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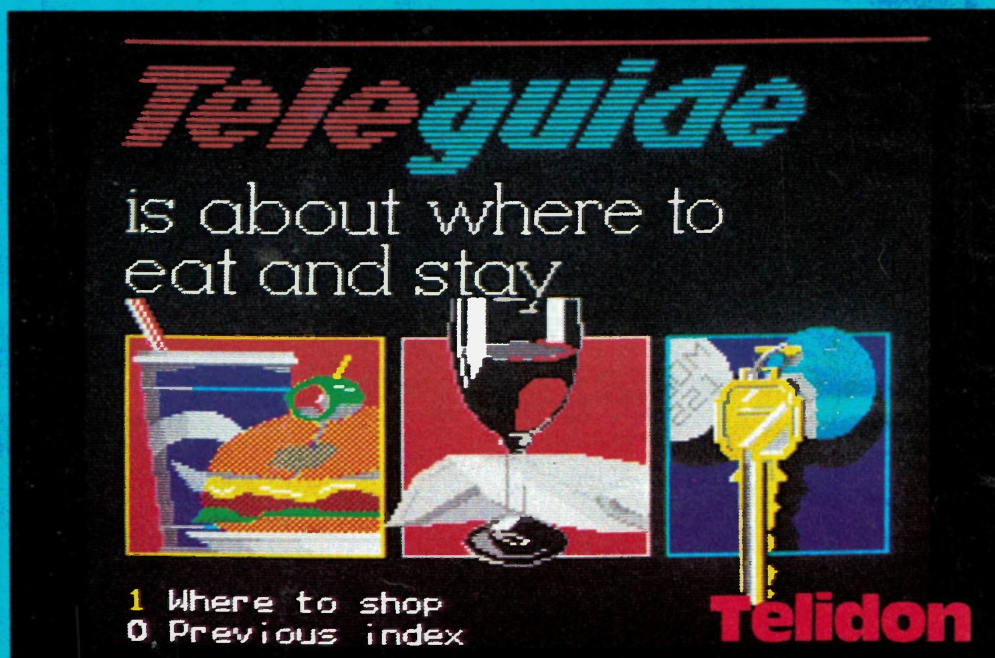

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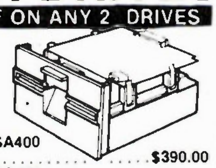

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Circle no. 5 on Reader Service Card.

The Magazine for Electronics & Computing Enthusiasts

SEPTEMBER 1982
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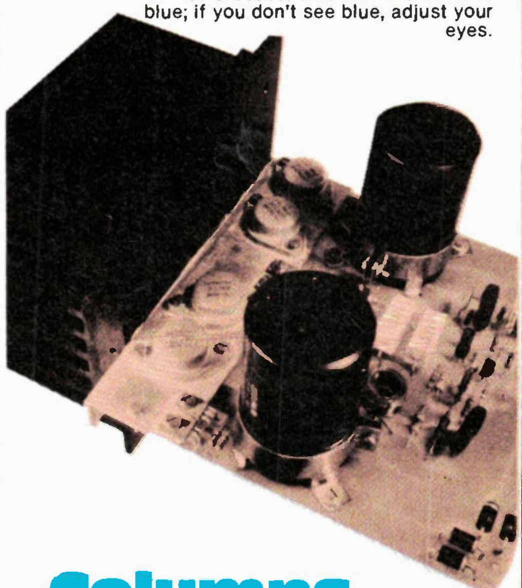
Member ABC Audit Bureau of Circulations

Features

Our Cover: Telidon may be the ultimate use for your TV. . . watch it for hours without a laugh track. Also, an explanation of the all powerful UPC codes. This month's cover is blue; if you don't see blue, adjust your eyes.



Projects

Columns, News and Information

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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 0.1uF 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.

K.S.K. Associates, P.O. Box 54, Morriston, Ont. N0B 2C0.
BR Electronics, P.O. Box 6326F, Hamilton, Ont., L9C 6L9.
Wentworth Electronics, R.R.No.1, Waterdown,Ont., L0R 2H0.
Danocinths Inc., P.O. Box 261, Westland MI 48185, USA.
Arkon Electronics Ltd., 409 Queen Street W., Toronto, Ont., M5V 2A5.
Beyer & Martin Electronic Ltd., 2 Jodi Ave., Unit C, Downsview, Ontario M3N 1H1.
Spectrum Electronics, Box 4166, Stn 'D', Hamilton, Ontario L8V 4L5.
Dacor Limited, P.O. Box 683, Station Q, Toronto, M4T 2N5.

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News

Handheld DMM

Fluke's new model 8060A 4½-digit handheld multimeter provides all the functions normally associated with a handheld DMM plus additional functions previously available only in bench instruments.

The Fluke 8060A features True RMS measurements for AC signals to 100 kHz, frequency measurements to 200 kHz, resistance measurements to 300 megohms, and the ability to store any measurement as an offset (a positive or negative relative reference value).

Voltage measurements can be directly displayed in dBm, referenced to 600 ohms, or in relative dB. Basic DC accuracy is 0.04%.

For more information, contact Miss Sindy Van Wieren, Allan Crawford Associates Ltd., 6503 Northam Drive, Mississauga, Ontario L4V 1J2, (416) 678-1500.

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Computer For All Seasons

Redland Automation, Inc. Sarasota, FL, introduces "Husky", a portable waterproof, outdoor computer having a membrane protected QWERTY keyboard and a sealed aluminum housing. With a maximum data memory of 144K bytes and ability to display 128 characters in 4 lines the unit is particularly suitable for inventory control, meter reading or computer controlled testing of remote microprocessor based devices. Husky can act as a computer terminal and will look like a peripheral to many IBM, Honeywell and DEC computers allowing direct down loading of programs. Its BASIC interpreter facilitates programming while the versatile microprocessor implements the Z80 instruction set and is CP/M compatible.

For more information, contact Redland Automation Inc., 1500 N. Washington Blvd., Sarasota, Florida 33577.

Daisy-wheel Printer

Comrex International, Inc. has introduced the ComRiter, a low cost, high quality daisy-wheel printer for microcomputer applications.

The ComRiter is an affordably-priced desk-top unit especially designed for word processing with print quality equivalent to most expensive office typewriters.

For more information, contact your nearest computer store or Comrex International, Inc., 3701 Skypark Drive, Suite 120, Torrance, CA 90505. Telephone (213) 373-0280.

New 'Scope

BCS Electronics Limited has released a new Hameg general purpose 20 MHz dual trace 'scope, model HM203-3. The trigger bandwidth and sensitivity enable the triggering of small signals up to well over normal, automatic (sweep runs in the absence of a triggering signal and triggers automatically for signals down to 30Hz), TV field, line, external; with slope selection for positive or negative going edges.

For portability in the field, this oscilloscope is extremely compact and light-weight.

For more information contact BCS Electronic Instruments, 980 Alness Street, Unit 7, Downsview, Ontario M3J 2S2. Telephone (416) 661-5585 or 661-5586.

Watchman™ TV

A new "FD" (Flat Display) Tube is incorporated in the Sony FD-210 black-and-white television. The TV tube provides a 2-inch picture (measured diagonally), yet the entire set is only 1¼-inches thick. The secret to the set's slim design is the positioning of the electron gun.

While conventional TV tubes use an electron gun positioned behind and perpendicular to the phosphor screen, the new Sony FD Tube locates the electron gun *underneath* the screen, and *parallel* to it. This gives the FD tube a distinctive paddle shape, and a thickness of only 5/8 inches. As a result, the FD-210 is an amazingly compact, portable set that can be used anywhere, at any time.

The flat TV screen can be switched off for sound-only operation to preserve battery power. To facilitate station selection, the FD-210 incorporates electronic tuning.

The Watchman FD-210 can operate on four different power sources: batteries, an optional rechargeable battery pack, household current with the supplied adaptor and car batteries with the optional car battery cord.

For more information, contact Sony of Canada Ltd., 411 Gordon Baker Road, Willowdale, Ontario M2H 2S6.

Interactive Graphic System

A new, moderately priced, user-friendly CAD/CAM interactive graphics system for precision pattern generation for matting, printed circuit design, drafting and digitizing is being introduced by WINCOM Corporation of Lawrence, Massachusetts.

The WINCOM AWW 100 CAD/CAM Interactive Graphics System features intricate multilayer two-dimensional pattern generation for integrated circuit design. Providing standard or user specified geometric shapes composed of minute rectangles, it achieves 10 micro-inch duplication on photosensitive surfaces with pattern or mask generating equipment.

Employing user-friendly prompts sequencially through all operations, the system is equipped with 64K RAM and dual floppy disk drives providing 388K storage each. Options include a 13 or 19" high resolution RGB monitor, a 9-channel tape drive and 12 Megabyte hard disk.

For more information contact WINCOM Corporation, Dr. Arthur Winston, 23 Shepard St., P.O. Box 329, Lawrence, MA 01842, telephone (617) 685-3930.

Also...

University of Ottawa researchers are working on developing shorter microwaves to bypass the communications glut. Using the most recent semiconductor advances, millimeter wavelengths are becoming possible. The work has important implications for Canada, which has always been in the forefront of technology.

•

Computer Camp for Kids at Geneva Park, Orillia, Ontario provides a departure from the usual summer camp activities. The kids write their own computer programs at the $400.00 a week camp; the computer room is open twelve hours a day and there is one instructor for every four children.

•

The ETI Bull logged over two hundred callers in its first week of operation. The most popular file by far seems to have been the Limericks... not for the faint of heart. The Bull is up from 6:00 pm to 8:00 am Monday to Friday and all day on weekend and holidays at (416) 423-3265.

•

The federal government will allocate twelve million dollars during the 1982-1985 period for field testing of Canadian "office of the future" technology, according to Francis Fox and Herb Grey. The area of development will be the intelligent workstation.

•

The Ottawa High Technology Show will take place at the Civic Centre, Landsdown Park, Ottawa October 26 and 27 For complete information contact 2847 Kaladar Ave., Suite 107, Ottawa, Ontario K1V 8B9 (613) 731-9850.

•

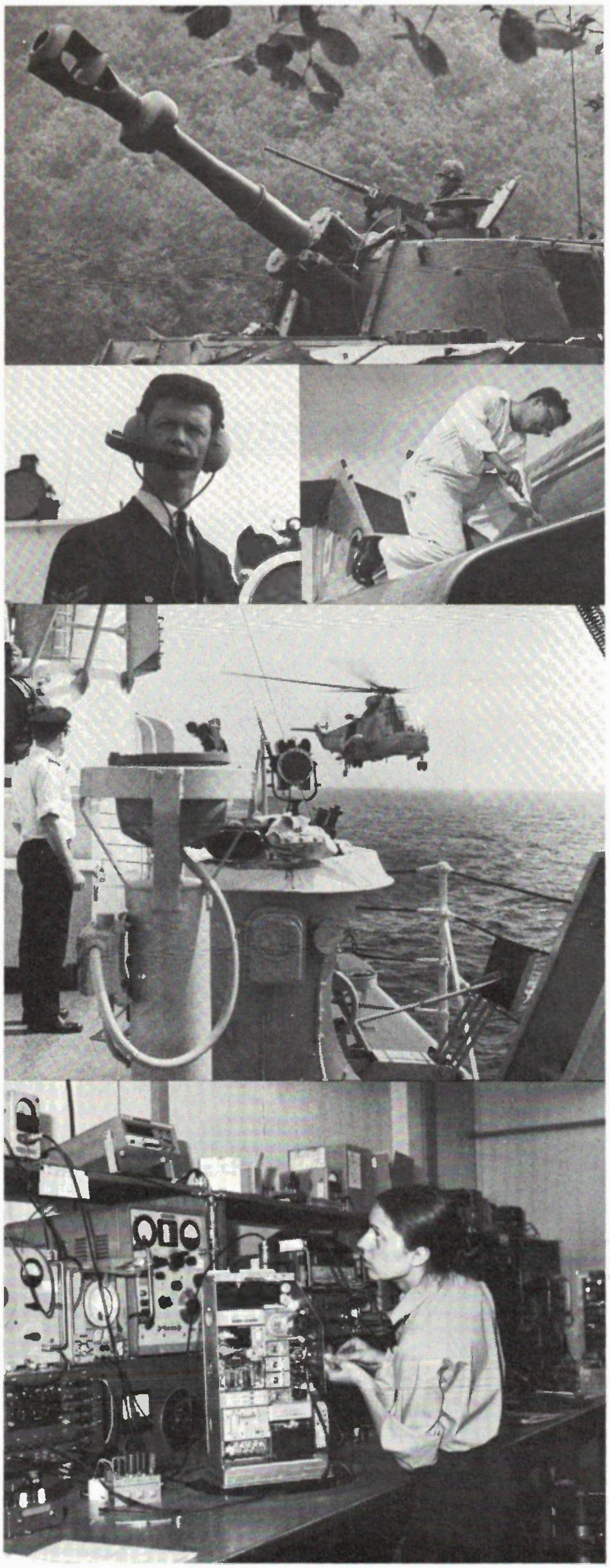
Dr. John Hartmann of Northern Illinois University has spent the last three years developing a computerized dictionary for the Tai Dam language. Many Tai speaking people have emmigrated to the U.S. and Canada. The complexity of the project is in the nature of the Tai language, in which tonal inflections alter the meaning of the words, but the tones are not directly indicated in the written text.

•

Publicly owned Teleglobe Canada, which operates overseas radio, telephone, telecom and television conections via satellites and undersea cables has released its annual report indicating operating revenues up 25.5% to $170 million, income up 16.9 percent to $68 million and net income after taxes up 28.5% to $47 million.

•

Sanyo Machine Works of Japan will open its first overseas plant in Elmira, Ontario, initially as a service depot. Current plans include having design facilities at the Elmira plant within two years.



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With a frequency coverage of 0.005 Hz to 5 MHz, the new 3025 is more than able to handle most lab and field function generator applications. In addition to sine, square and triangle waveforms, the 3025 offers a haversine function for more specialized needs. Linear sweeps to 1,000:1 and log sweeps to 10,000:1 are front-panel selectable, with independently settable start/stop limits.

The new 3015 is a very compact sweep/function generator intended for audio and ultra-sonic applications. Unique in its price class, the instrument covers 2 Hz to 200 kHz, with selectable linear and log sweeps. Both variable and fixed TTL level outputs are featured.

If you're "seeking signal sources," the place to stop is your local B&K-PRECISION distributor. To receive a free brochure on the full line of B&K-PRECISION generators, or for the name of your local distributor, call

ATLAS ELECTRONICS LIMITED
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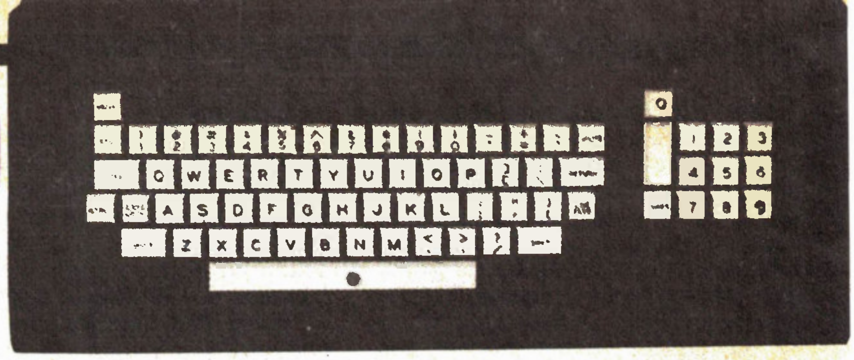
Telidon



If you aren't careful with Telidon you'll wake up with the head of a TV set in your bed. By Bill Perry.

VIDEOTEX is a linguistic goldmine for George Orwell's concept of "newspeak", where contractions and acronyms abound and plenty of "shop talk" has gone "household". The term itself is only two years old and is used interchangeably with *viewdata, teletext, telesoft,* and other generic terms. They all seem to refer to the mass utilization of cybernetic communications which would be something like enhanced timesharing, networking and associated activities. The words are new but the evolving social phenomena they describe is not. Within this marketing lexicon it is most difficult to get a fix on the process.

This article attempts to offer such a fix by locating Telidon within the larger context of videotex and videotex within the larger context of electronic information interchange . The reader is reminded that one element remains constant throughout videotex industrial development. The American Standard Code for Information Interchange (ASCII) is the thread that binds the whole mess together and provides the narrative continuity.

First Generation Videotex

ASCII consists of 96 alphanumeric characters (letters, numbers, punctuation, etc.) and 32 "control characters". Each of these 128 characters has a unique 7 bit binary description. Each set of seven one's and zeros lines up behind the other and marches down the telephone line to a computer that re-interprets them into letters and numbers to be displayed on a CRT or printer. ASCII has been a part of computerized communication so long that most computer enthusiasts take it for granted and most computers, no matter how big or small, use the ASCII standard to encode text.

ASCII is the basis for the simplest, and thus first, form of videotex. It is a misnomer to say "Telidon" in the same breath as electronic messaging, teleshopping, banking and other videotex applications. It is ASCII that enables this. Telidon only makes it appear quicker and look better. In this sense, the most common videotex standard, actually in the marketplace, is ASCII. Although some Canadian organizations might argue otherwise, the largest consumer-oriented videotex services in North America are Compuserve, and The Source. They are fully commercial, their revenue comes entirely from user connect fees, they have very little "sponsored" advertising, and they are far more widespread than Telidon. Compuserve alone claims to support 25,000 users.

Second Generation Videotex

The earliest and now low end form of alpha-mosaic graphics was the computerized portrait popular in shopping malls some years back. One may recall these crude portraits drawn from a mosaic of alphabetical characters. The picture was always better if you stood further away and squinted.

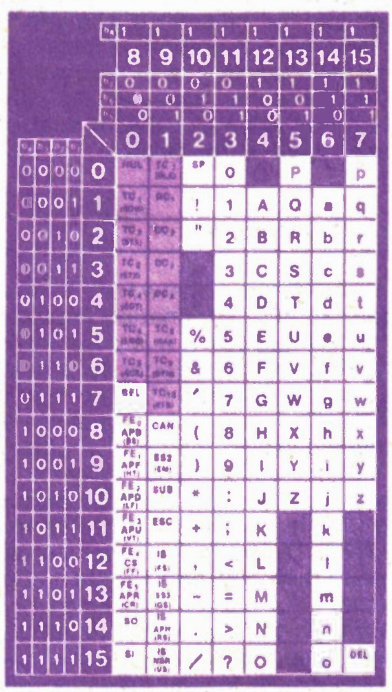


Fig. 1 ASCII Characters.

An improvement to this was to have the computer shift into a redefined or extended subset of ASCII that changed the letters into shapes that could be strung together to form better graphic representations. This approach was constrained by its inherently low resolution and the amount of digital information that needed to be transmitted over low capacity telephone lines.

Nonetheless, the British and French were enthusiastic. As early as 1975, *Prestel* and *Antiope* offered what they called "viewdata" with alphamosaic, low resolution graphics. In Canada and the U.S., most alphamosaic systems were being set up just as the Canadian federal Department of Communications (D.O.C.) ushered in third generation videotex.

Third Generation Videotex

The alpha-geometric approach was a radical departure from the previous method. So much so that the flurry of activity that resulted was misinterpreted as the actual birth of videotex. Systems such as Compuserve and The Source were all but forgotten by the popular media. A high-res colour photograph of Albert Einstein looked far better in newsprint than a photograph on the UPI wire service. As a result, Canada spent the year of 1981 "on top" of the industry. New companies were formed, jobs were created, investments were made, hardware was produced and a new Canadian videotex industry was born.

Telidon

Telidon is an alpha-geometric picture description instruction code. The

Telidon code provides the most efficient method of transmitting graphic images over most any electronic medium. When it was developed, the D.O.C. saw it simply as the very best code of its type and few people disagreed. Recognizing that a Canadian international standard of this type could have a favourable effect on our gross national product, the D.O.C. began to encourage private industry to get involved. The first step was the publication of the code and an invitation to Canadian hardware manufacturers to produce hardware based on the D.O.C. specifications. In 1980, the D.O.C. also committed twenty seven million dollars towards

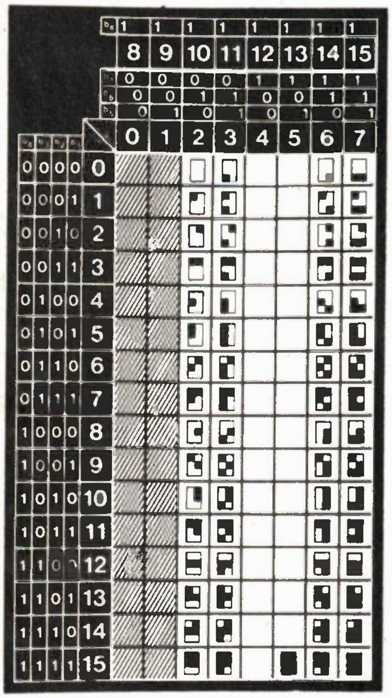


Fig. 2 Alpha MOSAIC Graphics.

developing a Telidon-based industry in Canada. This was allocated towards subsidizing hardware development, implementing Telidon field trial databases in collaboration with private industry, and international marketing.

In May of 1981, the alphageometric approach of Telidon was reinforced by an announcement and release of the American Telephone and Telegraph Presentation Level Protocol (ATTPLP). PLP is an enhanced or expanded version of Telidon P.D.I.'s. This was tremendously good news for Canadian participants. The D.O.C. committed an additional $18 million towards continuing the good work, as well as encouraging content development.

Today, the D.O.C. believes that its initial $45 million will generate $250 million from Canadian private investors before the end of 1983. Presently there are Telidon systems operating around the world (mostly in Canada), a multitude of Canadian individuals and organizations are acting as "Information Providers" to these systems, at least a dozen Canadian computer manufacturers have gone into mass production of Telidon hardware and the systems are operating over all possible electronic mediums.

The Canadian Telidon/Videotex Industry consists of four major players. They are System Operators, Carriers, Information Providers (I.P.'s) and Manufacturing. To a large extent, the roles played by each have been arbitrarily defined by the economics of "experimental" or "field trial" projects and services. Because these systems are being set up by corporations involved in centralized mass market media, the system models are central in design, usually a host database that gets information from a few large concerns to make available to lots of little concerns. Also due to "field trial" modes of operation, there is an unfortunate distinction in Telidon/videotex hardware between input equipment (page creation) and receiving equipment (user terminals). Generally, the content is almost all advertising and few users pay for the service. The effects of field trial operation is most apparent when we compare Telidon/videotex services to first generation videotex services such as Compuserve or The Source.

System Operators

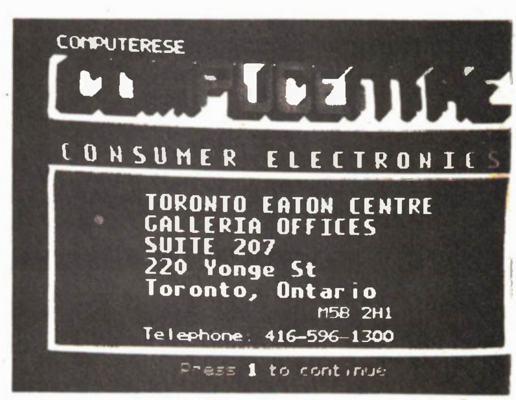
The distinction between System Operators and Information Providers is the most slippery. It *is* possible for any Information Provider to operate his own system; the I.P.'s content is in fact a "pseudo-system" and its performance can be identical whether it is stored on a large timesharing system or on a micro or minicomputer (e.g., Apple, IBM personal computer, HP3000). Theoretically, everyone can operate their own small system commercially. As these things tend to go, present practical attitudes regard the system operator as the person or party responsible for the operation and maintenance of a host database. If the System Operator wants to offer Telidon to potential users, the proper Telidon host system software is necessary. It is not essential that the host computer deal with Telidon P.D.I. It merely has to be able to transmit ASCII files and receive ASCII encoded responses.

The low end capabilities of such a system would include a tree structured database in which users can select numbered items from a short list of 9 topics (menu or index page), choose to press "next" for the page at the next highest logical page number, "retrace" for the page stored at the previous logical menu page number and "back" for the previous page viewed. Most any computer capable of sending and receiving ASCII text is capable of doing this type of service.

The first Telidon databases were low capability systems running on D.O.C. software. Over time, certain companies made strong commitments to the commercial development of the Telidon System software. Most noteworthy amongst these companies is the Genysis Group, and Informart (both produce system software for large DEC computers). Also noteworthy are the Systemhouse database software for the Hewlett Packard 3000, the Tayson software for IBM personal computers and the Information Technology Group's Apple/Telidon system.

Strictly speaking, questions of system capabilities are more relevant to videotex than they are to Telidon. The P.D.I. code works independently of the host system. Consequently, models of system capabilities can be drawn from Compuserve and The Source, as well as Prestel and Ceefax and from Telidon/videotex. The following is a sampling of presently available Telidon/videotex capabilities:

Action Tasks - FORTRAN programs stored as pages, useful initially for



things such as mortgage calculations and games. However, widespread use could play havoc on processing speeds.

User Statistics - Videotex is distinct from most media solely on its ability to document (eventually in real time) its own use.

Data Collection Pages - For those I.P.'s who would like to document user response, especially useful to retailers for collecting orders from potential tele-shoppers. D.C.P.'s could also be useful in improving the interactive quality of services.

Keyword Searching - Each page can be assigned up to 25 keywords. This is not keyword access in that the computer does not search the contents of the pages. Instead, it searches the identifiers attached to each page.

Teleshopping - Until legislation is passed regarding electronic funds transfer, teleshopping will need to rely on D.C.P.'s to gather orders and then bill buyers by mail, C.O.D., charge card, etc.

Downloading - The host sends programs, instead of static pages, to an intelligent terminal. Downloading relieves the economics of processing speeds and it is consistent with the

Information Providers

Reproduced here are the names of companies providing information to the Bell Canada Telidon field trial known as VISTA. These names have been arranged in the author's own categories and should not be confused with Bell Canada's classifications. The list is drawn on the basis of sponsorship. Corporate Sponsors are usually those interested in the advertising/merchandising potential of commercial videotex. Non profit/Government I.P.'s have similar expectations with a social benefits perspective. Educators, most of whom are represented by TV Ontario, are involved in an extended version of C.A.I. and C.A.L. The remaining I.P.'s on VISTA consist of "independents" and Videotex service organizations. In effect, all the I.P.'s listed are independent. However, those identified as such are usually single individuals or small groups exploring the "cottage industry" concept of videotex. For more information about any of these I.P.'s, you should consult your nearest public VISTA decoder (e.g., at the Royal Bank Plaza in Toronto).

Information Providers

Corporate Sponsorship

Air Canada	Tip Top Tailor
The Bay	Royal Insurance
British Tourist Authority	Miracle Food Mart
Canadian Imperial Bank of Commerce	Manufacturers Life
Canaglobe International	Encyclopedia Britannica
Time Inc.	Guaranty Trust
The Royal Bank of Canada	Holiday Inn
Reader's Digest	Iberia
A.E. LePage	Infomart
Continental Bank of Canada	Southan Inc.
Cooperators	Sears
Dominion Stores	Sony
Dominion Daries	Simpsons
Eatons	Standard Life
	Teledirect

Non Profit/Government

Atomic Energy	Environment Canada
Community Information Centre	Ministry of Energy
Consumers Association	Ministry of Industry & Tourism
Emerg. Plan. Can.	Statistics Canada

Independent

Christ. Comp. Based Comm	Sportsync
Computerese	Tanco
Concord	Telesync
Millions Mag.	Thompson
Operation Goodnight	Beta

Educators

Carleton
TVO
York

Services

Faxtel	Teledirect
Gabriel	Studio Esprit
Hemton	Infomart
Talamark 6345	Proulx Brothers

Manufacturers

Hardware is involved in the production, storage and retrieval of videotex services. This brings us to names of companies and their products. In that most Telidon systems have been established on an "experimental" or "field trial" basis, the economics of giving out equipment to voluntary users have produced very obvious, yet somewhat awkward distinctions, specifically between equipment used for inputting equipment (page creation) and that used for output (viewing).

Any computer that can handle ASCII text can be interfaced with Telidon to some degree. The simplest receiver (publicly displayed at Videotex '81) is the Atari 400. Known as the poor man's "Telidon receiver", this software driven interface ignored all of the picture description instructions, except in relation to text. In effect, it dealt with Telidon as straight ASCII with no graphics. Figure 4 lists most of the manufacturers presently involved in producing page creation equipment, user terminals or system hosts.

TELIDON/VIDEOTEX HARDWARE (AT&T PLP COMPATIBLE)

Page Creation Terminals	Manufacturers or O.E.M. Dist.	Basic Hardware
The Information Provider System 2 (IPS 2)	Norpak	PDP 11/03
The GC 1000	Norpak	OS 9 Operating System
Apple Telidon Graphic System	Apple/Norpak	Apple II & III
The Apple/Telidon Picture Creation System (PCS)	Information Technology Group	Apple II
The Videotex Information Provider System (VIPS)	Northern Telecom	Cromemco
The Electronic Picture Painter	Cable Share	A.E.L. Microtel
The AT&T Frame Creation System (ATFCS)	AT&T	AT&T Hardware
Telidon User Terminals (TUT)		
The Mark IV	Norpak	
The UTX 208	A.E.L. Microtel	
VISTA Terminal	Northern Telecom	
TELCO-R-NK	Electrohome	
Apple Telidon Graphic System	Apple/Norpak	
The Electronic Projector System (EPS)	Hemton/Norpak	
Database Systems		
Telidon System Software	Infomart	DEC PDP11
GENESYSTEM	The Genysis Group	DEC PDP11
Personal Videotex System	Tayson Info. Tech.	IBM Personal Computer
Telidon/plp 3000	Systemhouse	HP3000

principle that user terminals are on an increasing intelligence trend.

Electronic Messaging - Users may input messages through their own terminals to have them directed towards the terminals owned by I.P.'s or other users.

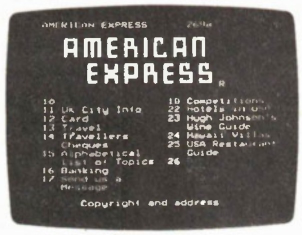
Carriers

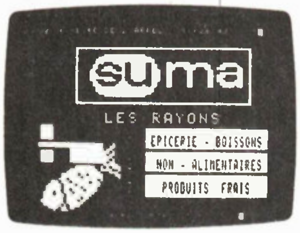
Anywhere ASCII goes, Telidon can go with it. This includes "clean" home phones, broadcast television, coaxial cable, fibre optics, and satellites. There are field trials involved in each of these mediums (see chart). However, ASCII text with alphageometric P.D.I.'s means the most to telephone technology. The common form of carrier for Telidon/videotex is the telephone company. Of the twenty three Telidon/videotex systems various phone companies are involved in seventeen.

