Electronics Today

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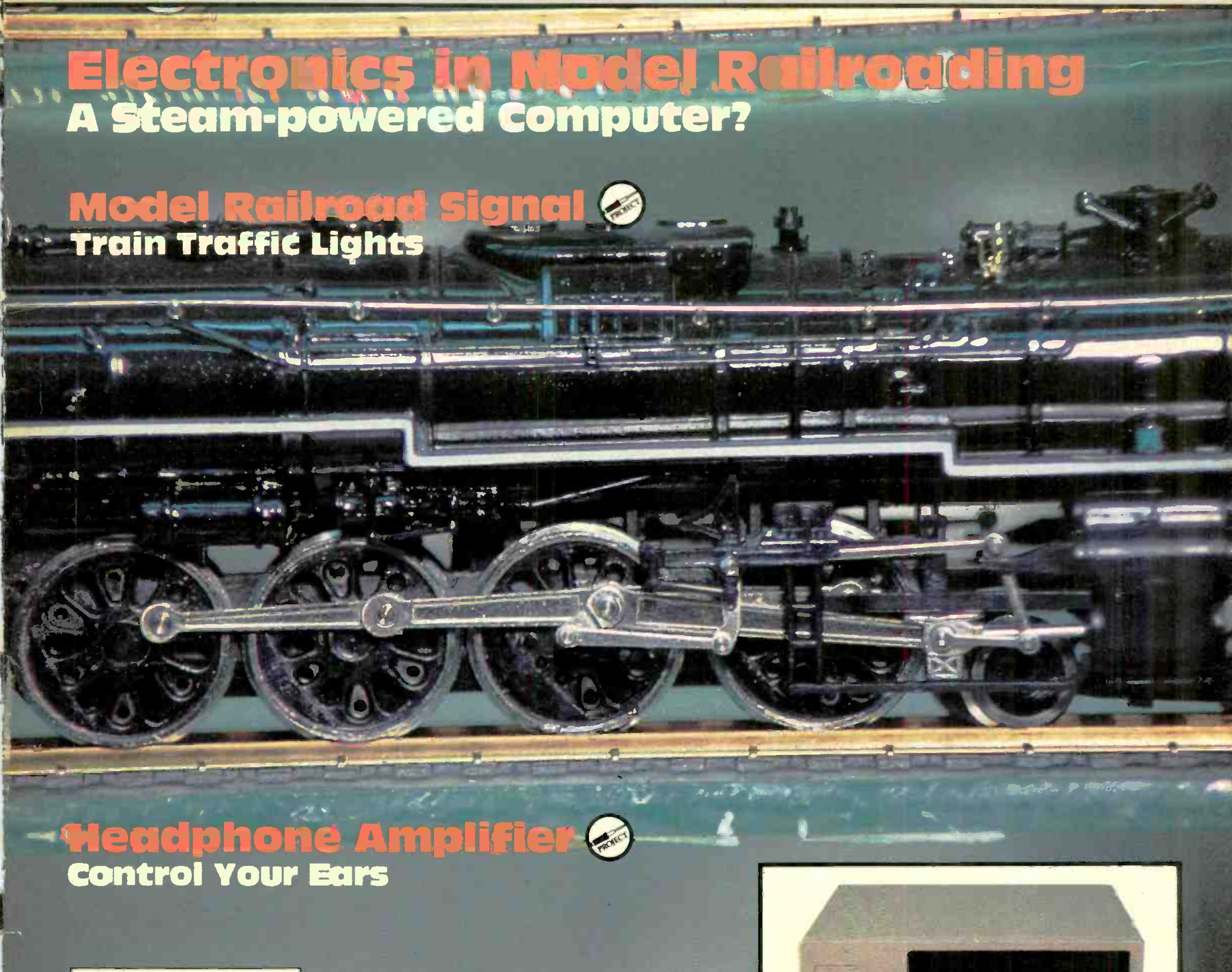
November 1984

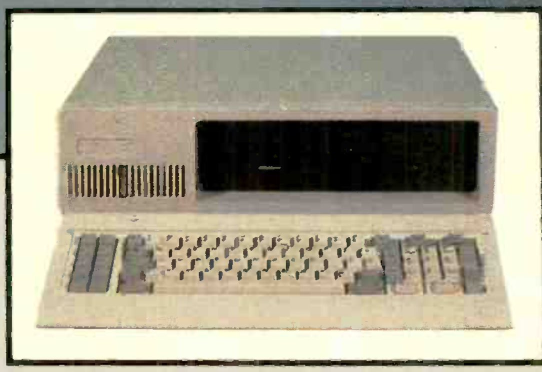
Canada's Magazine for Electronics & Computing Enthusiasts



Electronics in Model Railroading
A Steam-powered Computer?

Model Railroad Signal
PROJECT
Train Traffic Lights

Headphone Amplifier
PROJECT
Control Your Ears



Computer Review:
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IBM-Compatible

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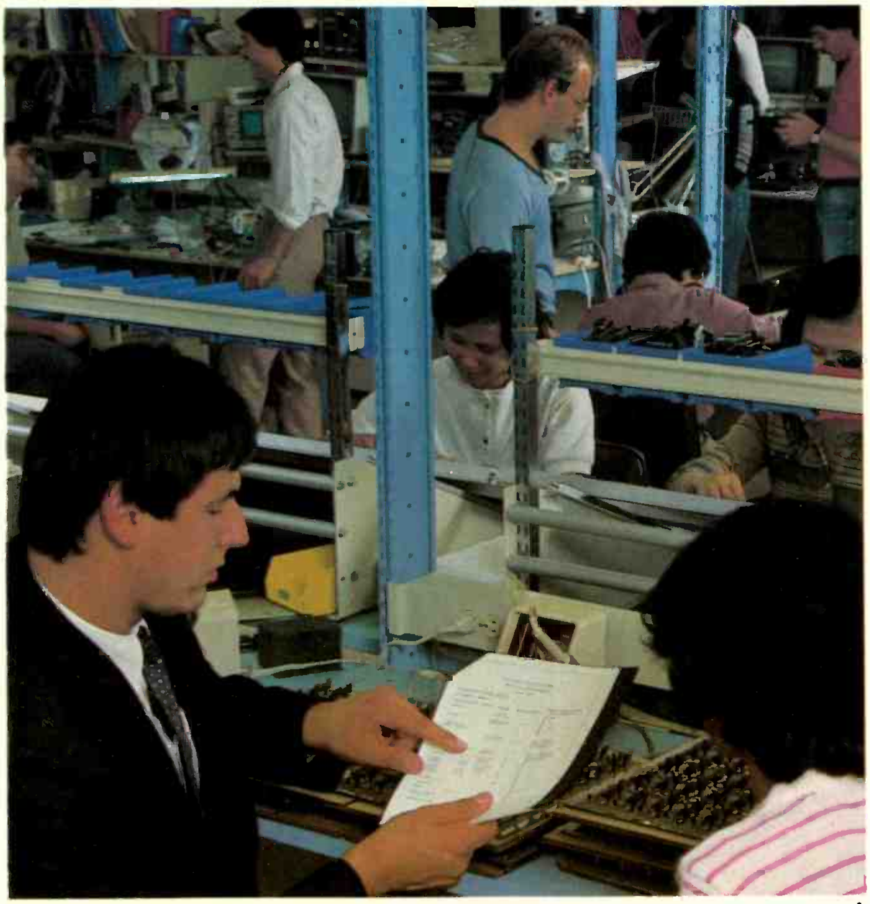

Eugen Hutka still takes an active interest in all aspects of the company's business and is seen here inspecting products on the production line.

Founded in 1979 by Eugen Hutka, the **Exceltronix** group has grown to sales of over $8 million a year with four retail branches, the original (but much expanded) one at 319 College Street in Toronto, 335 Evans Avenue also in Toronto and with Branches in Ottawa and Hamilton.

From a retail store specializing in electronic parts, **Exceltronix** is now only one of a group of companies, all controlled by Eugen Hutka.

Activities range from original research and development (almost $1 million was devoted solely to this last year), to manufacturing, to retailing and mail order.

Multiflex Inventions and Technologies Inc. are major suppliers to Canadian industry the advanced message display signs in the Toronto Subway system were designed by Multiflex and manufactured by Versa Digital Inc. and similar systems are in use with VIA Rail. Multiflex and associated companies do custom design, development and manufacture for all types of customers, including Northern Telecom, CGE and Bombardier.

Despite its phenomenal growth, Exceltronix has not forgotten what led to this success: personal service, and competitive prices. The same company who are mass producing IBM and Apple compatible peripheral cards will still sell you a single resistor if that is what you want.

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The Hamilton branch of Exceltronix opened in 1984. There is also a similar sized stored in Ottawa.

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Electronics Today INTERNATIONAL

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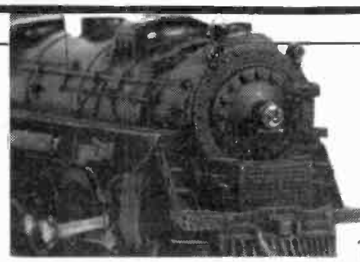
Features



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Projects

Columns, News and Information

Our Cover

One of the HO locomotives from George's Trains, Toronto, introduces our model railroad feature. The Mega-Board is reviewed on page 36. Photos by Bill Markwick.

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for your information

Sony Introduces New Car Stereo Line

Sony of Canada has announced the introduction of three new AM/FM stereo cassette players with auto-reverse: the XR-20, XR-30, and the XR-40. All three are designed with a mini-sized chassis, allowing installation into virtually any car dashboard.

The XR-20 features automatic local/distant switching for optimum reception of both strong/local, and weak/distant, stations and a power antenna lead. The XR-30 and XR-40 models have built in EQ adjustment, and both are equipped for four-speaker operation. In addition, both models have metal tape capability with a feather-touch front panel selector switch, and LED indicators for easy night-time operation.

All three models measure 6 3/8-inches wide by 2-inches high and 4 3/4-inches deep. The XR-20, XR-30, and XR-40 retail for $239, $269, and $319 respectively and became available in June at Sony auto sound dealers.

Memorex Canada has announced it will sponsor a new computer show to be aired on the CKO National Radio Network.

CKO began broadcasting the program in mid-September. Memorex will use their sponsorship to help promote the company's computer media products.

Power 3000 Update!

In our October issue of Electronics Today we featured a review of the Power 3000 computer. The tag at the end of the review stated that the distributor of the Power 3000 was Koller Engineering Products of Toronto. Well, KEP has since discontinued distribution of this computer and many of our readers have been contacting us as to why this is. All we know is that at press time KEP had several units in stock and were selling them at $29.95.

We will be conducting a search of possible other suppliers of the Power 3000 and will keep you informed as to our progress. As well, an avid reader informed us (and we confirmed this) that the output bus is not compatible with that of the ZX-81. We apologize for the inconvenience, please be patient, we shall overcome.

Liability

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

Editorial Queries

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

Binders

Binders made especially for ETI are available for $9.25 including postage and handling. Ontario residents please add provincial sales tax.

Back Issues and Photocopies

Previous issues of ETI Canada are available direct from our office for $4.00 each; please specify by month, not by feature you require. See order card for issue available.

We can supply photocopies of any article published in ETI Canada; the charge is $2.00 per article, regardless of length. Please specify both issue and article.

Component Notation and Units

We normally specify components using an international standard. Many readers will be unfamiliar with this but it's simple, less likely to lead to error and will be widely used everywhere sooner or later. ETI has opted for sooner!

Firstly decimal points are dropped and substituted with the multiplier: thus 4.7uF is written 4u7. Capacitors also use the multiplier nano (one nanofarad is 1000pF). Thus 0.1 uF is 100nF, 5600pF is 5n6. Other examples are 5.6pF = 5p6 and 0.5pF = 0p5.

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

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

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

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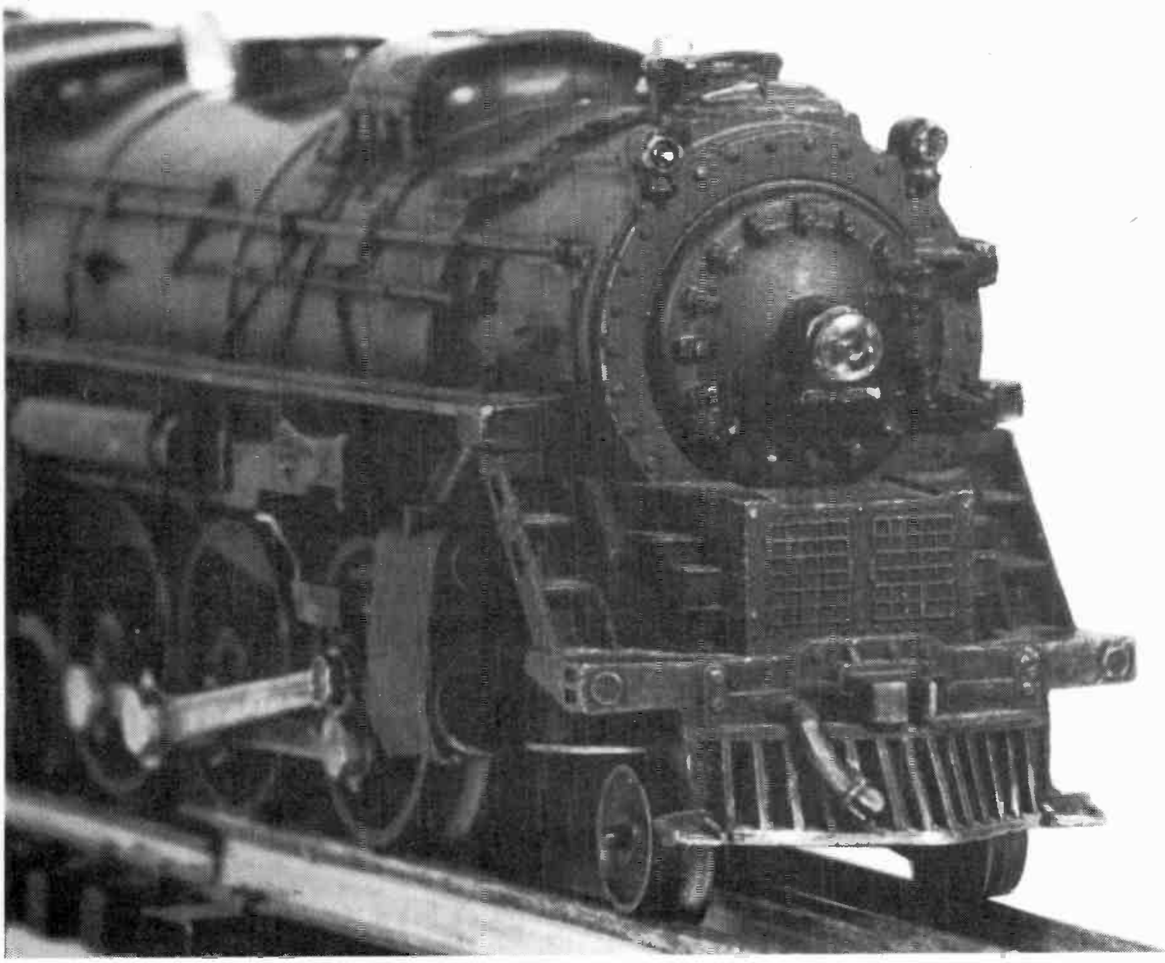
A Look at Model Railroad Electronics



They've come a long way since the only train control was a variable resistor.

by Bill Markwick

IF YOU'RE over thirty, your introduction to model railroading probably started with an electric train at Christmas. Daddies always buy their kids electric trains, and the kids are lucky if they can get near the trains for weeks because Daddy won't put down the controller. The controller, back in the dim past, usually consisted of a power transformer, rectifier, and a contact that slid over a coil of resistance wire. Once you elbowed Dad out of the way, you probably found that the resistance wire worked well enough most of the time, but that as the track got dusty or the load on the locomotive changed, there was a tendency to stall or lunge ahead.

If you were really keen and later got another loco, you could always install switches in parts of the track and run two trains at once, though not both at the same time. You were still stuck with the touchy performance of the power pack.

Well, time passed, and you've finally decided to get back into electric trains, now called model railroading, to try and avoid the fact that you do, in fact, play with electric trains again. A visit to a well-stocked train shop or hobby shop will quickly convince you that the same thing has happened to trains that has happened to the old electronic component stores: high-technology is everywhere.

Mind you, at the bottom of the line you can still get the old resistance-wire controller, but the economy and (high performance) of solid-state gadgets has revolutionized model railroading. Here's a quick look at some of the electronics available.

Basic Throttles

The biggest drawback to controlling trains with a variable series resistor is that a series resistance tends to look like a constant-current source. Imagine that you have set the throttle to a slow speed, which means a large series resistance, and that this resistance is about ten times the resistance of the motor. The current will now be largely determined by the wire, not by motor demand. This in turn means that any extra load on the motor won't cause more current to be drawn, and the result is stalling or erratic performance.

The cure here is to insert a solid-state regulator of some type after the power supply. The simplest hookup would be to use a power transistor's emitter as the out-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put and connect the slider of a pot to the base pin. The emitter will now follow the pot setting, producing a constant-voltage output; this doesn't mean that the voltage can't be changed, but that once a setting is made, the voltage stays there regardless of changes in load current (within limits). In other words, the transistor converts our former high-resistance output to a very low resistance. The final result of all this, is that the electric motor can draw lots of extra current when it wants it, resulting in smoother operation.

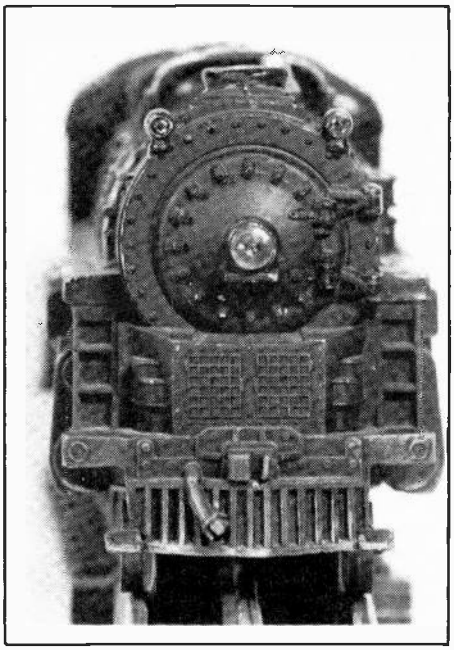
There are more sophisticated ways of controlling output voltage that just using a buffer transistor. Regulator IC's provide superb voltage control, very low potentiometer currents and built-in current limiting. This last item is important, because transistors will readily pass enough current to damage themselves unless some form of limiting is used, and every model railroader knows the probability of dropping a screwdriver across the energized tracks (100%).

Fancy Throttles

Now that you have improved slow-speed performance and stabilized the engine's speed, there's still the fact that your train doesn't move realistically. You've gone to no end of trouble to make your scenery and backdrops authentic, and yet your train stops and starts pretty much like a slot car. Resistors and capacitors to the rescue: now that we have a solid-state output, we can add a controllable slow-start, slow-stop feature with ease. It's just a matter of having the control voltage from the pot slowly charge the capacitor ("inertia simulation") and during braking, have the same voltage decay away slowly ("momentum simulation").

Most fancy (and some of the unfancy) throttles have one form or another of this simulation. A handy feature to look for in addition to this is a "panic button". This shorts the simulation effect (or the output) for a quick stop. Imagine your train racing at top speed towards a tight curve at the edge of the board and you've set the braking momentum for 30 seconds...

Another feature that contributes to realism is a pulse effect. In this type of throttle, the output voltage is controlled



by chopping the rectified waveform with a thyristor in much the same way as a lamp dimmer. This rough waveshape can nudge the motor along at very slow speeds, minimizing stalling from mechanical binding. The pulse waveform is often controlled more finely at slow speeds by using a special taper on the control potentiometer, or a feedback arrangement can be used to sense the back-voltage generated by the rotating armature; the pack's output voltage is then tailored nicely to keep the motor running at a constant speed.

Sometimes you don't want constant speed; a real train slows down going uphill and accelerates downhill, so you might prefer to be able to defeat any constant-speed feature.

Hobby dealers can show you the various makes and models available; in general, there's a very good selection indeed. The top-of-the-line packs usually have most or all of the described features, and in addition, are often available as dual units for running two trains at once. If you're really into prestige, some units have portable control pots attached to the main box with a cable, so you can walk around your layout gloating at this size.

Multiple Control

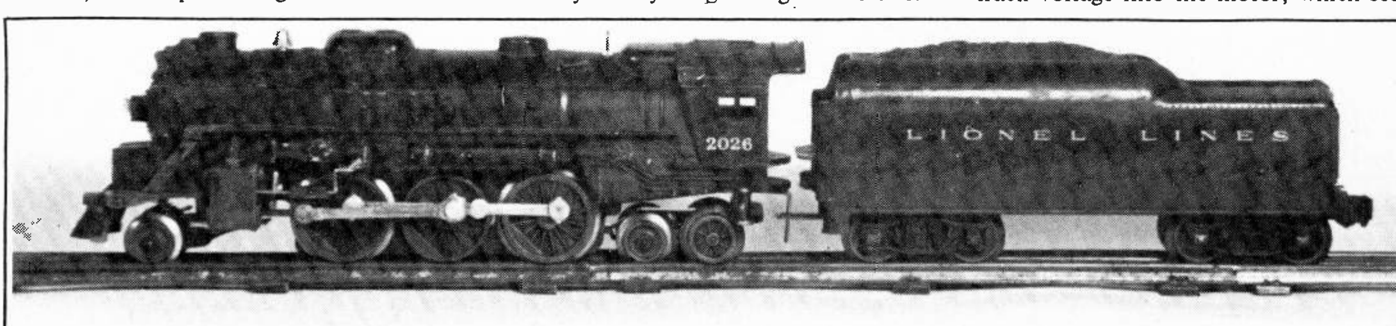
The easiest method of multiple control, as mentioned above, is to have multiple control units and sections of track isolated from each other. This is the route most people would choose due to its simplicity, but it means keeping the various trains separated completely, not to mention the necessity of complex wiring.

One solution is radio remote control. You could probably adapt model airplane controls to railroad use, but the necessary hacking would doubtless get a tad complicated, and you may have difficulty fitting the servo units in HO or smaller gauge rolling stock. If you're determined though, see Peter J. Thorne's book described at the end of this article.

A flexible, simple, and surprisingly affordable alternative has been provided by the Hornby company of England. Their Zero 1 command control unit costs under $275, and controls up to 16 locomotives and 99 track switches (turnouts). The main console has one control pot, and three more can be plugged in for simultaneous control of 4 trains; the other trains remain at preset speeds until you select them and change their settings. Each locomotive can have one of four momentum settings, and the console can supply up to four amperes to the rails.

Inside the master unit is a Texas Instruments TMS1000 4-bit microprocessor. It encodes the various throttle, momentum, and switching information into a 32-bit stream; the power to the rails consists of a squarewave which swings from 22 volts negative to 22 volts positive. Every third cycle the power is shut off for about 10 milliseconds and the 32 bits of data are inserted; this method minimizes external interference. Each tiny module can supply one ampere to the motor.

Inside each locomotive is a tiny receiver (about $33), consisting of an IC and two SCR's (replacing a triac in previous versions). The IC, unfortunately, was custom designed for Hornby and has to remain their deep, dark secret. However, it's a fair guess that it's a 1-of-16 decoder; when it sees its own code number in the bitstream, it gates the appropriate polarity and duty cycle of the track voltage into the motor, which sees



the equivalent of 12 volts maximum. Presumably it has a tiny memory to hold the setting until you next select and update it.

For operating switches or other accessories, the track voltage is applied to an accessory module; each can run up to four of anything that can use track power.

Although the Zero 1 seems to be the ideal system, there are a few things to keep in mind with any command control system: all your locomotives must be fitted with a receiver if you want to use them at all; the track must be scrupulously clean to ensure good reception of the bitstream; and the intermittent duty-cycle sent to the motors may cause noticeable mechanical noise. Some track insulators are still required; if the track loops back on itself, you still get a good old short circuit.

Other Accessories

The majority of research seems to have gone into control units, presumably because of better financial return (although none of the equipment is exorbitantly priced; the Tech II super-throttle was under $70), but you'll still find a wall full of electronic components at hobby shops. LED's are a natural for signal lights, and bridge rectifiers allow lamps in rolling stock to operate regardless of track polarity. The TTL logic family is perfectly suited to the requirements of signalling and interlocking train movements.

May We Recommend...

Electronics can be used for hundreds of uses around the layout, but not everything you'd like is commercially available due to the fairly small market. Just about everything you'd like, however, is available with a bit of soldering and testbench time. One of the very best sources of information is Peter J. Thorne's "34 New Electronic Projects for Model Railroaders," published by Kalmbach Publishing, 1027 North Seventh St., Milwaukee, WI 53233, and available at most hobby shops. You can also order it through any bookstore. It's an 80-page softcover that includes throttles, lighting systems, train detectors, sound circuits, signal systems, command control systems, and radio control. The projects are superbly designed and illustrated, and the book is a must for electronic experimenters with an urge to improve the layout.

Electronics Today would especially like to thank George Olieux and staff from George's Trains, 510 Mt. Pleasant Rd., Toronto, Ont., (416)489-9783. They kindly provided the locomotives and accessories shown on our cover and in this article. **ET**

HEADPHONE AMPLIFIER

Extend your listening hours into the depths of the night; bang your head without the neighbours banging on the wall.

THIS amplifier is suitable for driving both high and low impedance headphones, and can deliver enough power for low level monitoring on a sensitive pair of loudspeakers.

The Circuit

This circuit is fairly straightforward, Figure 1. Both channels use the same circuitry, so all references will be to just one channel (the left one).

The component numbering is the same as before, ie, C1 is the left hand channel, and C101 is the same component but in the right hand channel.

The signal is fed via a DC blocking capacitor, C1, to the volume control, and from there to the non-inverting input of an op amp. A FET op-amp is used, so there is no significant bias current flowing in the volume control. This is a desirable situation because a crackling noise could occur when the control is turned. On the other hand, if the wire from the wiper of the volume control were to become disconnected, then static charges might build up on the FET input. This would cause an offset on the output which could damage the headphones. All this means is that the wiring needs to be securely soldered.

The op-amp in the circuit provides all the voltage gain, and the transistors on the output provide enough drive capability to use low impedance headphones.

The gain of the circuit is set by R7 and R8, and is calculated by:

$$(\text{gain} = R7 + R8 \div R8)$$

The gain can be set to any required value from unity to about ten by a suitable choice of R7. Gains in excess of ten should be avoided in order not to lower gain too much and allow distortion to occur.

The value of R8 should remain as 10k unless unity gain is required. In this case, R7 can be replaced with a wire link, and R8 and C2 can be omitted.

Offsets

The presence of C2 ensures that the DC gain is only every unity, so that a larger signal gain does not result in larger DC offsets. Output offset = DC gain x input offset of op-amp.

Capacitor C2 is of a large enough value in that it comes nowhere near to affecting the audio frequency response of the circuit. It is a bead tantalum type because the offset of the circuit can be either positive or negative, and bead tantalums can function with a small reverse bias.

Biasing

The output transistors are biased into class AB by Q2. This is connected in a configuration which multipies its base-emitter voltage by the ratio of two resistances, R3 and R4 and the precise multiplication factor is set by RV2.

As long as the transistors remain at a similar temperature, the bias point will be similar over a wide range of ambient temperatures.

Resistors R5 and R6 are chosen so that the quiescent current does not rise destructively if the small output tran-

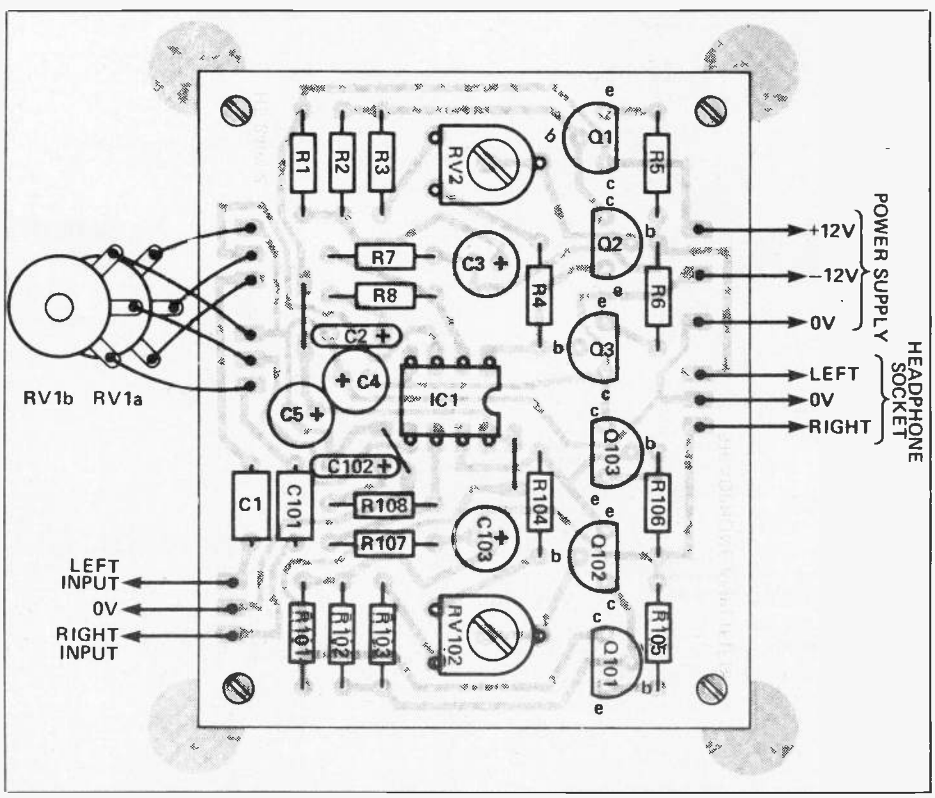


Figure 1. The PCB layout. Make sure that the pots are securely soldered.

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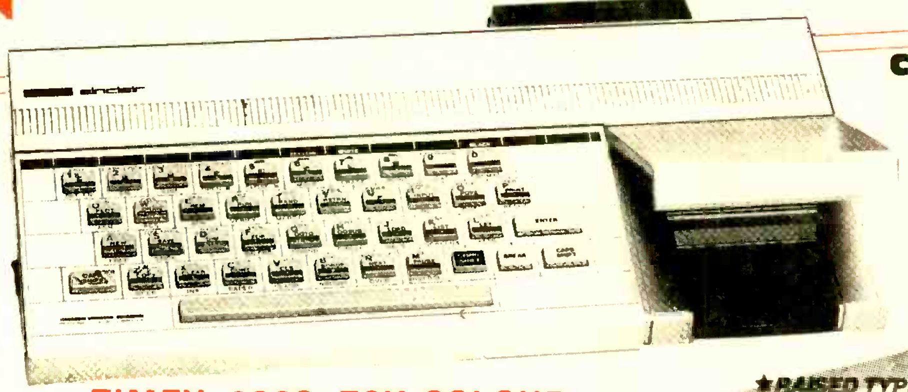

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Math Wizadry*	$24.95
Dragmaster	$24.95
Chess	$39 95
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Gulpman	$34 95
Assembler	$34.95
Disassembler	$34.95
Cyberzone	$34.95
Fun Golf*	$24.95
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*New

NEW *Just Arrived*

Centronics Parallel Interface for 2068

$169.95
Model CI-2068

- Outputs text and full hi-res graphics to Centronics parallel printers
- Includes 54 in printer cable
- Plugs into output port — no other connection required
- Special price $159.95 (save $10.00) when purchased with any Smith Corona printer

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PRODUCT INFORMATION
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Our 19th year

Still Available at Sale Price

Save $25 on Data-Recorder
$54.95 (was $79.95)

- LED indicator for SAVE or LOAD mode
- LOADING or SAVING sound monitoring
- Tape counter
- Built-in voltage stabilizer
- Fast-forward and rewind for faster manual search

New Hardware for Timex Sinclair

TS-2050 Modem

$229.95 3 or more at $215.00 each

- Works with ZX81, TS1000, TS1500, TS2068
- Auto answer, auto dial
- Direct connect — plugs into phone jack
- Includes terminal software
- Perfect companion to Compuserve Starter Package

Now your computer can talk to other computers! Plus there are a wide range of telecommunications data base services to which you can subscribe, from stock market information to shopping to banking. Your T/S 2050 modem opens a new world of information to you. Compatible with all Timex Sinclair computers.

2068 BUSINESS SOFTWARE

PURCHASE LEDGER™ **$49.95**
Prepares statements, tracks purchases and automatically calculates tax. Formats printout to TIMEX 2040 or 80 column printer.

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All the features of the above, but for sales.

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Balances check register, provides totals for 17 ledger accounts and handles up to 10 standing orders monthly. Formats printout to 2040 or 80 column printer.

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Includes all three of the above (SAVE $20.00)

S.C.A.M.™ **$99.95**
Sinclair Computer Accounting Method
Fully integrated!!! 64 column screen display!!

Ledger Accounts, Accounts Receivable, Accounts Payable, Payroll and Merchandise Inventory

These 5 accounting programs were developed for small business as an alternative to programs offered only on expensive micros or main frame computers. User prompts guide the book-keeper. All programs are menu driven and written in BASIC for easy modification. Virtually all your small business accounting needs have been met in this remarkable program.

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THE REAL TASWORD TWO™ **$79.95**
The professional standard word processor for the 2068
- 64 characters to screen and 2040 printer
- Outputs to full sized printers with centronics interface (listed above) for professional documents!

Featuring • Written in Machine Code for rapid operation. • Automatic word-wrap to keep your text neat. • Right justifying on demand or ragged right if you wish. • Block move and copy. (speeds up editing).

TASPRINT™ **$39.95**
If your printer does not have a lot of special modes, TASPRINT gives them to you. Allows you to print documents in 5 different type-styles on your dot matrix printer. Also, provides underline, boxed and inverse printing. All type fonts have true descenders (attention Seikosha or Gorilla Banana owners!) and may be merged with Tasword or your own BASIC programs.

TASWIDE™ PRINT UTILITY **$34.95**
Allows your "BASIC" programs to output the display in 64 columns to your T.V. or printer!

NEW FOR 2068

RUN SPECTRUM SOFTWARE ON THE 2068!
Simply plugs into 2068 port and will run software written for the Sinclair Spectrum. Over 1000 titles available!
Order no. SP-1 **$99.05**

RUN ZX-81 / TS 1000 SOFTWARE ON THE 2068!
The most valuable piece of 2068 software written! The "Upload 2000" will automatically convert ZX-81/TS-1000 BASIC programs into 2068 codes. Many programs can be resaved in the new format but all BASIC programs can be run normally.
Order Up-Load 2000 **$69.95**

Circle No. 29 on Reader Service Card

Save on Gladstone favourites . . .

Sinclair/Timex Users

Sale prices continue — many new items

Speech Pack

was $144.95

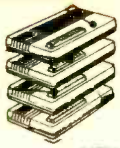
$89.95

Add high quality solid-state speech to your ZX81 or TS1000. Many applications in personal computing, education, and industry. DCP Speech Pack contains all the letters of the alphabet, numbers zero to over a million, and some other general words. Easy to use under ZX81/TS1000 control using POKE commands (fully explained in manual). The DCP Speech Pack connects directly onto rear of ZX81. It can be used in addition to a RAM Pack, Printer, or other accessories. Contains its own speaker and volume control, and allows an external extension to be added. Additional Word Pack ROMs are available and simply plug into sockets inside the Speech Pack to extend the vocabulary of the unit.

BASICARE MODULES STILL AVAILABLE

ITEM	PRICE
Personna	$79.95
Minimap	79.95
Ram 16	69.95
Ram 64	199.95
DROM	99.95
TOOLKIT	59.95
PERICON a	69.95
PERICON b	69.95
PERICON c	99.95
PERICON d	79.95
SONUS	79.95

FREE PUBLICATION-
Ask for "HOW TO GROW INTO 1 MEGABYTE ON YOUR ZX-81" Explains the BASICARE CONCEPT.



0000	ROM (8K)
2000	TOOL (8K)
4000	FILE A (16K)
8000	DATA (8K)
A000	PATH (4K)
B000	SLOT (4K)
	FILE B (16K)

ZX99 Automatic Tape Controller

Was $225.00

Clearout **$89.95**

- Controls up to 4 tape recorders
- For ZX81
- Allows full RS232 output to printer

The logical extension to the ZX81 giving data processing

***MANY SPECIAL FEATURES**

AUTOMATIC TAPE TO TAPE COPY: You can copy any data file regardless of your memory capacity (a C90 has approx. 200K bytes on it) as it is loaded through the Sinclair block by block.
TAPE BLOCK SKIP without destroying the contents of memory.
DIAGNOSTIC INFORMATION to assist in achieving the best recording settings.
The ZX99 contains its own 2K ROM which acts as an extension to the firmware already resident in your ZX81'S own ROM. The ZX99's ROM contains the tape operating system, whose functions are accessed via Basic USR function calls. Each function has an entry address which must be quoted after the USR keyword. All of the functions can be used in program statements, or in immediate commands (i.e. both statements with line numbers and commands without them).

***DATA PROCESSING**
The ZX99 gives you full software control of up to four tape decks (two for loading and two for saving) allowing 'mixing' of data files to update and modify them. This is achieved by using the remote sockets of the tape decks to control their motors as commanded by a program.

***PRINTER INTERFACE**

The ZX99 has a RS232C interface allowing you direct connnection with any such serial printer using the industry standard ASCII character code (you can now print on plain paper in upper and lower case and up to 132 characters per line.)

International Publishing (IPS) Factory Authorized Clearout on ZX81 Software Tapes

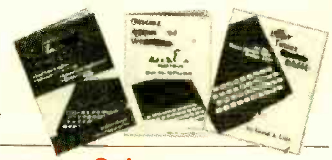
TITLE	M.S.L.	SALE
Mr. Munchee	19.95	5.95
Z-Aid	19.95	9.95
Froggie (Frogger)	24.95	5.95
Galaxy Invaders	19.95	5.95
Greedy Gulch	24.95	5.95
Blackjack	19.95	5.95
Magic Mountain	14.95	5.95
Around Europe	14.95	4.95
Home Money Mgr.	19.95	6.95
Planet of Fear	14.95	4.95
Zombies	19.95	5.95
Constellation	14.95	5.95
Personal Financial Planning (2 tapes)	29.95	12.95
Busniess Pack 1	39.95	12.95
ZX Assembler	19.95	9.95
ZX Forth	39.95	14.95
ZX Bug	19.95	9.95
Fastword (works only on Memotech Rams)	24.95	19.95
Fastload	24.95	19.95
Tiny Logo	24.95	9.95
Marine Rescue	12.95	5.95
ZX Galaxia	15.95	5.95
Shell Game	19.95	5.95
Slots	16.95	4.95
Battleship	15.95	5.95
Pop Star	12.95	4.95
Project Scheduler	14.95	5.95
Speed Snake	19.95	5.95
Catacombs	19.95	5.95

Books for ZX81, TS1000 & TS1500

Publisher's Clearance Sale

TITLE	M.S.L.	SALE
Not only 30 Programs	16.95	6.95
Makeing the Most of ZX-81	16.95	6.95
ZX-81 Pocket Book	16.95	6.95
49 Explosive Games	16.95	5.95
TS-1000 Users Guide	17.95	5.95
Getting Acquainted With ZX81	16.95	8.95

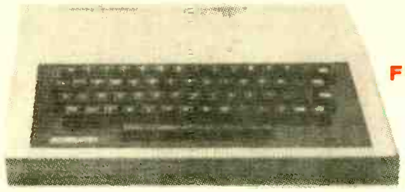
Our Best Selling ZX-81 Title-
Mastering Machine Code on Your ZX-81
This is still in publication, and not available on clearance, a good buy still at 16.95.



