44.95
On Res Add 7% PST
(That's $2/1055W or $3/15/100W)
Shipment $2 PER AMP
Certified Cheque □ (No unc. cheques pls)
Money Order □
Credit Card No. □
Delivery

3M PC Breadboard

3M now offers a new way to prototype circuits, the Scotchflex Breadboard System. The system combines the insulation-displacing capabilities of "Scotchflex" 'U' -contacts with a connecting system that permits solderless connection to boards with plated-through holes. Connectors include 8-contact solder strips, plug strips and 6-position dual sockets.

3M says the new system offers several advantages over systems using wrap posts. Cited are labour and time savings, greater accuracy and direct conversion from prototype to production boards.

Connections are made with continuous, 30 AWG solid insulated wire which can be easily inserted in the 'U'-contact with an inexpensive hand tool supplied by 3M.

For more information contact, Mr. A. D. Machuk, 3M Canada Inc., Electronic Products, Box 5757, London, Ontario, N6A 4T1.

A Canadian Business Micro

Megatel Computer Corporation Inc. of Toronto has just announced the next generation of small business computers — The MEGATEL 2000. Designed, developed and manufactured in Canada, the M2000 uses only one printed circuit board, resulting in substantial savings.

To be marketed by distributors throughout the world the MEGATEL 2000 is available in two models — 48K Central Processing Unit with one million characters of disc storage and a printer at under $11,000, plus a 64K central processing version with two million characters of disc storage and a faster printer for under $16,000.

For further information please call Dick Pepperdene at 416-745-7214, or write to Megatel Computer Corporation Inc. 150 Turbine Drive, Toronto, Ontario, Canada M9L 2S9.

Memory Interface IC

Motorola now has a memory address multiplexer and refresh counter circuit — the MC3232A — designed specifically for use with most popular 16-pin, 4K dynamic RAMs (such as the MCM4-027).

The address multiplexer splits the 12-bit Address Input signal into two sequential 6-bit outputs representing the Row Address and Column Address segments, respectively. This satisfies the 16-pin memory requirement which calls for the use of the same six input pins for all address bits in order to reduce the size and complexity of the memory package.

Price is $4.70 US for plastic package. Availability is from Motorola OEM Sales offices and authorized distributor warehouse stock.

Write to Motorola Semiconductor Products Inc., P.O. Box 20912, Phoenix, Arizona 85036, Phone (602) 244-6900.

NEWS DIGEST

Calendar Dates

The 10th annual Canadian Computer Show and Conference will be held on November 13, 14, & 15 at Toronto's International Centre. This year's show will feature over 150 exhibitors. In addition, Hewlett Packard is offering an HP-41C personal calculating system as a door prize.

For a conference brochure or more information, write Canadian Computer Show and Conference, 36 Butterick Rd, Toronto, Ont. MBW 3Z8.

February 12, 13 & 14, 1980 — Toronto, Ontario. The Data 80 Data Communications Conference and Show, Harbour Castle Hilton Hotel and Convention Centre.

The three-day conference program will feature panel sessions, audio-visual presentations, workshops and technical sessions related to the field of data communications.

For more information, write or call Jill Carrothers, Conference Coordinator or Laurie Whitsed, Show Coordinator, 2 Bloor Street West, Suite 2504, Toronto, Ontario M4W 3E2.

Looking Back ...

Lampert Spelled With a "P"

Sorry Murray! Our credit for Hamtraders' contribution to last month's cover should have Murray's name spelled correctly... it's Lampert.

Mystery Power Amp Power

Gladstone's catalogue in Oct 79 issue ETI has an unspecified power amp module on page G11. Please get out your pens and write in "30 Watts".

New Omega Phone + Address

Omega Computing, reps for Ohio Scientific have moved. Their new address is 200 Steelcase Rd., E., Unit 5, Markham Ontario L3R 1G2. Phone 495-1382.
Developments in audio reviewed by Wally Parsons

A KIT IS ANY PACKAGED ASSEMBLY CONTAINING ALL PARTS NEEDED TO ACCOMPLISH A CERTAIN RESULT. Thus, a record cleaning kit may contain fluids, pads, brushes etc., to be used for that purpose, and a pickup mounting kit may contain either a specific pickup or a variety of pickups to a specific or variety of arms. On the other hand, a preamp kit may contain all parts necessary to build an preamp, either in complete form, or just a module or circuit board assembly. In addition, it may come with some parts already assembled as sub-assemblies, and with adjustable parts pre-adjusted.

Most kits also include instructions on how to assemble or use the kit, as well as trouble-shooting guides, and application notes. Some may be so complete that the user need know nothing more than how to hold a soldering iron without getting a third degree burn (although one kit-maker even covers that), while others may include only parts and a schematic. Of one thing you can be certain; the more you get, the more it will cost. And you can be reasonably certain of one other thing; most kits will perform as the manufacturer claims, and usually work properly as soon as construction is completed. Provided, that is, that you follow the instructions and don’t try to be a Know-it-all.

A BIT OF HISTORY

KITS OF ONE SORT OR ANOTHER IN ELECTRONICS HAVE A HISTORY WHICH EXTENDS ALL THE WAY BACK TO THE DAYS OF THE CRYSTAL RADIO. An examination of suppliers’ catalogues and electronics magazines show a wealth of devices available in kit form, mostly in the form of simple receivers, but for the budding amateur various pieces of transmitting equipment were also available. Generally, their attraction was based on one simple premise: it was the most effective way to get a piece of equipment.

But it was not until the advent of the Long Playing record and the concomitant general interest in the high fidelity reproduction that audio equipment kits as such began to appear on the scene.

Many of the first kits were rather simple affairs, perhaps a two-tube amplifier, with volume control and "tone" control, suitable for use with a record player with a crystal pickup, and occasionally a really super job with a push-pull pentode output for all of ten watts and separate bass and treble controls. Later, a few enterprising types added a magnetic phone preamp, using the circuit in the back of the RCA receiving tube manual, for use with the newly developed GE and Pickering pickups, and even some making provision for the variety of equalization curves in existence at the time. And in England, several enterprising manufacturers, many of them primarily transformer manufacturers, were promoting kits of the fabled Williamson amplifier.

EDUCATION

The primary purpose in offering these kits was simply to make money; but one of the happy end results was the spurring of interest in audio not only among laymen, but students as well, with the result that they performed an educational function.

I vividly recall the second kit I built: it was a ten watt amplifier using 6V6-GT pentode output tubes, and bass and treble controls and no preamp. The preamp I built later using my own design and mounted under the turntable (a practice which, as regular readers know, I still advocate). It was called a Knightkit, and put out by Allied Radio of Chicago who later founded the original chain of Radio Shack stores. It was a pretty good amplifier, too. At least, I thought so at the time, and it
Audio Today

would certainly wipe out the majority of console sets available then.

I say that was the second kit; the first was built in the Air Force, where our project in the Communications course was a six tube superhet receiver. In fact, with typical Air Force efficiency (and I mean that sincerely) DND purchased a quantity of kits marketed by Meissner, perhaps better well known today for their line of coils. It boasted a Hartley oscillator, an RF stage, aligned like a charm and brought in local stations with no antenna, even within the shop surrounded by steel structures and fluorescent lighting.

This is, perhaps the area in which kits have their greatest value. It's one thing to read theory in a book, and even see it demonstrated in the lab, but it's quite another thing to apply that theory in a practical manner. The bridge between the two is the construction of a useful oscillator, an RF stage, aligned like a charm and brought in local stations with no antenna, even within the shop surrounded by steel structures and fluorescent lighting.

Most of the old kit makers have left the scene, or greatly restricted their product range. Of them all, only Heathkit can be said to have prospered and expanded their lines, specializing in kits. In the audio line, they can supply everything the audiophile may desire, from muscle amps to turntables, pickups and speakers. These are the guys that do everything but hold the soldering iron for you, but they even teach you to do that. Prices are significantly lower than similar ready-made equipment, although you still pay a premium for the painstaking attention to detail, the careful step-by-step instructions, and the theoretical information which in itself constitutes a section of the course in audio. This is the line also for the guy who wants something that looks factory made, performs factory made, yet saves money while affording the fun of building your own equipment.

But for those who are somewhat knowledgeable, or want to build their own housing and cabinetry, or otherwise customize the end result, more kit makers are springing up annually in Canada than appeared in the past twenty years. Many of these products are kits for ETI projects, while others have either been developed by the supplier or imported from overseas. On the whole, quality seems to range from very good to excellent, and with any encouragement, the variety of equipment offered promises to increase over the next few years, as can be seen by examining the list of ETI advertisers.

**Making a Choice**

If you are contemplating going the kit route, your choice will be determined primarily by your purpose. If you primarily wish to save money you'll select a bare bones type kit, such as the one reviewed in this month's products section. If it's a matter of learning by doing, the same applies, but you might consider one of the more elaborate kits such as the Heath. Likewise if you mainly want to saw money and have the fun of putting something together. If you're interested in building an ETI project but live in an area where parts availability is a problem, consider some of the ETI project kits offered in these pages.

On particular advantage of the ETI project kits lies in the fact that the supplier is usually able to buy parts in quantities, and so effect price benefits which the single unit buyer cannot, and yet can still make a profit. As a result, unless you have a good, well-stocked parts bin filled at bargain prices, the kits will be a lot cheaper than it would be if you assembled it yourself. And of course you don't have to build and, in some cases, drill holes in the cabinets.

Did you know that in the 1960's a German manufacturer produced an automobile in kit form, for about $900.00? Wonder what ever happened to it.

Audio Today Products

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

**Audiovision Model 7070 140 W Integrated Amplifier**

A two channel amplifier with phono preamp, bass, mid-range, and treble controls, balance, volume and loudness switch. All signal stages are built around integrated circuits, and the voltage section of the power amplifier is an integrated circuit. All sections are mounted on one board, with the exception of the power transformer which is mounted separately, and the output transistors and bias diode per channel, which are mounted on external heat sinks. The amplifier features electronic filtering and constant voltage supply to the IC's regardless of fluctuation in supply. Preamp, tone, controls, and power amplifier have their inputs and outputs brought out to terminals on the board and may be internally interconnected or brought out to switches or jacks externally to allow independent operation or the installation or signal processors or tape equipment. Load...
Building Jana Kits is only half the fun. Your friends will go bananas with the results!

Gorgeous! Romantic!
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Round & round she goes!
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Jana dice game

Exciting Games!
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Round & round she goes!
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Just like Las Vegas!
Jana dice game

The fun you have afterwards with your friends may be the best of all! Even better than being a proud Jana kit builder.

The true Jana kit builder doesn't mind that his friends sometimes win. Maybe one friend will 'shoot' more ducks on your unpredictably challenging Jana skeet game. Or another may 'roll' natural after natural in the intricately perfect Jana dice game you built.

So you have a friend who is hair-trigger fast. Or lucky. Everybody can see you are the clever person who can control LED displays so the lights whirl round faster than an intoxicated mind. You can create the disco carnival of light and fun! Even a tiny radio station...

They can also see you are noble. You didn't cheat so you would always win!*

Only you will know that Jana miracles are sensible, logical, possible. Jana provides all the parts (even a case). And Jana plans are complete, illustrated, simple to follow.

The fun begins when you open a new Jana kit. (There are 27 besides those shown above.) The fun continues when you share what you have built with your friends!

*It is firmly believed at Jana headquarters that no Jana Kit builder has ever cheated. Please don't tell us different!

Jana kits are available from dealers and distributors across Canada, including:

**Jana Industrial**

Atwater Electronics Limited
886 Dundas Highway East
Mississauga, Ontario
L4Y 2B8
(416) 276-4550

Exceltronix Inc.
319 College Street
Toronto, Ontario
M5T 1S2
(416) 921-5295

1777 Ellice Ave., Winnipeg, Man. R3H 0W5
Phone: (204) 786-3133

Circle No. 10 on Reader Service Card.
Audio Today

fault and speaker protection are provided by a relay.

Power response is specified as from 20 Hz to 20 kHz, and frequency response from DC to 100 kHz, input impedance of 50 Ohm, Damping factor of 100 at 8 Ohms. Power output depends on the transformer used (transformer is not included, but the supplier can provide one at extra cost.)

HOW IT WENT TOGETHER

This is a bare bones type kit described in AUDIO TODAY, and does not include any type of housing. Although parts are separated in packaging, this is essentially a matter of one poly bag containing resistors, one containing capacitors, one containing semi-conductors, and one with hardware. Therefore, the builder must know how to read a colour code.

Parts layout is identified on the component side of the epoxy glass board, and values labelled. The only criticism in this regard applies to clarity of printing, which appears to have been silk-screened but line delineation is not what it might be. Thus, a resistor location might be labeled "4.7K" and the decimal not clear. It could, therefore, be confused with "47K". The ink used can also rub off fairly easily, so if the board is handled a great deal some of the labelling might be obscured. This could be a problem to someone whose close vision is, shall we say, less than perfect (like mine), but current samples will solve this by providing a layout drawing using standard nomenclature as part of the construction manual.

The board uses what appears to be silver plating, but there are soldering difficulties unless it is thoroughly cleaned before use to remove oxides. Layout is good, although pad-hole registration is a little less than perfect, and some pads are open as a result. It appears to have been prepared using one to one artwork, rather than reduction, and requires some care in soldering.

CIRCUIT

The phone preamp and the active tone controls are conventional and straightforward, built around the 739 type IC. Although no data on the specific device is available, it appears to be an internally compensated version, judging by the fact that the pin-out is the same and performance identical, but unlike the 739, it is not possible to access the compensation circuitry, yet the circuitry could not possibly be stable without compensation.

Of special interest is the power amplifier circuit, shown in figure 1. The output stage is a complementary super-beta pair, biased by two diodes, driven by a 739 type IC, with feedback taken from the output to the IC input. Readers familiar with quasi-complementary circuits will recognize this as the circuit used in the lower half of such circuits. Although the output stage is operated in the common-emitter mode, combination has the characteristics of an emitter-follower with gain.

PERFORMANCE

As expected, the most outstanding aspect of performance was in the output circuit itself. Since local loop feedback is used between output stages and drivers, this section is virtually distortionless, with most of the actual gain provided by the power devices themselves. These are new Motorola devices rated at 20 A, 140V, and 250 W. Triangular waves passed without any observable deviation from a straight line, and square waves output looked like the input, right up to clipping level. No trace of cross-over distortion or switching glitches were apparent, thanks to the super-beta circuit, and bias could be accurately set using a scope without need for settling for a compromise setting.

RMS output is limited to 18W with 36V supply, with clipping occurring in the driver stage. The onset of clipping is sudden, but recovery is quick and symmetrical, and use of this limitation eliminates the need for more elaborate load-fault protection. Unusual, but it seems to work, and I can find no reason to fault it.

In the event of output device or power supply failure producing an offset voltage, a relay cuts out the speakers. It also functions during turn-on to prevent clicks and pops.

The manufacturer originally described this kit as only suitable for construction by someone with experience. I don't agree. It's a good performer (good enough for metoselt for speaker measurements) easily constructed. The only justification for the caution is the absence of a comprehensive manual. This has now been corrected as your professor here has agreed to prepare such a manual specifically for ETI readers, and this will be supplied with all future kits.


STOP THE PRESSES!

Just before deadline Technics demonstrated a new turntable to the press. The term "breakthrough", and "innovative" are greatly overworked adjectives in this business, but the new SL-10 can be rightly described in these terms. Very small, ultra stable, single play automatic operation, with a straight-line tracking system that really works.

It's so foolproof it can literally be handled easily by a blind person. I know — I operated it with my eyes closed with no goofs, and without knowing where the controls were.

Next month I'll describe it in more detail with a picture. It won't be available until next spring. Just thought you'd like to know.
The latest advanced way of measuring audio power output
- Works as a pair of VU meters, and adds exciting sights to your sound system.
- 3 color LED display, each channel.
- Enjoy the "dancing color light" show while you enjoy your music.
- Responds to musical signals at much faster speed than conventional mechanical VU meters.
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- Display panel, plated fiberglass p.c. board and all electronic parts included.

COLOR LED POWER LEVEL INDICATOR

SAD-02
18 step display
Front Panel
- Size 8-1/4"x2-1/2" for a 36 LED (4 colors) with peak, floating and gradual display.
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KIT: $56.00 . . . . Assembled: $66.00
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Specially imported from England for our readers!

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by Colin Carson

$4.80 including 30 cents postage and handling.

Please use card to order.

Circle No. 2 on Reader Service Card.
Curve Tracer

Get the straight dope on your transistors with this useful scope accessory.

THIS DESIGN WILL allow the dynamic voltage current characteristics of diodes and transistors to be displayed on the screen of a DC 'scope capable of taking an external X input.

The performance of the unit will not be up to that of a commercial machine. However the unit will give a good indication of the dynamic performance of a wide range of semiconductor devices (as the photograph shows) at a price that is a fraction of commercial equipment.

Construction of the curve tracer is straightforward. Mount all the components on the PCB according to the overlay. The internal layout of our prototype is shown in the photographs. The unit is line powered and a battery supply is not suitable for this circuit.

Initially try the curve tracer with a high gain npn transistor, a 2N3904 will be ideal. Connect it to one of the tracer's sockets and connect the unit to the 'scope. Set the Y gain on the 'scope at maximum and set up the maximum required level of collector voltage by adjusting RV1. RV2 will control the number of steps displayed on the screen. The X sensitivity of the 'scope should be 1 V per division.

The performance of the unit is degraded by the slight drop in the DC potential on C1 during the 10 ms sweep and the slight effect of the 100 R sampling resistor, in that its volt drop is included in the observed collector potential.
Fig. 1. Full circuit diagram of the curve tracer.

HOW IT WORKS

The principles of the full circuit can perhaps be best explained by consideration of a simpler form of the circuit. Figs. 2 and 3 show circuits for investigating the dynamic characteristics of a diode and transistor (at fixed base current) respectively.

The 'diode circuit' will, unless an inverter is available, produce a trace that will appear upside down.

Operation of this circuit is quite straightforward. RV1 allows the peak value of the AC supply to be adjusted. This is then applied to the device under test via a current limiting resistor as well as to the X input of the 'scope. The current flow in the device at any time is proportional to the voltage developed across a low value sampling resistor in the current path. This voltage is fed to the Y input of scope.

The simple transistor tester functions in much the same way. RV1 allows the base current to be adjusted within the range 10μA to 100 mA.

The characteristics of an N-Channel FET (2N3819) may also be examined with this basic building block. The output characteristics are displayed for a gate voltage selected by RV1. Transfer characteristics (gate voltage vs. Drain Current) may be shown by transferring lead X to the gate terminal and joining the 1000μF capacitor to the 15V supply (observing the change in polarity).

Moving now to the full circuit of Fig. 1 that allows a far more informative display providing, as it does, simultaneous displays of the characteristic curves for several equally spaced values of base current.

The circuit operates as follows: Every 10 ms the collector supply swings up and back, over a half cycle of the full-wave rectified supply. At the end of each half cycle, there is a short period during which the supply potential is below about 0.6 V, and during this time, Q3 turns off, sending a pulse from its collector into the charge store C1 C2 D3 D2. Each pulse increases the potential in C1 by approximately 0.2 V. This would go on until the potential on C1 and 20 V were if not for Q2, the little known and much mis-described programmable unijunction transistor, PUT. This device is the semiconductor version of a neon lamp, insulating up to a certain p.d. and conducting heavily at potentials above this breakdown value, but with the added advantage that, through a third terminal, this breakdown potential is programmable over quite a wide range. Varying this control potential through the setting of VR2 sets the number of steps that will occur before the potential on C1 is great enough to make Q2 fire, reducing the capacitor's potential to approximately 0.6 V and so re-starting the sweep sequence.

The tracer can hardly be expected to match all the performance of a commercial curve tracer, the prices of which range into thousands of dollars. There are errors, due to the slight droop in d.c. potential on C1, and hence in base current, during the 10ms sweep, and due to the slight effect of the 100R sampling resistor, in that its volt drop is included in the observed collector potential, but as can be seen, these are quite insignificant as regards the final display.

A suitable transistor for the device under test is any reasonably high gain npn transistors, e.g.2N3904, VR1 controls the maximum collector voltage, whilst VR2 sets the number of sweeps displayed. With the values given, the difference in base current between one step and the next is approximately given by:

\[ \frac{1}{5R} \mu A, \text{ where } R \text{ is in megohms.} \]
**PARTS LIST**

**RESISTORS**
- R1: 10k
- R2: 100R
- R3: 220k
- R4: 470k
- R5: 1k
- R6: 4k

All 1/4W, 5%

**POTENTIOMETERS**
- RV1: 1k lin
- RV2: 50k lin

**CAPACITORS**
- C1: 4u7 25V electrolytic
- C2: 47n polyester
- C3: 1000 25V electrolytic

**SEMICONDUCTORS**
- Q1: 2N2222
- Q2: 2N3904
- PUT1: 2N6027
- D1: 1N4001
- D2, 3: 1N914
- BR1: 1 Amp Bridge

**MISCELLANEOUS**
- ETI 143 PCB, case to suit, sockets, knobs, cable, etc.

---

**FINGERS TO DONUTS**

**KIT 551 NEW**

Photo Reversing Kit for Lifting Off Circuits

This kit may be used to lift off any circuit diagram in a magazine and gives sharp resolution and professional quality negatives. Drafting aids are mounted on a clear layout film over the circuit. This becomes the positive used by the kit to produce a real sharp negative which is then used on boards previously coated with a negative acting resist. This method produces a sharper image than positive resists. The PHOTO REVERSING KIT has 3 sheets of contact film 5 x 8 in., developer, fixer and toner.