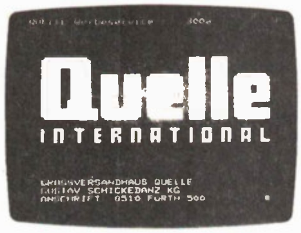
All carriers who decide to participate in videotex services must do so within the restrictions placed on them by regulating agencies such as the CRTC or the FCC. Such restrictions are usually based on anything but videotex services. It is unanimously agreed by all that the CRTC must re-evaluate its rules specifically in regards to the anomalies and inconsistencies brought about by the notion of answering your television or watching your telephone.

Future Videotex

This categorization of videotex into "generations" or "stages" is an arbitrary model chosen by the author for narrative clarity. These categories are roughly analogous to a more precise model provided by the International Standards Organization (ISO) in their "Reference Model of Open Systems Interconnection" (O.S.I.). The O.S.I. standard is a multilayered system architecture designed to allow information interchange over a variety of different media. Both videotex (associated with interactive telephone systems) and teletext (associated with broadcast systems) are addressed on separate levels of the O.S.I. standard.







There are seven functionally separate layers of the I.S.O. O.S.I. model Levels 1-4 are concerned with the *transference* of data while layers 5-7 deal with how the data is processed and used. ASCII is more or less identical to the O.S.I. method of encoding textual information. Alpha geometric P.D.I. is most relevant to the sixth layer, known as the presentation layer. The AT&T Presentation Level Protocol, which was based on the Telidon PDI, is specifically related to this sixth level.

Level 7, the Application Level, represents the immediate future of videotex. Application standards (or Application Level Protocol) involves legislative as opposed to technical issues. Some of these are:

Electronic funds transfer -Teleshopping, telebanking and other related videotex services are not yet legal or technically available. E.T.F. is expected to automatically transfer money from the buyer's bank account to the seller's bank account, no paper (or signature) invovled. E.T.F. is the backbone of the liberal view of "the cashless society".

System security - Obviously some form of security will be necessary for E.T.F. Other system security concerns involve willful or negligent system damage caused by I.P.'s, teletheft, be it fraudulent E.T.F. or illegal printing of database pages or programs, as well as questions of copyright protection.

Privacy - The popular imagination has been stunned and awed by the implications of computers and personal privacy. In videotex development, privacy has been over and underestimated, overestimated in the sense that we have been preoccupied with protecting citizens from the misuse of names, addresses, medical records, credit ratings and the types of traditional data perceived as personal. Personal privacy has been underestimated in the sense of user statistics. This gives rise to un-

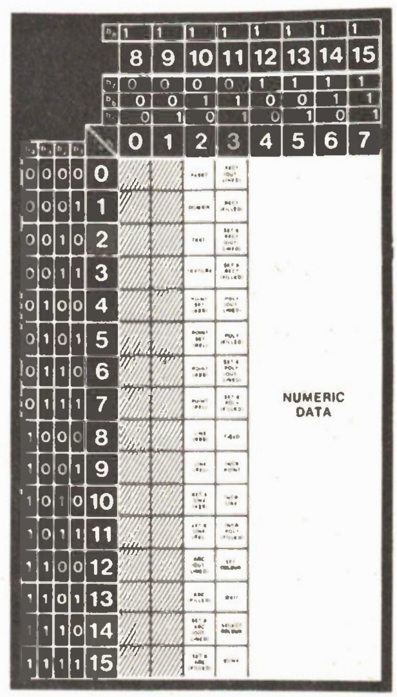
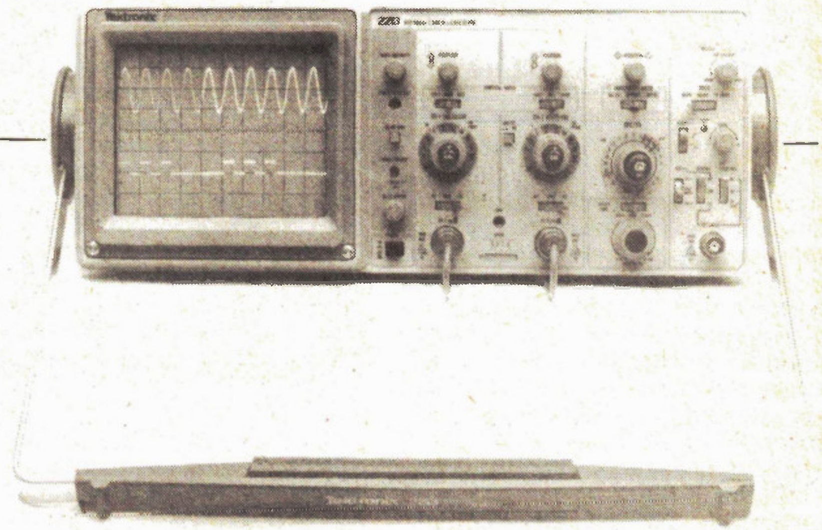


Fig. 3 PDI Code Set.

Continued on page 25

Aspects of the 'Scope



'Scopes used to have metal cases because the tubes within made them suitable for cooking on. Jack Woida, of Tektronix, who has a newer 'scope and a separate stove, observes that things have changed.

OVER THE PAST YEAR or so there has been a trend in the medium performance oscilloscope area for prices to come down. The oscilloscope had long been immune to the economic forces that had been driving down prices in many of the other areas of electronics. We're all familiar with the story of the hand-held calculator. Starting out at several hundred dollars for a basic model around 1971, we saw more than a ten-fold reduction in price to the ten to twenty dollar price range today. This is truly remarkable when you consider that inflation has more than doubled the prices of most consumer goods in the same time period.

We've seen similar trends in the test equipment industry with the digital voltmeter. A combination of mass production techniques employing largely automated assembly lines and L.S.I. technology to get the parts count down are one of the major reasons for this price lowering.

Oscilloscopes, however, are complicated and expensive instruments to design and build. They typically have very high parts counts. Production runs are often measured in thousands, instead of in hundreds of thousands like the hand-held calculator. Because of its largely analogue nature, the oscilloscope does not benefit as much from digital V.L.S.I. technology. Also it requires a calibration procedure before it can be shipped to the customer. Consequently, oscilloscope production, up until now at least, has required a great deal of hand labour. This resistance to high volume mass production techniques has been one of the main reasons why oscilloscopes have not followed the dramatic downward price trend enjoyed by other electronic products.

However, that is beginning to change. About a year ago Tektronix announced two new 60MHz oscilloscopes that were priced at about 60% of what similar products on the market had cost up until then. The reason is a new design with a dramatically reduced parts count that lends itself to mass production techniques.

Over the past year, many other manufacturers of scopes have either lowered their prices or brought out new low cost products of their own. The result is that relatively high performance 50 to 60 MHz bandwidth oscilloscopes that would have cost $3,500 or more a year ago, are now obtainable in the $1,900 to $2,400 price range. Admittedly, this is still more than the $1,000 or so that you would pay for a basic 15MHz scope, but then, you'll get a lot more performance.

The rest of this article is devoted to the performance differences you can expect to gain by going to a more expensive, higher performance oscilloscope.

Bandwidth

As we said earlier, the oscilloscope is primarily an analogue instrument. It has a bandpass characteristic much like a low pass filter, or a D.C. coupled amplifier. The bandwidth specification of a scope will be measured on screen at 3dB down from its actual level. In practical terms this means that if you try to measure a one volt peak-to-peak sine wave, at the bandwidth frequency of the scope, what you will actually measure on screen is 0.707 volts peak-to-peak - a 30% error! Most oscilloscopes are capable of making measurements to within 3% accuracy, but only if the frequency being measured is one-fifth or less the bandwidth of the scope.

What's that you say? You don't use an oscilloscope to make accurate amplitude measurements. You're more interested in qualitative rather than quantitative measurements. What you're interested in is waveshapes! Well consider this. The sine wave is the only wave shape that will pass through a filter and still maintain its same basic shape. Filters will try to turn any other wave shape into a sine wave. In fact, if you try to measure a one volt peak-to-peak 15MHz square wave on a 15MHz

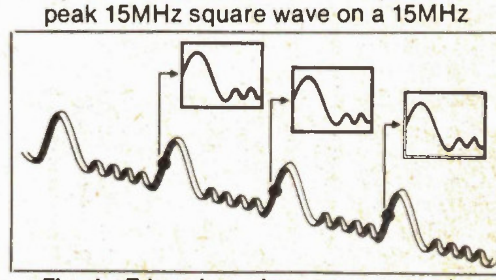


Fig 1. Triggering gives you a stable display because the same trigger point starts the sweep each time. Slope and level controls define the trigger points on the trigger signal. When you look at a waveform on the screen, you're seeing all those sweeps overlaid into what appears to be one picture.

scope, what you will see is a poorly shaped sine wave much reduced in amplitude. This basic fact of life is particularly important in today's digital world where we rely on the oscilloscope to make measurements on pulse shaped waveforms.

The important specification in pulse work is risetime. This is the amount of time it takes the oscilloscope's amplifier circuits to respond to a theoretically perfect input step with zero risetime. As you might expect, risetime is related to bandwidth; the higher the bandwidth, the faster the risetime. The formula relating the two is Tr=0.35/B.W., where Tr, the risetime, is measured from the 10% to the 90% amplitude points of the voltage step. This means that a 10MHz scope will have a 35 nsec risetime. A 100MHz scope, a 3.5 nsec risetime.

But so what you say. Why are you bothering me with all this theory? Well the practical part of all this is that many digital circuit designs don't work initially because of timing

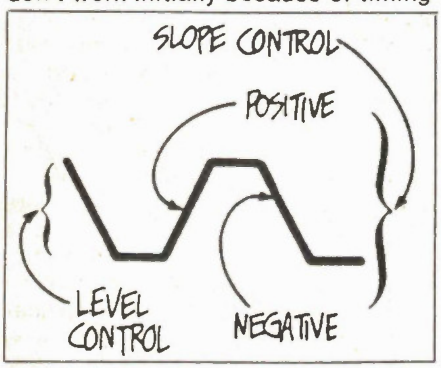


Fig. 2. Slope and level controls determine where on the trigger signal the trigger actually occurs. The slope control specifies either a positive (also called the rising or positive-going) edge or on a negative (falling or negative-going) edge. The level control allows you to pick where on the selected edge the trigger event will take place.

problems. Signals that were supposed to arrive at a gate simultaneously, don't. The result is that for a very brief time the gate gives an output state that the designer didn't intend. This state may only last for ten or tweny nsec, but this is long enough to fool further circuitry down the road. This is what is affectionately known as a "glitch", and it can be very troublesome to track down. Often the oscilloscope (or it's cousin the logic analyzer) is the only instrument capable of helping you find it.

The differences in time it takes different signals to pass through different signal paths is the main reason for these problems. This time is related to the number of gates the signal had to pass through to get to the trouble spot. Each gate adds a propogation delay of several nanoseconds. (The actual delay depends on the type of logic technology being used, e.g. CMOS, TTL, ECL, etc.). All it takes is for one of the signals to have a few more gates in it's path than the other. The result can be a 20 nsec. glitch. This may not sound like a very long time, but it's enough of a signal to cause a flip-flop to toggle. If this happens when you didn't want it to the result can be disastrous. And remember, this sort of a fast glitch can occur no matter what the intended speed of your circuit.

Now consider the response of a 10Mhz scope to such a glitch. Remember that the risetime of such a scope is 35 nsec. That means that it takes 35 nsec for the trace on the scope to rise to almost its full amplitude after it first sees the input signal. It then takes a further 35 nsec for the signal to return to its zero voltage level after the input signal goes away. In other words, the narrowest possible pulse you could detect with a 10MHz scope is 70 nsec wide. The 20 nsec pulse we're trying to detect would have come and gone before the scope could react.

A 50 Mhz scope, on the other hand, is capable of detecting a 15 nsec wide glitch.

The trend in digital technology is to increase the speed of the components. Greater speed means more operations per second, and ultimately, that translates into greater productivity. Microprocessor clock speeds are now pushing past 10Mhz.

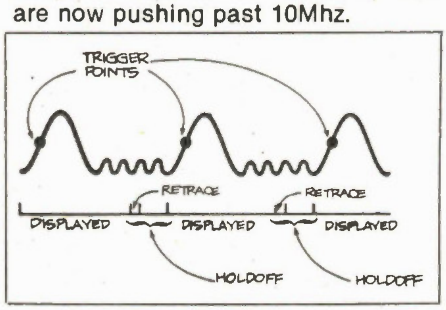


Fig. 3. Trigger holdoff time ensures valid triggering. In the drawing only the labeled points start the display because no trigger can be recognized during the sweep or the retrace and holdoff period. The retrace and holdoff times are necessary because the electron beam must be returned to the left side of the screen after the sweep, and because the sweep generator needs reset time. The CRT Z axis is blanked between sweeps and unblanked during sweeps.

One final note about vertical amplifier circuits. Good high frequency vertical amplifiers can be expensive and difficult to build. A typical problem that you will find when the designer compromises on quality is compression. There is a simple test for compression. It goes like this.

Give the scope a signal at its rated bandwidth. Position the signal

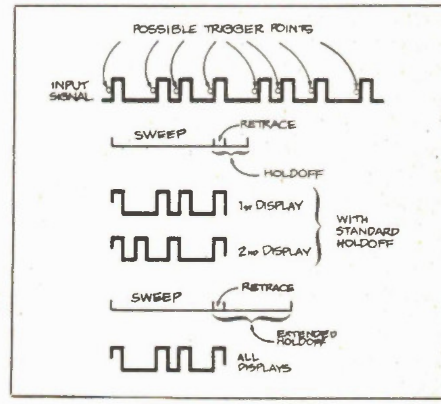


Fig. 4. The variable holdoff control lets you make the scope ignore some potential trigger points. In the example, all the possible trigger points in the input signal would result in an unstable display. Changing the holdoff time to make sure that the trigger point appears on the same pulse in each repetition of the input signal is the only way to ensure a stable waveform.

to mid screen and adjust the amplitude to exactly two divisions. Then, reposition the waveform to either the top or the bottom of the screen. Of course, a good scope should still display exactly two divisions of amplitude. The amplifiers in a not-so-good scope, however, will begin to exceed their dynamic range and what you will see on screen is a compressed signal, something less than the previously set two divisions. Needless to say, compression is not desirable in an oscilloscope.

Generally, designers of higher frequency scopes pay more attention to the vertical amplifier circuits than they would in say a 10 or 15 MHz scope. They're usually careful about designing amps that don't have this compression problem.

Writing Rate

Non-storage oscilloscopes depend on a constantly repeating signal to give a bright, stable display. Display brightness in fact depends on how many electrons strike the phosphor on the screen per unit time as well as how much energy they have when they strike the screen.

A waveform that constantly repeats itself at a high repetition rate will appear bright on almost any scope, regardless of the energy that the electrons have. Where you get into trouble is when the waveform you want to look at has a very low repetition rate. For example, very fast pulses (say 1 u sec. or less duration), that only occur a few times a second will appear very dim on most scopes. This kind of a problem is typical when you're working with digital circuitry. The reason for the dim display, of course, is that now you have very few electrons striking the screen per unit time. The only way to increase brightness now is to increase the electron energy. This is done by increasing the accelerating potential across the cathode ray tube. Modern day oscilloscopes have anywhere from 1.5KV to as high as 24KV of accelerating potential across the CRT. The rule of thumb is that the higher the bandwidth (and the more expensive the scope), the more accellerating potential you'll get. The actual amount of brightness that you get is specified as writing rate.

Signal Delay

Why would you want to delay the signal in an oscilloscope? Well, as it turns out, there are several good reasons. The first of is so that you can see the leading edge of the signal that you've triggered on. To obtain a stable display, your scope's horizontal sweep needs to be synchronized to the incoming signal you're trying to view. This is done by triggering the sweep circuits whenever the incoming signal voltage reaches a preset level. To accomplish this a sample of the incoming signal must be picked off and sent to the trigger circuits. The trigger circuits then need to process the signal and produce a trigger pulse. Then, the trigger pulse needs to be sent over to the sweep generator to tell it to get moving and start its sweep. Finally, the sweep generator gets going and begins to sweep the electron beam across the screen.

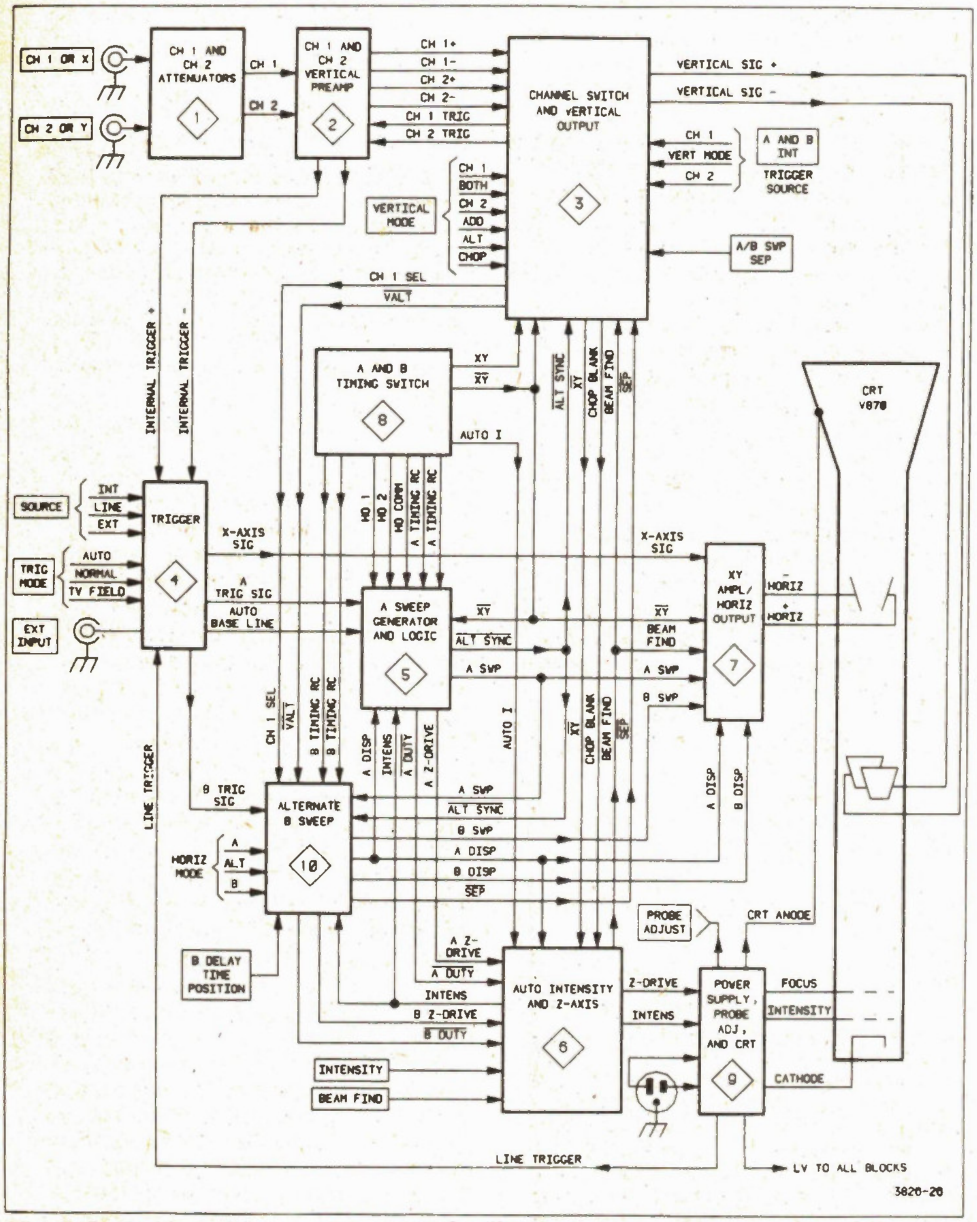


Fig. 5. Basic block diagram of the 2215 Oscilloscope.

The problem is that this whole process takes time (perhaps as long as 50 nsec). While the scope is busy triggering itself, the signal that caused the trigger has come and gone. By the time the sweep finally gets going, its too late to view the signal that caused the trigger. This problem is solved by inserting a passive delay line into the vertical amplifier signal path after the trigger pickoff point. This delay line typically holds the signal back for about 100 nsec, while it gives the horizontal circuits time to catch up. In fact, they hold the signal back long enough to allow the sweep to get started *before* the vertical signal reaches the screen, and as a result, you can actually see a few nanoseconds ahead of your trigger point.

This virtue is particularly nice to have when you're working with digital pulses.

Most scopes with bandwidth's of 15 MHz or less don't have such a delay line, while most scopes with bandwidth's of 25 MHz or greater do. For scopes with 50 MHz or greater bandwidth, a delay line is essential and virtually all scopes in this class have a delay line.

Do not confuse a delay line with delayed trigger or delayed sweep however. These are totally different animals altogether.

Often, in digital or pulse work, you want to examine a small time slice portion of the signal. You do this by cranking up the sweep speed which effectively makes the time window that you see on screen smaller and, consequently, magnifies the on screen signal.

A problem arises however when the signal you want to magnify occurs somewhere in time after the trigger point. Each time you crank up the sweep speed one notch, the magnification process blows up everything from the trigger point on the left hand side of the screen to the centre of the screen so that what was half of the screen now occupies a full screen. This is fine if what you wanted to look at was orginally to the left of centre screen. However, everything that was to the right of the centre screen has now been pushed off screen and if you wanted to view something there, you're out of luck.

The solution to this problem is a trigger delay. You still have your original trigger point but instead of starting the sweep with this first trigger, you start a delay time instead. Once the delay time elapses, a second trigger is generated and this triggers the sweep. The amount of delay is variable and you preset it so that the sweep now begins with the point of interest and you can blow it up all you like without fear of expanding it off screen.

Delayed sweep is an even more powerful technique for accomplishing the same thing. A delayed sweep oscilloscope actually has two timebases. The first timebase displays the overall picture. Then, once again, you can dial in a certain amount of delay. Once this delay time has elapsed, a second timebase is fired up. The amount of delay is set so that the second sweep takes place around the signal of interest. This second sweep is also set so that it is much faster than the first and the result is that the point of interest is magnified.

The beauty of this technique is that you can see both the unmagnified and the magnified signals on screen at the same time. Not only that, but the unmagnified display highlights the area that's being magnified by showing it as an intensified portion of the display.

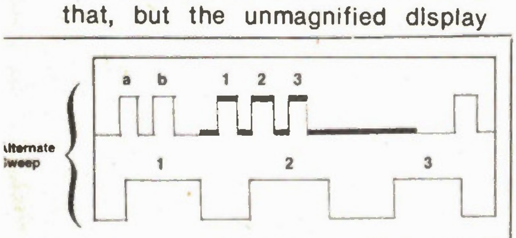


Fig. 6. Delayed sweep allows you to select a portion of the main sweep to be magnified. The selected portion is highlited by intensifying it. The intensified portion is then redisplayed at a faster sweep speed using a second timebase. The result is a magnified view of the selected portion.

Once again, if you're doing any sort of digital work, you'll find that at least a delay line is absolutely essential. Some form of delayed trigger is also very useful. Delayed sweep is nice to have but is expensive and not essential. Most of the things you would use a delayed sweep for can be accomplished with trigger delay.

Triggering

Probably the most misunderstood and potentially frustrating thing about a scope is getting it triggered. More cuss words have passed users' lips on this subject than on any other single aspect of scope usage. The simple fact is, there's a lot more wrong ways to try to trigger a scope than there are right ways.

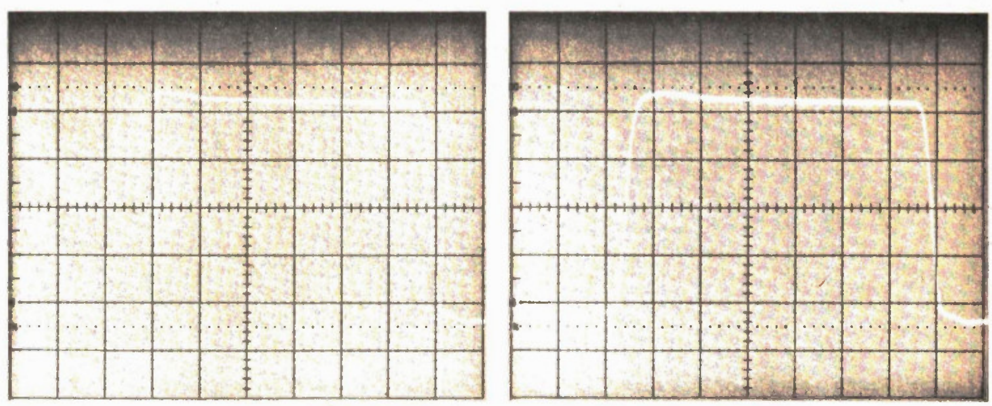
What's triggering all about anyway? Well, first of all, if you want to see a stable display on screen, you're going to have to synchronize the oscilloscope horizontal sweep rate with the incoming signal that you want to view. The way you do this is to tell the sweep circuits to wait until they get a trigger.

The trigger is voltage level sensitive. Whenever the input signal rises to a certain preset voltage, you get a trigger and the sweep beings. While the sweep is running, you hold off all further triggers until the sweep is over. This way, the sweep begins at the same point on every waveform. Each successive repetition of the signal is displayed on screen precisely on top of the previous occurrence. The result is seen by the human eye as a stable display. Sounds simple doesn't it.

But wait a minute. Where do we get the trigger signal from? What does hold-off mean? Do I really need to worry about trigger coupling? What about slope and level?

As I mentioned earlier, the triggering circuits are voltage level sensitive. You preset the level and as soon as the signal you're triggering on rises through that level, a trigger pulse is produced. However, what goes up must come down. This is as true of electronic voltages as it is of airplanes. Consequently, every signal passes through the trigger level setting twice; once on the way up and once on the way down. If you want to see a stable on-screen display, the trigger circuit has to select one of these crossings and ignore the other. This is done with the slope control. If you want the trigger to occur on the rising edge of the signal you select positive slope. Selecting negative slope causes the trigger to occur on the falling edge of the signal.

Next, you need to tell the trigger circuits where to get the signal from. If you only have a single channel scope, this is no problem. If you have a dual channel scope, now you need to make a choice. Should the trigger come from channel one or from channel two. Most scopes also give you the option of triggering off of some external source that is independent of the input signals. A third input is



100 MHz scope
Slow Writing Speed

100 MHz scope
Faster Writing Speed

Fig. 7. Writing speed is the rate at which the CRT can record a signal without having breaks in the trace. An oscilloscope may have sufficient bandwidth to accurately display a signal but, if the writing speed is too slow, the trace will not be readable with the naked eye.

provided for this purpose.

Finally, most scopes also allow you to select the 60 Hz power line voltage as a trigger source. There, now you have four separate sources to choose between for your trigger source; channel one, channel two, line or external.

See, it's starting to get complicated, but we're not finished yet. Once you've selected the source, the next thing you'll need to do is decide how to couple it over to the trigger circuit. D.C. coupling will hook it up directly. A.C. coupling will insert a D.C. blocking capacitor in the signal path. This is useful when you want to trigger on pulses or waveforms that are sitting on a D.C. level

Finally, we've selected a trigger source and decided on how to couple it to the trigger circuit. We've set a trigger level and picked which slope we want the trigger to occur on. We should now get a trigger and a nice bright stable display but suppose we don't. Suppose we did something wrong. Suppose we set the trigger level too high and the signal never passes through it, or we picked the wrong source by mistake. Then, the electron beam patiently sits at the left hand side of the screen waiting for a trigger and there we sit, dumbly looking at a blank screen; no trigger, no sweep.

This mode of operation is call NORMAL. Normally, it's expected that you'll be able to find a trigger and get a trace. This is not always the case however. Often, you want the time base to free-run when there's no input signal. This will give you a baseline. This is useful because the baseline represents a zero volt level. If you can see it, you can then position it to some reference graticule line before injecting your signal and making your measurement. Unfortunately, in the NORMAL mode, you need a trigger first to get the sweep running.

There are other times as well when you think you've done everything right and you still don't have a trigger. Once again, it's useful to have a mode where the time base free runs in the absence of a signal just so you can see whether or not something is there.

This free run feature is built into most oscilloscopes and is called AUTO mode. The Auto Baseline circuit sits waiting and looking for triggers. If it doesn't see a trigger within a preset time period - typically 100 msec - it then puts out a signal that causes the time base to free run.

Scope users generally leave the instrument in AUTO most of the time. One word of caution however. In Auto, the scope won't properly trigger on signals slower than 10 Hz. When the signal is slower than this, the Auto Baseline circuit is fooled into thinking it isn't getting any triggers and will automatically free run the sweep. To get stable triggering on very slow signals, you'll need to put the scope back into NORMAL mode.

Well, that pretty well covers triggering - almost. Actually, modern scopes carry things a little bit further.

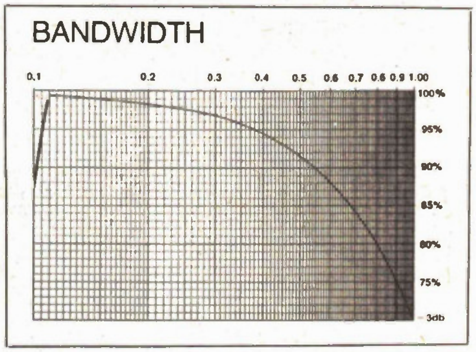


Fig. 8. Bandwidth is the frequency at which a scope can display a sine wave with a 30% reduction in signal amplitude with respect to a known standard.

They give you three more trigger convenience features that used to be found only in very expensive scopes.

The first of these is an automatic trigger source selector called *VERTICAL* mode. With the trigger source set to this position, the scope automatically picks whichever channel it is looking at as the trigger source. You no longer need to worry about trigger source; the scope chooses for you. This even works when the vertical system is automatically alternating between two totally dissimilar input signals. The trigger source will also automatically switch back and forth and you'll always be triggering on the signal that happens to be going to the CRT at that instant. This is a very handy feature that allows you to view two asynchronous signals simultaneously.

The next convenience feature is an enhancement to auto mode. It is an auto trigger circuit that detects the amplitude of the incoming signal and then adjusts the sensitivty of the trigger level control so that it just matches the amplitude of the incoming signal.

If you have the trigger level control set to the middle of the range, the auto trigger circuit will do the rest and you won't need to concern yourself with setting the trigger level.

These two convenience features, vertical mode and auto trigger level, allow you to have totally hands off triggering for most measurements.

The third convenience feature is very useful for triggering on digital signals.

Trying to trigger on digital signals is not as easy as it may appear at first. Remember, the trigger is a voltage level sensitive circuit. Digital pulses however, are all the same amplitude. Every digital pulse looks pretty much the same as every other one. The information they convey is contained in their sequence, or time pattern, and not in their amplitude.