Books for Commodore Clearance Sale

TITLE	M.S.L.	SALE
Commodore 64 Exposed	19.95	14.95
VIC 20 Innovative Computing	22.95	16.95
VIC 20 Exposed	22.95	16.95

Acorn Atom Hardware (for 12+12 models)

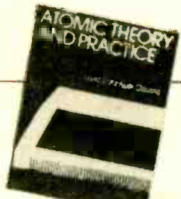


FIRST TIME OFFERED ON SALE

ITEM	DESCRIPTION	OLD PRICE	SALE PRICE
64K	Expands user Ram space to 64K - Save $300.00!	$449.95	$149.95
Colour Card	- Adds 8 colours to standard b/w Atom	79.95	34.95
MZ165	ROAM Board - Plugs into utility rom socket for selection of 3 more ROMS (total 4), and adds additional 2K Ram. Can select roms via keyboard.	139.95	79.95
MB-1	9 Volt, 1.75A Power Supply Use in any application where a power supply of these specs is required.	39.95	19.95
	5 or more		16.95
MB-3	5 Volt, 3A Power Supply	79.95	39.95
	5 - 9	79.95	34.95
	10 or more	79.95	29.95
Printer	Cable (to standard Centronics style connector)	39.95	33.95
2114	Memory chip. Priced per pack of 20 chips. (300 ns)		
	1 - 4 packs of 20	79.95	39.95
	5 - 9 packs of 20	79.95	36.95
	10 - 24 packs of 20	79.95	32.95
	25 up packs of 20	79.95	29.95
Disk Drive	I.C. set (Not previously sold separately). Plugs into Atom for connection to a disk drive.	24.95	24.95

The following items were offered on sale in previous catalogue, and are still available at same sale priceing.

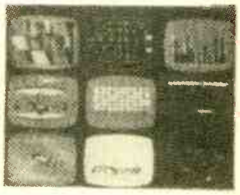
Work Pack Rom - Work Processor	89.95	44.95
Programmer'S Toolbox - 40 new Commands	69.95	39.95
Atomcalc - spreadsheet	99.95	44.95
Machine Code monitor/disassembler	69.95	39.95



Acorn Manual $14.95

Books for the Acorn Atom

GETTING ACQUAINTED WITH YOUR ACORN was 23.95 sale 15.95
39 TESTED PROGRAMS FOR ACORN ATOM was 19.95 sale 12.95



Acorn Software Clearout

Includes some new titles!

Reduced 60%

only $7.95 each

previously $19.95

DRAGONSLAYER
MUSIC BOX
ASTRAFIRE
SPACESTORM
DISSASSEMBLER
DAMBUSTER
CONSTELLATION
ZOMBIES
EARLY WARNING
MARTIANS
JUNIOR GAMES PACK
LABYRINTH
MUNCHYMAN
ASTROBIRDS
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TANGLED
DEMON DUNGEON
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ALIEN MAZE
3D OXO
YAN
CONDENSE
AZTEC
SHEEP DOG
SUPER COS
LIFE
TERRITORY
ATOMSTORE
RUN THE PARK
SHOOTOUT
LUNAR LANDING
SPACE PACK
RACETRACK
MISSLES
STOCKBROKER
SKETCH PAD
ESCAPE
REVERSI
ADVENTURE
ANTEATER
MINEFIELD
HISTATS
ROBOT / NIM
BREAKAWAY

Order any 10 for $69.95 — any 20 for $130.00

Software for VIC-20

Publisher's Clearance Sale

TITLE	M.S.L.	SALE
Subspace Striker	19.95	5.95
Guitar Pix 1 (Learn to play Guitar)	34.95	7.95
Brainstorm	24.95	5.95
Pixel Graphics	24.95	5.95
Harvester	19.95	5.95
Encounter	19.95	5.95
ZOR	19.95	5.95
Starquest	19.95	5.95
Trader Trilogy	19.95	5.95
Martians	19.95	5.95
Blob / Connect 4 (2 programs)	19.95	5.95
Calc Pro / Statistics (Spreadsheet)	39.95	19.95
Personal Home Money Management	37.95	17.95
Graph It (Graph Drawing)	22.95	12.95
Real Estate Management	37.95	15.95

Note: Vic-20 Software is on cassette, and requires 16K

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Home + Business For Commodore C 64

MADE IN CANADA

CALC-PRO Financial Spreadsheet — only $ 19⁹⁵

An easy-to-use, flexible financial spreadsheet that lets you ask those "what if?" and "how much" questions and get results quickly! CALC-PRO allows up to 64 columns and 999 rows and 95 math statements or equations making it one of the largest capacity spreadsheets available for Commodore computers. Uses the function keys to simplify operations for scrolling, setting up equations, entering data and calculating, storting a new spreadsheet, screen printing, and saving files.

CALC-PRO includes a Replicate feature that enables you to entend math statements or calculations in either a row or column direction over many cells. CALC-PRO provides the usual math functions (add, subtract, multiply and divide), and also supplies 15 trigonometric and statistical functions (such as SIN, COS, LOG, PERCENT, AVERAGE) and a logical function (IF THEN). Combined with intelligent use of color and sound, plus extensive control over the screen format, these features make CALC-PRO an incredibly useful program and exceptional value for the home or business user.

As a bonus, STAT-PAC statistics program is included providing regression analysis, mean, variances and deviations, moving average and forecasts.

A 20-page user manual is provided giving both explanations and examples on how to use CALC-PRO and STAT-PAC.

PERSONAL MONEY MANAGEMENT — only $19⁹⁵

Seven complete programs to help you gain control over and manage your personal home finances and investments.

BUDGET PLANNER allows you to establish a monthly schedule of income and expenses, and provides monthly and year to date totals in categories you define.

CHEX WATCHER records your check writing activity and reconciles your bank statement, reports if you are keeping non earning excess funds in your current account that should be put into savings or investments, and gives reports of high, low and average balances.

MY WORTH establishes personal net financial worth.

Investors will benefit from the INVESTMENT MANAGER program which records transactions, reviews your portfolio, and measures your returns.

CHARTIST records individual stock information and displays prints in point and figure format.

MARKET TRACKER builds a data base of market statistics, and plots prints data using a moving average routine.

A-LOAN displays mortgages and Rule of 78 loan schedules.

Each program is Menu-driven and is designed to be easy to use. There is a 24 page user guide provided.

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Qty.	Description & Part #	Price each	Total

TOLL FREE ORDER LINE

1-800-268-3640 Orders only

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Product Information Phone (416) 787-1448

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Ont. res. add 7% p.s. tax ______

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TOTAL $ ______

SOFTWARE YOU CAN LEARN AT A PRICE YOU CAN AFFORD.

DISKOVERY

Learning works

Helping children learn is what DISKOVERY software is all about. DISKOVERY learning is challenging and every DISKOVERY lesson helps children gain new insights, see new relationships and learn the important skills. Success in learning means success at school.

DISKOVERY software is developed by experienced educators and is soundly based on school core curriculum. Every DISKOVERY lesson is child tested!

DISKOVERY IS REAL EDUCATIONAL VALUE

DISKOVERY takes children's skill development seriously then injects the fun to make skill acquisition long lasting.

DISKOVERY LEARNING IS SERIOUS FUN

DISKOVERY acbvities are exciting, stimulating, involving – all the elements that make learning happen.

DISKOVERY software takes full advantage of your computer's color, sound and graphics to make your child's learning fun and successful.

MADE IN CANADA

ALL TITLES $ 19⁹⁵ each WAS $39.95

AGES 3 to 8 — READING SKILLS

ALPHABET FACTORY allows children to "work" with Robbie the Robot in the Alphabet Factory packing and shipping upper and lower case letters
- Upper & lower case alphabet learning
- Letter matching
- Symbol recognition
- Early reading

(Disks for Commodore 64 and Atari)

MATCH UP is 4 arcade style games that prepare children for reading and writing
- Letter, symbol, number matching & recognition
- Punctuation
- Alphabet learning
- Eye-hand coordination
- Beginning reading

(Disks for Commodore 64 and Atari)

MATH SKILLS

ADDING MACHINE teaches children addition facts using an interactive game format, fun graphics and animated action
- Adding facts
- Number comparisons
- Set combinations
- ELECTRIC REPORT CARD (Print-out option)

(Disk & cassette for Commodore 64. Disk for Apple)

TAKE AWAY ZOO lets children learn how to subtract in a fun game format
- Counting
- Set separation
- Subtraction facts
- Math practice
- Number awareness
- ELECTRIC REPORT CARD (Print-out option)

(Disk & cassette for Commodore 64. Disk for Apple)

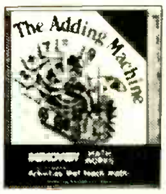
AGES 6 to 12 — READING SKILLS

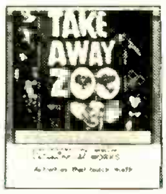
THE WORD BIRD helps children understand spatial relationships and the words that tell about them using bright, funny and exciting graphics
- Vocabulary development
- Word order
- Sentence meaning
- Spatial words
- Reading

(Disks for Commodore 64)

TIME ZONE enhances abilities to see relationships between objects in space and events in time using colorful, humorous settings
- Vocabulary development
- Word order
- Time words
- Sentence meaning
- Reading

(Disks for Commodore 64)





NEW

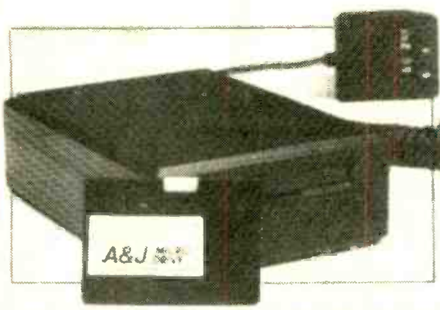
Commodore 64 Network

Up to 8 C64s or Vic-20s on 1 network!

- Up to 8 computers on one network
- Multiple disk drive use
- Can be used with most printers
- Software transparent
- Convenient on-off switch to reset the system
- Visible scanner — See where your network is at all times
- Additional extension cable lengths available

3 meters — $25.95
6 meters — $35.95
12 meters — $55.80

$349⁹⁵ each — 3 for $999.00



225K Micro Drive For Commodore 64

- Includes Centronics printer interface

$299⁹⁵

Average access time is 10 seconds — 35 times faster than Data Cassette

The features are:

- One Stringy Floppy Drive
- One Parallel Centronics Printer Port
- One Serial Port (For Daisy Chaining)
- Printer Buffer Spooler (100k)
- 18000 BAUD Transfer Rate
- Sophisticated FM Data Encoding
- Phase Lock Oscillator Recovery Circuit
- Compatible with some Disk Programs
- Switch Selectable Between Device 7 & 8
- Rugged With Only One Moving Part

Extra Micro Drive Tapes

Model M-3
1-9 — $12.95
10-24 — $10.95
25 Up — $8.95

GLADSTONE ELECTRONICS

CHRISTMAS 1984

Holiday Savings!

Timex TS-1000 personal computer

2K Memory expands to 64K

THE BEST SELLING COMPUTER IN HISTORY

OVER 1 MILLION SOLD

STILL AVAILABLE

ONLY **$39.95**

The Timex TS-1000 has just about everything you could ask for in a personal computer. Timex BASIC (the TS-1000 "language") offers features usually found only on computers costing two or three times as much. It is an ideal computer for learning programming. It is also excellent for your children's education, and for household and business management. The TS-1000 hooks up to a standard black and white television; programs are stored on an ordinary cassette recorder.

- Unique 'one-touch' key word entry: the 1000 eliminates a great deal of tiresome typing. Key words (PRINT, LIST, RUN, etc.) have their own single-key entry.
- Unique syntax-check and report codes identify programming errors immediately.
- Full range of mathematical and scientific functions accurate to eight decimal places.

COMPLETE WITH ALL ACCESSORIES

- Graph-drawing and animated display facilities.
- Multi-dimensional string and numeric arrays.
- Up to 26 FOR/NEXT loops.
- Randomize function.
- Programmable in machine code.
- Cassette LOAD and SAVE with named programs.
- 2K-byte RAM (expandable).
- Full editing facilities.

16K RAM

$49.95

We will supply Memotech or Timex RAM depending on availability

64K Gladstone RAM $99.95

2040 Printer $99.95

Works on ZX81, TS1000, TS1500, TS2068

Now you can have hardcopy printouts of your computer calculations and graphics! 32-column dot-matrix thermal printer. Full-screen, program-controlled printing. Quiet operation. Compatible with all Timex Sinclair computers.

3 rolls extra paper — $16.95

TOP 5 PROGRAMS FOR TIMEX/SINCLAIR

WERE $19.95 EACH

YOUR CHOICE $7.95 EACH

FLIGHT SIMULATION: Voted in the TOP TEN of Best Programs available for ANY MICROCOMPUTER in the U.K.. True simulation of flying a small aircraft. Excellent educational and pilot instructional aid.

BACKGAMMON: Just try and beat your micro at this game. Full board graphics. Super quich computer responses including doubling cube action for serious action!

VU-FILE: A general purpose filing system with many Database features. Options include; numerical and alphabetical sorting, ascending and descending arrangements and sample file for assisting command operations.

MUNCHYMAN: Newest "Pac" styled arcade game. Super fast M/C software makes this the best version seen to date!

VU-CALC: Constructs, generates and calculates large tables for such applications as financial analysis, budget sheets & projections and an immensely powerful analysis chart fully documented.

BASIC COURSE FOR ZX-81/TS-1000/TS-1500

WAS $39.95 **$18.95**

At last, a comprehensive all-in-one learning program for your TIMEX SINCLAIR computer. Designed to teach you to write and develop BASIC programs — no other books or aids are necessary. Every concept, every function is fully described in a simple program that you can enter on your computer in minutes. The complete BASIC course is an excellent reference work for experienced programmers (including tips on using special techniques and machine code) as well as a comprehensive step-by-step guide for complete beginners. The Complete BASIC course has over 240 pages in an attractive durable ring binder. Price now INCLUDES all major programs in the BASIC COURSE on two cassette tapes at no extra charge

NEW 50K Floppy for ZX81/TS1000/TS1500

YOU WILL WONDER HOW YOU EVER WORKED WITHOUT IT!

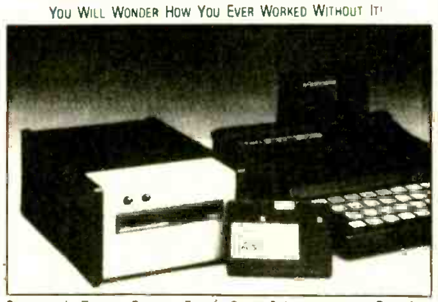
Model 82002

Micro Drive

$319.95

3 or more at $299.95 each

- Data transfer rate 10.4K baud
- 30 times faster than cassette
- Typical access time for 16K — 8 seconds
- Automatic Verify with SAVE
- Plugs into expansion port
- Up to 127 files
- Works for BASIC or ML
- Compatible with all other plug-in peripherals
- Program chaining capabilities



PICTURED IS TS1000, STRINGY FLOPPY DRIVE & INTERFACE, 16K RAM AND A MICRO WAFER

SPECIAL MICRO WAFER MYLAR BACKED TAPE FOR LONG LIFE AND HIGH RELIABILITY

MODEL M-1

1-9	10-24	25-UP
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MICRO WAFER TAPE

CompuServe $59.95

STARTER PACKAGE

WHAT IS COMPUSERVE?

CompuServe is a versitile easy to use interactive communications system designed for the computer user -- and simply connected through the phone lines. Among the over 1000 services supplied are magazines, news and weather, movie reviews, electronic banking and shopping, financial information, bulletin boards for selling & swapping, CB simulator, electronic mail, medical information, access to mainframe computers, encyclopedias, a wide variety of games, and much more.

STARTER PACKAGE: The CompuServe Starter package provides step by step instructions for the beginner on how to operate your computer to access this system. Also provides free CompuServe time, subscription to TODAY magazine, and instructions on how to sign up for this service. Now you can enter the exciting world of computer telecommunications! Order today. Gets the most from your communications hardware.

Includes 5 hours of connect Time! (A $60.00 value)

Memotech Hardware For ZX81/TS1000/TS1500

Save $50.00 on RS232 Interface

was $179.95 Now **$129.95**

RS232 Cable for above — $35.00

MEMOPACK HRG The Memopak High Resolution Graphics, with up to 192 by 248 pixel resolution, enables display of high resolution "arcade game" style graphics through its resident 2K EPROM, programmed with a full range of graphics subroutines. $99.95

GLADSTONE ELECTRONIC Supply Co. Ltd.

1736 Avenue Rd., Toronto, Ontario M5M 3Y7

Order Toll Free 800-268-3640

In Ont. (416) 787-1448

Product Information (416) 787-1448

do it yourself ROBOT KITS easy to build

* NO SPECIAL TOOLS REQUIRED
* A HANDS ON LEARNING EXPERIENCE
* MOVE TOTALLY UNDER YOUR CONTROL (BATTERIES NOT INCLUDED)

As Featured in Popular Mechanics, June 84 and ETI, August 84

Programmable Robot - 256 Step Memory

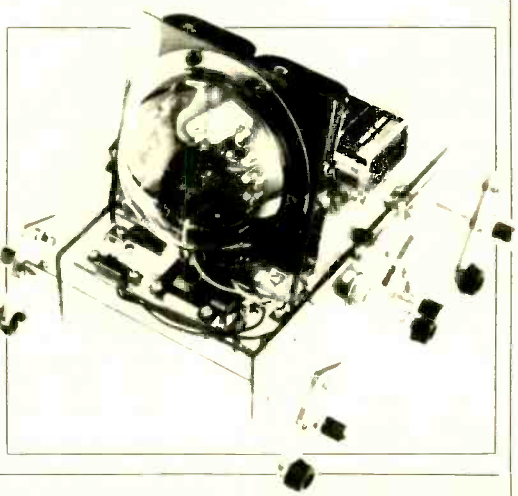
Movit MEMOCON CRAWLER 119.95

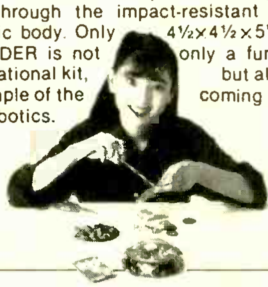
Build the CRAWLER and then program it to move according to your instructions! The CRAWLER uses a sequence function static RAM 256 × 4 bit memory. You input your control sequence of up to 256 steps through the keyboard (supplied) and the CRAWLER responds by moving according to the programmed sequence. There are five modes: forward, left, right, sound a "beeper" and light an LED; a pause step can also be built into the program. The inputted program repeats itself after it has completed its sequence. The CRAWLER is easy to build. The kit portion is purely mechanical — the electronics on the circuit boards are already built. The design is extremely ingenious using three wheels and two DC motors (requiring a 9V and two AA alkaline batteries — not supplied). The more innovative user can also interface the CRAWLER to a personal computer.

Walks on 6 Legs - Can Sense and Avoid Obstacles!

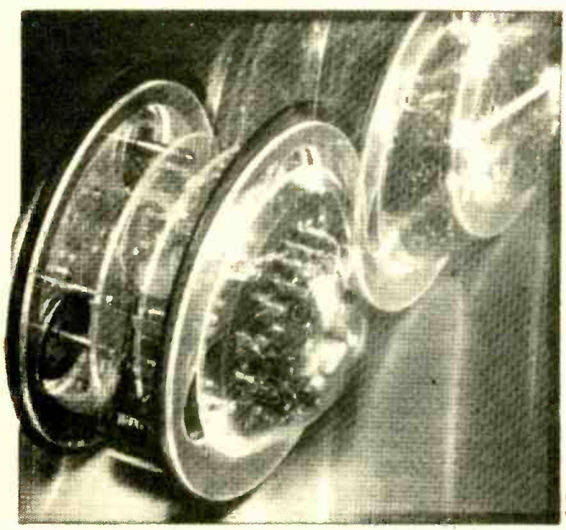
Movit AVOIDER 69.95

Featuring an INFRA-RED electronic sensor, the AVOIDER moves continuously away from any obstacles placed in its path of motion. Just like full-size robots, the AVOIDER walks and turns thanks to its two motors and 6 legs. Easy to build with preassembled/tested circuit board, the AVOIDER does not require any fancy tools. All circuits and parts are fully visible through the impact-resistant clear acrylic body. Only 4½×4½×5", the AVOIDER is not only a fun and educational kit, but also an example of the coming world of robotics.





Fully Radio Controlled
WATCH THIS ROBOT ROLL!



MOVIT

CIRCULAR

MV-935 (green)
(Sensor control PC board ready assembled)

The band new CIRCULAR model has two large wheels which roll this super robot left and right, forwards, or round and round. All the movements can be perfectly controlled by a hand-held remote control box. The CIRCULAR slips silently and smoothly along, making your friends stare in wonder, how does it move they must be asking themselves?

It's a new robot from another age and can provide endless hours of amusement for all the children, and adults too!

*Power source: Battery type 1.5V "AA" x 3 (not included) 9V x 1 Pcs.

$139.95 for use Main body. Battery type 9V x 1 for use control box.

GLADSTONE ELECTRONICS
Our qualified sales staff will be thrilled to assist you.

$64.95

* Follows any black line
* Kit contains 2 motors

LINE TRACER II

Guided by an infra-red light sensor this robot will automatically follow any black line drawn on white paper. Movement: 3 wheels driven by 2 DC motors. Control: Infra-red sensor including infra-red diode photo diode IC. How to play: Draw a black line on white paper board. Line width should be 10mm min. Narrowest turning radius 15 cm.

* POWERED BY TWO MOTORS
* MOVEMENTS INCLUDE LEFT OR RIGHT TURN, FORWARD AND STOP
* RESPONDS TO YOUR COMMANDS VIA THE WHISTLE ENCLOSED

$69.95

PIPER MOUSE

This is a super-sonic robot controlled by a single channel circuit and sound sensor. Follows your commands immediately.

* Walks on two moving legs
* Control movements by sound (e.g. — clap of hands)

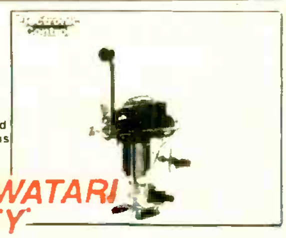
$39.95

MOVIT 917 SOUND SKIPPER

Order the Sound Skipper to walk with any sudden noise or your voice. Operates on sound sensor.

$39.95

* Climbs rope on command
* 2 moveable climbing arms

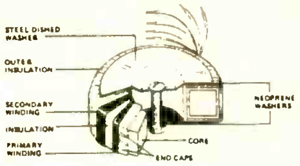


TSUNAWATARI MONKEY

Order your MONKEY to Move with a loud voice or clap to your hands and the robot starts romping along a rope and stops after a while by himself. Movement: Two alternatively moving gripper arms driven by crank motion. Control: Sound sensor, including condensor microphone transistor.

Holiday Savings!

TOROIDAL TRANSFORMERS



• LOW WEIGHT & VOLUME
Typically 50% lighter and smaller than stacked laminated core transformers. LOW PROFILE.

• HIGH EFFICIENCY
The continuously wound core has no air gap resulting in a stacking factor of 95% of its theoretical weight. Since all windings are symetrically spread over the entire round gapless core, a higher flux density is possible. The magnetic flux is in the same direction as the grain oriented silicon steel core, thus achieving very high electrical efficiencies.

• REDUCED TRANSFORMER HUM
The absence of an air gap typically provides an 8:1 reduction of induced noise. In addition, the windings enveloping the core effectively reduce magnetostriction. The main source of the familiar 'HUM' found in standard vertically laminated transformers.

• LOW IRON LOSSES
ILP toroids have Fe losses measured typically as 1.1 W/kg. These low losses provide COOLER OPERATING TEMPERATURES and LOW MAGNETIZING CURRENTS.

• EASY MOUNTING
All ILP Transformers are supplied with a simple mounting kit.

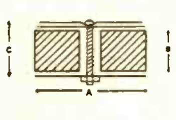
ILP STANDARD RANGE TOROIDS: General Specifications
Input Voltage: 117 VAC.
Frequency: 60 Hertz
Insulation: Primary to secondary 4KVAC
Temperature Rise: < 65 degrees Celsius
Lead Length: 7¾ in. (20cm.) P.V.C. sleeved winding wire
Output Voltage Tolerance: better than 3% @ full load

MADE IN CANADA

TYPE	RMS VOLTS	RMS CURRENT
30VA		P.O.R.
1A010	6+6	2.50
1A011	9+9	1.66
1A012	12+12	1.25
1A013	15+15	1.00
1A014	18+18	0.83
1A015	22+22	0.68
1A016	25+25	0.60
1A017	30+30	0.50
50VA		$28.00
2A010	6+6	4.18
2A011	9+9	2.77
2A012	12+12	2.08
2A013	15+15	1.66
2A014	18+18	1.38
2A015	22+22	1.13
2A016	25+25	1.00
2A017	30+30	0.83
2A028	110	0.45
2A029	220	0.22
2A030	240	0.20
80VA		$30.95
3A010	6+6	6.64
3A011	9+9	4.44
3A012	12+12	3.33
3A013	15+15	2.66
3A014	18+18	2.22
3A015	22+22	1.81
3A016	25+25	1.60
3A017	30+30	1.33
3A028	110	0.72
3A029	220	0.36
3A030	240	0.33

TYPE	RMS VOLTS	RMS CURRENT
120VA		$34.00
4A011	9+9	6.66
4A012	12+12	5.00
4A013	15+15	4.00
4A014	18+18	3.33
4A015	22+22	2.72
4A016	25+25	2.40
4A017	30+30	2.00
4A018	35+35	1.71
4A028	110	1.09
4A029	220	0.54
4A030	240	0.50
160VA		$39.95
5A012	12+12	6.66
5A013	15+15	5.33
5A014	18+18	4.44
5A015	22+22	3.63
5A016	25+25	3.20
5A017	30+30	2.66
5A018	35+35	2.28
5A026	40+40	2.00
5A028	110	1.45
5A029	220	0.72
5A030	240	0.66
225VA		$44.95
6A014	18+18	6.25
6A015	22+22	5.11
6A016	25+25	4.50
6A017	30+30	3.75
6A019	35+35	3.21
6A026	40+40	2.81
6A025	45+45	2.50
6A033	50+50	2.25
6A028	110	2.04
6A029	220	1.02
6A030	240	0.93

TYPE	RMS VOLTS	RMS CURRENT
300VA		$49.95
7A016	25+25	6.00
7A017	30+30	5.00
7A018	35+35	4.28
7A028	40+40	3.75
7A025	45+45	3.33
7A033	50+50	3.00
7A026	110	2.72
7A029	220	1.36
7A030	240	1.25
500VA		$65.95
8A017	30+30	8.33
8A018	35+35	7.14
8A026	40+40	6.25
8A025	45+45	5.55
8A033	50+50	5.00
8A042	55+55	4.54
8A028	110	4.54
8A029	220	2.27
8A030	240	2.08
625VA		$78.95
9A017	30+30	10.41
9A018	35+35	8.92
9A026	40+40	7.81
9A025	45+45	6.94
9A033	50+50	6.25
9A042	55+55	5.68
9A028	110	5.68
9A029	220	2.84
9A030	240	2.60



TYPE	DIMENSIONS (mm) A	B	C	WEIGHT (Kgms)	REGULATION (%)*
30VA	70	33	37	0.45	18
50VA	80	35	43	0.90	13
80VA	95	35	38	1.00	12
120VA	95	40	43	1.20	11
160VA	110	45	50	1.80	8
225VA	110	50	55	2.20	7
300VA	110	57	62	2.60	6
500VA	135	62	67	4.00	4
625VA	140	75	80	5.00	4

Quantity discounts available for large volume users and OEMs. Please contact us for quotation.

ILP also manufacturers custom toroid to customer specification for quantity requirements.

GLADSTONE ELECTRONICS
1736 Avenue Road
Toronto, Ont. M5M 3Y7

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1-800-268-3640
Have your credit card ready; Orders only.

POWER SUPPLY UNITS

Hybrid Regulator Modules

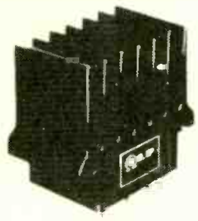
The HR314 and HR614 regulated power supplies provide a constant 13.8 volt d.c. output at up to 3 Amp or 6 Amp respectively. The modules are encapsulated to an integral heatsink and are fully short circuit protected making them suitable for home or bench running of CB, car stereos of any 12 volt d.c. equipment required for many hobby or professional applications. They require a d.c. input voltage of between 16 volts and 30 volts which can be derived easily by a simple transformer, bridge rectifier and smoothing capacitor arrangement - see PSU31 and PSU56 later in this data sheet.

TECHNICAL SPECIFICATIONS

MODULE	HR314 $34.95	HR614 $61.95
Output Voltage	+13.8v ±15%	+13.8v ±5%
Output Current	Up to 3A	Up to 6A
Current limit (nominal)	3.5A approx.	7A approx.
Maximum Input Voltage	+30v	+30v
Minimum Input Voltage	+16v	+16v
Maximum Input Voltage for nominal output current	+20v	+20v
Maximum output current at 30v input	1.8A approx.	3.5 approx.
Output ripple (100Hz) - See Note 1	<10mV rms	<10mV rms
Size in mm & inches	76x68x40mm high (3.0x2.7x1.6")	120x78x40mm high (4.7x3.1x1.6")

Power Supply for HR314	
30048 Transformer (ILP toroid)	$31.95
PCB310 Printed Circuit Assembly	$26.95
Power Supply for HR614	
50048 Transformer (ILP toroid)	$39.95
PCB560 Printed circuit assembly	$42.58

HSC2412 Hybrid Switching Converter



$ 99.95

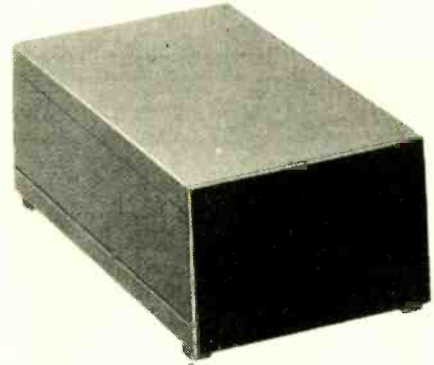
The HSC2412 is a modular power converter designed for use in commercial vehicles or situations where the supply voltage is nominally 24V d.c. and there is a requirement to run 12V audio, entertainment or communication equipment. The high efficiency of the unit will result in lower battery drain than conventional dropper or regulator circuits or from using split supplies from the battery.

The converter is encapsulated in an integral heatsink making a compact and reliable unit which is resistant to high humidity levels.

TECHNICAL SPECIFICATION

Input voltage range (See note 1)	20 - 30V d.c.
Output voltage	13.6 ±2%
Ourput current (See note 2)	3A continuous
Efficiency	>80% at 3A Load over full input range
Ripple	<0.2V peak to peak
Switching frequency	>6KHz
Regulation	±0.1V of nominal
Fuse Rating	5A fast blow
Dimensions	70mmx95mmx48mm (2.76"x3.75"x1.9")
Fixing Hole centres	40mm (1.575 oz.)
Operating Temperature Range (See note 3)	-25°C to + 70°C

ILP METAL UTILITY CABINETS

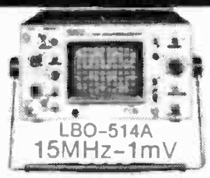


The same cabinets as used in ILP audio kits, these unique "unicase" cabinets are ideal for providing quality housing all kinds of electronic projects — power supplies, amplifiers, test equipment. Constructed using an ingenious aluminum panel design, these are quality cabinets that will protect as well as make your projects look sharp. Each cabinet includes 2 extruded panels for top and bottom, 4 blank panels for front and back, assembly hardware, and self adhesive feet for the finishing touches. Manufacturers and quantity users please contact us for volume pricing.

Part No.	Size (W × H × L) Inches	Price Each
UNO64214	4.75 × 2.5 × 8.5	$29.95
UBO64107	4.75 × 2.5 × 4.2	$24.95
UNO104214	4.75 × 4.1 × 8.5	$29.95
UBO104107	4.75 × 4.1 × 4.2	$24.95

LEADER TEST INSTRUMENTS

5"CRT. DUAL TRACE

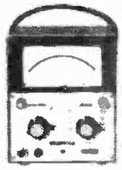


$919.00

Sensitivity	5mV/div (1mV: GAINX5)
Bandwidth	DC (2Hz) ~ 15MHz
Vertical Mode	CH-1, CH-2, CHOP, ALT, X-Y
Sweep Speeds	0.5μs/div ~ 200ms/div
Sweep Magnification	X5 ±5%
Synchronization	Automatic, Normal
CRT	130mm, 8 x 10div (1div = 1cm)
Size (W.H.D)	290 x 160 x 375mm
Weight	7.8 kg

ELECTRONIC MULTIMETER

LEM-73A



$232.00

DC Voltage	0.3 ~ 1000V
AC Voltage	0.3 ~ 1000V
AC/DC Current	30μA~300mA f.s., 8 Ranges
Resistance	0.2Ω ~ 500MΩ
Display	Analog
Operation	Manual
Battery	—
Size (W.H.D)	150X175X125mm
Weight	3kg

ATTENUATORS

LAT-45

$325

$499.95

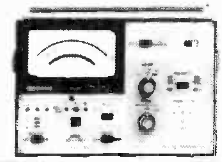
LAT-48

Input/Output Impedance
600Ω (LAT-45), 75Ω (LAT-48)
Attenuation Range
0.1dBX10, 1dBX10, 10dBX9 (LAT-45)
1, 2, 3, 6, 10dBX1, 20dBX3 (LAT-48)
Frequency Response
DC~100kHz (LAT-45),
DC~150MHz (LAT-48)
Accuracy ±0.2dB (LAT-45)
Size (W.H.D)mm
300 X 100 X 150 (LAT-45)
222 X 56 X 46 (LAT-48)

Automatic Transistor Checker

Measurement DC PARAMETER

LTC-906A

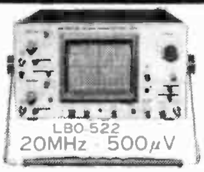


- Automatically Identifies Leads
- Automatic Good/Bad Check
- In and Out of Circuit Testing

$329.00

Auto Test Measuring Mode: Good/Bad, Identify PNP/NPN, Identify Base/Gate.
DC Parameter Mode
Measurement Range:
VD, VBE ... 0 ~ 3VDC
ICEO .... 0 ~ 10000μA
HFE .... 0 ~ 10000
Size (W.H.D) & Weight
210x140x75mm, 1.1kg

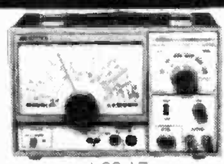
6"CRT. DUAL TRACE



$1049.00

Sensitivity	5mV/div (500μV: MAG X 10)
Bandwidth	DC (10Hz) ~ 20MHz
Vertical Mode	CH-1, CH-2, CHOP, ALT, ADD, CH-2 Invert
Sweep Speeds	0.2μs/div ~ 0.2s/div
Functions	ALT trigger, Hold off, X-Y, TV-V/H
CRT (Rectangular)	150mm, 8 x 10div (1 div = 1cm)
Size (W.H.D)	290 x 160 x 375mm
Weight	8.5kg

SIGNAL GENERATOR

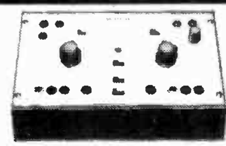


LSG-17

$229.95

Freq. Range	100kHz ~ 150MHz (up to 450MHz on harmonics)
Output Voltage	0.1Vrms (no load)
Output Control	HIGH/LOW selected
Modulation	Internal: 1kHz; Ext.: 50Hz~20kHz
Audio Output	1kHz, 1V or more
Size (W.H.D)	238x150x130mm
Weight	2.5kg

CURVE TRACER



LTC-905

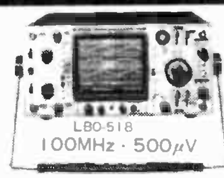
$279.95

Characteristics curves on a scope

Collector/Sweep:	
Sweep Freq.	120Hz
Sweep Voltage	10~100V
Current	100mA max.
Step Generator	10μA~2mA
Size (W.H.D)	240X90X170mm
Weight	2kg

4 CH · 8 TRACE DELAYED/ALT. SWEEP

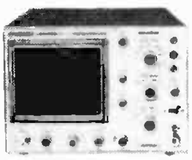
Reduced $321
was $3320.00
$2999.00



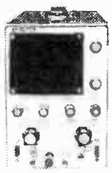
Sensitivity	5mV/div (500μV: MAGX 10)
Bandwidth	DC (10Hz) ~ 100MHz
Vertical Mode	CH-1, CH-2, CH-3, CH-4, ADD, CHOP, ALT, Dual, Triple, Quad & X-Y
Sweep Speeds	Sweep A: 20ns ~ 0.5 s/div; Sweep B: 20ns ~ 0.5 s/div
Functions	Delayed & ALT sweep, ALT trigger, Hold-off, B ends A
CRT (PDA 20kV)	150mm, 8 x 10 div (1div = 1cm)
Size (W.H.D)	305 x 145 x 400mm
Weight	9.5kg

OSCILLOSCOPES (RECURRENT SWEEP)

LBO-510B 4MHz



LBO-310A 4MHz

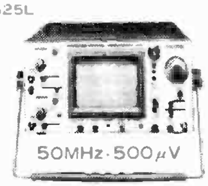


$529.00 $350.00

MODEL	LBD-510B	LBD-310A
Sensitivity	20mVp-p/div or better	20mV/div or better
Bandwidth	DC (2Hz) ~ 4MHz	DC (2Hz) ~ 4MHz
Sweep Speeds	10Hz ~ 100kHz, 4 steps	10Hz ~ 100kHz, 4 steps
Synchronization	Internal, External, Line	Internal
CRT	130mm, 8 x 10 div (1 div = 1 cm)	75mm, 8 x 10 div (1 div = 6 mm)
Size (W.H.D)	250 x 175 x 375mm	125 x 180 x 300mm
Weight	7 kg	4 kg

DUAL TRACE DELAYED SWEEP

LBO-525L NEW

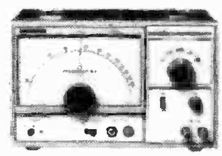


$1895.00

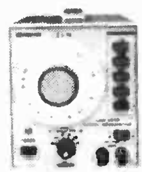
Sensitivity	5mV/div (500μV: MAG x 10)
Bandwidth	DC (10Hz) ~ 50MHz
Vertical Mode	CH-1, CH-2, CHOP, ALT, ADD, CH-2 Invert
Sweep Speeds	Sweep A: 0.2 μs ~ 0.2 s/div; Seep B: 0.2 μs ~ 0.5 ms/div
Functions	Delayed Sweep, ALT trigger, Hold-off, X-Y, TV-V/H, Delay Line
CRT (PDA 12 kV)	150mm, 8 x 10 div. (1 div = 1 cm)
Size (W.H.D)	290 x 160 x 375mm
Weight	7.5 kg

AUDIO SIGNAL GENERATORS

LAG-27



LAG-120A



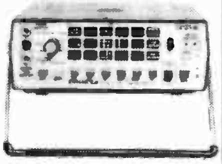
$259.00 $429.00

MODEL	LAG-27	LAG-120A
Frequency Range	10Hz ~ 1MHz, 5 Ranges	10Hz ~ 1MHz 5 Ranges
Amplitude Control	HIGH/LOW	0 ~ 50dB attenuator
Sine Wave	Level: 5Vrms (no load) Distortion: 200Hz ~ 100kHz, 0.5%	Level: 3Vrms, 600Ω Distortion: 500Hz ~ 20kHz, 0.05%
Square Wave Burst Output	5Vp-p, Rise time 200ns	3Vp-p, Rise time 200ns
Size (W.H.D)	238 x 150 x 130mm	132 x 150 x 250mm
Weight	2.5kg	3kg

NTSC COLOR PATTERN GENERATORS

LCG-396

LCG-397

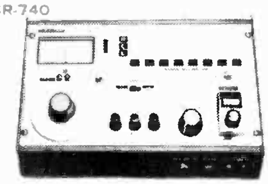


$1395.00 $339.00

MODEL	LCG-396 (NTSC)	LCG-397 (NTSC)
Patterns	11 Patterns	18 Patterns
Color bars	Full-field/split-field color bars	Offset subcarrier type 10 color, 3 color & rainbow
Patterns	Dots, Crosshatch, 4-Rasters, Staircase	Dots, Crosshatch, Raster, Vert./Hor.-Lines
RF Output	USA: CH-5, CH-6	USA: CH-5, CH-6, VIF
Video Output	1Vp-p (into 75Ω load)	2Vp-p (open circuit)
Size (W.H.D)	200 x 120 x 300mm	160 x 62 x 12mm
Weight	3.2kg	0.7kg

LCR BRIDGE

LCR-740

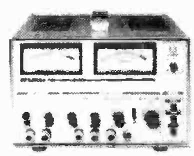


$520.00

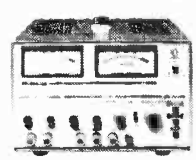
Resistance Measurements:	
Range	0.001Ω~11MΩ
Resolution	1mΩ
Capacitance Measurements:	
Range	1pF~11,000μF
Resolution	1PF
Inductance Measurements:	
Range	0.1μH~1100H
Size (W.H.D)	240X85X170mm
Weight	2kg

DC TRACKING POWER SUPPLIES

LPS-151 NEW



LPS-152 NEW



$929.00 $1090.00

MODEL	LPS-151	LPS-152
Output Voltage	0~+6V, 0~±25V	0~+6V, 0~±25V
Output Current	0~3A, 0~±0.5A	0~5A, 0~±1A
Ripple Voltage	Less than 3 mVp-p	Less than 3mVp-p
Voltage Meter	0~7V, 0~30V	0~7V, 0~30V
Current Meter	0~3.5A, ±0~0.6A (F.S.)	0~6A, ±0~1.2A (F.S.)
Size (W.H.D)	215x132x332mm	215x132x360mm
Weight	6.1 kg	7.5 kg

HOLIDAY SAVINGS GLADSTONE ELECTRONICS WINTER '84/'85

Always a winner at Gladstone's

thandar

Professional Test Instruments

thandar LCD Digital Multimeter

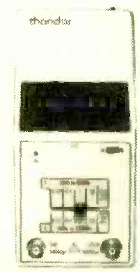
TM354 $124.95

- 2000 hours battery life
- DC Volts: 1mV to 1000 volts
- AC Volts: 1V to 500 volts
- DC Current: 1uA to 2A
- Resistance: 1 ohm to 20 Meg
- Diode check

The Thandar TM354 is a very compact 3½ digit hand-held multimeter featuring a large 0.5" liquid crystal display, 0.75% accuracy, and exceptional 2000 hour battery life.
The meter provides five functions in 14 ranges permitting accurate measurement of DC and VC volts, DC current, resistance, and diode check. The unit is supplied with a set of test leads, protective vinyl pouch, and instruction booklet. Has overrange indication, plus reverse polarity indication. Housed in rugged ABS plastic case measuring 155 × 75 × 30mm and weighs only 165 grms. Fully guaranteed for one year.