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Circle No. 1 on Reader Service Card.
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MARKS Dynamic RAMs

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MOS Memories

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LED Lamps

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Prices in this ad are valid only until Nov. 30, 1979.
ETI Project

Simple 60W Low

The popularity of our first 50 W 'universal' amplifier modules has been very high since they were published two and a half years ago. Since that time the state of the art has moved on. This project, designed by Phil Wait from an original circuit by Trevor Marshall, is intended to replace the ETI 480 and features simpler mechanical construction, low distortion (particularly TID) and generally better performance.

Distortion Amplifier

MANY DIFFERENT amplifier circuits have appeared in popular electronics magazines over the years.

While these seemed to have satisfied a large demand, our attention has been drawn to the need for something a 'step up' from there — something that approaches the current 'state of the art' for hi-fi equipment. Lower distortion than previously obtained, better bass performance and flexibility was the message we received from reader's letters and kit and component suppliers (“Why don't you . . .”, “What I'd like to see . . .”, “I need a . . .”, etc.).

Late last year we set in motion the 'wheels' necessary to bring this project into fruition.

A great many factors place sometimes quite severe constraints on project design — particularly component availability and ease of construction; not forgetting that this design had to perform significantly better than those that came before it.

There is clearly little point in describing a project that includes components that are impossible to get or one that is difficult to construct.

A strong point that came across to us from reader feedback and from the popularity of our 480 series of amplifiers was that constructors favoured a modular concept. It seems that the days of the single-board stereo amplifier project have come and gone.

This power amplifier offers a significant improvement in specifications and ease of construction over most kit amplifiers offered to date. It has been designed particularly with low transient intermodulation distortion in mind.

Although a difficult parameter to measure, transient intermodulation distortion is an inherent characteristic of many amplifier designs — especially those which incorporate large amounts of feedback to even out frequency response and reduce harmonic distortion. The heavy feedback 'school' of design produces an impressive list of specifications — but the difference to the ear between such an amplifier and one designed for low TID has to be heard to be believed.
The input stage of the amplifier consists of an emitter coupled differential pair (Q4, Q5) with a constant current source (Q1, Q2 and Q3). The use of a constant current source reduces distortion, as well as the possibility of high frequency oscillation and prevents any ripple on the positive supply from unduly affecting the input stage. Unequal emitter resistors (R1, R2) allow the currents in Q4 and Q5 to be optimised. Input lag compensation is provided by C3, limiting the slew rate of the amplifier to reduce high frequency intermodulation. The gain of the differential pair, driving Q10 and Q11, is very low. Almost all the gain of the amplifier is obtained from the parallel pair Q10 and Q11. They are operated with series (R13, R14) and shunt (R12) feedback, and a constant current source (Q6, Q7). This results in a highly linear stage. Q9 protects Q10 and Q11 from high peak currents or damage should a fault occur. When the current through R13 exceeds the safe limit, Q9 conducts and shorts out the drive to Q10 and Q11. Bias from the output stage is set by RV1 and a shunt regulator (Q8). Q8 is mounted on the same heatsink as the output stages and stabilises the output bias current against heatsink temperature rise. Resistors R15-R24 in the emitters of the output Darlington's, Q12 and Q13, maintain operation in their safe region as well as reducing the chance of thermal runaway.

Protection against ultrasonic oscillation is provided by C7 and the network consisting of R25-R28 and C5, C6. Both DC and AC feedback is taken from the output, via R8, to the negative input of the differential pair, the amount of feedback being set by the ratio of R8 to R7. C4 increases the feedback, and therefore decreases the overall gain, at very low frequencies. The feedback also automatically holds the DC output voltage at close to zero volts.
Simple 60W Low-Distortion Amplifier Module

**SPECIFICATIONS**

- **Power Output**: 60 watts into 8 ohms (±40V supply)
- **Frequency Response**: 10 Hz to 100 kHz ±0.5 dB
- **Input Sensitivity**: 500 mV rms for 60 W output
- **Hum and Noise**: better than −110 dB on full output (dependent on power supply)
- **Feedback Ratio**: 35 dB
- **Distortion**: at 1 kHz, 30 V p-p output into 8 ohms, Closed Loop: 0.04 % (open loop 1 %)
- **Stability**: The amplifier was found to be completely stable when operated into reactive loads consisting of R + C, L + C and pure L
- **Intermodulation (calculated values)**: at 1 kHz, 30 V p-p output into 8 ohms, 3rd order: less than 0.015 %, 5th order: less than 0.0023 % (Intermodulation reduces with reduced power)

**WHY LOW TID?**

Looking at the circuit and a quick glance at the specifications, there’s little in the circuit that looks outstandingly different from others. So what makes this amplifier special?

The difference in concept that makes this amplifier unique is the use of a very linear, high gain driver stage (Q10, Q11), with a constant current source (Q6, Q7), so that the gain of this stage is dependent upon the input impedance of the output transistors. However, their input impedance is dependent upon their gain, and therefore the gain of the amplifier stage is dependent solely upon the characteristics of the output devices.

Series and shunt feedback is used with Q10 and Q11 which results in a highly linear stage with a very low input impedance (about 28 ohms).

The gain of the differential pair when fed into this low impedance is close to unity, so almost all the gain of the amplifier is concentrated in Q10 and Q11.

Provided the phase shifts in the differential pair and the gain stage are negligible the feedback loop is unconditionally stable.

There are two other design features which result in low TID.

The total open loop (feedback disconnected) distortion is only 1% at 30 V p-p output. So, very little feedback is necessary to reduce this to an acceptable level.

Protection of the output transistors is done by fuses, rather than electronically, and very high transient currents can be fed to the speaker without being affected by the (inevitably) non-linear impedance of an electronic protection circuit.
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| 2SA 699 NPN RF/AA 45V/100mA/250mW | only 0.49 ea. |
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| 2SC 1853 NPN SI RF/MIX/30V/200mA/300mW | |
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| 2N 582N NPN Darlington 20A/20V/60W | |
| 2K 582 NPN Darlington 20A/200V/100W | only 4.99 ea. |

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| 2SA 699 NPN RF/AA 45V/100mA/250mW | only 0.49 ea. |
| 2SC 50/3AA/20W | |
| 2SC 554 NPN RF/AF 45V/100mA/250mW | only 0.45 ea. |
| 2SC 630 NPN RF/AF 45V/100mA/250mW | |
| 2SC 1317 NPN 50V/200mA/200mW | only 0.59 ea. |
| 2SC 1567 NPN 100V/500mA/200mW | |
| 2SC 1853 NPN SI RF/MIX/30V/200mA/300mW | |
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| 2SC 50/3AA/20W | only 1.66 ea. |
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| 2SC 630 NPN RF/AF 45V/100mA/250mW | |
| 2SC 1317 NPN 50V/200mA/200mW | |

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| 2SC 693 NPN RF/LN 40V/50mA/100mW NF 8dB/FT | only 0.29 ea. |
| 2SC 352 NPN 40V/20A/25W | |
| TOSHIBA SPECIAL | |
| 2SC 784 NPN 40V/20A/100mW/FT 500mW | only 0.49 ea. |

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| 2SC 693 NPN RF/LN 40V/50mA/100mW NF 8dB/FT | only 0.29 ea. |
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| 2N 2222 PNP S NPN S | |
| 2N 2222 NPN S NPN S | |
| 2N 2222 PNP S NPN S | |
| 2N 2222 NPN S NPN S | |

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| 2N 3055 NPN S 650 BASE/600V/115W | only 0.99 ea. |
| MJ 2955 PNP S Complement to 2N 3055 | |
| 2SC 1226 NPN Complement to 2N 564 | |
| MJ 802 NPN S 100V/200W | only 1.99 ea. |
| MJ 1002 NPN S Complement to MJ 802 | |
| MJ 2001 NPN Darlington Complement to MJ 5001 | only 4.45 ea. |
| MJ 3001 NPN Darlington 10A/80V/150W HFE | only 5.99 ea. |
| MJ 3001 NPN Darlington 30A/150V/150W HFE | |
| MJ 1001 NPN Darlington 8A/80V/150W HFE | |
| MES 29-1 equivalent to ECG 291 | only 1.99 ea. |
| MES 19-6 equivalent to ECG 196 | |
| MES 19-1 equivalent to ECG 191 | |
| MES 18-8 equivalent to ECG 188 | |
| MES 17-1 equivalent to ECG 171 | |
| MES 16-4 equivalent to ECG 164 | |
| MES 15-8 equivalent to ECG 158 | |
| MES 14-8 equivalent to ECG 148 | |
| MES 13-8 equivalent to ECG 138 | |
| MES 12-8 equivalent to ECG 128 | |

**MOTOROLA SPECIAL**

| 2N 3055 NPN S 650 BASE/600V/115W | only 0.99 ea. |
| MJ 2955 PNP S Complement to 2N 3055 | |
| 2SC 1226 NPN Complement to 2N 564 | |
| MJ 802 NPN S 100V/200W | only 1.99 ea. |
| MJ 1002 NPN S Complement to MJ 802 | |
| MJ 2001 NPN Darlington Complement to MJ 5001 | only 4.45 ea. |
| MJ 3001 NPN Darlington 10A/80V/150W HFE | only 5.99 ea. |
| MJ 2501 NPN Darlington 20A/100V/150W HFE | |
| MJ 3001 NPN Darlington 30A/150V/150W HFE | |
| MJ 1001 NPN Darlington 8A/80V/150W HFE | |
| MES 29-1 equivalent to ECG 291 | only 1.99 ea. |
reactive loads such as electrostatic loudspeakers.

CONSTRUCTION
All components are mounted on a pc board - including the output devices. This method of construction is recommended. The module has been designed so that it is mechanically simple to assemble, much simpler than our ETI 480 module. Wiring errors are also avoided when a pc board is used.

Firstly, assemble and solder all the components on to the printed circuit board with the exception of Q12, Q13 (the output Darlington) and Q8. Carefully observe the polarity of all the electrolytic capacitors and orientation of the transistors.

The board is then mounted hard against the heatsink using small right-angle brackets.

Smear heat conducting compound on either side of the mica insulators (don't use too much though) and insert these between the devices and the heatsink.

Assemble the washers and mounting bolts for these, finally checking with an ohm meter that there is not a short circuit between the metal tags (collectors) of the devices and the heatsink.

The input connection to the module is via a single-hole mounting RCA socket. This is mounted directly on the pc board. The centre pin connects to C1 via a short length of tinned copper wire.

If this facility is not required the RCA socket may be omitted and a length of shielded cable soldered directly between C1 and the pc board common.

The power supply and speaker connections are soldered directly to the appropriate copper lands on the underside of the pc board.

The ground side of the speaker must be returned directly to the zero volt connection of the power supply, as close to the filter capacitors as possible (preferably direct to the negative terminal). Do not connect this side of the speaker to the amplifier board.

PARTS LIST

<table>
<thead>
<tr>
<th>Resistors</th>
<th>all 1/4W, 5% except</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>100R</td>
</tr>
<tr>
<td>R2</td>
<td>82R</td>
</tr>
<tr>
<td>R3</td>
<td>33k</td>
</tr>
<tr>
<td>R4</td>
<td>82R</td>
</tr>
<tr>
<td>R5</td>
<td>3k9</td>
</tr>
<tr>
<td>R6</td>
<td>100R</td>
</tr>
<tr>
<td>R7</td>
<td>82R</td>
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<tr>
<td>R8</td>
<td>3k8</td>
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<tr>
<td>R9</td>
<td>10k</td>
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<tr>
<td>R10</td>
<td>22R</td>
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<td>R11</td>
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<td>R12</td>
<td>22k</td>
</tr>
<tr>
<td>R13</td>
<td>12R</td>
</tr>
<tr>
<td>R15-R24</td>
<td>.1R 1 watt</td>
</tr>
<tr>
<td>R25-R28</td>
<td>.22R 1 watt</td>
</tr>
</tbody>
</table>

| Potentiometer | RV1 | 100R mini trimpot (vertical) |

| Capacitors | C1, 2 | 220µ 16V electrolytic |
|           | C2    | 470p ceramic          |
|           | C3    | 0u47 35V tant         |
|           | C4    | 220µ 16V electrolytic |
|           | C5, 6 | 470n mylar            |
|           | C7    | 2µ2 mylar             |

| Semiconductors | Q1, 2 | 2N5400 |
|                | Q3    | 2N3906 |
|                | Q4, 5 | 2N5400 |
|                | Q6    | 2N3906 |
|                | Q7    | 2N4920 |
|                | Q8    | 2N4923 |
|                | O9    | MPS6515 |
|                | Q10, 11 | 2N4923 |
|                | Q12   | TIP141  |
|                | Q13   | TIP146  |

| Miscellaneous | SK1 | single hole, panel mounting RCA socket. |
|              | F1, F2 | 2 Amp 3AG Fuses. |
|              |       | Fuse holders, heatsink for Q7, mica insulating kit (for Q8, Q12 and Q13), flat sided heatsink (75mm x 110mm), angle brackets, ETI 470 pcb. |

| Parts List for Power Supply | D1-D4 | IN5404 or sim |
|                            | C8, 9 | 5000µ 50V electro (see text) |
|                            | SW1  | 120V Dpdt switch |
|                            | T1   | 28V-0V-28V, 2 amp transformer |

For pcbs for this project, contact Spectrum Electronics, or B&R Electronics, see Classified Advertising Section for addresses.

Left: closeup view of the output stage showing how the Darlington transistors are mounted and how the pc board attaches to the heatsink.
Everybody's making money selling microcomputers. Somebody's going to make money servicing them.

New NRI Home Study Course Shows You How to Make Money Servicing, Repairing, and Programming Personal and Small Business Computers

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or telephone 416-293-1911
Check pinouts of your TO-92 transistors before using.
Follow e-b-c lettering on positioning diagram.
HEATSINKS

The leads before soldering them in. have given drawings for both. Verify small signal transistors available. We promise between cost and temperature is critical.

In this respect the lead geometry Q8 is mounted on the heatsink. Remember, rosonic. The TIP 29 & TIP 30 will work but the leads are backwards.

There are two varieties of TO 92 small heatsinks run quite cool. You will probably find that relatively high heat dissipation is required. Darlington transistors are hard to temperature stabilise and should be run as cool as possible. This is why we have opted for a fairly large heatsink.

COMPONENTS

Most semi conductors are available from Future Electronics and similar suppliers.

The only difficulty might arise finding the 2N4920 & 2N4923 transistors. These are available from Electrosonic. The TIP 29 & TIP 30 will work but the leads are backwards. Remember, it is imperative that Q8 is mounted on the heatsink.

In this respect the lead geometry is critical.

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HEATSINKS

Heatsinks on any amplifier are a compromise between cost and temperature rise.

Unless you are going to play long passages of organ music, or run a disco, you will probably find that relatively small heatsinks run quite cool.

However, Darlington transistors are hard to temperature stabilise and should be run as cool as possible. This is why we have opted for a fairly large heatsink compared to other designs. The transistors should be bolted directly to the heatsink, not through a steel chassis. A slt could be cut in a chassis large enough to slide the assembled amplifier through the rear. Heatsink fins should always be vertical to provide the most efficient convection cooling.

POWER OUTPUT

Simple 60W Low Distortion Amplifier Module

Components

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Operational Amplifier

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ETI Project

Model Train Controller

A simple project offering auto-reverse, inertia, emergency brake and loop track facilities.

MODEL TRAINS HAVE ALWAYS BEEN popular with both lads and dads — with dads perhaps coming first. Many a boy has complained “Daddy won’t give me a turn”. It seems there is some inexplicable attraction in playing trains which never dims with the passing years. A couple of our friends have recently decided to buy train sets — for the kids (they say). Our model train controller project was designed to give them many features that are not found in commercially available controllers (for roughly the same cost). Most commercial devices cost around $30 and consist of a transformer followed by a selenium rectifier, a high power rheostat and an carlight bulb. Such controllers have numerous operating disadvantages mainly due to their very poor voltage regulation.

Our controller It may look a little complex but in fact it is very simple to build and quite inexpensive. If the full capability is used the features of the controller are:

- Forward or reverse control by a single slide potentiometer (centre for stop)
- Separate reversing switch for the main track
- Short-circuit proof
- Regulator-type control circuitry
- Emergency brake (which stops the train instantly regardless of the position of other controls)
- Simulated inertia (gives more realistic starts and stops)
- The facility to operate with track loops

Loop operation Although not possible with simple controllers, loop operation adds much more operating fun and realism to your model railroad and the feature is well worth including. A typical loop is shown in Fig. 1 and the operational problems of such a loop are as follows:

![Diagram of train controller](image)

Fig. 1. A typical track loop. Gaps must be inserted in the rails of the loop in the positions shown. Polarities shown are with MAIN and LOOP track switches in the normal position.

If a train is approaching the loop and the ‘main’ and ‘loop’ switches are both set at normal, the polarity of the voltages to the track will be as shown. If the points are set so that the train enters the loop towards ‘A’ it will continue normally around the loop. If the points are now set to ‘B’ so that the train may
The MEK6802D3 Microcomputer Module is the heart of the new educational/evaluation product series, the MOKEP Family.

The MEK6802D3 is a self-contained system, utilizing an on-board hexadecimal keypad and an 8-digit LED display, and based on the MC6802 micro-processor and MC6846 ROM/IO/Timer combination. On-board RAM includes 128 bytes in the MC6802, 128 bytes of Stack in one MCM6810 and 128 bytes in a second MCM6810 which may be configured as Stack or User space. A full 2K firmware package is also included. The module has provision for expansion – a ROM socket is available for firmware supplied with some of the optional modules.

The module operates from a single 5-volt power supply. Maximum current required is 1 ampere.

Unit price is $231.00

The MEK6802D3C Module is the same product without the keypad, display, and associated drivers. Unit price is $165.00

EDITOR AND ASSEMBLER AVAILABLE. BASIC COMING.

<table>
<thead>
<tr>
<th>ACCESSORY MODULES</th>
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<tbody>
<tr>
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<tr>
<td>MEK68CC</td>
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<tr>
<td>MEK68CMB</td>
</tr>
<tr>
<td>MEK68WW</td>
</tr>
<tr>
<td>MEK68WW1</td>
</tr>
</tbody>
</table>

*indicates assembled module

MOKEP is a trademark of Motorola Inc.

AVAILABLE THROUGH LOCAL MOTOROLA DISTRIBUTORS IN VANCOUVER, EDMONTON, CALGARY, WINNIEP, TORONTO, LONDON, HAMILTON, OTTAWA, MONTREAL, QUEBEC CITY.
Fig. 2. Circuit diagram of auto reverse controller which incorporates all the facilities mentioned in the text.

**How it works**

Transformer T1 reduces the 120V line voltage to a supply or 24 volts (centre tapped) which is then rectified by D1 to D4 to provide supplies of +16 and -16 volts dc. The speed control potentiometer is connected between these supplies so that its wiper may select any potential between plus and minus 16 volts, depending on setting.

The output of the potentiometer must be well buffered before it can supply enough power to run a train. This is achieved by transistors Q3 and Q5, for the forward direction (that is for output voltages between zero and +15 volts), and by Q4 and Q6, for the reverse direction (that is for output voltages between zero and -15 volts). The output voltage at the collectors of Q5 and Q6 will be about 0.6 volts closer to zero than the voltage at point 'K' (providing the voltage at point 'K' is more than 0.6 volts away from zero). This means that the control

**Parts List**

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q3</td>
<td>2N3904</td>
<td></td>
</tr>
<tr>
<td>Q4</td>
<td>2N3904</td>
<td></td>
</tr>
<tr>
<td>Q5</td>
<td>2N3905</td>
<td></td>
</tr>
<tr>
<td>Q6</td>
<td>2N3905</td>
<td></td>
</tr>
<tr>
<td>R1</td>
<td>22 k</td>
<td>1/2 W, 5%</td>
</tr>
<tr>
<td>R2</td>
<td>10 k</td>
<td></td>
</tr>
<tr>
<td>R3,4</td>
<td>4 k7</td>
<td></td>
</tr>
<tr>
<td>R5,6</td>
<td>100 ohm</td>
<td></td>
</tr>
<tr>
<td>R7</td>
<td>0.22 m</td>
<td>5 W</td>
</tr>
<tr>
<td>R8,9</td>
<td>100 ohm</td>
<td>1/2 W</td>
</tr>
<tr>
<td>RV1</td>
<td>5 klin 45 mm slide</td>
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</tbody>
</table>
The potentiometer will have a small dead band in the centre of its travel where the output voltage remains at zero. This is an advantage because it is frequently necessary to set the controller for exact zero output.