The problem with this is that conventional scope trigger circuits have no way of telling the difference between different pulses. To solve this problem, modern scopes have a *variable holdoff* control added to the trigger circuit. With this control, the user can vary the length of time that the timebase locks out all further triggers. If you set this control properly, you can make the scope ignore all those pulses you're not interested in and then time the inhibit so that it is taken off just prior to the pulse of interest. In this manner, you can force the scope to trigger on the pulse of interest every time.

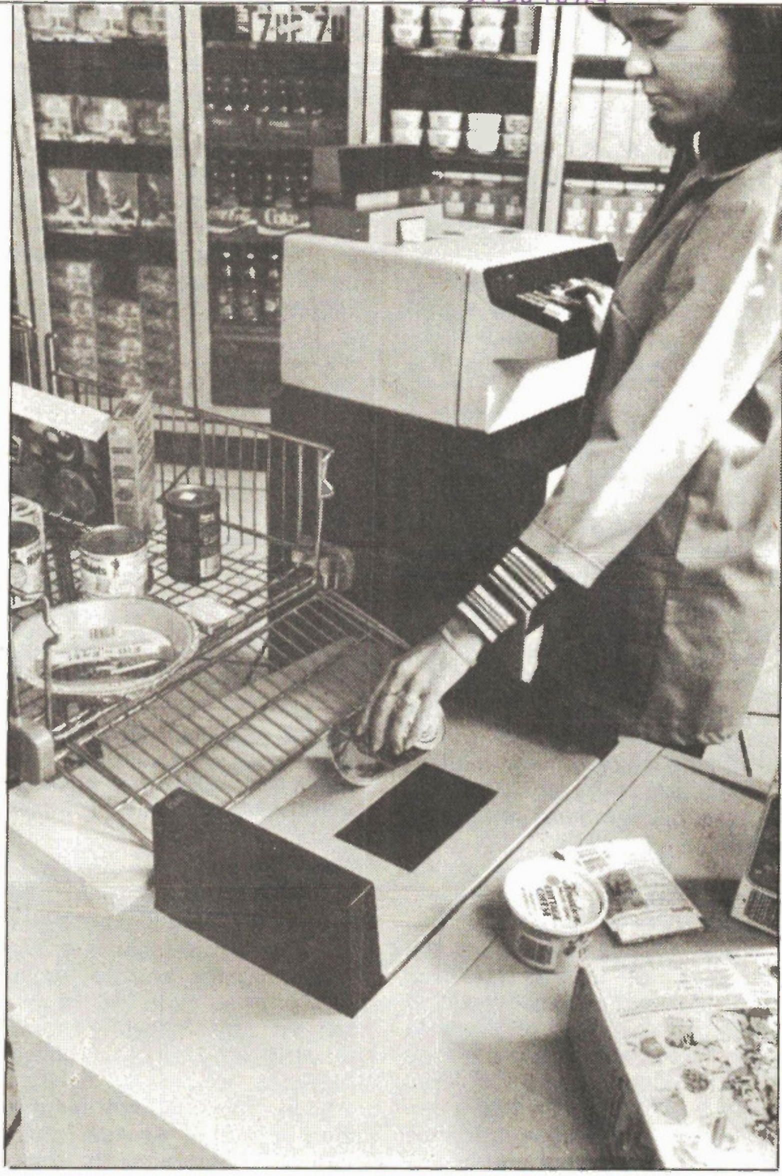
The new scopes give you Vertical Mode source switching, Auto Trigger Level and Variable Holdoff. In addition, because they're higher frequency scopes, you'll usually get better triggering than you would in a lower frequency scope.

Finally, a few qualitative words about triggering. Good trigger circuits are not easy to design and build. Where scopes typically start running into trigger difficulty is at high input frequencies. A good scope should trigger well past its rated bandwidth. Actual trigger quality is difficult to specify. If possible, try out the scope before buying it. Give it a signal at its rated bandwidth and check for good solid triggering.

ETI

UPC Codes

The hidden mysteries of the little computer box that appears on everything we eat, wear, read, plug in, turn on or rub into our bellies will now be explained by Roger Allan



THE UNIVERSAL PRODUCT CODE, or UPC, with its machine readable symbol is the basic element which has permitted something akin to a revolution in the process of retail marketing.

With the electronic scanning system, manufacturers, wholesalers and retailers are able to derive a number of benefits previously expensive or impossible to obtain about their products; product movement, inventories and marketing information to assist manufacturers in product testing and future marketing.

While many of the benefits are internal to the company, most are obtainable at the point of retail sale. As the items are presented to the checkout clerk, they are passed over an optical scanner, which reads the symbol. The scanner decodes the symbol into the UPC code number and transmits this number to a computer where the price and other information on store items are programmed.

This computer automatically sends back to the checkstand information on the item's price and description. The point of sale terminal or cash register, which is part of the system, displays the product's price and description and prints them onto the register tape. Often, retailers will use a 12-character description on each coded product to program into the computer for this tape printout. Also fed into the terminal automatically is information on taxability, etc.

As a part of this same operation, the computer captures and stores item movement information. The system's ability to capture data on every scanned item and the related total transaction gives the computer information that can be used in a wide variety of control reports. These reports have recently been used as the basis of in-depth market research studies.

Reports also assist in areas of inventory control, automatic resupply, linear footage analysis, *per capita* sales, etc. Coupon usage can be tracked automatically by item, and the price changes can be made by a simple data update in the computer.

Because it is possible to scan and bag an item faster than it is to enter department and price information on a keyboard, the checkout operation is speeded up, as well as being made more accurate and fully recorded.

The version of the UPC symbol most commonly encountered by the consumer in Canada is the Canadian Grocery Product Code (CGPC). It is an 11-digit, all-numeric code that will identify the consumer package and/or the shipping container. The code consists of a number character, a 5-digit manufacturer identification number and a 5-digit item code number.

The first position in the 11-digit CGPC code, the number system character, serves to 'key' the other numbers as to meaning, as well as category. Currently, there are three categories of the number system in use in Canada:

0 denoting regular grocery items
2 denoting random-weight items such as meat and produce
5 denoting coupon items

The next five digits are the manufacturers identification number assigned by the Grocery Products Manufacturers of Canada for products manufactured in Canada or imported products sold in Canada only.

The final five digits are assigned and controlled by the member company. The item codes, as they are called, are unique for each consumer package and/or shipping container.

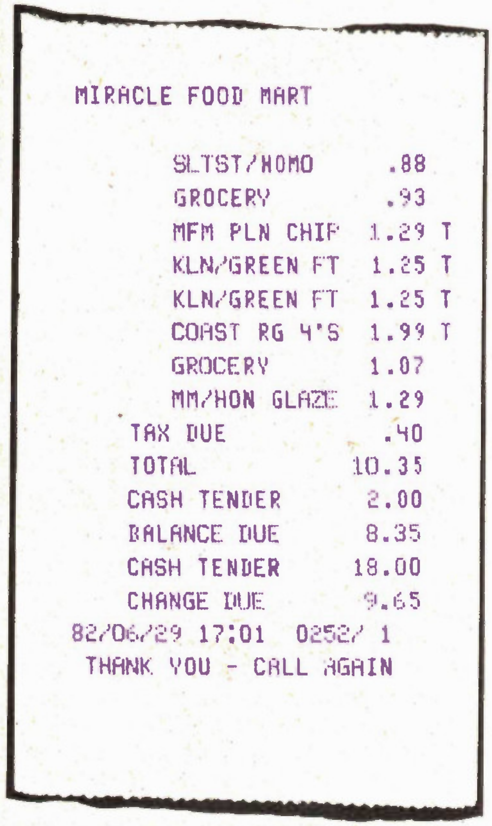
There are other versions of the UPC code. One, the European Article Numbering System used in Europe, Japan and Australia differs from the CGPC in that it has two number system characters.

Printing

The size of the bar code and numbers is variable to accomodate various packages. Tolerances, however, usually have to be exact, with a nominal size of 1.020" high x 1.469" wide. The symbol can vary from 80% of nominal to 200% of nominal. If the symbol is at 80% of nominal size the tolerance in printing is .0104" while at 120% nominal the tolerance is .0156". This requires printing of the masters and on the packages of a very high order. Further, the readability of the bar codes must be increased to the maximum level by the use of contrasting colors. While any combination of colors that will yield the reflectance and print contrast specified by the manufacturers can be used in general, light colors (yellow, pink and particularly white) are used for the background, while dark colors (dark blue and dark shades of green but particularly black) are used for the bars. Other factors, including overwrap of the symbol, some background colors, over-printing and package material may effect clarity.

There are a number of companies which manufacture UPC reading devices; Hanat, NCR, etc. Perhaps the state of the art is the IBM 3687 scanner which uses holography to read UPC information on standard and irregularly shaped articles. By reducing the need for precise alignment of merchandise as it is scanned, this device simplifies checkout operations and can help speed customer service.

Due to its general usefullness, and despite initial customer wariness, scanning is now gaining wide acceptance. As of the end of 1980, the last year for which figures are available, the Food Marketing Instititute in the United States reported that 1,472 supermarkets were equipped with scanning systems. Most significantly, almost 900 had been installed in 1979 alone.


MIRACLE FOOD MART

SLTST/HOMO	.88	
GROCERY	.93	
MFM PLN CHIP	1.29	T
KLN/GREEN FT	1.25	T
KLN/GREEN FT	1.25	T
COAST RG 4'S	1.99	T
GROCERY	1.07	
MM/HON GLAZE	1.29	
TAX DUE	.40	
TOTAL	10.35	
CASH TENDER	2.00	
BALANCE DUE	8.35	
CASH TENDER	18.00	
CHANGE DUE	9.65	

82/06/29 17:01 0252/ 1
THANK YOU - CALL AGAIN


MIRACLE FOOD MART

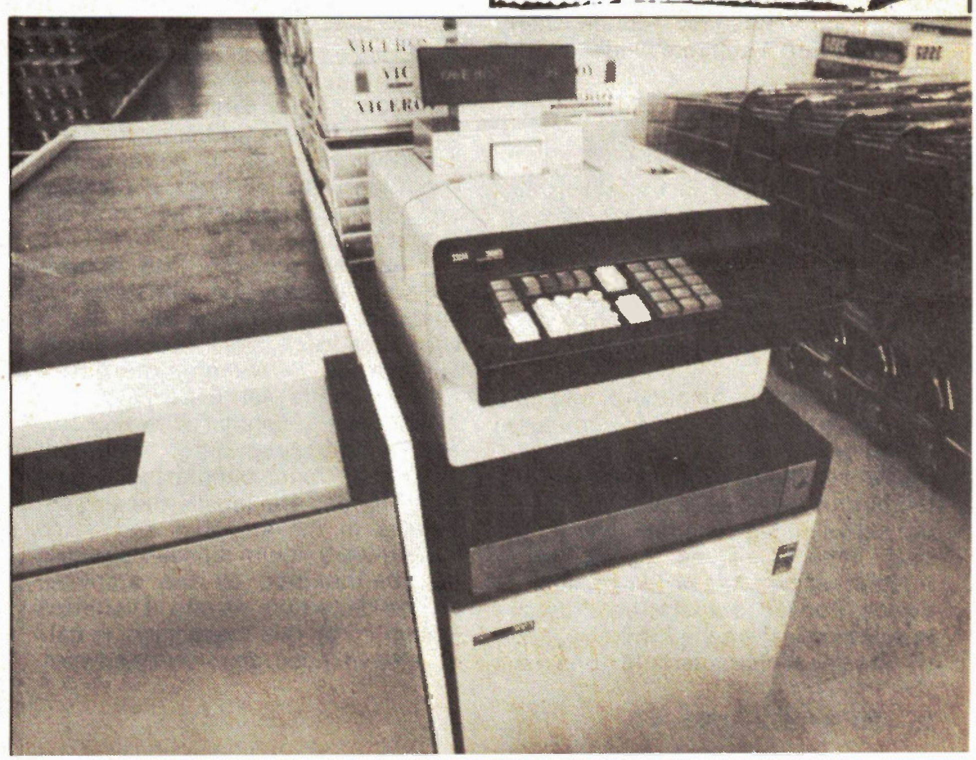
PRODUCE	.98	
	.480KG	
@1.96/KGPEAC	.94	
MM/XLGE EGGS	1.29	
SLTST/HOMO	.88	
BOUNCE/40S	3.99	T
SUNLIGHT DET	2.67	T
TAX DUE	.47	
TOTAL	11.22	
CASH TENDER	15.00	
CHANGE DUE	3.78	

82/06/29 17:00 0252/ 1
THANK YOU - CALL AGAIN


MIRACLE FOOD MART

SFR CAULIFLW	1.79
DOWN/WAFFLES	1.05
SAL/TEA BAG	1.79
TAX DUE	.00
TOTAL	4.63
CIG LG KG PK	1.62
TAX DUE	.00
TOTAL	6.25
CASH TENDER	10.00
CHANGE DUE	3.75

82/06/29 17:06 0252/ 1
THANK YOU - CALL AGAIN



150 Watt Amp

Here's a high power, general purpose power amplifier module for guitar and PA applications employing rugged, reliable MOSFETs in the output.

THE CIRCUIT USED in the MOSFET Power Amp is a development from one published in the Hitachi application notes for these MOSFETs. The original circuit used very high-gain bipolar driver transistors developed especially by Hitachi for use as MOSFET drivers. Unfortunately these devices are at present unavailable in Canada. Since these are an extremely fast device, replacement by more common bipolars limits the open loop bandwidth and causes the amplifier to be unstable. The main departures from the Hitachi circuit are therefore to ensure a stable design with common transistors.

We used a complementary video output pair as drivers, supplying good slew rate and V_{CEO} figures at a reasonable price. The resulting power amp module is fast and stable, with distortion figures completely adequate even for many high fidelity applications. The module is easy to construct and capable of withstanding continued clipping or full-power operation for extended periods when provided with a suitable heatsink.

Why MOSFETs?

The power MOSFET is a relatively recent development and offers several distinct advantages over the more common bipolar transistor. To understand these differences it is helpful to look at some of the characteristics of bipolar output transistors.

Most power amplifiers employ bipolar transistors in a common-collector or emitter-follower configuration. The relationship betweeen the output signal voltage and the input signal voltage is a function of the load impedance and the forward transfer admittance of the particular device. Forward transfer admittance is commonly given the symbol y_{fs} and its non-linear characteristic gives rise to distortion in the output stage. With bipolar transistors, the greatest non-linearity occurs for low input voltages, typically between 0V and 0.6V. Once outside this voltage range the forward transfer admittance is high and quite linear. So most of the distortion generated in a bipolar output stage occurs at low signal voltages and is called crossover distortion.

The most common method used to overcome this problem is to make use of bias current. A fixed voltage of around 0.6V is applied to the bases of the output transistors so that the applied signal voltage does not have to operate the transistor over the most non-linear region. However, a problem arises with this technique because this voltage must be controlled extremely accurately. Even 0.5V in excess of the correct voltage will saturate the output devices, probably destroying them. Furthermore, as the output devices heat up due to normal operation, the bias voltage must be decreased to maintain the same operating conditions. This is very difficult to do accurately enough, so the power amp is often running either with insufficient bias current or is dangerously close to destruction.

The problem occurs because the bipolar transistor has a positive temperature coefficient. This means that as the temperature of the device is increased the collector-emitter current will increase if the base-emitter voltage is held constant. The increased current causes further heating and a further increase in current. This condition is called thermal runaway and results in the destruction of the output device.

Another problem with conventional bipolar output transistors is speed. The techniques used in the construction of these devices to ensure broad SOAR characteristics (SOAR stands for Safe Operating ARea) usually conflict with those to ensure high speed. Since the output transistors must handle the largest currents they are usually the slowest devices in the amplifier and determine the maximum signal slope that can be handled by the amplifier before distortion results. Distortion generated by this mechanism is called *slew-induced distortion* and *transient inter-modulation distortion*. Once unnecessarily high signal slopes have been removed by a suitable filter at the input of the power amp the only solution is to increase the slew rate of the output devices.

One of the major advantages of power MOSFETs is their extremely high speed. When driven correctly the MOSFETs used in this project can switch a current of around 2A in 30 nanoseconds! This is roughly 100

SPECIFICATIONS

Power output
150 W RMS into 4 ohms
100 W RMS into 8 ohms
(at onset of clipping)

Frequency response
20 Hz to 20 kHz, +0 −0.5 dB
10 Hz to 60 kHz, +0 −3 dB
(measured at 1 W and 100 W levels)

Input sensitivity
1 V RMS for full output

Hum
−98 dB below full output

Noise
−114 dB below full output

Total Harmonic Distortion
0.006% at 1 kHz
0.03% at 10 kHz
(measured at 12 W level)

Stability
Unconditional — tested to full output driving 3.5 uF short circuit at 10 kHz.

times the speed of commonly available bipolars. Another advantage of MOSFETs is their very high input impedance. Unlike the bipolar transistor, they are a voltage-controlled device and require only enough drive current to overcome their input capacitance. Probably their most important advantage over bipolar transistors, however, is that they have a negative temperature coefficient. Heating causes an increase in the resistance of the device, so MOSFETs are inherently self-protecting. If one part of the device attempts to conduct more current it heats up more than the surrounding region, increasing its resistance, which distributes current over the rest of the device. Similarly if several devices are used in parallel, the negative temperature coefficient will ensure that all devices share current equally. In guitar and PA applications the negative temperature coefficient of MOSFETs provides the amplifier with unprecedented reliability, and the high speed helps to eliminate the problem of slew-induced distortion.

On the other hand a disadvantage with MOSFETs arises from their relatively low forward transconductance when compared to a good bipolar transistor. Although the transconductance of bipolars is highly non-linear when the base emitter voltage is below 0.6V, it increases dramatically once outside this region. The MOSFET, although not as non-linear for small voltages, never achieves the forward transconductance of the bipolar transistor. The distortion generated by the power MOSFETs is therefore higher than that of bipolar transistors and must be reduced to acceptable limits through the use of negative feedback. This is not a real problem, however, since the high input impedance eliminates at least one stage of a conventional bipolar amplifier design. This allows a simpler circuit with fewer active devices and consequently improved stability margins, allowing greater levels of overall negative feedback before oscillation results.

Construction

Construc.'on of the MOSFET Power Amp is relatively simple, since all the components mount on the pc board, including the output transistors and power supply components. The design of a good pc board pattern is often as difficult as the design of the original circuit! This is especially true for power amplifiers or any circuit in which both large and small currents are involved. The problem of large currents occurs because of voltage drops across ground return paths, destroying the integrity of ground reference points for small signal currents. To overcome this problem, the pc board must be designed to ensure the validity of the grounding arrangement. If at all possible, the pc board published should be used, as departures from this design could seriously affect amplifier performance.

Commence construction by soldering all the resistors onto the circuit board with the exception of the four OR22 output resistors. These effectively connect all the sources of the MOSFETs together and make it difficult to locate faults in the mounting of the MOSFETs. Solder the 1W resistors slightly above the circuit board since these can become hot under certain conditions. The components marked with an asterisk on the circuit diagram are mounted on the rear of the pc board. They should be mounted close to the MOSFETs. Do not solder the resistors to the rear of the circuit board at this stage. These are best left until after the MOSFETs have been mounted.

Solder the capacitors onto the circuit board with the exception of those on the rear of the board and the two large electrolytics. The 100u capacitor C3 is the only other electrolytic, so be careful with the orientation of this component. The capacitor is marked to indicate which of its leads are to be connected to a positive or negative voltage. Check the correct orientation on the overlay diagram. This also applies to the diodes and zener diodes used in the circuit, which can be mounted next.

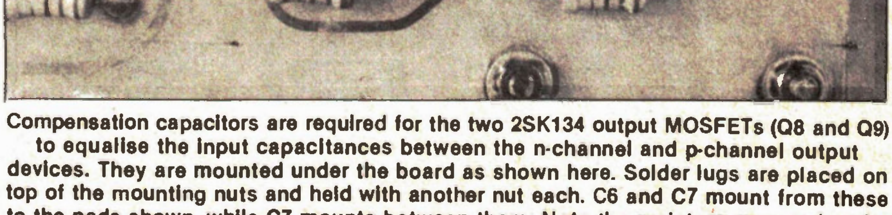
Both the driver and power transistors are mounted on a length of aluminium angle extrusion, which is bolted to the pc board by bolts through the transistor mounting holes. This is shown in the accompanying diagrams. The extrusion is used to conduct the heat generated by the output and driver transistors to the heatsink, which will also be bolted to the extrusion. Drill all the necessary holes before proceeding further. Make certain the holes are free of burrs of shavings that might otherwise cut through the transistor insulating washers. This is best done with a couple of twists of an oversize drill (i.e., around 13mm diameter).

The bolts holding the MOSFETs in place also serve to make electrical connections to the cases of the devices. These bolts must be insulated from the heatsink bracket,

HEATSINKING

The heatsink will need to dissipate around 100 W when the module is run at full output for lengthy periods. A heatsink with a thermal capacity of around 0.65°C/watt is recommended if free-air cooling is contemplated. A 152 mm length of Philips 65D6CB will do nicely (cost—around $30).

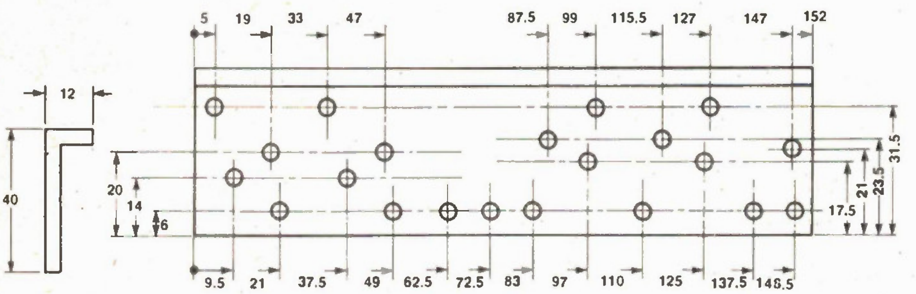
If fan-forced cooling is contemplated, then a heatsink rated at 1.2 to 1.5°C/watt should be used. A 225 mm length of commonly available extruded 'fan' type heatsink will do the job. This type of heatsink is flat on one side, the other side having two sets of fins fanning out from a central channel. A suitable length will set you back about $10. A fan will set you back around $20 to $30, unless you have one lying around.



Compensation capacitors are required for the two 2SK134 output MOSFETs (Q8 and Q9) to equalise the input capacitances between the n-channel and p-channel output devices. They are mounted under the board as shown here. Solder lugs are placed on top of the mounting nuts and held with another nut each. C6 and C7 mount from these to the pads shown, while C7 mounts between them. Note the resistors mounted under the board also.

ALL 4 mm DIA.
MATERIAL 40 x 12 x 3 ALUMINIUM ANGLE EXTRUSION
Drilling details for the heatsink bracket assembly. All dimensions are in millimetres.

BRACKET DRILLING DETAILS



which will be at ground potential. This is done with the use of short insulating sleeves cut from a length of 'spaghetti' insulation. Use a small quanitity of heatsink compound on both sides of the transistor insulating washers to ensure good thermal contact. Insert the sleeves in the holes of the heatsink bracket and mount the four MOSFETs as shown in the accompanying diagram.

The four driver transistors can now be mounted. Again, use transistor insulating washers between the metal sides of the transistors and the heatsink bracket, although insulating sleeves are not necessary.

Once all the transistors have been mounted on the heatsink bracket use a multimeter to check for any short circuits to the heatsink bracket by measuring the resistance from the case of each MOSFET, and from the centre lead of each driver transistor, to the bracket. The measurements should show open circuit on all transistors. If a short does exist the transistor should be removed and remounted, possibly with a new insulating washer. Finally, solder the leads to the transistors.

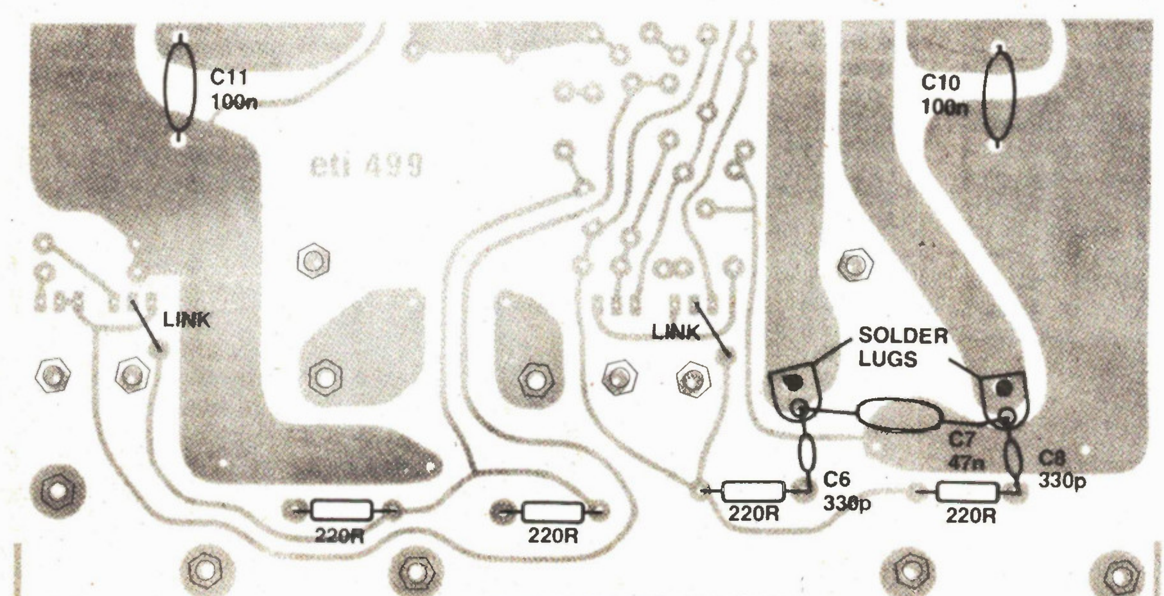
Once the MOSFETs and drivers have been mounted, the remainder of the components can be mounted on the pc board, including the small signal transistors and the components on the rear of the pc board. Mount the two 8000u electrolytic capacitors last. Mount the four OR22 resistors now, leaving around 5mm between the resistor and the board. Ensure that all components mounted on the rear of the pc board are mounted close to the board with their leads cut as short as possible.

The output inductor, L1, is formed by winding 20 turns of 0.8 mm enamel wire around a 14 mm former.

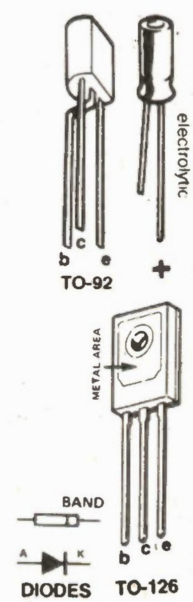
Powering up

Supply fuses have not been included on the pc board because the resulting resistance necessitates the use of a second set of electrolytic capacitors close to the output devices. To protect the loudspeakers in the case of failure of the power amp a fuse should be used in series with the loudspeaker cable.

Before powering up check all stages of construction, including the orientation of all polarised components. Check that no shorts exist between the cases of the output devices and the heatsink bracket. Mount the heatsink bracket to a suitable heatsink, again using heatsink compound to ensure good thermal contact. Do not connect a loudspeaker at this time. Adjust RV1 to centre and RV2 fully counterclockwise, as viewed from the positive rail side of the pc board. If all is in order, connect the module to the power transformer and switch on. Using a multimeter on the 1V range, adjust RV2 so that the voltage between the ends of RV2 reads 0.8V. Now adjust RV1 so that the voltage between the output terminal and ground is as close to zero as possible. Ideally, a digital multimeter should be used for this measurement since most analogue meters do not have the necessary resolution. Adjust TV1 to achieve a dc voltage on the output of less than 10 mV, if possible. If your multimeter does not allow measurement of voltages this small, leave RV1 set at the centre position. When both of these adjustments have been made, the module is ready for operation.



TRACK SIDE OVERLAY DIAGRAM



PARTS LIST

Resistors (all ½W, 5% unless stated)

R1,2	100k
R3,11	1k
R4,5,18-21	220R
R6,7	3k9
R8	22k
R9	680R
R10	10k
R12,15,16,17	100R
R13	33k
R14	10k 1W
R22-25	0R22 W
R26	4R7 1W
R27	1R 1W
RV1	100R preset
RV2	250R preset

Capacitors

C1,9	220n greencap
C2	2n2 greencap
C3	100u/25V electrolytic
C4	33p ceramic
C5	6n8 greencap
C6,8	330p ceramic
C7	47n greencap
C10,11	100n greencap
C12,13	8000u/75V electrolytic

Semiconductors

Q1,2,3	BC546
Q4,5	BF470
Q6,7	BF469
Q8,9	2SK134 Hitachi MOSFET
Q10,11	2SJ49 Hitachi MOSFET
D1-4	1N914
D5-8	1N5404
ZD1,2	12V 400mW zener

Miscellaneous

pc board; plastic bobbin; 5 A fuse (speaker fuse, not mounted on pc board); fuse holder; 1m of 0.8mm enamel-covered copper wire; 155mm length of aluminium extrusion, 40mm x 12mm, for use as the heatsink bracket; assorted nuts and bolts, hookup wire, etc; two solder lugs.