200 Meg Frequency Counter

20Hz to 200MHz



- ★ Pocket Size
- ★ 8-digit L.E.D. Display
- ★ Frequency range 20Hz – 200MHz
- ★ Resolution 0.1Hz
- ★ Sensitivity typically 10mV rms
- ★ Timebase accuracy 2ppm
- ★ Battery life 10 hours
- ★ Frequency; 2 ranges, 4 gate times
- ★ BNC Input Sockets

$195.00

PFM 200A

FUNCTIONS

Range A

Frequency Range	20Hz 10MHz
Gate Times	0.01 to 10 secs in 4 decade steps
Readout	kHz
Resolution	100Hz to 0.1Hz in step with gate times of 0.01 to 10 secs
Accuracy	(1 count + timebase accuracy)

Range B

Frequency Range	5MHz 200MHz
Gate Times	0.02 to 20 secs in 4 decade steps
Readout	kHz
Resolution	1kHz to 1Hz in step with gate times of 0.02 to 20 secs
Accuracy	(1 count + timebase accuracy)

Canada's Most Popular Portable Scope

- Full performance
- Light weight - 2½ lbs.
- Only 2" thick!

$480.00

SC110 LOW POWER PORTABLE OSCILLOSCOPE

* 10 Meg Bandwidth

The new Thandar SC110 represents a breakthrough in oscilloscope development. For the first time every engineer, serviceman and technician can carry the most fundamental piece of electronic test gear with him everywhere - an oscilloscope. The SC110 is less than 2 inches thick and weighs under 2 pounds, yet it has the performance of a standard bench oscilloscope.

Oscilloscopes have been described as portable before, but until now none has achieved the low weight, low power consumption, or good ergonomic design that are the essence of true portability.

A light, slim but tough package

The weight of the SC110 has been kept to a minimum. Even with the heaviest disposable batteries fitted it weighs under 2½ lbs. Despite the clear and easy to operate controls, the size has also been minimized and the complete oscilloscope is under 2 inches thick. The result is an instrument that can be taken anywhere, slips unobtrusively into a briefcase or toolkit, can be held in one hand, or operated whilst slung around the neck, in the optional carrying case.

DISPLAY. 32 x 36 mm blue-white, medium persistence, 5 horizontal x 4 vertical divisions. Adjustments: intensity, focus, trace rotate.

VERTICAL DEFLECTION (Y input). 10mv/div to 50V/div in 12 ranges. Bandwidth D.C. to 10 MHz 3 db at 1 div. 1 Megohm input impedance. Maximum input 350V (DC & A.C. peak)

HORIZONTAL DEFLECTION (X input) – switch selectable. 0.5V/division sensitivity. Bandwidth D.C. to 2 MHz 6 db. Maximum input 2.5V, protected to 250V rms.

TIMEBASE – switch selectable. Sweep times, 0.1 uS to 0.5 secs/division in 21 ranges. Calibrational accuracy 3%.

TRIGGERING CIRCUIT. Internal or external switchable. Coupling, A.C., D.C. T.V. frame, or T.V. line.

Full-sized performance

The SC110 has a 10MHz bandwidth and sensitivity down to 10mV per division. Full trigger facilities are provided, including Bright Line and Auto with TV Line and Frame filtering.

Ultra low power consumption

The SC110 is based around a 2" diagonal CRT which requires extremely low power both in the heater and in the deflection circuits. This, combined with specially developed circuitry which automatically shuts down unwanted sections of the instruments, means that the SC110 can operate for very long periods on low cost disposable batteries as well as rechargeables. In the standby mode, power drain is typically 350 milliwatts.

Superb Ergonomic design

The SC110 has a similar front panel layout to a high cost bench oscilloscope. Timebase speed and Y- sensitivity are set by simple, clear, rotary switches. Function and trigger controls are positive, unambiguous push-buttons. The screen graticule is divided into 5 x 4 divisions, and the trace is bright and sharp.

Oscilloscope Probes

x1 Probe	$34.95
x10 Probe	$34.95

Rechargeable Battery Pack	$34.00
X/X10 Probe	$39.95
Case	$29.95
AC Adapter	$16.95

Prescalers

TP 600 $139.00

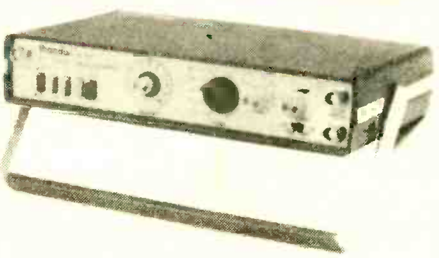
The TP600 is a high sensitivity prescaler which will extend the upper frequency limit of most frequency meters by a factor of 10 times up to a maximum of at least 600MHz.

- ★ Frequency range 40MHz – 600 MHz
- ★ Sensitivity 10mV rms
- ★ Powered direct by TF200 or TF040 .(lead supplied)

TP-1000 — As above, from 100 Mhz to 1000 Mhz **$185.00**

TG100 FUNCTION GENERATOR

$281.00



- 1Hz — 100KHz output in 5 selectable ranges
- Selectable waveforms: sine, square, and triangle
- DC and TTL outputs
- Linear sweep range greater than 300:1

An excellent value in a versatile function generator. The TG100 is an excellent example of THANDAR'S commitment to professional instrumentation at reasonable cost. Oscillator frequency is selected by a five position range switch and a calibrated vernier or controlled by the sweep input which enables the generator to be adjusted or modulated by an external voltage. The 600 ohm variable output level provides a 0.1V-10V and 1 mv-0.1V peak to peak from 600 ohm, giving 50 mv- 5V and 0.5mV-50 mV peak to peak into a 600 ohm load. DC offset is switch selectable and vernier provides adjustment of up to 5 volts from 600 ohms. AC operated.

GLADSTONE ELECTRONIC Supply Co. Ltd.

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For Product Information **(416) 787-1448**

Our 19th year

 continued from page 12

PARTS LIST

RESISTORS

(All 1/4W, 5% carbon)

R1,2,101,102	1k
R3,103	100R
R4,104	180R
R5,6,105,106	47R
R7,107	100k
R8,108	10k

POTENTIOMETERS

RV1a,b	47k + 47k log dual gang potentiometer
RV2,102	100R horiz preset

CAPACITORS

C1,101	220n carbonate
C2,102	4u7,25V tantalum
C3,103	47u, 16V radial electro
C4,5	47u, 16V radial electro

SEMICONDUCTORS

Q1,2,101,102	2N3904 NPN silicon
Q3,103	2N3905 NPN silicon
IC1a,b	LF353 dual op amp

MISCELLANEOUS

SK1	1/4 inch stereo jack socket

Printed circuit board; connecting wire; IC socket if required; 12V power supply solder etc.

Both channel components are included in the above parts list.

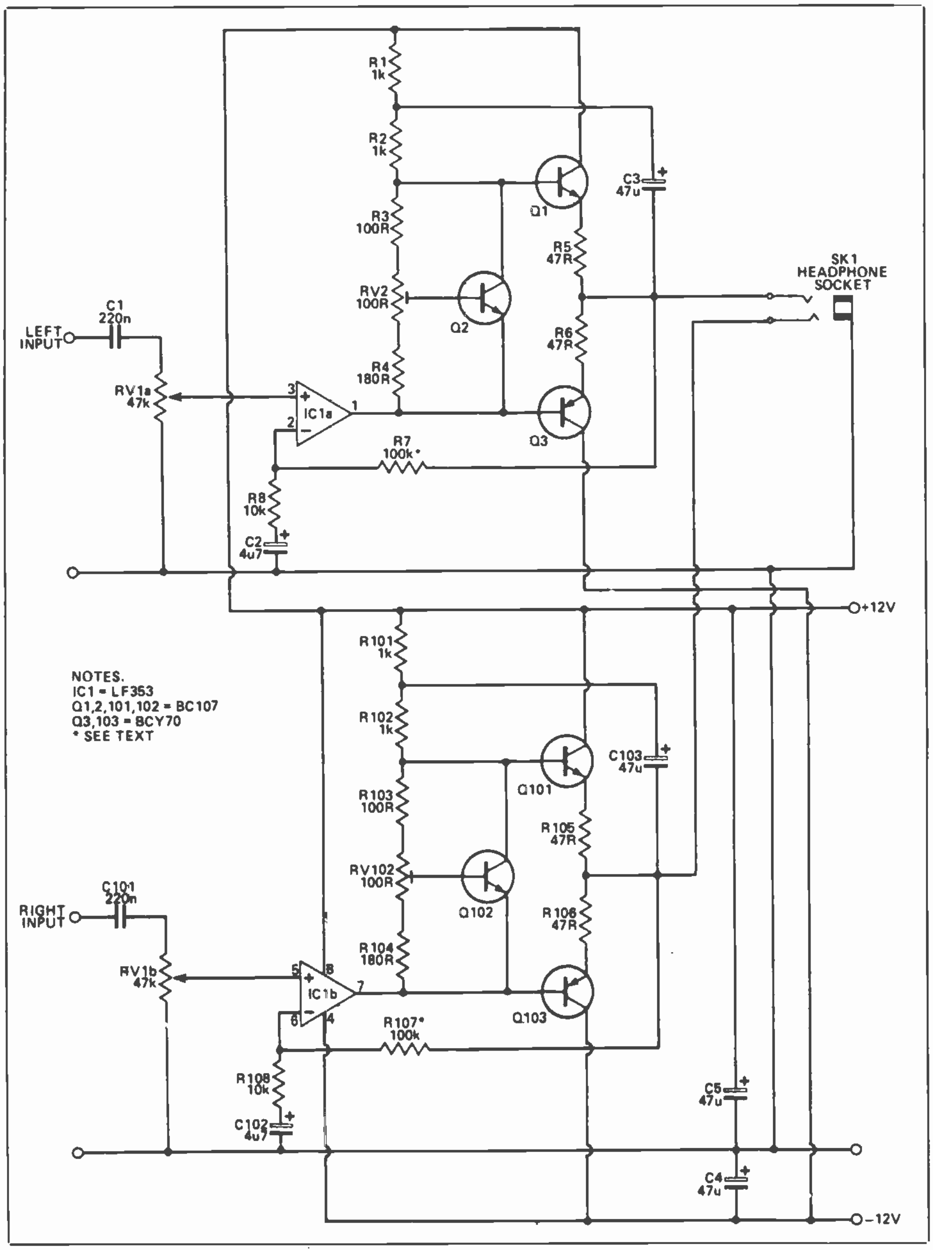
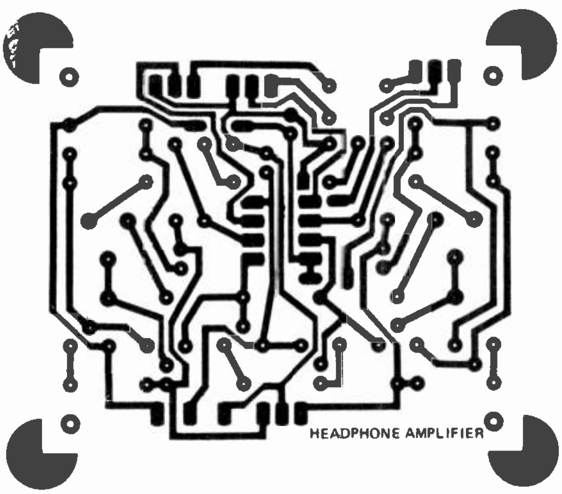


Figure 2. The circuit is straight-forward, but the construction needs care.



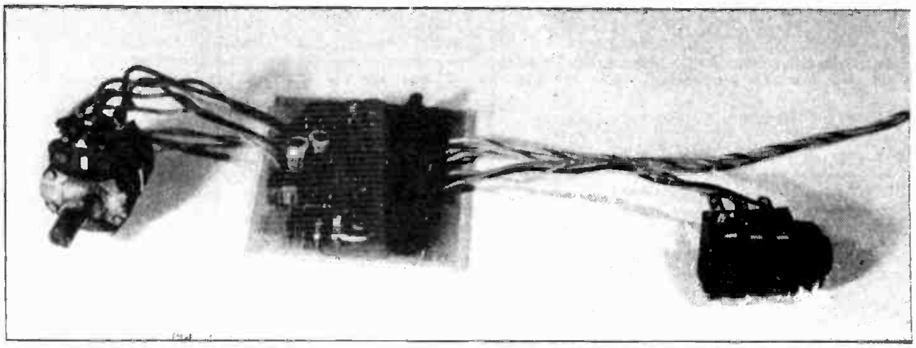
sistors should heat up due to a heavier load than anticipated. Their fairly high value also gives the advantage that the output level into low impedance headphones is limited, hopefully to safe levels.

So as not to ask too much of the op amp, a constant current source is provided to feed current through the biasing chain. If this were not done, then the op amp would have trouble sinking the current during negative signal excursions, while the bias chain would be starved of current during positive swings. This would hardly be conducive to low distortion, even though the op amp would try hard to correct for the inevitable non-linearities.

The components responsible for this constant current are R1, R2 and C3. The negative end of C3 is connected to the low impedance signal output. Therefore its positive end follows the output signal waveform. Since the output stage has a gain of unity, or in fact very slightly less, the voltage across R2 remains constant. The current flowing down through R1 varies over the signal waveform, and on substantial positive peaks current can actually flow back in the other direction.

However, as long as the time constant of C3 and the parallel combination of R1 and R2 is long enough, voltage variations across C3 are small, and therefore the constant current source is very nearly constant.

This circuit technique, more widely known before the days of cheap op-amps, is called bootstrapping.



Construction And Testing

The unit is best built on a printed circuit, the layout of which is shown in Figure 2, though constructors wishing to do so should not have too much trouble with a Veroboard layout, as long as some attention is paid to the layout of the 0V track.

Once the unit is built, connect up to the power source and switch on. Measure the DC offsets on the outputs, junction of R5/R6 (R105/R106). These should be less than about 25 millivolts — or too small to measure on most moving coil type meters.

Anything greater than this indicates a fault, and the power should be removed very quickly. First see if you can spot the short circuit or bad joint. If not, see if the appropriate op amp output is offset in the same direction or the opposite direction.

If offset in the same direction suspect the op amp, if in the opposite direction suspect the output stage.

Assuming the offsets are small, the only remaining job is to set the quiescent current of the output transistors. If you have a digital voltmeter which can read down to mullivolts, then measure the voltage across the emitter resistors of the output transistors, Q1 and Q3.

Connect one lead to the emitter of Q1 and the other lead to the emitter of Q3, then adjust RV2 for a reading of 10mV. Do the same for the right hand channel, measuring the voltage across R105 and R106 and adjusting RV102 for the same 10mV reading. The output transistors seem to work best at a low currents, so do not adjust the presets for a reading appreciably greater than 10mV.

An alternative method is to temporarily disconnect one end of one of the emitter resistors and connect a microammeter in series. Then adjust RV2 and RV102 for a current of 100u.

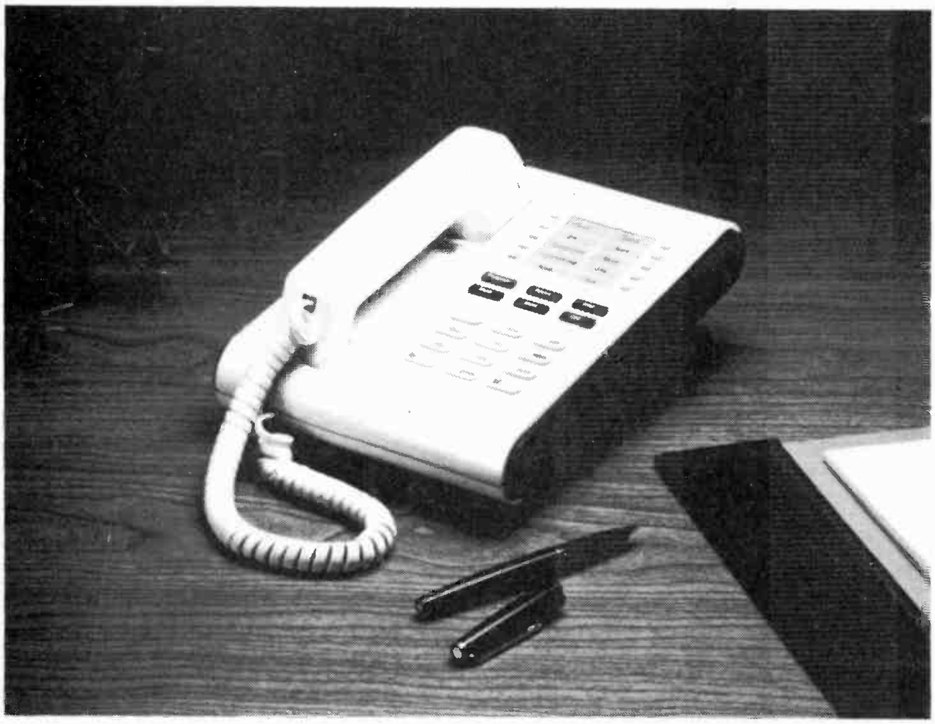
After the adjustments have been made, you can then put on the headphones and face the music! **ET**

The ABCs of Telephone Choice

A guide to the many types of telephones available now that the telephone company has been deregulated.

by Roger Allan

RECENTLY, you received an advisory notice with your telephone bill that the Canadian Radio and Television Commision (CRTC) has followed in the footsteps of its American brethren, the Federal Communications Commission (FCC) and commenced a partial deregulation of the Bell Telephone System. The little slip advised you that henceforth you would be permitted to attach your own equipment to the Bell System providing it had been certified to meet hte phone system's technical requirements. Further, as a private householder you may now rent the actual phone from Bell (as is currently done) or purchase phones. The kicker is that it will cost you an arm and a leg if something goes wrong, and Bell determines that it was not due to their phone system acting up.



This has opened up the market to manufacturers of phones such as never before. True, one has been able to buy phones from various companies to date, but most people have shied away from doing so. Now with the blessing of the CRTC, it is a whole new manufacturing ballgame.

And it's not as if the market isn't there. In 1983, the first year that the FCC deregulation of the US telephone industry finally gripped, the consumer purchase of telephones simply skyrocketed. It is to be expected that a similar situation will occur here in Canada.

The Market

For example, cordless phones, which can be purchased for less than $50 US, were sold to the tune of 4.7 million units last year (more than double the 2 million units sold in 1982), representing an expenditure of $400 million US. They now represent a market penetration of some 7% being more than double the market penetration rate of telephone answering machines, and we all know how prevalent they are. The increased sales of corded phones in the US is even more dramatic. In 1982 some 3.7 million units were sold, at a factory sales value of $200 million US. In 1983 sales had risen to 15 million units, with a factory sales value of $525 million US.

A Primer

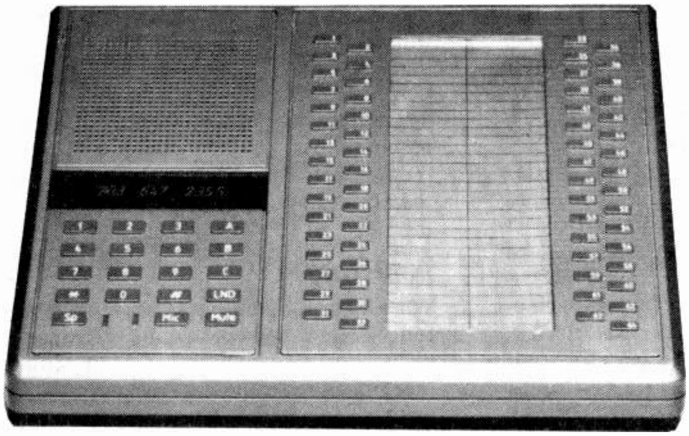
While it may initally seem a little simplistic for those into electronics, a quick one-over of what's available and what to look for is in order, if only to refresh the memory. Beginning with the basic and moving to the complex:

There are quite a variety of phones available for purchase. Standard or basic phones made by well known companies (those that one is currently renting from the phone company), as well as electronic phones by reputable dealers, are usually sturdy and reliable. Repair is usually easily available. Should you consider purchasing one, either in a desk or wall version, they are pretty safe bets. Decorator phones, such as antique models, designer phones, or cartoon character phones are also widely available, but you should check to make sure that service and replacement parts are easily available. It should be remembered that one-piece electronic phones are lightweight and easy to move around and plug in, if that is part of your requirements. Should you purchase a lower priced model, particularly the one piece version, you may find that if it breaks after the warranty has run out, it may be more economical to throw the unit away and purchase a new one.

Slightly further up-market are the multi-function electronic phones which have automatic dialing of commonly used numbers, combination phones with a clock/radio or answering machine built in, cordless phones which free one to walk around, key set phones (sometimes referred to as multi-line phones) which permit one to switch between two or more phone lines and telephone home security systems which tie into systems that monitor for fire, loss of electricity, floods, burgal intrusion, and in case of an emergency, automatically dial pre-programmed numbers, such as 911 or a number where one can be reached.

Buyer's Guide

Having determined which generic form of phone you wish to purchase, there are a number of straightforward, but easily forgotten or overlooked questions which should be asked. For example, is this to be your only phone? If so, you should make sure that it is sturdy and reliable. How



does the phone look and feel? Is it comfortable to hold and operate? Is the ring sound too loud or soft (electronic ringers sound better)? How does your voice sound to the person that you're telephoning? Has anyone you know purchased one and found that their voices sound tinny, representing cheap quality? Are service and replacement parts available? If so, who pays for shipping and how long will you have to wait for repair? If it has to be sent back to the factory, who pays for the shipping? Will a 'loaner' phone be available while it is being repaired? After the warranty expires, is the repair cost based on a flat charge, or on the repair time? If it is based on repair time, is there a minimum charge and if so how much?

Having answered those questions one now has to take a momentary step into the telephone system itself, specifically 'tones' and 'pulses'. There are, in the eyes of the telephone system, two types of phones: the touch tone phones, pushbutton models that create different 'musical' notes when you dial, the notes being read by the system as numbers and the pulse phones (sometimes referred to as outpulse of DigiPulse) which make a series of clicks or pulses when you dial. Older pulse phones are rotary, but it must be borne in mind that newer pulse phones may also be pushbutton; the button presses are converted on the final number to the slow, 10-pulse-per-second train.

Investigate the System

The important point about the above is that pulse phones, either rotary or pushbutton, are universal; they will operate on any phone line in North America (at least for the next decade or two). However, tone or touch tone phones require a different operating system. This upgraded system, being retro-fitted across the country, can handle either pulse or touch tone phones. It has the advantage that one can use the phone to tap into computers, potentially banking services (such as the one operated experimentally by the Bank of Montreal to a limited number of subscribers in Toronto, and a similar system being offered in Manitoba via the Grassroots Telidon system) and other electronic systems. AS such, you should first determine what system is currently in operation in your home area; it's no good buying a touch tone phone if the system hasn't been retrofitted yet.

If you want to get a little fancy, you can convert a pulse (eg. universal) phone into a touch tone phone via a touch tone adapter, sometimes called a touch tone generator. This is a device which is held up to the telephone mouthpiece. When a number is dialed using its push button keys, it makes touch tone sounds. Alternatively, you can purchase a switchable pulse/tone phone. This sort of phone is useful for those living in areas that have not been retro-fitted with the tone system, for it permits one to use the pulse mode (eg. universal) to make the telephone call, then to switch to the touch tone mode for entering a password or authorization code to access a computer or banking service, accesses which cannot be accomplished using a pulse phone. Further, it you are connected to a touch tone system, you can use a rapid dial phone which lets you dial out more than twice as fast.

Accessories

Once you have determined which generic form of phone you'd like, and whether it will work on your particular phone system, you come to the icing on the cake: accessories.

They are legion. Rapidly running through them, there is the mute (or privacy) button which lets one talk to someone in the room without being overheard by the person on the other end of the line. A 'hold' button does essentially the same thing, plus letting you walk away from the phone. In up-market versions, this hold button will beep every few seconds to let the caller, and you, know that you are still connected.

'Melody-on-hold' entertains the caller with music, either canned or tapped into a radio. 'Ringer selector' allows you to adjust the volume of the ring or turn it off completely. Up-market versions may have a light that will flash when the volume control is off. 'Readout' shows the phone number just dialed, elapsed time of the call (useful for long distance calls or as a way of reining in verbose teenagers) 'intercom' lets you talk to other extensions in the house or office, and 'memory' (sometimes referred to as speed dialing) gives you one or two-button dialing of frequently called or emergency numbers.

'Automatic redial' (sometimes referred to as redial or LND for 'last number dialed') automatically redials the last phone number you called, a convenience if the line was busy. Some models will also keep trying automatically. 'On hook' dialing lets you dial without picking up the handset. An up-market version of ths is the Command Dialer, reviewed in ETI's Electronics In Action, which is voice activated (eg. 'Call Fred!' and so it does).

'Speaker' phones permit talking without having to hold the handset; it may have a multi directional microphone built in so you don't have to sit right in front of the phone itself.

There are a number of other accessories. 'Auto-dialers' automatically dial commonly used numbers with the press of a single button. Answering machines, with some having voice synthesis (an artificial voice) are self-explanatory. There are amplifiers for group discussions or for the hearing impaired, locks to prevent unauthorized usage, telephone head sets for hands-free conversation, home controllers to control lights and appliances by telephone, modems to connect the home phone to a computer, etc.

There is a bit of tripping through the forest to be done in the selection of cordless phones, seemingly the 'in thing' these days. Cordless phones consist of two parts: a base station which plugs into the phone line and an electrical output and the battery powered handset. When in use, the two parts are separated, being connected via a radio signal. And there lies the problem. As they are similar to two-way radios, cordless phones are susceptible to interference from electrical noise and from other cordless phone users. If your phone should operate on the same channel as a neighbour's, especially in an apartment building, there may be interference from other people speaking on the same channel. Incoming calls may ring your phone in error. Further, and most expensively, your neighbours may be able to place calls on your phone line at your expense. Lastly, they will be able to listen in to your calls.

These problems may be solvable with a little bit of thought and a modicum of effort. You can start by having the dealer change your phone's channel (some phones let you do this yourself). A lockout security feature, built into many such devices, works such that when one places the phone's handset into the base station, another cordless user cannot dial into your base station, nor can someone use your frequency to dial out.

Guard tones are another security feature, in that your dealer (and sometimes you) can change the guard tone if you should find that your neighbour has the same channel. Digital coding lets you select one of many, sometimes hundreds, of security codes.

The range of cordless phones is a wide one; short range phones customarily operate up to one hundred feet from the base station, while long range ones can operate up to a thousand feet. However, the acutal range that you will achieve depends on building materials, electrical and electronic interference in one's neighbourhood, terrain, etc.

As with the other generic forms of phones, cordless ones have a number of accessories. 'Intercom' lets you talk from the base station to someone else with a portable handset, a 'page' (sometimes referred to as a 'call') button lets you beep handset users, alerting them to an incoming call. 'Two-way paging' lets you page the base station from the handset. 'Answer only' means one can answer incoming calls remotely with the handset, but cannot make out going calls. 'Originate/answer' means that you can dial out with your handset batteries.

As with anything made by humans, its operation is solely dependent on the smiling of the gods. Eventually, one will misread the duck's entrails, and the gods will cease to smile. You're then adrift on that sea known as 'warranties'. Warranties vary from 30 days to five years, depending on the reliability of the manufacturer and how much confidence they have in their product. It is well worth the effort to read the warranty even unto the finest of the fine print.

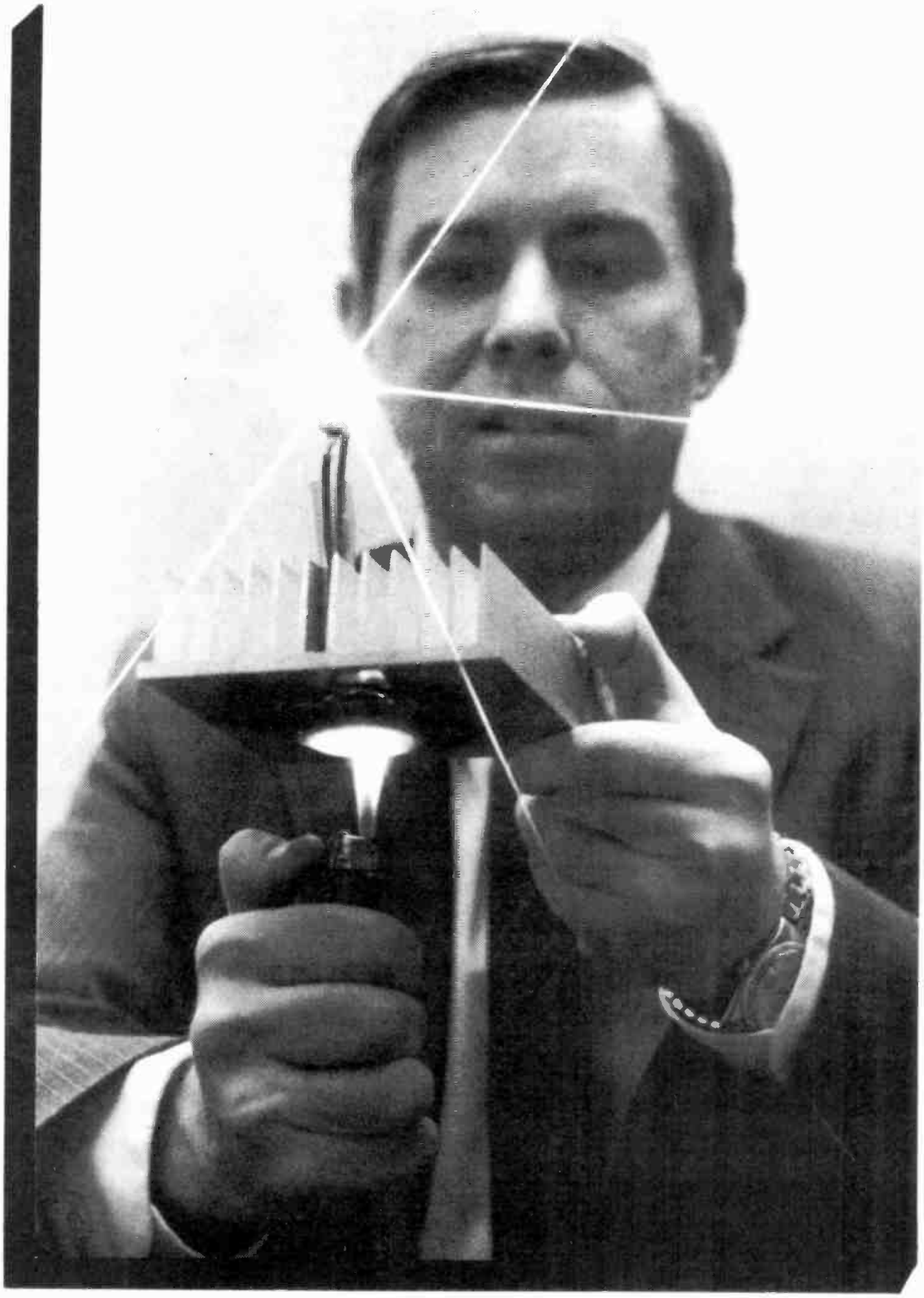
And Lastly

When all is said and done, there are really four things to be kept in mind. Firstly, is it really worth buying rather than renting (keeping in mind that service calls will cost an arm and a leg if it's not the phone company's fault)? If the answer is to purchase, then you have to find out what type of telephone system you're hooked into (does it have touch tone capability or not?). Thirdly, determine what it is that you wish to use the phone for, and choose accordingly. And lastly, read the fine print. For if the US experience is any indication, the market in this country will boom for such devices, with little companies springing up all over the place like mushrooms. And as the circus magnate P.T. Barnum oft remarked, 'There's a sucker born every minute.'

ET

OTEG Devices

Generating electricity from a heat source? Not exactly a new idea, unless you're doing it by heating a semiconductor with a flick of your lighter. Kevin Ransom gives us some insight into the development of solid-state thermoelectric devices.



SUPPOSE — just suppose — you had an inexpensive machine able to convert heat to electricity, all without moving parts. Imagine the applications...

Thermoelectrics, the conversion of heat into electricity without moving parts, was discovered more than 100 years ago. But for many years, it didn't enjoy large-scale commercial application. During the 1950's and 60's, even though there was a resurgence of interest in using thermoelectric energy conversion, lower-cost energy sources were still plentiful, limiting the use of thermoelectrics to space satellites and special applications.

But times have changed. Now, in an energy-conscious world, thermoelectrics has emerged as a viable method of converting heat — sometimes waste heat, into useable electrical power.

Recently, Ovonic ThermoElectric Co., of Troy, Michigan, began production and marketing of Ovonic ThermoElectric Generators (OTEG's), a patented product the company feels puts it one up on other such thermoelectric devices introduced thus far. The reason: the OTEG's use semiconductors made from an 'Ovonic'' material, a material that has been chemically modified and given properites that the company claims make it more versatile, and therefore superior, to the materials traditionally used as electric semi-conductors. In the case of the OTEG, that special property is its highly efficient conversion of up to 250°C of applied heat into electricity. The company claims other thermoelectric devices operate at much lower efficiency when working at such high temperatures.

Ovonic ThermoElectric is a union of Energy Conversion Device, Inc. (ECD) and American National Resources Company (ANR), an oil and gas exploration, extraction and transportation firm that recently branched out into the arena of new energy technology. The two companies became partners in 1981, but ECD has been in the energy conversion business since 1961, when scientist and inventor Stanford Ovshinsky founded the company in Detroit. Ovshinsky's premise was that certain materials could be modified in a way that altered their molecular structure. He believed that introducing molecular disorder to a meterial, made it more versatile than a material whose naturally-occurring molecular structure was more orderly.

Ovshinsky discovered that these chemically-modified substances could be used in the commercial development of inexpensive semi-conductor devices, solar cells and storage batteries.

In 1977, ECD consultant Sir Neville Mott, lent credibility to Ovshinsky's theories by winning the Nobel Prize in physics for his own studies of semiconductors made from modified, disordered substances.