To protect the transistors from damage in the event of an overload or a short circuit, transistors Q1 and Q2 are used to monitor the output current (by measuring the voltage across R7) and the voltage across the output transistors. By this method the power dissipation in the output transistors is controlled such that when driving into a short circuit only about one ampere is available. Yet when set to about 12 volts, about two amps is available to drive normal loads. The diodes D7 and D8 are included to protect the transistors Q1 and Q2 against reverse bias which can occur under certain conditions.

To add the 'inertia' facility or 'momentum', as it is sometimes called the control voltage from RV1 is filtered by C3 and C4. This means that if the potentiometer is suddenly moved from stop to full forward (for example) the voltage applied to the transistor buffer rises only slowly. The train accelerates at a realistic rate without wheel spin. A similar action takes place when the train is stopped. If the controller is moved from full forward to full reverse the train will slow down and stop for a short time and then start off and increase speed in the reverse direction. The diodes D5 and D6 allow normal electrolytics to be used in this position.

If inertia is being used and an emergency situation occurs, eg train moving into a siding that it should not be entering, the brake facility may be used to short the track (SW3b) and also the input to the buffer stage (SW3a). The brake over-rides the speed control and by its use the train will be stopped in a much shorter distance than it would if the power were simply switched off. When loops in the track system are used, as described in the introduction, a separate reversing switch is used to control the polarity in the loop with respect to the main line so that the train may go into and come out of the loop without any change in speed. The two controller outputs required for this mode of operation must each be reversible and this is performed by SW4 and SW5.

If a second controller is required for another train in the system then it may be built without the power supply. The second controller may be powered by linking the +16, 0 and -16 volt lines between the two controllers.

For pcbs for this project, contact Spectrum Electronics, or B & R Electronics, see Classified Advertising Section for addresses.

---

**Component Overlay**

**Printed-circuit board layout ETI 541 train controller. Full size 65 x 105 mm.**

**Fig. 3. Component overlay – auto reverse controller.**

**Fig. 4. Component overlay – simple controller.**
Fig. 5. Circuit diagram of simplified controller without the auto-reverse facility.

The power transistors are mounted to a bracket with countersink bolts. They can, if desired, be mounted directly on the front panel. Note how the pcb is mounted — by epoxying to the bracket.
The controller is not required if all the facilities of the auto-reverse controller are not required. If only a single direction is required from the throttle control then the circuit in Fig. 5 may be used. If loop operation is not required then the controller may be further simplified by deleting SW5 and the associated wiring.

**CONSTRUCTION**

We constructed our controller into a plastic box with an aluminium lid. Some people wish to construct a complete control panel or other box. This is quite acceptable as the method of construction is not critical.

**Simpler versions**

If all the facilities of the controller are not required then it may quite easily be simplified. If only a single direction is required from the throttle control then the circuit in Fig. 5 may be used. If loop operation is not required then the controller may be further simplified by deleting SW5 and the associated wiring.

---

**Fig. 7.** Interconnection diagram for the auto-reverse controller given in the circuit of Fig. 5.

---

**Fig. 6.** Assemble of the printed-circuit board and bracket to the front panel.

---

**Fig. 8.** Mounting bracket for transistors 05 and 06.

---

**ETI CANADA—NOVEMBER 1979**
Along time ago, in a far-off land, there lived a town full of musicians. The musicians would get up early in the morning and start to practice their craft, and they would practice all day until they were perfect. In the evenings, they would all gather in the public square and have a grand concert. People from all around would come to hear them play. Word of their skill soon reached the king's ears, and he sent his music inspector to listen and make a report. The music inspector told the King what a wonderful group of citizens these musicians were, and before very long, they were playing at the Royal Court. They enjoyed all sorts of special privileges, such as being able to play their instruments all night long, being able to play anywhere they pleased, and being able to play as loud as they pleased, even if people complained. It wasn't often that people complained, but when they did, the King's Department of Music would send along an inspector, and usually discovered that the complainant had far too sensitive ears and told the musician he could go on playing.

Many, many years went by, and music became an important part of life in the kingdom. Very soon after the King recognized music, many people discovered ways to make money at it, but the King was very shrewd and made regulations covering how they could play for profit and how much they could charge. He even made regulations covering how loud all these people could play as years went by, so they would not interfere with each other's playing. Despite the large revenues the King got from the music tax charged on playing. The King was very shrewd and made regulations covering how they could play for profit and how much they could charge. He even made regulations covering how loud all these people could play as years went by, so they would not interfere with each other's playing. Despite the large revenues the King got from the music tax charged on all playing for profit, he had a very soft spot for the amateur musicians. He made special concessions for them and reserved special places for them all to play together. Since they were not all competing for profit, they did not need to be regulated like the commercial musicians, and he more or less let them get on with it unhindered.

Very soon, however, there were far too many amateur musicians for the King to have personal audiences with them, and even too many for his music inspectors to visit. Things were becoming far to busy on the commercial front, where there were many more musical instruments, including cheap little toy instruments that any member of the public could play softly without much musical skill. So the amateur musicians formed little clubs at first, which all then banded together to form one club for the whole kingdom. Now the King was happy again because he could quietly whisper into the ear of one of the club leaders about anything that he didn't like about the way the amateur musicians were doing their thing, and words would be said to the offenders and the problem solved, without the king having to make bothersome regulations.

In time, musical instruments became louder and louder, and the King's musicians were heard in other countries. So it became necessary to sign treaties with the other countries promising to keep his musicians in line. More regulations, more bureaucracy. The King hated bureaucracy, but it all seemed necessary. Despite all this, the amateur musicians were still very well-behaved and escaped much of the attention of the King's music inspectors.

Times change, however. Soon, musicians from the big industrialised country next door imported bigger and louder instruments, and started a whole new trend in playing music. It didn't sound half as nice as the music the king was used to, and so he sent out his inspectors to find out what it was all about. They reported back and the King wept. He was so fond of the concerts he had started, how the amateur musicians played so well together. They were now all playing out of tune. It sounded horrible. It seemed that they couldn't decide amongst themselves which way up to put their sheet music while they were playing. Some put it up the normal way, others put it upside down. The result was that they could never keep in time, or play the correct notes. When the King asked for a report on why things had changed this way, he was told that this was the way they had always done it in other countries, and it was better that way.

For a while, the King went along with this way, but he still missed the nice concerts that he had attended in his younger days. But the time came when he could not stand it anymore. He sent his music inspectors out to seize all the instruments from the amateur musicians. They would be much better used by the commercial musicians, since
they created revenue and paid a lot more taxes.

Soon afterwards, the old King died, heartbroken at thinking he had let a good thing be spoiled. He created revenue and paid a lot more taxes. After the death of the old King, the amateur musicians were soon able to keep their hands on some of our frequencies.

Be sure to tune into QRM next month, when, Deo volens, we will have a report on what happened at the Ottawa RSO convention, a very special interview with an important person, and a report on a recent court case in Toronto that could have a staggering effect on amateur radio’s future in the automobile.

If you have anything to say, please write to me at: QRM LETTERS, ETI CANADA, Unit 6, 25 Overlea Blvd, Toronto, Ontario, M4H 1B1.

DEAR BILL,

Pardon the rusty form of this letter, but I am typing it on my home computer and my typewriter, which is not exactly a commercial text editor, anyway. It does what I want, and I am having a lot of fun with it, setting it up for Morse practice, RTTY and soon, Packet Radio — how to join the local crowd when we get the “digital” going this fall on 220.14.

So, I just finished reading the September issue of QRM. I have been a charter subscriber of ETI, and have been reading your column since it started, have enjoyed every column, and find your views quite agreeable, especially on the RSO repeater. I agree with the local amateur who said that you were too kind to the RSO, after your original criticism. Enuf said about that. I agree with this month’s column — who will do the experimenting if we keep churning out new amateurs the way we are now? It sure sounds like a lot of them are fresh off of another band... not that I have anything against some ops in general. A number of them operate better than the new amateurs showing up on 2 metres these days with their brand new appliances. Now the thing that bothers me is, can we keep 220 and packet experimentation free of these types with their ‘X’ radios, model ‘D’ plug-in packet radio interfaces and ‘Z’ computers? I agree with RTTY. I think that it is great for the DOC to open up HF RTTY to amateurs, possibly many of them are more technologically oriented, but have passed the code anyway. Our club recommends this route to newcomers interested in Packet Radio, because of the expanded possibilities it gives them. We suggest that they get their digital ticket afterward if they are still interested in having it. And could being HF RTTY up to more modern standards? We should, as Canadians, be using ASCII far more than we do on the HF bands. I do know a lot of amateurs — not advanced would be interested in putting their micros etc. on HF and having a lot of fun. But who are prevented by the present SITTY regs, forbidding HF to amateurs on HF. C/N amateur could set up a plug-in transmitter in their car and key them alternately, and be quite legal. I think that it will be good to get the amateurs with some microcomputers on HF RTTY, but I hope that we don’t shortly see a glut of HF appliance ops on the same band with the same thing with their pets, and plug-in ‘amateur tele-type interfaces’.

Be sure to tune into QRM next month, when, Deo volens, we will have a report on what happened at the Ottawa RSO convention, a very special interview with an important person, and a report on a recent court case in Toronto that could have a staggering effect on amateur radio’s future in the automobile.

If you have anything to say, please write to me at: QRM LETTERS, ETI CANADA, Unit 6, 25 Overlea Blvd, Toronto, Ontario, M4H 1B1.
Kit Survey

In this month's Audio Today, Wally Parsons tells you why you should buy a kit, John Van Lierde reviews kits available in Canada.

THE PROBLEM FACING MOST friends and lovers of electronic 'Do-it-Yourselfers', is what to get them for Christmas. Chances are most parents could not walk into a major industrial outlet and select a suitable array of transistors and ICs as stocking stuffers. On the other hand, the true hearted home constructor might be offended on opening his presents and discovering a commercial piece of equipment. After all, HE could have built it HIMSELF if only HE had time. Home handymen can be a difficult lot.

It is with this dilemma in mind that we proudly present our survey of kits available in Canada (and some from the US).

The virtues and benefits of buying a kit are manifold. Indeed I had about five pages of them in my original manuscript. But, unfortunately Wally Parsons got the jump on me (he won't get off!) and so I gracefully deleted my material.

Unlike our receiver survey, this month’s effort is not intended to list every kit we could possibly find. Rather, we are merely trying to make you aware of what’s available from whom.

The material requested from manufacturers consisted of a catalogue, price list and sample instructions. In this way we tried to get a ‘feel’ for the products and to what level of proficiency they’re suited for. Some kits (like Heathkit) are documented to the point of redundancy. Others just give you a schematic and parts and leave you to your own devices. This is not a reflection on the quality of any kit, but it will affect the success of the prospective kit builder.

When you write for catalogues be sure to say you saw it in ETI. It makes our surveys go better.

Like all our surveys, we couldn’t reach everyone, and not everyone wanted to participate. It is beyond the ken of mere mortals and assistant editors why manufacturers will turn down free publicity. Maybe we took them by surprise.

WHERE TO GET IT

<table>
<thead>
<tr>
<th>Vanasco</th>
<th>Speakerkits (KEF, Philips, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>●Vansco, 102 Vanscøy Rd., Winnipeg, Manitoba.</td>
<td>●Gladstone Electronics, see PAIA.</td>
</tr>
<tr>
<td>ATV Research</td>
<td>Audiovision</td>
</tr>
<tr>
<td>EICO Electronic Instrument Co.</td>
<td>Paccom</td>
</tr>
<tr>
<td>●H.W. Cowan Canada Ltd., P.O. Box 268, Richmond Hill, Ont. L4C 4Y2.</td>
<td>●Paccom, 14905 N.E. 40th Street, Redmond, WA98052.</td>
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<tr>
<td>RAEEKIT</td>
<td>Moonlighter Electronics</td>
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<td>Compubit</td>
<td>Heath Company</td>
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<tr>
<td>●Compubit, 1857 Wavell Cres., Mississauga, Ontario L4X 1X2.</td>
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<td>●1400 Sauve Ouest, Montreal, Quebec H4N 1C5.</td>
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<td>●n.Longman Sales Inc., 1715 Meyerside Drive, Unit 1, Mississauga, Ontario L1T 1C5.</td>
<td>●12863-97th Street, Edmonton, Alberta T5E 4C2.</td>
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<tr>
<td>PAIA</td>
<td>●1315 Portage Ave., Winnipeg, Manitoba R3G 0V3.</td>
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<tr>
<td>SDS Technical Devices Ltd.</td>
<td>●3058 Kingsway, Vancouver, B.C. V5R 5J7</td>
</tr>
<tr>
<td>●SDS Technical Devices Ltd., P.O. Box 1988, Winnipeg, Manitoba R3C 3R3.</td>
<td>Science Of Cambridge</td>
</tr>
<tr>
<td>Jana Kits</td>
<td>●Gladstone Electronics, see PAIA.</td>
</tr>
<tr>
<td>●Jana Industrial Electronics, 1777 Ellice Ave., Winnipeg, Manitoba R3H 0W5, or check ads in previous issues of ETI.</td>
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</tbody>
</table>
Audiovision

Audiovision markets a line of basic audio kits intended for the more experienced constructor.

Available are 5 different power amplifiers ranging from 20W (#20A at $39.00) to 140W (#7070 at $129.00). A review of the 7070 can be found in this month's Audio Today.

Audiovision sent us two preassembled kits, the SAD-01 Audio Level Display ($26.00) and the SAD-02 LED Power Indicator ($56.00).

Both kits appear to use fairly good quality components, and the PCB board layout has a clean symmetrical appearance. The SAD-01 has its LEDs arranged in a 'V' type pattern and the outward flashing lights produce an eye catching effect. Both indicators come with pre-cut, silk-screened bezels.

Assembly instructions are by and large sketchy but the boards have component locations silk-screened and a schematic is provided. A little common sense will ensure proper operation.

Jana

While not dressed up in flashy cases, the Jana line of educational kits do offer surprising value for the money you spend.

These are one or two evening kits that go together with no bizarre tricks or annoying surprises. With a little care they will invariably work the first time.

Jana offers over 25 kits. There are noise makers such as the Curiosity Box (#7), The Road Runner (#32), or the Loudmouth (#24). Games offered include shootout (#31), Dice (#27), and Roulette Wheel (#25).

In addition, Jana offers kits of a more practical nature.

Kit $34 starts you off in electronics by having you build your own soldering iron. Price is $7.95 including tweezers and two screwdrivers.

The Bug Shoo (#3, $5.25) repels mosquitoes by means of ultrasonic sound.

Other kits include an FM Mini Broadcaster, Code Oscillator, Strobe Light and more.

Most Jana kits come in a plastic box that also serves as a case for the finished product. The box looks rather like a square margarine tub, but is actually considerably more durable. It is easily worked with drill, saw or soldering iron. The printed circuit board is not silk screened, but the instructions include a good parts positioning diagram.

Jana kits were originally intended for educational use, but they are also ideal as first kits. They also make good modules for other projects.

Jana kits are widely distributed throughout Canada.
ATV Research

ATV has been in the closed circuit TV business since the mid-sixties and offer a number of attractive kits to the prospective video buff.

Of particular interest is a solid state B&W camera for $185 US. The XT1A features video or RF output and automatic light compensation. The catalogue also boasts an illustrated step by step manual. (We didn't get one and therefore can't comment.)

ATV also supplies hard to get CCTV parts such as peaking coils or focus deflection kits for 1" vidicon tubes. The latter come with all necessary hardware to mount the vidicon as well as plans for a complete camera. Price is in the $20—30 US range. ATV will even sell you the vidicon.

Other kits; Pixe-verter, an RF modulator for CCTV cameras at $8.50 US, the ASC71 Audio Subcarrier Unit ($28.95 US) to add capability to existing cameras, and the TCS-6, a series of six television test patterns ($3.50 US).

All orders shipped prepaid and insured from ATV Research.

Heathkit

Over the years Heathkit has grown to be a name synonymous with kit building. Heath supplies kits in every type of electronic hardware imaginable; audio, test and service, amateur radio and more. Flipping through their catalogue, it becomes apparent that their design philosophy encompasses functional ability with aesthetically pleasing styling. Each kit is thoroughly tested and reviewed before it is released for market. In addition, documentation for Heathkits is very complete. The instructions are designed for people with previous experience in electronics or in handling tools.

All this, of course costs you bucks, but then you're paying for all the research and service behind your kit.

Heath's 5280 line of instruments are ideally suited for experimenters on a budget. The series consists of the IG5282 Audio Oscillator, IG5280 RF Generator, IM5284 Multimeter, IB5281 RCL Bridge and IT5283 Signal Tracer. All instruments are $69.95 each. In addition, there is a power supply (IPS5280-1) for all five at $39.95.

Heathkit also has a wide range of amateur equipment such as 2m transceivers, keyers, 1KW linears and so on. One example is the SB104A transceiver, which will deliver 100W CW or SSB on the 80m to 10m ham bands. Broadband design eliminates the need for pretuning. Tuning is accomplished by means of a 6 digit LED readout.

Price, $1400.

For the audiophile, Heath offers their top of the line Rack Mount system, $2420 just about covers the cost of the entire system which includes the AJ1600 AM/FM Digital Tuner (with Dolby FM), AP1800 Stereo Preamplifier, AD1701 Graphic Output Indicator, AA1600 Stereo Power Amplifier and the AE1705 stereo component rack to house it all. The net result is a professional looking 125W/channel system with terrific sound.

There are six Heathkit Electronic Centres in Canada.
**ARKON KITS**

<table>
<thead>
<tr>
<th>Part Code</th>
<th>Description</th>
<th>Price</th>
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<tbody>
<tr>
<td>01</td>
<td>5 Transistor 1 W. amp</td>
<td>$8.95</td>
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<tr>
<td>02</td>
<td>0-24V 1 Amp Power Supply</td>
<td>$18.95</td>
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<tr>
<td>03</td>
<td>Strobelight</td>
<td>$15.95</td>
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<td>04</td>
<td>Light Chaser</td>
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<td>05</td>
<td>Light Organ 500w/ch</td>
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<td>06</td>
<td>Light Organ 1500w/ch</td>
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<td>07</td>
<td>FM Mike</td>
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<tr>
<td>08</td>
<td>FM Mike, with preamp</td>
<td>$4.95</td>
</tr>
<tr>
<td>09</td>
<td>Tone Decoder</td>
<td>$4.95</td>
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<tr>
<td>10</td>
<td>Timer board 555</td>
<td>$3.95</td>
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<tr>
<td>11</td>
<td>Code Oscillator 555</td>
<td>$3.95</td>
</tr>
<tr>
<td>12</td>
<td>Code Key, brass WWII</td>
<td>$3.95</td>
</tr>
<tr>
<td>13</td>
<td>LED Blinky</td>
<td>$2.95</td>
</tr>
</tbody>
</table>

**ARKON CP-I0-1**

The ARKON CP/I0-1 is an S-100 card that has all the CPU, Disc control and 10 capability needed to construct a disc based microprocessor system for business, hobby or scientific use. Features include:
- 2 MHz $8080-A, fully buffered S-100.
- EIA-RS232 port, 110 to 75,600 baud.
- Fully vectored interrupt (TMS-5501).
- 5 Interrupt controlled timers.
- EIA port for printer up to 9600 baud.
- Disc controller on board (1771).
- Shugart 400, 800, Memorex 550, plus.
- On board digital data separator.
- 2K bytes EPROM.
- 24 fully handshaked IO lines.
- Dual mapped IO.
- MWRITE generation on board.
- Software driven cassette interface.

**HOT PLATE**

Large Manufacturers Surplus; 5x100W in. Made of 3/8 in. tempered glass with heating element laminated on back. Works off 110V AC. Protected by thermostat and two thermal fuses. Rated 120 Watts. Use for any heating applications. Perfect for heating nicotine to increase PCB etching efficiency. These units are branded non-submersible.

**OHIO SCIENTIFIC SUPERBOARD** $417.00

You’ve seen all the ads, at last this great item is in stock. What more can we say.

**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 CP/M system.
- Direct 10 to 8060 ports
- Accepts embedded-in-line code
- Fortran interrupt control
- ANSI FORTRAN IV subset
- Single, double precision
- Custom IO drivers
- Memory mapped IO
- Made in Canada

Send now for a full data sheet and sample program.

Copyright Arkon Electronics, Digital Research of Canada

FORT/80                        $38.00
MANUAL ONLY (APPLIES TO BUY)    $20.00
DATA SHEET AND SAMPLE PPM       NC

**LED BAR GRAPH AND ANALOG METER DRIVER**

New from National Semi. #M3914. Drives 10 LED directly for making bar graphs, audio power meters, analog meters, LED oscilloscopes, etc. Uses can be stacked for more LEDs. A super versatile and truly remarkable IC. Just out! SPECIAL PRICE $4.95 INCLUDES 12 Page Spec. Sheet

**UPPER PLATE**
Eico

Eico Electronic instrument company is a major kit name in North America. They should be, they've been at it since 1945. Eico instruments feature rugged construction and good solid design. A large number of their kits have been around for over 10 years and while admittedly they use vacuum tubes, you know they are of proven design. In fact, I noticed that one scope, the 460, has a graticule graduated in inches. That's one up on a metric Canada.