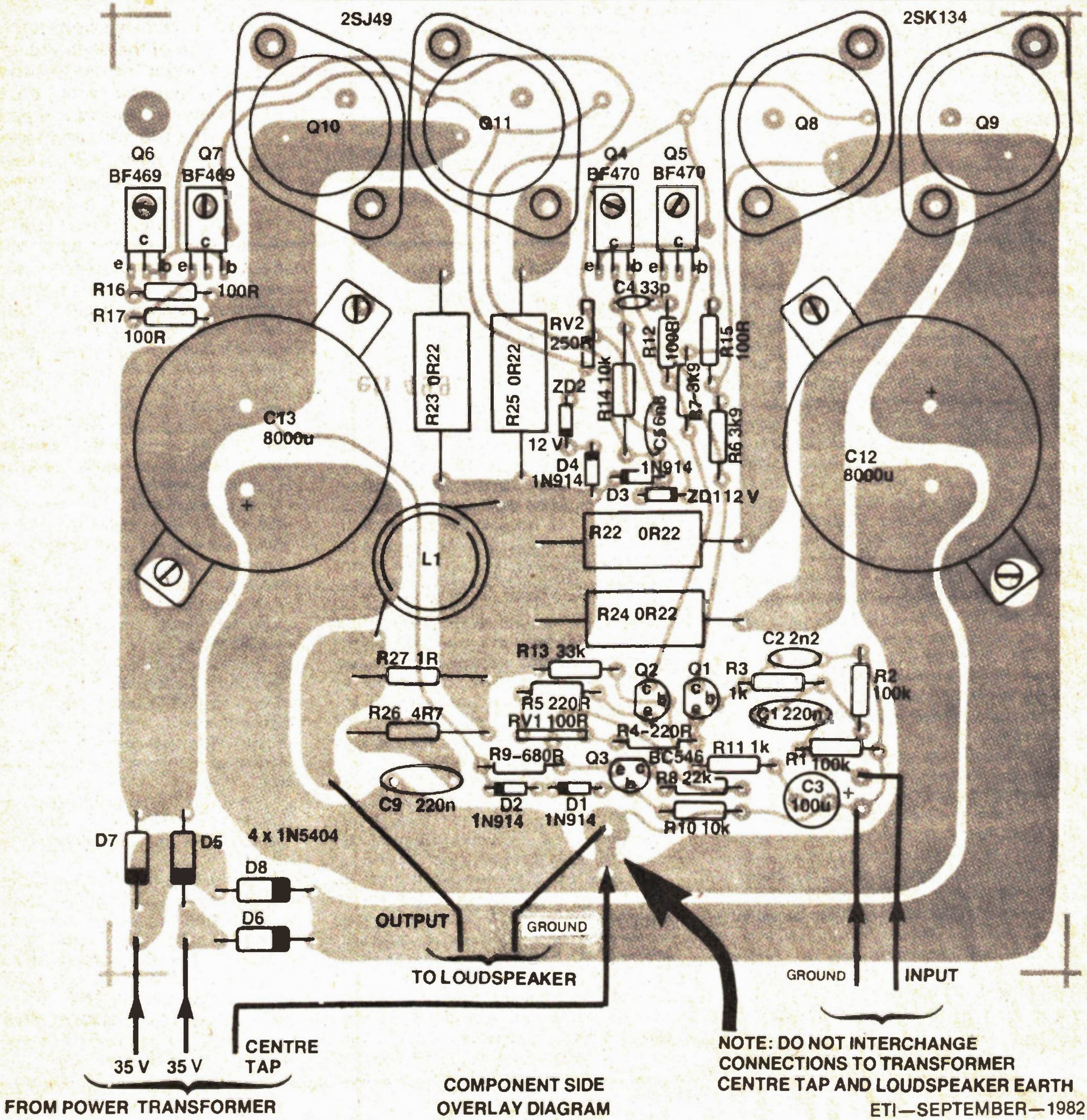
BUYLINES

The tricky bits are the semiconductors. The bipolar transistors, as you may have noticed, have rather unusual numbers. These are European parts, as there just aren't suitable 2N types to do the job (that don't cost a fortune and come in 1000 lot minimums). However, Philips of Canada assures us that all Philips distributors carry these little fellows, or can get them. Readers are urged not to try to substitute these transistors.

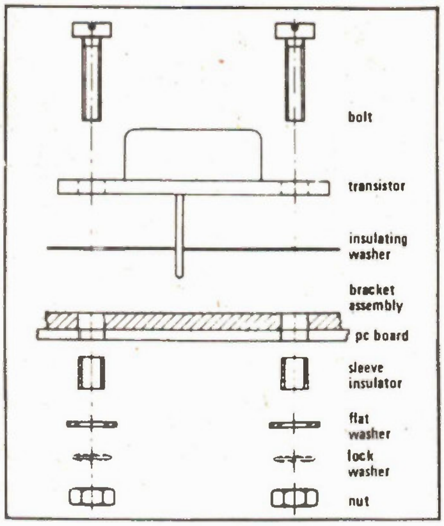
The output devices have been specially imported for this project by our friends,

Altair Electronics
660 Progress Ave.,
Kingston, Ont.
K7M 4W9

Readers having dificulty finding these transistors may contact us for a list of Philips distributors. This list will also be on the Bull.



COMPONENT SIDE OVERLAY DIAGRAM



Exploded view of how to mount the output devices to the bracket and pc board.

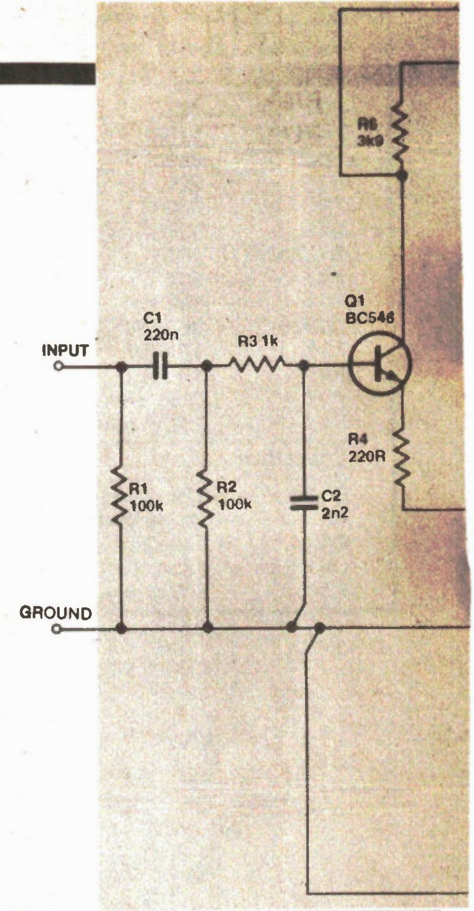
Performance

We have tested the prototype into both inductive and capacitive loads and at all times it performed impeccably. The sound is clean and smooth with no sign of the harshness sometimes experienced with transistor power amps. The high speed of MOSFETs helps to ensure freedom from slew-induced distortions and the amp clips cleanly with no sign of instability.

SOME CAPACITORS AREN'T . . .

For the R26-C29 network to provide an effective high frequency load to the output stage it is imperative that C9 (220n greencap) have low self inductance. From experience, we have found Elna type greencaps and Philips polycarbonates meet this requirement. High frequency instability, if not outright oscillation, may result if this requirement is not met.

To a lesser extent, the same applies to C7, C10 and C11. Note that C7 ac-couples the sources of Q8 and Q9 together, so that the self inductance of the source ballast resistors R22 and R24 is no longer important, preventing high frequency instability in this section of the output stage brought about by the inductance of the wirewound ballast resistors.



HOW IT WORKS

The circuit is a development from one published in Hitachi's application notes for these MOSFETs. The original circuit uses driver transistors designed by Hitachi for use as MOSFET drivers. Unfortunately these devisces are not available at the present time, so most of the differences are to ensure stability and low distortion with a more readily available driver. We have used the BF469, BF470 complementary video output pair. These transistors provide the necessary speed so as not to degrade the performance of the output transistors.

One of the most difficult stages in the development of an amplifier module of this type is the pc board design. Separation of the large currents flowing to the electrolytic capacitors from signal ground is absolutely imperative if low distortion is to be obtained. An earlier pc board using exactly the same circuit gave distortion figures as high as 1% when driven into 8 ohms at around 10 W RMS! The problem was simply interaction between charging currents to the electrolytic capacitors and the ground reference to the input differential pair. For best performance use the pc board design published with this article and pay special attention to all ground and supply connections. In particular ensure that the connections to the centre point of the transformer and the loudspeaker ground are soldered into the correct positions on the pc board. Although these two points are immediately adjacent on the pc board they are not equivalent electrically due to the slight resistance of the board. If these wires are connected the wrong way around the distortion will be increased possibly by as much as 20-30 dB!

Transistors Q1 and Q2 form an input differential pair. Their function is to compare the output signal with the input signal and drive the voltage amplifier transistors in the driver stage with the necessary correction signal, sometimes called the error voltage or error signal. The base of Q1 is held at ground potential by resistor R2. Capacitor C1 in conjunction with R2, R3 and C2 forms an input filter, which defines the upper and lower 3 dB points of the amplifier. This filter therefore restricts the maximum possible signal slope capable of being driven to the input of the differential pair. This is an essential function since it eliminates slew-induced distortions such as TIM, provided that the rest of the power amp has a slew rate in excess of this limit.

The gain of the differential pair is around 17, so most of the open loop gain is done by the driver transistors Q4 and Q5, and their associated current mirror formed by Q6 and Q7. The series RC network C4, R12 ensures stability of the amplifier by decreasing the gain of the driver stage at very high frequencies, while keeping the phase shift produced within 90°.

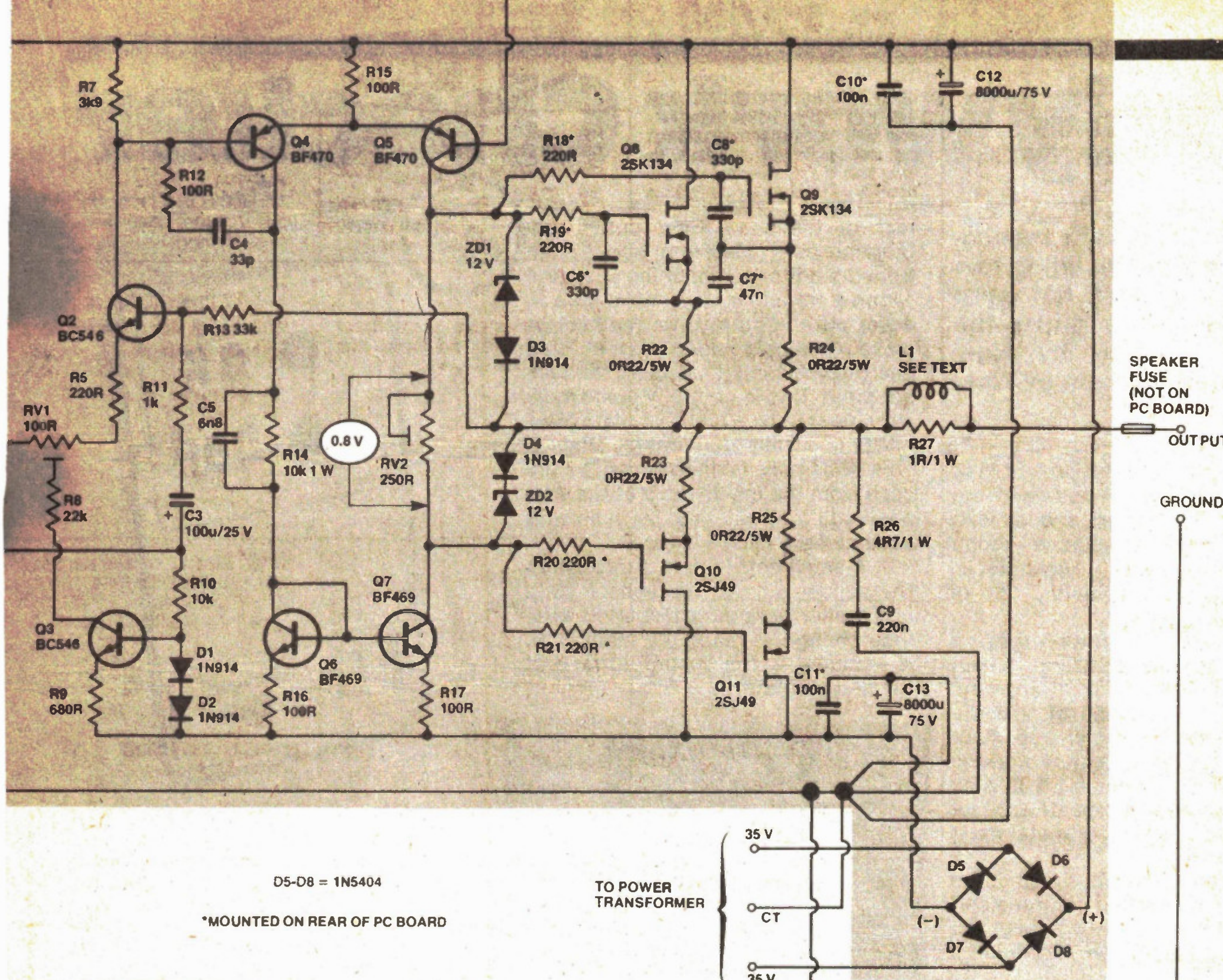
As stated above, transistors Q6 and Q7 form a current mirror. The purpose of these devices is to ensure the current through the two driver transistors remains identical. At the same time the very high impedance represented by Q7 on the collector of Q5 ensures high open loop gain, and consequently low distortion through the relatively large amount of negative feedback available. RV2 varies the voltage between the gates of the output MOSFETs and therefore the amount of bias current through the output transistors. If the voltage across this preset is set to around 0.8V the bias current will be approximately 80 mA, which is about right. If the bias current is decreased completely by turning RV2 fully away from the MOSFET end of the board, the MOSFETs will remain off until a signal is fed to the input. This is pure class B operation and results in the coolest operation of the power amplifier. The disadvantage, however, is that a slight increase in distortion, called crossover distortion, will result. In PA or guitar applications this is not a problem, so the amplifier can be used in this mode without hesitation.

The diodes D3, D4 and the zener diodes ZD1 and ZD2 ensure that the voltage between the gates of the FETs and their sources never exceeds 12.6 V, the most common cause of MOSFET failure.

Capacitors C6 and C8 equalise the capacitive input characteristics of the MOSFETs and make it considerably easier to correctly stabilise the output stage. Capacitor C7 brings the sources of the two 2SK134 MOSFETs to the same potential at high frequencies, and overcomes possible problems that might otherwise be caused by inductance in the source resistors R22 and R24.

The four resistors R22-R25 help to match the difference between the characteristics of the different output devices.

The passive filter network formed by R26, C9 ensures that the module always has a load at high frequencies. If the amplifier is tested with large high frequency sinewaves this resistor will become extremely hot, but this does not indicate a fault condition. The inductor L1 and the resistor R27 help to ensure total stabillity into capacitive loads, such as when driving extremely long loudspeaker leads.



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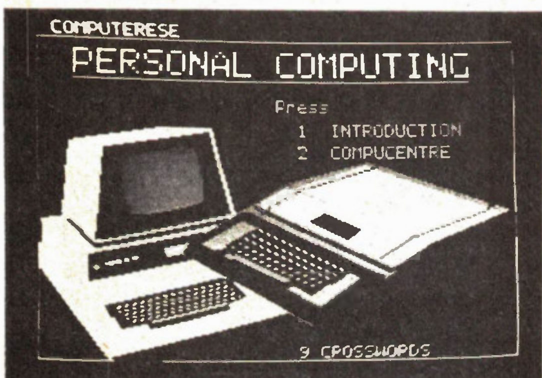


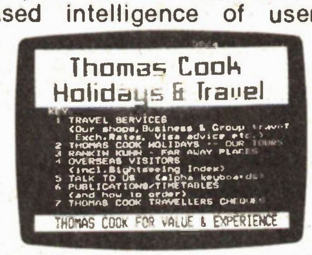
Continued from page 12

precedented abuses and benefits. On the one hand is the possibility of psychodramatic advertising. On the other hand, user statistics are proportionally related to the level of interactive videotex capabilities. User statistics define both the value and the worthlessness of the videotex medium.

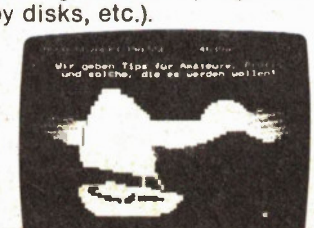
Interactive capabilities - The present level of information on videotex is of the simplest form and can be represented by the concept of menu and document pages. Menus provide the choices that lead you to the

TELIDON

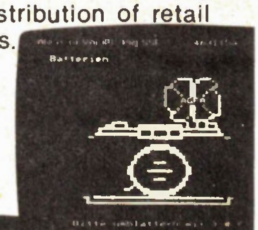
documents you desire. Usually these pages are completely new screens of information. Increased interactive quality is contingent upon the development of user statistics, the increased intelligence of user ter-



minals, the improvement of input devices (from keypads to full keyboards, graphics tablets, joysticks, etc.), output devices (printers, high resolution television) and storage devices (magnetic tape, floppy disks, etc.).



Telesoftware - Through the three generations of videotex we have witnessed a predominant trend to increased front end (user equipment) performance for a lower price. Telesoftware relates to the notion of using videotex to distribute computer programs. Telesoft would be similar to the benefits of traditional downloading. It transfers much of the processing tasks to the user equipment and provides an alternate method for the distribution of retail computer programs.



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Bodywork Checker

Don't go out and buy a second-hand car without building this handy little gadget. It'll point out any problems under the paintwork. Design by Rory Holmes. Development by Tony Alston.

THE PURPOSE OF THIS project is to help the selective second-hand car buyer detect the amount of body-filler used under well-disguised repair jobs. The unit gives a two-state indication of metal or plastic, ('OK' or 'BAD' respectively).

Our metal detector uses a capacitive sensing principle, which will detect the presence of any conductive object. Because of this the circuitry is much simpler and more reliable than metal detectors working on an inductive principle. It is also more suitable in this type of application where large areas of metal must be checked.

In use the device is switched on and lightly run over the car panels; if it runs over an area of body-filler the 'BAD' light will come on, otherwise it should read 'OK'.

Construction

The case is the most important part of this project as it is also part of the electronic sensing circuit. Take a careful look at the photographs of the finished project and you can clearly see the sensor area at the bottom rear of the case. First cut a rectangular hole (30x35mm) about 8mm from the bottom edge of the case and 14mm from either side; make sure to clean off any burrs from the hole. A piece of single sided copper clad board (24x30mm) is used for the sensor plate. This is centrally glued (copper side out) to a piece of plain plexiglass or similar material (35x45mm). This assembly is then glued to the case from the inside, so that the copper clad board will then be flush with case surface.

A small hole is drilled through to the copper side of the sensor plate and a short length of insulated wire, long enough to reach the main PCB, is soldered to the copper surface of the sensor plate.

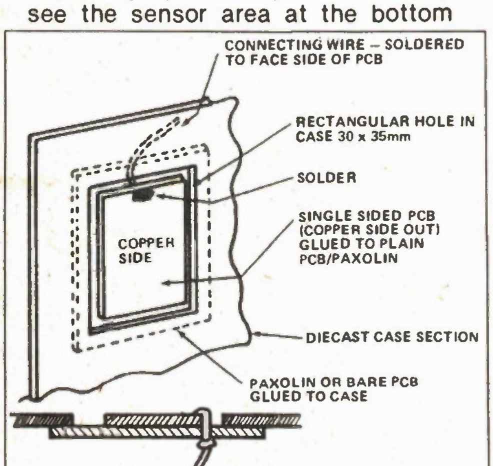
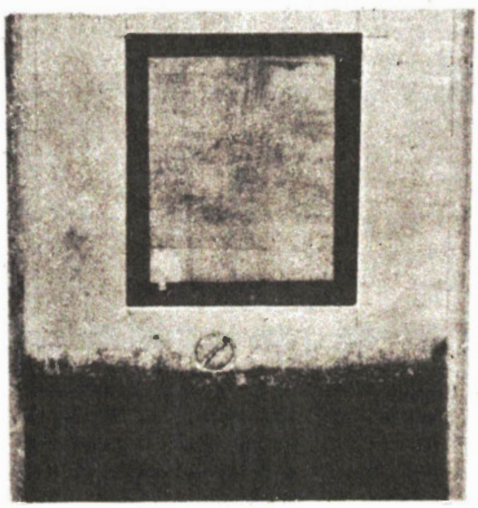


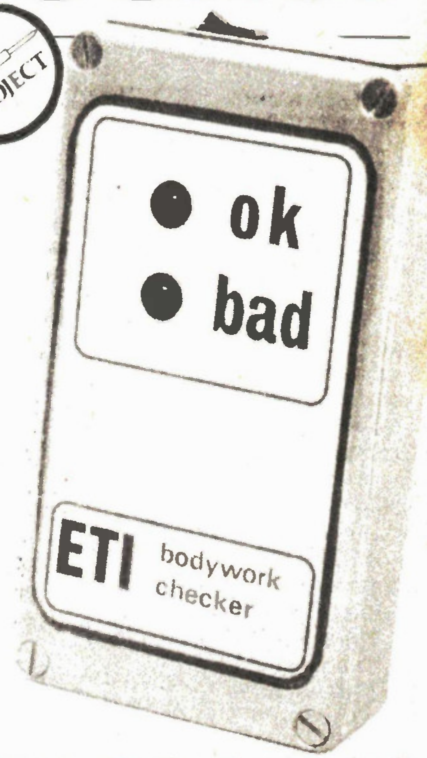
Fig. 1 This cutaway diagram shows the constructional details for the sensor plate.



With the protective felt peeled back to reveal the sensor, you can see how the fixing screws should be countersunk so they lie flush.

The components can now be assembled and soldered to the main PCB as shown on the overlay diagram, making sure to correctly orientate D1, D2, IC1 and IC2 and the LEDs. Make sure to fit the link adjacent to IC1.

A short length of insulated wire is connected from the PCB to a solder tag fixed to the case; make sure this is a good connection as it forms part of the detecting circuit. The connecting lead from the sensor plate is soldered to the main PCB as indicated. A further insulated lead is taken from this same point on the PCB and held against the side of the case by a piece of insulating tape to form a capacitive trimming circuit (see photograph and refer to the setting up procedure). The LEDs are directly mounted on the PCB and appropriate holes are drilled in the front case panel to allow these to pass through.



In the internal shot, note how the trimming wire is taped to one side of the case.

Finally, a piece of felt cut to size is then glued to the rear of the case, covering the sensor plate; this prevents the case from scratching the car bodywork and upsetting your friendly second-hand car dealer!

Setting Up

Setting up the circuit is straightforward; PR1 controls the detecting sensitivity and PR2 the metal/plastic switching threshold. When altering the presets bear in mind that replacing the case lid will slightly offset the adjustments, so replace the lid after each adjustment to check the effect.

Start with maximum sensitivity, i.e., set PR1 to its full resistance (counterclockwise). Then place the case, sensor side down, onto a non-conductive object. With the lid off, PR2 can now be adjusted until the switching threshold is found. When the 'OK' LED is on, back off preset PR2 until it just extinguishes and the 'BAD' LED comes on (indicating no metal). The unit can now be placed against a metal surface and the 'OK' LED should re-light.

The trimming wire capacitively couples a small degree of HF voltage into the detector, effectively altering the switching threshold. Its effect can be varied by trimming the length. By experimenting with this if necessary, together with PR1 and PR2, a suitable switching action can easily be found.

Note that the human body is a fairly good conductor; you can prove this by holding your hand against the sensor, when the 'OK' LED should come on. This resulted in one member of staff wandering round the office, checking out the female employees and reassuring them that all was well.

HOW IT WORKS

CMOS inverter gates IC2a and IC2b form a high frequency oscillator of about 150 kHz. This signal is connected directly to the case, which in turn is capacitively coupled via the sensor to the high-impedance detector circuitry based around IC1. This unusual way of screening the circuit prevents the user's hand from affecting the capacitance between the detector input and the 0V ground rail.

D1, D2, C1, and PR1 rectify the signal from the sensor and pass this voltage to the positive input of the op-amp, which is configured as a simple comparator. PR1 is used to set the input impedance and hence the sensitivity of the sensor. PR2 sets the switching threshold voltage on the non-inverting input to the comparator. When the coupling capacitance is increased, due to a conductive object lying across the case and sensor, the high frequency signal strength arriving at the detector will increase, raising the voltage on pin 3 of the comparator above the threshold, and switching the output from pin 6 fully positive.

IC2c, d are connected as a Schmitt trigger with R4 supplying positive feedback. This sharpens up the switching action coming from the comparator and further provides suitable drive signals for the two LEDs. These drive signals are buffered and current-limited by IC2e,f which power the LEDs. When metal is detected LED2 is lit and LED1 is off; the converse is true if metal is absent.

PARTS LIST

Resistors (all ¼ W, 5%)

R1	22k
R2	8k2
R3	100k
R4	8M2

Potentiometers

PR1	4M7 miniature horizontal preset
PR2	47k miniature horizontal preset

Capacitors

C1	4n7 disc ceramic
C2	470p polystyrene

Semiconductors

IC1	CA3140
IC2	4069B
D1,2	1N4148
LED1,2	5mm red LEDs

Miscellaneous

SW1 miniature rocker switch
Battery and clip; diecast case.

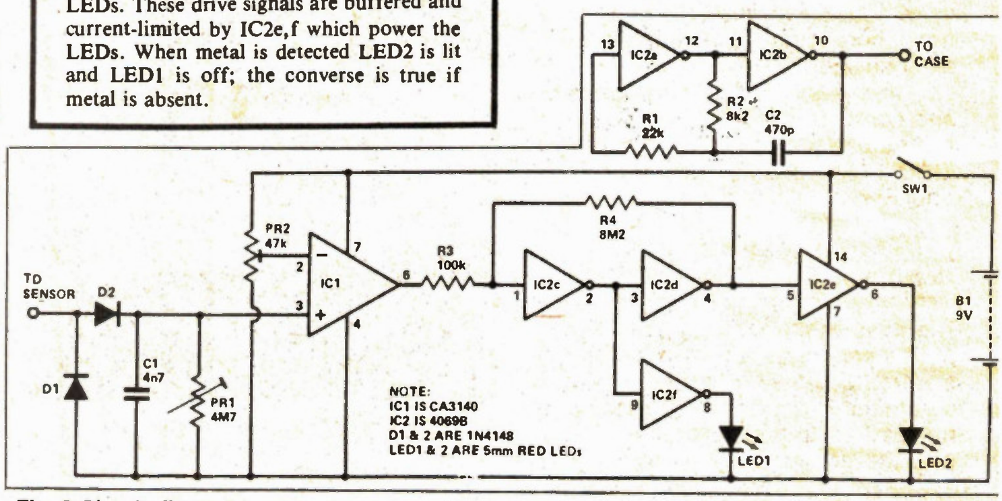


Fig. 2 Circuit diagram.

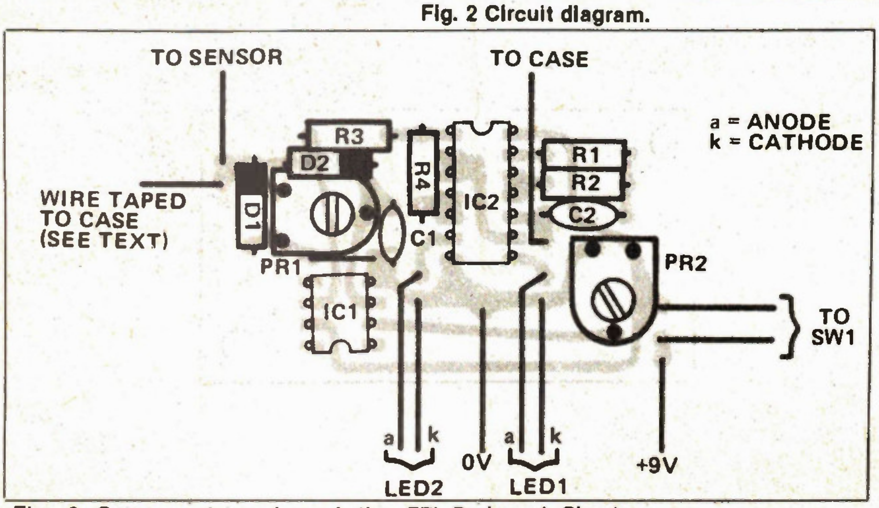
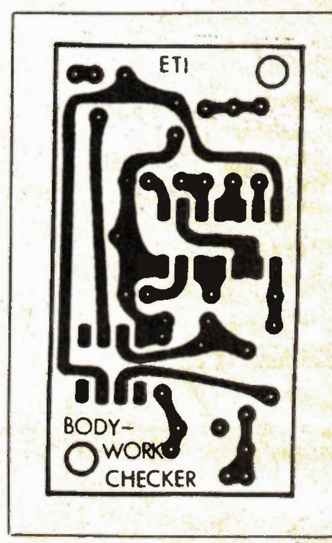


Fig. 3 Component overlay of the ETI Bodywork Checker.



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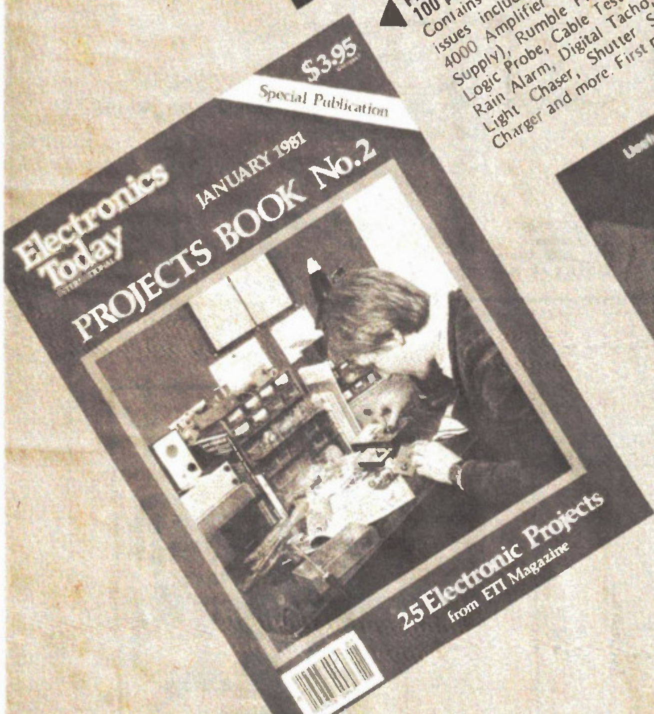

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Into Digital Electronics

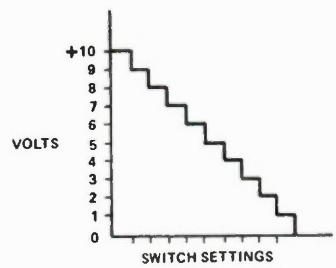
Ian Sinclair returns with a new series aimed exclusively at the newcomer to Digital Electronics. In part one we look at some of the ways electronics are helping us to count. In the coming months Ian Sinclair will deal with all of the most important aspects of this most important branch of electronics.

WHAT IS IT THAT frightens so many people away from digital electronics? Does the word digital conjure up pictures of advanced mathematics, or do you just wonder what possible use you could make of these circuits? Perhaps you've browsed through descriptions, and wondered if you were reading the same language as they were written in. Your worries are at an end, for the usual ETI service is here, to provide you with a clear and right-from-the-beginning guide to the new electronics where everything is happening so quickly.

Finger Trouble?

The word digital sounds as if it might have something to do with fingers and there is indeed a connection. When we're very young (and sometimes when we're a bit older, too) we count on our fingers. Later on, we usually get out of that habit, but it's not a bad description of how computers do their counting. The difference is the number of fingers and how fast they can be used. Our standard allocation of fingers and thumbs totals ten, so it's not very surprising that we count in tens, and place figures in columns to show how many units, tens, tens of tens (hundreds) and so on, each figure represents.