The OTEG is Ovonic ThermoElectric's principal product. It is a patented solid-state device that is typically one to two inches square and contains 50 to 100 tiny (about 50/1000 of an inch) elements — made from an Ovonic substance — arranged in a grid and covered on both sides by aluminum oxide. The aluminum oxide acts as both an electrical insulator and a conductor of heat.

How OTEG's Work

The OTEG's make use of a physical phenomenon called the Seebeck effect, in which heat applied to one side of a semiconductor creates a temperature differential that causes free electrons to run toward the colder region.

Inside of an OTEG, the Ovonic semiconductors are arranged in pairs. (See drawing). Each pair is comprised of an N-type semiconductor, in which the carriers of electrical current are the negatively charged electrons; and a P-type semiconductor, in which the charge carriers are positive. The pairs are connected by conductive copper straps.

For the OTEG to convert heat to electricity, sufficient heat is applied to one side of the OTEG to create a temperature differential of about 200 degrees (Celsius) — the optimum range between the heated side and the non-heated side. The charge carriers (positive in the P-type, negative in the N-type) at the hot side of the elements become more energetic than those at the cold end. These more energetic carriers then move toward the cold end. The cold end of the P-type element is now loaded with positive carriers, making it positively charged. Meanwhile, the cold end of the N-type is now dominated by the negative-charged electrons; hence, it is negatively-charged.

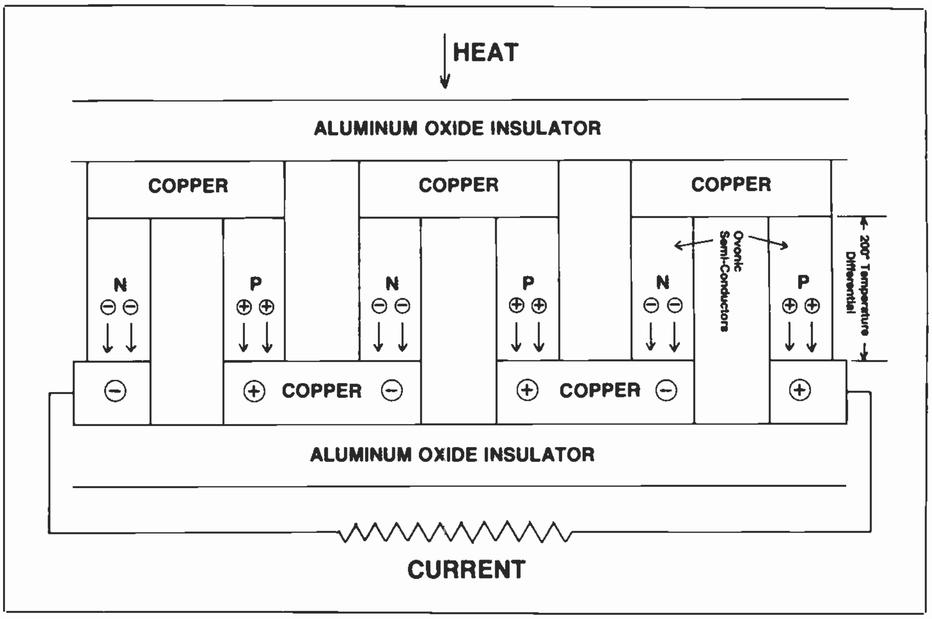
The two elements are also electrically connected at the charged cold ends — allowing electric current to flow between them, making electrical energy available for useful work.

With the 200-degree temperature differential, each pair of elements will produce roughly .08 volts. Higher voltage is attained by using 25 to 50 pairs of elements, connected in series.

OTEG Applications

Ovonic ThermoElectric is currently producing remote power generators which use several OTEG's to provide power in areas not serviced by electric companies. There are four different verisons, ranging in power output from 6 V, 100 milliamps to 24 V, 10 amps, depending on how much power is needed. They can be used as an electrical power source for oil and gas flow measurement devices, weather monitoring stations, navigational lights and radio repeaters. Additionally, a remote power generator can be used to put a positive charge into a gas or oil pipeline to protect it from corrosion caused by electrical ground current.

Ovonic has found that the biggest demand has been from companies that manufacture electronic measurement devices used to record and control oil and gas flow at wellsite and at pipeline locations, where ownership of the gas changes from a pipeline company to a gas distribution company.



An illustration of the Ovonic ThermoElectric Generator showing the N-P pairs.

Traditionally, such information has been recorded mechanically by a device called a chart recorder which records hydrocarbon flow with a jagged line on a circular paper graph. Data from these recorders, often subject to varying interpretations, have led to controversies between gas producers and gas buyers. The use of such devices also requires that technicians travel to the site, often remote, to retrieve the graph and install a new one — time-consuming and expensive, particularly if the locale is an offshore platform.

Well owners are finding that the electronic recording of such information is quicker and far more accurate. One manufacturer of electornic gas measurement devices — Nu-Tech Industries, of Oklahoma City — cites an outside test in which its measurement device recorded gas flow with a one-tenth of one per cent margin of error. Chart recorders, on the other hand, made errors of 100 per cent and higher in the same test. Nu-Tech presently has 25 of its "Nu-Flo" devices in operation in Texas and Oklahoma, with plans to expand into Louisiana.

The use of such computerized devices at remote locations requires an independent energy source. That's where the OTEG comes in. Several OTEG's are lined up on both sides of a burner face that uses a platinum catalyst to burn a small amount of gas drawn from the well. The OTEG converts that heat into electricity, which in turn powers the computer that electronically records and transmits (via Nu-Tech's radio network) the gas flow information to a central radio receiver station.

When used as a power source for navigational lights, radio repeaters or weather monitoring stations, the remote generators rely on cylinders full of propane or compressed natrual gas for primary energy. The canisters are replaced about once a month.

Future OTEG Applications

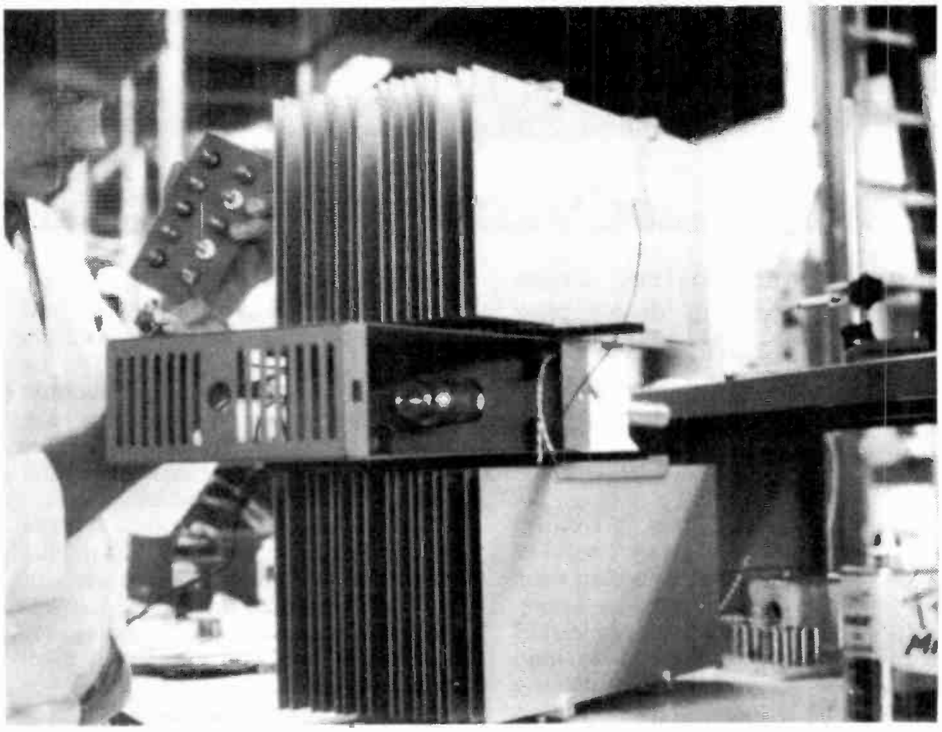
In addition, the OTEG's can convert heat from a wood stove into enough electricity to power a blower, radio, reading lamp or small water pump.

Although it is only in the prototype phase, Ovonic ThermoElectric has also developed a unit that employs a number of OTEGs to convert heat from a truck's exhaust into electrical current that would power the vehicle's electrical system, thereby elinating the need for an alternator. The company predicts a practical application of such a device within three or four years.

The technology that has produced these two devices is on that Stan Ovshinsky likes to compare with DuPont's successes with plastics in the 1950's.

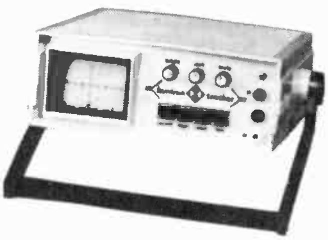
"DuPont was making incredible strides back then," recalls Ovshinsky, "You could walk up to one of their chemists with a list of desired properties — such as colour, flexibility, scratch resistence, etc. — and he'd come back to you with a material that met all your specifications. They were joining molecules together in ways that didn't exist in nature.

"That's what we're doing here, except we're working with alloys of inorganic materials instead of organic materials. We can create a new non-crystalline substance, alter its composition with certain additives and dopants, and give it electronic properties suitable for a variety of applications. We think this is an important step in the electronics industry." **ET**



Ovonic technician, Ken Richardson, checks the power ouput of the Ovonic remote power generator, which uses several OTEGs in its conversion of heat to electricity at remote locations.

ETI NEXT MONTH



Another Look at Test Equipment

We follow up this summer's look at test equipment with another: a continuing compendium of what's out there and how to get the best from it.

Signal Generator Project

A useful signal generator for the testbench; based on the XR2206 function chip, it provides sine, triangle, and square waves.

ZX81 Tape Controller Project

Switch the cassette deck on and off via software; a relay prevents interaction between input and output lines.

Machine Code Programming

Bob Bennett offers some general advice on de-bugging machine code programs before taking us step-by-step through the development of a program to convert decimal to hex.

THROUGHOUT this series I have tried to show that there is no mystery attached to machine code, no more so than when you first encountered BASIC as a computer language. And, just as you learned to use BASIC, the only way to learn machine code programming is to have a go, or, as it is sometimes put, to gain 'hands on experience.

At times I have shown machine code instructions as though they were part of a program, in order to demonstrate the effect of the instruction. to remind you: if you were to place the Z80 instruction C9h — Ret in an address and then call that address from BASIC, the computer would execute the instruction and return you immediately to the BASIC program. Nothing very spectacular about that, you might say, but that single instruction constituted a program. Obviously you will want to write programs which are longer than one byte, but somewhere in that program will be at least one RETurn instruction.

This brings me to two very important things you must always keep at the back of your mind . . . crashes and infinite loops, which are not the same thing. The simplest crash will produce an error report, while more complex ones give rise to some very exotic displays. With infinite loops, the most usual form leaves you staring at a blank screen, but the solution is always the same, just pull the plug out. This should not really be so since there should always be some form of escape route, but of course, you wrote the program in the first place, didn't you? To help you avoid problems of the kind I've just mentioned here are a few tips and pointers, which, although I have covered them in this series, you may not recognise.

It might be stating the obvious, but you should always make sure the program starts at the correct entry point, which may not be the first address of the program. I made it clear earlier that a byte could be either an instruction or a data byte, so consider the following example. The Z80 instruction to load register A with the ASCII code (of which more later) for the capital letter A would be 3E,41, with the comma representing the divsion between two adjacent addresses. If by chance (or accident!) the program started at the byte 41, the computer would now read this as Load B,C. The program following would then be interpreted in a completely different manner to that intended.

The main cause of this type of error is the miscalculation of offset bytes and addresses for JUMPing or CALLing. It is always worth doing the calculation in two different ways, for example, counting from each end of the jump in turn. Failure to include a RET in a program can cause some interesting effects, the results depending upon what the computer meets after zooming past the place where the RET should have been. Calling routines based in ROM is another potential disaster area. Quite often these routines use the full register set to work on, so before calling, preserve and register contents by PUSHing.

Even if you have got all your calculations right and your RET in, failure to match all your POPS with the PUSHES will almost certainly end in disaster. During a program, unless done deliberately, POPing in a different order to PUSHing can raise the old blood pressure. Follow the rules for nested loops and you can't go wrong (cue maniac laughter). One final point on this subject, don't blithely decrement a register pair and expect the zero flag to inform you when zero has been reached, because it won't. By way of consolation, expert programmers will have made most, if not all, of the mistakes I've mentioned, and still do! Just remember, a computer only follows orders . . . yours.

But now for something completely different I would like to show you how to develop a useful program. The one I have in mind is a decimal to hex conversion routine which I wrote for my own machine. I don't use a printer on my computer, so small routines, like the one I am going to show you, I put into the printer buffer. The program could be written entirely in machine code, but, at least for now, I'll keep the techniques simple and just give you a few lines of BASIC.

Because I will need to refer to it, and because some of you may not be familiar with it, the full ASCII code is shown in Table 1. The American Standard Code for

Character	ASCII	Character	ASCII	Character	ASCII	Character	ASCII
NUL	00	SPACE	20	@	40		60
SOH	01	!	21	A	41	a	61
STX	02	"	22	B	42	b	62
ETX	03	#	23	C	43	c	63
EOT	04	$	24	D	44	d	64
ENQ	05	%	25	E	45	e	65
ACK	06	&	26	F	46	f	66
BEL	07	'	27	G	47	g	67
BS(←)	08	(	28	H	48	h	68
HT(→)	09	)	29	I	49	i	69
LF(↓)	0A	*	2A	J	4A	j	6A
VT(↑)	0B	+	2B	K	4B	k	6B
FF(home)	0C	,	2C	L	4C	l	6C
CR (return)	0D	—	2D	M	4D	m	6D
SO	0E	.	2E	N	4E	n	6E
SI	0F	/	2F	O	4F	o	6F
DLE	10	0	30	P	50	p	70
X-ON	11	1	31	Q	51	q	71
TAPE	12	2	32	R	52	r	72
X-OFF	13	3	33	S	53	s	73
TAPE	14	4	34	T	54	t	74
NAK	15	5	35	U	55	u	75
SYN	16	6	36	V	56	v	76
ETB	17	7	37	W	57	w	77
CAN	18	8	38	X	58	x	78
EM	19	9	39	Y	59	y	79
SUB	1A	:	3A	Z	5A	z	7A
ESC	1B	;	3B	[	5B	{	7B
FS	1C	<	3C	\	5C	¦	7C
GS	1D	=	3D	]	5D	}	7D
RS	1E	>	3E	^	5E	~	7E
US	1F	?	3F	_	5F	DEL	7F

Table 1 The ASCII code.

```
2333200 two reserved
     00 bytes
233343E Ld A,n
     02 count
     01 Ld BC,nn to point
     25 to address
     5B 23333
     21 Ld HL,nn to point
     4F to start of table
     5B 23375
     F5 Push count
     E5 Push table address
     0A Ld A, (BC) with byte
     F5 preserve it
     E6 AND,n to mask off first
     F0 part
     1F RRA four times
     1F over to the
     1F right to get offset
     1F to index
     11 Ld DE,nn with zero
     00 ready for first offset
     00 byte
     5F Ld E,A first offset
     19 ADD HL,DE HL now indexed
     7E Ld A,(HL) first ASCII code
     D7 print it
23359F1 retrieve first byte
     E1 retrieve table start
     E6 mask off
     0F second part
     5F second offset
     19 now added to table
     7E get second ASCII code
     D7 and print it
     F1 retrieve count
     3D decrement it
     28 jump if zero
     03 to finish
     08 Dec BC — point BC to low byte
     18 now jump
     DDback to address 23339
        to process low byte
     C9 Return
2337530 start of ASCII code table
     31
     32
     33
     34
     35
     36
     37
     38
     39
     41
     42
     43
     44
     45
     46 end of table letter F
```

Fig. 1 Machine code program.

```
10 INPUT "Enter decimal number" ;n
20 IF n<1 OR n>65536 THEN GOTO 10
30 POKE 23332, n-256* INT (n/256)
40 POKE 2333, INT (n/256)
50 CLS:PRINT n; "=" :RANDOMIZE USR 23334
60 GOTO menu
```

Fig. 2 BASIC program.

Information Interchange (ASCII) uses the first 7 data bits (bits 0 to 6) to generate printable character or data communication codes. An example of each code would be 41h to print the capital letter A, and 0 Dh to act on a printer attached to the computer to cause a carriage return. Most computers, use either all or some of the ASCII codes.

Now, getting back to that decimal in/hex out problem, what range of decimal numbers will I need to convert? Well, there's no need to spoil the ship for two bit's worth of bytes, so to speak, so let's go the whole hog; any positive whole number up to 65536 it is. This will mean two addresses to hold the number as shown in Fig. 2, with line 30 storing the low byte (LSB) first, and line 40 the high byte (MSB) as is usual; the hex conversion representation will cover the range 0000 to FFFF.

So far I haven't put pencil to paper, but now the time has come to do so, and if you intend to follow my reasoning I suggest you do the same. What I am looking for is a possible connection between any decimal number within the range and the ASCII code for the hex conversion. This is because I want to print these characters to the screen in the machine code part of the program. Having once done the conversion the hard way, I remember that decimal 30,000 is 7530h, so I decided to use that as my starting point. Licking my pencil, I dutifully write at the top of the page 30,000 — 7530h; so far, so good. After admiring my handiwork fully for ten minutes, I suddenly realise what I am supposed to be doing. Well, I think, the MSB of the hex would be first on the screen, so I'll work on that first. Using my (t)rusty calulator I divide 30,000 by 256, and the answer is 117.18. Because I only want the INTeger, the decimal for the MSB is 117. My manual tells me this is 75 hex, so I write down 117-75h, Aha, that's just what I want, but a quick look at the ASCII codes shows that the required numbers are 37h and 35h. Well, at least I'm getting nearer. So now the problem is to make the MSB — 75h into two bytes of ASCII Code ready for printing. This means that both the MSB and the LSB will have to be worked on twice. You can see that the difference between the ASCII code and the MSB is 30h, so it's a question of isolating the 7 and the 5 and then adding 30h. That's it then, a little more work and I'm home and dry. Hang on though, what's this? another look at the ASCII set shows that some clown has added extra characters between 39h and letter A, which is 41h. That makes a right mess of the 30h difference.

So far, I have presented the problem as a beginner to machine code programming might see it, and, so far, the reasoning looks fairly sound. But let's re-think the problem using slightly different reasoning. I have found that problems of this nature are best approached with two things in mind. The first is to look at the best and worst cases in this instance the upper and lower limits which have already been defined. Secondly, examine what you already have and can be sure of, and our example of that is decimal 117 which we know is 75 hex. The position of the hex character determines the equivalent decimal value, for example, 0F is less in value than F0. However, no matter which position the hex character occupies, the one constant is that 0 to F represents decimal 0 to 15, and thereby lies a clue. Bearing in mind that there are two hex characters per byte I can write down 00-0F=0 to 15, and then the binary representation of each byte. The pattern looks like this — 00000000 and 00001111, and immediately I see the answer to the problem.

Now you must remember that a computer doesn't know the first thing about decimal or hex; the only things it sees' are the bit patterns. Next I write down the binary for the MSB of decimal 117—75h—01110101. Earlier I said that all that was needed was to isolate the 7 and the 5 and add 30h, which is only half right because the 30h is useless. In this series I have covered a method for isolating or masking off numbers, and this is the logical AND operation. If we AND with F0 — 1111 0000, this will isolate the 7, and similary AND 0 F for the 5. This, then, is a method of obtaining two separate bytes from one byte (think about it).

At this point I had better reveal the answer to the problem, which is a table of ASCII codes representing the characters 0 to F. The principle of using the table is very simple indeed. By pointing a register pair to the start of the table, any number added to that register will index into the table by the amount of the number. To make things easier, once indexed, the register pair would be pointing to the ASCII code for the number that was added. To make things clearer, the register pair is pointing to the start of the ASCII table which is 30h—0; nothing added would cause the character 0 to be printed for the hex character, which is correct. The only problem lies with that first AND operation; AND F0—11110000 left us with 01110000—70h. Moving that bit pattern over to the right four times would solve our problem, so that's exactly what we do. The Z80 instruction we use is 1F — RRA which means Rotate Right Accumulator (reigster A). The full machine code listing is in Fig. 3, but please remember that the addresses given are for the printer buffer. If you want to re-locate the program, the addresses in HL and BC plus the ones in BASIC will have to be altered. Regarding the BASIC, I have given just enough lines to run it, my own version is a bit more user friendly. One last parting shot — if you want to write a hex to decimal program the clue lies in the difference of 30h and 40h! **ET**

ZX81 Improvements

Your typical cassette storage unit in the buff. The pencil points to the azimuth adjustment screws.

If you have problems loading and saving with your ZX81, John Cox offers some simple alternatives to hardware modifications.

THE BIGGEST problem most Sinclair ZX-81/TS1000 users face (apart from the keyboard) is saving and loading programs. A vast amount of misinformation has been published about this business: filters, compression amplifiers and comparators have been described, and one or two firms have even marketed such devices, though their usefulness is marginal because they don't address the situation as it actually exists.

It is important to realise there is nothing wrong with the ZX-81/TS1000 save/load system (except its speed, or lack of it). The waveform and amplitude of the signal sent out to the tape is just fine and normally plays back just fine, too. If it doesn't work for you, it isn't your Sinclair's fault, but shortcomings in the record/playback system that are to blame; if you will but abide by the following rules you may never know the exasperation of failure:

The Recorder

You have probably heard that 'shoebox' tape recorders work best — that is, monophonic AC/Batt portables — and this is true, but there are shoeboxes and there are shoeboxes. Though most of them nowadays use a standard good quality IC for the record/playback electronics, some of the cheaper makes are unduly noisy, some run at the wrong speed, and some come fresh from the factory with incorrect azimuth adjustments. (If you don't know your azimuth from your elbow, continue reading — we'll come to that). If your tape

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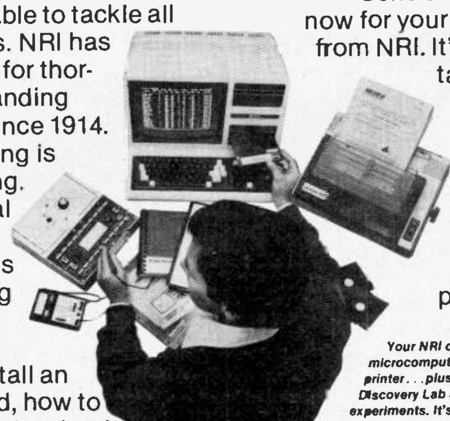

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recorder suffers from any of these deficiencies, you will have hours of fun trying to load and save programs.

'Any old' cassette recorder will just not do. The tape recorder is a critical component of your computer system, so get a good one. Makes such as GE, Hitachi and Panasonic are reliable (but be wary of buying a used one).

Azimuth

The azimuth is the angle the tape head makes with the tape moving past it. How do you know if your azimuth is wrong? Tapes played back at a different azimuth from that at which they were recorded sound weak and distorted, and as far as computer programs are concerned, they usually won't load. If programs you yourself saved will load, but your friend's don't, then one of you is using a machine with an incorrect azimuth, or at least, the two azimuths are different. If you can load your own programs but not store-bought ones, then your azimuth is wrong. And so on — this isn't hard to figure out.

Adjusting the azimuth on shoeboxes can be a bit of a hassle because the adjusting screw is often not accessible without taking the entire works out of the cabinet. However, if you can get at the adjustment, the easiest way is to play a commercially pre-recorded tape and adjust the screw for the highest level. It helps to meter the output if you have a meter handy, but if the whole procedure seems beyond you, then get a better shoebox. Correct azimuth is critical, and though sticking a comparator in the playback signal path may help if it's only slightly off, it's generally unnecessary.

Tape

Use good quality tape. I've heard people say 'any old tape will do for computing', but it won't. If you can get reliable performance out of 'bargain' tape, then you're very lucky. Cheap tape is likely to give low output and high noise, along with 'dropouts.' A dropout occurs when the magnetic coating on the tape is so thin and uneven that the signal level drops down to next-to-nothing at some point or points. Natually the program is de-railed every time you have a dropout and the computer gives up.

The best tapes to use will be labelled 'high output/low noise,' though practically any tape from a reputable manufacturer will work. Wide dynamic range types aren't necessary or worth paying a premium price for. I've found TDK excellent and Hitachi very good; however, even these can have dropouts which you can identify from the fact that no program saved along certains tretches of the tape (specified by the counter) will ever load, but will always drop out at the same point.

We're not quite through with tapes. Shoebox tape recorders use what is known as DC erase, and this tends to leave a permanent magnetic bias on the tape every time it is run through in 'record' mode. You can't hear the effect except as noise, and you might not expect it to mess things up, but after about a dozen 'records' it can. The easiest solution is to periodically 'clean' the tape by running it through a hi-fi tape deck in record mode. (The hi-fi deck has AC erase which removes the magnetic bias).

Store-boughts

Occasionally you will have trouble loading store-bought programs. If you are sure that your tape recorder is a good one and your azimuth adjustment correct, then it is reasonable to blame the commercial tape and take it back to the store. I will mention that I have encountered several defective tapes, some with catastrophic dropouts, and some recorded with the azimuth slightly off (which might or might not give trouble). In some cases it was suggested by the store that my cassette equipment was perhaps to blame, so it was important for me to be able to assert that I was in A1 shape in that respect (and prove it if necessary!) It would seem very false economy to go along with iffy equipment and then expect commercial software to work.

You can also eliminate the noise and buzz preceding the program on tape if you push the SAVE key a fraction of a second before you start the tape recorder, and you won't hurt anything this way (there will still be a few seconds between pressing SAVE and the start of the routine).

Fast Saves

You may have read about 'fast saving' software. My understanding is that there were problems with one such tape and it was withdrawn from the market. I would say these problems were strictly a case of production trouble resulting in severe dropouts; my own copy loads with difficulty on the 64K version and not at all on the 16K (despite my incredible efforts to retrieve the signal!). Another problem is that the 16K version parks itself in high RAM, so if the program that you want to save or load has any machine code in that area, which a lot of bought software does, you're out of luck. However, if you have a 64K RAM and the 'fastload' comes in a version that parks itself in the 8K area, then I strongly advise you to go that route. You can save/load four or six times faster than normally, and for my money far more reliable — in fact, I can honestly say that I have never had a missave or misload using this system, and that's in spite of having programs as long as 38K.

Add-on hardware is not necessary if you take pains to optimise the record-playback system.

Playback

In the case of programs you save yourself, playback generally needs the level control set at about 65% of maximum. Of course this is a ballpark estimate, but holds for most shoebox cassette recorders. If the load drops out before it is finished (cursor returns to K) you probably need to raise the level; if you get a 'white-out', or if it turns out that there were errors in the load (variables changed, weird graphic symbols appearing mysteriously), you probably should reduce it.

RFI

Sometimes the physical location of the system components (computer, TV and cassette recorder) can result in interactions between oscillators. This is not usually a problem if the computer and cassette deck are located at least 1 metre from the TV.

The LoadLead

You will get cleaner saves if you unplug the playback (load) lead — the one which runs between EAR and EAR — before saving.

And finally . . .

The above should explain why add-on hardware is not necessary and sometimes doesn't help. There is no point boosting the 'save' signal from the computer when it is already at a suitable level, and filtering may be more pointless; a comparator in the playback signal path may clean up a signal that is distorted due to slight azimuth maladjustment or slight dropout, but it won't rescue it in a serious case; and no conceivable hardware can ever deal with serious dropouts or defects in the tape. **ET**

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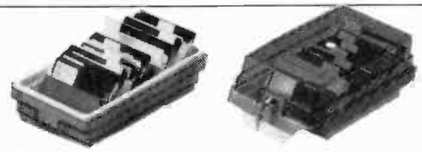

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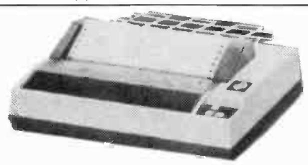

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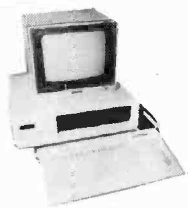

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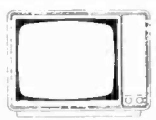

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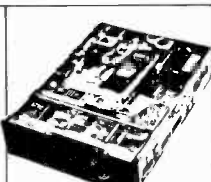

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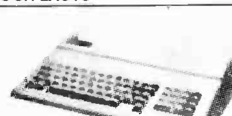

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Circle No. 25 on Reader Service Card

Computer Review: The Mega-Board

by Bill Markwick

NOW THAT IBM has securely established its computer and its operating system as the 16-bit standard, tinkerers may be looking for an economical way to tap into the huge PC-DOS or MS-DOS software market.

One good way to do this is being provided by Parts Galore, a computer store and mail-order house located at 316 College St., Toronto, Ontario M5T 1S3. They are importing the Display Telecommunications Corporation (DTC) Mega-Board, and offer full support for the various bits of hardware you'll need to make it go.

Bottom of the Line

If you're familiar with electronic components, can do reasonably fine soldering, and have bunches of ambition, your PC-compatible can start life for as little as $99.95; this buys you the printed circuit for the motherboard and assembly instructions. Lest you throw down this Electronics Today and bolt for the store, let me assure beginners that it ain't as easy as it sounds. Heavy-handed soldering will result in solder bridges that take hours of debugging time, or worse, make those $25.00 chips get all hot and smelly just before they kick off. In addition, some of the chips around may be manufacturer's seconds. I think these are worse than dead ones, because they only cause trouble sometimes, a situation that causes premature greying in any troubleshooter.

Well, if you're undaunted, you can take your PC board and start collecting the parts you'll need to stuff it. Parts Galore also stocks the various little pieces, larger pieces like disk drives and peripheral cards, and even the ROMs; these are called the Mega-BIOS and are said to be PC-DOS and MS-DOS compatible.

Should you be daunted, but still hate to cool off the old soldering iron, the Mega-Board is available in a number of levels of completion:

1. Socketed but with no ICs; this saves under-board soldering. This presently lists at $299.00.
2. Socketed and filled with all ICs, BIOS, 64K RAM: $595.00
3. As above with 256K of RAM: $820.
4. As above with one megabyte; price on request (from them, not us).

Assembly

Let's assume that you're only partially lazy, or partially broke as the case may be, and you'd like to buy the Mega-Board nicely stuffed and tested in its 64K form. The minimum extra equipment you'll need to turn it into a computer will be:

1. A power supply. This is a somehwat heftier, higher-current supply than the sort you'll find in Apple clones. $50-$75.
2. A disk controller. This is available as a bare board for $24.95, or you can buy a tailor-made. You can save on the space required for a printer card by buying the disk controller that has a parallel port as well; the parallel D-type connector pokes out the back of the case.
3. A video output such as the Colour Graphics card.
4. A box to put it in. The case shown in the photograph has plastic card guides and spring clips, so you can lift the hood and check the oil easily.
5. A keyboard with a cable to fit the IBM 5-pin DIN plug. These start at about $160 and head upwards.

There are seven slots on the Mega-Board, all of which are IBM-card-compatible, and at least two will be filled with the disk controller and graphics board. The rest can be used for modems, clocks, wirewrap cards, etc. There is also an edge connector which is PC-compatible as well, but our test verison had no opening cut in the side of the case to accommodate this.

Once you have all the components ready, assembly consists of nothing more than bolting things in place and clicking in the power supply harness and disk ribbons. If you're determined to use that edge connector, it'll take three times longer to saw a slot in the side.

More Features

Before powering it up, let's look at some of the other features of the Mega-Board. One is the Reset button peering out of the rear panel. This is a welcome addition, since the IBM occasionally gets stuck and ignores its Shift-Alt-Delete reset command. Unfortunately, the reset is a cold boot, and has the same result as turning the power off and on again. It would be nice to have a warm-boot function similar to Applesoft's Reset key; this generally doesn't wipe out your program in RAM.

There are five ROM sockets, one of which is taken up by the Mega-BIOS chip. The other four are said to be compatible with any PC ROMs. A power socket is available for the application of external ROM-burning voltages. The processor is an 8088, accompanied by a socket for an 8087 arithmetic processor. There's a speaker port, though ours was obscured by the second disk drive, as was the small wirewrap area for experimenters and the configuration switches also found on the IBM.

A Tryout

The machine we received for review had dual half-height double density disk drives and 256K of RAM in 8-kilobyte 4564's. It was fitted with the colour graphics card and the disk controller with the additional parallel port. The power supply had a built-in fan which made a bit of noise, though it's acceptable.

We fitted a Maxiswitch keyboard to the PC-compatible DIN plug; this keyboard, one of several offered with the Mega-Board, is a duplicate of the IBM version, and in some people's opinion (including mine), one of the silliest inventions since the rubber crowbar. Wonderful keyboards have been designed for lots of electric typewriters, including IBM's, and I'll never see why they have to keep tinkering with them. Give us a Selectric-type keyboard and be done with it. They won't, of course. It took legions of reviewers dumping on IBM before they'd get rid of the PCjr's laughable toy keys.

The on-board ROM consisted of Mega-BIOS, the Basic In-Out System that boots everything up and tells the computer how to deal with its disk drives, video, and ports. It's designed to work with PC-DOS and MS-DOS software.

MS-DOS in drive A produced a prompt after about 15 seconds worth of an announcement saying the Mega-BIOS was checking its memory. WordStar was then loaded in another seven seconds or so, comparable speeds to the PC. The display was sharp and clear, with only a bit of screen jitter during refresh, but then, even real IBM's pulse the screen at you, something like a big ZX-81.

The various MS-DOS and PC-DOS software I tried ran nicely with one exception: BASIC on the DOS disk will not work. This is due to IBM's weird philosophy of putting part of the BASIC in ROM, and as you can imagine, parts stores are reluctant to start selling IBM firmware. Mind you, the space is there for the ROMs if you can find them. You can get BASICA.EXE to work, more or less, if you don't minding copying it down with a pencil and paper; the LOAD and SAVE functions won't work without ROMs.

One easy solution is to use a disk BASIC that doesn't need to access ROMs; I found that Microsoft's GWBASIC worked beautifully, though it is an extra expense if you don't already have it.

Other Features

The front panel of the available case will accept two full-size drives, or four half-height types; these double-sided double density drives hold 360K each. At the going price of $249.00 per drive, you could have yourself an inexpensive 1.4 megabytes of storage if you don't mind using a steamer trunk to hold all your floppy disks. The drives worked smoothly and with about the same amount of noise as an IBM: unobtrusive, but not entirely quiet.

The rear panel is punched for all manner of extra connectors, letting you graft in whatever you want. Despite the room taken up by the drive(s), there's lots of space for adding custom-made cards; a wirewrap prototyping card for $29.95 will let you dream up your own circuits. Also, there are two switched AC outlets on the power supply that protrude through the rear panel, minimizing the need for a power bar.

The 256K bytes of RAM on the motherboard can be expanded to one

continued on page 66

Circle No. 21 on Reader Service Card

Circle No. 14 on Reader Service Card

Barcodes

Bar codes are everywhere and on everything; even home computers often have bar code ports. Here are the inner workings of the little black lines.

By Roger Allan

THE use of bar codes to identify and classify items is based on a technology known for some years, but it was only when the supermarkets recognized that such an identification procedure could significantly lessen check-out operator errors and substantially reduce the time, expense and overall difficulty in warehouse stock-taking that bar codes gained general acceptance.

Now, of course, one has difficulty in finding any food produce item that doesn't have a bar code printed on it somewhere, so much so that industry sources state that some 95% of all packaged foodstuffs in North America have a bar code label on them, with the remainder expected to have them within the year, so universal has their application become. With their widespread acceptance in the food industry, bar codes were picked up by other retail organizations; department stores started labelling clothing with them, record shops their LP's, shoe companies their inner soles, etc.

A recent decision by the United States Department of Defense, moreover, is going to carry bar codes onto almost everything.The Pentagon has found that the use of such a system reduces warehousing errors dramatically, permits the determination and availability of items at speeds and accuracies previously unknown, costs substantially less than any other accounting process and is some five times faster than a person using a pencil and paper method. They like it enough that while they are going to give industry a couple of years lead time to get themselves organized, it will soon be mandatory for everything sold to the military to be marked with a bar code.

By everything, they mean everything: aircraft turbine blades, boxes of pins, jeep hub caps, whatever. Since the Pentagon is the largest purchaser in the United States, the effect will be enormous, with a ripple effect felt throughout US warehousing and accounting procedures. After all, if GM is required to mark piston rings for military trucks with bar codes (laser engraved tags of anodized aluminum so they'll stand up to dust and grime) they may as well do it for the civilian ones as well, and since they're going that far, they may as well do it for their entire warehousing system. This in turn means the automobile industry from top to bottom will be bar coded, with the rest of industry soon following suit. Since Canadian industry takes its lead from our neighbours, we won't be far behind.

The Workings

But what actually is a bar code and how does it work? There are a number of them, each with slightly different parameters and potential applications. Some have simple names, like the Universal Product Code (UPC), some sound esoteric, like the Interleaved 2 of 5, some have specifications that can be printed in a few pages while others require over a hundred printed pages of documentation. But they are all essentially the same: bars of black and white.

The Theory

The bars are encoded by virtue of their widths, the height of a bar being irrelevant. Its height is only to permit an operator to move the tip of the scanner or the scanning beam across the bar code without falling off the top or bottom. Sometimes the height is referred to as the 'y' dimension.

The important element is the the width, or 'x' dimension, usually known as a module. The bars and the spaces between them are integer (whole number) multiples of the module width. Information is encoded in a binary fashion, the data bits being determined just by the bars, by both the bars and the spaces, or by the bars representing the bits for one character and the spaces representing the bits for the second character.

Bar code interpretation is dependent on the relationship or comparisons of the bars and the spaces in between them. This permits varying degrees of magnification and reduction to be introduced into the bar code label manufacture, providing that the module relationship between bars and spaces remains constant. This in turn permits an operator to pass a reading device over the bar code at varying speeds and still get an accurate reading.