By far the largest segment of the Eico line is devoted to test equipment. They offer a wide selection of test meters, oscilloscopes, generators, transistor testers, substitution boxes (pause, deep breath), frequency counters, power supplies, battery eliminators, bridges and more. You can easily stock a lab from the catalogue.

One notable kit is the 270 DMM. This is a 3½ digit, 10 megohm multimeter for $179.95. Other kits include the DLP6 Logic Probe which can detect pulses as short as 20 ns for $39.40. The PST-2 Signal Tracer Probe ($38.30) can demodulate signals all the way up to 200 MHz.

Eicocraft kits are for those people who are after more functional design at lower costs. Prices range from $15.00 to $60.00 for a variety of products such as preamplifiers, power supplies, an ESP tester and color organs.

We were supplied with a 31 page assembly manual for the model 465 DC to 10 MHz oscilloscope. Instructions are detailed and straightforward and the average constructor should have no trouble, even if the doctors botched his lobotomy. Also included was a sheaf of 5 large assembly pictorials. Documentation is quite adequate.

Eico kits are distributed in Canada by H.W. Cowan Canada Ltd.

SDS Technical Devices

With the mushrooming growth of microcomputer applications comes an attendant need to educate users in using such devices.

The TDS-M68 is a wholly self contained 6800 based teaching and development system, aimed at introducing the beginner to the programming, interfacing and applications of a 6800 microprocessor. Features include keyboard, seven segment display, 16K of RAM and 8K of EPROM.

Peripherals include CRT display, floppy disk drive, cassette interface and so on. Also a book, 'Understanding and Applying the 6800' by Allan Robbins and a lab manual are available.

The TDS-M68 is available from SDS for $750.
ETI CANADA—NOVEMBER 1979

Available in Canada from

THE PERSONAL COMPUTER STORE

Check these sensational new products (and the oldies) at these sensational new prices!!

Econoram boards are generally available in 3 forms: unkit (sockets and bypass caps are pre-soldered) in place for simple, one-evening assembly, assembled and tested, or qualified under our high-reliability Certified System Component (CSC) program (200 hour burn-in, immediate replacement in event of failure within 1 year of invoice date). 1 year limited warranty on all products. Refer to chart below for pricing.

LED VU/Peak Meter

- 12 LEDs
- Red, green, yellow
- Hold, or reset button
- Fast 'attack' time

$22.95

Light Organ

- 3 channels
- 25W/channel
- Level control

$479

CMOS Electronic Dice

- Touch-activated
- Random order
- Automatic turnoff
- Last if recall

#3010 DICE $24.95

UNIVERSAL DESIGNER

- 2 Bounceless Pushbuttons
- 2 LED Monitors
- 4 Switch Outputs
- 2 Variable Clock Generators
- 4 decade counters
- 1.6 Volt Battery

6100 Universal Designer $43.95

Circle No. 5 on Reader Service Card.

MAIL ORDERS WELCOME!

Circle No. 20 on Reader Service Card.

TERMS: Visa/Master Charge (Please include expiry date)
check or Money Order. Add 2% for shipping and handling.

Ontario residents add 7% Provincial Tax.

COMPUMART, P.O. Box 6132, Station J, Ottawa, Ontario, K2A 1T2. Showroom: 411 Roosevelt Ave.; or phone (613) 725-3192.


da of the A-100 LED Indicator Kit.

"INTERFACER" S-100 I/O Board

Unkit $269.00, assm $339.00.

DUAL SERIAL PORT with 2 independent ports for RS-232 handshaking.

LED VU/Peak Meter

- 12 LEDs
- Red, green, yellow
- Hold, or reset button
- Fast 'attack' time

$22.95

Light Organ

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da of the A-100 LED Indicator Kit.
Raekit

RAE Industrial Electronics started in the kit business over ten years ago (see News Digest, Aug. '79 ETI) and now offer some thirteen kits.

For experimenters, RAE offers their Universal Designers Board (#6100, $39.95) which plugs directly into any breadboarding strip. The 6100 can then supply 5 VDC and two sets of variable clock pulses directly to the circuit. In addition it has 8 LED monitors, 2 decade counters and two BCD inputs.

Another interesting kit is the 2100 LED VU Meter ($29.95). It features fast attack time and slow decay to indicate otherwise unreadable peaks. The 2100 can be mounted in either vertical or horizontal fashion with the same bezel.

RAE also sent us an 8204-2 Tone Ringer for inspection. The unit can be plugged directly into telephone lines and generates a two-toned beep when someone calls. The kit comes with a modular jack that is compatible with Bell's current jacking program. Instructions are clear and detailed. Documentation is quite good and includes an easy to understand technical description.

RAE kits are available from RAE Industrial Electronics Ltd.

Above, 6100 Universal Designer Board and 2100 LED VU meter.

RAEKIT 1979 CATALOGUE

Below, a simple computer from Science Of Cambridge.

SCIENCE OF CAMBRIDGE

For a cheap and easy way in to micro computers Science of Cambridge offers a bare bones micro kit.

The MK14 is available for $139.95. The kit features 256 byte RAM, 512 byte PROMED monitor and the whole thing runs on a 4 MHz clock. In addition you can add another 256 bytes of RAM on Board.

Accessories include a RAM I/O and cassette interface.

The 88 page manual that came with the kit had a very slick appearance and included quite a wide diversification of programs to try. The actual constructional part was 5 pages long. But then the parts count of the kit is low. Documentation is good. The MK 14 is available from Gladstone Electronics.
PACCOM

Paccom is another manufacturer of the "unboxed" type of kit. All their kits feature "State of the art" design and are complete in that they have on board power supplies.

Paccom offers a number different clock kits. These range from the FTK0106 Auto Clock with calendar to a full size wall clock (FTK0101) which features 2.5" display (using 28 LEDs per digit).

Other kits include an appliance timer with key board entry (FTK0107) and several power supplies. Unfortunately prices were not available at the time of writing.

Instruction manuals are quite good with an abundance of overlays. The step-by-step instructions are quite explicit and there's no way even a catatonic three year old could screw up explicit and there's no way even a student in mind.

Instruction manuals are quite good with an abundance of overlays. The step-by-step instructions are quite explicit and there's no way even a catatonic three year old could screw up explicit and there's no way even a student in mind.

As a rule, most students go through school on a limited budget. Cost is therefore a primary consideration in selection of kit.

The uSO kit 68 is designed with the student in mind.

It consists of a 6800 microprocessor with 256 bytes of memory and peripheral interface adaptor. The unit is fully expandable to 65K of RAM and UK of PROM through two 15 pin edge connectors.

All documentation is in one 1/2" thick duotang bound manual. It seems like the sort of book it would take several sleepless nights to complete.

Cost is $175.00 less power supply. You will require a 5V 2A power supply.

The uSO68 is available from Compu-kits or Longman Sales Inc.

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Kit Survey

PACCOM

Right, the uSO kit 68 from Compukit.
PAIA

PAIA offers a strong line of music synthesizers and related equipment.

At the top of the line we have the 4700/S. For $1100.00 you get 2 VCAs, Stereo Mixer, three power supplies, control oscillator and noise source, reverbo, 3VCOs, 1 VCF, two envelope generators and 12 event sequencer. To hold it together the system is enclosed in two road cases with keyboard.

There are actually several permutations of the 4700 ranging from $700 to $1130. You can also get the 4700 series of modules separately.

If you’re into building your own synthesizer there’s the 8782 encoded keyboard kit at $249.

Other kits include the Gnome micro synthesizer, Organtua, Surf Synthesizer, Wind Chimes Kit and more.

We were provided with assembly instructions for the 4750 Programmable Drum Set and a users manual for the 3740 Gnome Synthesizer. Assembly instructions appear to be clear and unambiguous along with a wad of pictorials and schematics. The design analysis is also fairly comprehensive.

The users manual for the Gnome starts out with a quick course on synthesizers before going into actual operation. Once again there are plenty of pictorials and a design analysis at the end. We also noticed that manuals and pictorials were punched for three ring binder use. Nice touch. PAIA Synthesizers are distributed by Gladstone Electronics who kindly provided us with manuals and information.

SPEAKER KITS

Speaker kits is a general name Gladstone applies to all speaker combinations they carry. These include such name brands as KEF, Philips and Decca.

System 1-15/78
Small Bass Reflex System for Home or Mobile

System 2-60/60
Three Way 60 Watt Floor Standing System 12 inch Woofer
Aside from a very popular line of HiFi speakers and crossovers, Philips has also designed a number of very effective enclosure/speaker combinations. You can obtain a flyer detailing eight such systems for $1.00. Gladstone Electronics will also sell you the proper speaker combinations.

Of course some ability in carpentry is required but diagrams and graphs are clear and should be adequate.

Gladstone is also the exclusive distributor for two new KEF speaker kits.

One of these is the Cantata kit. $499.00 gets you a T52 tweeter, B110 midrange, B139 9x13" woofer and crossover mounted on, baffle board. The system is capable of handling 150W with a response of 35 to 20000 KHz.

You can get a good idea of Gladstone Electronics selection of speakers from the 16 page insert to October, 79 ETI.

VANS CO

Vansco is entering the kit market with two kits, Electronic Dice and Electronic Roulette.

Both utilize CMOS technology and feature automatic shut off after 10 seconds. Price is $33.98 each. Apparently a burglar alarm kit is in the works for some time in the future.

Instructions are clear and include fairly good technical descriptions. They’re also the only instructions we’ve seen in both French and English.

Vansco kis are available direct from Vansco Electronics.

LAST MENTIONS

There are several companies who we know are supplying kits, but who we have not included. This was mainly due to lack of material, so it’s worthwhile checking the offerings of the following:

A1 Electronics: see ads in previous issues of ETI.

Arkon: see ads in this and previous issues.

Dominion Radio: see catalogue in September issue.

Teknikit Associates: see classified ads, this issue.

Northern Bear Electronics: suppliers of some ETI projects as kits: see the classified ads in this issue.
Ultra Fidelity, Part II
Design Principles

Last month Stan Curtis looked at the theory behind ultra fidelity, this month he discusses some basic design principles.

OUT OF THE RUT

A few years ago power-amplifier design had settled into a satisfying rut. In the UK the Quad 303 and the Cambridge P-Series had achieved very satisfactory performance figures and they were generally considered to be good amplifiers. In the USA the Crown DC300 has achieved an almost theoretically perfect specification and was hailed as "State of the Art".

However, the first crack to appear was caused by new loudspeaker designs. Some had very demanding impedance curves which in some cases presented a two ohm load to the amplifier. Such a low value of load (almost a short circuit to some minds!) operated protection circuits in many amplifiers, limiting the current to protect the output transistors.

The operation of these caused a very unpleasant "clipping" sound in some cases and even stranger "clicks" and "bangs" in others. Thus alerted it became apparent to some designers that conventional protection circuits were turning partly-on quite frequently in the course of a piece of music and so giving a sort of premature clipping action.

Without any doubt the best results are achieved when the output stage is devoid of any protection at all. The output stage should be designed to deliver all the current a load demands without limiting. Consider the reproduction of a bass drum. If the amplifier starts to limit the start of the "thump" the sound pressure will collapse and the bass-drum will appear to have no body and thus sound unrealistic.

The output-stage should ideally be able to sink the full energy of the power-supply until its regulation causes the current to limit progressively. So in a good amplifier design the output-stage and the power-supply must be designed as a single item, and not as separate circuits. Several amplifiers are designed like this. The Lecson AP3 Mk II, the BGW models 500 and 750, and the Mission Power Amplifier. The Lecson AP3/11 can, for instance, deliver nearly 20 amps into a two ohm load before the mains fuse blows and the BGW model 750 even more.

However, with such high current capability it is essential that the amplifiers have speaker muting to prevent switch-on "thumps" (or more accurately, earthquakes) and dc offset protection to protect the loudspeakers from the effects of 20 amps of pure dc.

If the amplifier now has to drive a capacitive load eg. electrostatic speakers, or complex crossover networks; another pole is added at the output.

In the case of the unconditionally stable amplifier the only ill-effect will be some "ringing" in the closed loop step response - but in the case of the marginally stable amplifier it may go completely unstable. The most popular "belt and braces" solution to this problem is to fit a resistor-inductor network at the output to "cancel-out" the effect of the capacitive loading.

It is interesting to note that some marginally stable amplifiers omit those components as most speaker cables have sufficient resistance and inductance. However, some of the new "Super-Cables" (Litz and Lucas, etc) have a very low resistance and almost no inductance but some capacitance - and their use with certain amplifiers has caused instability, with the amplifier (or speakers) eventually blowing-up!

WHICH PARAMETERS MATTER

For many years it has been usual to specify and compare amplifiers through their ability to handle a continuous (steady state) sine-wave signal. Thus such a signal is used to measure power-output, frequency response, harmonic distortion, crosstalk, input overload capability, intermodulation distortion, damping factor, and gain! Unfortunately many engineers and Hi Fi pundits still believe that such information is ALL that is necessary to quantify an amplifier's performance and to compare it with others. Not so!

Steady-state sine-wave testing can tell only part of the story and can often be misleading. Music contains complex wave forms with a spectral content of greater than eight octaves and dynamic ranges of up to 100 dB. Yet such complexity is readily understood by the human brain which, in mastering the subtleties of spoken language, has evolved the ability of extraordinary auditory sensory perception. The music signal, as with all audio signals, can be considered in terms of two variable qualities - the frequency domain, and the time domain.

The frequency domain has monopolised engineers' thought
for so long — even the most complex music signal can be represented by a Fourier analysis.

This mathematical equation lists separately each frequency making up the signal, (together with its phase and amplitude). However, a Fourier analysis is only complete in the case of simple waveforms, with more complex waveforms it becomes only a convenient approximation.

To make a Fourier analysis of a signal the components of that signal have to be analysed over a period of time such that complete cycles of the lowest frequency can occur. Thus we take consideration of the time domain.

Where steady-state signals are concerned the time domain is not normally considered, as the signal is of a continuous unchanging nature between any two periods. If the “time window”, during which the signal is Fourier analysed, is reduced progressively it becomes apparent that an accurate spectral analysis becomes less possible. It can then be seen that the important characteristics of the signal are amplitude and rate of change. In other words its envelope.

WHAT DO WE WANT

What is required is the amplification of an audio waveform in such a way that the ear can detect no degradation.

Let us consider ways in which such degradation can occur. The waveform envelope can be distorted by amplitude changes of any component or by changes in the phase relationship of the component harmonics.

Experimental work has established that changes in the relative amplitudes of the harmonic structure of the waveform are readily detectable.

Other work has shown that the qualitative characteristics of a complex sound depend upon the phase relationships of the component harmonics. It would seem that as a phase difference must be interpreted as a time delay between the component parts of the signal, then a sufficient phase shift in a system must eventually become audible as these component parts are moved in respect to each other in time. In practice large phase shifts are very audible and indeed telephone lines are often phase and delay corrected to render speech intelligible. However, establishing an acceptable degree of phase shift is extremely difficult.

Following the arrival of “linear phase” loudspeakers great controversy has raged over whether phase shifts affect sound quality. A study of the experimental work performed to date shows that

1. It seems to be very difficult to replicate someone else’s experiment.
2. It seems, on balance, that where recurrent waveforms (steady state) such as sine-waves (and instruments producing a “continuous” although decaying tone) are concerned; then quite large phase shifts, between the extremes of the frequency band, have no identifiable effect on sound quality. However, a phase non-linearity on the leading edge of a true transient appears to be audibly more perceptible, particularly on speech and percussive sounds.

BANDWIDTH AND TID

Transient signals cause many problems of which phase linearity is but one. Other problems include; instability and ringing, clipping, slew-rate limiting, and transient intermodulation distortion.

Transient intermodulation distortion (TID or TIM) is much in vogue but is often misunderstood. TID most commonly occurs when an amplifier, with overall negative feedback over several stages, is driven by a large enough signal whose frequency (or equivalent rise time) is above the open loop bandwidth of that amplifier.

Because the feedback loop is fed from the output of the amplifier, there is no effective feedback until signal current flows at the output, i.e. during the open-loop rise time of the amplifier.

Very large signals occurring in the intermediate stages of the amplifier cause those stages to distort or even to clip. With some amplifiers this clipping can cause the stage to latch-up for a time until the operating conditions restabilise. Thus not only is the leading edge of the signal severely distorted — in some cases it is removed completely.

TID is therefore a form of overloading that is dependent upon both amplitude and time. It is audibly (but at a higher signal level) similar to cross-over distortion, as both effects cause phase and amplitude modulation of the signal due to momentary change in gain. (Remember that at the cross-over point zero, there is no current flow in the output stage and hence no feedback current and so the amplifier is momentarily open-loop.)
MAKING BIG BANDS

TID can be avoided by designing an amplifier whose open-loop bandwidth is greater than the highest frequency of the input signal. The maximum bandwidth can then be defined at the input by a passive RC filter. Thus if we decide upon a maximum signal bandwidth of 20 kHz then our filter will limit the signal waveform rise-time to \( T = 0.35 \frac{20 \text{ kHz}}{17.5 \mu s}. \)

\[
T = \frac{0.35}{20 \text{ kHz}} \\
\text{i.e. } 17.5 \mu s.
\]

![Diagram](image)

Third method of avoiding TID. Each stage in the design has a wider bandwidth than the preceding one.

Our amplifier's open-loop bandwidth should be designed to be, say, 23 kHz, giving it an open-loop rise-time of 15 \( \mu s \) and freedom from TID. If however, in the interests of a good specification, and possibly better reproduction, we decide upon a close-loop bandwidth of 100 kHz (i.e. a rise-time of 3.5 \( \mu s \)) then our amplifier will need an open-loop bandwidth of greater than 100 kHz to maintain freedom from TID. In a power amplifier such performance is not easy to obtain. Fast power transistors are notoriously easy to blow-up and are expensive. The common form of lag compensation (used where the open-loop bandwidth is restricted) has to be replaced by lead compensation:

Another technique is an extension of the first in that the preceding stage of the power-amplifier is designed to have a lower open-loop bandwidth than the next.

IMPORTANT OR NOT

Many people now consider that TID is unimportant or even that it doesn't exist. This is partly because it is very difficult to measure and only readily visible (in the laboratory) in the "clipping" state. To reach this stage with most amplifiers (but not TID - free designs) there is a requirement for either fast rise-time or higher signal levels or both, - conditions that are unlikely to occur in practice. However, a large degree of non-linearity and hence bad intermodulation will still occur with more realisable input signals. Although this cannot be measured yet (how do you measure say, 5% IM over a period of 5 milliseconds?) it can be predicted mathematically and, just as important, heard. Amplifiers free of TID have a very "open" quality with accuracy of depth.

An amplifier designed with a wide open-loop bandwidth, for low TID, often has other more tangible benefits. The high frequency THD is usually no higher than at the mid-point; in stark contrast to more traditional designs. This is because gain is still available at high frequencies for negative feedback. Such amplifiers also usually have much higher slew-rate.

SLEW

Slew-rate defines the speed with which the amplifier can deliver output voltage to the load. For example, if an amplifier has a maximum output of 100 volts p/p and a rise-time of 100 \( \mu s \), then the amplifier, if it were perfect, should have an output of about 80 volts after 10 \( \mu s \) in response to a suitable square wave input. In other words the output voltage would have risen at the rate of 8 V/\( \mu s \). However, amplifiers do not generally respond to large changes as fast as their small signal characteristics predict, for circuit and transistor capacitances can be charged only as fast as their driving circuits allow.

In its simplest form the slew-rate of an amplifier defines how fast the output voltage can change for large signal conditions, and it is normally quoted in volts per micro second. The maximum slew-rate of an amplifier is usually limited by the slowest stage in its circuit.

That stage will have an operating current \( T \) (as set in the design) and a capacitance \( C \) (usually a frequency compensation capacitor)

\[
\text{Slew-Rate} = \frac{T}{C}
\]

Thus if a transistor stage has a standing current of 100 \( \mu A \) and is compensated by a 43 pF capacitor then its slew-rate will be

\[
\frac{100}{33} \text{ i.e. } 3 \text{ V/}\mu s
\]

Depending upon the design some circuits have a different slew-rate depending upon whether their output is negative-going or positive-going. Slew limiting also defines the full-power bandwidth; a figure more commonly quoted by manufacturers.

\[
fp = SR (10^6) \quad \text{E op = peak output swing in volts} \\
2 \pi \text{E op} \quad \text{fp = Full power bandwidth in hertz.}
\]

Thus in a 100 watt (into 8 ohms) amplifier having full-power bandwidth of 20 kHz the required minimum slew-
The effects of slew-rate on a signal passing through an amplifier prone to this fault.
Top: a squarewave, note the slight over–shoot. Below that, a sinewave. In both cases the dotted line represents the input.

rate would be about 5 V/µs. This is, however, the absolute minimum figure and experience suggests that such an amplifier would have a hard, gritty high-frequency sound. Such an amplifier should have a slew-rate greater than 20 V/µs to be certain of avoiding the increase in distortion caused by the gradual onset of slew-limiting.