When we come to try to do something similar in electronics, though, there's no obvious way of using ten of anything. We could, of course, imagine a transistor working from a 10 V supply, with its bias adjustable (Fig. 1.1) so that the collector voltage could be changed in 1 V steps from zero to ten. Now from what you know (don't you?) about transistor bias, what do you think would be the chances of things staying that way?



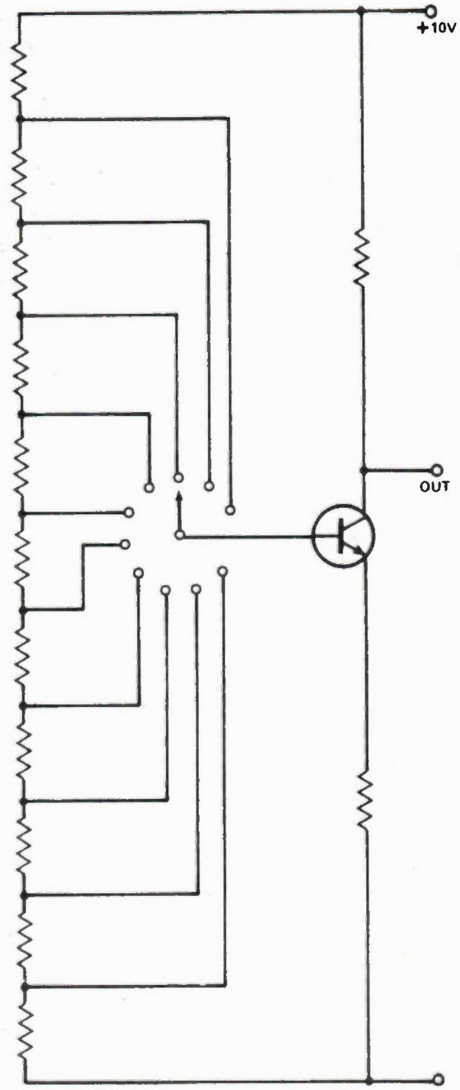


Fig. 1.1. Yes, you could use a transistor to count in a scale of ten — but it's a fearsome method, and the reliability would be poor. The step diagram above shows how we can use a voltage gradient to count from 1 to 10 in one volt steps. This method is not, however, very practical.

Quite right, pretty low! As the transistor warmed up, the bias would change, and the collector voltage would alter. Not a promising start.

Two's Company

No, the really natural counting system for electronics is a scale of two. Its pretty easy to set an electronics system to be either fully on or cut-off, two *states*, as they're called, which can be set quite definitely. A transistor which is fully on, or bottomed, has a collector voltage of nearly zero (Fig. 1.2), and it's not difficult to make this state stable, meaning that it's not easily upset by changes of temperature or anything else. For example, the transistor in Fig. 1.2 is bottomed, and will stay that way because of the resistor which connects the base to the supply voltage. Provided that the resistor is not of too high a value, there will be more than enough current flowing into the base to keep the transistor collector voltage bottomed no matter what happens in the way of temperature changes, ageing of components and all the other things that can beset transistor circuits.

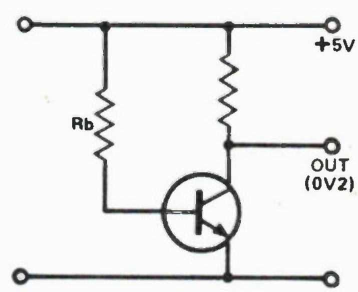


Fig. 1.2 Saturating or bottoming the collector voltage of a transistor. Connecting the base to the positive supply voltage makes sure that the transistor is passing as much current as the resistors permit.

The cut-off state is equally stable. As long as you keep the base voltage of a transistor below 0.5 V, there will be no collector current flowing unless

the transistor is quite hopelessly leaky. These two conditions can be used in several ways. Two of the most important of these uses are in digital logic circuits and in digital counting circuits. We're going to start with digital logic circuits for the very good reason that they're simpler, and we'll move on to look at the counting circuits later.

Easy as Falling off a Log (ic)

Now you've probably come across the word logic many times before in articles dealing with digital circuits, but you've probably never seen it explained. Logic means a system for arriving at a conclusion starting from facts. If a baseball suddenly thumps through your window (fact), you start looking for someone with a baseball bat (logical conclusion). If you thump the first guy you meet who's carrying a tennis racquet, you've been illogical! Logic is about thinking clearly, as mathematics is, but the language of logic is ordinary English (or close to it), and it doesn't *have* to be expressed in symbols. Like mathematics, though, logic is a lot tidier and shorter if we do use symbols to express what we mean.

No, No, Yes, Yes, No

Now logic has been studied for a long, long time, several thousand years, and yet it took centuries for people to realise that each step in a logical argument could be simplified so that it consisted of a question which could have only two possible answers — yes or no. Logic, remember, is about getting conclusions from facts, and 'maybe' answers aren't much use for that purpose. Fig. 1.3 shows a simple logic process (is the kettle heating?) broken down into a set of these YES/NO steps just to illustrate what is needed. What's that? You don't need to use transistors to put the kettle on? Of course you don't, but the fact that *any* logical process can be broken down into a set of questions, each of which must have a YES or NO answer, does have a lot of uses. YES and NO are two *states,* and we can use the two stable states of a transistor to represent them. We can, for example, decide that a cut-off transistor, collector at supply, represents YES and a bottomed transistor, collecter at 0 V, represents NO; which opens the way to using transistors for any sort of logic operation.

Now this way of looking at logic problems was invented a long time ago by a self-taught genius called George Boole, and he worked out a system for writing down logic problems in a kind of mathematical shorthand, and of solving the problems using what is now called Boolean Algebra. Boolean Algebra was at that time just a curiosity, a fascinating sideline for people with nothing more urgent to do, until much later it gradually dawned on engineers that

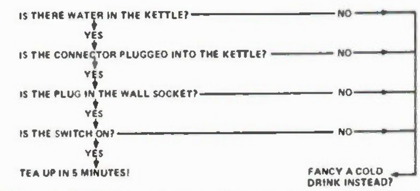


Fig. 1.3 YES/NO decisions for the kettle problem.

telephone switching circuit problems could be solved by using Boolean Algebra. It didn't take engineers very long after that to find that Boolean Algebra was almost indispensible in computer design — and it's been a top-priority topic ever since. Moral is that no piece of truly *scientific* research (as distinct from a lot of so-called 'social science') is ever really wasted.

Do IC Digits?

We're not here to do a course on the theory of Boolean Algebra, though, our task is to show how digital ICs can be used. Digital ICs, like any digital circuits, use signals which are either zero volts (transistor bottomed) or supply volts (transistor cut-off). We could, of course, call these NO and YES signals, but we usually shorten the description a bit more by referring to zero volts as 0 and supply volts as 1. The input or output of any digital circuit will consist of just these voltages, perhaps a signal which changes between 0 and 1 at intervals. We can forget about waveshapes, amplitudes, phase shifts and all these problems of linear circuits; all we're interested in is the two levels 0 and 1. That, incidentally, can make digital circuits a lot simpler than most linear circuits.

Long before digital transistor circuits were invented, logic circuits were built using switches. A switch is another device which is either off or on, and that's why the first use of Boolean Algebra was in switching circuits. The great advantage of the transistor is that its switching action doesn't rely on any mechanical contacts making or breaking. The switching of a transistor can therefore be much faster, with none of the bouncing, sparking and contact-wear problems which plague mechanical switches.

How are we going to learn about all this, then? The easiest way, of course, which is the ETI practical way. We'll knock up circuits which make use of digital ICs, show what they do, and what they could do. We're not going to build our own computer, nor gadgets for playing the National Anthem every time a tap is turned on, but we are going to understand how these things *can* be done. What we will do is to put signals into digital ICs, using switches (mainly), and see what comes out (using LEDs). Once you understand what each of these circuits does, the way is clear to understand more complicated circuits, and that's what it's all about.

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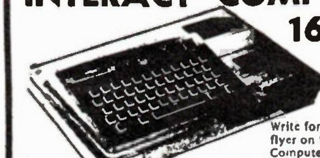

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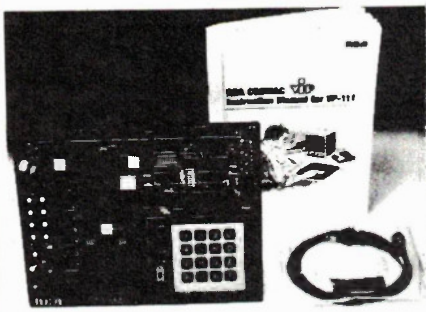

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VP—3303 Interactive Data Terminal (RF & Video/Audio)
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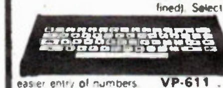

ASCII Keyboard Fully encoded, 128-character ASCII alphanumeric keyboard. 58 light touch keys (2 user defined). Selectable "Upper-Case-Only"
VP-601 . . . . **$109.75**

ASCII/Numeric Keyboard ASCII Keyboard identical to VP-601 plus 16 key numeric entry keyboard for easier entry of numbers.
VP-611 . . . . **$149.75**

Cable: ASCII Keyboards to VP-711 Flat ribbon cable, 24 in. length, for connecting VP-601 or VP-611 and VP-711. Includes matching connector on both ends.
VP-620 . . . . **$27.50**

Cable: ASCII Keyboards Flat ribbon cable, 36 in. length with mating connector for VP-601 or VP-611 Keyboards. Other end is unterminated.
VP-623 . . . . **$27.50**

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58-Key Typewriter Format for Alphanumeric Entry	
VP-601 - 8-bit parallel output	$109.75
VP-606 - Asynchronous serial output	139.75
58-Key Typewriter Format Plus Separate 16-Key Calculator-Type Keypad for Fast Numeric Entry	
VP-611 - 8-bit parallel output	$149.75
VP-616 - Asynchronous serial output	159.87
VP-3301 - Video output & built in audio	475.95
VP-3303 - Connects directly to TV set	498.95
VP-3501 - With built in modem & RF modulator	549.95

Sinclair ZX81 Computer
ASSEMBLED $159.95
Kit $109.95

The ZX81's advanced capability.
The ZX81 uses the same fast microprocessor (Z80A), but incorporates a new, more powerful 8K BASIC ROM — the "trained intelligence" of the computer. This chip works in decimals, handles logs and trig, allows you to plot graphs, and builds up animated displays. And the ZX81 incorporates other operation refinements — the facility to load and save named programs on cassette, or to select a program off a cassette through the keyboard.

New, improved specification.
•Unique 'one-touch' key word entry: 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. •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. •1K-byte RAM expandable to 16K. •Full editing facilities. •Able to drive the new Sinclair ZX Printer (to be available shortly).

If you own a ZX80. . .
The new 8K BASIC ROM as used in the ZX81 is available as a drop-in replacement chip. (Complete with new keyboard template and operating manual). With the exception of animated graphics, all the advanced features of the ZX81 are now available on your ZX80 — including the ability to drive the Sinclair ZX Printer.

16K Memory Expansion Kit (No P.C. Board) $69.95

Sinclair's new 8K Extended Basic offers features found only on computers costing three or four times as much. •Continuous display, including moving graphics. •Multi-dimensional string and numerical arrays. •Math and scientific functions accurate to 8 decimals. •Unique one touch entry of "key words" (i.e. basic and system commands). •Automatic syntax error detection. •Randomize function. •Built-in interface for ZX Printer. •Connects to standard TV and cassette recorder. •164 page manual included. •Power supply (9V at 650 ma) optional for $14.95. •1K of memory is included. •Easy-to-build.

ZX81 Printer $169.95

Designed exclusively for use with the ZX81 (and ZX80 with 8K basic ROM), the printer offers full alphanumerics and highly sophisticated graphics. COPY command prints out exactly what is on screen. At last you can have a hard copy of your program listing and results. Printing speed is 50 characters per second, with 32 characters per line and 9 lines per vertical inch. Connects to rear of ZX81 — using a stackable connector so you can use a RAM pack as well. A 65 ft paper roll, instructions included. Requires 9 volts, 1.2 amp power supply (option extra).

64K $249.95

MEMOTECH 64K MEMOPAK

The Memopak is a 64K RAM pack which extends the memory of the ZX81 by a further 56K. Designed to be in the price range expected by Sinclair owners. Plugs directly into the back of the ZX81 and does not inhibit the use of the printer or other add-on boards. There is no need for additional power supply or cables. The Memopack together with the ZX81 gives a full 64K, which is neither switched nor paged, and is directly addressable. The unit is user transparent, and accepts such basic commands such as 10DIM A(9000).
With the Memopak extension the ZX81 is transformed into a powerful computer, suitable for business, leisure and educational use, at a fraction of the cost of comparable systems.

Machine Language Software

ZXAS Machine Code Assembler. A full specification Z80 assembler. Standard mnenonics are written directly into your BASIC program. $13.95

ZXDB Disassembler/Debugger. Perfect complement to ZXAS, also provides single step, string search, block transfer, hex loader. $13.95

Hardware

ZX81 Assembled	$159.95
ZX81 Kit	109.95
ZX Printer	169.95
64 K-RAM	249.95
16K RAM	99.95
16K RAM Kit	69.95
Power Supply (for ZX81 + 16k memory)	14.95

Software

Multifile Data Storage System	$39.95
Dictator	19.95
Constellation	19.95
ZX Chess	29.95
Star Trek	13.95
Vu-Calc	29.95
Viewtext	19.95

Books

Not only 30 programs for the ZX81 — $16.95
Understanding your ZX81 ROM —23.95
Getting acquainted with your ZX81 — 16.95
The explorers guide to the ZX81 — 16.95
The gateway guide for the ZX81 & ZX80 — 16.95
Mastering machine code on your ZX81 — 24.95
The ZX81 pocketbook — 16.95

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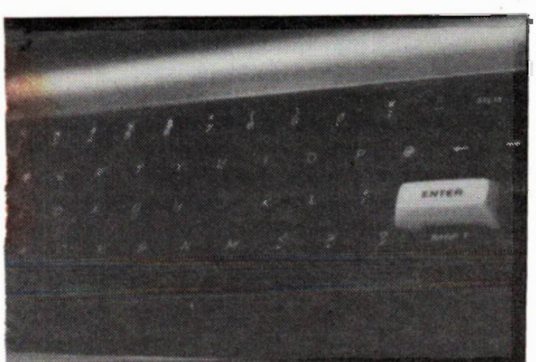
TRS 80 Model 3 review

Another big grey computer to peer at. It doesn't float (we didn't try, but it seems pretty sure), but it does do some neat things. Steve Rimmer attacks the keys.

THERE ARE TWO FEATURES of the TRS-80 Model III which will immediately endear it to anyone who digs gadgets and wizzbangs. The first is the location in RAM which holds the replaceable cursor character, and the second is the printable finger. The first permits you to replace the flashing dot with, for example, a smiling face character, and the second produces these little gloved hands pointing right on the screen anywhere you want. This latter function has led me to write several rather rude games for this computer.

The Model III comes in a variety of permutations, with no disks, one disk or two disks, 16 K of RAM up to 48 K of RAM and several other options. Cheap Model IIIs can be upgraded to expensive Model IIIs after purchase, which is good, as the thing will grow with you. Predictably, Radio Shack loaned us the full house system, 48 K with two drives and packs of software.

Overall, the Model III seems to be well put together. . . it doesn't sag or anything. . . and nothing has thus far died on it. This last bit is probably not too meaningful; in reviewing a computer one never has it long enough for it to croak unless it was put together by drunk pygmies.



Going Up

Getting the system up entails jamming yonder disk into yonder drive and hitting return. This places one in TRSDOS, which is Radio Shack's disk operating system. This is a kind of mini-TRSDOS, as compared to our Model II's; it is really just the disk drivers and very little else. For example, the TERMINAL routine of the Model II is absent, which seems strange, since the machine has an RS-232 port.

If you read the Model III reference manual, you will find a BASIC terminal routine, but, because it's in BASIC, it's limited to 110 baud, while most BBS's and dial up networks use 300 baud.

Typing BASIC loads, yes, you've guessed it, BASIC, and sends you on your way.

The BASIC is an interactive BASIC interperter with lots of good bells and whistles. It has a number of really executive features, and is one of those BASICs with a really good balance of things to suit both the beginner and the buzzed out cross eyed computer freak. We'll look at a few of the things on it which may not be familiar.

First off, there's TRON and TROFF, the brothers TR. These little devils toggle the TRACE function, which allows you to execute a program line by line to see what it does at each stage. By putting the TR commands in a program, specific sections can be traced. This is a good 'un for newcomers or those into writing really gross, complex BASIC text.

DEFINT allows a range of variable letters to be specified as integer at the beginning of a program, which makes for faster operation when floating point isn't required. Similarly, DEFSNG defines single precision variables and DEFDBL does double precision. DEFSTR defines variables as strings. This last means that previously DEFSTR'd variables don't need a "$" after them to be regarded as strings by the program.

ON ERROR GOTO is neat. When the program encounters it, it builds a routine which causes the program to remain running if an error is encountered, but to jump to a routine for dealing with it. Thus, for example, if one had a program that was supposed to read in a disk file, and the file wasn't found, it could go to a routine to say so and request alternate action rather than coming to a crashing halt. RESUME is a RETURN from an error handling routine.

IF-THEN statements can have ELSE tacked onto them, which, while not essential for anything is elegant in some cases.

TIME$ communicates with the machine's internal clock. We left it on for a day to see if it kept time, which it did with decent accuracy. A bit heavy to strap on your wrist, though.

The stable of functions is also quite crowded, with such things as CDBL, to return double precision representations of arguments, FIX, which lops off anything right of the decimal point, SGN, which returns the sign of an argument and CINT, which returns the largest integer not greater than the argument. There are, however, no inverse periodic things like cosecant directly available. . . although these can, of course, be derived.

SET plots graphics blocks at specified points on the tube. They can be erased by RESET. POINT returns a true or false depending upon whether a specific point has been SET or RESET, obviating the need for keeping track of things.

INP returns a byte from a specified Z-80 I/O port. OUT outputs a byte. Since Z-80 I/O is not memory mapped, as is the case in 6502 based systems, simple PEEKing and POKEing won't do for these functions.

VARPTR is really esoteric: it returns the pointer which designates the absolute address in RAM where a variable is stored. Of limited use, this, but interesting to play with.

The Model III's editor is a line, rather than screen oriented system, which is rather less easy to use than the editor on a CBM computer (ya, I do like PETs for that). However, it's a good line editor, with all the possible functions you can put in one of these things, and it works quite well. Unlike the editor on the Model II's TRSDOS BASIC, this one does not suffer from occasional dramatic hangings-up.

As far as utilities go, there is AUTO, for automatic line numbering, but RENUM, line renumbering seems to be absent. Pity, what, as this is sort of an important feature if you're into large programs.

All told, a good BASIC, and one that will probably give you many joyous and fond "Syntax Errors" in the years to come.

Hardware

The screen of the Model III will hold 16 lines of 64 characters across its 12 inch tube. These are produced, naturally enough, by a keyboard, this one having 65 keys. The keyboard feels all right; it is certainly as good as most small system keyboards, and has a positive feel to it. There is a separate numeric keypad.

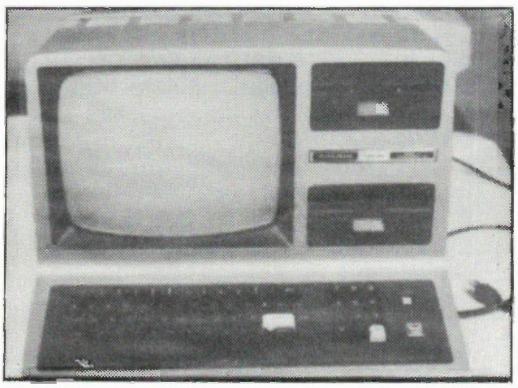
When you first turn the machine on, it types with a blinking block cursor in upper case only. However, typing a shifted 0 toggles a register which permits the displaying of upper and lower case characters. Location 16412 determines whether the cursor flashes or not. Location 16419 holds the character that the system uses as its cursor, and, as was previously mentioned, you can put in a different character from the block that's normally used. As we'll see, there are quite a number of unusual ones to choose from. I think that if I owned this thing I'd definitely modify the boot to stick in a smiling face character.

The characters from 192 on up can contain either special "text compression" characters or one of two sets of graphics characters. The alternate graphics symbols are Japanese characters. . . probably of very limited use. . . but the primary set, as shown, is really a trip. Among the range are 196 and 197, smiling and frowning faces, 224, omega, 239, copyright, 244, 245 and 246, the afforementioned flying finger, 247, the druggist's Rx, 249 and 250, the symbols for Mars and Venus, or male and female, and 253, a little man. A pound sign, umlauted "u" and "o", "e" with an *accente grave* and other foreign language things are also available.

The graphics are amazingly fun to play with. The Japanese characters are a mite of a drag, and one might be inclined to wish for better use of the space. . . maybe with Sanskrit.

Characters 128 to 191 are block graphics for drawing boxes and the like.

It is also possible to have the whole screen switch to double width characters, which look quite horrible



compared to the regular ones, but would probably be ideal if young children were going to be learning to use the machine. How you get the Fruit Loops out of the disk drive is, of course, your problem.

Other things that can be called from the keyboard are Shift ◄, start over at beginning of the current line, Shift @, pause program execution and Shift down arrow asterisk, which dumps the screen to the printer, assuming you have a printer. This last is quite grand.

The possible peripheral bitsies provided for on the Model III are disk expansion for up to two additional drives, for a total of four, parallel printer interface, RS-232 port, parallel I/O port and jacks for a cassette recorder. With the exception of the cassette recorder jacks, all the connectors are located on the bottom of the computer. While the rubber feet keep the computer from resting directly on its cables, this is still a bit bizarre. However, if you aren't up for a lot of plugging and unplugging it probably won't be a hassle.

The ON Switch

If you don't read the manual you'll never find the little troll.

The "TRS-80 Model III Operation and BASIC Language Reference Manual" is a well written book about the system. You could probably puzzle your way into BASIC from complete ignorance with it, although Radio Shack has a beginner's guide to TRS-80 BASIC with the appropriate cartoons thoughout, which would likely be an easier trip. There are lots of high level bits, like ROM calls and system organization and a good index. Appendicies include error codes, decimal to hex conversion tables and little block diagrams of the characters. All told, a goodly little book, with nothing lacking even if you plan to crawl inside the computer to live.

This system is probably a good choice for anyone who wants to get into computers, or anyone who wants to get a sort of heavy personal/small business trip, as it can be configured in a number of ways. I am still quite pleased by the almost infinite facilities of CP/M, which TRSDOS certainly is not, but this only really applies to those wanting to use a lot of weird software or who want to use Digital Research's Z-80 assembler tools. For anyone interested in doing a lot of BASIC programming, or running a specific business software package like Visi-Calc or Profile, the Model III is a good choice. A major attraction of the Model III is the vast amount of software available from independent suppliers and because of the competition the prices are reasonable. Once the novelity of the hardware has worn off and you're used to the machine it's software that is important.

The fact that the system is supported by Radio Shack is also a favorable aspect of it, as its manufacturer is probably not about to bite the dust in six months.

...And, Hey, Billy. . . if you plug headphones in the back I bet it could be a Walkman for gorillas, too. . .

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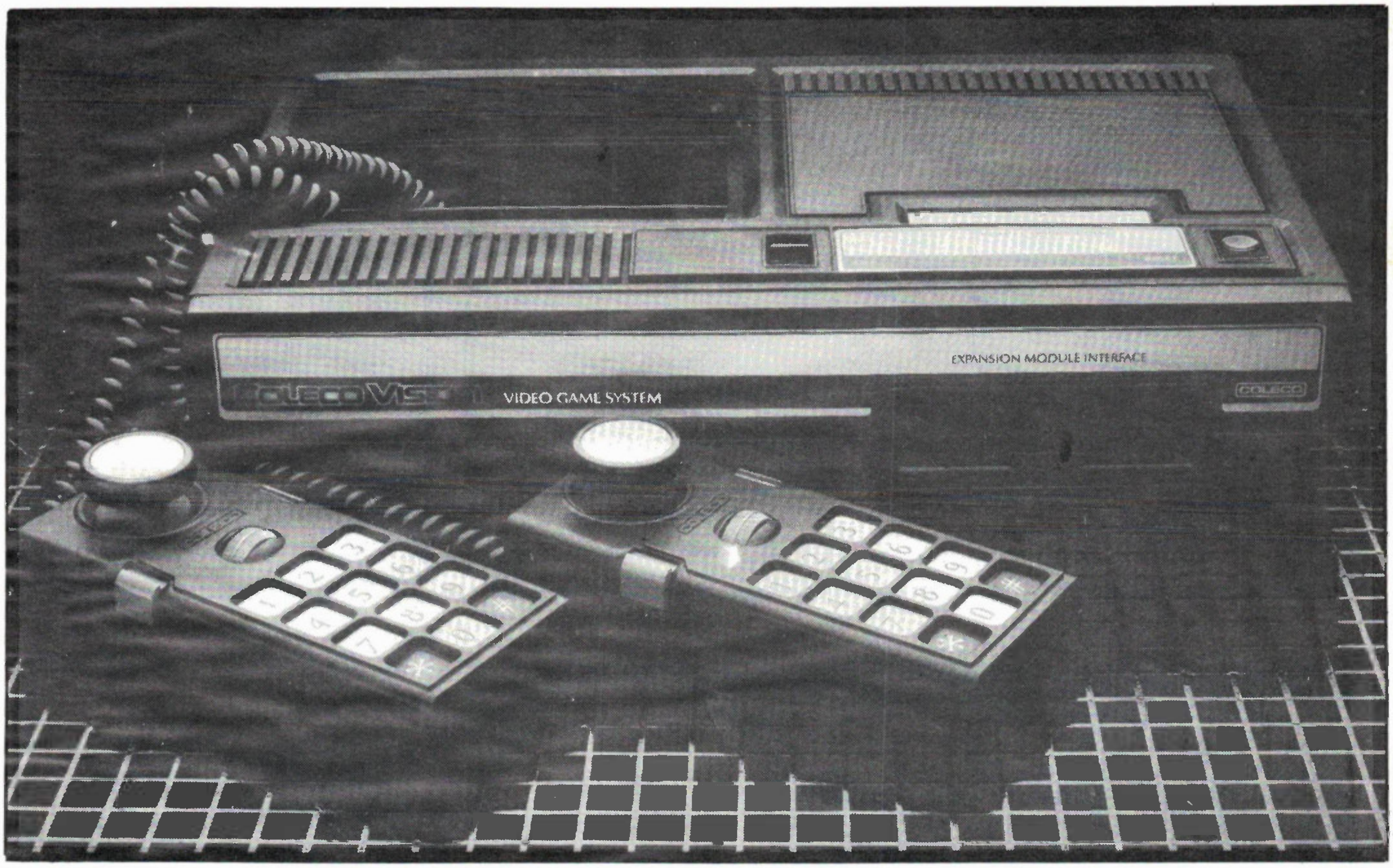


The Coleco Vision System will be on Software Shop Stand.

ONLY A FEW YEARS ago 'consumer electronics' (if you heard the term at all) meant TV, Radio and Hi-Fi. Things have moved a long way very fast and chip technology has led to an explosion of new products for the home, car and office.

A window on many of these new products is being provided by **Electronic Showplace**, Canada's first annual public consumer-orientated exhibition which opens its doors on September 16th in Toronto.

Exhibitors include manufacturers, distributors and retailers as well as service organisations, Government departments and educational institutions.

As well as continuous demonstrations there will be several workshops and seminars on subjects related to the exhibits; these will be about half an hour long followed by a question and answer session.

ADT Security Systems of 5734 Yonge Street, Toronto will be showing up-to-date residential and industrial electronic security system.

The Software Shop, 6174 Yonge Street, Toronto claim to have the largest selection of video games and home computer software around. At the exhibition they will be spotlighting the Colecovision video game system which, in addition to its own cartridges will accept Apollo, Atari and Imagic software and a second module that accepts Intellivision software. At the stand visitors will be invited to use Colecovision, Atari and Intellivision systems and then give a comparison rating!

The Software shop will also be showing the Scanvertiser, a computer based electronic sign.

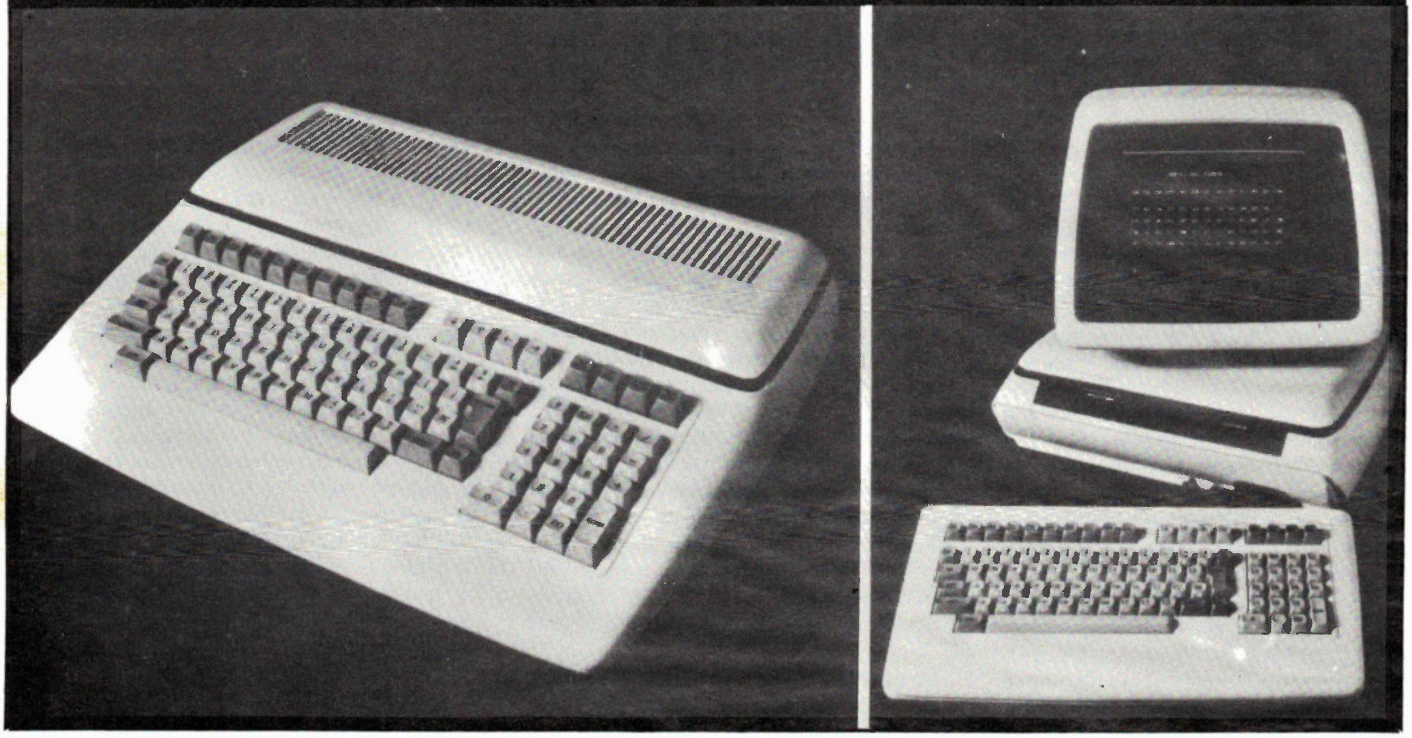
Comspec Communications Inc, P.O. Box 217, Station A, Downsview, Ontario, will be showing the full Commodore line and new software packages for them. The PET, SuperPET, VIC-20 and Commodore 64 will all be on show.