Interpreting

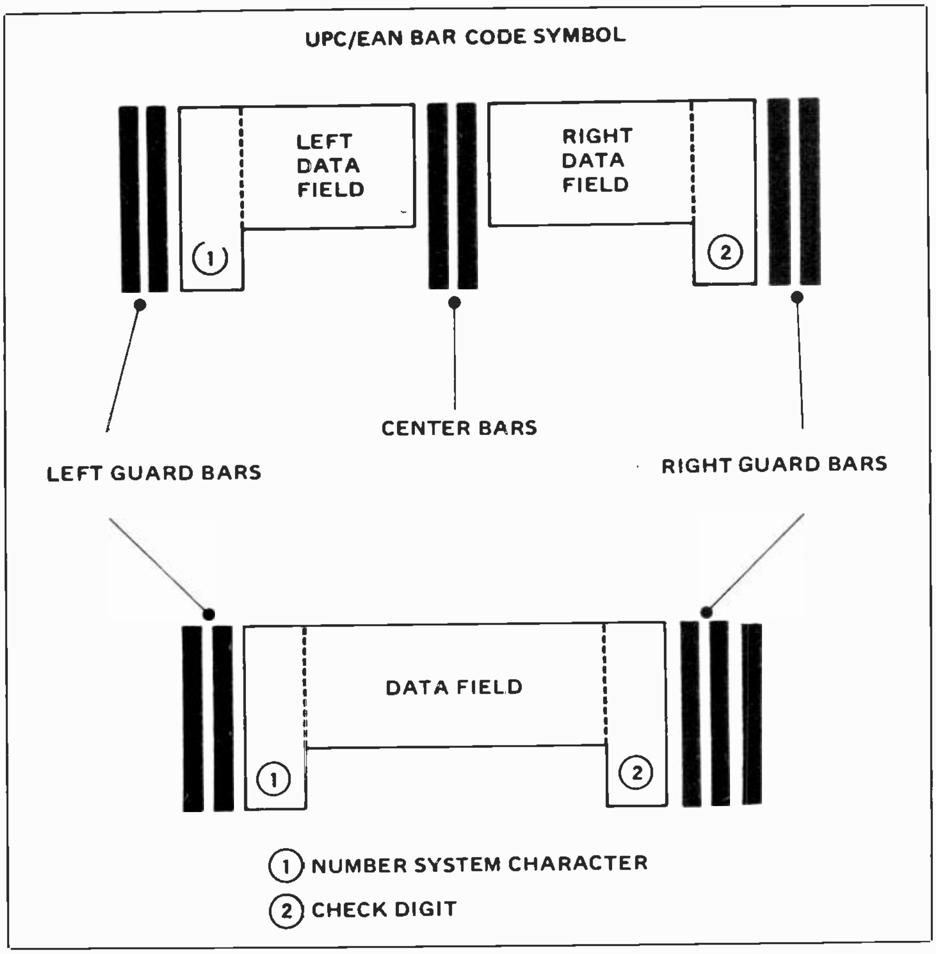
Once the data is received by the scanning device, interpretation via algorithms is undertaken. Usually two algorithms are involved in the decoding process: a primary algorithm (usually binary in nature) which defines how the 1s and 0s are to be assigned to the bars and spaces, and a secondary algorithm applied to the result of the primary algorithm to determine the final code.

Once the final code is determined, one can do almost anything one wishes with it: check via computer as to how many of the item one has left in stock, what the new price is, and so on.

The Practice

So much for the theory, and now for the practice. Having determined which code one wishes to use, the specifications of the label design are easy to follow, so much so that once the basic design has been done, one can run off duplicates on a dot matrix printer.

While some bar codes operate on magnetic stripes or by the shapes of the characters (letters or numbers), most bar code labels require bars and spaces to be read by some form of light, either white light, infrared or laser. There are advantages and disadvantages to each reading method; for example, infrared light reading is difficult under high ambient light conditions, such as outdoors in the sunlight. However, regardless of which light reading mechanism one determines to use, the difference between the bars and spaces must be easily readable; hence the customary use of black and white, as the contrast between the two is good. One can find bar code labels of other colors (red and green seem to be popular) but the contrast between the bar and the bar's neighbouring space is the important point, and must be optically high.



UPC/EAN Bar Code Symbol

Scanners

There are many designs of scanners or readers available, ranging from the large permanent installations, such as those at supermarket check out counters, to small hand held devices hardly larger than a pack of cigarettes. They do, however, fall into two generalized types: contact and non-contact.

Contact scanners, as the name suggests, require physical contact between the reader and the label: an interface is used, such as the checkout-counter plate or a wand-like tip on a handheld version. But regardless of the type they all require two basic components, a light source and a light detector.

In a self-contained wand scanner, both the light source and light detector are contained in a pencil-like container. Light is projected through an opening in the tip of the wand, strikes the bar code, and is either absorbed by the label (the black lines) or reflected (by the white spaces). The reflected light passes back into the wand, passes through a fibre optic cable and is demodulated via the electronics. Most wand contact scanners use LEDs for their light sources, though some are constructed to use infrared; this has the advantage of being somewhat more power-efficient and less susceptible to ambient light interference (at least indoors).

One of the difficulties with this type of scanner is that the distance from the bar code to the detector is critical due to the necessity of maintaining a precise focal length. This is easy enough to achieve at a supermarket where the focal length is maintained via the glass plate over which the item passes, but is somewhat trickier to achieve in handheld models. It can be obtained using a plastic tip to the scanner; one merely places it against one end of the bar code, moves it across the label and takes a reading. The problem is that the tips wear down, decreasing the focal length and producing odd readings. Of course, one can always replace the tips every once in a while, but that increases the user costs.

Handhelds

The most important element in the construction of a handheld contact scanner is the aperture of the opening at the tip; it is in fact two apertures, one providing the light source and the other determining how much reflected light the unit will see. The larger the scanner aperture, the greater will be the amount of reflected light which reaches the light detector. As the detector has a nominal range in which it will function, scanners with smaller apertures require more light from the source than larger ones to meet the range requirements of the detector. As such, scanners with small apertures consume more power than scanners with large apertures.

A further element in aperture size is that if it is too large and the bar width too small, the scanner will not recognize the bar; conversely, if the aperture is too small a print flaw such as an ink speck may be erroneously read as a bar and a printing ink void read as a space.

Demodulating

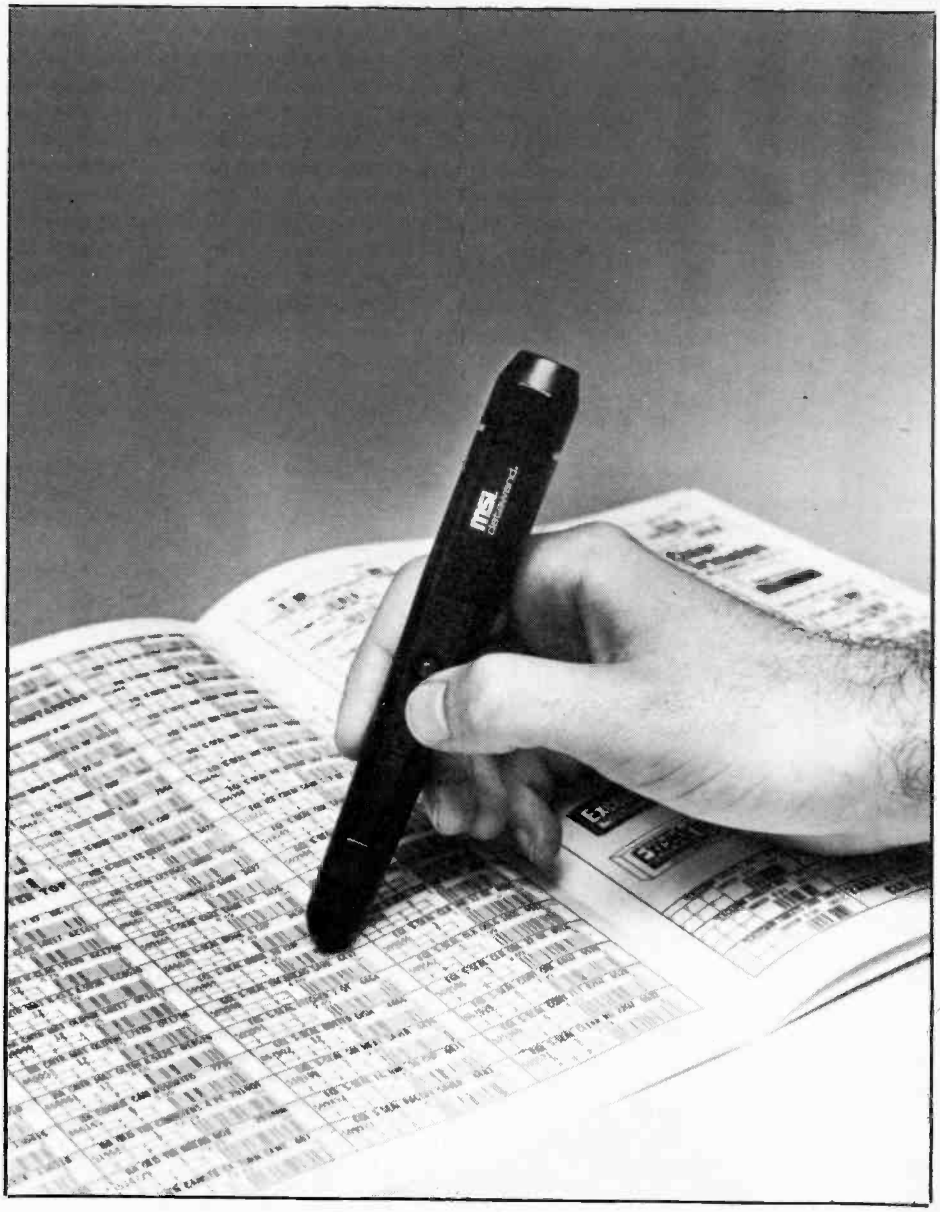
Having run the light over the bar code and received the reflection, the next element involves the light's demodulation. Unlike the human eye, a scanner does not recognize the vertical edges of the dark bars. When the scanner is moved across the label it reads the reflected light as increases and decreases of intensity. In other words, as the scanner proceeds across a white space and reaches the edge of a dark bar the intensity of the reflected light starts to decrease. When the decrease reaches a threshold, a logic decision is made to recognize the reading as a bar. As the scanner reaches the far edge of the dark bar, passing into a light bar, the percentage of reflected light starts to increase. Again, when it reaches a predetermined level, a logic decision is made to recognize it as a space. These logic decisions are then transformed into digital form and processed by customary computing methods.

Non-contact Scanners

Bar code scanners which do not physically touch the label are, not surprisingly, known as non-contact scanners. While some designs incorporate visible light sources, most utilize a low-power laser beam to maximize the distance from which the symbol may be read.

In this form of reader, the laser light is projected through an optical arrangement onto a rotating mirror. As the laser beam strikes the mirror, it is reflected through the scanner 'window' (analogous to the apertures in the non-contact scanners) onto the bar code label. The reflected light is passed back through the window and a polarizing filter, and onto a photosensitive diode. The diode converts the light into an electrical impulse which is then decoded by the device using customary methods.

There are several advantages to using a non-contact, laser-type bar code reader. One is the ability of the device to focus a beam of light so that its projected spot size remains small over an extended distance. It is this capability that produces the large depth of field resulting in the longer reading ranges of this type of device compared to other designs. A second advantage is the ability of the scanner to automatically scan. This increases the chances of securing an accurate reading with only one pass, as well as permitting the achievement of higher scanning speeds in general; it also has the ability to read poorly printed, irregularly shaped and degraded or dirty labels.



The UPC

While it is tempting to plod through an esoteric example of a bar code, it is probably more useful to deal with the most commonly seen, though mathematically/electronically least interesting version: the ubiquitous UPC Code. Actually, this code is known as the UPC/EAN Code (the second part stands for European Article Number) of which there are six versions and five forms. But their basics are common and quite straightforward.

Essentially, the bars and spaces of the UPC/EAN Code are integer multiples of the module or narrowest bar/space, usually, but not always, 4mm. Each bar or space varies from 1–4 modules in width. Each character is composed of two dark bars and two light spaces containing a total of seven multiples. The primary algorithm is binary with Zeros represented by light bars or spaces, and Ones by the dark bars. The code character set is limited to numerics (0–9) and three special characters: Start, Centre and Stop.

The UPC/EAN takes two basic forms. The first is composed of a left guard bar (start code), a number system character, a left side data field, centre bars; then a right side data field, check digit and finally the right guard bars. The second form has left guard bars, number system character, a single data field, then the check digit and the right guard bars.

The left guard bars are encoded 101 as are the right guard bars. In the standard format of the symbol, the centre bars, used to separate the two data fields, are encoded 01010.

There are five versions of the UPC Code and two for the EAN, the encoding of these being identical; the difference lies in the configuration of the data field. The five versions of the UPC Code are designated A to E. The A form (the most commonly found) is the basic version and is used to encode a 10-character number for grocery, National Drug Code and health-related items. Version B is a variable-length type utilized to provide a reasonable and completely compatible version of the symbol for use in retail stores selling general merchandise. The C form is a zero-suppression version to provide a short form of the symbol for use on small packages. It has no check digit or explicit numbering system due to its brevity. The D and E versions have yet to have a common numbering system designed for them.

To make matters even more confusing, each version above is subdivided by a number system character. For example, version A is subdivided into ten concurrent number sets: 0 for regular UPC Codes, 2 for random-weight items such as meat or produce, 3 for the National Drug Code and health related items, 4 for use

3

8151-054100

0123456789

ABCDEFGHIJ

⑆1220000431⑆ 2627⑈

Scannable Symbols

without code format restrictions and with check digit protection for in-store marking of non-food items, 5 for coupons, with 1,6,7,8,and 9 currently reserved for future usage.

The two versions of the EAN Code are a 13-character version used for marking articles requiring long numbers and an 8-character version used for articles requiring a shorter number. The 8-character version is not zero-suppressed nor is it a shortened 13-character code; it is a unique version.

The Future?

Essentially, then, by simply determining the amount of reflected light from a set of bars the world is being categorized and pigeonholed in a fashion and a speed as never before. While they are certainly most useful, expeditious and cheap, this writer at least is dreading the day when some bright-eyed wunderkind decides that bar codes would be far better than numbers for government processing and starts issuing us with little bar labels rather than SIN numbers. **ET**

ries on a Chip

Silicon is turning out to have more uses than just a conventional chip material. It can be chemically machined to form a wide variety of structures, perhaps even miniature laboratories with built-in computers. Stephen McClelland explains.

WHAT COULD be a new era of Lilliputian engineering is quietly unfolding thanks to a different kind of silicon chip development. Now, microscopic mechanical structures, some less than the thickness of a human hair, can be fabricated in silicon just like standard transistors and integrated circuits.

Silicon has been used for some time to create pressure and strain gauges but present techniques can produce nozzles, valves valves and sensors of all types. The manufacture of complex 3D mechanics in silicon is now being contemplated. Researchers at Stanford University, California — who dub these operations 'micromaching' — have even been able to place most of a gas chromatograph on a flat silicon wafer 5 cm in diameter. This sort of result indicates that complete electromechanical and electronic systems can be made in silicon less expensively and yet more accurately than conventional techniques would allow. The processing methods so well established in the integrated circuit industry will be capable of producing simultaneously large numbers of components in a silicon wafer with a consequent cost reduction.

All this is possible because of continuous improvement of silicon integrated circuit technology, particularly in the area of pattern definition and photolithography (the generation and transfer of a small enough mechanical pattern onto the silicon to be machined) and etching (the chemical disolution of selected areas of silicon).

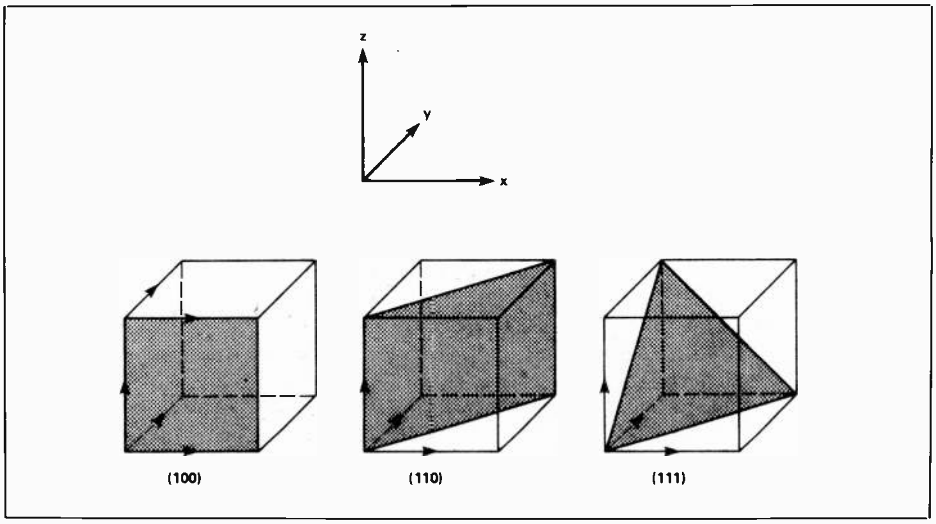


Fig. 1 The three basic index planes of silicon.

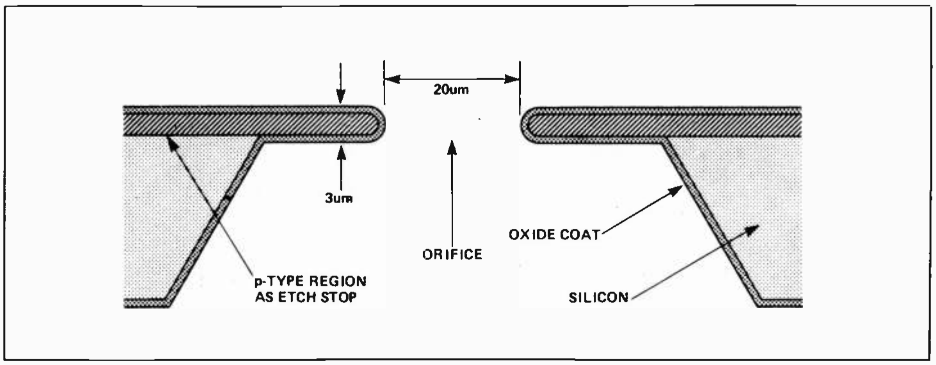


Fig. 2 The smallest nozzle in the world? IBM Research Labs made this silicon nozzle.

Photolithography and Etching

Photolithography has been propelled forward because of demands made by high density electronic chips which are approaching VLSI (Very Large Scale Integration) complexity. At the moment it is possible to design patterns, 200 x or 500 x larger than life, which will eventually produce a minimum feature size of 2 or 3*u*m quite routinely. Next generation equipment will allow such features to be cut less than 1 *u*m, making it possible to fabricate, easily, novel optical componets such as diffraction gratings in silicon. But the key to micromaching has been the variety of etching techniques that carve detail on the silicon surface.

Some (isotropic) etchants merely dissolve silicon at equal rates in all directions, but some show anisotropic behaviour; that is, they preferentially etch only certain crystal planes of silicon. By etching faster in certain directions than others — and the relative difference in speed can be two orders of magnitude — predictable three-dimensional shapes can be cut.

What is cut depends on both the etchant used and the crystallographic orientation of silicon used. We describe the crystallography of silicon numerically using Miller indices, which essentially state the orientation of a plane of a silicon atomic lattice by defining its intercepts with the hypothetical set of axes (Fig. 1). From the micromaching point of view the most important planes are the (100), (110) and (111) in the (cubic) silicon lattice. Etchants like potassium hydroxide or an ethylene diamine/pyrocatechol mixture essentially migrate much faster in the (100) direction than they do in the (111) direction because the packing density of silicon atoms is much lower in the 100 direction. The result when etching is that a V-shaped notch is formed in a (100) slice where the sides of the 'V' are the slower-etching (111) planes.

But the groove can be very accurately reproduced and its sidewalls will always make an angle of 54.74° with the surface of

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How Micromachining Works

Standard silicon processing techniques basically involve one or more repeats on an oxidation-etch-diffusion cycle, outlined below:

• Oxidation — A layer of silicon dioxide is grown on the silicon wafer by heating it in an oxygen stream. This layer will act as the pattern definition layer for the rest of the process (1).

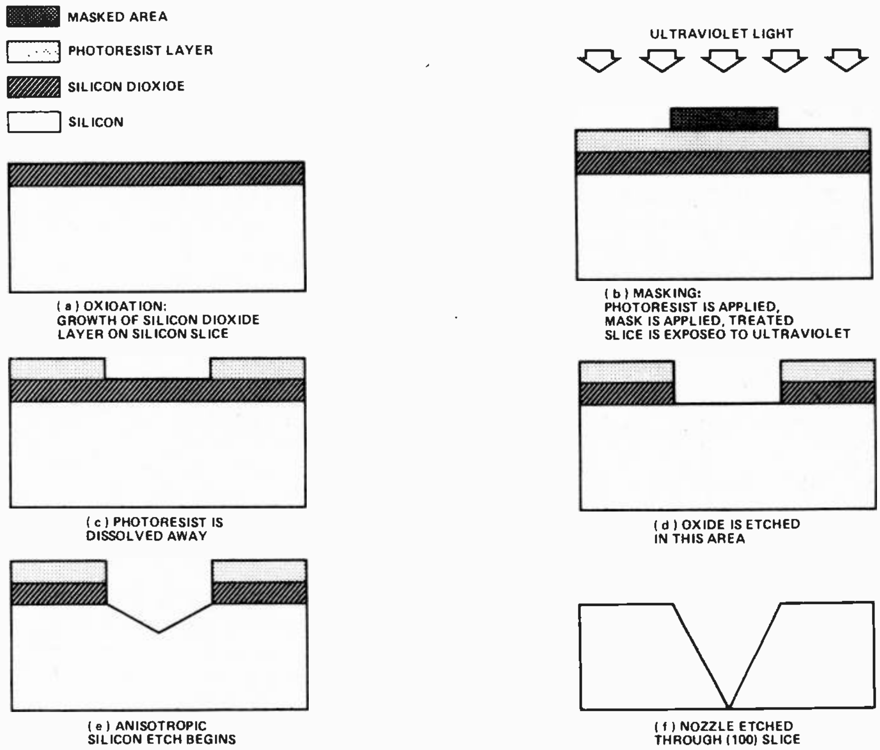
• Etching — The wafer is now coated with photoresist (a light-sensitive compound) which is exposed to light via a master negative glass plate on which are detailed the features to be machined (b). Unexposed parts of the resist (underlying the negative) are then easily rinsed off, but the exposed, hardened resist remains. This serves to protect the underlying oxide from dissolution when the wafer is treated with hydrofluoric acid. Unprotected oxide is dissolved off leaving bare silicon (c,d).

If the wafer is now treated with an etching solution that dissolves silicon but not oxide, the silicon will be eaten away beneath the oxide window exclusive (e). If the etchant is *isotropic* the rate of etching will be the same in all directions. If the etchant is *anisotropic* it will etch in a preferential direction, eg potassium hydroxide solution will produce a V-groove in (100) orientated silicon and a vertical walled profile in the (110) direction (f).

For many devices, the process ends here or is cycled through again after a complete re-oxidation of silicon, depending on the profiles required. For more complicated structures (eg. Dr. Bassous' membrane-nozzle desribed in the article) and to make electronic devices such as integrated circuits, gaseous impurities (eg boron compounds) are carefully allowed to diffuse into the silicon, through oxide windows like those made previously.

After the micromachining has been fully performed, the silicon, through oxide windows like those made previously.

After the micromachining has been fully performed, the silicon wafer is split into individual silicon chips each containing a copy of the micromachined device.



Cross-section of silicon wafer, or slice, showing the procedure for cutting a simple nozzle through the wafer. Dimensions are not to scale.

the silicon. Moreover the depth of the groove is directly related to the width of the surface opening etched, since etching effectively stops at the (111) planes which intersect the sides of the opening. Wafers are typically of the order of a few tenths of a millimetre thick and so it takes a few hours to etch a deep groove, or, if the surface detail is wide enough, a nozzle-shapped hole right through the slice.

Nozzles, Valves And Beams

Dr. Ernest Bassous' group at IBM has patented a variety of nozzle structures, based essentially on this technique, which are intended for projecting very fine ink sprays in high resolution printers. Although accurate dimensioning can be achieved by simply etching right through the silicon as described above, Bassous has found that better nozzles can be made by employing the natural resistance to etching of heavily-doped P-type silicon. A thin layer of this is formed at the back of the wafer, uniform except where orifices are required. The wafer is then etched anisotropically from its upper surface. Etching is terminated only by the thin P-barrier but punctures the slice completely in its unprotected regions. After cleaning and silicon dioxide regrowth the final structure is shown in Fig. 2. It has an orifice typically less than 20 *u*m wide set in a membrane only 3 *u*m thick.

Another IBM researcher, Kurt Petersen, takes membrane manufacture further. He allows the etch to deliberately undercut the overlying silicon dioxide layer and so produces an ultra-thin, springy, 'diving board' structure made entirely of oxide. The 1 mm thick membranes can be easily — but not irreversibly — bent by an electric field and IBM has used them as electronically controlled scanning mirrors to reflect illuminate data from a single character generation on a ground glass screen for display purposes. IBM also foresees applications for them in high-isolation electromechanical switches.

A flexible structure is also the basis of Dr. Lynn Roylance's miniature accelerometer to study heart wall motion. In the Stanford laboratories she made a 3 x 2 x 0.6 mm cantievered beam unit entirely from etched silicon. The beam bends in response to applied acceleration with considerable sensitivity — it can detect an acceleration from 0.01 g to 50 g, with a 1% accuracy. The actual detecting elements for this kind of transducer are usually of a *piezorestive* variety. This means that the resistance of a diffused element (usually p-type) changes when it is mechanically stressed. However, these resistive elements are usually quite sensitive to temperature changes, which is why they usually take the form of a Wheatstone Bridge circuit.

Engine-eering

Silicon transducers, if they're small and light enough, can find their way into a whole spectrum of applications. They have been mounted on heart walls, on turbine components in aircraft and may well be shot into space on planetary probes. But most engineers believe that the traditional benefits of silicon processing (ie mass-produced, low cost, high precision techniques) will only really show when micromaching is adopted by a mass-production industry.

The US car industry could be just such a sponsor. Silicon sensors have been edging their way onto the Detroit production lines in a drive for higher fuel efficiency through better monitoring techniques in automobiles, although not as widely as predicted. William Wolber, a Michigan sensor specialist, describes the place of silicon components in the automobile industry as a 'useful addition' but warns that improvements in processing will continually be required if silicon is to be competitive. At present, the US industry wants to monitor a variety of variables in the engine including air and coolant temperatures and fuel metering. The latter is derived from the determination of the manifold absolute pressure by silicon strain gauge techniques.

Chromatography On A Wafer

Perhaps the most spectacular development of date, however, has been the fabrication of a gas chromatograph system on a single silicon wafer, by Dr. Stephen Terry and his colleagues at Stanford. Gas chromatography, the separation of a mixed sample gas back into its components, can be broken down into three separate stages:

- sample injection from the outside world.
- sample separation in a long thin column
- detection and quantity measurement of individual component.

The sample gas is injected into the system mixed with a carrier gas, typically nitrogen. Separation occurs in the column and is determined by the relative migration rates of each component in the sample. These in turn are influenced by both the carrier gas velocity and the relative adsorption/desorption parameters of the components, in so-called stationary phase, a substance which lines the walls of the column. With a sufficiently long column, the individual components emerge as separate entities ready to be detected by a suitable transducer.

The Stanford instrument cleverly reduces the large-scale complexity required for such an instrument with micromaching. In particular, the separator column (which has to be long to achieve good separation) is coiled into a spiral groove 1.5 m long but only 200 um by 30 um in cross-section. It is sealed after etching with a Pyrex cover slip to make a closed capillary column. Once again, the etching is patterned through a 'grown silicon dioxide overcoat to define the spiral.

The components are detected by a simple, yet very effective, thermal conductivity sensor. This is essentially a nickel film resistor heated by an electric current. The temperature it actually reaches for a constant current depends on the thermal conductivity of the gas stream passing through the device.

The results of the chromatograph are impressive, especially when compared to larger laboratory instruments. It has been used so far to analyse hydrocarbon mixtures and does this very efficiently with a fast time constant — which means that sample peaks can be as short as one tenth of a second compared with the width of several seconds realized by standard laboratory instruments. This in turn means the instrument can provide better resolution of the sample.

Material Benefits

But of course, one need not be restricted to silicon for micromachining. With slight modification, other materials can be used as long as they are compatible in basic ways with the planar process for making chips. With a little imagination, the number of applications can match the number of different materials. And some are highly exotic. The gas chromatograph discussed above, for example, has been suggested for planetary probes and what are essentially entire chip-based 'laboratories' are now being actively researched. In the space of a few milimetres, such a chip could collect, treat and analyse a sample, even to the extent of heating or micro-refrigerating it through use of the Peltier effects. For ambitious experiments on space probes, the above could be combined with gas detectors, magnetic and electric field detectors and pressure and temperature detectors, all in silicon with the advantage of suitable signal processing electronics fabricted simultaneously. **ET**

Electronic Publishing

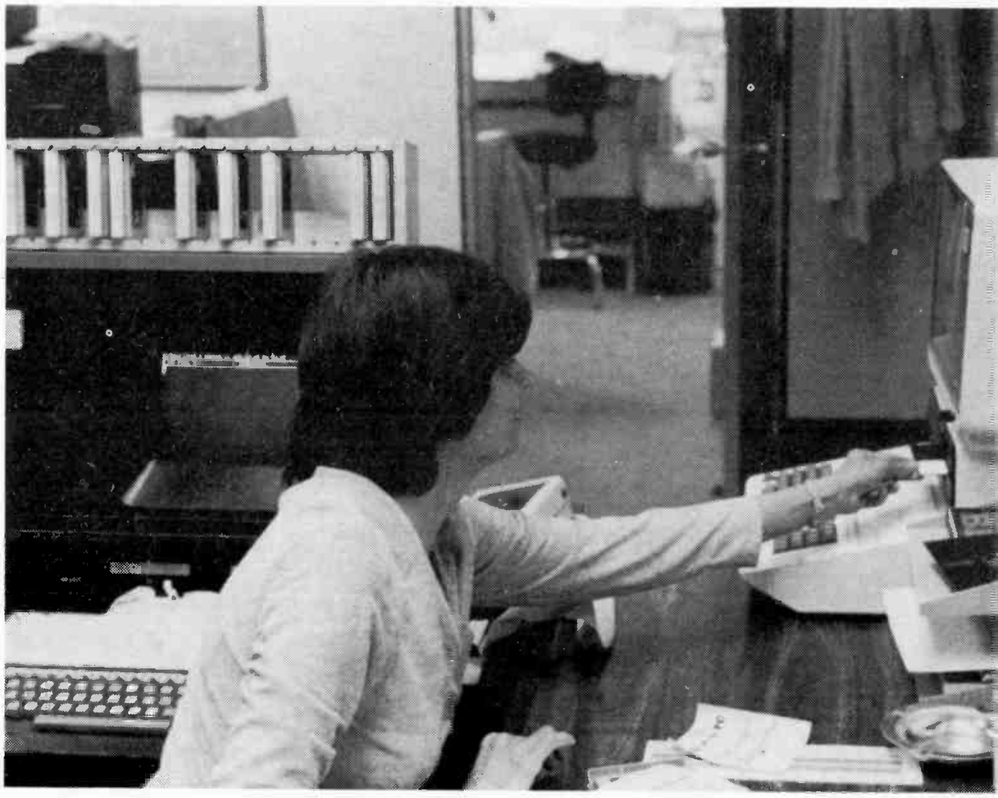
The quill pen dipped in ink is about to be replaced by the floppy disk, assuming standards can be achieved.

by Roger Allan

IT is probably a trite point with which to begin an article on electronic publishing to speak of the enormous ripple effect that the advent of word processing has had on authors, particularly those who write to deadline or have complicated manuscripts to produce. In the interests of completeness it should, however, be mentioned.

Speed in composition when writing to deadline is purchased by writers either staying up late at night or attempting to produce the copy at an ever faster typing speed. The speed with which editing is achieved, formatting arranged and most importantly, the tremendous amount of time that is saved in generating a hard copy when utilizing a computer armed with a decent word processing program is simply wonderful. Deadlines are met, editors cease to have brows creased with worry, and the saved time can be spent hunting up more work or, preferably, taking more research time for the article in the first place.

There is, however, an obverse side to this coin: what happens to the copy once an author has submitted it. It is divided into two parts, magazines/newspapers and book publishers. Many magazines (including Moorshead Publications) and most north American newspapers (such as the Globe and Mail) actively encourage or even require that manuscripts be submitted electronically, either on floppy disks to be copied, or directly through a network connected to a central computer such as is found at the newspapers. What the editors then do with the articles is straightforward: edit, delete, re-format, check spellings, and bung it over to the automatic typesetting machine preparatory to sending the copy to the printers. This process has reached the point that numerous publications, though particularly newspapers, have such an automated process that the first time the article is visible in hard copy print is when it is shipped out to the news vendors, all intervening steps being done electronically.



Naznin Sunderji of Moorshead Publications readies the microcomputer which allows direct interfacing between an author's disk and the typesetting machine at left.

Books

Theoretically, this process should reach its logical fruition in the book publishing trade. After all, a 600 page manuscript of a novel, or even worse, a reference work with lots of foot notes is a typesetters nightmare, typing errors being so frequent. So much so, that (depending on what type of book it is one is producing) the typesetting costs represent between 40 and 70% of total book production costs. It is the prime reason why books are so expensive these days, and why the disparity in cost between a hardcover and a paperback is steadily narrowing to the point where a softcover can now cost some four times what it did five years ago, while a hardcover has only (roughly) doubled in price. If ever publishers had a financial cross to bear through the streets of their industry, typesetting is it.

Surprisingly enough, the reaction among publishers of books to the rise of word processing among their authors has been 'confused', 'mixed' or 'raring ahead' depending on which industry expert one consults. It appears that while book authors are taking to word processing like ducks to water, and while 'the new generation' is considering it to be as much of a necessity for writing as the electric typewriter was considered ten years ago (to wit: some 50% of the 30,000/year doctoral theses produced in the US, for example, are written to a greater or lesser extent on a microcomputer), and while there are some notable exceptions, that publishers as a group are lagging far behind the input from their authors.

Computerised Authors

In an Association of American Publishers (AAP) survey, it was found that some 80% of responding authors intend to prepare manuscripts electronically by 1985, up from 10% in 1980. Yet respondent publishers stated that they would only be prepared to accept some 40% of the manuscripts submitted electronically in 1985.

Yet despite the professional confusion mentioned above above, it is commonly accepted that electronic processes can save publishers time and money by reducing labor, waste and the guesswork associated with what the industry calls 'resource requirements.' The degree in which these benefits can be realized relates directly to how and at what stage in the publishing process the manuscript is keyboarded. Ideally, the author's keystrokes, in industry view, should be captured for editorial processing. While some authors have expressed reservations about performing what may turn out to be a typesetting function for the publishing companies without increased renumeration for doing so, the advent of electronic publishing is very much upon writers of books and their publishers.

Standards

In response to this the AAP is currently part way through a $250,000 project to bypass the problems inherent in different operating systems by devising a uniform code which they hope will become the industry standard. Their project, known as Project Metre and run by Aspen Systems Corp. of New Jersey, is predicated on the belief that an author's keystrokes are valuable only if the publisher's system can process them. The difficulty, in their view, is that most publishing systems cannot economically process input from all the versions of personal computers, word processors, electronic typewriters and mainframes that authors use for manuscript preparation. Each brand and class of hardware has its own unique set of internal codes, rendering it incompatible with devices of another brand or class.

Newspapers, according to the AAP's Electronic Publishing Subcommittee, don't have this problem because their authors are customarily staff writers who use compatible hardware supplied by the publisher. This approach is generally uneconomical for book publishers who compete with each other for manuscripts from independent sources. For a given project it might work, but as a general approach it is expensive as well as risky, considering the rapid obsolescence rate of current hardware.

Moreover, in their view, if every publisher did this, it could and probably would compound the problem of incompatibility. The combination of what they term 'vendor-specific' hardware and 'publisher-specific' coding and keyboarding would effectively obstruct the interchange of electronic manuscripts, inflate the publishing industry's cost base and restrict the possibilities for data base publishing.

Conversely, in their view, by moving toward a generalized approach and away from the vendor- and publisher- specific approaches everyone in the publishing process (except perhaps the authors) stands to gain economically. Moreover, in their view, the earlier in the process that such an approach is introduced, the greater is its economic impact. Their arguments, backed by the $250,000, is that there is a need for a standard method for authors to keyboard their manuscripts: a method that is device-independent, that is compatible with publishing systems, and that is relatively easy to use.

Project Metre

As such, the goal of Project Metre involves the concept of generic coding. Generic coding does not presuppose that the end product will be pages. It does, however, presuppose that pages will be one of a variety of possible end products. Generic coding avoids giving typographic attributes to the manuscript. All it does is generically identify or tag the manuscript's structural parts (eg. an extract, table, running head, whatever) along with any special symbols, words and phrases. An editor or designer then can electronically edit and mark up the file for page composition or for some other application. Alternatively, composition software could read an author's generically tagged manuscript, retrieve the prescribed typographic codes from a programmed style sheet, and insert them automatically into the text stream.

Because generic coding produces nothing more nor less than a structured data base, it would permit the free manipulation of text and images, unencumbered by format-specific coding as is currently found in word processing programs.

A stock industry example comes from auto-industry parlance, whereby generically tagged data would be simply another term for interchangeable parts. Final selection and assembly of those parts would depend on what the customer or dealer ordered. To a publisher, the order might be for an indexed and photocomposed compilation of articles, abstracts or tables from a variety of publications. It might also be for an online data base or some other secondary product. The point of all this is that by capturing and storing electronic manuscripts that have been coded generically, publishers can keep their options open for updating, revising and reprinting products as well as for generating new products and revenue opportunities.

Auto Indexing

Generic coding would also facilitate the bibliographic control of published works. Bibliographic processing could be automated more fully and readily if it were rooted in a document's original creation as an electronic file. Electronic manuscripts could be marked up for automated indexing and cataloguing while being marked up for automated text processing and page composition. It could all be done in the same process, using many of the same tags. Publishers could do this if they had a common and authoritative set of bibliographic rules.

Nonetheless, some publishers are attempting to take the bull by the horns while waiting for the AAP project to crystalize. For example, the US publisher John Wiley and Sons has a policy whereby authors submit a hard-copy manuscript from their word processing system, along with the disc. Wiley then inserts its own generic coding on the manuscript, and the manuscript and disc go together to a conversion service bureau that converts the disc into compatibility with the publisher's typesetting system while inserting the codes. This process, according to a Wiley spokesperson, eliminates the need for rekeying.

A second example is HP Books, which specifies in its contracts that its authors must use an OCR-readable font on their typewriters and follow special formatting instructions. The resulting manuscript is then scanned into the publisher's composition system for editing and typesetting. The final manuscript is stored on floppy discs, and the author keeps a hard-copy printout. Authors who have been remiss in following instructions are charged back for any additional typing that is required.

Canada

Yet despite the US publishers at least attempting to face the realities of the electronic publishing revolution, there appears to be a dichotomy based on the 49th parallel. For example, Canada's largest publishing house, General Publishing in Toronto, which has recently undertaken to publish a major series of computer books, does not use electronic publishing at all. While it is true that a number of their authors submit, or attempt to submit, manuscripts on floppies, there is no in-house facility to edit them. Further, according to a company spokesperson, a good deal of their editing is contracted out to free-lancers who themselves do not have the equipment. When the coding question settles down, however, they intend to explore the situation.