Unfortunately the higher the power output of the amplifier the greater the required slew-rate as more volts swing at the output in the same period of time and so as our 100 W amp needs 20 V/µs an otherwise identical 50 W amp needs 14 V/µs and a 20 W amp needs only 9 V/µs. But these forms of distortion tend to give subtle audible effects compared to the most common amplifier problem — that of clipping.

CLIPPING
Clipping occurs when an amplifier is overloaded by high level signal peaks. Such peaks occur frequently in much music material and so the manner in which the amplifier clips determines its audibility. A soft, clipping effect where the distortion rises gradually (typical of valve amplifier circuits) is audibly preferable to the hard clipping typical of transistor circuits.

Worse still, some amplifiers tend to suffer saturation effects on clipping and take a time to recover; thus artificially extending the length of time the signal is clipped. The use of overall negative feedback to reduce distortion unfortunately makes things worse. Overall feedback effectively linearises the clipping — the distortion changes from 0.01% (say) to 10%, and quite suddenly too.

DESIGN PROCEDURE
We have covered just a few of the requirements a designer must consider when working upon the design of power-amplifiers. There are many more to be considered to even rough out a design specification before the circuit hardware is considered. The following sequence is mandatory:
1. What parameters are important to prevent audible degradation of the signal?
2. Detail a performance specification that meets the requirements of (1).
3. Decide upon the circuit technology necessary; Bipolar; MOSFET; Tube; Class A; Class B; Switching; etc; etc.
4. Undertake a development programme to produce a prototype.

At this point the designer has to accept that it's a real world and that his performance specification cannot be achieved in a way that is acceptable to accountants, salesmen, customers, customer's wives or whoever else is around. Trade-offs are necessary and much of the "art" is in deciding which defects and degradations are more acceptable than others.

As an illustration of the changes in design approach over the years we will briefly illustrate three designs for which the author has been responsible:
1. Cambridge Audio P60 (P80)
2. Leeson AP3 Mk II
3. Mission Electronics Voltage Amplifier
The P60 power amplifier is of a conventional design but with care being taken to optimise each stage. Q8 and Q10 form a long-tailed pair with Q9 as their emitter current source. Q8 and Q10 must be very closely matched for minimum DCoffset and for maximum common-mode rejection to avoid H.T. ripple appearing at the output.

The next stage is the Q13 voltage amplifier which is loaded by a current source (Q12) instead of the more common "bootstrapped" resistors. Note that Q13 is buffered from the long-tail pair by an emitter follower (Q11) to prevent any loading of that stage worsening the distortion characteristics.

Capacitor C33 gives lag compensation which defines the dominant pole of the amplifiers. The open-loop bandwidth is quite high (for this type of circuit) at 12 kHz but none the less this amplifier is prone to TID effects. The protection circuit is very unusual in that the output is limited by an FET (Q7). Q19 and Q20 each form conventional V-I summing circuits which monitor the loading on the output stage.

If either Q19 or Q20 turns-on, the gate of the FET Q7 (normally biased-off by R54 to the negative HT) is biased positive and it starts to turn-on. It then acts as a potential divider with R52 and thus attenuates the audio signal. This protection only turns on at the equivalent of 50 W into 2 Ohms load and when it turns on it only adds moderate distortion (0.2% typically) as distinct from clipping.
Ultra Fidelity, Part II

Particular attention has been paid in the design to achieving:
1. Low distortion with a very low order of overall feedback
2. Wide open-loop bandwidth with an excellent slewing rate
3. Minimum time and phase distortion
4. A high transient power capability with virtual freedom from clipping effects.

The output stages have a very high current capability but have no protection circuits, the output transistors being designed to sink the full energy of the power-supply into the load. A patented form of voltage feed to this stage gives the amplifier a short term power delivery capability of about 600 watts (compared to the rated 150 watts 8 ohms). This represents a 6 dB increase in power availability over the rated figure. The voltage amplifying stages are designed to clip softly and this combined with the low-overall feedback gives overload characteristics similar to those of an equivalent tube amplifier.

CONCLUSION
This feature has discussed just some aspects of modern audio amplifier design. At present much attention is still given to whether an amplifier is designed around bipolar transistors, FETs, valves, or switching transistors. However designers are beginning to appreciate that the major stumbling block is not designing a circuit using any of these technologies but in deciding upon what is the performance specification required that will give faithful reproduction of the sound source. Until this problem is solved there will continue to be an element of uncertainty in amplifier design.

HOW IT WORKS—Lecson AP3

Transistors Q1 and Q2 form a long-tailed pair differential amplifier with Q3 as the emitter current source. Local feedback is applied in the form of emitter resistors R5 and R6. The base of Q2, instead of being grounded, is connected to a potential divider RV1 which permits the DC offset at the output to be set to zero. The input signal to Q1 is passed through a low-pass filter (R1, C2) which sets the bandwidth to 22 kHz (i.e. below the open loop bandwidth for no TID effects). The bi-phase outputs of the long-tail pair feed a second differential amplifier Q5 and Q7. Transistor Q5 has a constant current load (Q8) whilst is terminated by a current mirror (Q9 and Q10). Transistor Q10 will always deliver the same current as transistor Q9 hence the term "Current Mirror" and the excellent symmetry and balance this stage achieves. Functionally, however, Q10 can be considered as an active load whilst Q7 is a voltage amplifier from whose collector the drive to the output stage is taken. Note that Q5 and Q7 both have local emitter feedback (R17, R24) and that both are buffered from the long-tail pair (Q4 and Q6 emitter followers).

The whole amplifier is in the inverting mode with overall shunt feedback through R4 and C3. This amplifier is quite fast having an open-loop bandwidth of about 27 kHz. The circuit is stable without the usual compensation capacitors within the loop. THD is low being typically (at 100 W into 8 Ohms) 0.004% at 1 kHz and 0.02% at 10 kHz. The HF distortion can be further improved by selection of transistor Q7 for a device with a low collector-base capacitance.

No conventional protection circuits are used as extremely high power transistors are fitted and these can survive a short-circuit condition in the time taken for the power supply to shut down.
Using UARTs

Don Rost discusses UARTs, how they work, and when they can be used, with particular attention given to the 5303, and PROM programming.

THE UART, ALIAS the Universal Asynchronous Receiver Transmitter, is a parallel to serial, serial to parallel converter that saves the designer a board full of shift registers and numerous control and error detecting gates, and does it fairly economically too. Applications for this, typical, 40 pin LSI chip include converting the parallel output data bits of a computer into serial form to be used in routing the data to another terminal; conversely, it is often necessary to take the serial data say from a TV Typewriter and translate this back into parallel form for the computer to act upon. Perhaps less obvious applications include centrally monitored alarms, traffic control and meteorological data gathering to name a few (Fig. 1).

WHAT'S INSIDE?

Looking (Fig. 2) inside the UART we find two sets of shift registers and a considerable assortment of control logic. The two sets of registers are used for the outgoing (transmitting, pins 21-40) and incoming (receiving, pins 1-20) data. Separate clock input pins are assigned to the receiver and transmitter portions to allow different baud rates to each section (in other words the receiver and transmitter of one UART can be used independently of each other). Figure 3 shows how this independent clocking can be used between two terminals and between a faster terminal to computer line.

To function properly the receiver and transmitter at respective ends must be referenced to the same clock rate which is 16 times the line transmission rate; this allows the UART to recheck for valid start signals and to sample data at the center of each interval. Communicating with Teletype the transmission rate is often 110 baud (bits/second) and therefore the clock rate equals 1760 Hz, usually clock accuracy of 1% or better is desirable. There are some exceptions to the common clock frequency, such as when a UART is used in a cassette interface circuit (discussed later).

At the start of the transmitting or receiving the internal circuitry must be cleared of any leftover logic states. Reset pin 21 accomplishes this with a logic 1 pulse applied — this might be an automatic circuit that provides this when power is applied as in Figure 4 or it could just be a manual pushbutton switch tied to the +5 volt line. Various control pins allow variations in the way character format is sent or received. These include transmitter stop bit control, no-parity control, parity select, character length and mode control strobe, pins 36, 35, 39, 37 & 38, and 34 respectively. Parity refers to an error testing technique whereby an extra parity bit is added to the data. Even parity means the sum of all 1’s in the number and its corresponding parity bit will be even, odd parity indicates the sum of all 1’s and parity bit will be odd. Hence, if even parity is being used and data received indicates the l’s are odd, an error has occurred somewhere and the data is unreliable.

Therefore, we have three options concerning parity with the UART, 1) we can select no-parity via a logic 1 on pin

![Fig. 1. Meteorological Data Gathering.](image1)

![Fig. 2. Basic pin-out and internal structure of the UART.](image2)

![Fig. 3. Independent clocking allows different receive and transmit baud rates.](image3)
35 which eliminates the parity bit from transmitted data, removes receiver parity check and causes pin 13 to go to logic 0, 2) we can select even parity by applying logic 1 to pin 39, or 3) odd parity with a logic 0 at pin 39. It might be emphasized that the parity selected controls both halves of the UART being used.

A logic 0 or 1 applied to pin 36 causes, respectively, one or two stop bits to be transmitted — mention of the stop bits will again be made in the discussion on data transmission.

Character length is determined by the logic applied to pins 37 & 38, see Table 1 — 5,6,7, or 8 bits per character are possible.

Logic 1 to pin 34, mode control strobe, enables the previous control bits — often this pin is hard-wired to +5 v.

### TABLE 1

<table>
<thead>
<tr>
<th>Pin 37</th>
<th>Pin 38</th>
<th>Character Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pin 35</th>
<th>Pin 39</th>
<th>Parity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>X</td>
<td>None</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>Odd</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>Even</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pin 36</th>
<th>Stop Bits</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

**TRANSMITTING DATA**

Once all control pins have been selected transmission Fig. 5 of parallel data to serial form begins with pins 26 through 33, assuming all 8 bits are used. If less than 8 bits are used the data is right justified, that is, starting with the least significant bit at pin 26. Data is entered into the holding register after a short settling delay by a negative going pulse (logic 0) on pin 23, the input data strobe. When this pulse returns to its logic 1 state, data is transferred to the transmitter output register, unless the transmitter section is presently transmitting data in which case the new data entry is delayed until the transmission has been performed. As the data is loaded into the output register a start bit appears at output pin 25 after the next negative going clock cycle. This is followed by the data bits (at a rate of one bit for every 16 clock pulses) with the MSB sent first and the parity bit and 1 or 2 stop bits (whichever has been selected). Therefore, the maximum number of bits transmitted would be 12 (1 start, 8 data, 1 parity and 2 stop) and the minimum 7 (1 start, 5 data, 1 stop).

The UART is double buffered which allows the loading of a new character as soon as the one in the output register begins transmitting. Trouble could arise if the input holding register was full (waiting for the output register to clear) and new data was coming in, a kind of traffic jam. To prevent this the input empty flag, pin 22, provides a signal for indicating the state of the input register. If it is full a 0 appears at pin 22, 1 indicates the UART is ready to accept the data. Pin 24 goes high when the complete character including stop bits has been transmitted from the output register. Thus, via pin 22, we can put a stop on the incoming data from the keyboard, computer, etc. by holding data until the input registers are clear.
The transmitter can be used in either of 2 modes, unconditional or handshaking. The basic method of sending data is simply to send it as it arrives, thus no conditions are required before the UART accepts the data. Problems arise when the characters are not spaced far enough apart from each other, a log jamming effect resulting in erroneous data transmission. Where this is a problem or might be suspected as a problem the handshaking mode is preferred. In this mode the UART chooses to receive a new character at its parallel input via the outputs of pins 22 &/or 24, the "handshaking" being done between the UART and the device sending the data to the UART. With this set-up, characters are only sent to the UART when the UART agrees that all is well.

When no data is being transmitted the output sits at logic 1. Start of transmission is defined as the transition from a high to low at pin 25.

RECEIVING DATA

To agree with the transmitting end the input of the receiver (Fig. 6) must be high with no data present. Internal circuitry monitors the input for a change from high to low which signifies data being received. When this happens a counter is initiated clocked at 16 times the baud rate. To verify that this is a valid start bit the UART looks for logic 0 at pin 20 again when the counter reaches 8 (the middle of the start bit) (Note: This is not universal with all UARTs, for instance the RCA 1854 uses 6½ clock periods for verification.). Once it is established that a valid start bit has been received, the UART counts in steps of 16 clock pulses identifying each data bit in the center of its pulse or no pulse.

Data is loaded into the serial to parallel input register via shift pulses every 16 clock pulses. Since the LSB was the first bit to be transmitted it is the first data bit to be received. Following the data bits are parity and stop bits that are loaded into the input register to be used by the control circuits to detect errors in transmission and the end of transmission, respectively. If an error in parity is detected pin 13 goes high. To verify the end of transmission the bit following the parity is tested for logic 1 and if the stop bit is not present the framing error flag, pin 14, goes high. The output of the two flags (parity and framing error) are updated each time a character is transferred to the input register. Character length has already
been programmed by the user — corresponding with its respective transmitting character length.

Once the serial data has been fully loaded into the input register it is parallel loaded into the output holding register. Pin 19 then goes high indicating an entire character has been transferred to the holding register and the data is now available to output. Once this go ahead signal is given the processor can read the data from the tri-state outputs by applying logic 0 to pin 4; a logic 1 inhibits the data from being read.

Pin 16 is a status flag disconnect at logic 1 and will disconnect the three state output drivers for pins 13, 14, 15, 19 & 22 allowing these outputs to be bus connected. Normally, pin 16 is held low usually wired directly to ground. Typically, you would use the floating alternative where several UARTs are connected by a common bus. Each

**VARIATIONS**

There are many pin compatible UARTs. It should be noted, however, that most UARTs are very similar to each other and often can be interchanged with little difficulty on the part of the user. Some of the new versions use only a 5 volt supply rather rather 5v & -12v, for instance the General Instruments 1013 uses the dual voltage while the 1014 works off a single 5 volt line. A few devices have internal baud rate generators requiring only an external crystal to be connected to two pins of the UART.

Some UARTs are dedicated versions designed to work with certain microprocessors and so are generally only used in such systems. The Intel 8251 and the Motorola 6850 working with the 8080 and 6800, respectively, are examples of this. The RCA 1854 UART is designed to work in either of two ways (user selected), that is 1) as a standard type UART and 2) as a dedicated version interfacing directly with the 1802 uP without additional components.

Another variation really deserves a special title: Some Like it Soft. With software problems being the biggest headache in any computer system one might question the sanity of replacing a readily available IC like the UART with a software program. The reasoning behind this goes something like this: a UART can be looked at as a very dedicated, almost retarded, microprocessor so why not use a program to replace it? Indeed, if our uP is fast enough (not always true) we can replace practically every piece of digital hardware with a program. Also, greater flexibility can be arranged by the use of programming rather than modifying existing hardware designs. This reasoning furnished part of the impetus to design a uP in the first place. Originally, the uP wasn't designed for all you computer hobbyists out there nor was it designed for number crunching companies like IBM, in fact the current trend toward making uP's into miniature data processing computers does some injustice to the original concept which was to provide the designer (not the programmer) with a programmable digital device that could replace many IC's in dedicated hard-wired complex logic systems. At any rate the UART is one IC and while there are certain times to take advantage of this technique the software addict should remember that he is substituting some form of memory as well as CPU time in place of it.

**DESIGNING WITH UARTS**

Now that we have a fair understanding of how the UART works we can look at a few designs using them. Three examples are given which should provide enough variation in design to make you feel comfortable using them.

**EPROM PROGRAMMER**

This project (Fig. 9) appeared in the December 76 issue of ETI and compared to most commercial units it represents a real bargain for the computer hobbyist. As well, it could pay for itself if you wanted to start a programming service for 2708's.

The UART used here is a National Semiconductor MM5303 and is typical of most general purpose UARTs. Only the receiver half of the UART is used since the only thing we are concerned with is receiving the transmitted program from the computer, although conceivably with a little redesigning you could, once the EPROM is programmed, verify the EPROM's programming by sending it back to the computer via the transmitter portion of the UART and print the results.

The clock frequency of 16 times the baud rate is applied to pin 17 — in this case the baud rate is 300 so the clock runs at 4800 Hz. Initially, the registers and associated circuitry must be cleared by a logic 1 pulse — this is accomplished in the ETI EPROM Programmer by pressing the RESET button which momentarily sets pin 21 at +5 v. Stop bit control, parity and character length are user defined by tying each of pins 35-39 to either +5 or ground (0 v). For instance, if a full 8 bit character is used (the 2708 is 1K x 8 so this would probably be the case) pins 36 & 37 would both be wired to 5v. Since the controls remain the same throughout the programming, the mode control pin 34 is hard-wired to logic 1. Pin 16 is connected to ground enabling the status bits — in this case only the data available, pin 19, is used. Likewise, pin 4 is grounded allowing the
Using UARTs

data output lines 5-12 to be read by the EPROM. Pin 19, the data available, provides a signaling pulse that is used to control four important sections of the timing sequence. These are 1) reset, 2) the 26 volt programming pulse required by the 2708, 3) clock pulse for the address counter, and 4) the data available reset pulse going to pin 18 of the UART. Further circuit description of the EPROM Programmer is found in the Dec. '78 issue.

CASSETTE INTERFACE SYSTEM

This would be a computer hobbyist type arrangement usually run at 300 baud. Since digital signals don't record well (or to be exact not at all) on home audio cassette recorders and since variations in tape speed can cause numerous transcription errors, a method of representing a logic 1 as 8 cycles of 2400 Hz and a logic 0 as 4 cycles of 1200 Hz was devised. By utilizing the services of a UART (Fig. 10) can overcome much of the problems associated with speed variations, thus making the usage of programmed cassette tapes more reliable, both for the hobbyist's own use and for duplicating or sharing other hobbyists' taped programs via ordinary cassette tape.

The steps involved in recording a program onto tape are 1) serial data from the computer is fed to the serial input of the receiver half of the UART, 2) the data is transformed into parallel data and then back to serial assuring an accurate 300 baud rate, 3) the serial data is fed to a gate that is synchronized with the clock to produce 2400 tones for a 1 and 1200 Hz for a 0, 4) the output filter allows the signals to be recorded on an audio tape recorder.

Notice that the receiver and transmitter portions of the UART are wired in the handshaking mode, i.e., pin 22 signals the receiver when the buffer register is empty, then when data is available pin 19 goes high signaling the transmitter load command pin 23. To read a taped program the interface circuitry works by 1) removing low frequency noise from the tape and squaring the signals, 2) transforming the waveforms into digital 1's and 0's, 3) using the data to clock the UART, 4) feeding the serial data into the receiver portion of the UART, 5) making parallel to serial conversion through the transmitter and 6) sending the serial output to the terminal or computer.

In the case of reading a program the clock for the receiver section of the UART is derived from the tape itself. Tape speed can vary from different and aging cassette recorders but the parallel data will output only after a complete character word is ready. This tends to stabilize the data rate since the only variation will then be between complete characters. Then the transmitter is clocked at a clean and reliable 300 baud from the main clock and will thus transmit the original tape program at a uniform 300 baud to the terminal. This system, therefore,
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Using UARTs

corrects for speed errors that may occur from taped programs.

METEOROLOGICAL DATA GATHERING

Let's suppose you are doing a research project that involves among other things, knowing weather conditions on a continuous basis. Your research building is on the other side of the city from the main computer which you need access to for processing your data. You will want to measure wind speed and direction, temperature, barometric pressure and relative humidity all at the same time or at least reasonably close to the same time. What's to be done?

First, you will want to use the phone lines (Fig. 11) to communicate with the computer and you will want all of this to be done automatically — you have better things to do than sit at a terminal all day punching in numbers. So you require digital outputs for all of the instruments, if they are not digital devices, then an A/D conversion will be necessary — ETI has already saved you some work by providing circuits for a Digital Anemometer (Dec. '78) and a Digital Thermometer (Nov. '77).

Next we will tie all of these instruments to a common bus using tri-state outputs and direct them to a UART which will transmit the data serially. The UART will then be connected to a modem (modulator-demodulator) which in turn will be connected to an acoustic coupler, Data Access Arrangement (DAA), to the phone lines.

The control logic is shown in a handshaking mode with the UART but the unconditional mode could be implemented, say, using the UART's clock as a reference. The instruments will be read sequentially via the selector lines and although this is not an exact instantaneous reading of all five it is very close to be considered such.

READ ON

Hopefully, some of the mystery has vanished by now and the reader feels at home when he sees a UART used in a design. For more information on a particular device consult the manufacturers' specifications sheets, usually obtainable for the asking.