CounterAct Systems of 70A Main Street North, #103, Markham, Ontario will be showing for the first time a new computerised car theft deterrent system that removes the thief's profit motive. The system identifies the car all over with an 11-digit code that can't be removed or erased without destroying or damaging the areas marked.

At Electronic Showplace, CounterAct will be showing a fully marked car, the micro-terminal and registration facilities.

Leisure Dyamics of Canada will be featuring Odyssey 2 and Leisure Vision video games and cartridges as well as hand-held electronic games.

Mitel Corporation, 350 Legget Drive, Kanata, Ontario will be showing their advanced telecommunication systems.



Third Generation Commodore P128 Series Microcomputer to be shown by Comspec Communications.

Robot Research and Development Inc., P.O. Box 541, Station Z, Toronto, plan to show special projects in robotonics. These include two working models. Robot Research will also be taking part in the seminars which will concentrate on the hobby side of robot construction.

Torch International Computers, 7430 Woodbine Ave., Markham, Ontario are well-known to ETI Readers for the Acorn Atom computer (reviewed January 1982). This will be on show with much of the recently introduced software.

Vedacom Canada Inc., 1456 Cyrille Rd., Ottawa, Ontario feature Satellite Antenna Systems.

Zenith Radio Canada have recently introduced a lot of new, highly sophisticated products. Amongst the items on show will be their new Video Hi-Tech Component TV.

Where and when

Location: Automotive Building, Exhibition Place, Toronto, Ontario.

Dates: Thursday to Sunday, September 16-19th.

Hours:

Thursday and Friday	**1 p.m. - 10 p.m.**
Saturday	**10 a.m. - 10 p.m.**
Sunday	**10 a.m. - 6 p.m.**

Admission:

$4.00. For Senior Citizens and under 15 $3.00.

Zenith will be showing their new Video Hi-Tech Component TV.

Designer Circuits

Triggered Flash Unit

By triggering an electronic flashgun using a sound operated switch, photographs of such things as a balloon bursting, the cork leaving a champagne bottle and objects splashing into water can be taken. Since electronic flashguns normally give an effective shutter speed of around a 1000th of a second, a "frozen" action photograph is obtained.

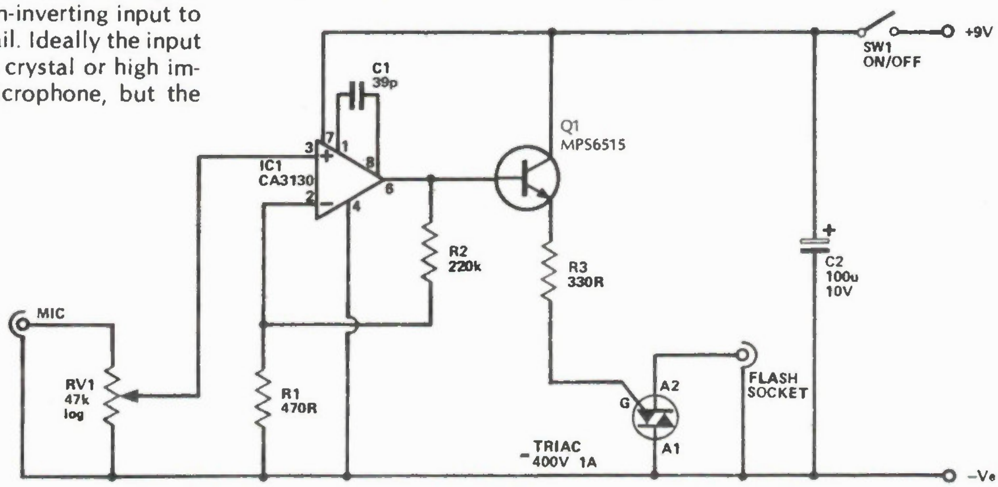
The photograph must be taken under fairly dark conditions so that the ambient light does not give an exposure if the camera's shutter is set to "B" and opened.

The circuit is based on operational amplifier IC1 which is used in the non-inverting amplifier mode. R1,2 are a negative feedback network which set the gain of the unit at about 500. RV1 (sensitivity) biases the non-inverting input to the negative supply rail. Ideally the input should be fed from a crystal or high impedance dynamic microphone, but the unit will work quite well using a low impedance dynamic microphone or even a high impedance speaker as the signal source.

Q1 is used as a discrete emitter follower output stage which provides the relatively high trigger current required by the triac. R3 is a current limiting resistor. Under quiescent conditions the output of IC1 will be at virtually negative supply potential, and the triac, therefore, receives no gate current. When a signal is received by the microphone, positive going signals are amplified by IC1 to give an output that is a few volts positive. The triac then receives a strong gate bias, causing it to trigger and give a low resistance across its A1 and A2 terminals. These terminals connect to the flashlead via a suitable socket (or flash extension lead with the nwanted plug removed) and the flashgun is, therefore, fired. The circuit operates almost instantly, giving very little delay between the commencement of the sound and the flashgun being triggered. Sometimes more interesting photographs can be obtained by introducing a small delay.

This can be achieved by moving the microphone a metre or two away from the object(s) being photographed.

The current consumption of the unit is approximately 4 mA. It is advisable not to advance RV1 much more than is absolutely necessary in order to give reliable triggering, as frequent spurious operation sof the unit could otherwise result.



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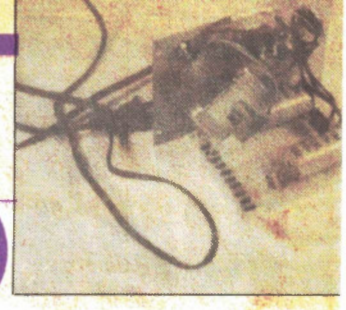
Synthesizer II



The sound of the VCO module, presented last month, will be greatly improved if it's powered. The PSU follows, by Steve Rimmer.

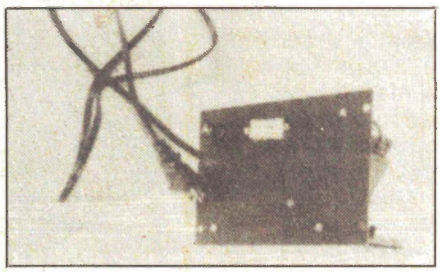
DUE TO A RATHER profound lack of space this month, the second installment of the ETI synthesizer will be a fairly simple, although undeniably useful, module; the power supply. Capable of producing an earth-shattering 15 volts at plus and minus at the same time and simultaniously, the PSU will be a welcome addition to any synthesizer project not operated by wind power.

It has a distribution patch for ten modules plus an extension to jumper into a further distribution patch at a later date. The modules don't draw much current, so the supply need not be too huge.

The board has been designed to permit the use of either tab regulators or the smaller (cheaper) TO-5 types. Use one or the other; *not both*. The TO-5 regulators will probably only be applicable to those visionaries constructing prepatched, fairly limited instruments.

Construction

Getting this one together should prove no problem unless your soldering iron is burned out. The board is designed for a diode bridge (of the square sort) but, as was the case in the prototype, you can use one of the upright types by just bending the leads. The regulators probably won't



need heatsinks. Don't leave out the bypass capacitors, lest everything go merrily into oscillations.

As was the case with the VCO, the interconnections for the distribution patching area are done with AP header pins cut into clumps of three.

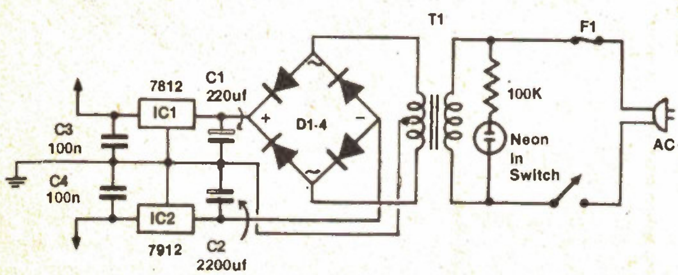
PARTS LIST

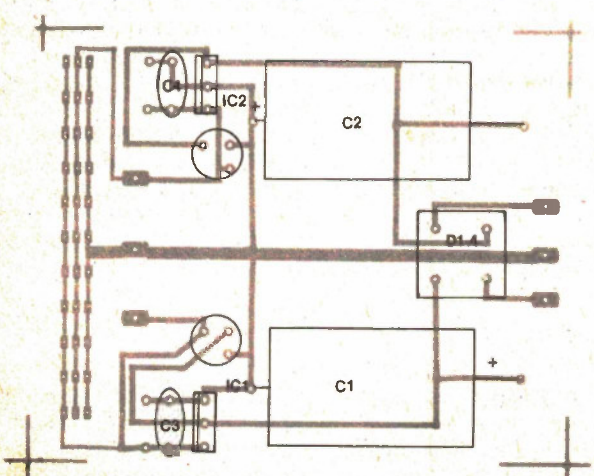
Parts List

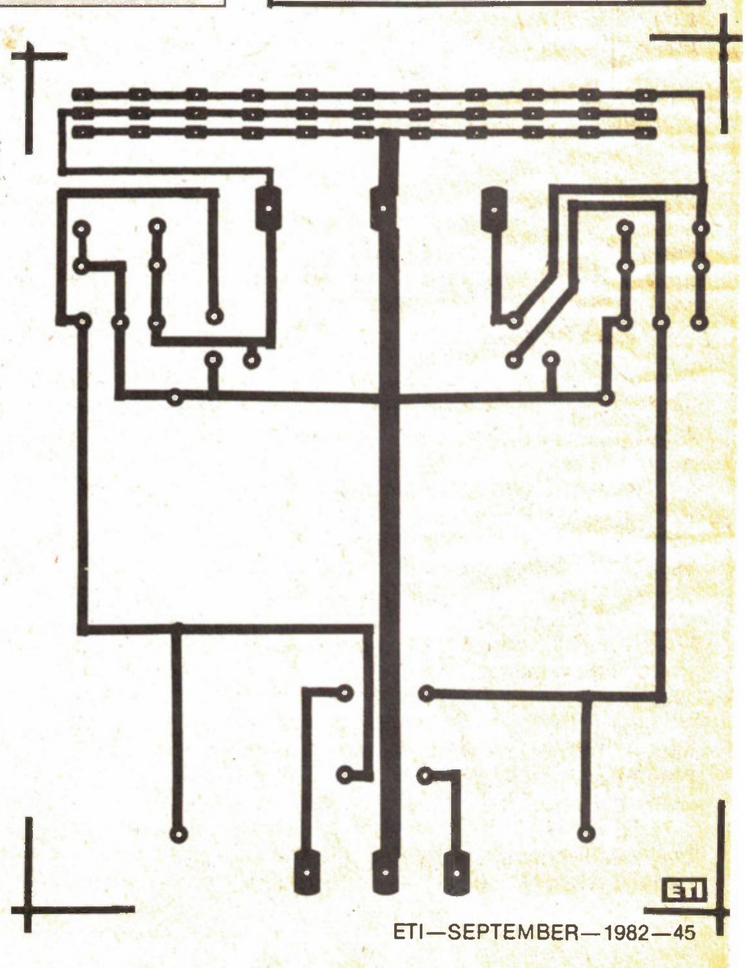
C1,2	2200uF, 50V
C3,4	100n (0.1 uf,) 100V
R1	47K, 1/2 Watt
D1-4	Diode Bridge, 50V, 2 Amps
IC1	7815 (See Text)
IC2	7915 (See Text)
T1	Transformer, 30 VCT, .5 Amps

Miscellaneous

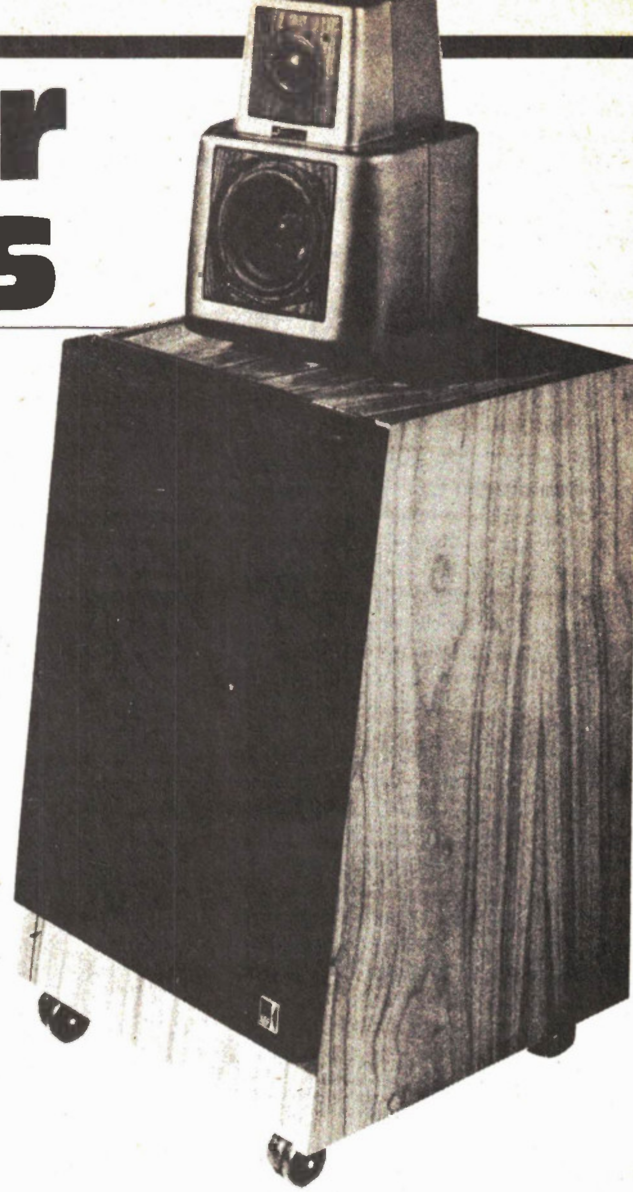
Switch (Armaco SW113, Hammond Panel 1431-8, fuse, line cord, AP header pins.







Crossover Networks



Put down that inductor you're winding on an old Pablum box and read this article on crossovers and loudspeaker design from KEF Electronics. It'll tell you why you've been wasting your time.

THE BASIC requirements for a high-quality loudspeaker include on the one hand a smooth and uncoloured response maintained over an angle of radiation wide enough to cover the listening area, and on the other, freedom from audible non-linear distortion, together with a combination of efficiency and power handling capacity adequate for the conditions of use. For each drive unit in a multi-way system, there is only one frequency band over which all these requirements are simultaneously satisfied; outside this band there will be regions in which some of them cannot be met. A low-frequency drive unit, for example, if allowed to operate in the high-frequency range, would introduce colouration through diaphragm resonance. Again a high-frequency unit, if allowed to operate at low frequencies at which the necessary diaphragm excursion exceeds the linear limit, would introduce distortion products. To avoid degradation of the overall sound quality by such unwanted contributions, it is therefore essential that the output from each drive unit outside its working frequency range should be reduced to a sufficiently low level by adaquate attenuation in the crossover filter.

Filtering Through

Filters in practice cannot have an infinitely sharp cut-off, so that there is an overlap region around the nominal crossover frequency in which the total sound output is made up of contributions from two different drive units. Ideally, the combined characteristic of each unit working in conjunction with its associated filter network should be such that the sum of the two contributions gives a flat response over the entire transition region; in addition, if the frequency characteristic of a unit within its working band is not quite flat, the network should be designed to rectify this. Each filter has therefore to be tailored to suit the response of its associated drive unit both in the working band and in the nominal cut-off region; moreover, it must be designed to operate into the input impedance of the unit, which will in general be complex and will contain additional components associated with the fundamental resonance of the diaphragm. Finally, the impedance presented by the filters to the power amplifier must be kept within prescribed limits which apply not only to the magnitude or modulus, but also to the relationship between the resistive and reactive components.

To measure the phase shift in a loudspeaker has been until recent times a very difficult operation, largely because of the additional, and much greater, phase shift associated with the time taken for the sound to reach the measuring microphone; this phase shift depends on the distance of the microphone from the acoustic centre of the drive unit, i.e., that point within the unit at which the sound appears to originate. The exact location of the acoustic centre is initially unknown but can be readily determined by the pulse test method (developed by KEF); a short electrical impulse is applied to the unit, and the complete frequency response, in both amplitude and phase, is derived by computer analysis of the resulting transient sound output. This technique allows the phase shift introduced by the drive unit to be separated from the multiple phase rotations associated with the distance of the microphone from the acoustic centre, so that the position of the latter can be accurately calculated.

On Target

In designing crossover filters to suit individual drive units, the method adopted by KEF is to consider the overall electro-acoustic response of the network and unit together, and to make this conform as closely as possible to some known filter function that gives adequate attenuation in the cut-off region together with a smooth transition at crossover; the response/frequency relation to be aimed at is referred to as the *target function* and is represented by the symbol T(f). The response/frequency function of the drive unit alone, already measured under working conditions, is represented by S(f). The next step in design is to compute the frequency characteristic H(f) of a filter that will convert the existing response S(f) into the wanted reponse T(f); the functions T(f), S(f) and H(f) are in linear units, not dB, so that the conversion is a multiplication process, i.e.,

$$T(f) = H(f).S(f) \text{ and } H(f) = T(f)/S(f)$$

In specifying the function T(f) we can use any of the known forms of filter response, ignoring however the circuit configurations conventionally associated with these. The form commonly adopted is that of the classical Butterworth filter. Figure 1 shows three high-pass filters of this type; the corresponding low-pass

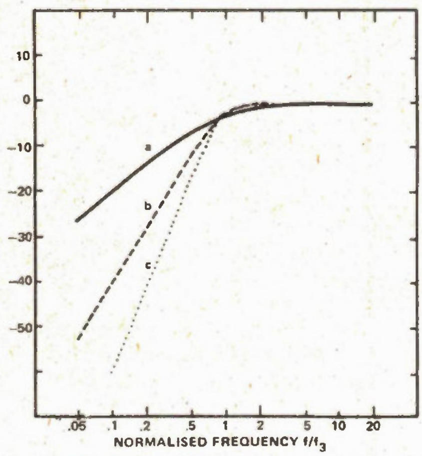


Fig. 1 Butterworth high-pass filter characteristics. (a) 1st order, maximum slope cut-off 6dB/octave; (b) 2nd order, 12 dB/octave; (c) 3rd order, 18 dB/octave.

characteristics are the same but reversed left to right. All these curves are of the type described in filter theory as 'maximally flat'. This means that the attenuation within the pass band is kept as small as possible down to the nominal cut-off frequency f_3, at which the loss is 3 dB, without introducing peaks or ripples in the characteristic. The curves in Fig. 1 represent Butterworth characteristics of the first, second and third order; the higher the order, the greater the cut-off slope, which in the three cases illustrated rises to a maximum of 6 dB and 18 dB per octave respectively, but also the greater number of circuit components required.

Cross Over Choice?

Although a first-order crossover network exhibits such desirable characteristics as unity amplitude and zero phase shift at all frequencies, the relatively slow cut-off rate of 6 dB/octave gives rise to a number of practical difficulties and such designs are not used. Crossover networks of the second order were at one time favoured but now have little application in high-quality systems. The overall frequency reponse obtained is not flat in the crossover region, but exhibits either a crevasse or a hump, depending on whether the drive units are connected in the same or opposite polarity. Moreover, the cutoff slope of 12 dB/octave is still insufficient for many purposes.

Third-order crossovers, on the other hand, satisfy many of the requirements and are widely used. Figure 2 shows a commercial high-frequency drive unit fed

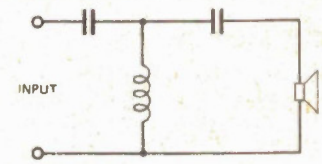


Fig. 2 High-frequency drive unit with conventional 3rd order Butterworth high-pass filter.

through a conventional third-order Butterworth high-pass filter having a nominal cut-off frequency of 3 kHz, and Fig. 3a the measured amplitude and phase response of the filter unit together. Figure 3b represents the theoretical response of the filter alone when loaded with a resistor numberically equal in value to the nominal impedance of the unit. Comparing curves (a) and (b) it will be seen that the response of the filter/unit combination deviates substantially from that which the filter was intended to produce. At high frequencies the characteristic is modified by the voice coil inductance, which resonates at 5 kHz with the second capacitor of the filter. From 3 kHz downwards, the cut-off slope, which for a third-crder filter should be 18 dB/octave, starts off at 12 dB/octave and below 1.2 kHz, the fundamental resonance frequency of the diaphragm, increases suddenly to nearly 30 dB/octave. This large change in slope is reflected in the phase shift in the cut-off region, which far exceeds the proper value, the disparity extends up as far as the crossover frequency and would have a significant effect on the overall loudspeaker response in the transition region.

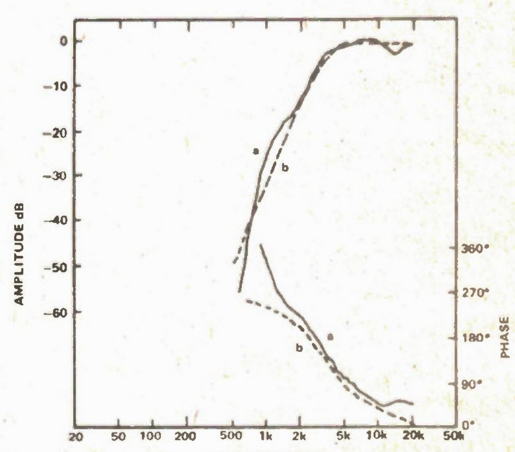


Fig. 3(a) Measured amplitude and phase response of the Fig. 2 circuit; (b) Theoretical amplitude and phase response of the filter alone, terminated with the correct resistive load.

Figure 4a shows the same high-frequency unit with a new network computed by taking the theoretical filter response of Fig. 3b as the target function. Figure 4b illustrates a different but equivalent circuit configuration

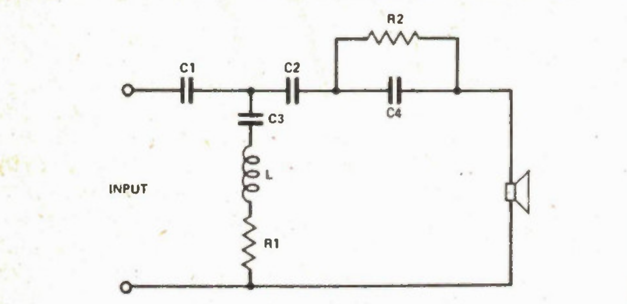
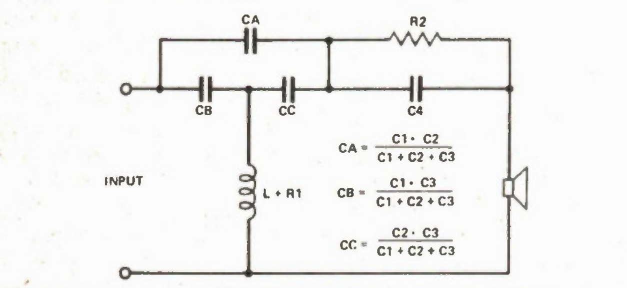


Fig. 4 (a) Computed Acoustic Butterworth filter designed to compensate for the non-flat response and complex input impedance of the high-frequency drive unit; (b) Practical realisation of Acoustic Butterworth filter.



adopted for greater convenience in manufacture. The new network compensates for the electro-acoustic characteristics of the drive unit, including the effects of the voice coil inductance and the fundamental resonance. The voltage at the terminals of the unit varies with frequency in such a way as to produce the acoustic response shown in Fig. 5a; over most of the range from 500 Hz to 20 kHz this response conforms closely to the theoretical Butterworth characteristics, reproduced in Fig. 5b, the residual deviations being within ± 1 dB in amplitude and within a few degrees in phase.

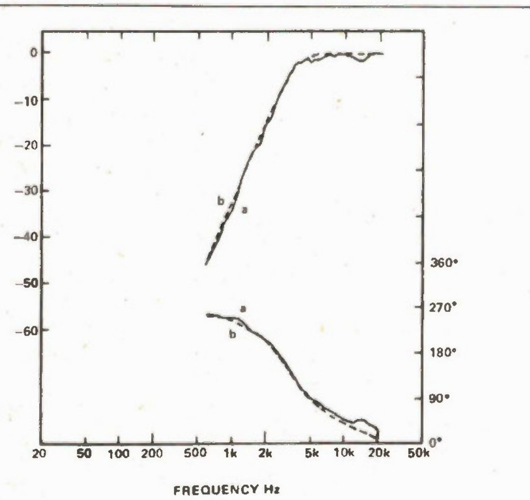


Fig. 5 (a) Measured amplitude and phase response of the high-frequency drive unit with the filter shown in Fig. 4; (b) Theoretical 3rd order Butterworth filter characteristic (as in Fig. 5b).

Avoiding Interference

For maximum horizontal distribution of sound without interference, the drive units in a multi-way loudspeaker should be mounted one above the other. Because of the unavoidable separation between the units, some interference effects must then occur when the listener is located above or below the design axis and thus no longer equidistant from the different sound sources; the amount of this interference sets a limit to the angle above and below the axis within which the response can be maintained substantially constant.

This situation is further complicated by the phase shift necessarily associated with the high- and low-pass characteristics of the individual filter/unit combinations. The high-frequency drive unit, which at crossover normally has a phase lead over the low-frequency unit, is commonly mounted above the latter. What happens then is illustrated by the polar diagram in Fig. 6, which shows how the loudspeaker response at crossover varies with angle in the vertical plane. It will be seen that the main lobe of the polar characteristic, instead of coinciding with the axis of zero inter-unit time delay, is tilted downwards and has a maximum amplitude 3 dB above the on-axis response. A great deal of sound energy is thus directed away from the listening area and towards the floor, producing unwanted frequency-dependent reflections which modify the relationship between the direct and reflected sound in the room. Worse still, there is a region, just above the axis, where the outputs from the two units are beginning to get out of phase and at one angle almost cancel each other. As a result, a small vertical displacement produces a large change in the response of the system around crossover, and hence in the spectrum of the reproduced sound.

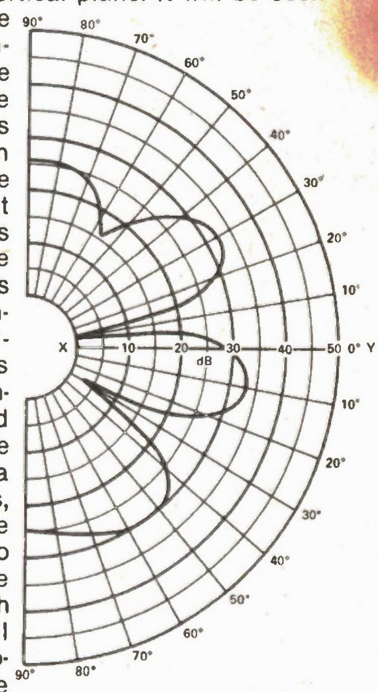
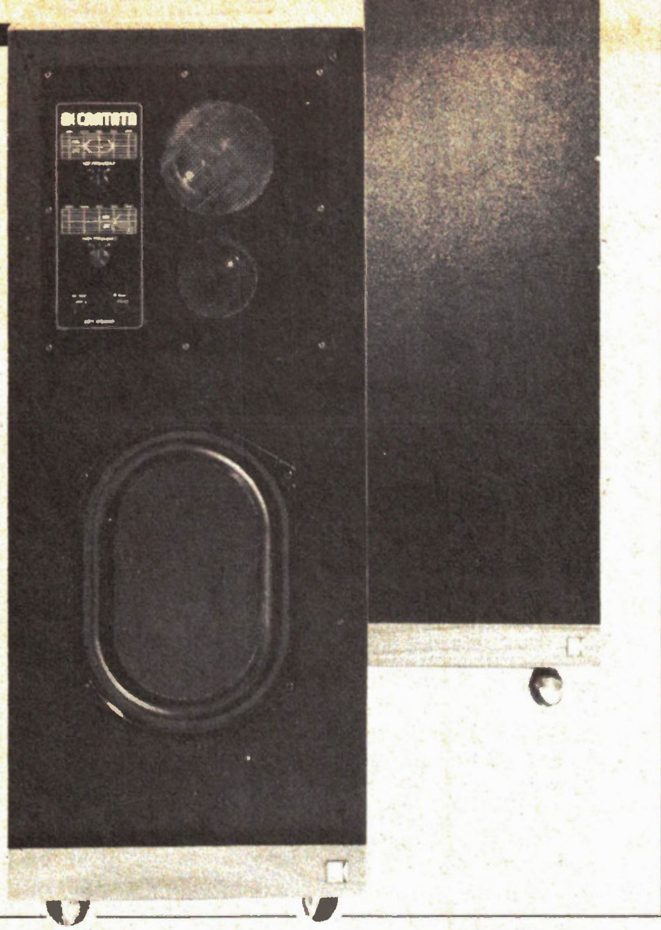


Fig. 6 Vertical plane polar diagram of two-way speaker system. X-Y indicates axis of zero inter-unit time delay.

One way of dealing with this situation is to mount the low-frequency drive unit (or mid-range unit in case of a three-way system) above the high-frequency unit, thus turning the polar diagram upside down. The main lobe is then directed away from the floor and the cancellation region placed where it can do little harm. A more radical solution is to choose for the target functions a form of filter characteristic that keeps the acoustic outputs from the high- and low-frequency drive units in phase over the whole frequency range, so that the main lobe of the polar curve remains symmetrical about the axis of zero inter-unit time delay. The crossover networks used to achieve this end are of a special type of fourth-order filter which is equivalent to two second-order Butterworth filters in cascade and thus gives a cut-off slope of 24 dB/octave.