McClelland and Stewart, Canada's second largest publisher, is only involved in a minor way with this process. Essentially, they have a single mini in-house on which they can do a bit of editing, but not really anything to write home about. House of Anansi, which for almost two decades has been a leader in Canadian publishing, is not involved at all, not even so far as electronic typesetting.

Portable computers such as the Epson HX20 shown above are a natural for journalists on assignment; textfiles can be sent to the publisher over telephone lines using either a direct-connect or a handset modem.

Avon, a division of an American company, is a little more active, but not much. Their parent in New York has an IBM system on which some editing is done, and occasionally when a Canadian author submits a manuscript on floppies they will send it south for editing and typesetting. But other than that, while they appear interested in the process, the coding problems still have them snookered, a situation which in their opinion will apparently remain for the foreseeable future.

McGraw-Hill Ryerson, on the other hand, is forging ahead as best they can within the context of the coding problems. According to Clive Powell, about 20% of their manuscripts are edited in whole or in part electronically. There is, however, a catch. While authors may submit manuscripts on floppies, this company then produces a hard-copy which is hand edited. The floppies and the corrections are then passed to their outside contracted typesetters who incorporate the edited changes as they are 'keying in' the typesetting commands onto the floppies. Even though this process may sound a little convoluted and backwards, it is having an effect. It has been found to significantly cut the project's cost by some 30% (typesetting costs being reduced by some 50%) and the turnaround period has been reduced from three weeks to some 2 days, a cost saving in itself. Powell further suggests that by 85/86 some 40–45% of books from this company should be edited in this fashion.

That Coding Again

The problem, however, according to Powell, is (yet again) the coding. While in his view electronic publishing is 'absolutely the coming thing', the manufacturers of word processing programs 'have absolutely no idea of what book publishers require.' At present, to be effective, his company would require copies of virtually every word processing program and a mini of many types on the desk of each of its editors. The cost is simply too high.

Top of the line, at least in the Canadian context, is the Coach House Press in Toronto. Their authors are encouraged too submit manuscripts composed on the most powerful system that the author can afford, such as UNIX Writer's Workbench which is capable of logging onto a more powerful system that makes available complex word processing programs. This, according to Stan Bevington who runs Coach House, creates what he terms 'machine independent text' which can be transmitted by telephone and read by another computer, regardless of the kind of software or hardware used to generate the text in the first place. While Coach House still accepts manuscripts in a hard copy format, most of their books come to them in this electronic format.

Apparently, none of the above spokespeople have heard of the Dimension 68000 reviewed in our sister publication Computing Now! a month or two ago; it is capable of handling central processing varieties from a number of different types of computers (ie. Apple, IBM, whatever) just by telling it which type of computer the floppy was originally composed on.

One thing, however, is certain. The electronic creation of book manuscripts is being led by the authors and hamstrung by the publishers who seemingly have been unable to agree to an industry standard coding process. **ET**

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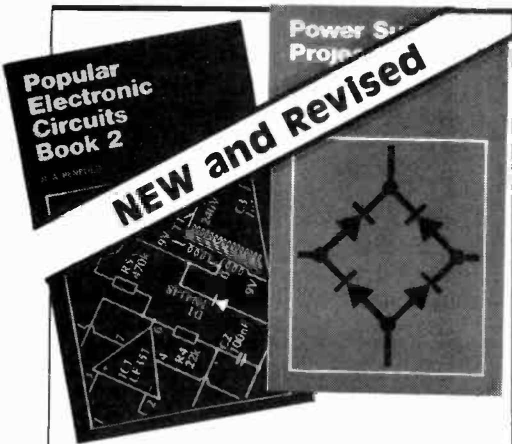

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Although one of the more recent branches of amateur electronics, electronic music has now become extremely popular and there are many projects which fall into this category. The purpose of this book is to provide the constructor with a number of practical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

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

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

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

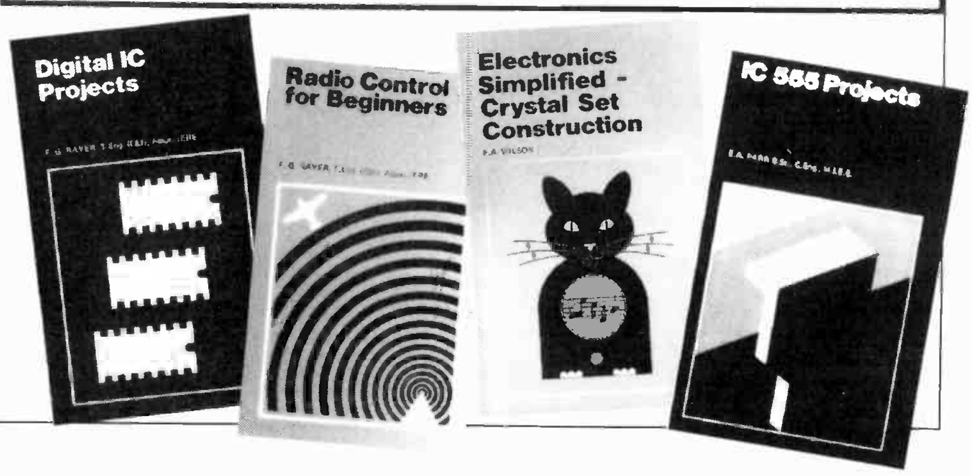
Details are then given of actual solid state transmitting equipment which the reader can build. Plain and loaded aerials are then discussed and so is the field-strength meter to help with proper setting up.

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

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

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

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



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RADIO AND COMMUNICATIONS

BP96: CB PROJECTS $7.60
R.A. PENFOLD
Projects include speech processor, aerial booster, cordless mike, aerial and harmonic filters, field strength meter, power supply, CB receiver and more

222: SOLID STATE SHORT WAVE RECEIVERS FOR BEGINNERS $7.60
R.A. PENFOLD
In this book, R.A. Penfold has designed and developed several modern solid state short wave receiver circuits that will give a fairly high level of performance, despite the fact that they use only relatively few and inexpensive components.

BP91: AN INTRODUCTION TO RADIO DXing $7.60
This book is divided into two main sections one to amateur band reception, the other to broadcast bands. Advice is given to suitable equipment and techniques A number of related constructional projects are described

BP105: AERIAL PROJECTS $7.60
R.A. PENFOLD
The subject of aerials is vast but in this book the author has considered practical designs including active, loop and ferrite aerials, which give good performances and are reasonably simple and inexpensive to build. The complex theory and math of aerial design are avoided.

BP125: 25 Simple Amateur Band Aerials
E.M. Noll $7.60
Starting from simple dipoles through beam, triangle and even mini-rhombics (made from TV masts and 400ft of wire) this title describes several simple and inexpensive aerials to construct yourself. A complete set of dimension table are included.

BP46: RADIO CIRCUITS USING IC's $5.40
J.B. DANCE, M.Sc.
This book describes integrated circuits and how they can be employed in receivers for the reception of either amplitude or frequency modulated signals The chapter on amplitude modulated (a.m) receivers will be of most interest to those who wish to receive distant stations at only moderate audio quality, while the chapter on frequency modulation (f m) receivers will appeal to those who desire high fidelity reception

BP92: ELECTRONICS SIMPLIFIED—CRYSTAL SET CONSTRUCTION $6.80
F.A. WILSON
Aimed at those who want to get into construction without much theoretical study Homewound coils are used and all projects are very inexpensive to build.

BP70: TRANSISTOR RADIO FAULT-FINDING CHART $2.50
CHAS. E. MILLER
Across the top of the chart will be found four rectangles containing brief descriptions of various faults; vis: — sound weak but undistorted; set dead; sound low or distorted and background noises One then selects the most appropriate of these and following the arrows, carries out the suggested checks in sequence until the fault is cleared.

AUDIO

205: FIRST BOOK OF HI-FI LOUDSPEAKER ENCLOSURES $3.75
B.B. BABANI
This book gives data for building most types of loudspeaker enclosure Includes corner reflex, bass reflex, exponential horn, folded horn, tuned port, klipschorn labyrinth, tuned column, loaded port and multi speaker panoramic. Many clear diagrams for every construction showing the dimensions necessary.

HOW TO BUILD A SMALL BUDGET RECORDING STUDIO FROM SCRATCH. . .
TAB No.1166 $15.95
The author, F Alton Everest, has gotten studios together several times, and presents twelve complete, tested designs for a wide variety of applications If all you own is a mono cassette recorder, you don't need this book If you don't want your new four track to wind up sounding like one, though, you shouldn't be without it

BP51: ELECTRONIC MUSIC AND CREATIVE TAPE RECORDING $7.75
M.K. BERRY
Electronic music is the new music of the Twentieth Century. It plays a large part in "pop" and "rock" music and, in fact, there is scarcely a group without some sort of synthesiser or other effects generator

This book sets out to show how electronic music can be made at home with the simplest and most inexpensive of equipment It then describes how the sounds are generated and how these may be recorded to build up the final composition

BP81: ELECTRONIC SYNTHESISER PROJECTS $6.80
M.K. BERRY
One of the most fascinating and rewarding applications of electronics is in electronic music and there is hardly a group today without some sort of synthesiser or effects generator. Although an electronic synthesiser is quite a complex piece of electronic equipment, it can be broken down into much simpler units which may be built individually and these can then be used or assembled together to make a complete instrument.

ELECTRONIC MUSIC SYNTHESIZERS
TAB No.1167 $10.95
If you're fascinated by the potential of electronics in the field of music, then this is the book for you. Included is data on synthesizers in general as well as particular models. There is also a chapter on the various accessories that are available.

TEST EQUIPMENT

BP75: ELECTRONIC TEST EQUIPMENT CONSTRUCTION $6.80
F.G. RAYER, T.Eng. (CEI), Assoc. IERE
This book covers in detail the construction of a wide range of test equipment for both the Electronics Hobbyists and Radio Amateur. Included are projects ranging from an FET Amplified Voltmeter and Resistance Bridge to a Field Strength Indicator and Heterodyne Frequency Meter. Not only can the home constructor enjoy building the equipment but the finished projects can also be usefully utilised in the furtherance of his hobby.

THE POWER SUPPLY HANDBOOK
TAB No.806 $15.95
A complete one stop reference for hobbyists and engineers. Contains high and low voltage power supplies of every conceivable type as well mobile and portable units.

REFERENCE

BP85: INTERNATIONAL TRANSISTOR EQUIVALENTS GUIDE $11.75
ADRIAN MICHAELS
This book will help the reader to find possible substitutes for a popular user-orientated selection of modern transistors. Also shown are the material type, polarity, manufacturer selection of modern transistors. Also shown are the material type, polarity, manufacturer and use The Equivalents are sub-divided into European, American and Japanese. The products of over 100 manufacturers are included. An essential addition to the library of all those interested in electronics, be they technicians, designers, engineers or hobbyists. Fantastic value for the amount of information it contains.

BP108: INTERNATIONAL DIODE EQUIVALENTS GUIDE
ADRIAN MICHAELS $8.95
This book is designed to help the user in finding possible substitutes for a large user orientated selection of the many different types of semiconductor diodes that are available today. Besides simple rectifier diodes also included are Zener diodes, LEDs, Diacs Triacs, Thyristors, Photo diodes and Display diodes.

BP1: FIRST BOOK OF TRANSISTOR EQUIVALENTS AND SUBSTITUTES $5.75
B.B. BABANI
This guide covers many thousands of transistors showing possible alternatives and equivalents. Covers transistors made in Great Britain, USA, Japan, Germany, France, Europe, Hong Kong, and includes types produced by more than 120 different manufacturers.

BP14: SECOND BOOK OF TRANSISTOR EQUIVALENTS AND SUBSTITUTES $6.75
B.B. BABANI
The "First Book of Transistor Equivalents" has had to be reprinted 15 times. The "Second Book" produced in the same style as the first book, in no way duplicates any of the data presented in it. The "Second Book" contains only additional material and the two books complement each other and make available some of the most complete and extensive information in this field. The interchangeability data covers semiconductors manufactured in Great Britain, USA, Germany, France, Poland, Italy, East Germany, Belgium, Austria, Netherlands and many other countries.

TOWER'S INTERNATIONAL OP-AMP LINEAR IC SELECTOR
TAB No.1216 $17.95
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CMOS DATABOOK
TAB No.984 $12.50
There are several books around with this title, but most are just collections of manufacturers' data sheets This one, by Bill Hunter, explains all the intricacies of this useful family of logic devices . . the missing link in getting your own designs working properly. Highly recommended to anyone working with digital circuits.

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ROBOTICS

THE COMPLETE HANDBOOK OF ROBOTICS
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BP100: AN INTRODUCTION TO VIDEO
D.K. MATHEWSON $7.60
Presents in as non-technical a way as possible how a video recorder works and how to get the best out of it and its accessories. Among the items discussed are the pros and cons of the various systems, copying and editing, international tape exchange and understanding specifications

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J. DOUGLAS-YOUNG $11.95
Packed with scores of easy-to-understand diagram and invaluable troubleshooting tips as well as a circuit finder chart and a new section on logic circuits

BP101: HOW TO IDENTIFY UNMARKED IC'S $2.75
K.H. RECORR
Originally published as a feature in 'Radio Electronics', this chart shows how to record the particular signature of an unmarked IC using a test meter, this information can then be used with manufacturer's data to establish the application

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TALLEY
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A. BARBER $10.95
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BP121: How to Design and Make Your Own PCBs
R.A. Penfold $7.60
The emphasis is on practical rather than theoretical techniques. Starts by giving simple methods of copying from magazines, carries on with photographic methods of producing PCBs and continues with layout design.

Electronics Today Bookshelf

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

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

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

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

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

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

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

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

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

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

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

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

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

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

CIRCUITS

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

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

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

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

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

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

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

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

BP42: 50 SIMPLE L.E.D. CIRCUITS $5.75
R.N. SOAR
The author of this book, Mr. R.N. Soar, has compiled 50 interesting and useful circuits and applications, covering many different branches of electronics, using one of the most inexpensive and freely available components — the Light Emitting Diode (L.E.D.). A useful book for the library of both beginner and more advanced enthusiast alike.

THE ACTIVE FILTER HANDBOOK
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Whatever your field — computing, communications, audio, electronic music or whatever — you will find this book the ideal reference for active filter design.

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

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MASTER HANDBOOK OF 1001 MORE PRACTICAL CIRCUITS
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BP88: HOW TO USE OP AMPS $8.85
E.A. PARR
A designer's guide covering several op amps, serving as a source book of circuits and a reference book for design calculations. The approach has been made as non-mathematical as possible.

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

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

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

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

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

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CMOS IC's are probably the most versatile range of digital devices for use by the amateur enthusiast. They are suitable for an extraordinary wide range of applications and are also some of the most inexpensive and easily available types of IC.

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

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

BP24: 50 PROJECTS USING IC741 $6.75
RUDI & UWE REDMER
This book, originally published in Germany by TOPP, has achieved phenomenal sales on the Continent and Babani decided, in view of the fact that the integrated circuit used in this book is inexpensive to buy, to make this unique book available to the English speaking reader. Translated from the original German with copious notes, data and circuitry, a "must" for everyone whatever their interest in electronics

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

BP50: IC LM3900 PROJECTS $5.40
H.KYBETT,B.Sc., C.Eng.
The purpose of this book is to introduce the LM3900 to the Technician, Experimenter and the Hobbyist. It provides the groundwork for both simple and more advanced uses, and is more than just a collection of simple circuits or projects.

Simple basic working circuits are used to introduce this IC. The LM3900 can do much more than is shown here, this is just an introduction. Imagination is the only limitation with this useful and versatile device. But first the reader must know the basics and that is what this book is all about.

ELECTRONIC DESING WITH OFF THE SHELF INTEGRATED CIRCUITS
AB016 $12.95
This practical handbook enables you to take advantage of the vast range of applications made possible by integrated circuits. The book tells how, in step by step fashion, to select components and how to combine them into functional electronic systems. If you want to stop being a "cookbook hobbyist", then this is the book for you.

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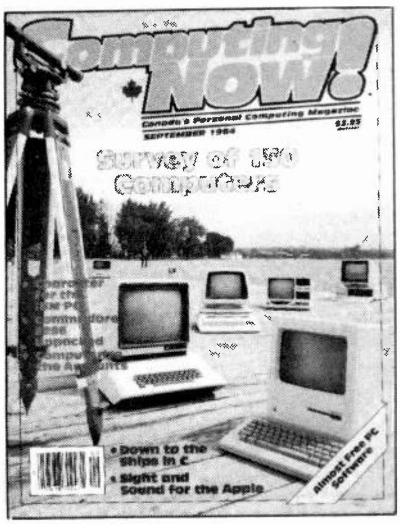

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Railroad Signal Lights

The right lights for your layout, by C.K. Jones.

THE ELECTRONICS of the system consist of two circuit modules. The basic Track Module controls one set of signal lights for one section of track; it responds to the location of the train and the settings of any points, level crossings etc in that section of track. The second module is a Junction Module, required to drive the white lights of a branch line indicator and to control the Track Modules on either side of the junction.

For the signal lights, it is easy to use Light Emitting Diodes (LEDs) which, conveniently, are available in red, yellow (amber) and green. There are several methods that can be used to detect the position of a train; one of the simplest and most reliable is to use small bar magnets attached under the locomotives at axle height, and magnetically operated reed switches positioned on the track between the rails. Model points do not usually provide a signal suitable for driving the circuits but, with a little ingenuity, microswitches can be attached to the points to give suitable inputs to the modules.

The Track Module

The circuit diagram of Figure 1 is for a single Track Module; a model layout will need one of these for each set of lights. The circuit itself is quite simple (though as we shall see, the interaction of two or more modules becomes slightly more complicated!). the 'brain' of the circuit is the bistable flip-flop consisting of NAND gates IC1c and IC1d (truth tables for both NAND and NOR gates are shown in Table 1 Switches SW2 and SW3 are the magnetic reed switches which close momentarily when the locomotive passes over them.

When SW2 closes, pin 5 of IC1c is taken to 0V (logic 0 or 'low') for just a moment, so that the output at pin 6 goes high (logic 1, +5V). This high is coupled to pin 2 of IC1d and, since its pin 1 input is already helf high through R6 and R7, pin 3 goes low. This is coupled back to the other input of IC1c at pin 4, ensuring that output stays high. Thus the momentary low on pin 5 is 'latched' by the flip-flop and it will maintain this state, which indicates that there is a trian in the section controlled by the module.

When the train leaves the section of track, SW3 closes and pin 1 of IC1d goes low for a moment; this is coupled to pin 4 of IC1c and, since pin 5 in being held high through R4, R5, the output at pin 6 goes low. This is fed back to the pin 2 input, maintaining the high output on pin 3. So, the new state is latched in and this indicates to the following circuitry that the train has cleared the section.

If the flip-flop is the brain of the circuit, the quad-input NOR gate IC2 is its 'heart'. Its output at pin 8 directly drives the red signal light, LED3, and indirectly controls the other two lights. As shown in Figure 1, two of the inputs are wired directly to 0V, one to 0V via the normally closed points switch SW1, and the fourth is connected to the pin 6 output of the flip-flop. When all four inputs are low, the output will be high and the LED is

INPUTS		OUTPUT
A	B	$\overline{A \cdot B}$
0	0	1
1	0	1
0	1	1
1	1	0

NAND
OUTPUT = NOT (A AND B)

INPUTS		OUTPUT
A	B	$\overline{A+B}$
0	0	1
1	0	0
0	1	0
1	1	0

NOR
OUTPUT = NOT (A OR B)

Table 1. Truth tables for NAND and NOR gates.

biased off, with +5V on both the anode and cathode. However, when the flip-flop is triggered by a train entering the section, pin 9 of IC2 goes high, pin 8 goes low and LED3 turns on. The result is the same if SW1 is opened (indicating that the points are set against an oncoming train), since the internal circuit of the TTL gate puts a high on any open circuit input.

If the section of track monitored by a module does not contain a set of points, them terminal 2 should also be wired to 0V. The other two inputs, at module terminals 3 and 4, are available for other switch functions within a section of track, eg for level crossing indication, etc.

Keeping Track

To understand how the remainder of the circuit works, it is easier to look at the interaction between several modules, controlling two or more sections of line, and to trace the logic sequence as a train passes through. The composite circuit diagram of Figure 2 shows the internal circuit of the module controlling Section 2 of a length of line, together with the outlines and terminals of the adjacent modules. The internal circuit has been simplified by drawing the flip-flop as a block with SET

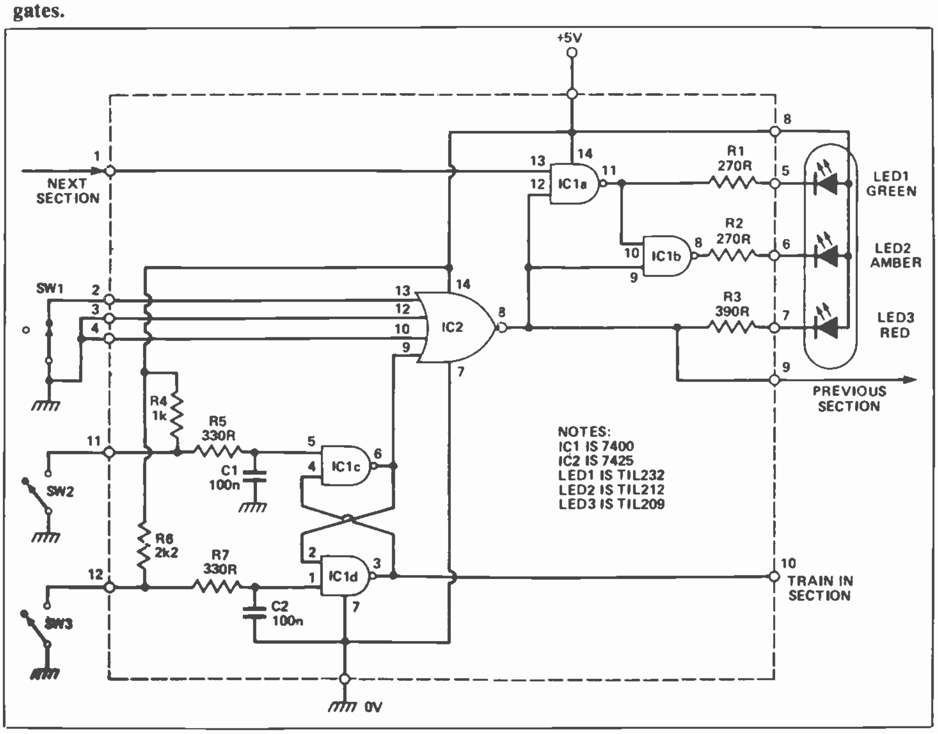


Figure 1. Circuit diagram of the Track Module

and RESET inputs, and Q and Q outputs, in standard notation; however, its operation is exactly as described earlier. The timing diagram, Figure 3, will be helpful in tracing the action of the sequential logic.

We should establish the starting conditions. After a power-on reset, all inputs to IC2 are low and the red LED is turned off. The output from Module 2 terminal 9 is a high, indicating that the section is clear. Similarly, the terminal 9 output from Module 3 is high. Therefore, the inputs to NAND gate IC1a are both high; its output will be a low and the green light, LED1, turned on. The gate IC1b has a high input from IC2 and a low from IC1a so its output will be high and the amber light, LED2, is turned off. The logic conditions are the same for Modules 1 and 3.

Junction Module

The function of the second circuit module is to control the signal lights indicating a branch leaving the main line, and to connect the Track Modules on either side of the junction, according to the setting of the points. The composite diagram, Figure 4, shows the internal circuit of a junction module and its connections to the Track Modules. It is most easily understood with the aid of the timing diagram Figure 5, which traces the logic sequence of trains passing through the junction, and with the truth tables of the NAND and NOR gates.

We can assume, at the start, that all signals are showing green, ie, all Track Modules are in their reset condition, and that the points are set for a straight-through run. The inputs and outputs of the Junction Module are as follows: the inputs to IC2d are a high (since TS1 is open) and a low (from PS1, which is closed); therefore its output is high and the branch lights are turned off.

Normally, in a straight section of track, Module 1 is reset by the train passing over TS2; in this case, however, it is reset via the Junction Module. When TS2 closes, it takes one input of IC2a low for a moment, forcing the output to go high. With both its inputs high, IC2c will go low, providing the reset pulse to terminal 12 of Modul 1 and turning off the red LED of L1.

The train now moves through Section 1 and takes the branch line, which we have called Section 3. As it does, TS3 closes, turning L3 to red and putting a low on one input of IC2b, so that its output is forced high. The other input of IC2c is being held high by PS1, via ICs 1d and 2a, therfore IC2c will go low, putting a reset pulse on terminal 12 of Module 1 and turning off its red LED. Simultaneously, terminal 9 of Module 3 has gone low; IC1c now has two low inputs (the other is held low by

PARTS LIST

Track Module

RESISTORS (All 1/4 watt 5% carbon)

R1,2	270R
R3	390R
R4	1k
R6	2k2
R5,7	330R

CAPACITORS

C1,2	100n C280 polyester

SEMICONDUCTORS

IC1	7400 TTL quad 2-input NAND
IC2	7425 TTL dual 4-input NOR
LED1	TIL232 green 0.2" LED
LED2	TIL212 orange 0.2" LED
LED3	TIL209 red red 0.2" LED

MISCELLANEOUS

SW1	SPST switch track switch-see text
SW2	SPST switch points switch-see text

PCB; signal stands (see text); wire solder etc.

Junciton Module

RESISTORS (All 1/4 watt 5% carbon)

R1	1k

SEMICONDUCTORS

IC1	7402 TTL quad 2-input NOR
IC2	7400 TTL quad 2-input NAND

MISCELLANEOUS

SW1	SPST switch points switch-see text

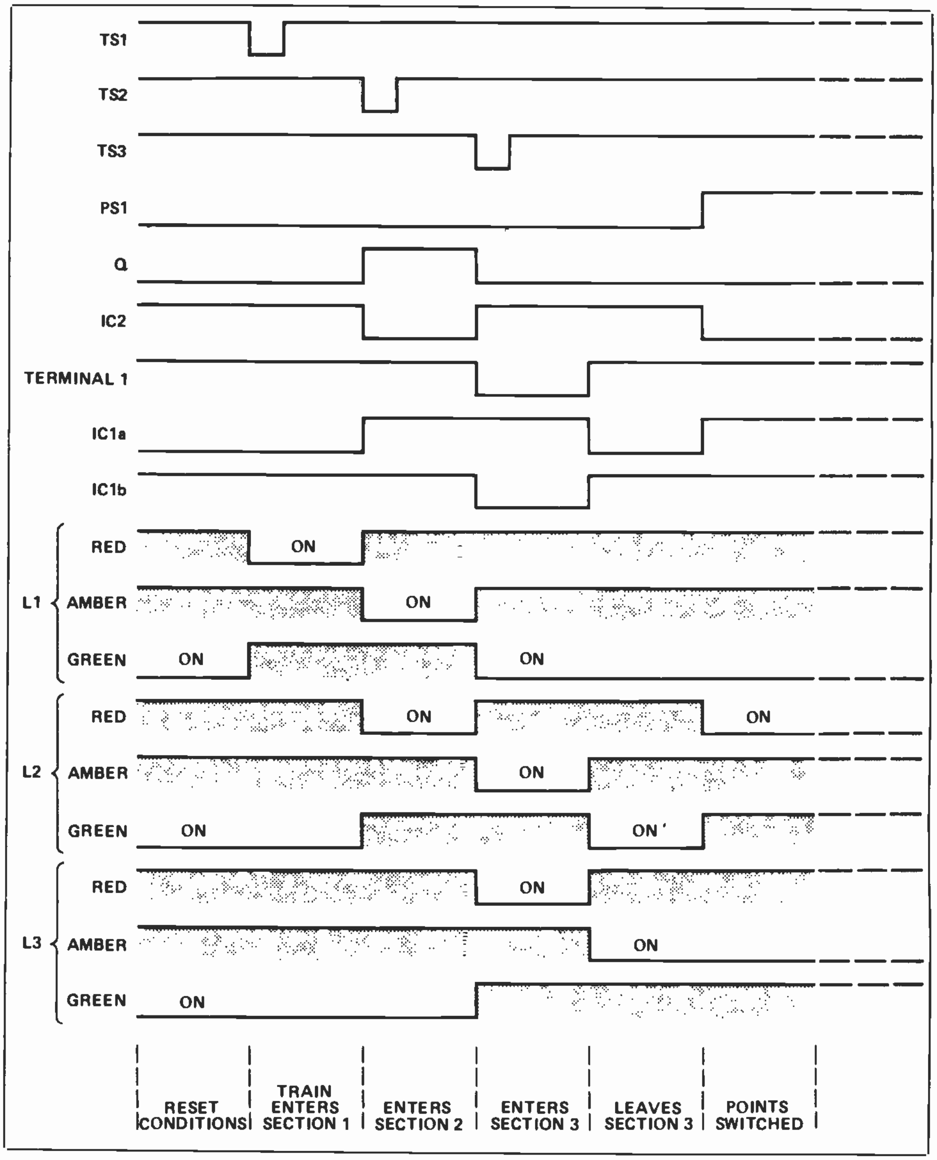


Figure 3. Timing diagram for "Keeping Track".

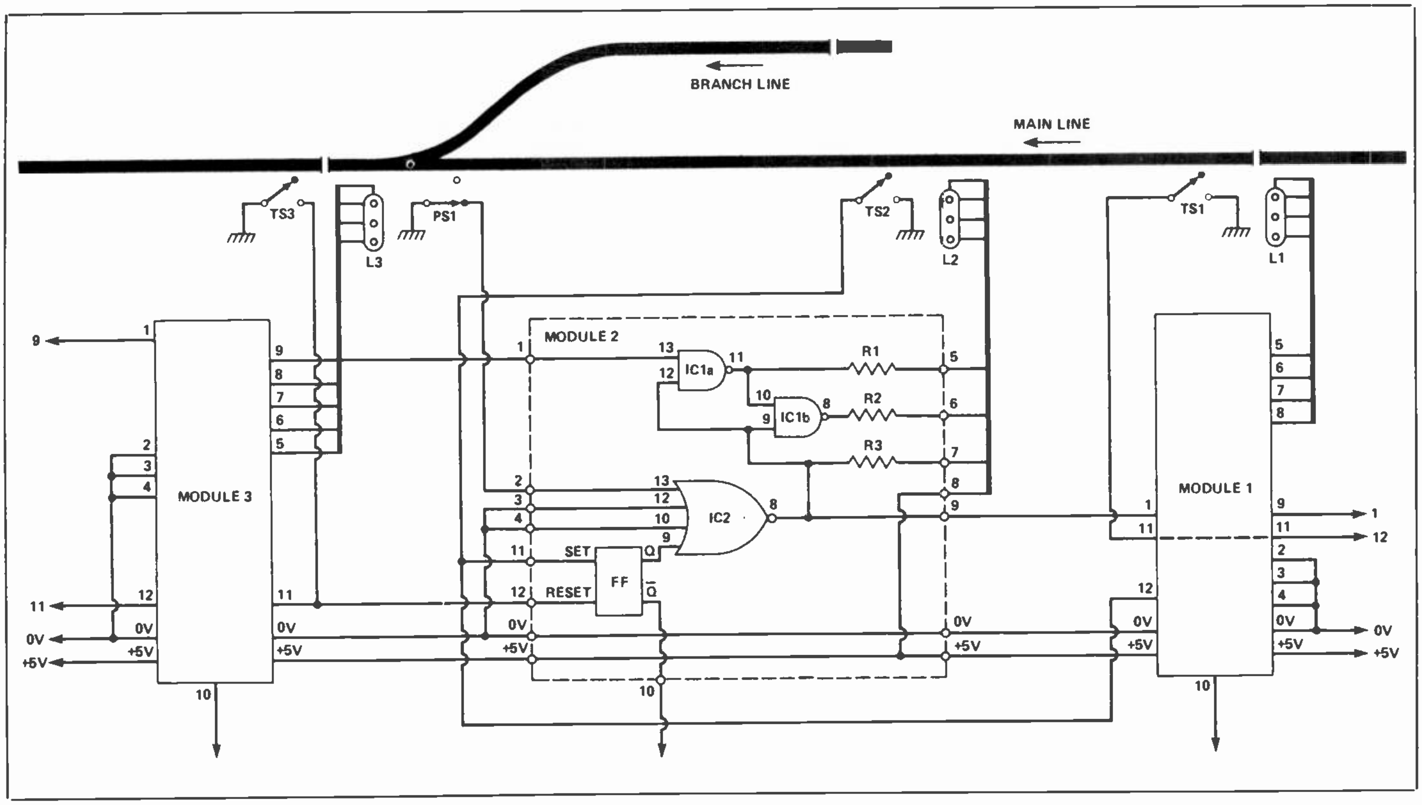


Figure 2. Combines Module circuit and track layout diagram; note that the flip-flop has been drawn here in standard 'block' form.

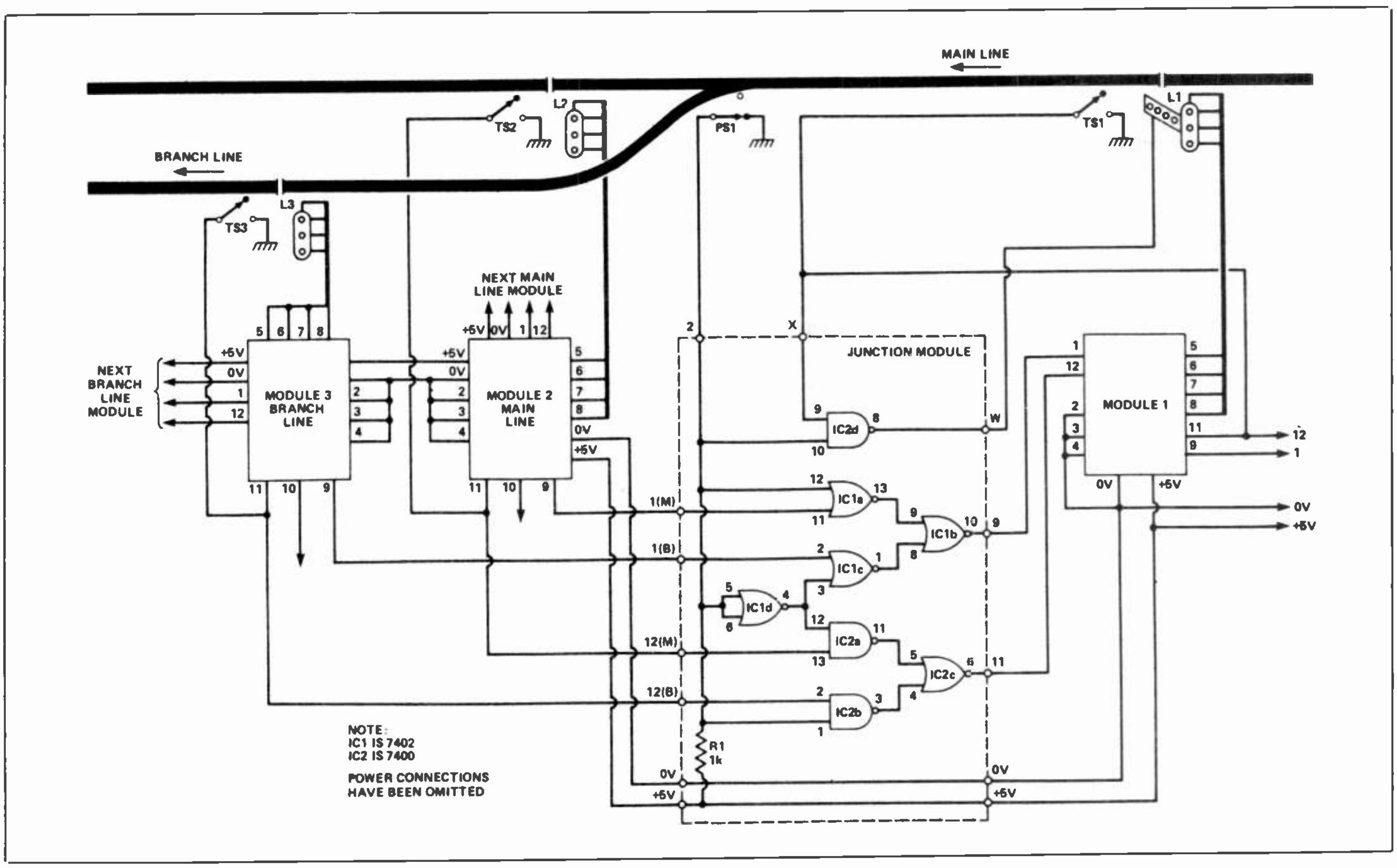


Figure 4. Combined Junction Module circuit and track layout diagram.

PS1 via IC1d), so its output goes high, forcing IC1b high and thus turning on the amber LED in L1 via Module 1.

A similar sequence of logic will set L1 to green when the train finally clears Section 3. The timing diagram, Figure 5, shows this sequence as well as that which results when the points are reset.

These circuits, although very simple by themselves, can be quite complicated in their interactions, as we have just seen! Everything depends on the timing of the various switch closures, together with the conditions which resulted from the last operation. Timing diagrams are essential for understanding circuits of this kind.

In fact, if the timing of the switch closures (which trigger the logic changes resulting in the appropriate signal lights) are not correct, the system will not produce the right results. The track switches must be positioned very carefully, at the start of each section of line, to produce the desired signals. Another small trap, which should not normally be of any bother, is that a set of points cannot be changed until the train has cleared the section controlled by the branch indicator. In other words, the points cannot be set for the branch line, in our example, until the train has cleared Section 2. Otherwise the amber light on L1 will not clear.