SOME REFERENCES:
1. "EPROM Programmer," ETI, December '78, pp. 29-34.
7. RCA, CDP 1854 Data Sheet.
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See Page 62

**DECEMBER**

WHAT'S ETI'S handsome attractive, young, unattached (phone 416-423-3262) Assistant Editor doing with a Radar Gun? Stopping fast women perhaps? Not likely, he's doing some dead serious research for ETI's Special Report on Speed Measuring Radar. If you've ever driven in a car, you'll want to know how these fascinating devices work, how they're used, and about the Canadian company which is a world leader in these instruments. Did you know you can even rent a speed meter for your own purposes?

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JOIN A SHORTWAVE CLUB

IN ORDER TO ENJOY the hobby of shortwave listening to the fullest, I would strongly recommend that you join one of the many DX or SWL clubs. Generally these clubs provide their members with a monthly news bulletin with many pages of valuable information to help the listener find those shortwave stations that are broadcasting to the world. In this month's column I will give you some of the details of a number of clubs around the world. The membership fee is usually just enough to cover the cost of postage and printing costs for the bulletins. The officers and editors of these clubs contribute their time and effort on a voluntary basis and do not get paid thus keeping membership fees as low as possible.

The Association of North American Radio Clubs (ANARC)

The Association of North American Radio Clubs was founded in February of 1974 as a uniting organization for DX clubs in North America. ANARC's objectives are the following: a) to promote closer ties between radio clubs; b) to promote interchange of ideas and information between radio clubs; c) to work for the common good of the hobby; d) to provide a forum to work out differences and problems involving radio in North America.

Membership in ANARC is open to any radio club with at least 50 members and which has been in existence for at least 12 months. Associate membership is available to those radio clubs with less than 50 members and which have been in existence for more than six months. At present there are 15 member clubs and five associate member clubs in ANARC, located throughout the United States and Canada. In addition the European DX Council (a federation of European DX clubs), the Southern Cross DX Club in Australia, the Indian DX Club International, and the Japan Broadcasting Listeners' Federation, have affiliate status with ANARC.

ANARC holds an annual summer-time convention at a different site in North America each year. DXers and SWLs from all over North America and other parts of the world attend the annual ANARC convention, which is usually three days long and filled with talks, films quizzes, discussions, demonstrations, exhibits and presentations of various types related to the DX hobby. The 1979 convention was held in Minneapolis, Minnesota and featured representatives from nine international broadcasters — Radio Israel, Swiss Radio International, The Voice of Turkey, The Voice of Belgian Radio and Television Service, the Voice of America, and Radio Canada International. Approximately 200 listeners attended and during the annual Auction for the Handicapped Aid Program (a program to help the handicapped enjoy the radio listening hobby) over $2000 was raised.

There are several ANARC committees which serve the radio hobbyists. The Public Relations Committee works to promote ANARC and its member clubs to potential members and to the general public. Most of the information about ANARC in this column was prepared by the chairman of this committee, Jeff White. The Frequency Recommendation Committee helps overseas shortwave stations pick the best frequencies for their broadcasts to North America. There is also a DX Equipment Committee, a QSL committee and a Broadcasters Liaison Committee.

Although only clubs may become members of ANARC, individuals may subscribe to the monthly newsletter called "ANARC Newsletter." This is a six
page paper covering news of ANARC Clubs, DX meetings, committee news, ANARC business and general DX news. The subscription rate in North America is $4.00 ($8.00 overseas). Sample copies of the newsletter are available for 30c. ANARC, 557 North Madison Avenue, Pasadena, CA, 91101, USA.

The following are full member ANARC Clubs:

Canadian S-W-L International (C-SWL-I)

C-SWL-I was founded in May, 1977 and now has members in all twelve Canadian provinces and territories as well as in seventeen other countries around the world. The total membership is close to 200. The monthly bulletin, CANDX, contains 40 or more pages of information useful to the shortwave listener such as loggings by members; QSL cards received; utility report; broadcast schedules; technical articles; and a members mailbag. Annual dues are $12.00 worldwide. Sample copies of CANDX are available for $1.00. Canadian S-W-L International, P.O. Box 142, Thunder Bay, Ontario, P7C 4V5, Canada.

Canadian International DX Club (CIDX)

CIDX was founded in 1962. Their monthly bulletin “CIDX Messenger” covers all radio waves, including SW, from CIDX headquarters. Annual dues are $11.00 in North America or $13.00 for overseas members. Canadian International DX Club, 169 Grandview Avenue, Winnipeg, Manitoba R2G 0L4, Canada.

Club Ondes Courtes Du Quebec (COCQ)

This is a French speaking club, founded in 1974. Their offset monthly bulletin “L’Onoe” covers SW, MW, Hams and Utilities. The bulletin is printed in French. Annual dues are $13.50 in North America and $17.00 for overseas members. Club Ondes Courtes Du Quebec, 3420 Chemin Ste-Foy, App. 5, Sainte-Foy, Quebec, G1X 1S6, Canada.

Ontario DX Association (ODXA)

ODXA was founded in 1974 for DXers in the province of Ontario. While membership is limited to Ontarians others may subscribe to their monthly news bulletin “DX Ontario” which contains 40 or more pages covering shortwave and medium wave. Columns are devoted to member’s loggings, QSLs received, articles by members and much more. The annual membership fee or subscription for non-Ontario Residents is $12.00. Ontario DX Association, 3 Camrose Crescent, Scarborough, Ontario, M1L 285, Canada.

North American Shortwave Association (NASWA)

The largest club in North America with about 1700 members, NASWA was founded in 1961. The monthly bulletin “Frendx” covers news of shortwave broadcasters only. Station schedules, loggings and QSLs as well as many other items are covered. Annual dues are $13.00 in North America, $20.00 (airmail) to Latin America and Europe, $22.00 to Africa, Asia and the Pacific, or $19.00 to surface mail. Sample copies of Frendx are available for $1.00. A mid-month “Update” flashsheet is also available for $3.00 a year ($5.00 overseas). North American Shortwave Association, P.O. Box 13, Liberty, IN, 47353, USA.

SPEEDX (Society to Preserve the Engrossing Enjoyment of DXing)

Another large club with over a thousand members, SPEEDX was founded in 1971. The monthly bulletin contains 64 pages and is called “SPEEDX”. SW and Utility bands are covered. Columns include loggings by countries, QSLs, schedules, technical and others. Annual dues are $12.00 in North America, $18.00 in the Caribbean & Central America, $20.50 in Europe and South America, $23.50 in Asia, Africa and the Pacific. Sample copies are available for $1.00. A mid-monthly publication is available for $3.00 annually ($5.00 overseas). This flashsheet is called the “SPEEDX-gram”. SPEEDX, P.O. Box E, Elsinore, CA 92330, USA.

Newark News Radio Club (NNRC)

The Newark News Radio Club is the oldest club in North America having been founded in 1927. The newspaper by that name started the club but it is no longer connected with the club. The "NNRC Bulletin", published monthly, covers all waves—SW, MW, Longwave, Utility, FM, TV, Hem, and CB. Annual dues are $15.00 in North America. For Overseas rates write to NNRC Headquarters. Sample copies of the bulletin are $1.00. Newark News Radio Club, P.O. Box 539, Newark, NJ 07101, USA.

American Shortwave Listeners Club (ASWLC)

ASWLC was founded in 1959. Their bulletin "SWL" is published monthly and covers Shortwave, Utilities, QSL news and Time Index. Annual dues are $13.00. Overseas rates are $13.00 by surface mail or $15.00 airmail to Central America and the Caribbean, $18.00 airmail to Europe and South America and $20.00 for the rest of the world. Sample copies are $1.00. American Shortwave Listeners Club, 16182 Ballad Lane, Huntington Beach, CA, 92649, USA.

Brooklyn DX Club (BDXC)

The BDXC was founded in 1975. "ALB", their monthly bulletin covers SW, QSLs, Utilities. Propagation, technical and non-technical articles, transmissions in English and other topics. Sample copies are available for 50¢ or 3 IRCs (International Reply Coupons). Annual membership fee is $6.00 in North America, Overseas rates are $6.00 for surface mail or $8.00 for airmail. Other non-periodical publications are also available. Write BDXC for details. Brooklyn DX Club, 1137 E. 12th Street, Brooklyn, NY 11230, USA.

International Radio Club of America (IRCA)

IRCA is a medium wave only club, founded in 1964. "DX Monitor" is published by the club 34 times per year. Sample copies are 50¢. Annual dues are $16.50 in North America. Write the club for overseas rates. A trial membership is also available for $6.00. This includes 10 issues of "DX Monitor" and a copy of "Principles of Broadcast Band DXing". IRCA also publishes the "Foreign Log Of Medium Wave Stations" on a yearly basis. International Radio Club of America, P.O. Box 26254, San Francisco, CA 94126 USA.

Longwave Club of America

Another specialised club, the Longwave Club of America was founded in 1974. "The Lowdown" is published monthly and covers frequencies below 550 kilohertz and the 1750 meter band. A sample copy is available for a self addressed stamped envelope or 2 IRCs. Annual membership dues are $6.00 in North America or $12.00 for airmail overseas. Back issues of "The Lowdown" are also available in yearly volumes. Longwave Club of America, Box 33188, Granada Hills, CA 91344, USA.
National Radio Club (NRC)

Another club that has been around for a long time, the National Radio Club was founded in 1933. This is also a medium wave only club. Their bulletin “DX News” is issued 30 times each year. Sample copies of “DX News” are 50¢ or 3 IRCs overseas. The yearly membership fee is $15.00 in North America. $18.00 for Mexico and the Caribbean, $22.00 overseas (airmail) or $18.00 for surface mail. National Radio Club, P.O. Box 118, Poquonock, CT 06064, USA.

Miami Valley DX Club (MVDXC)

Founded in 1973, the Miami Valley DX Club covers all bands with an emphasis on shortwave. Their monthly publication, “DX World” is sent to the members. Annual dues are $4.00 in North America. Write the club for overseas rates. Sample copies of “DX World” are available for 50¢ (6 IRCs overseas). Miami Valley DX Club, 4666 Larkhall Lane, Columbus, OH 43229, USA.

Worldwide TV-FM DX Association (WTFDA)

WTFDA was founded in 1967 and, as the name implies, they specialize in TV, FM and VHF/ UHF radio. Their “VHF/UHF Digest” is published monthly. Annual dues are $11.00 in North America, $18.00 overseas. Samples of the Digest are available for $1.00 (6 IRCs overseas). WFTDA also have several publications available including “Beyond Shortwave” and “FM Atlas and Station Directory”. Worldwide TV-FM DX Association, P.O. Box 202, Whiting, IN 46394, USA.

Radio Communications Monitoring Association (RCMA)

RCMA was founded in 1975 and covers the VHF/UHF public service bands (police, fire, marine, weather). The “RCMA Newsletter” is published monthly. Sample copies are 30¢ (3 IRCs overseas). Membership dues are $3.00.

The following five clubs are associate members of ANARC:

- Club DX Quebecois (CDXQ)
- This is another French language club, founded in 1977. “L’Echo des Ondes” is their monthly bulletin and it covers shortwave, medium wave and utility bands. Sample copies are 50¢. Membership dues are $8.50 in North America and $10.00 overseas. Club DX Quebecois, 1445 Rue Racine, Ancienne-Lorette, Quebec, G2E 5P4, Canada.

University of Manitoba DX Club (UMDXC)

UMDXC have no regular bulletins but meetings are held on a regular basis in the Winnipeg area. Write them for details if you live in or around Winnipeg or if you plan on visiting there. They have been in existence since 1972. Membership is limited to residents of the province of Manitoba. University of Manitoba DX Club, Room 517, Box 131, University Centre, Winnipeg, Manitoba, R3T 2N2, Canada.

Minnesota DX Club (MDXC)

Founded in 1973 this club is basically for residents of Minneapolis, St. Paul. They were the sponsors of this year’s ANARC Convention. No regular bulletins are issued but meetings are held in the Minneapolis area. Minnesota DX Club, 5212 Drew Avenue, Minneapolis, MN 55410 USA.

Association of Illinois DXers (AIDX)

AIDX was founded in 1976 as a regional club but now have members from other parts of North America. The monthly “AIDX Journal” covers shortwave and medium wave. Sample copies may be obtained for a self addressed stamped envelope or 2 IRCs. Annual dues are $5.00 in North America or $9.00 overseas. Association of Illinois DXers, P.O. Box 94672, Schaumburg, IL 60194, USA.

Washington Area DX Association (WADX C)

Founded in 1978 this club is open to anyone in North America. Their quarterly publication, “WADX C Newsletter covers shortwave, medium wave and utility bands. Meetings are held several times a year in the Washington, DC area. Annual dues are $2.00. Washington Area DX Association, 606 Forest Glen Road, Silver Spring, MD 20901, USA.

OVERSEAS CLUBS

Many listeners like to belong to an overseas club to obtain first hand information on stations in their favourite countries. Of course some of the stations heard on the other side of the world quite easily might be more difficult here.

European DX Council (EDXC)

This is a confederation of European clubs similar to ANARC. For information about EDXC memberclubs and EDXC publications write to them. They were established in 1965. European DX Council, P.O. Box 4, St. Ives, Huntingdon, Cambs. PE17 4FE, England.

Indian DX Club International (IDICI)

This club was organized in 1975. Their monthly “DX Digest” covers shortwave and medium wave. For dues and a sample copy of DX Digest write to: Indian DX Club, 26/1B Northern Avenue, Calcutta 700 030, India.

Southern Cross DX Club (SDC)

This club was founded in 1973 and covers shortwave and medium wave bands. “DX Post” is published monthly except December. Dues are $5.00 a year in Australia. Write for overseas rates. Southern Cross DX Club, GPO Box 336, Adelaide, South Australia 5001, Australia.

Japan Broadcasting Listeners’ Federation

Shortwave, medium wave, FM/TV (UHF-VHF) bands are covered in their publications — HZ (monthly) and BCL (annually). Both are in Japanese. The organization was founded in 1975. For a sample copy and membership rates write to: Japan Broadcasting Listeners’ Federation, 5F UNI Roppongi Bldg, 7-chome 15-17, Roppongi, Minato-ku, Tokyo 106, Japan.

Danish Shortwave Clubs International (DWSCI)

DWSCI publish a very attractive monthly bulletin in English called “Short Wave News”. They cover SW, MW, Utility and clandestine stations. They also publish a very comprehensive Tropical Bands Survey each year. Membership rate is $14.00 US for surface mail. For airmail to North America the cost is $19.75. Danish Shortwave Clubs International, Greve Strandvej 144, DK-2670 Greve Strand, Denmark.

For information about the following clubs write to the addresses given:

Australian Radio DX Club, P.O. Box 67, Highett, Victoria, 3190, Australia.

TELEX, B.P. 68, B-1170, Brussels, Belgium.

Benelux DX Club, P.O. Box 1306, Nijmegen 6800, The Netherlands.

La Salle DX Club, Apartado Aerol 8528, Bodota, Colombia. (Spanish)
Shortwave World

Finnish DX Association, P.O.B. 454, SF-00101, Helsinki 10, Finland.


New Zealand Radio DX League, P.O. Box 1313, Invercargill, New Zealand.

South African DX Club, P.O. Box 145, Milverton, 7405, Cape Province, South Africa.

Union of Asian DXers, 32/4a Malwatte Rd., Dehiwala, Sri Lanka.

Swedish DX Federation, P.O. Box 3108, S-103 62 Stockholm, Sweden.

Swiss SW Club, P.O. Box 309, CH-8051 Zurich, Switzerland.

World DX Club, Flat 2, 71 King Charles Road, Surbiton, Surrey, England, KT5 8PG.

I belong to several of these clubs and have seen many of the others' bulletins. They all have much valuable information for the shortwave (or other bands) listener. So join one or more of these clubs and enjoy the great hobby of shortwave listening even more.

Until next month, 73 and good listening.

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Mobile Discotheque Handbook
- The vast majority of people who set up "Mobile Discos" know very little about their equipment or even what to buy. Many people have wasted a small fortune on a not very matchy apparatus.
- The aim of this book is to give you enough information about the equipment to have a better understanding of the devices and approaches adopted to ensure the reader receives the knowledge and skills for the fundamental popupularly characterisation when all aspects are for the price or less and so go unappreciated. But that is not to say that this is no mean piece of the full story.
- The book starts with the basics: Amplifiers, Power Amplifiers, Audio, Antenna Equipment, Cables and Plugs, Loudspeakers, Lighting Equipment and the information has been carefully sub-divided for quick and easy reference.
- Price $4.60 including 30c postage and handling

28 Tested Transistor Projects
- Mr. Richard Torrins is a highly experienced author who regularly contributes to so many applications in all types of circuit.
- The principle of this book is to introduce the LM3900 to the Technician, Preamplifiers, Mixers and Tone Controls, Relays, silicon controlled rectifiers (SCR's) and bidirectional transistors (B'dos). It has made a wide range of applications and is now one of the most inexpensive and easily available devices available to the home constructor.
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- Shows equivalents and equivalents to many popular transistors made in Great Britain, U.S.A., Europe, Japan and Hong Kong etc.
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- CMOS IC's are probably the most versatile range of digital devices to be used by the amateur electronic enthusiast. They are suitable for an extraordinary range of applications and are also some of the most inexpensive and easily available types of IC.
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ETI CANADA—NOVEMBER 1979
Teacherm's Topics

On students, teachers and electric vehicles.

Electric vehicle "ThunderVolt 3" now provides family transportation for teacher Renton Patterson (foreground). From left to right are students who designed and modified the car: Tim McNamara, Carey Bucholtz, Daryle Budarick, Mike Irwin, Al Moreau, Brian Boudens, and Lorne Macdonald. Photos by Montaignes.

WHY AN ELECTRIC CAR?

There are many reasons:

Most high school electrical courses concentrate on a theoretical and experimental approach to the study of electrical principles and devices. When an experiment or exercise has been completed, equipment is disassembled and put back in cabinets. A more motivating and meaningful approach to the study of electrical principles is to have the students work on something which stays together and is used after it is completed. This is the same approach that is used so successfully in the Architectural Drafting and Carpentry shops where furniture, toolhouses, cottages, etc. are designed and built; or in the Mechanical Drafting and Machine shops where wood lathes, model engines, or other tools and machinery are designed and constructed as student projects. Therefore, an electric vehicle design and construction project for the Electrical shop fulfills this same project approach very well.

The success of ThunderVolt #1 and ThunderVolt #2 confirmed to the instructor that the learning experience provided by the design and construction of these projects was far superior to any other approach previously used. The students mature so much in their understanding of the real technological world that they are "light years" ahead of their peers who graduate from high school having spent all of their time at a classroom desk. ThunderVolt students, along with all other Technical Course students, have actually done something and have experienced a very real contact with the world of work before they graduate.

The concept of the electric vehicle has been described recently as "an idea whose time has come". In view of our dwindling oil supplies there are many experimental electric vehicles traveling the roads of various countries. ThunderVolt students are therefore working on the fringes of a new and increasingly important technology. The motto for our Technical Department "Educating Today's Students For Tomorrow's Jobs" is well exemplified in the ThunderVolt program.

THUNDERVOLT 1

In September of 1973, the combination of a world concern for oil supplies and an idea suggested by a superior group of students, finally got an electric car project into action. The aim of this project was to design and construct a small practical electric car suitable for providing transportation to and from work, or for shopping, or other short hops around town.

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The students first investigated the overall problems: a suitable weight for such a vehicle, the availability of parts at a reasonable cost, the probable maximum range and performance characteristics, etc., and then got busy studying many of the normal things covered in an Electrical Technology course, but which, in the end, would have a definite application. The main areas of investigation were: direct-current motors, motor control, and battery characteristics; then there were the many other related topics such as generators, relays, instruments, wire sizes, etc. This theoretical study took the first of the two years required. The second year concentrated on construction. As well as this design and construction, the students experienced operating as part of a team, scheduling work, and solving problems. The students were motivated to such an extent that during the final stages of assembly they were in working before nine, during their lunch hour, and after school.

The car is an MG of the 1950′s purchased from a student for $15. Two was $115. The batteries were borrowed from the Auto Mechanics shop and are standard, but good quality, automotive-type batteries. Not including the batteries, the car’s total cost to the school budget was $115.

The motors develop a total of 7 1/2 hp and are connected by a chain directly to the transmission (no clutch). The car was $115. The other batteries in the front operate the motors. Current is supplied by four 12-volt batteries placed in the stern. The motor. Current is supplied by four 12-volt batteries placed in the stern. The motor is mounted in the bow and drives, via V-belts, two shafts through the boat bottom connected to two 8-inch propellers. Twin propellers were chosen for two reasons; so that the main central structural member of the boat would not have to be disturbed, and to facilitate a belt drive which allows for different speed reductions by interchanging pulleys.

ThunderVolt 2 cost about $500 and in 1979 had its fourth summer of operation. It is a very stable boat, starts instantly, is extremely quiet - the only noise is from the bow waves and wake - costs only pennies to run, and is one hundred percent pollution free. It won’t pull any water skiers, but for transportation, fishing, or just cruising, electric power makes just as much sense on water as it does on land.