Time Travel

Before leaving the subject of interference, it may be



noted that the acoustic centre of a high-frequency drive unit usually lies approximately in the plane of the panel on which the unit is mounted, while that of a low-frequency or mid-range unit is located further back, a short distance in front of the voice coil. The resulting difference in time delay can be allowed for in the physical positioning of the units in the loudspeaker assembly. It is however possible in some cases to achieve the equivalent result electrically by modifying the amplitude response, and hence the phase shift, in the crossover filters in such a way as to introduce a compensating time delay, while still satisfying the basic requirements of flat overall response and adequate cut-off slope. The target functions adopted then differ from the classical forms illustrated above. For example, the high-and low-pass characteristics at crossover may not be of the same order. Given the necessary computational facilities, a number of useful variants of this kind can be evolved to meet particular design requirements.

Network Synthesis

The first step in network synthesis is to examine the frequency response curves of a large number of mid-range drive units, measured under standard production test conditions, and to select one specimen, the characteristic of which coincides with the mean of the production spread. This unit is then mounted in the enclosure designed for the complete loudspeaker system, and its response under these conditions measured without a filter, i.e., with constant voltage applied to the input terminals.

Since the filter has to be designed to operate into the complex impedance presented by the input of the drive unit, this impedance must now be measured. For the purpose of network synthesis however it is convenient to represent the result by an equivalent electrical circuit with specified component values rather than by a series of resistance and reactance figures at a number of frequencies. This approach makes it easier to calculate the effect of certain parameters of the unit.

The next step is to decide what circuit configuration will produce the best fit to the desired network response curve while using the minimum number of components, taking into account the complex load imposed by the drive unit and the need to present an acceptable impedance to the power amplifier. The order of network required can usually be deduced by comparing the slope of the frequency characteristic for the drive unit alone with that of the target function representing the desired overall response curve. In principle, a number of alternative circuit configurations could be considered at this stage, but in the designer's experience the choice will usually be narrowed down to one or two.

Details of each network to be investigated, the response characteristic required and the equivalent circuit for the drive unit input impedance are now fed into a computer. This is programmed to carry out an optimisation routine which determines the network component values giving the best fit to the desired response curve and also the degree of accuracy achieved. The optimisation process is initiated by assigning approximate values to the various circuit elements. The computer then calculates the effect of making small changes in each element, and retains any of the new values that bring the response nearer to the ideal. This operation is repeated, possibly a thousand or more times, until the residual error in the curve fitting cannot be reduced any further. With the component values thus arrived at, the input impedance of the network is then checked to ensure that it remains within acceptable limits throughout the working frequency range.

The above procedure is repeated, if necessary, for alternative types of networks so that a final choice of the optimum circuit configuration can be made.

Choose Your Components

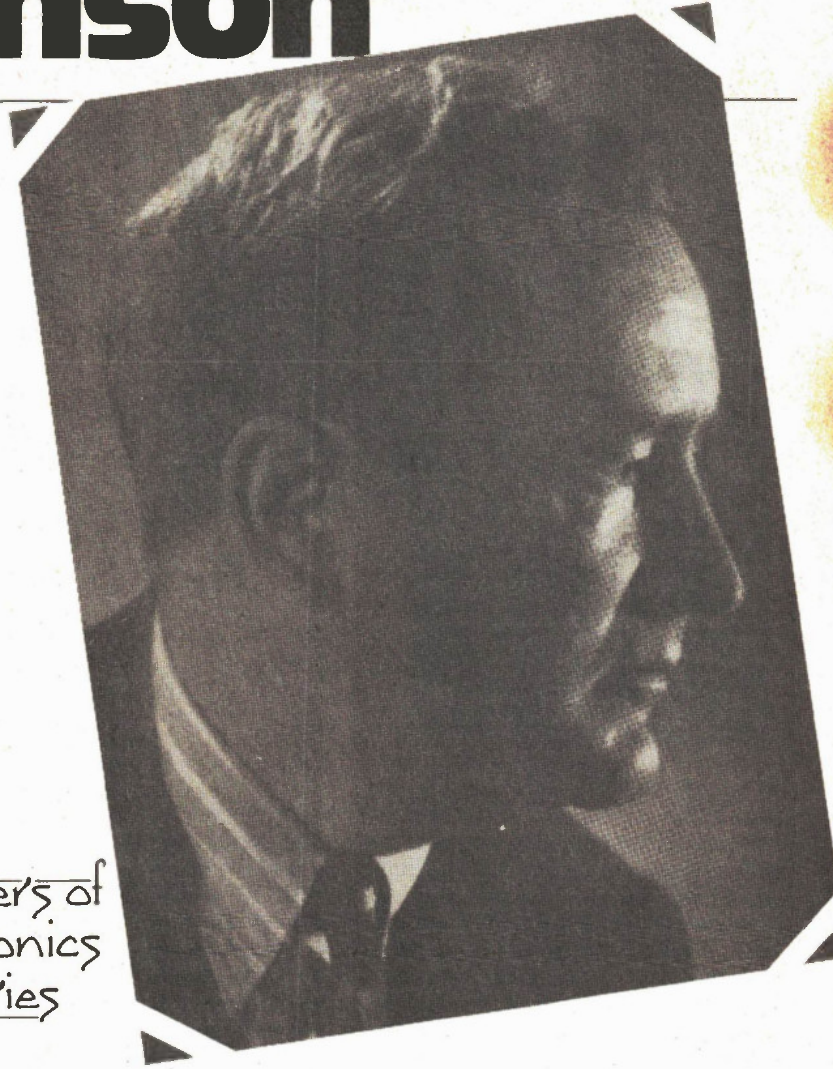
At this stage the designer has to consider ways of utilising readily available circuit components, avoiding the need for non-standard values and close tolerance limits, both of which add considerably to the cost. The computer program is accordingly re-run with the calculated values of capacitors and resistors replaced by the nearest preferred values. Provided that a sufficiently accurate fit to the target response was achieved in the original calculation, the effect of these changes can be off-set without appreciable detriment to the performance of the filter by altering the inductance values in the circuit, a simple matter since the coils are in any case wound to suit the individual design.

The process is now extended to allow for the production spread in component values. By arranging that the deviations of different circuit elements from their nominal values have opposing effects on the overall performance of the filter, it is possible to utilise stock components, having normal commercial tolerances, with very little wastage. The known manufacturing

Continued on page 63

Stephenson

More than just your average spy, Sir William Stephenson was also into. . . electronics? 'Tis true. By Roger Allan



Pioneers of Electronics Series

THE LIFE OF SIR WILLIAM Stephenson seems to be a study in opposites; great secrecy on the one hand epitomised by his work during the war as the spymaster "Intrepid", juxtaposed with colorful showmanship demonstrated by his film company, Sound City Films, producing half of all films made in Britain during the 1930's. One little known fact about Stephenson is his work as an inventor.

William Samuel Stephenson was born at Point Douglas, a suburb community of Winnipeg on January 11, 1896. His father was a lumber mill owner, a decendent of the Scot settlers brought over by Thomas Douglas, Earl of Selkirk.

Winnipeg in those days possesed a particularly good, if not very elegant, educational system which Stephenson attended by way of the Argyle High School. Unlike so many other inventors, he was a good student, being particularly adept at mathematics. After school hours he liked to box, attaining a position as a reasonably good light-weight on the school team. None who witnessed him in the ring in those days ever expected that one day he would hold the amateur world championship from 1918 to 1923.

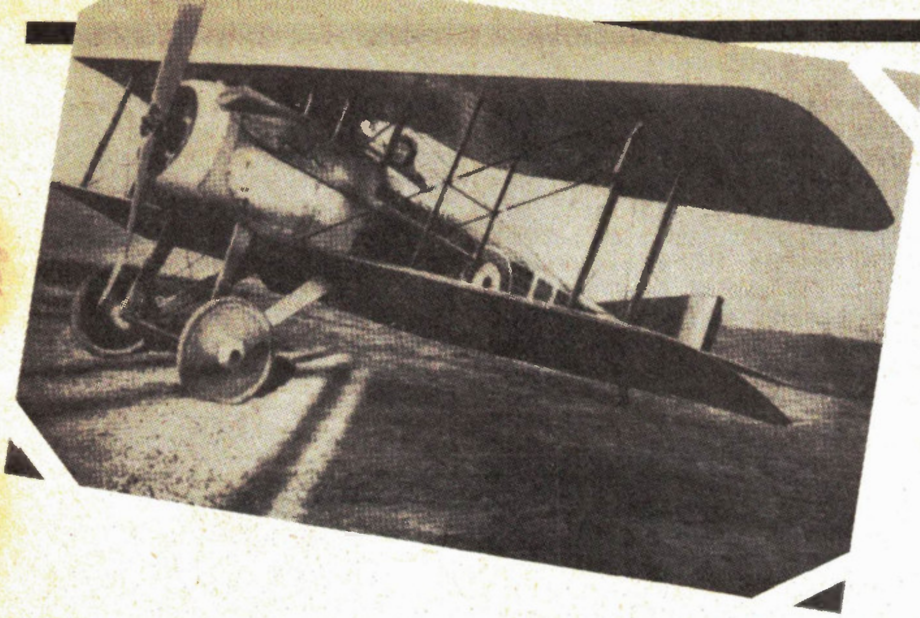
With the commencement of war in 1914, Stephenson joined the Royal Canadian Engineers, was commissioned, sent to the trenches, promoted to Captain and gassed. Invalided to England in 1915, he applied for a transfer to the Royal Flying Corps, and after attaining his wings at Cranbrook was posted to No. 73 Squadron of the RFC in France.

For some time Stephenson was a competant if unspectacular flying officer, being where he should when he should be there, doing what he should be doing. However, casualties being as heavy as they were, he eventually percolated up through the administrative ranks to become one of the two Flight Commanders. Despite this rather unpropitious start, things changed for Stephenson very rapidly in March of 1918.

Stephenson was out on a flight with a Sopwith Camel and got badly beaten up by two enemy fighters. When, after extreme difficulty, he managed to return to base, he was so furious at what had happened that he immediately climbed into another aircraft and returned to action. By the end of the day he had shot down two enemy fighter planes, his first 'kills' of the war.

The catharsis of having been almost shot down appears to have liberated Stephenson's previously restrained killer instincts, for in the next few weeks he shot down no less than eighteen enemy machines and two kite balloons. The story is told of how Stephenson made a bet in the mess one evening that he would "bring back a Hun for breakfast." Early the following morning, while on dawn patrol, he succeeded in downing an enemy machine within a mile of his own aerodrome, winning the bet. One of his victims was Lothar Von Richtofen, brother of the "Red Baron."

But things didn't always go well. During a solo reconnaiss flight on July 28, 1918, Stephenson found a French reconnaissance plane being attacked by seven Fokker fighters. By exemplery use of cover, he succeeded in bringing down two enemy machines and driving off the rest. Pulling alongside the French machine to escort it back to base, the French machine gunner mistook him for another enemy machine. He fired a burst into Stephenson's engine which put it out of action, simultaneously wounding him in the leg. Stephenson crashed in No Man's Land, and crawling out of his now burning aircraft attempted to make it to British lines. An enemy machine gunner succeeded in wounding him



again in the same leg, and he was captured. Sent to Holzminden POW Camp on the River Weser near Brunswick, he promptly engaged in the age old POW game; how to escape. A few weeks before the Armistice he finally succeeded, taking with him a photograph of the camp commandant which he had purloined from his office the previous night.

When Stephenson was demobilized, his exploits had won him the Military Cross, and the Distinguished Flying Cross, as well as the French Legion of Honour and Croix de Guerre with Palm.

After conclusion of the war, Stephenson returned to Winnipeg, where he became interested in his possibilities of radio and television. Unsuccessful hunting for a job in broadcasting on both sides of the border, Stephenson returned to England. He expected to stay for a few months picking up ideas about radio which he hoped he could translate into a broadcasting job back in Canada. He stayed for nineteen years.

The most striking fact about radio in those days, to Stephenson, was the poor response among the public to the possibilities of radio. Determining that this was the area of greatest growth in broadcasting, Stephenson used what little capital he could raise to invest in the General Radio Company and the Cox-Cavendish Electrical Company, which manufactured broadcasting equipment. Within a very short time, Stephenson had persuaded Cox-Cavendish to manufacture cheap but reliable radio sets. They promptly flooded the market.

Stephenson then turned his attention to research, believing that one of the greatest difficulties faced by communications at the time was the inability to send pictures quickly and reliably over great distances. There was a device on the market at the time which for the previous thirty years or so could be used to transmit a wireless photograph. It functioned by taking the original photograph and splitting it into small sections. Each section was then labeled to denote the appropriate degree of light or shade. It was not a particularly successful system, since it was very slow, and the quality of the wireless photograph upon receipt was not very good.

Stephenson determined that a vast improvement in the picture quality could be obtained if the picture itself in some way operated the transmitting device. But first he had to find funds and a chemist to help him.

The London *Daily Mail*, then the largest newspaper in the world, was headed by Lord Northcliffe, a dynamic far-seeing aristocrat. He had recognized the importance of wireless photographic transmission as early as 1908, and had been using his newspaper's funds to try and improve the system. When Stephenson was brought to his attention, Northcliffe immediately offered to help, by way of partially bankrolling Stephenson's experiments at General Radio's laboratory at Twyford.

In those days, the element which was conventionally used to convert light into an electric current was selenium. The difficulty in using this element was its long rate to changes in the input light level. As such, a selenium based device's scan rate of more than a few pixels per second were impossible. For slow facsimile work this was of little importance, but for the transmission of any sort of moving picture, which was Stephenson's ultimate goal, the time-constants were impossibly long. Stephenson and Baker succeeded in producing a substitute for pure selenium.

The next step was to develope a scanning device which could sweep the photograph to be copied exactly and as near automatically as possible. Stephenson rejected the use of mirrors, and returned to the Nipkow disk, developed in 1884 by P. Nipkow.

The Nipkow scanner consists of a circular disk having a number of small holes arranged in a spiral about its center. A scanning disk is placed at the image plane of the pickup device and at the viewing areas of the receiver. As the disk rotates, the holes move across the image field in succession sweeping out a pattern of parallel lines. A light sensitive device is located behind the disk in the pickup device. In moving across the image areas the apertures in the disk allow the light from only one element of the picture at one time to reach the light sensitive element. The light reaching the light sensitive device fluctuates in accordance with the content of the picture, and produces a corresponding fluctuation in the current output, which, in turn, can modulate a transmitter.

A radio receiver receives and demodulates the signal from the transmitter. The signal, after suitable amplification, controls the light output of a light source.

A Nipkow disk rotates in front of this light source. The rate and phase of rotation of the disk is controlled by the synchronizing signal in such a way that an aperature in the receivers' disk is at all times in the same relative position with respect to the image area as the corresponding one in the disk of the transmitter.

Since there is a one-to-one time correspondence between the positions of the apertures in the transmitting and receiving disk, and a similar correspondence between the amount of light passing through the respective apertures, a reproduction of the image at the transmitter will be seen in the plane of the disk at the receiver.

Stephenson modified the Nipkow disk and his shaped selenium substitute making them both more reliable and faster. It then only took a very short time before Stephenson and Baker developed a machine for automatically transmitting wireless photographs.

It is recorded that a visitor to his laboratory was shown a small picture with a parallel line effect reminiscent of a fine half-tone reproduction on the cinema screen and informed, "This photograph was transmitted by our method in twenty seconds. It is only a question of speeding up the apparatus to reduce the twenty seconds to the time necessary for the persistance of vision." Stephenson, in so saying, was thinking ahead to television.

The *Daily Mail* published the first picture transmitted by this process on December 27, 1922, hailing the inventor as 'a brilliant scientist,' and the development of his device 'a great scientific event." The accompanying article went on to say,

"Wireless photography is now an accomplished fact. That is to say, an actual photograph can now be made to operate a wireless transmitting apparatus in such a manner that the photograph is reproduced on sensitive film at some distant station. One of the goals toward which inventors have been working for more than half a century, ever since the transmission of signals by the ordinary telegraph became possible, has been reached; and a new era in illustrated journalism is beginning. The wireless machine can now, automatically, and without the intervention of a human operator, tick out an exact reproduction of a photograph at a distance."

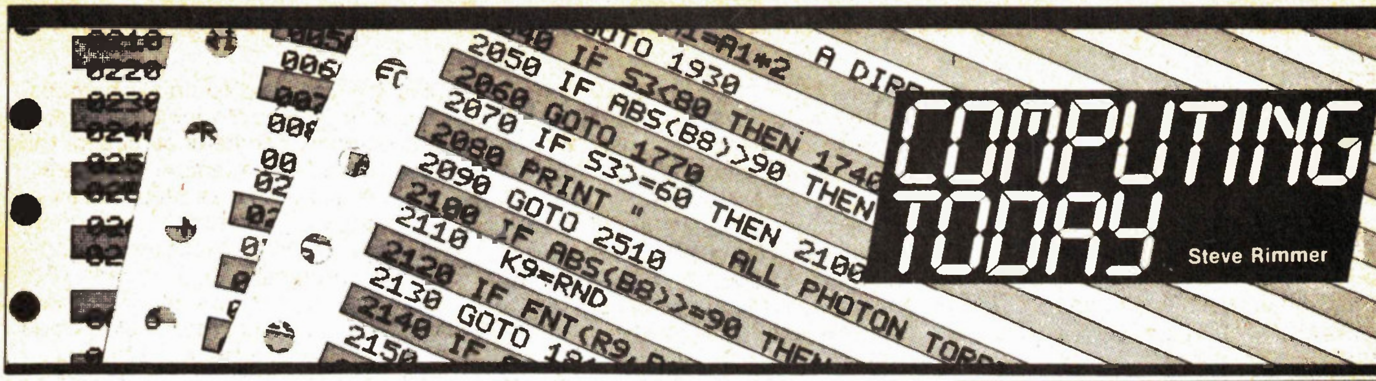
The effect on illustrated journalism was tremendous, with virtually every newspaper who could possible afford a device buying one. The basic process is still used in newspaper photography, all subsequent designs being essentially (despite the use of satellites and laser beams) no more than a speeding up of the process. In the eighteen years that Stephenson's patents protected his invention, his annual royalties averaged $100,000 a year, a very considerable sum in the late twenties and early thirties.

Investing his royalties in industry and commerce, Stephenson by the early '30's owned or controlled a score of companies including Sound City Films, Earls Court Ltd., Catalina Ltd., one of the first manufacturers of plastics, and Pressed Steel, which made 90% of the car bodies built in Britain.

His business led him to all continents, and into contact with a vast range of people, both those in power and those prominent in industry and commerce. It was his work with Pressed Steel which led him to go on many business trips to Germany. From his observations of German rearmament, brought to the attention of Winston Churchill, then out of office, lay the seeds of Stephenson's wartime work in Intelligence. For when Churchill returned to power he needed a man to head British Security Coordination (which he once called 'the Ministry of Ungentlemanly Warfare'). The obvious man was Stephenson.

Married in 1924 to the American, Mary Simmons, Stephenson now lives in retirement in Bermuda. For his wartime work as the now near legendary "Intrepid' he was awarded a knighthood, and later the Order of Canada.

ETI



THIS MONTH we're going to further meditate on the existential metaphysic of 6502 machine language programming by the most splendid and eternal contemplation of some subroutines, oh wandering soul. Yes, sit thyself upon this prayer blanket, shake these magic sticks four times, chant your postal code and load the monitor into your computer.

Shanti. . .

Below BASIC

These programs were devised on a VIC-20 computer using a public domain monitor called VICMON 2, a derivative of SUPERMON. . . the copy of which was kindly provided by Karl Hilden at Commodore. They are, however, generally applicable to any 6502 based computer with a few changes. In any case, it's the ideas we're after here, wisdom and the like. Glory. . . right on.

Let's start with a fairly uncomplicated one. This routine prints out a message. It uses one call to the VIC's ROM, $FFD2, which will print the contents of the accumulator as a character in whatever position is specified by the row and column bytes in page zero. Note that, while this routine simply prints using the VIC's printing routines to move the cursor around, it could be directly manipulated by STA'ing data into these bytes if you felt like it. However, enough of this; the code.

```
        LDX   #$00
LABEL   LDA   $1BA1,X
        JSR   $FFD2
        INX
        CPX   #$20
        BNE   LABEL
        BRK
```

Now, as to what's happening here. . . This routine prints the thirty two character message beginning at location 1BA1 hex. This is a RAM location. . . you should probably install a message of some kind here prior to running this thing, or else expect a couple of lines of randomness. If you're up for probing around in the VIC's ROM, you'll find some of the system messages, and, of course, you can alter the address to point to one of them. There's fairly little point to this, of course.

This routine uses what is called indexed addressing. Normally, one would load the accumulator, LDA, from a specified address somewhere. However, it is possible to specify that it be loaded from an address plus a displacement, in this case specified by the X register. The instruction LDA $1AB1,X, then, is load the accumulator from the adddress ($1AB1+X), from whence it can be printed. As X is an eight bit register, and can hold any number from 00 to FF, or 0 to 255, 256 byte areas of memory can be accessed by this technique.

Roughly about the mind capacity of Mark Lalonde.

The most useful application of this sort of thing is in table scanning, which is what we've done here. The thirty two bytes beginning at 1AB1 are a table containing the characters of the message. Since we know the length before hand, we can scan the table for a predetermined number of entries, using X as both the LDA index and a counter. The CPX statement compares X to 20 hex, which is decimal 32, and branches back for another go until it reaches this magnitude.

Another way to scan tables is to scan until one reaches a specific byte. This is useful when it is not known how long the scan will be. Thus, one could put a CMP statement in, rather than the CPX, which might look for, say, 03 (the stop character), which would have the routine scan until it found this byte.

The danger in this is that there may be no 03's in the 256 byte range, in which case the routine will loop indefinitely. To forestall this nastiness, it is wise to retain the CPX, branching out of the loop when X reaches a value that is clearly beyond the limits of the table.

ROL Over, Beethoven

This next routine is a bit more complex. It's very long to write out, although it's quite economical of actual programming space, as most of the instructions are only one byte long. It takes a byte in memory, stored in location 1203 hex, and prints it as a hexidecimal number.

This is not as simple as it sounds. If 1203 contained the number AF, and this were to be loaded into the accumulator and printed, you wouldn't see AF on the screen, but, rather, the character designated by AF. Hex representation is actually an arbitrary convention, and, as such, some manipulation is required to arrive at it.

If you contemplate on AF for a while, it will become clear, sort of, that A represents the high order nybble, the upper four bits of the byte, and F the low order nybbble. The high nybble contains A, or ten, and the low nybble F, or fifteen. It happens that the high nybble is regarded as being worth sixteen times as much as the low one, but this doesn't really matter for this program, since the actual value of the byte never comes into question.

The process of printing the nybbles is the same for both. The problem is in separating out the two nybbles and reducing them both to hex numbers with the data in the low nybbles. To do this, we needs check out two fairly backwater instructions, ROR and ROL, the bit rotate brothers (Right and Left).

In ROR, rotate one bit right, each bit is shifted one position lower in magnitude. The lowest bit gets stuck in the carry bit, and the previous value of the carry gets dumped into the blank space formed by the vacuum left by the upper bit's leaving. In ROL, the carry takes up the lowest bit position, and, in turn, gets loaded with the value of the highest bit, which gets bumped off the end of the chain.

Profound, I know.

This, then, is the routine. The printing subroutine's at the beginning.

```
PRINT     CLC
          CMP      #$09
          BPL      LABEL 1
          ADC      #$30
          JMP      LABEL 2
LABEL   1 ADC      #$36
LABEL   2 JSR      $FFD2
          RTS
START     LDA      $1203
          CLC
          ROR
          CLC
          ROR
          CLC
          ROR
          CLC
          ROR
          JSR      PRINT
          LDA      $1203
          CLC
          ROL
          CLC
          ROL
          CLC
          ROL
          CLC
          ROL
          ROR
          ROR
          ROR
          ROR
          JSR      PRINT
          BRK
```

The print routine is fairly cool. It requires that the byte in the accumulator be in the range of 0 to 15, or 0 to F hex, which is taken care of by the rest of the program. It compares the accumulator to 09, and, if it is larger, adds hex 36. If it is 9 or less, it adds 30 hex, which produces the characters for 0 to 9. The routine then calls up $FFD2 to print the accumulator.

Now for the tricky bits.

The main routine can be split into two parts, that what gets the high nybble, and that what gets the low nybble. Since the high nybble gets printed first, it is convenient to do first, and, as we'll see, the two parts are independant.

The byte to be printed, located at 1203 hex (you can, of course, put it anywhere you want) is loaded into the accumulator, which is then ROR'd four times. In each case, the carry is set to zero by the CLC instruction. Thus, the high order nybble is passed over to the low order nybble location, and the high order nybble location is filled with four cleared carrys, or four zeros. Thus, effectively, we have moved the high nybble and made it into its own private number. If 1203 held AF, the accumulator would hold 0A after runing this part of the routine, which would cause the printing of "A" when the PRINT subroutine was called.

Filtering the low order byte is a mite different, as, in fact, it is already in the right place; it's just a question of killing off the high order nybble. There are several ways to do this, but, since we're here to check out the rotates, we'll use them.

The four CLC/ROL's in the second part of the routine move the low order nybble into the high order position and filter out the high order bits in exactly the same way as we isolated the high nybble a while back. However, this leaves one with the low order nybble in the wrong place, so it must then be rotated back into the low order spot to be printed.

Hot stuff, what. . .

FILTER your coffee

The last routine to be perused is called FILTER. In many applications, it is desirable to enter characters from the keyboard, but only permit certain ones to be displayed. The rest are trapped and ignored, or some may be used as control characters.

The following is a fairly simple FILTER for inputting a hex address. A lot has been chopped out of it to make it of a useful size for this illustration: since hex addresses are usually four characters long, it would probably want a counter, and you'd probably want to implement DELETE, as well. This routine clears the screen and puts the cursor up in the left hand corner; you might want to use the message printing routine to print ENTER ADDRESS, or the like.

If you make sure that the first character to be entered will be in column 0 of the screen, it is fairly easy to use the cursor position register as a counter, refusing to input anything

but a return when it reaches 04.

It's also cool to STA a 00 in the cursor on/off register, which will set the little fellow to blinkin'.

The masterpiece follows:

```
START     LDA      #$93
PRINT     JSR      $FFD2
CHRGET    JSR      $FFE4
          CMP      #$00
          BEQ      CHRGET
          CMP      #$03
          BNE      LIMIT
          BRK
LIMIT     CMP      #$30
          BMI      CHRGET
          CMP      #$47
          BPL      CHRGET
          CMP      #$3A
          BMI      PRINT
          CMP      #$41
          BPL      PRINT
          JMP      CHRGET
```

First off, the accumulator is loaded with 93, which is the "clear screen" character. Then the print routine at $FFD2 in ROM is called, doing the deed. The other call, $FFE4, is the character getter. Like the BASIC GET statement, it does not wait for a character, but returns a null, 00, if there isn't one present when it shows up. Thus, immediately after it, the accumulator is compared to 00, and, if it turns out to be so, we return unto $FFE4 for another crack.

The next compare is for 03, which is the STOP character. It is done for debugging purposes. If a STOP is encountered, the routine BRKs to the monitor. In a practical program, you'd probably look for 0D, a carriage return, and RTS to the routine that called this code.

The next bit is the actual character filter. First off, it looks for any characters below 30 and above "47" and, finding them, abandons hope and returns to the character getter. These are the limits of "0" and "F" ASCII. Then it filters out the stuff in between "9" and "A", mostly punctuation, only branching to the PRINT call if the character is outside this range. Otherwise, it JMPs back to the character getter for another try.

And that's it.

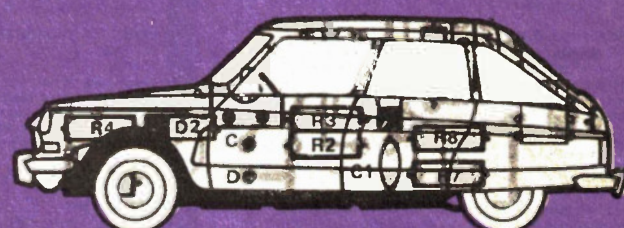
It should be noted that these routines will also run quite happily on PETs and CBMs, as the jump table, of which the $FFD2 and $FFD4 calls are part, is the same in all CBM machines.

ETI

ETI next month

Pest Controller Project

This clever little box scares off cats, dog, squirrels, and giant Chinese panda bears. It also infuriates wildebeests and gnus, though, and is not recommended for use in the African grasslands.

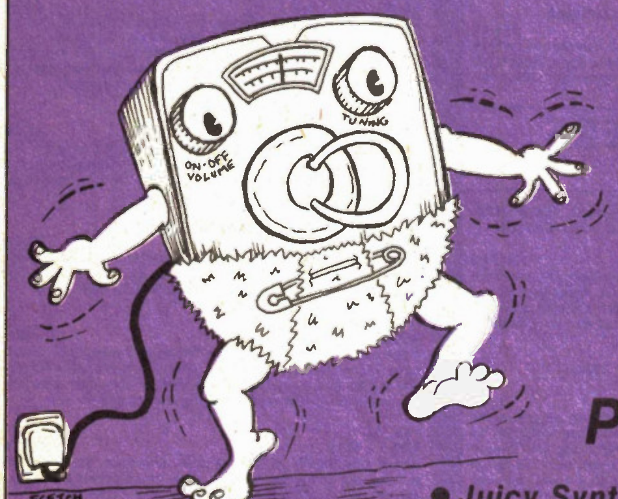


Early Radio

A history of the hardware that tamed the last great frontier. . . livingrooms. Harken back to the days before the Shadow knew, prior to the Inner Sanctum. Roger Allan grows a beard and recollects.

Electronics in Cars

Put a micro-processor in your tank and a zillion LEDs on your dashboard. The computer I/O serves as a light show for long boring trips.



Terminal Project

A do-it-yourself terminal so stuffed full of features and useful nifties that it could have been a food processor. An all time first, from E.T.I.

PLUS!!!

- ***Juicy Synthesizer Part III Parisien***
- ***Delicious Particle Beam Fusion***
- ***Medium-rare DAC-ADC Circuits***
- ***Marinated Ni-Cad Charger***

All served on a bed of brown rice, with bean sprouts, organically grown mushrooms, your choice of dressing and a roast gopher with a tennis ball in its mouth.

ETI book shelf

COMPUTERS
(HARDWARE)

THE ESSENTIAL COMPUTER DICTIONARY AND SPELLER
AB011 **$9.45**
A must for anyone just starting out in the field of computing, be they a businessman, hobbyist or budding computerist. The book presents and defines over 15,000 computer terms and acronyms and makes for great browsing.

A BEGINNER'S GUIDE TO COMPUTERS AND MICROPROCESSORS — WITH PROJECTS.
TAB No.1015 **$13.45**
Here's a plain English introduction to the world of microcomputers — it's capabilities, parts and functions . . . and how you can use one. Numerous projects demonstrate operating principles and lead to the construction of an actual working computer capable of performing many useful functions.