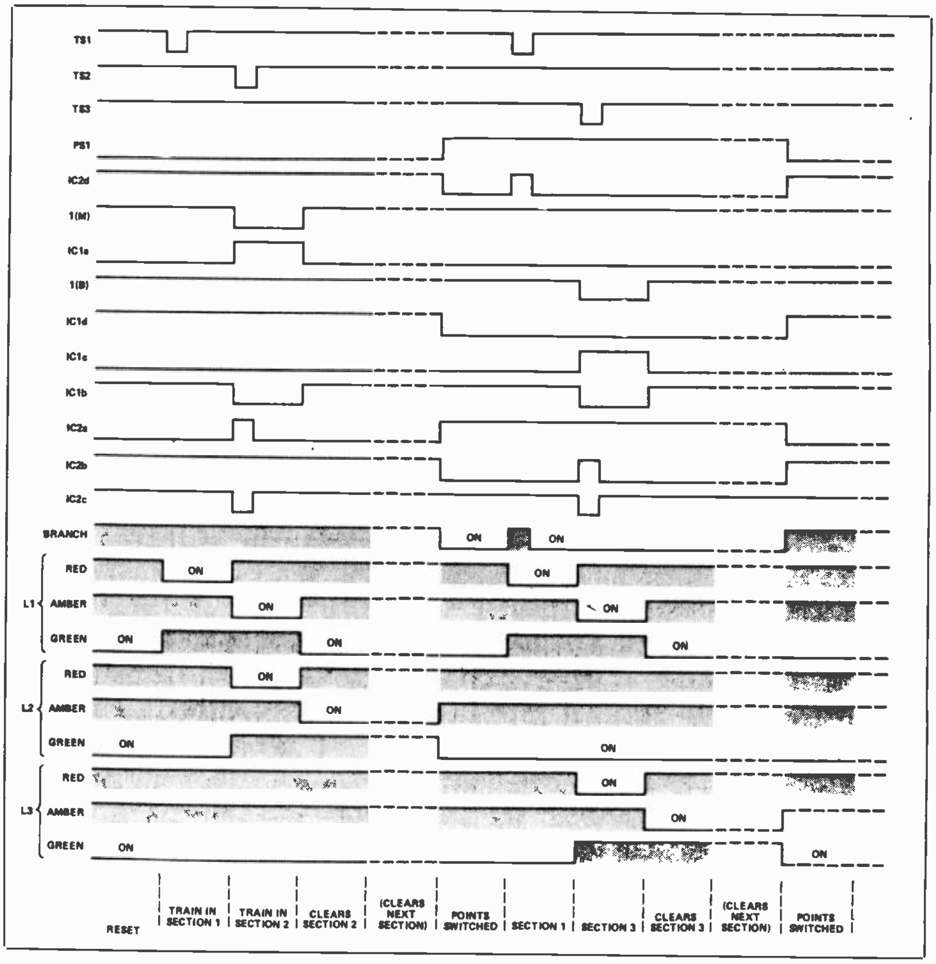
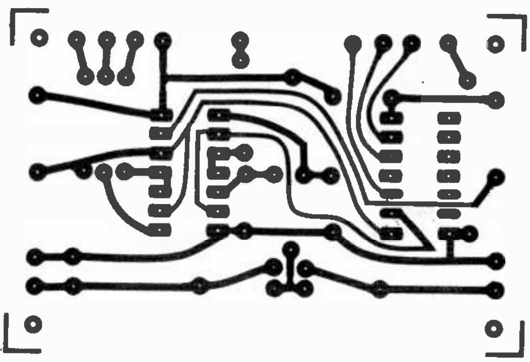


Figure 5. timing diagram for tracing the Junction Module operation.

Construction and Layout

The component overlay diagrams for a Track Module and for a Junction Module are shown in Figures 6 and 7, respectively. Full sized PCB patterns are reproduced on the PCB Printout page.

The construction is quite straighforward and should not give any difficulty. The ICs are all TTL, so no special handling procedures are needed except for normal care not to overheat them or bend the pins. The composite circuit diagrams, Figures 2 and 4, should be used as a guide to positioning the track switches and signal stands. The modules are most conveniently mounted under the track layout and connected together, as shown in Figures 2 and 4, by lengths of four-way ribbon or multicore cable. The connections to the signal lights can also be made with four-way cable.



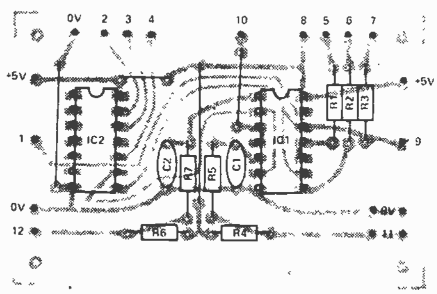


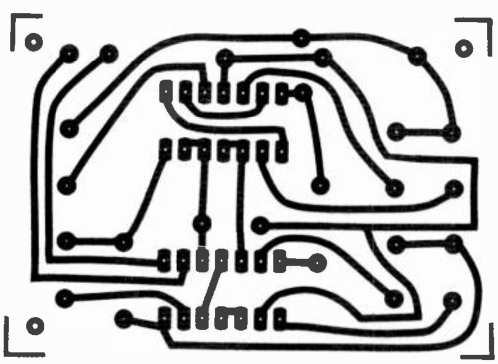
Figure 6. Component overlay for the Track Module.

Power Supply

All the circuit modules are powered from +5V, which can easily be derived using a three-terminal 5V regulator. Each module will draw approximately 50 mA, so the source must have the capability to supply this current, times as many modules are there are in the layout.

Signal Posts

As for the signal posts, we leave this up to the ingenuity of the individual instructor. They can be fashioned out of anything resembling a signal post and the LEDs should be wired using color-coded wire to avoid confusion.



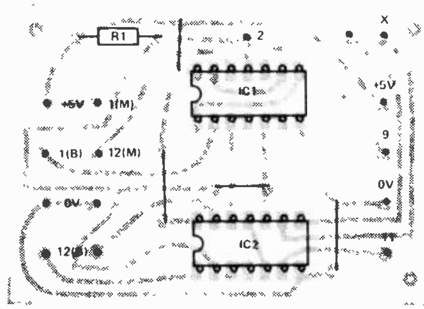


Figure 7. Component overlay for the Junction Module.

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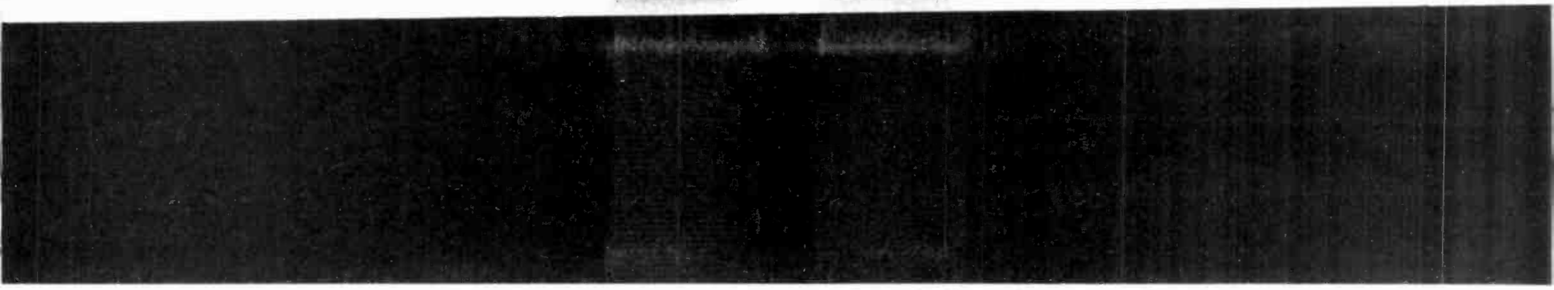

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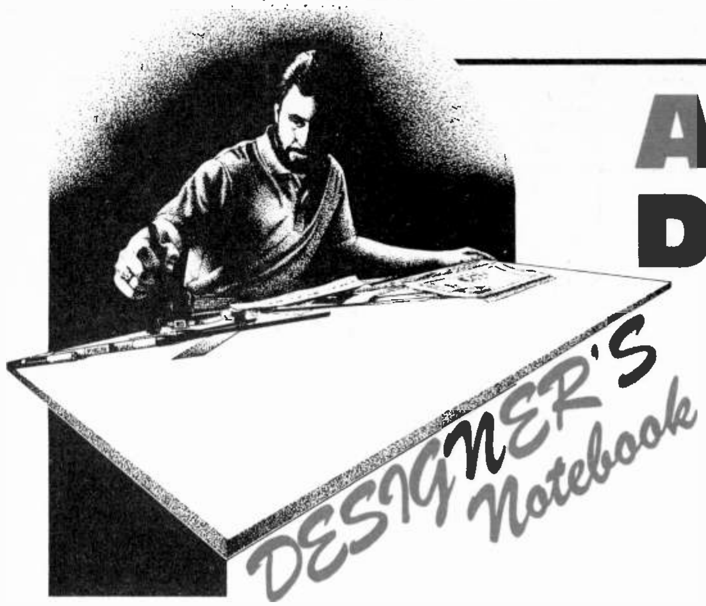


Analog Audio Design Part 2

Problems and ICs often, as we all know, go together. John Linsley Hood takes a look at the two of them in audio.

AS A GENERAL classification, one can divide linear ICs into two broad categories: purpose-built or dedicated ICs, aimed at the performance of one specific application; and general purpose ICs, such as the operational amplifier types, which are designed for use as versatile building blocks in a wide range of circuit configurations. The first of these categories contains a host of useful devices, whose numbers increase daily, that are capable of doing a very wide range of jobs, from providing well stabilized, ripple free, power supplies, to complete radio systems or audio amplifiers in a single package.

As a rule, hi fi circuit designers and their customers tend rather to look askance at such purpose-built ICs in audio applications, since these devices are intended mainly for use in mass-produced consumer hardware, to simplify and reduce the cost of manufacture of competitively priced domestic electronics. A hi fi specification is not usually either part of the IC designer's brief or of the customer's cost expectation. Nevertheless, some of these dedicated ICs perform extremely well, and have found their way into some of the most prestigious of audio systems. One must, therefore, try not to harbour preconceived opinions about their potential quality, but rather to judge these devices on their individual merits.

So far as the circuitry associated with these dedicated ICs is concerned, although it is great fun to explore their internal construction and to work out schemes for using them in applications their designers had never envisaged, this is rather an exotic field, and full of pitfalls for the unwary. So, in general, it is prudent to stick fairly closely to the circuit applications and component values recommended by the manufacturers in their application data sheets (which one should make sure one gets with the device) since it will probably be difficult to improve greatly upon these recommendations. With general purpose ICs, these constraints upon the method of possible use do not exist, and a very wide range of circuit uses can be envisaged.

Basic IC Amplifier Layouts

Taking the op-amp gain block as a starting point, this will be familiar as a simple, fairly wide bandwidth amplifier unit, having two inputs — one phase-inverting, one non-inverting, an output pin, and two further pins for conncetion to a + ve and -ve DC voltage supply. Some ICs of this type (in fact, most of the packages which contain just one gain block) also have two further pins which can be used, when connected to an external trimmer potentiometer, to adjust the DC output level of the amplifier when this is used as a DC amplifier stage. Such an op-amp IC will normally be designed to work over supply voltage ranges from ±1.5v to ±15v, or indeed, in a suitable circuit layout, from a single DC supply within the range 3-30 volts.

The conventional circuit drawing for such an op-amp is shown in Fig. 1, where, as ever, the + and - symbols on the input leads imply the non-inverting and inverting amplifier characteristics. Although on this drawing I have shown the + and -supply connections to the IC, it is a common practice to take these as read where the ICs are used from a symmetrical or otherwise unremarkable power supply arrangement, and I propose to follow this convention and omit the power supply connections, where these are standard, in future drawings.

Most of the popular op-amps of the 741 type are what is known as *internally*

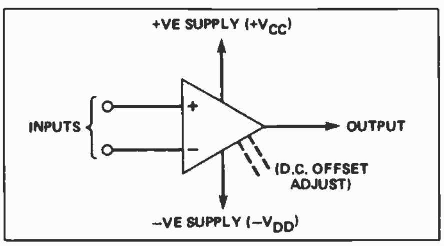


Fig. 1. Conventional circuit drawing of an operational amplifier.

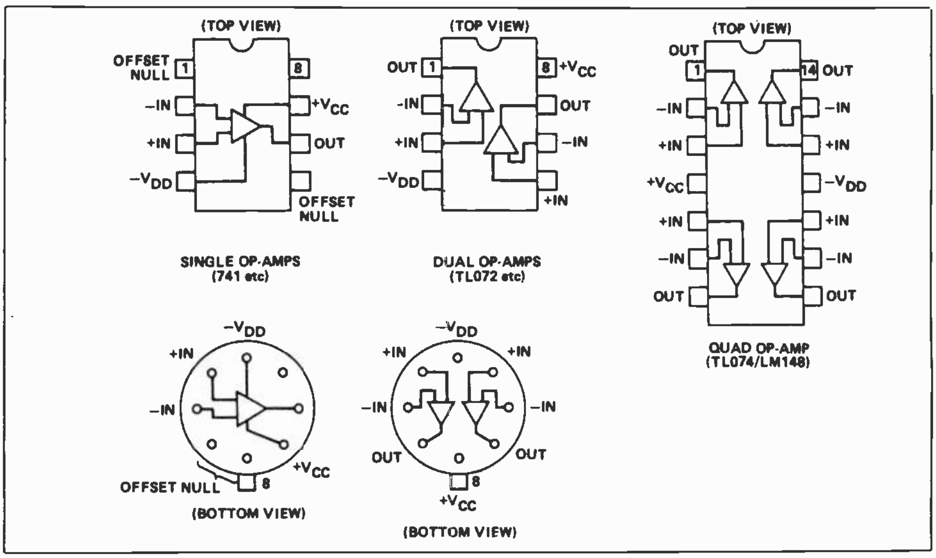


Fig. 2. Common op-amp pin connections.

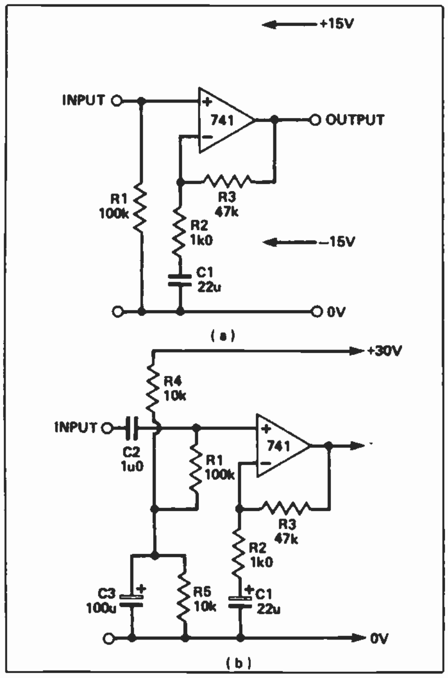


Fig 3(a) A simple circuit for bipolar supplies, (b) for single supplies.

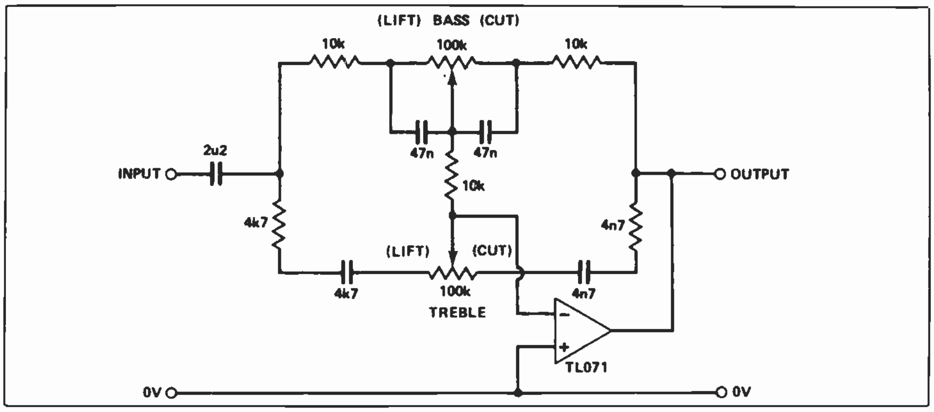


Fig. 4. 'Baxandall' type tone control circuit.

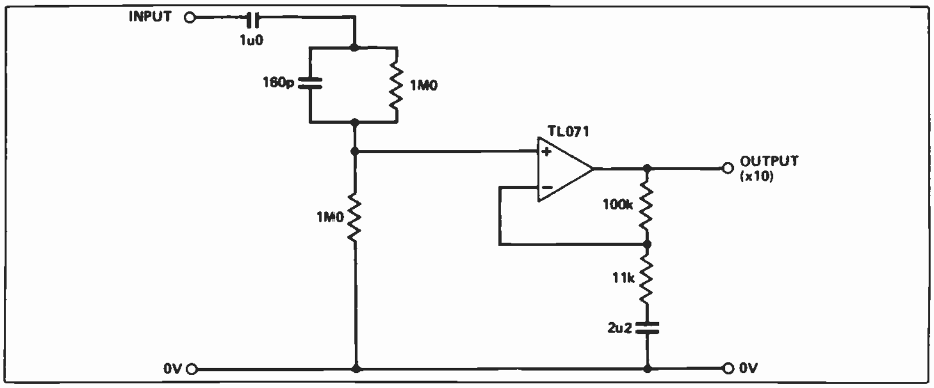


Fig. 5. Compensated ceramic pickup input amplifier.

compensated, which implies that negative feedback can be used in the circuit by the connection of a suitable network between the output and the inverting input pins, without having to worry about whether the amplifier will then be stable. In some of the erlier op-amp ICs, internal HF compensation was not provided, on the grounds that the necessary worst-case (unity-gain) compensation would lead to a less good HF performance from the IC at higher than unity-gain conditions, than if the compensation was done by a suitably chosen network of Rs and Cs external to the IC package. However, this situation has been overtaken by progress in IC design, and most of the contemporary IC designs will give a good HF performance without the need to accept an inconvenient external RC network.

Typical values of *open-loop* (i.e., before any negative feedback is applied) small signal, low frequency voltage gain are in the range 100,000-200,000 and the rejection of unwanted noise and voltage fluctuations on the voltage supply lines is usually of a similar order. The *common mode rejection ratio* (the ratio between the open-loop gain and the 'fault' gain you get when you tie the + and - inputs together and use them as if they were just one input) is usually in this range also, but it is very difficult to organize any circuit layout which will allow gains much higher than 1000 to be achieved. The most common pin configurations for IC op-amps are shown in Fig. 2, and a typical circuit for a small signal AC voltage amplifier is shown in Fig. 3a.

The circuit will give a stage gain determined by the ratio $(R_3 + R_2)R_2$. For the resistor values shown this is 48, and this circuit will have a frequency response at 1 V out (RMS) — assuming a ± 15 V DC supply — which is substantially flat from 10 Hz to 30 kHz, the LF limit being set by the value chosen for C1 (bigger = lower) and the HF end being determined by the characteristics of the IC itself, as a consequence of its internal HF compensation.

At 1 V RMS and 1 kHz, a typical distortion figure into a 2k ohm load, would be about 0.02% and a S/N ratio (assuming a low source impedance) of about 75 dB, when measured over the 10 Hz-30 kHz bandwidth. Substituting one of the newer designs of IC intended for audio use, such as a TL071 or a LF351, would halve the noise, increase the bandwidth to about 300 kHz, and reduce the 1 kHz distortion to some 0.002%. Such is progress!

Such a gain block, particularly when built using a TL071 or a LF351, both of which have high impedance FET inputs and very low noise characteristics, makes a very respectable hi fi amplifier stage, in any application where a flat gain/frequency response is appropriate. To take advantage of the convenience of a single power supply rail, which facilitates joining IC circuitry on to discrete transistor layouts, the circuit of 3a can be rearranged as shown in Fig. 3b without any loss of performance. (To assist in comparing the layout of 3b with that of 3a, I have retained some of the component numbering of 3a in 3b). Lower supply voltages diminish the available output swing and tend to worsen the THD (total harmonic distortion) at any given output, though this will only become conspicuous as the expected output signal level begins to get near the maximum available due to the DC supply provided.

Both of these op-amp gain stages compare favourably, both in terms of the cost of the components and in terms of performance, with the comparable separate transistor versions, the only major snag being the limit on the possible output voltage swing imposed by the ICs restricted HT supply capability. It is no use, therefore, to try to use an IC of this type if one wants a 100 V P-P signal output.

As shown inf Fig. 2, IC op-amps of this type are available in packages which contain up to four separate amplifiers on the same chip, usually with very little sacrifice in performance, and with only minimal signal breakthrough from one to another. In particular, the dual op-amp TL072 and LF353 types have become very popular among audio circuit designers as a means of handling a pair of stereo signal channels in one device.

Frequency Response Shaping

While quite a lot of audio signal handling can be done with stages with linear gain/frequency characteristics, it is very useful to be able to modify this frequency response. I have mentioned above, in the

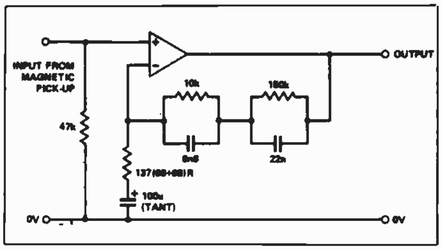


Fig. 6. Conventional RIAA equalized magnetic pickup amplifier stage (gain = 100 at 1 kHz).

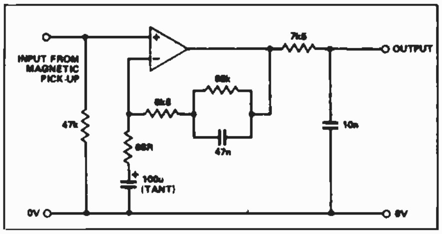


Fig. 7. Improved RIAA equalized magnetic pickup amplifier (stage gain = 100 at 1 kHz).

case of Fig. 3a, that the LF response was determined by the value of C1. This is because, in a feedback amplifier, the gain of the stage is really determined by the ratio of the impedances in the two limbs of the feedback network. So long as the impedances of any capacitors (or inductors) in these limbs can be ignored in comparison with the resistive elements, the gain will be independent of frequency. However, if the effects of these *reactive* components are significant within the audio band, this linearity of frequency response will be modified, and this gives the designer considerable scope.

In order to do this kind of design work properly, it is very desirable to be able to work with *complex numbers* (i.e., those containing the so-called *imaginary* value **i** or **j**, which is the square-root of -1). Doing the necessary calculations with this type of equation is not really at all difficult once some simple rules have been memorized, and this allows one to work out quite precisely how a circuit containing capacitors and inductors will operate, and gives both the actual gain and the phase shift. However, it is very hard to find textbooks which give a simple explanation.

However, for the moment it is sufficient to remember that the -3 dB point (the frequency at which the gain is reduced to 71% of its flat response value) occurs in a stage such as that shown in 3a when the impedance of the capacitor C1 (given by $Z_c = 1/(2 \times pi \times fC)$) is equal in value to R2. Where the impedance of C1 is either very much less than R2 or very much greater than R2, the stage gain calculations can be simplified to $(R3 + R2)/R2$ or $(R3 + Z_c)/Z_c$. If one draws a graph and smoothly joins these three

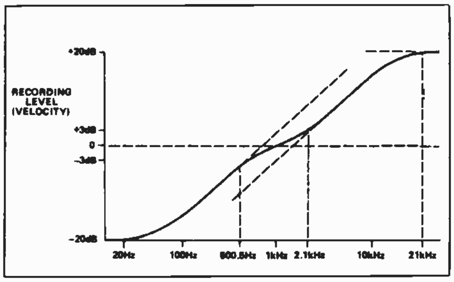


Fig. 8. Recording velocity characteristics employed in RIAA pre-emphasis convention for 33 and 45 RPM discs.

points, one will get a near-correct idea of the true way the circuit will behave.

Thus the circuit varies its response according to frequency, and this is entirely due to the presence of the reactive components (more usually capacitors than inductors). Very many practical and úseful designs are made possible; some examples are Fig. 4, which is a tone control circuit, and, as explained in the captions, Figs. 5, 6 and 7 which are pick-up amplifiers that accord with the RIAA specifications as shown in Fig. 9. The circuit arrangement shown in Fig. 7, in which the necessary double-step correction of the curve shown in Fig. 9, is done in two stages, is more accurate, particularly in respect of the sonically important transient performance, than the simpler, more commonly used arrangment of Fig. 6. The ceramic cartridge equalization has a different requirement, since this is an amplitude — rather than velocity — sensitive device, and requires the type of replay curve shown in Fig. 10. Otherwise, when it is used with an adequately high input impedance to give a flat LF response, the reproduced sound is rather lacking in treble.

Combining bass cut and treble cut stages allows one to make local lift and local cut response circuits, such as those shown in Figs. 11a and 11b and whose performance is illustrated in Figs. 12a and 12b. Figs. 11a and 11b are really both the same circuit, but with the 'shelf' frequencies moved sideways.

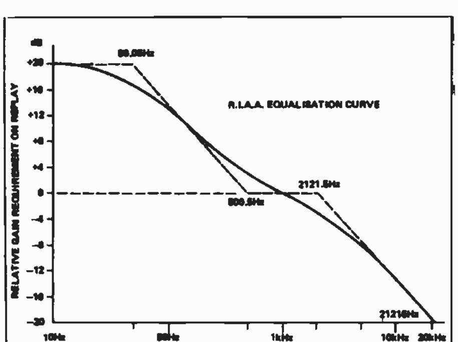


Fig. 9. Required replay curve for magnetic (velocity sensitive) pickup cartridges.

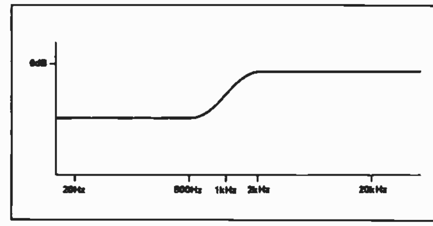


Fig. 10. Required replay curve for flat frequency response output from ceramic (displacement sensitive) pickup cartridges.

I have illustrated all these later circuits using op-amps (a TL071 will work satisfactorily in all these). Let me confess that this was at least partly for convenience — it's much simpler (and easier to follow) if one can just show an amplifier as a triangle with three leads going to it. However, this also makes the point that circuit design (and circuit layout in the PCB) with op-amps is very much easier than with the equivalent discrete components (this is provided, of course, that the devices you are using have adequate performance in terms of output capability, distortion, noise, etc.). But I still have the feeling that, for 'ultimate-fi', circuits using discrete components alone can be superior, if only because one can get the equivalent results with far fewer components (remember that a typical op-amp can contain the equivalent of 39 separate resistors, transistors, diodes, and capacitors, each with its own imperfections, all of them contributing to an accumulated total imperfection). Instinctively, I feel that the less one handles a hi fi signal, the better the end result.

Steeper cut curcuits using two or more RC elements can be built, and if these RC groups are included in the feedback network, we are now building active filters. There are great fun, but working out just what is going to happen requires rather more tricky mathematics, and a few useful dodges. So, while I certainly use ICs in my own designs, and I accept that I will do so even more in the future as they get better and more versatile, nevertheless I do not see them displacing the circuits built up with separate transistors and resistors in yet awhile. On the other hand, if one is making something like a car radio to which hi fi standards are not really appropriate, or an FM tuner where the discrete component circuitry would be very cumbersome, not to use ICs would be truly ostrich-like behaviour.

Noise, Distortion, and Other Problems

So far, I have largely pretended that we are living in an ideal world, where everything is as good as we could wish. Unfortunately, this isn't true, and the extent to which we will be successful in the field of audio design — as in any other —

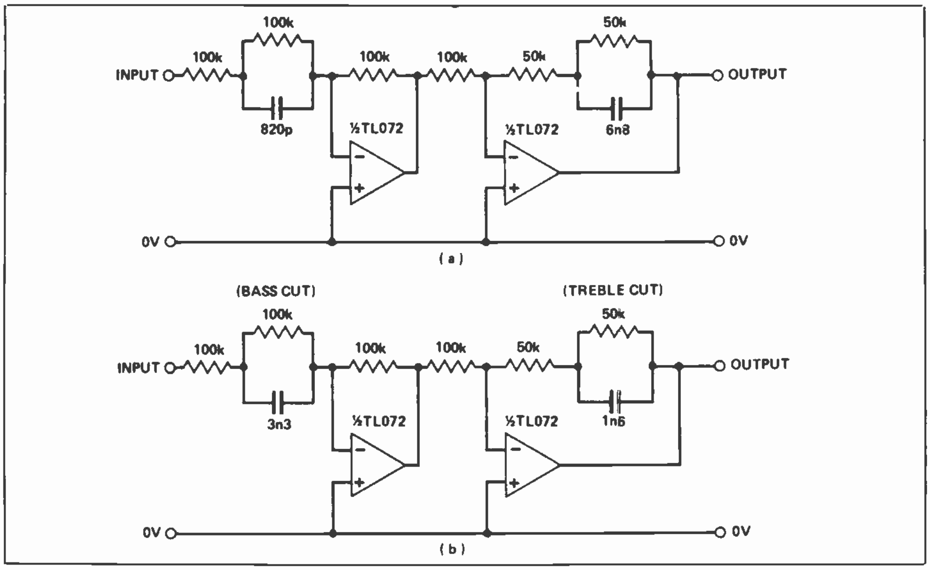


Fig. 11. Combined bass and treble cut circuits.

will depend on our ability to recognize the possible existence of defects, and to shape our designs, both on paper and as hardware, to avoid them. The problem, of course, is that it just isn't possible to optimize everything simultaneously, so what one ends up with must be a working compromise in which one has tried to assess what are the most important problems likely to affect one's listening pleasure, and to make sure that these are adequately dealt with.

This is, incidentally, one of the areas in which the designer has a great advantage over the person who simply goes along to his hi fi shop and hands over a fistfull of dollars for the latest black and chrome creation. This is because the commercial hi fi is built to provide a good specification/price ratio, which will get a good review in the buyers' guides and ensure healthy sales. Unfortunately, no one really knows what makes hi fi equipment, such as amplifiers, tuners and recorders, sound well; so, in the absence of any firm knowledge, a series of specifications relating to bandwidth, signal-to-noise ratio, power output, distortion and channel separation, have arisen — and these are the specs for which the commercial manufacturers seek to get good values. Whether the final thing sounds well cannot be so easily specified, but these are some areas where something which measures less well does indeed sound better. So, if one is doing one's own thing, one can design for sound rather than specifications.

Noise

If in this term one includes all unwanted intrusions into the signal output, noise consists of five main categories. These are: thermal noise, defective component noise, radio breakthrough, impulse noise, and hum (from the AC mains power supply). There are also some other kinds of device noise with transistors (and ICs) which relate to the device operating conditions, and I have lumped these with thermal noise. I will leave this until last.

Hum: In any normal domestic environment, there is a possibility of the local 60 Hz) AC mains field intruding into the circuitry, even when this is battery operated. The only answer, in this case, is full sheilding of the circuit, and care in the layout of connecting wires. Diecast metal boxes, provide ideal housings for low-level and high-gain circuitry. When one is powering equipment from the mains anyway, these problems multiply. Here one must make sure that one does not

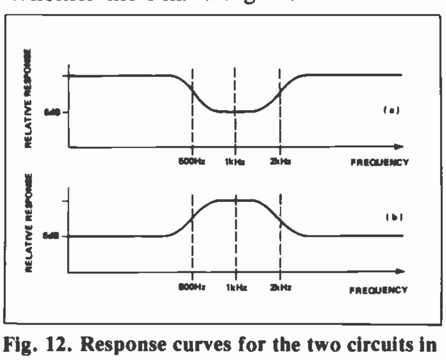


Fig. 12. Response curves for the two circuits in Fig. 11.

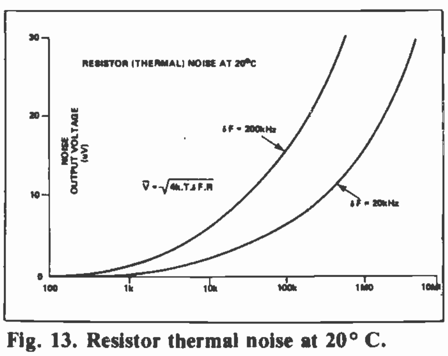


Fig. 13. Resistor thermal noise at 20° C.

ground the equipment separately in more than one place (the all too familiar *ground loop* problem), one must make sure that the mains transformer has an adequately low external AC magnetic field, and that it is an adequately low external AC magnetic field, and that it is sited as far away as possible from low signal level areas. Also, one needs to remember that the currents flowing in the transformer secondary, rectifier, and filter capacitor loop have very high peak values and will produce quite significant voltages across even small wiring resistances. Take care, therefore, to take the DC supply from across the filter capacitor, including your 0V return! A further important point to watch is that there is no incipient instability in the circuitry of any amplifier, in that this will make it very prone to a hard rasping hum sound — similar to that given by two different ground points on the mains DC supply.

Impulse noise: This has a lot in common with radio breakthrough, and is that annoying problem of clicks and bangs when other mains operated equipment in the same locality, lamps, fridges, central heating equipment, and so on, is switched on and off. This can be caused, partly, by the same things as radio breakthrough (see below), particularly exaggerated by incipient instability and unnecessarily wide gain bandwidth. If one had a moving coil head amp feeding the preamplifier input, and if the head amp had a 10 MHz bandwidth, one would expect impulse noise problems. Thorough shielding will also help here.

Defective component noise: In my early days as an electronics enthusiast, resistors which crackled, capacitors which spluttered, sizzled, and hissed, and tubes which rang like a bell when one tapped them, were just part of life — and one tried, by replacement, to end up eventually with a good set, until yet another component 'went noisy'. Happily, things have changed for the better, and nowadays, defective components are relatively rare, at least at normal signal levels, where an electrolytic capacitor installed with reversed polarity is likely to be the major noise culprit.

Thermal noise: This is the result of the random motions of electrons — the basic carrying elements — as a consequence of their being excited by heat. This noise component increases with absolute temperature (°K = 273 + °C), and with the amount of resistance in the circuit. The formula for calculating this is:

$$V = 4k.T.dF.R$$

where V is the main AC output voltage; k is Boltzmanns constant (1.38×10^{-23}); T is the absolute temperature (° Kelvin); dF is the measurement bandwidth; and R is the circuit resistance. It follows from this, immediately, that the larger the amount of resistance in the circuit (other things being equal) the worse the noise. A graph showing this relationship is given in Fig. 13.

To summarize this, the lowest noise in a transistor stage will be given by an optimally chosen device (in respect to type and performance), operated at the collector current which is best suited to its base and emitter circuit resistance and its chip size, at the lowest sensible temperature and operating voltage, and the lowest input impedance. Since all of the noise sources are bandwidth dependent, those which arise before a bandwidth limiting filter, such as an RIAA equalizing stage, are less obstrusive than those which occur after this — other things being equal. Also, those noise sources which are inductive in character, such as magnetic pick-up on the input to a preamplifier, have an impedance which increases with frequency, and will therefore give a worse noise level — since the ear sensitivity increases with frequency up to a few kHz — than a simple calculation based on its DC resistance would suggest. **ET**

Computer Review continued from page 37

megabyte, by using 256 kilobit chips. This should give you more than enough for any software requirement.

Intel's 8087 arithmetic co-processor was missing from the socket on our review model, so we couldn't do any time trials on how it improves number-crunching, but since everything else was comparable to the PC in speed, this should be the same.

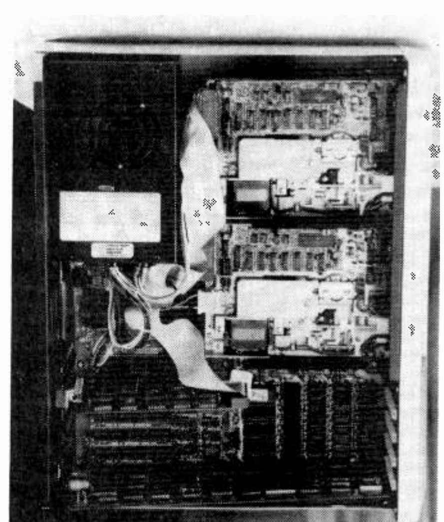
Ready-to-run

If you are reluctant to get the soldering iron going, but still like the Mega-Board features, you can take one home and plug it in and use it for $1,995.00. This amount buys you the motherboard, one disk drive and controller, one colour graphics board, one keyboard, the power supply, 64K of RAM, and a case with it all assembled and tested inside. The operating system is the Mega-BIOS described above. Each additional 64K up to 256K total will cost you $95.00.

If you're somewhere in the middle, you can always buy any part of the computer in wired form and then build what you need as the money accumulates; all the peripheral cards are available in bare-board form, complete with instructions, giving you the honour of collecting and soldering in the parts.

There's also a user's manual containing applications notes, schematics, and theory of operation.

In addition, you can also buy the Mega version of the IBM-XT, the MBE-XT. This one is a smaller version of the Mega-Board, selling for $495, wired and tested; it's also available in bare-board or socketed form.



And Finally...

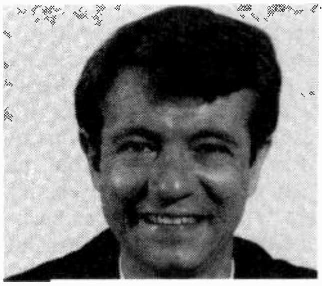
The Mega system appears to be well designed and manufactured; it gives you a chance to buy into the IBM software market by offering components at several different levels of completion from bare-board to completely assembled. With the exception of the BASIC problem, which isn't insurmountable, there didn't appear to be any operational difference between the Mega-Board and the IBM PC. A good way to go.

Quick Reference

Mega-Board IBM-compatible

Mfg:	Display Telecommunications
CPU:	8088
RAM:	64K min, 1M max
Screen:	80 x 25
Graphics:	640 x 200
Video:	composite colour
Other:	available in components from bare motherboard at $99.95 to assembled minimum system at $1,995.00

ET



Electronics In Action

This month, a stereo mute, an analog delay line, a digital micrometer, and a bionic couple.

By Roger Allan

One of the minor irritations of contemporary living is having to toddle round the house turning down the stereo or radio when the phone rings, and then having to re-adjust it when one has completed the call. Add on to this, at least in this author's household, the occasional missing of an incoming call because one didn't hear it, and one occasional wishes for a device which will do it all automatically for you. Enter the Phone Mute Corporation.

Their device will automatically lower one's stereo's volume automatically to a lower preset level via a smooth fade, either when an incoming call is detected, or when one lifts the receiver preparatory to making an out-going call. Upon the conclusion of the phone call, the device will restore the stereo's volume back to its original level.

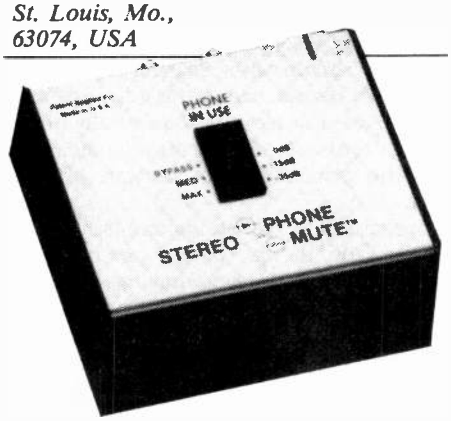
According to Bill Hammond, President of the company, the electronics, while patented, are really rather straightforward. The device is connected via a telephone jack to an extra phone outlet, and thence between the amplifier and the speakers. The signal from the amplifier to the speakers passes through an LDR, that is a light detecting resistor. An LDR essentially consists of an LED facing a photodiode in an encapsulated unit. The audio signal is transferred into light by the LED, detected by the photodiode, converted back into an electrical signal and passed on to the speakers. This is when the phone is 'on hook', as it were.

Simultaneously, the device is monitoring the phone line. When it detects a signal of sufficient strength, interpreted as one taking the phone off the hook preparatory to making an outgoing call, the device smoothly changes the current to the LED, resulting in a change in the LDR's resistance and hence a decrease in the sound's volume. Upon replacing the phone on the hook, the device returns the audio signal to normal volume.