Renton Patterson has been in the habit of buying a new car every ten years. In the spring of 1976, the ten-year period for his 1966 Rambler was up, - he needed a new car! Vowing years ago that his next car would be an electric, he investigated the purchase of one, and found at that time no Canadian supplier of personal electric passenger cars. The US was found to have two such manufacturers. The Canadian government, however, while allowing duty-free import of gas-hogging Cadillacs and Lincolns, penalized very severely, the purchase of foreign alternate-energy vehicles. This fact, coupled with three others, led to the initiation of the ThunderVolt 3 projects.

The other factors were - 1) The unqualified success of ThunderVolts 1 and 2. 2) The fact that during the research for ThunderVolt 2, it was found from the available literature, that the components necessary for building a modern, practical, high performance electric vehicle are available today. 3) The students moving up to the Senior Electrical Technology course were an unusually capable group. This group also had the advantage of retaining Lorne MacDonald, who led the ThunderVolt 2 team, as the foreman. Lorne was then in Grade 13.

The intricate metal work required was done by some Machine-Shop students under instruction Hank McCann. His boys machined an aluminum adapter plate to go between the electric motor and the transmission bell housing, made a motor coupling, and modified the flywheel.

Since the requirement of ThunderVolt 3 was to fulfill the normal around-town driving needs of the Patterson family of five, as well as a highway range of 40 miles so that the car could get past Renfrew to Hurds Lake where ThunderVolt 2 sits docked, the car to be converted had to be one with the appropriate passenger and battery room. The station-wagon model of the new Aspen-Volare series of Chrysler products fit these requirements best. As soon as final information on the electric motor was received, the required gear ratios were determined and the car was ordered accordingly. As well as allowing us to get exactly what we wanted, a new, rather than a used car was chosen so that the body could be properly treated for rust and hopefully approach the expected life of the electrical drive train; 400,000 miles. Also, the work and expense involved in the conversion did not warrant using a vehicle with its best years behind it. Although an automatic transmission was considered ideal for driving ease, this type was found to consume an
As for my Ministry, I can best describe it commend you on the programmes and development of your association and second anniversary. I have followed the address your association on this your "I appreciate the opportunity to fine address, which I quote verbatim: conversational style he delivered a very received, and in his usual pleasant speaker. Mr. Drea was most warmly accepted their invitation to be the guest of Consumer & Commercial Relations, The Honourable Frank Drea, Minister Constellation Hotel, Toronto, Ontario. General Meeting and Luncheon at the Electronic & Appliance Service ON SEPTEMBER 6, 1979 the Canadian government. "I appreciate the work always a cost of doing business with the pleased to see happen for there is effectively to self -regulation. This I am to regulate itself but we find that costly affair involving people and sys- mantle its regulatory forces which is a regulates an industry, turn the regulatory functions back to government to regulate for atime, then Government cannot do it alone! In business must meet the challenge! very things that business does best. But real thrust is to return to business the isn't intended to save tax money. The regulation. The quality of service must keep improving without putting the little guy out of business. De-regulation makes a lot more sense than legislation and so my Ministry encourages self-regulation. The quality of service must keep improving without putting the real thrust is to return to business the very things that business does best. But business must meet the challenge! Government cannot do it alone! In many areas the pattern was for government to regulate for a time, then turn the regulatory functions back to industry. When the government de-regulates an industry, it has to dismantle its regulatory forces which is a costly affair involving people and system. It isn't always easy for an industry to regulate itself but we find that business today is responding very effec- tively to self-regulation. This I am pleased to see happen for there is always a cost of doing business with the government. "I appreciate the work being done by your association. At times you may think the going is slow but rather slow than no action. There is no model for you to follow and there must be acceptance of your plans and programmes outthere if your efforts are to be successful. My Ministry has been following the work you are doing unselfishly for persons who cannot afford to do it for themselves. "In today's society, everything is going from electric to electronic. Many home appliances think for themselves and, although they provide more leisure for the consumer, the function of the appliance is a mystery to many people. The consumer becomes a pawn in the game of chance — left to the mercy of the dealer. What about Product Warranty Legislation? Quite frankly we have no plans to pursue any regulatory action on warranties. This is no time for the government to get into the warranty field. There is a limit to human resources and I'm not sure we need new warranty regulations. There is a myth that we live in a 'throw-away society', that things can't be fixed any more. Sure, there are cost considerations to be recognized in today's consumer products but isn't always a case of replacing the car because a spark plug is fouled up. "The government did step into the automobile insurance field recently because we felt an injustice existed and the insurance industry hadn't taken the necessary steps to regulate the business but we didn't want to take the step until it appeared there was no other solution. "My advice to you is don't let government do your thinking for you! A government regulatory body is expensive and hard to get rid of. Why should government issue licences for employees when they are employed by a licenced dealer? Surely that is enough control since a dealer's license can be reviewed at the time of renewal. "Yes — self-regulation is the way government wishes to go. The Canadian Electronic & Appliances Service Association is doing it for itself without government assistance. "May I commend you for the work you are doing. My Ministry appreciates your efforts. "Thank you." I was unfortunately ineligible to attend the meeting, but thanks to Mr. Bill White, the General Manager of the Association, a few high-lights from the agenda were passed on to me.

There was some considerable discussion re Provincial service associations. A member opened the discussion by pointing out that there are hundreds of independent technicians across Canada who would like to be members of the CEASA but do not qualify because they cannot belong to a Provincial service association that does not exist. There are even technicians in Provinces where associations do exist who would rather belong to the CEASA than take out membership in their existing Provincial association.

Another member felt that many interested technicians have not formed an association due to lack of knowledge on how to go about it. The secretary reports that the CEASA office is intending to issue a booklet on how to form an association. A member then volunteered to assist in this project based upon the B.C. experience. It is obvious that CEASA is on the move.

Here is an extract from Service Contacts which I feel says it all:
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"See the September 1979 issue of ETI."

"The future tomorrow."

"... and don't overlook is personal protection and security for yourself and your loved ones. CEASA, through its Group Protection Plans, is making available to Canadian Electronic and Appliance Service technicians several insurance, pension and investment programmes. Don't short change yourself and your dependants! Get the full details today and plan for a secure future tomorrow."

"See the September 1979 issue of ETI."

"... but it was also lucky enough to have conversations with a number of old friends from the old days of TV servicing in the Toronto area."

"Many thanks, CEASA, for an enjoyable luncheon and for permission to use your material from Service Contacts, etc."

"All the best,
Richard H. Cartwright"
THE CONTINUING SAGA OF AMPLEX

THIS COLUMN WAS originally going to be concerning TV games. There have been quite a few popping up in the last year. We began with the basic "PONG", and then, "SQUASH", which were both fairly cool and safe. Then we got "TANK", "SPACE WAR", and the like, and things began to heat up a bit. It was the latest round of video armaments, however, that really turned me off the whole scene. "PILLAGE AND RAPE" is a full colour, one chip game for two or four players that gives you the thrill of being a ruthless barbarian. For armaments, however, that really turned me off the whole scene. "PILLAGE AND RAPE" is a full colour, one chip game for two or four players that gives you the thrill of being a ruthless barbarian. For devotees, there is a second, expander chip that converts the game into "MASS MURDER AND ORGY AFTERWARDS". We also have the ever popular companion to the "TANK" game, "FLAME THROWER". General incineration, the manufacturers of the IC, are presently working on a full arsenal of video arms. Chips will be combinable for various combat strategies. Lastly, for the real fan of video Armageddon, we have "ICEM". Each player has a button. The rules are probably familiar. Twenty minutes after pushing either button, the chip self-destructs and the set explodes.

So, like I said, I was going to do TV games, but I think I'll hold off for a bit; at least until after SALT II gets ratified and we can see where the industry stands.

Turning toward more peaceful matters, this month we're going to look at the AMPLEX one inch video tape recorders. Descendants from the first commercial VTR, the VR-1000, the ones which usually crop up range from the VP-4900 to the VR-7500. Feature-wise, they begin with the basic monochrome players and move on to include everything from full colour to assembly editing and stereo, sel-sync-able sound. While models made after the VR-7500 are still fairly widely in use, most of those prior to and including this machine have been undergoing retirement for a few years now. No doubt among the most popular machines in the industry in their day, it might be useful to have a more detailed look at the workings of them than was possible in the ETI "old VTR survey" that ran last December to March.

The VR-6000 shown in figure 1 is representative of the machines of this system. They all take much the same configuration. The tape resides on the left hand spool, gets wrapped around the centre head drum assembly and eventually finds its way to the take-up reel on the right. The head drum uses a single head, as opposed to the Japanese recorders, which, for the most part, employ two. This, in itself, is a rather positive feature for those of us who are lazy and/or poor, as there is simply one head less to clean and, eventually, replace. The tape rests over about 180° of the drum when first threaded and gets dragged in to cover a total of a bit more than 35% of the drum when things get rolling. Because most of complex tape movements are done by the mechanics of the machine itself, the Ampexes are among the easiest VTRs to thread, short of a cassette deck. There are no little openings through which to jam the ragged and tooth marked ends of your tapes when setting up.

As well, there is really only one point where it is possible to mis-thread one of these things, so the chances of a recording turning out scarfed due to "operator error", or the more common "operator doing a 'j.'", are considerably reduced. Especially considering the age of the system, there are surprisingly few panel

Steve Rimmer again avoids the topic of video discs.

Fig.1 Ampex VR6000 mounted controls for the user to meddle with on a regular basis. On the basic black and white recorder, these are limited to the audio and video record level pots, and, on playback, the audio volume and video tracking. A seldom-used tension adjustment control is also provided. (We'll ignore any hecklers who query regarding the power switch or the stop, start and record buttons here.)

PLAYING WITH IT

Turning to the innards, we find... well, for a start, there's a bunch of transistors in here. All the circuitry of the machines is built on pc boards, which can be removed for servicing by sliding them out of their respective edge connectors. No desoldering is necessary. Depending upon the specific model in question, there are between ten and twenty internal, trimmer type adjustments on these cards. While the Ampex service manuals give really exact directions concerning how these are to be set up, which includes the test equipment to be used to do the deed (much of which costs more than the recorders themselves), the basement engineer faced with these wavy fields of thumbwheel pots can usually get acceptable results simply by turning
changes the tach pulse rate. When a change in the head drum speed which drives the head drum motor. A change in the voltage controlled oscillator that eventually winds up being applied to proportional error pulses during playback or the stripped tach pickup, which eventually wind up head drum spins, it induces pulses in a as mentioned before, a loop. When the speed and phase of the video head behind your back.

SPINNING RUBBER

When the belt gets old, a lot of funny things start happening. Because it is now physically larger, as well as being less firm, there comes a time when there is actually some slack between the motor and the drum. Thus, if the speed of the motor begins to increase in response to the error voltage applied to the VCO, this increase in speed will not be immediately felt by the drum, and, in turn, by the tach pulse generator. However, the control circuit wants more speed, and, seeing that nothing has happened, it will say "well, it still isn't going fast enough; let's crank it up some more". Somewhere along the line, the slack runs out. At this point, the frequency of the VCO is artificially high anyway, and, secondly, the belt acts something like a rotary slingshot, so that the drum vastly overshoots the mark. The circuitry then has another fit, and frantically tries to slow the head down, but, again, it overshoots because of the slack in the belt. The result is that the head perpetually hunts, and the picture looks like the set's been dropped.

It isn't hard to spot this particular syndrome, should you suspect that you have it. For one thing, the belt will feel very slack and, in fact, it might actually have become sticky feeling; a sure sign that the artificial rubber blues have taken hold. Secondly, a 'scope on the output of the VCO will show that the pulses, far from being stable, are swaying back and forth like a partygoer who's too stoned to find the family auto. There is no way to repair an aging belt, but for the five bucks or so these things cost, there is also little reason to try.

The problem just outlined, when cured, will probably leave you with the aftermath of a still more common complaint; the magic thumbwheel game. Usually, as the belt begins to go, the servo loop circuitry can be adjusted to compensate for it, to a degree. These adjustments can, in fact, pull the loop pretty far off spec, and, of course, when the new belt is installed, they all have to be set right again. Otherwise, you will probably find that you have a picture that has snow pulsing in and out, which is of some annoyance while viewing video tapes of the Toronto Symphony, Gimme Shelter, or other artsy stuff.

If you peruse the manual... probably that paper thing you've been storing under the cat... you will be able to find places on the circuit cards that will tell you have a look at the ramp waveform, which is controlled by the tach on the head drum, and the vertical sync, which emerges from the video sync stripper. Naturally, you can't adjust the vertical sync rate while recording, but, by meddling about with the ramp trimmers, you will be able to get these two pulses to lock in so that they are both running at the same rate; i.e., they'll be in sync. Now, upon playing back a properly synced recording, you will now want to get the ramp and the control track pulses in gear. This is accomplished via the VCO frequency and stability trimmers. After a bit of fiddling, you should be able to get a stable, no-revulso picture.

VIDEO SNOW

While we're here, we might as well deal with the actual cause of the snow that was involved in all that pulsing. You may still see some of it around, even with a stable picture, and, while there are numerous causes, the most usual is that the video head driver that puts the video on the tape is not functioning at maximum efficiency, causing a weak signal going on, which, in turn, produces a weak signal coming off that will, now and then, dip down into never-never land. To get the drivers balanced; connect a scope probe alternately to the bases of the two driver transistors, whilst adjusting the "RF BAL" trimmer. Stop when you get the signal levels equal for both points. If you haven't been graced with a high frequency 'scope, you can make this adjustment another way. Plug a mike into the mike jack, and slowly adjust the trimmer full range while reading off the positions of the thumbwheel. Since these things aren't calibrated, clock face positions are useful in describing where the adjustment is set at any given moment. Make a recording covering the complete range of the trimmer, and, upon playback, note the setting that provides the best picture. Set the thumbwheel to this position.

Since, in making this adjustment, the overall recording current at the head may have been changed, as the two driver transistors cannot be expected to be closely matched, and because this is another adjustment technicians tend to fool around with, it isn't a bad idea to optimize the record current setting at
this point. This is done, naturally, using the "RECORD CURRENT" trimmer provided for the purpose. Adjust this control in the same manner as the balance pot above, by making a recording, noting the thumbwheel position on the radio track, and then set it for the best picture, as seen on playback.

A troubleshooting guide for something as complex as a VTR, would, of course, run to volumes. However, there are only a few really heavy problems you're likely to encounter in these particular machines, and, of them, this one is about the most likely to drive one wholly, totally mad trying to find the cause. There are a few others that may make you feel that your brain is unwinding at first, but, all in all, the circuitry is fairly intelligently designed, and things can eventually be untangled if you hammer at them long enough.

And, of course, if that doesn't work, try a bigger hammer.

SURPLUS 2001

It intrigues me to think, upon reading the reams of literature I seem to wind up with every month, that no matter how brilliantly designed a piece of equipment is, no matter how expensive it should happen to be at the moment, in ten or fifteen years it's going to be getting dusty under a plastic dry cleaning bag at the back of someone's studio, and anyone who should inquire about it will be informed that the possessor of a large enough truck will be able to cart it away for fifty cents a pound. And this applies to everything, not just video equipment. For instance, if you can come up with a use for a second hand Conservative Government, just keep your eyes open. There'll be one up for grabs any day now.

The nicest bit of pre-scrap I've run across in many a day arrived at my desk about a week ago, in four colour, glossy paper, and four pages of general specifications. It's the latest grandchild of the Ampex VTRs we've just been dissecting, the VPR-2. Just so you'll have an idea of what to look out for in the years to come, here's a brief look at the beast.

The current crop of video recorders are, curiously enough, reel to reel machines again, just like their predecessors of a decade ago. However, as you are probably aware, the return to the reel format is quite recent, for, over the last five or six years, most of the industry has been having a merry time with the ever decreasing size of the video cassette.

In a practical sense, the cassette boom began with the 3/4" U-Matics, which appeared for use in "non-broadcast" situations; school audio-visual departments, industrial training tapes, and cable TV community programming. However, the picture produced by the U-Matics weren't all that bad ... certainly no worse than could be resolved by the average home TV set, and, thus, a lot of them found their ways into some of the smaller TV stations. The ENG (Electronic News Gathering) folks loved them, because they were small, and you could walk around with them without having the tape spew all over the place. And, by and by, the convenience of not having to thread big, huge spools of tape all the time gained favour, and soon, quite a bit of material was coming off cassettes and winding up out over the waves.

This, of course, is a touchy problem, for, while most people never get to see what TV really should look like, i.e., what a high resolution, low noise picture really looks like, there are some who do have the equipment to actually do what is going out ... only it isn't really going out anymore.

You can't exactly blame the broadcasters, though. Well, you can, but it won't do any good. The only alternative to the small formats was the massive, two inch Quadruplex system, which was big, complicated and very, very expensive. Thus came the new one inch reels.

The one inch broadcast VTRs offer another advantage over the U-Matic cassettes. You can edit with them. Now, editing video tape is not done in the same manner as one might with audio. You don't use a blade. Instead, material is dubbed from one tape machine to another, with special synchronization circuitry in there, somewhere, to make sure that the sync pulses of the new material are in phase with the old.

Editing is available for cassette systems, of course, but the narrow track width involved in these slow tape speed formats makes it rather imprecise.

The Ampex VPR-2 is a rather complicated little beastie, but its dozens of lights, knobs, readouts, buttons, switches, fangs, zorts, whatzits, widgets and three speed synchronous bandsnatches do make it exceptionally versatile ... if a bit imposing at first. It has stereo sound for people who are partially schizot ... three channels. It uses separate video record and playback heads, which avails one of a wonderful 4.2 MHz bandwidth at -46 db S/N ... better than the home VCRs even when the manufacturers lie quite a lot. This also permits monitoring of what one has recorded after it has gone on the tape ... to be sure it has, in fact, actually gone on the tape. It can play back at any speed from the usual blur of normality right down to still frame without breaking up. And, to make a good thing even better, the system is designed to be expandable. In other words, when you get it, there are no card slots without any cards, so that, if someone comes up with a better off/on switch in a few years, you can just plug it right in. Your family will love it; you'll never be a problem when it comes to finding Christmas gifts.

It is the editing system of the VPR-2 that really deserves some mention, though. A couple of these recorders will essentially provide one with a complete
post-production facility. The editing panel holds a tape jogging system, to permit shuttling the tape around, backwards and forwards, at any speed desired, until the precise location of a perspective edit is found. A digital clock/counter will actually count the frames as they go by, and the insertion circuitry is so precise that a different image could be edited onto every frame. Disney-type animation is well within the scope of the system. Add-ons and accessories for the editing functions include a digital editor console option, complete with a joystick controller.

The price? If you have to ask, you can't afford it.

While machines of this calibre are still denizens of the studio, and probably likely to remain so for the foreseeable future, there is no reason why many of these features could not be incorporated into future home VCRs... in modified forms, of course. For one thing, they'd have to be made out of plastic. Things like editing capabilities would give the advanced TV nut the opportunity to really get into small scale video production. As the manufacturers continue to try to find ways to sell you this years deck before you've figured out how to load last year's, we may see some of this stuff turn up.

MORE ABOUT VIDEO DISCS

You may have noticed that this column, like the last, doesn't have much to do with video discs. The data is just not coming in, and the possibility of the things being wholly obsolete before we ever get a chance to look at them is becoming quite real. Next month, for sure, I'll have something to say about them... very likely another little note at the end, like this one.

As always, anyone having any questions concerning video or the placating of eternal swamp gnomes should feel free to write in.

Until next month, stay tuned.

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— See Page 62
exorbitant amount of energy (up to 5hp just to run the oil pump) so a manual 3-speed transmission was chosen. However, as it turns out, no shifting is necessary for normal around-town driving; starting and driving is all done in "second" gear.

The car was delivered in March. It was driven for two days and then moved to the Auto Shop during the winter break. With the help of Keith Curry, the Auto Mechanics instructor, it was stripped of all unnecessary components (engine, exhaust system, gas tank, etc) and moved to an old portable classroom for its transformation.

As spring approached, we were notified of serious delays in component deliveries. This meant that the end of the school year would come with the assembly a little more than half completed. It was keen disappointment for all. Consequently, as items arrived during the summer, Renton Patterson ended up doing a good portion of the assembly and wiring, but with help from the odd team member who dropped in.

The motor was the last item to arrive, it was delivered in eleven, - a full seven months late. Again with the help of Keith Curry and Hank McCann, the Auto Shop was used to bolt the motor to its adapter plate and coupling (both made in the Machine Shop) and secure it firmly in place ahead of the transmission. The other front compartment components were then reinstalled above the motor.

Happily, the last item was put in place over the Christmas holidays when Al and Lorne were back from college and university. On Monday, Dec 26, 1977, ThunderVolt 3 pulled away from the school under its own power. Like its predecessors, the car performed exceedingly well right from the start. There was only one small wiring change and one minor mechanical adjustment necessary to get everything functioning. Performance-wise, only the custom-designed charger is not up to par, the charging rate being lower than specified.

A tremendous achievement for a group of young high school students.

PERFORMANCE SPECIFICATIONS: (from actual tests)

Range: - at 48 km/h: 104 km; at 72 km/h: 68 km  
Acceleration: — 0 — 32 km/h in 6.6 seconds, 0-48 km/h in 11.8 secs, 0-72 km/h in 23.4 secs.  
Top Speed: — 100 km/h (62 mph)  
Recharge Time: — after one or two short city trips (about 4 or 5 km) a few hours in the evening will suffice, more or longer trips require an overnight charge, and a drive to maximum range may require 36 hours or more depending on the equalization charge considered necessary. (A properly-working charger on 220 volts — a stove outlet — would reduce this time considerably.)

Energy Consumption and Running Costs (at Pembroke's rate of 2.4¢ per kwh)
At a 48 km/h steady running speed, energy consumption from a-c lines is about 0.25 kwh/km for a cost of about 0.6¢ per km;
At a steady running speed of 72 km/h (45 mph), it is 0.31 kwh/km for a cost of about 0.75¢ per km;
For a stop-and-go driving cycle in the city, with constant acceleration and braking, energy consumption is more like 0.39 kwh/km for a cost of 0.94¢ per km; or 0.62 kwh/mile for a cost of 1.5¢ per mile.

Maintenance: — electrolyte level in batteries checked every month and distilled water added as necessary. All components checked for cleanliness yearly. Contactor tips and motor brushes checked for wear every 6000 miles or so.

Winter Operations: — same as for summer except that the fuel for the passenger compartment heater should be checked and the battery heaters should be kept plugged in. Energy consumption increases with snow on the road, but driving traction is excellent.

FROM HERE?
Mr. Patterson tells us that more such EV projects are in the offing, in fact he has a waiting list of local people who now want similar cars built to their specifications, and who are of course willing to pay the price. He has also been involved in the newly formed Canadian Electric Vehicle Association. For more information on the ThunderVolt programs, for more moral support, or conversation on Electric Vehicles, Mr. Patterson may be contacted at Fellowes High School, 420 Bell St. Pembroke, Ontario K8A 2K5. Phone (613) 735-6858.

For information and membership application form for the CEVA, contact Mr. F.T. Green, Membership Chairman, Canadian Electric Vehicle Association, P.O. Box 4044, Station "E", Ottawa, Ontario K1S 5B1.

LAST MONTH
Looks like those ink electrons were flowing the wrong way in one critical sentence, which should have read: 'So the term 'current', when properly used, has ... come to mean a flow in the opposite direction to ELECTRON flow, but equal in magnitude.'
Order Form Formule d’inscription

NAME/NOM: ____________________________

A(D)RESS(E): ____________________________

TOWN/CITY/VILLE: ____________________________

PROVINCE: ____________________________ POSTAL CODE: ____________________________

DATE: ____________________________

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Total Number of Books Total des livres

SUBTOTAL SOUSTOTAL $ $ oz.

POST* $ $ oz.

TOTAL $ $ oz.

Please refer to postal rate chart. Consultez s. v. p. la carte des tarifs postales.

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PLEASE SEE SEPARATE ORDERING INSTRUCTIONS FOR SUBSCRIPTIONS, BABANI BOOKS, AND OTHER ITEMS ON THE CARD IN THIS ISSUE, PAGE 62.

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PAR ARRANGEMENT spécial, le magazine ETI peut vous fournir "Sam’s Technical Books" et certain d’autres publications techniques dans la langue française. On peut obtenir ces publications par l'intermédiaire du Service spécial des livres ETI à Montréal.

Prière de remplir ce coupon pour commander vos livres. Pour expédier vos livres dans une façon la plus économique, nous pouvons accepter paiement par chèque ou par mandat.

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Example: Destination Yukon, weight/poids

261 oz = (approx) 17 lb...

5 x 80c + 5 x 60c + 7 x 35c = $9.45

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ETI CANADA—NOVEMBER 1979

** erklärtoueurs eeacrau.**
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Les amateurs de reproduction so

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**Livres techniques en Français.**

**R. BONAL**

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Les amateurs de reproduction sonore à toute échéance devront de plus en plus nombreux. L'auteur a réuni dans son ouvrage un but essentiellement pratique, il a décrit les types les plus courants d'enceintes existantes et des techniques spécifiques par des expériences.

**CALCUL ET REALISATION DES TRANSFORMATEURS**
par Ch. Gsellert

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**BASES DE MICROINFORMATIQUE**

**Mr. John E. T.**

**Le microprocesseur**

**F 30**

**TABLES DE MIXAGE ET MODULES DE MIXAGE**

**ET DE RADIO-ELECTRICITE**

**50 MONTAGES ELECTRONIQUES A THERMISTORS**
par W. Schrader

**B. FIGHIERA**

**Les jeux de lumière**

et autres sonores pour guitares électronique

Au cours de cette troisième étude, totalement réfléchie et augmentée, l'auteur a réussi une grande partie de la description pratique des principaux systèmes d'automatisation sonores. Les sonorités et les jeux de lumière sont de plus en plus utilisés par les professionnels et les amateurs de musique. Ce livre vous aidera à comprendre les principes de base de la musique électronique et à en faire un instrument de création. Vous y découvrirez les techniques les plus modernes et les plus avancées de la musique électronique.

**Voir le page 76 pour formule d'inscription et autre information propre à votre commande.**

**ETI CANADA—NOVEMBER 1979**
Tech Tips

Tech Tips is an ideas forum and is not aimed at the beginner. ETI is prepared to consider circuits or ideas submitted by readers for this page. All items used will be paid for. Drawings should be as clear as possible, and the text should preferably be typed. Circuits must not be subject to copyright. Items for consideration should be sent to ETI Tech Tips, Unit 6, 25 Overlea Blvd., Toronto, Ontario, M4H 1B1

20 AMPERE LIGHT DIMMER

HUGH GORDON

This circuit was designed primarily as a dimmer for a large 2000 W, 120 V, follow-spotlight used in an auditorium, but can be used for almost any light dimming application. It will handle 20 Amperes with ease, providing the triac has an adequately sized heat sink. L1 and C1 are optional and are used only as an interference filter. L1 must be capable of passing at least 20 Amperes. R2 controls the intensity of the lamp by adjusting the triggering point of the diac.

The prototype used a Radio Shack Universal Heat Sink, No. 276-1361, with an added 1/8-inch aluminum plate. Heat sink compound was applied between the plate and the sink, and also between the triac body and the plate. The triac has a maximum current rating of 40 Amperes. With 20 Amperes of current, the triac was just barely warm.

Care must be taken when mounting as the circuits is connected directly to the AC Power line. Use wire of sufficient size to pass the desired current.

Triangle Generator

R.I. Harrison

The circuit consists of a comparator IC2 driving an integrator constructed from IC1, C1 and R1. The output of the two circuits is controlled by the JFET switches Q1 and 2. The peak and trough of the generator is controlled by RV1 and RV2 respectively. The frequency is set by C1 and R1.

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The advertisers in this magazine are interested in talking to you about their products or services. That is, of course, why they are advertising. But they can't necessarily say all they would like, and besides, they can't anticipate all your questions. So you may be left wanting more information.

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Finally, the card will help keep us in touch with our readers, and thus help us to serve and interest you best.

More details on page 62!
ETI's 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.

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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.

NEW STORE! for the Hobbyist, Ham Audio, CB's. Special; Video Camera and Monitor $349.95. Ont. res. add 7% sales tax. GENERAL ELECTRONICS, 5511 Yonge St., Willowdale, Ont. 221-6174.

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50 PRIME IC's, standard and house numbers, $4.95 PPD. ELECTRONICS, Box 6B, Whitecourt, AB. T0E 2L0

$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!! (VE3EH)

SPECTRUM ELECTRONICS; Quality pcbs Ont. Res. add 7% PST; PO Box 4166D Hamilton, Ontario, Canada, L8V 4L5 ETO: 491: $9.45; 319 A&B: $3.25; 350 $1.65; 591: $1.65; 541: $3.20; 470: $5.90; Write for free price list.

BARGAINS GALORE! Surplus Electronics, hardware and handyman items for the hobbyist. K-W SURPLUS 327 Breithaupt St., Kitchener N2H 5H6 (519) 745 2661.

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 additional 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.)

Should you find that there are notes you wish to read for which you do not have the issue, you may obtain them in one of two ways. You can buy the back issue from us (refer to Project Chart for date of issue and see also Reader Service Information on ordering). Alternatively you may obtain a photocopy of the note free of charge, so long as your request includes a self addressed stamped envelope for us to mail it back to you. Requests without SASE will not be answered.

Write to: Project File
Electronics Today International
Unit 6, 25 Oversea Blvd.,
TORONTO, Ontario
M4H 1B1

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

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PLEASE NOTE: WE CANNOT ANSWER PROJECT QUERIES BY TELEPHONE.

Firstly decimal points are dropped and substituted with the multiplier, thus 4.7uF is written 4u7. Capacitors also use the multiplier nano (one nanofarad is 1000pF). Thus 0.1uF is 100n, 5600pF is 5.6n. Other examples are 5.6pF = 5p6, 0.5pF = 0p5. Resistors are treated similarly: 1.6M ohms is 1M6, 56k ohms is 56k, 4.7k ohms is 4k7, 100ohms is 100R, 5.6k 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 accompanied by a self addressed stamped envelope.

ETI Project Chart

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 referred to on hand.

Canadian Projects Book

Audio Limiter
SW Stereo
Notes N, D May 79
Digital Dial
Log Exp Convert.
Digital Tach.
FM Transmitter
Phasemeter & Neg.
SW Radio
Light Chaser & Neg.
Tape-Slide Synchron. seq.
Dual Dice
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Two Octave Organ
Light Act Tacho.
Field Strength Meter
Sound Effects Unit
Digital Wind Meter
Up/Down Counter
Single Graphic Eq
Digital Dial
Variviper
Cable Tester

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

ETI CANADA—NOVEMBER 1979
The Fun of Electronics

NOW GET THIS STRAIGHT, JIM; THIS IS A 300 DOLLAR HANDHELD RADIO AND DON'T EVER LET ME HEAR YOU CALL IT A WALKIE TALKIE AGAIN!

I TELL YA, FRED, IT'S AMAZING HOW INSECTS CAN ADAPT LAST WEEK I BOUGHT AN ELECTRONIC BUG KILLER, AND WITHIN 2 DAYS, ALL THE INSECTS IN MY NEIGHBOURHOOD WERE WEARING TINY LITTLE RUBBER GLOVES.

SURE HE'S EXPENSIVE TO HAVE AROUND BUT SINCE I BOUGHT THAT VIDEO TENNIS GAME, IT'S THE ONLY WAY I CAN KEEP PEACE IN THE FAMILY.

TO BE HONEST, MR CAMPBELL, OUR FIRST REACTION WAS ONE OF ANGER BUT THAT GRADUALLY TURNED TO CURiosity, AND NOW WE AT THE POWER COMPANY ARE JUST DYING TO KNOW HOW THAT LITTLE MICROPOWER CIRCUIT OF YOURS MANAGED TO DESTROY ONE OF OUR 900 ME-GAWATT GENERATORS.

AND NOW FOR THE ULTIMATE IN REALISM, THIS MODEL WILL INSULT YOUR PLAY AND MAKE RUDE NOISES WHILE YOU'RE TRYING TO CONCENTRATE.
General Information
For Readers

Editorial Queries
Written queries can only be answered when accompanied by a self-addressed, stamped enveloped, and the reply can take up to three weeks. These must relate to recent articles and not involve ETI staff in any research. Mark your letter ETI Query.

Projects, Components, Notation
For information on these subjects please see our Project File section.

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

Sell ETI
ETI is available for resale by component stores. We can offer a good discount and quite a big bonus, the chances are customers buying the magazine will come back to you to buy their components. Readers having trouble getting their copy of ETI could suggest to their component store manager that he should stock the magazine.

Back Issues and Photocopies
Previous issues of ETI-Canada are available direct from our office for $2.00 each. Please specify issue by the month, not by the features you require. The following back issues are still available for sale.

1977
February
May
June
July
September
November

1978
February
March
May
June
July
August
September
October

1979
January
February
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April
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June
July
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October

We can supply photocopies of any article published in ETI-Canada, for which the charge is $1.00 per article, regardless of length. Please specify issue and article. (A special consideration applies to errata for projects, see Project File.)

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

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LENLINE

NIBBLER

HEAVY DUTY HAND NIBBLER
Cuts sheet metal up to 18 gauge, or plastic material up to 14 gauge quickly and cleanly without bending or distortion. Nickel plated, PVC coated handles and self or spring opening.

CIRCUIT BOARD HOLDERS AND VISES

ST-10 CIRCUIT BOARD HOLDER
Freely rotatable with printed circuits clamped on it. Heavy base, clamp tilts for preferred working position. Useable as a soldering iron holder and solder reel keeper.

DESOLEDING TOOLS from EDSYN

DS017 DELUXE "SOLDAPULLT" DESOLDERING TOOL. Extremely rugged for volume desoldering.
US140 UNIVERSAL "SOLDAPULLT" DESOLDERING TOOL. Compact tool for convenient tool box storage.
DS101 DELUXE "SOLIDVAC" DESOLDERING TOOL. Features an enclosed loading shaft with storage locks and clear barrel for easy cleaning.

PANAVISE® CIRCUIT BOARD HOLDER
Holds boards of any shape, up to 8" wide, in any position... flat, vertically, at any angle. It is easily rotated, tipped, tilted, elevated, lowered, moved left or right, or turned over.

SOLDERING IRONS

7700 WAHL QUICK CHARGE "ISO-TIP" CORDLESS SOLDERING IRON
Solder anywhere, anytime, indoors or outdoors. Kit consists of cordless soldering iron, charging stand, one fine tip and one heavy duty tip. Premium long-life nickel cadmium batteries.

6500 "ISO-TIP" PC DRILL ATTACHMENT
This high speed drill attachment fits over the "ISO-TIP" Iron after tip has been removed. Ideal for drilling PC boards and removing components.

180K BURNISHING TOOL
A pocket size burnishing tool fitted in a handsome pen type case. It is of great value in keeping contacts on relays, solenoids, brushes, thermostats, protectorelays and other electrical devices smooth and free from carbon-like deposits which would otherwise leave them inoperative.

MAIL TO: len finkler ltd.
25 Toro Rd., Downsview, Ont. M3J 2A6
Please send catalogues and brochures describing your complete line of products (mail this coupon or circle no. 12 on the Reader Service Card).

Company Name: ____________________________
Address: ___________________________________
_____________________________________________
Name: ______________________________________

len finkler ltd. 25 Toro Road, Downview, Ontario M3J 2A6 (416) 630-9103 Telex 065-24010
LEAD CUTTING & BENDING TOOLS

PR/1
COMPONENTS LEAD
BENDING TOOL
For bending the legs or leads of resistors, capacitors, transistors, etc. Made of pressed iron with baked enamel finish. The bending clamps are of tempered steel. Bend distance adjustable from 12mm to 50mm. Guides on tool can be set to precise spacing required.

TP/2A
CUTTING & BENDING TOOL
Rugged but light tool evenly cuts and bends, at the same time, the leads on various components to be inserted into the P.C.B. Does leads from .3 to 1.5mm with no adjustment. Made of blue poliamide and glass fibre.

PD801
SPEEDY BEND
This affordable tool bends 1 component or 100 in less time than it takes to set up and run any automatic bender. 1 tool forms jumper, 1/4 and 1/2 watt resistor, and diode leads. Made of high impact cycolac plastic.

‘IC’ INSERTERS & EXTRACTORS

4990 SERIES
DIP INserter
Fastest manual inserter available. Compensating screw allows you to adjust for package tolerances and make corrections for lead spacing. Inserts with no stress on package body and is safe for M.O.S. and CMOS devices. Anodized aluminum and stainless steel construction.

565
IC EXTRACTOR
For use on up to 16 way D.I.L. integrated circuits. Made of plastic, small clip type opens over IC. Jaws grip IC under leads.

800
I.C./DISPENSING BASE

4916
IC EXTRACTOR
Unique plier type construction. Withdraws IC straight up out of the board without bending leads of the IC. Removes all 14-16-24 lead dual inline packages. Insulated, made of A.B.S. plastic.

TRIPLETT DVOMs METER
Built to fit your hand and budget, the new Model 3400 is loaded with features. High and Low Power Ohms for sensitive I.C. testing, makes the Model 3400 ideal for design, production and maintenance testing, vocational tech training schools, commercial electronic equipment test and measurement use.

Circle no. 12 on Reader Service Card.
FILL IN COUPON FOR CATALOGUES AND BROCHURES DESCRIBING OUR COMPLETE LINE OF PRODUCTS.
SCREWDRIVERS

HUNTER "MAGIC TIP" SCREWHOLDING SCREWDRIVER
Drives and removes steel, nonferrous or nylon screws in areas where other screwholders will not work. No rings to push, no bulky clips. Blades are alloy steel, heat treated and hardened. Handles are job matched with Hunter's comfort grip. A genuine precision tool.

HUNTER NUT DRIVER
The most popular series of nut drivers. Precision sized socket with solid shaft for strength and durability with colour coded job matched comfort grip handles to take the fatigue out of the job.

MMK-4 MASTER TOOL KIT
The ultimate in miniature precision tool kits. The MMK-4 contains 4 individual Moody kits: a screwdriver and an awl kit, a Phillips and Allen wrench kit, a socket wrench kit, and an offset openend wrench kit. These tools are ideal for a variety of applications such as repairing photographic equipment hi-fi, ham radio, CB's and electronic instruments.

PLIERS & WRENCHES

"SMITTY" HEX WRENCHES
The original and most popular folding Hex Key set from Hunter. Blades of cold alloy steel heat treated and hardened with special attention to the tips. Cases are deburred and heavily nickel plated for comfort and durability.

70 SERIES ERASING AND BURNISHING BRUSHES
Designed for a variety of industrial applications. Adjustable for reaching corners, crevices and other hard places. Stiff cleaning action or soft brushing action depending on extension. Removes foreign matter from various surfaces. Cleans contacts, PCB's, removes oxidization and restores contact making surfaces to new condition.

STR 23 AUTOMATIC WIRE STRIPPER
An automatic wire stripper for stranded or solid wire that strips 6 of the most popular sizes of stranded or solid type hook-up wire from No. 8 thru to No. 24. Rugged die cast frame, vinyl covered handles, spring opening. Stop attachment included for continuous stripping. Individually boxed. $TR-23B Replacement Blades

AT LAST A CASE DESIGNED FOR TOOLS, NOT A CONVERTED ATTACHE CASE.
The pockets of a Platt Pallet are molded without any seams, stitches or rivets to form a one-piece unit. They are practically indestructible. The cases themselves are that same rugged one-piece construction. Made of lightweight ABS thermoplastic. The Model 600T comes with two pallets. All Platt Tool Cases have an aluminum rim for extra strength.

THESE PRODUCTS ARE AVAILABLE FROM YOUR FAVOURITE ELECTRONIC PARTS DISTRIBUTOR. IF YOU CANNOT LOCATE A LOCAL OUTLET PLEASE WRITE US FOR THE NEAREST DISTRIBUTOR IN YOUR AREA.
SOLVENT DISPENSERS
Precision instruments in every respect. Pump units are constructed of the finest stainless steel obtainable to give a lifetime of satisfactory service. Airtight check valve eliminates evaporation over long periods. Yet the light pressure of an applicator or sponge on dispenser dish pumps solvent to surface the instant you need it. Bottles are molded linear polyethylene. Ideal for dispensing: Methyl Ethyl Ketone, Alcohol, Carbon Tetrachloride, Acetone, Ether, Perchloroethylene, Trichloroethylene and any other solvents.

270 THIN PROFILE WIRE CUTTERS
5" angled flushcutters with patented shearing action for soft wire to 20 gauge. This is a U.S. made, quality tool of high carbon steel fabrication with significantly longer life. Its double-coil spring return and thin profile tips give you a smooth effortless flush cut with lower stress and operator fatigue. Unique vinyl foam non-slip handles allow you a comfortable cushion grip. Distinctive green color.

270F THIN PROFILE SAFETY WIRE CUTTER
Same as above cutter but with a built-in lead catcher that retains cutoff wire, eliminating flying ends.

MILLER STRIPPERS
101-S
An excellent stripper and cutter for all commonly used stranded and solid wire. Features adjustable stop on handles for various wire sizes, and self opening spring.

JUST WRAP WIRE WRAPPING TOOL
AWG 30 Wire
.D025" Square Posts
Daisy Chain or Point To Point
No Stripping or Slitting Required . . . JUST WRAP . .
Built in Cut Off
Easy Loading of Wire
Available Wire Colours:
Blue, White, Red & Yellow

JUST WRAP UNWRAPPING TOOL

JUST WRAP REPLACEMENT ROLLS (50ft.)
Blue Wire
White Wire
Yellow Wire
Red Wire

WIRE-WRAPPING TOOL
Battery operated wire-wrapping tool. For .025" (0.63mm) square post "MODIFIED" wrap, positive indexing, anti-overwrapping device.