In the case of an incoming call, matters are somewhat more complicated, since the period between rings represents, in the device's circuitry, an 'on hook' situation not requiring an increase in the LDR's resistance. To overcome this problem, there is a second piece of circuitry which effectively times the periods of high AC voltage on the phone line (when the phone is ringing). If the time periods between the high AC voltages is sufficiently small, representing the ringing of the phone (as opposed to momentarily high AC voltages representing line transients), then the fading circuitry goes into effect.

As for the degradation of the audio signal as it passes through the LDR, it is quite small, representing a Total Harmonic Distortion (THD) of less than .01% from 20-20,000 Hz. Further, the device can operate with any type of phone, including speaker phones and cordless models. As it is connected between the amplifier and the speakers, and not between the amplifier and the tape deck, it will not interfere with recordings, though the speakers will mute. It may also be connected between one's VCR and television set, producing the same result.

The Phone Mute Corp.,
3913 St. Timothy,
St. Louis, Mo.,
63074, USA



Acoustic Time Delay

In the world of the audiophile one of the prime difficulties in achieving the ultimate in sound is the general inability to reproduce the acoustic qualities found in symphony halls. Customarily, living rooms and dens just do not have the sound reflection characteristics required to achieve the resonance and timbre of such a hall. As such, to the true audiophile, no matter how high the quality of one's stereo equipment, reproduction of an orchestral or symphonic arrangement sounds tinny.

In an attempt to overcome this qualitative difficulty, the Bozak company has devised two pieces of equipment, technically known as the E-901A and E-902A (the only difference between the two is that the 902 does not have a 35 watt integrated amplifier). They are time delay units, carrying the claim that one can electronically reproduce the resonance of a orchestra, or any other form of music, played in a symphony hall. Further, these devices will permit one to 'sculpture' one's audio sound to fit the space in which it is being played, taking out the detrimental effects of sound being bounced by the steel beams in one's roof, for example.

In addition to the two speakers one requires for stereo sound, the system requires two further such devices. These are customarily placed either alongside one's main listening area, or behind it. Connected to them is the Bozak device, which links into one's stereo system between the preamp and the receiver, turntable, or tape deck.

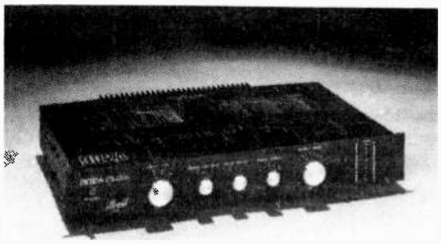
According the Bozak's Bill Kieltyka, the device operates via an Analog Shift Register system. A pure analog system was selected so as to eliminate the dual conversion of the music from its analog form to digital mode and then back to analog with a consequent degradation of signal as is sometimes found in other such time delay devices. In operation, the device samples the signal voltages coming from the receiver at intervals ranging from 10 to 60 millionths of a second. The sample is stored in one cell of some 2000 composing a CCD IC. At each pulse of the system's master clock (running between 15,400 and 66,700 cps), the newly stored charge is transferred to another cell, and a second voltage sample is taken and stored in the first cell.

The speed of transfer is regulated by the system's clock, which in turn has been pre-set by the listener. At its fastest setting (30 msec) through the CCD, a short time delay occurs. At its slowest setting (130 msec) a longer time delay occurs. Having been delayed, the signal is then passed through a smoothing filter which averages the stored charges to restore the continuous waveform of the music, and thence out to the secondary set of speakers.

There are several control functions to this device, which permits one to sculpture the sound. The delay time control sets the electronic master clock for the initial time delay and determines the 'room size'. Sound travels at approximately one foot per millisecond. A 60 msec setting simulates a hall in which the walls and ceiling are at least thirty feet away from the listener. The delay re-mix control generates multiple delays (reverberation) to recreate the ambience of a live performance the blend of the direct signal from the front speakers and this reverberant signal results in a much fuller bodied sound. The blend control permits the listener to mix direct signal from the front speakers plus delayed sound through the rear speakers. This reduces the effect of the time delay circuitry for specialized listening purposes. The other controls (treble and volume) are straightforward.

By delaying the sound returning from the walls behind, the listener can duplicate the wave patterns found in symphony halls or anywhere else where music is 'created' rather than 'reproduced'. While there is no 'correct' setting for the device's controls (it is dependent upon one's own perception of the sound one hears) experimentation with the device produces a noticeable improvement when compared to the same music played through the same system, but without the time delay circuitry.

Bozak Inc.,
68 Holmes Road,
Newington, CT.,
06111, USA



Electronic Digital Micrometer

It is one of the great advantages of contemporary electronics that numbers and readings can be electronically recorded and integrated on ICs of ever decreasing size. Devices which operate ths way seem to be cropping up all over the place, most recently in the Sears Craftsman line of electronic power tools and ancillary devices for the home handyman, light industry and the research lab.

One of these is an electronic digital micrometer which can be attached to a paper printout device. Similar in size, weight and handling capability to a normal micrometer, this device constitutes an multi-purpose device which includes an integral microcomputer for statistical analysis. A single thumb-operated switch permits the selection between standard measuring, sampling memory (up to 255 samples) and the calculation of average, minimum and maximum values. All three modes have a floating zero for checking the direct reading of deviations from the standard reference size, with the digital readout either in inperial or metric (one can instantly switch between the two readout forms).

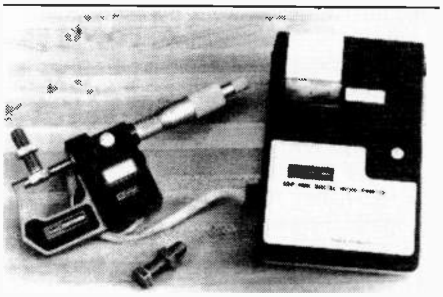
For convenience and to help prolong the battery life, the device has an automatic shut off after five minutes of non-use.

Its accuracy is rather good at .001 mm or .0001 inch, being based on a rotary encoder. According to Peter Chonley, from General Hardware which markets the device to Sears (it is imported, being manufactured by Fowler), a rotary encoder consists of a circular glass disk attached to the racket thimble. The disk is scored with bars. Through the disk passes light generated by an LED, which is read on the far side of the disk by a phototransistor. As one turns the racket thimble, and hence the glass disk, the light is momentarily blocked by the bars, producing a decrease in voltage from the phototransistor. The number of such decreases is counted by the IC, representing the number of turns of the ratchet and hence the measurement. Once the data, or number of counts is in the IC, the rest of the computations are straight forward, being read out by an LCD.

The electronic printer/recorder which can be attached to this device prints and records the samples sequentially on a 33 foot long roll of electrostatic paper. It can also print statistical analysis of the data.

And finally, according to Chonley, if all else fails, the micrometer can be used as a conventional one, having the appropriate measurement scoring along its ratchet, along with the standard locking screw.

Sears, Roebuck and Co.,
Sears Tower,
Chicago, IL.,
60684, USA.



Adam and Eve

One of the more useful elements to be derived from the application of minicomputers to the business and light industry world is the integration of Computer Assisted Design (CAD) functions onto the drawing board such that quick and relatively easy changes may be made by designers. This of course has been integrated with Computer Assisted Manufacturing (CAM) producing CAD/CAM. It was inevitable, therefore, that one day (probably sooner rather than later) CAD would be re-worked so that it could show the interface between humans and machines while still in the design stages. And so it has come to pass.

The Lockheed Missiles and Space Company have been prime contractors for the US government in many high-tech/military projects, the most recent of which is for the Trident II Fleet D-S Ballistic Missile (FBM) soon to be the major element in the US triad defence posture. It is the first missile that has been totally designed using CAD/CAM or CADAM (Computer-Graphics Augmented Design and Manufacturing), as they refer to it. One of the elements in their contract was to make sure that the Trident II D-5 could be regularly and easily checked in their launching tubes while at sea, and if necessary to permit a sailor to crawl through the launch-tube access door into the missile itself to engage in parts checks and if necessary effect replacements.

Since Lockheed was already utilizing CADAM for the design of the Trident II, it was a relatively simple step to move to a CADAM based assist in determining whether or not the sailor could in fact get in and out of the launching tube, and once in, to determine whether the sailor could generate the torques necessary to remove and replace bolts, etc.

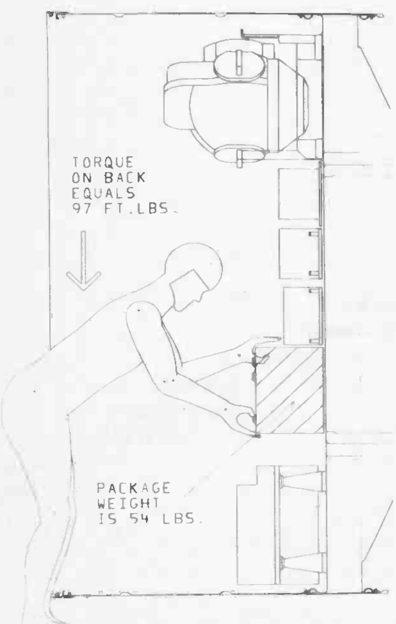
Hence the Anthropometric Design Aid Manikin, or ADAM. It is the first scale version of a human to be derived from CADAM, and the first 'human' to 'crawl' through a Trident II's entry port. As many women are employed in performing much of the shoreside assembly and maintenance of the Trident II while in port (women are not yet allowed on US combat vessels) a program, Ergometric Value Estimator, or EVE was developed for the female form.

When ADAM is called up, it adjusts automatically to the drawing scale on the video screen. It comes in three sizes: a 5 percentile male who is 5 feet 4 inches tall, weighs 122 pounds and has a functional reach of 28.6 inches, a 50th percentile male and a 95th percentile male, all with comparable increases in height, weight and reach. EVE is three proportional female figures.

When called up on the CADAM screen in top, side or frontal views, the operator can, utilizing a light-pen, move the body postures intoworking shapes, bending, kneeling and reaching. Closeups can be shown to determine wrist and arm freedom, such as is required to tighten a bolt in a confined space, for instance.

As such, the program permits the designer to visualize relationships between design ideas and the human interfaces they require, a far cry from the previous method. Lockheed's previous four missile designs. Required plexiglass mock-ups to be placed on top of paper blue-prints to see if everything would fit, along with cardboard and styrofoam mock-ups to see whether the engineer's torque calculations were correct (which they often weren't). they often weren't).

Lockheed Missiles and Space Company,
Sunnyvale, California,
94086, USA



ET

Apple's new ProDOS won't work on a non-Apple. Here's a quick fix.

Computing Today

ProDOS Booter

By Yin H. Pun

ProDOS 1.0.1 is the newest disk operating system for the Apple II computers. Unfortunately, it boots only on legitimate Apple machines. When you boot ProDOS on an Apple compatible or "clone" machine, you see a title screen with Apple's copyright notice, the disk stops and nothing more happens.

But all is not lost. ProDOS refuses to be loaded into your machine because it checks the "Apple II" name in the ROMs to see if your machine is really an Apple. Other aberrations simply will not verify.

There are two ways to get ProDOS working. Replace the F8 ROM with one with a perfect, unchanged copy of the original Apple F8 ROM with an "Apple II" name, or follow the less drastic "software" approach below.

Clone Discrimination Routine

ProDOS loads itself at $2000, does some initialization and checks what kind of Apple it is running on, a II, II+, IIe or III. The identifying byte is fetched and stored in $0C. Then ProDOS calls a subroutine at $2639 which performs a checksum on the supposed "Apple II" name located in the ROM. A zero is calculated if the name is correct and the identifying byte is loaded from $0C. Otherwise, a zero — the error code — is loaded. Program flow returns to the main program. If it sees a zero, it will lock itself in an endless loop rather than load the rest of ProDOS.

Fortunately, there is one very easy way to defeat this protection: simply cripple the checking program. Press the RESET key and you will find yourself in the monitor, confronted by the prompt, "*". $265B contains the crucial conditional branch instruction, BNE, that decides whether it should return an error code or not. Defeat this branch by changing the instruction's operand and then start the loader program again.

Type:

```
265C:0 N C0E9 2000G
```

$C0E9 turns the disk drive on and $2000G executes the loader.

You may change this modification permanently by using a "diskzap" program, a sector modifier, to change track 1, sector 9, byte $5C from a $03 to a $00. If you do not have a "diskzap" program, I have written a short machine language program that will do that automatically. This program uses the DOS 3.3 RWTS (Read/Write Track Sector) subroutine; therefore, it must run under DOS 3.3. Enter the object code (on the left-hand side of the listing) directly via the monitor (invoked by a CALL-151), or enter the source code (on the right-hand side of the listing) into a macro-assembler such as LISA 2.5 and compile it. When you have the program entered, type:

```
BSAVE BOOT PRODOS, A$803,L$122
```

To execute it, type:

```
BRUN BOOT PRODOS
```

or
```
CALL 2051 from Applesoft
803G from the Monitor
```

Insert a ProDOS disk into the disk and press "RETURN".

Why the Discrimination?

The original monitor F8 ROM supplied with Integer BASIC does not contain the "Apple II" name. Since ProDOS does not utilize Integer BASIC, checking for the name would be a test to see if an Apple has Integer BASIC. If it does, ProDOS would refuse to load. However, ProDOS could have been written to check for other parts of the ROMs unique to Integer BASIC (such as the BASIC itself) instead of the presence of the name. This is my conjecture as to the reason why this discriminative routine is used.

When DOS 3.3. was introduced in late 1980, no Apple clones existed. However, when ProDOS came forth in early 1984, there were a multitude of Apple compatibles on the market, which meant competition for Apple. Apple probably wanted to suppress the competition by making its newest disk operating system work only on Apples. However, with this single byte modification, ProDOS is now easily accessible to the many non-Apple compatibles.

PRODOS BOOT PROGRAM

```
0800             ***************************************
0800             *                                     *
0800             *            ProDOS BOOTER            *
0800             *                                     *
0800             * Program to make ProDOS 1.0.1 disks  *
0800             * boot on Apple compatible computers. *
0800             *                                     *
0800             * By Yin H. Pun, 1984                 *
0800             *                                     *
0800             * assembled by                        *
0800             * LISA 2.5 MACRO-ASSEMBLER            *
0800             *                                     *
0800             * Use CALL 2051 to execute this program *
0800             *                                     *
0800             ***************************************
03D0             WARMST   EQU $3D0
03E3             LOADIOB  EQU $3E3
03D9             RWTS     EQU $3D9
00FC             BUFADR   EPZ $FC
00FE             PTR      EPZ $FE
FC58             HOME     EQU $FC58
FD0C             INKEY    EQU $FD0C
FD8E             CROUT    EQU $FD8E
FDED             COUT     EQU $FDED
0800                      OBJ $803
0803                      ORG $803
0803 20 58 FC             JSR HOME
0806 20 8E FD    INIT     JSR CROUT
```

```
0809 A2 00       29            LDX #$0
080B BD 99 08    30   TITLE    LDA TEXT1,X          ;print title
080E 20 ED FD    31            JSR COUT
0811 E8          32            INX
0812 C9 80       33            CMP #$80
0814 D0 F5       34            BNE TITLE
0816 20 0C FD    35            JSR INKEY            ;get a key from keyboard
0819 C9 9B       36            CMP #$9B             ;is it "ESC"?
081B D0 03       37            BNE CHKB
081D 4C D0 03    38            JMP WARMST           ;yes, return to BASIC
0820 C9 C2       39   CHKB     CMP #$C2             ;is it "B"
0822 D0 03       40            BNE START
0824 4C 00 C6    41            JMP $C600            ;yes, boot disk
0827 20 E3 03    42   START    JSR LOADIOB
082A 84 FE       43            STY PTR
082C 85 FF       44            STA PTR+1
082E A0 03       45            LDY #$3
0830 A9 00       46            LDA #$0              ;load volume number of 0 to
0832 91 FE       47            STA (PTR),Y          ;match any volume number
0834 A0 04       48            LDY #$4
0836 A9 01       49            LDA #$1              ;set track 1
0838 91 FE       50            STA (PTR),Y
083A C8          51            INY
083B A9 09       52            LDA #$9              ;set sector 9
083D 91 FE       53            STA (PTR),Y
083F A0 0C       54            LDY #$C
0841 A9 01       55            LDA #$1              ;set read command
0843 91 FE       56            STA (PTR),Y
0845 20 E3 03    57            JSR LOADIOB          ;load address of IOB
0848 20 D9 03    58            JSR RWTS             ;access disk
084B B0 2C       59            BCS ERROR
084D A0 08       60            LDY #$8              ;get address of disk
084F B1 FE       61            LDA (PTR),Y          ;buffer
0851 85 FC       62            STA BUFADR
0853 C8          63            INY
0854 B1 FE       64            LDA (PTR),Y
0856 85 FD       65            STA BUFADR+1
0858 A0 5C       66            LDY #$5C             ;byte $5C in track 1, sector 9
085A B1 FC       67            LDA (BUFADR),Y
085C C9 03       68            CMP #$03             ;is it a $03?
085E F0 04       69            BEQ WRITE            ;yes, modify it
0860 C9 00       70            CMP #$0              ;is it a $00?
0862 D0 25       71            BNE ERROR2           ;if not, disk is not ProDOS
0864 A9 00       72   WRITE    LDA #$0
0866 91 FC       73            STA (BUFADR),Y
0868 A0 0C       74            LDY #$C
086A A9 02       75            LDA #$2              ;set write command
086C 91 FE       76            STA (PTR),Y
086E 20 E3 03    77            JSR LOADIOB          ;load IOB address
0871 20 D9 03    78            JSR RWTS             ;write disk
0874 B0 03       79            BCS ERROR
0876 4C 06 08    80            JMP INIT             ;begin again
0879 A2 00       81   ERROR    LDX #$0              ;print out DISK ERROR
087B BD FD 08    82   ERROR1   LDA TEXT3,X
087E 20 ED FD    83            JSR COUT
0881 E8          84            INX
0882 C9 80       85            CMP #$80
0884 D0 F5       86            BNE ERROR1
0886 4C 06 08    87            JMP INIT
0889 A2 00       88   ERROR2   LDX #$0              ;print out message
088B BD 0C 09    89   ERROR3   LDA TEXT4,X          ;to tell that disk
088E 20 ED FD    90            JSR COUT             ;does not contain ProDOS
0891 E8          91            INX
0892 C9 80       92            CMP #$80
0894 D0 F5       93            BNE ERROR3
0896 4C 06 08    94            JMP INIT
0899 C9 CE D3    95   TEXT1    ASC "INSERT PRODOS DISK IN CURRENT DRIVE AND"
089C C5 D2 D4
089F A0 D0 D2
08A2 CF C4 CF
08A5 D3 A0 C4
08A8 C9 D3 CB
08AB A0 C9 CE
08AE A0 C3 D5
08B1 D2 D2 C5
08B4 CE D4 A0
08B7 C4 D2 C9
08BA D6 C5 A0
08BD C1 CE C4
08C0 8D          96            HEX 8D
08C1 D0 D2 C5    97   TEXT2    ASC "PRESS ESC TO QUIT, B TO BOOT OR"
08C4 D3 D3 A0
08C7 C5 D3 C3
08CA A0 D4 CF
08CD A0 D1 D5
08D0 C9 D4 AC
08D3 A0 C2 A0
08D6 D4 CF A0
08D9 C2 CF CF
08DC D4 A0 CF
08DF D2
08E0 8D          98            HEX 8D
08E1 C1 CE D9    99            ASC "ANY OTHER KEY TO CONTINUE."
08E4 AC CF D4
08E7 C8 C5 D2
08EA AC CB C5
08ED D9 A0 D4
08F0 CF A0 C3
08F3 CF CE D4
08F6 C9 CE D5
08F9 C5 AE
08FB 8D 80       100           HEX 8D80
08FD 8D          101  TEXT3    HEX 8D
08FE C4 C9 D3    102           ASC "DISK ERROR!"
0901 CB A0 C5
0904 D2 D2 CF
0907 D2 A1
0909 8D 8D 80    103           HEX 8D8D80
090C 8D          104  TEXT4    HEX 8D
090D CE CF D4    105           ASC "NOT A PRODOS DISK!"
0910 A0 C1 A0
0913 D0 D2 CF
0916 C4 CF D3
0919 A0 C4 C9
091C D3 CB A1
091F 8D 8D 80    106           HEX 8D8D80
0922             107           END
```

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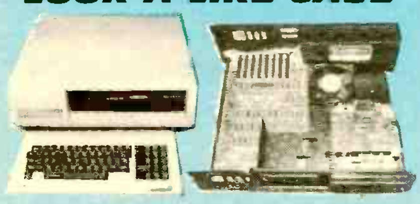

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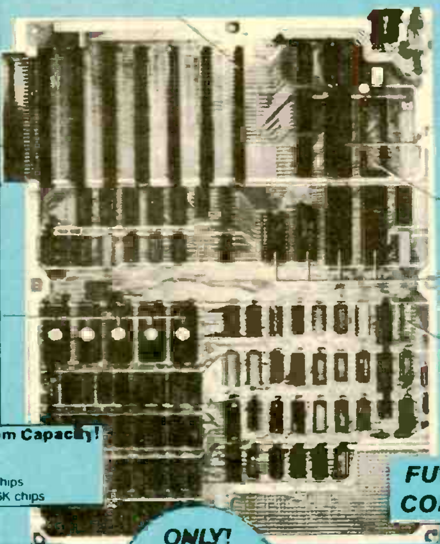

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Mega-Board® $99.95
With full assembly data.
Mega-Board®, Users manual with schematic, ap. notes and theory, etc. $19.95
MEGA-BIOS©, a fully MS—DOS, PC-DOS compatible non-infringing BIOS $29.95

ONLY! **$99.95** Evaluation Board Kit

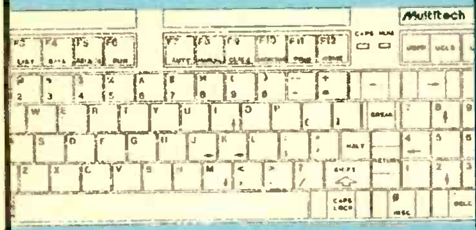
MEGA-BOARD™ **Evaluation Board Kit!** (Blank board with full assembly instructions and parts list.)

Includes highest quality PC board with gold plating, silk screen solder mask

IBM® STYLE KEYBOARD

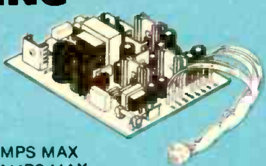
At last, a good low cost keyboard for the IBM PC, XT or compatible machine. Uses capacitive keys, has a very good "feel", and has TYPEWRITER LAYOUT for easy wordprocessing. All this at the very low price of $145.00

APPLE® DETACHED KEYBOARD



The MAK-II is a very good separate keyboard that uses serial data transfer (like the IBM) for the lowest error rate possible. This keyboard has 10 user definable keys and has 64 pre-coded macros for single stroke entry of most basic commands, plus auto-line-number and selectable key clicks. A really feature packed keyboard $169.95

SWITCHING POWER SUPPLY



SPECS: +5 VDC 5 AMPS MAX
#1 +12 VDC 2.8 AMPS MAX
#2 +12 VDC 2.0 AMPS MAX
-12 VDC .5 AMPS MAX
INPUT: 115 or 230 VAC 60Hz

A Best Buy at **$46.95 each**

BARE PCB FOR IBM™

(A) Colour graphics board, similar to the PERSYST board, but not quite the same, has all the same features and is easy to build complete with parts list and placement diagram ... $34.95

(B) IBM disc controller board, similar to the original, runs 2-4 DS/DD drives $24.95

(C) IBM disk controller I/O board, like the above but will also control a printer via a parallel port $29.95

(D) Multifunction board, has 14 functions including calendar, time, serial ports, parallel ports, etc. $29.95

All boards come with a parts list and a placement diagram for easy assembly.

(E) Wire Wrap, DB-25, DB-9, all holes $29.95

(F) Memory, wire wrap, with 256K/1M memory gridded onto card front, rest holes $34.95

(G) Card extender, lifts any plug in card up by about 6" for easy service $29.95

SHUGART SA455A3
5-1/4" HALF SIZE DRIVES

- 40 Track per side
- Double-sided, double density
- Latest head & drive technology
- Fast access time

Two of These Half Size Drives will Fit in the Same Space as 1 Full Size Drive! **$239.00**

WIRED N TESTED MEGA-BOARD™

(A) Socketed and tested with no IC's, all soldered in parts are included, just buy the IC's, and memory $249.00

(B) Socketed and tested with all IC's, BIOS, 64K of RAM and complete manual and schematics $549.00

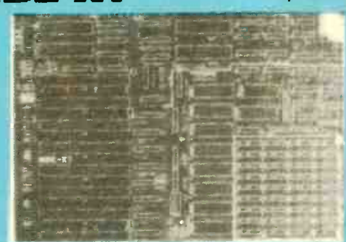
(C) As above, each 64K increase $75.00
Up to 256K, for 256K RAMs, price on request.

(D) Minimum system, 1 DS/DD drive, Disk controller, colour graphics, 100W power supply, full cabled, 64K $1995.00
Each 64K up to 256K $95.00

IBM CASE

At last, a nice new case for the 5 slot or 8 slot IBM workalike boards. Fits our power supply and most others, and has either 5-6 slots or 8 slots (please specify when ordering). Comes with all rubber feet, drive blind plugs, card guides and has the best feature of all, a hinged lid that allows quick and easy access to the insides for service; the top opens when two spring clips are pushed and re-latches automatically $89.95

MBE-XT $49.95



At last, an affordable high-tech IBM PC/XT workalike. Has full 256K memory and the same size as the original, 8 slots, plus space for 8 ROMS, or EPROMS holding the language of choice and a BIOS, fully IBM compatible and works perfectly with the MEGA-BIOS listed on this page. It is not expandable on board to 1M, nor does it have all the features of the MEGABOARD, but it is smaller and works like a champ.
MBE-XT, with assembly data $49.95

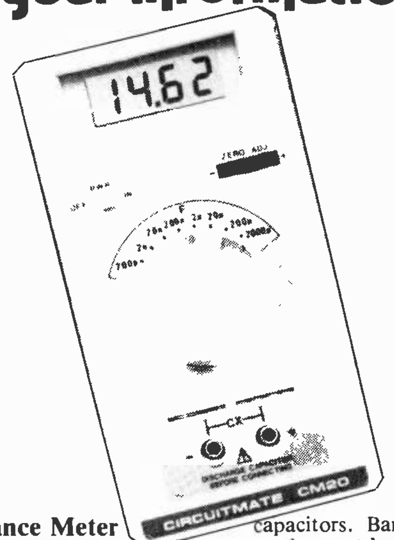
(A) Socketed and wave soldered with all solder in parts. Good quality AMP sockets, all you need are the IC's to get it going $225.00

(B) As above but with all IC's and fully tested and ready to go with 64K on board and with a MEGA-BIOS installed $495.00

MEGABOARD/MBE-XT PARTS

a) Max. keyboard .. $189.00	n) 6-35pf trimcap $1.00
b) IBM case hinged . $89.95	o) 62 pin edge con ... $2.95
c) Intel/AMD IC set $159.00	p) 5 pin DIN $1.95
d) 8253-5 .... $11.95	q) power con M/F $2.50
e) 8259A $11.95	r) 4.7K x 6 SIP ...... $ .75
f) 8237A-5 .... $34.95	s) 4.7K 16 pin NTWK . $1.00
g) 8255A-5 .... $29.95	t) 8.2K(10K) 16PNTWK $1.50
h) 8284 .... $8.95	u) 33Ohm res NTWK . $1.50
i) 8288 .... $29.95	v) TBP24S10 PROM .. $9.95
j) 8088 .... $34.95	w) BUS bars, ea. $1.50
k) 8087 .... $399.00	x) header pins, ea. ... $ .05
l) 100 NS delay $14.95	y) speaker (2 3") $2.95
m) 7 NS delay $14.95	z) 0.1uF (1 or 2") ..... $ .17

Circle No. 6 on Reader Service Card.

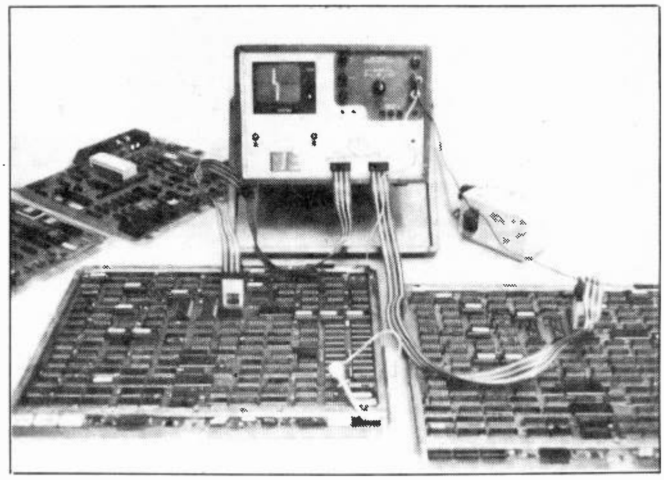


Capacitance Meter

The Circuitmate CM20 is a convenient digital capacitance meter that fits in the palm of the hand, but is capable of performing large jobs. Key features of the CM20 include an easy-to-read, 3½ digit, ½ inch high LED display, tilt bail and anti-skid pads for convenient use on bench tops. Capacitance readings are made quickly at a rate of 2½ measurements per second, which results in no waiting.

Other features of the Circuitmate DM20 include two types of input jacks for measuring of capacitors. Banana jacks accommodate test leads and are suitable for large capacitors. For smaller capacitors with leads, there is a test socket. The CM20 also comes with an easily replaceable fuse for overlead protection. The CM20 can be a battery or power operated meter. Price for the Circuitmate CM20 is $180.00 Canadian. For further information contact Doug Pettifer, Lenbrook Electronics, 111 Esna Park Drive, Unit 1, Markham, Ont., L3R 1H2 (416)477-7722.

Circle No. 55 on Reader Service Card



Automatic Circuit Test System

The ATS Search or Automatic In Circuit Tester allows unskilled technicians to test digital or analog PC boards or IC devices by visually comparing nodal impedance signatures of good ones with suspected bad ones. Checking up to 80 pins, the portable system tests in 1/5th the time needed to manually probe.

Simultaneously scanning pins while displaying signatures and pin numbers, the ATS Searcher Automatic In Circuit Tester operates at 18 through 120 volts p-p open circuit impedances. Accurate to ±5% on all ranges, the remote-controlled 10.5 lb. system couples to board connectors and clips to IC devices.

The ATS Searcher Automatic In Circuit Tester is priced at $2,495. For more information contact: Associated Technical Services, David F. Weidlich, 212 South Main Street, Middleton, MA 01949, (617)774-6556.

Circle No. 56 on Reader Service Card

continued on page 78

THE MODEL 64 KV

64 K BYTE MEMORY FOR THE VIC 20

This is the first of its kind for the VIC 20. Your VIC will now have 69119 bytes of memory. An **1800% INCREASE!!** Just think of the programs you can put together now!

How did we do it? We employed the latest in memory technology and made it available to you in a plug-in module that's as easy to connect as any game cartridge. The 64KV has 8K in each of VIC's BLOCKS 1, 2 and 3. Plus BLOCK 3 can be swapped (paged) under program control, with five other separate 8K sections of memory. These paged segments are selected by a single poke instruction. Six different 8K segments may be selected to be in BLOCK 3. Complete instructions are included.

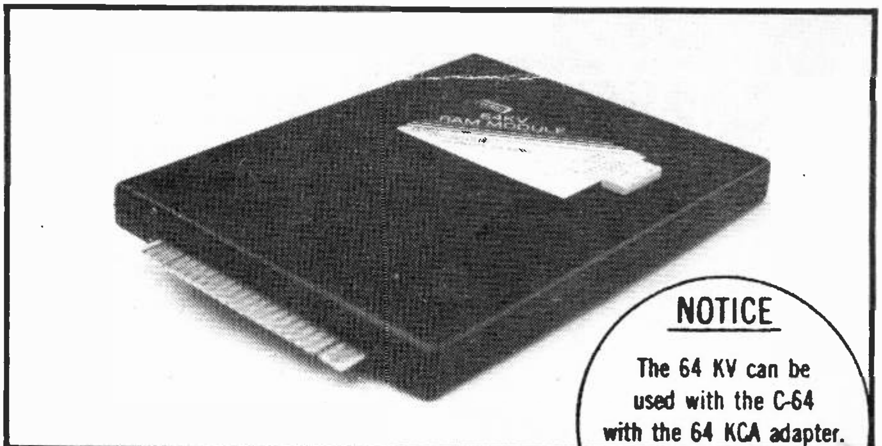
This is a total of **65536 BYTES** of extra memory. If you want, you can still use a 3K expansion module with the 64KV. Heaven forbid you should get an out-of-memory message again!

Each BLOCK has a separate enable switch and a write protect switch and there is a switch to make BLOCK 3 respond as though it's BLOCK 5 (the normal game BLOCK). This switch alone could save you the entire cost of the 64KV.

SPECIFICATIONS

SIZE .... 5.5 X 7.25 X .625 INCHES
POWER .... 1.25 WATTS
CURRENT .... 250 MA.
MEM CAPACITY .... 65536 BYTES
BLOCK SIZE .... 8192 BYTES
TOTAL BLOCKS 8
BLOCK ADR BLK1 8192-16383
BLK2 ... 16384-24575
BLK3 ... 24576-32767
WARRANTY .... 90 DAYS

PRICE $179.95
PLUS $10.00 S&H. ONTARIO RESIDENTS ADD 7% P.S.T



NOTICE

The 64 KV can be used with the C-64 with the 64 KCA adapter.

64 KCA ADAPTER
$49.95

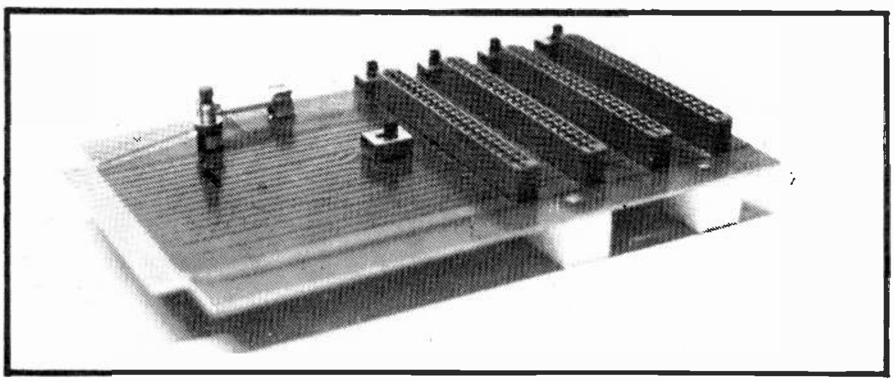
THE MODEL 4XV

DELUXE FOUR-SLOT EXPANDER CHASSIS

This four-slot expander will give you the flexibility of having up to four of your favorite cartridges plugged in at the same time.

A special switch on the 4XV will make it very easy to make back-up copies of most game cartridges. You can even use BASIC to save cartridges to tape or disk.

A power switch is included for each of the four slots. This will save you from having to remove a game when it's not in use. Other features include fuse protection and a master reset switch.



SPECIFICATIONS

SIZE .... 5.875 X 8.125 INCHES
CAPACITY .... 4 MODULES
POWER SWITCHES .... ALL SLOTS
OTHER FEATURES
.... RESET SWITCH
.... FUSE
.... ADDRESS SWITCH
WARRANTY .... 90 DAYS
PRICE $59.95
ADD $6.00 FOR S&H
ONTARIO RESIDENTS
ADD 7% SALES TAX

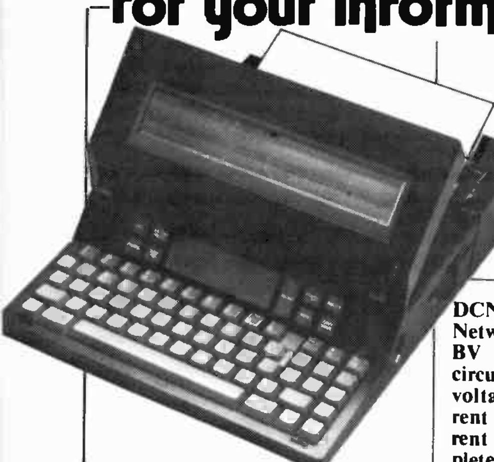
All products are available factory direct

B & R Enterprises Inc.

Pefferlaw, Ontario L0E 1N0

Circle No. 15 on Reader Service Card

 continued from page 74



Portable Computer

A new portable computer, the Gavilan, has been announced by Gavilan Computer of California. It uses an 8088 CPU and the MS-DOS operating system. The LCD screen has 16 lines by 80 columns, with 128 by 480 pixel graphics; data storage is via 160K of RAM and a 360K floppy disk. Canadian list price is $5900. For information, contact the distributors, Tempest Security Integrators (TSI), 1750 Courtwood Cres., Suite 101, Ottawa, Ont., K2C 2B5 (613) 226-3227.

Circle No. 53 on Reader Service Card.

DCNAP is a general purpose DC Network Analysis Program from BV Engineering which analyzes circuits consisting of resistors, voltage sources, independent current sources, and dependent current sources. DCNAP will completely analyze circuits of up to 200 components and 30 nodes. DCNAP automatically computers worst case node voltages, component sensitivities, branch currents, and component power dissipation. A complete built-in editor will add, delete, and change components and nodes. Free format input, input error trapping, and menu driven input makes DCNAP easy to learn and use. DCNAP files are compatible with BVE's ACNAP program. Available for MSDOS, CP/M, and PCDOS, $62.95. Contact: BV Engineering, 2200 Business Way, Suite 207, Riverside, CA 92501. (714)-781-0252.

Circle No. 54 on Reader Service Card.

Scientists at the U.S. National Bureau of Standards have developed a portable magnetic-field meter that will be useful in characterizing workplace environments which may contain high magnetic-field components of electromagnetic fields.

Designated MFM-10, it is intended to serve as a survey tool, measuring magnetic fields emanating from various high-power radiofrequency sources, including industrial equipment and broadcast antennae. Battery-operated and requiring only a single probe head, the MFM-10 offers wide frequency coverage (300 kHz to 10 MHz) and large dynamic range (44 dB, corresponding to magnetic fields from 0.01 to 16 amperes per metre).

Three video heads have been incorporated into the TriScan special effects system on the new VCR 4670 from Sanyo, resulting with clean, clear special effects: still picture, frame advance, three slow motion speeds — all jitter and interference free, plus high quality Betascan.

The front-loading VCR4670 has front panel controls including a bright florescent time counter display positioned for convenience and ease-of-operation. An automatic rewind feature means automatic rewinding at the end of the tape for added convenience.

Priced at $969.95, the VCR4670 offers an impressive array of performance features including 14-day/8-event programmable recording; 105-channel, cable-ready tuner, 13-function wireless remote control, including channel search, pause/still frame control; memory rewind; and high speed Betascan picture search.

Circle No. 9 on Reader Service Card

Circle No. 12 on Reader Service Card