BP66: BEGINNERS GUIDE TO MICROPROCESSORS AND COMPUTING **$7.55**
E.F. SCOTT, M.Sc., C.Eng.
As indicated by the title, this book is intended as an introduction to the basic theory and concepts of binary arithmetic, microprocessor operation and machine language programming.
There are occasions in the text where some background information might be helpful and a Glossary is included at the end of the book.

BP72: A MICROPROCESSOR PRIMER **$7.70**
E.A. PARR, B.Sc., C.Eng., M.I.E.E.
A newcomer to electronics tends to be overwhelmed when first confronted with articles or books on microprocessors. In an attempt to give a painless approach to computing, this small book will start by designing a simple computer and because of its simplicity and logical structure, the language is hopefully easy to learn and understand. In this way, such ideas as Relative Addressing, Index Registers etc. will be developed and it is hoped that these will be seen as logical progressions rather than arbitrary things to be accepted but not understood.

BEGINNERS GUIDE TO MICROPROCESSORS
TAB No.995 **$10.45**
If you aren't sure exactly what a microprocessor is, then this is the book for you. The book takes the beginner from the basic theories and history of these essential devices, right up to some real world hardware applications.

HOW TO BUILD YOUR OWN WORKING MICROCOMPUTER
TAB No.1200 **$16.45**
An excellent reference or how-to manual on building your own microcomputer. All aspects of hardware and software are developed as well as many practical circuits.

BP78: PRACTICAL COMPUTER EXPERIMENTS **$7.30**
E.A. PARR, B.Sc., C.Eng., M.I.E.E.
Curiously most published material on the microprocessor tends to be of two sorts, the first treats the microprocessor as a black box and deals at length with programming and using the "beast". The second type of book deals with the social impact. None of these books deal with the background to the chip, and this is a shame as the basic ideas are both interesting and simple.
This book aims to fill in the background to the microprocessor by constructing typical computer circuits in discrete logic and it is hoped that this will form a useful introduction to devices such as adders, memories, etc. as well as a general source book of logic circuits.

HANDBOOK OF MICROPROCESSOR APPLICATIONS
TAB No.1203 **$14.45**
Highly recommended reading for those who are interested in microprocessors as a means of a accomplishing a specific task. The author discusses two individual microprocessors, the 1802 and the 6800, and how they can be put to use in real world applications.

MICROPROCESSOR/MICROPROGRAMMING HANDBOOK
TAB No.785 **$14.45**
A comprehensive guide to microprocessor hardware and programming. Techniques discussed include subroutines, handling interrupts and program loops

BP102: THE 6809 COMPANION **$8.10**
M. JAMES
The 6809 microprocessor's history, architecture, addressing modes and the instruction set (fully commented) are covered. In addition there are chapters on converting programs from the 6800, programming style, interrupt handling and about the 6809 hardware and software available.

AN INTRODUCTION TO MICROPROCESSORS EXPERIMENTS IN DIGITAL TECHNOLOGY
HB07: **$15.85**
SMITH
A "learn by doing" guide to the use of Integrated circuits provides a foundation for the underlying hardware actions of programming statements. Emphasis is placed on how digital circuitry compares with analog circuitry. Begins with the simplest gates and timers, then introduces the fundamental parts of ICs, detailing the benefits and pitfalls of major IC families, and continues with coverage of the ultimate in integrated complexity — the microprocessor.

DESIGNING MICROCOMPUTER SYSTEMS
HB18: **$15.85**
POOCH AND CHATTERGY
This book provides both hobbyists and electronic engineers with the background information necessary to build microcomputer systems. It discusses the hardware aspects of microcomputer systems. Timing devices are provided to explain sequences of operations in detail. Then, the book goes on to describe three of the most popular microcomputer families: the Intel 8080, Zilog Z-80, and Motorola 6800. Also covered are designs of interfaces for peripheral devices, and information on building microcomputer systems from kits.

S-100 BUS HANDBOOK
HB19: **$22.75**
BURSKY
Here is a comprehensive book that exclusively discusses S-100 bus computer systems and how they are organized. The book covers computer fundamentals, basic electronics, and the parts of the computer. Individual chapters discuss the CPU, memory, input/output, bulk-memory devices, and specialized peripheral controllers. It explains all the operating details of commonly available S-100 systems. Schematic drawings.

BASIC MICROPROCESSORS AND THE 6800
HB06: **$21.45**
Provides two books in one: a basic guide to microprocessors for the beginner, and a complete description of the M6800 system for the engineer.
Each chapter is followed by a problem section.

DIGITAL INTERFACING WITH AN ANALOG WORLD
TAB No.1070 **$14.45**
You've bought a computer, but now you can't make it do anything useful. This book will tell you how to convert real world quantities such as temperature, pressure, force and so on into binary representation.

MICROPROCESSOR INTERFACING HANDBOOK: A/D & D/A
TAB No.1271 **$14.45**
A useful handbook for computerists interested in using their machines in linear applications. Topics discussed include voltage references, op-amps for data conversion, analogue switching and multiplexing and more.

COMPUTER TECHNICIAN'S HANDBOOK
TAB No.554 **$17.45**
Whether you're looking for a career, or you are a service technician, computer repair is an opportunity you should be looking at. The author covers all aspects of digital and computer electronics as well as the mathematical and logical concepts involved.

HOW TO TROUBLESHOOT AND REPAIR MICROCOMPUTERS
AB013 **$10.45**
Learn how to find the cause of a problem or malfunction in the central or peripheral unit of any microcomputer and then repair it. The tips and techniques in this guide can be applied to any equipment that uses the microprocessor as the primary control element.

TROUBLESHOOTING MICROPROCESSORS AND DIGITAL LOGIC
TAB No.1183 **$13.45**
The influence of digital techniques on commercial and home equipment is enormous and increasing yearly. This book discusses digital theory and looks at how to service Video Cassette Recorders, microprocessors and more.

HOW TO DEBUG YOUR PERSONAL COMPUTER
AB012 **$10.45**
When you feel like reaching for a sledge hammer to reduce your computer to fiberglass and epoxy dust, don't. Reach for this book instead and learn all about program bug tracking, recognition and elimination techniques.

COMPUTERS
(SOFTWARE)

HOW TO PROFIT FROM YOUR PERSONAL COMPUTER: PROFESSIONAL, BUSINESS, AND HOME APPLICATIONS
LEWIS
HB01 **$17.00**
Describes the uses of personal computers in common business applications, such as accounting, managing, inventory, sorting mailing lists, and many others. The discussion includes terms, notations, and techniques commonly used by programmers. A full glossary of terms.

PROGRAMS FOR BEGINNERS ON THE TRS-80
BLECHMAN
HB02 **$13.05**
A valuable book of practical and interesting programs for home use that can be understood and used immediately by the beginner in personal computer programming. You'll learn step-by-step how 21 sample TRS-80 programs work. Program techniques are described line-by-line within the programs, and a unique Martri-Dex™ matrix index will enable you to locate other programs using the same BASIC commands and statements.

THE JOY OF MINIS AND MICROS: DATA PROCESSING WITH SMALL COMPUTERS
STEIN AND SHAPIRO
HB03 **$15.85**
A collection of pieces covering technical and management aspects of the use of small computers for business or science. It emphasizes the use of common sense and good systems design for every computer project. Because a strong technical background is not necessary, the book is easy to read and understand. Considerable material is devoted to the question of what size computer should be used for a particular job, and how to choose the right machine for you.

BEGINNER'S GUIDE TO COMPUTER PROGRAMMING
TAB No.574 **$16.45**
Computer programming is an increasingly attractive field to the individual, however many people seem to overlook it as a career. The material in this book has been developed in a logical sequence, from the basic steps to machine language.

USING MICROCOMPUTERS IN BUSINESS
VEIT
HB04 **$14.45**
An essential background briefing for any purchaser of microcomputer systems or software. In a fast-moving style, without the usual buzz words and technical jargon, Veit answers the most often asked questions.

BASIC FROM THE GROUND UP
SIMON
HB15 **$17.00**
Here's a BASIC text for high school students and hobbyists that explores computers and the BASIC language in a simple direct way, without relying on a heavy mathematical backbround on the reader's part. All the features of BASIC are included as well as some of the inside workings of a computer. The book covers one version of each of the BASIC statements and points out some of the variations, leaving readers well prepared to write programs in any version they encounter. A selection of exercises and six worked out problems round out the reader's experience. A glossary and a summary of BASIC statements are included at the end of the book for quick reference.

BASIC COMPUTER PROGRAMS FOR BUSINESS:
STERNBERG (Vol. 1)
HB13 **$15.85**
A must for small businesses utilizing micros as well as for entrepreneurs, volume provides a wealth of practical business applications. Each program is documented with a description of its functions and operation, a listing in BASIC, a symbol table, sample data, and one or more samples.

BP86: AN INTRODUCTION TO BASIC PROGRAMMING TECHNIQUES **$8.25**
S. DALY
This book is based on the author's own experience in learning BASIC and in helping others, mostly beginners, to program and understand the language. Also included are a program library containing various programs, that the author has actually written and run. These are for biorhythms, plotting a graph of Y against X, standard deviation, regression, generating a musical note sequence and a card game. The book is complemented by a number of appendices which include test questions and answers on each chapter and a glossary.

THE BASIC COOKBOOK.
TAB No.1055 **$9.45**
BASIC is a surprisingly powerful language . . . if you understand it completely. This book, picks up where most manufacturers' documentation gives up. With it, any computer owner can develop programs to make the most out of his or her machine.

PET BASIC — TRAINING YOUR PET COMPUTER
AB014 **$16.45**
Officially approved by Commodore, this is the ideal reference book for long time PET owners or novices. In an easy to read and humorous style, this book describes techniques and experiments, all designed to provide a strong understanding of this versatile machine.

PROGRAMMING IN BASIC FOR PERSONAL COMPUTERS
AB015 **$10.45**
This book emphasizes the sort of analytical thinking that lets you use a specific tool — the BASIC language — to transform your own ideas into workable programs. The text is designed to help you to intelligently analyse and design a wide diversity of useful and interesting programs.

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Aimed specifically at TRS-80 users, this book discusses how to load, use and write PASCAL programs. Graphic techniques are discussed and numerous programs are presented.

PASCAL PROGRAMMING FOR THE APPLE
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A great book to upgrade your programming skills to the UCSD Pascal as implemented on the Apple II. Statements and techniques are discussed and there are many practical and ready to run programs.

APPLE MACHINE LANGUAGE PROGRAMMING
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The best way to learn machine language programming the Apple II in no time at all. The book combines colour, graphics, and sound generation together with clear cut demonstrations to help the user learn quickly and effectively.

ALL PRICES INCLUDE SHIPPING

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The Z80 MPU can be found in many machines and is generally acknowledged to be one of the most powerful 8 bit chips around. This book provides an excellent 'right hand' for anyone involved in the application of this popular processor.

HOW TO PROGRAM YOUR PROGRAMMABLE CALCULATOR
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Calculator programming, by its very nature, often is an obstacle to effective use. This book endeavours to show how to use a programmable calculator to its full capabilities. The TI 57 and the HP 33E calculators are discussed although the principles extend to similar models.

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Save time and money with this collection of 114 ready-to-run BASIC programs for the hobbyist and engineer. There are programs to do such statistical operations as means, standard deviation averages, curve-fitting, and interpolation. There are programs that design antennas, filters, attenuators, matching networks, plotting, and histogram programs.

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MICROCOMPUTERS AND THE 3 R'S
DOERR
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This book educates educators on the various ways computers, especially microcomputers, can be used in the classroom. It describes microcomputers, how to organize a computer-based program, the five instructional application types (with examples from subjects such as the hard sciences, life sciences, English, history, and government) and resources listings of today's products. The book includes preprogrammed examples to start up a microcomputer program; while chapters on resources and products direct the reader to useful additional information. All programs are written in the BASIC language.

GAME PLAYING WITH BASIC
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"I must rate this chess program an excellent buy for anyone who loves the game." Kilobaud.
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FREIBERGER AND CHEW
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The first edition was chosen by Library Journal as one of the 100 outstanding sci-tech books of 1978. Now, there's an updated second edition!
Besides offering an introduction to the principles of microcomputers that assumes no previous knowledge on the reader's part, this second edition updates prices, the latest developments in microcomputer technology, and a review of over 100 microcomputer products from over 60 manufacturers.

THE BASIC CONVERSIONS HANDBOOK FOR APPLE, TRS-80, AND PET USERS
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Convert a BASIC program for the TRS-80, Apple II, or PET to the form of BASIC used by any other one of those machines. This is a complete guide to converting Apple II and PET programs to TRS-80, TRS-80 and PET programs to Apple II, TRS-80 and Apple II programs to PET. Equivalent commands are listed for TRS-80 BASIC (Model I, Level II), Applesoft BASIC and PET BASIC, as well as variations for the TRS-80 Model III and Apple Integer BASIC.

SPEAKING PASCAL
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An excellent introduction to programming in the Pascal language! Written in clear, concise, non-mathematical language, the text requires no technical background or previous programming experience on the reader's behalf. Top-down structured analysis and key examples illustrate each new idea and the reader is encouraged to construct programs in an organized manner.

BP33: ELECTRONIC CALCULATOR USERS HANDBOOK **$4.25**
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An invaluable book for all calculator users whatever their age or occupation, or whether they have the simplest or most sophisticated of calculators. Presents formulae, data, methods of calculation, conversion factors, etc., with the calculator user especially in mind, often illustrated with simple examples. Includes the way to calculate using only a simple four function calculator: Trigonometric Functions (Sin, Cos, Tan): Hyperbolic Functions (Sinh, Cosh, Tanh) Logarithms, Square Roots and Powers.

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An understandable guide to BASIC subroutines which enables the reader to avoid tedium, economise on computer time and makes programs run faster. It is a practical rather than a theoretical manual.

PROJECTS

BP48: ELECTRONIC PROJECTS FOR BEGINNERS **$5.90**
F.G. RAYER, T.Eng.(CEI), Assoc.IERE
Another book written by the very experienced author — Mr. F.G. Rayer — and in it the newcomer to electronics, will find a wide range of easily made projects. Also, there are a considerable number of actual component and wiring layouts, to aid the beginner.
Furthermore, a number of projects have been arranged so that they can be constructed without any need for soldering and, thus, avoid the need for a soldering iron.
Also, many of the later projects can be built along the lines as those in the 'No Soldering' section so this may considerably increase the scope of projects which the newcomer can build and use.

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

BP49: POPULAR ELECTRONIC PROJECTS **$6.25**
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.

EXPERIMENTER'S GUIDE TO SOLID STATE ELECTRONIC PROJECTS
AB007 **$9.45**
An ideal sourcebook of Solid State circuits and techniques with many practical circuits. Also included are many useful types of experimenter gear.

BP71: ELECTRONIC HOUSEHOLD PROJECTS **$7.70**
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Some of the most useful and popular electronic construction projects are those that can be used in or around the home. The circuits range from such things as '2 Tone Door Buzzer', Intercom, through Smoke or Gas Detectors to Baby and Freezer Alarms.

BP94: ELECTRONIC PROJECTS FOR CARS AND BOATS **$8.10**
R.A. PENFOLD
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.

BP69: ELECTRONIC GAMES **$7.55**
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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.

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110 THYRISTOR PROJECTS USING SCRs AND TRIACS
MARSTON
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A grab bag of challenging and useful semiconductor projects for the hobbyist, experimenter, and student. The projects range from simple burglar, fire, and water level alarms to sophisticated power control devices for electric tools and trains. Integrated circuits are incorporated wherever their use reduces project costs.

110 CMOS DIGITAL IC PROJECTS
MARSTON
HB23 **$11.75**
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BP76: POWER SUPPLY PROJECTS **$7.30**
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.

BP84: DIGITAL IC PROJECTS **$8.10**
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 **$7.55**
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.

213: ELECTRONIC CIRCUITS FOR MODEL RAILWAYS **$4.50**
M.H. BABANI, B.Sc.(Eng.)
The reader is given constructinal details of how to build a simple model train controller; controller with simulated inertia and a high power controller. A signal system and lighting for model trains is discussed as is the suppression of RF interference from odel railways. The construction of an electronic steam whistle and a model train chuffer is also covered.

BP73: REMOTE CONTROL PROJECTS **$8.60**
OWEN BISHOP
This book is aimed primarily at the electronics enthusiast who wishes to experiment with remote control. Full explanations have been given so that the reader can fully understand how the circuits work and can more easily see how to modify them for other purposes, depending on personal requirements. Not only are radio control systems considered but also infra-red, visible light and ultrasonic systems as are the use of Logic ICs and Pulse position modulation etc.

BP99: MINI—MATRIX BOARD PROJECTS **$8.10**
R.A. PENFOLD
Twenty useful projects which can all be built on a 24 x 10 hole matrix board with copper strips. Includes Doorbuzzer, Low-voltage Alarm, AM Radio, Signal Generator, Projector Timer, Guitar Headphone Amp, Transistor Checker and more.

CIRCUITS

BP98: POPULAR ELECTRONIC CIRCUITS, BOOK 2 **$9.35**
R.A. PENFOLD
70 plus circuits based on modern components aimed at those with some experience.

BP80: POPULAR ELECTRONIC CIRCUITS — BOOK 1 **$8.25**
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.

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The GIANT HANDBOOK OF ELECTRONIC CIRCUITS
TAB No.1300 **$24.45**
About as twice as thick as the Webster's dictionary, and having many more circuit diagrams, this book is ideal for any experimenter who wants to keep amused for several centuries. If there isn't a circuit for it in here, you should have no difficulty convincing yourself you don't really want to build it.

BP39: 50 (FET) FIELD EFFECT TRANSISTOR PROJECTS **$5.50**
F.G. RAYER, T.Eng.(CEI),Assoc.IERE
Field effect transistors (FETs), find application in a wide variety of circuits. The projects described here include radio frequency amplifiers and converters, test equipment and receiver aids, tuners, receivers, mixers and tone controls, as well as various miscellaneous devices which are useful in the home.
This book contains something of particular interest for every class of enthusiast — short wave listener, radio amateur, experimenter or audio devotee.

BP87: SIMPLE L.E.D. CIRCUITS **$5.90**
R.N. SOAR
Since it first appeared in 1977, Mr. R.N. Soar's book has proved very popular. The author has developed a further range of circuits and these are included in Book 2. Projects include a Transistor Tester, Various Voltage Regulators, Testers and so on.

BP42: 50 SIMPLE L.E.D. CIRCUITS **$3.55**
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.

BP82: ELECTRONIC PROJECTS USING SOLAR CELLS **$8.10**
OWEN BISHOP
The book contains simple circuits, almost all of which operate at low voltage and low currents, making them suitable for being powered by a small array of silicon cells. The projects cover a wide range from a bicycle speedometer to a novelty 'Duck Shoot', a number of power supply circuits are included.

BP37: 50 PROJECTS USING RELAYS, SCR's & TRIACS **$5.50**
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.

BP44: IC 555 PROJECTS **$7.55**
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.

BP24: 50 PROJECTS USING IC741 **$4.25**
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 **$8.20**
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.

BP65: SINGLE IC PROJECTS **$6.55**
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.

BP97: IC PROJECTS FOR BEGINNERS **$8.10**
F.G. RAYER
Covers power supplies, radio, audio, oscillators, timers and switches. Aimed at the less experienced reader, the components used are popular and inexpensive.

BP88: HOW TO USE OP AMPS **$9.35**
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.

IC ARRAY COOKBOOK
JUNG
HB26 **$14.25**
A practical handbook aimed at solving electronic circuit application problems by using IC arrays. An IC array, unlike specific-purpose ICs, is made up of uncommitted IC active devices, such as transistors, resistors, etc. This book covers the basic types of such ICs and illustrates with examples how to design with them. Circuit examples are included, as well as general design information useful in applying arrays.

BP50: IC LM3900 PROJECTS **$5.90**
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.

223: 50 PROJECTS USING IC CA3130 **$5.50**
R.A.PENFOLD
In this book, the author has designed and developed a number of interesting and useful projects which are divided into five general categories: I — Audio Projects II — R.F. Projects III — Test Equipment IV — Household Projects V — Miscellaneous Projects.

224: 50 CMOS IC PROJECTS **$4.25**
R.A. PENFOLD
CMOS IC's are probably the most versatile range of digital devices for use by the amateur enthusiast. They are suitable for an extraordinary wide range of applications and are also some of the most inexpensive and easily available types of IC.
Mr. R.A. Penfold has designed and developed a number of interesting and useful projects which are divided into four general categories: I — Multivibrators II — Amplifiers and Oscillators III — Trigger Devices IV — Special Devices.

THE ACTIVE FILTER HANDBOOK
TAB No.1133 **$11.45**
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.

DIGITAL ICS — HOW THEY WORK AND HOW TO USE THEM
AB004 **$10.45**
An excellent primer on the fundamentals of digital electronics. This book discusses the nature of gates and related concepts and also deals with the problems inherent to practical digital circuits.

MASTER HANDBOOK OF 1001 PRACTICAL CIRCUITS
TAB No.800 **$20.45**
MASTER HANDBOOK OF 1001 MORE PRACTICAL CIRCUITS
TAB No.804 **$19.45**
Here are transistor and IC circuits for just about any application you might have. An ideal source book for the engineer, technician or hobbyist. Circuits are classified according to function, and all sections appear in alphabetical order.

THE MASTER IC COOKBOOK
TAB No.1199 **$16.45**
If you've ever tried to find specs for a so called 'standard' chip, then you'll appreciate this book. C.L. Hallmark has compiled specs and pinout for most types of ICs that you'd ever want to use.

ELECTRONIC DESIGN WITH OFF THE SHELF INTEGRATED CIRCUITS
AB016 **$10.45**
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.

BP35: HANDBOOK OF IC AUDIO PRE-AMPLIFIER AND POWER AMPLIFIER CONSTRUCTION **$5.50**
F.G.RAYER, T.Eng.(CEI),Assoc.IERE
This book is divided into three parts: Part I, understanding audio IC's, Part II, Pre-amplifiers, Mixers and Tone Controls, Part III Power Amplifiers and Supplies. Includes practical constructional details of pure IC and Hybrid IC and Transistor designs from about 250mW to 100W output.

BP47: MOBILE DISCOTHEQUE HANDBOOK **$5.90**
COLIN CARSON
The vast majority of people who start up "Mobile Discos" know very little about their equipment or even what to buy. Many people have wasted a "small fortune" on poor, unnecessary or badly matched apparatus.
The aim of this book is to give you enough information to enable you to have a better understanding of many aspects of "disco" gear.

HOW TO BUILD A SMALL BUDGET RECORDING STUDIO FROM SCRATCH. . .
TAB No.1166 **$16.45**
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 **$5.50**
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.

BP74: ELECTRONIC MUSIC PROJECTS **$7.70**
R.A. PENFOLD
Although one of the more recent branches of amateur electronics, electronic music has now become extremely popular and there are many projects which fall into this category. The purpose of this book is to provide the constructor with a number of practical circuits for the less complex items of electronic music equipment, including such things as a Fuzz Box, Waa-Waa Pedal, Sustain Unit, Reverberation and Phaser-Units, Tremelo Generator etc.

BP81: ELECTRONIC SYNTHESISER PROJECTS **$7.30**
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 **$10.45**
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.

AUDIO

BP90: AUDIO PROJECTS **$8.10**
F.G. RAYER
Covers in detail the construction of a wide range of audio projects. The text has been divided into preamplifiers and mixers, power amplifiers, tone controls and matching and miscellaneous projects.

HOW TO DESIGN, BUILD, AND TEST COMPLETE SPEAKER SYSTEMS.
TAB No.1064 **$13.45**
By far the greatest savings in assembling an audio system can be realized from the construction of speakers. This book contains information to build a variety of speakers as well as instructions on how to design your own.

205: FIRST BOOK OF HI-FI LOUDSPEAKER ENCLOSURES **$3.55**
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.

TEST EQUIPMENT

BP75: ELECTRONIC TEST EQUIPMENT CONSTRUCTION **$7.30**
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.

99 TEST EQUIPMENT PROJECTS YOU CAN BUILD
TAB No.805 **$14.45**
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!

HOW TO GET THE MOST OUT OF LOW COST TEST EQUIPMENT
AB017 **$9.45**
Whether you want to get your vintage 1960 'TestRite' signal generator working, or you've got something to measure with nothing to measure it with, this is the book for you. The author discusses how to maximize the usefulness of cheap test gear, how to upgrade old equipment, and effective test set ups.

THE POWER SUPPLY HANDBOOK
TAB No.806 **$16.45**
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.

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.

ELECTRONIC TROUBLESHOOTING HANDBOOK
AB019 **$9.45**
This workbench guide can show you how to pinpoint circuit troubles in minutes, how to test anything electronic, and how to get the most out of low cost test equipment. You can use any and all of the time-saving shortcuts to rapidly locate and repair all types of electronic equipment malfunctions.

COMPLETE GUIDE TO READING SCHEMATIC DIAGRAMS
AB018 **$9.45**
A complete guide on how to read and understand schematic diagrams. The book teaches how to recognize basic circuits and identify component functions. Useful for technicians and hobbyists who want to avoid a lot of headscratching.

RADIO AND COMMUNICATIONS

BP79: RADIO CONTROL FOR BEGINNERS **$7.30**
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.

BP96: CB PROJECTS **$8.10**
R.A. PENFOLD
Projects include speech processor, aerial booster, cordless mike, aerial and harmonic filters, field strength meter, power supply, CB receiver and more.

BP91: AN INTRODUCTION TO RADIO DXing **$8.10**
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.

SHORTWAVE CIRCUITS & GEAR FOR EXPERIMENTERS & RADIO HAMS
No. 215 **$3.70**
Covers constructional details of a number of projects for the shortwave enthusiast and radio "Ham". Included are: an add-in crystal filter, adding an "S" meter in your receiver; crystal locked H.F. Receiver; AM tuner using phase locked loop; coverter for 2MHz, 40 to 800 MHz RF amplifier, Aerials for the 52, 144MHz bands, Solid State Crystal Frequency Calibrator, etc.

BP92: ELECTRONICS SIMPLIFIED—CRYSTAL SET CONSTRUCTION **$7.30**
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.

AUDIO AND VIDEO INTERFERENCE CURES
KAHANER
HB21 **$9.05**
A practical work about interference causes and cures that affect TV, radio, hi-fi, CB, and other devices. Provides all the information needed to stop interference. Schematic wiring diagrams of filters for all types of receivers and transmitters are included. Also, it supplies simple filter diagrams to eliminate radio and TV interference caused by noisy home appliances, neon lights, motors, etc.

Book Of The Month

BASIC Conversion Handbook ....HB17 ....$11.75

So, you have a BASIC asteroids program for your 8K PET. A bit slow, a bit low in resolution and a bit of a problem, as it was originally written for an Apple. Hey, no sweat. Just buy this amazing little book and convert.

This magnificent tome is a complete translation guide for BASIC software written for TRS-80's, PETs/CBMs and Apples, and will permit the modification of most software written for one of these systems to be adapted for use with any of the others. An ideal reference source for those who like to exchange software or enter programs from magazines.

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.

REFERENCE

THE BEGINNER'S HANDBOOK OF ELECTRONICS
AB003 **$9.45**
An excellent textbook for those interested in the fundamentals of Electronics. This book covers all major aspects of power supplies, amplifiers, oscillators, radio, television and more.

ELEMENTS OF ELECTRONICS — AN ON-GOING SERIES
F.A. WILSON, C.G.I.A., C.Eng.,
BP62: BOOK 1. The Simple Electronic Circuit and Components **$8.95**
BP63: BOOK 2. Alternating Current Theory **$8.95**
BP64: BOOK 3. Semiconductor Technology **$8.95**
BP77: BOOK 4. Microprocessing Systems And Circuits **$12.30**
BP89: BOOK 5. Communication **$12.30**
The aim of this series of books can be stated quite simply — it is to provide an inexpensive introduction to modern electronics so that the reader will start on the right road by thoroughly understanding the fundamental principles involved.

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

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

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

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

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

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

BOOK 5: A book covering the whole communication scene.

BP85: INTERNATIONAL TRANSISTOR EQUIVALENTS GUIDE **$12.25**
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.

BP1: FIRST BOOK OF TRANSISTOR EQUIVALENTS AND SUBSTITUTES **$2.80**
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 **$4.80**
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 **$13.45**
This book contains a wealth of useful data on over 5,000 Op-amps and linear ICs — both pinouts and essential characteristics. A comprehensive series of appendices contain information on specs, manufacturers, case outlines and so on.

CMOS DATABOOK
TAB No.984 **$14.45**
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.

MISCELLANEOUS

BP68: CHOOSING AND USING YOUR HI-FI **$7.25**
MAURICE L. JAY
The main aim of this book is to provide the reader with the fundamental information necessary to enable him to make a satisfactory choice from the extensive range of hi-fi equipment now on the market.

Help is given to the reader in understanding the equipment he is interested in buying and the author also gives his own opinion of the minimum standards and specifications one should look for. The book also offers helpful advice on how to use your hi-fi properly so as to realise its potential. A Glossary of terms is also included.

BP101: HOW TO IDENTIFY UNMARKED IC'S **$2.70**
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.

SIMPLIFIED TRANSISTOR THEORY
TRAINING SYSTEMS, INC. AND LEVINE
HB20 **$10.25**
This book is designed to provide thorough comprehension of the physical theory and basic operating principles of transistors and transistor circuits. The book assumes no previous knowledge of the subject other than an understanding of basic electricity.

The information is presented in a series of brief, logically-developed steps, or frames—over 400 in all. A concluding summary section provides both a concise review and a convenient reference source for future use.

BASIC TELEPHONE SWITCHING SYSTEMS
TALLEY
H827 **$15.25**
The Revised Second Edition of this book, for trainee and engineer alike, includes updated statistical data on telephone stations, and new and improved signaling methods and switching techniques. It also includes E & M signaling interface for electronic central offices and automatic number identification methods used in step-by-step, panel and crossbar central offices.

INTERRELATED INTEGRATED ELECTRONICS CIRCUITS FOR THE RADIO AMATEUR, TECHNICIAN, HOBBYIST AND CB'ER
MENDELSON
HB29 **$11.35**
This book provides a variety of appealing projects that can be constructed by anyone from the hobbyist to the engineer. Construction details, layouts, and photographs are provided to simplify duplication. While most of the circuits are shown on printed circuit boards, every one can be duplicated on hand-wired, perforated boards. Each project is related to another projects so that several may be combined into a single package. The projects, divided into five major groups, include CMOS audio modules, passive devices tohelp in benchwork, test instruments, and games.

BASIC CARRIER TELEPHONY, THIRD EDITION
TALLEY
HB28 **$14.45**
A basic course in the principles and applications of carrier telephony and its place in the overall communications picture. It is abundantly illustrated, with questions and problems throughout, and requires a minimum of mathematics.

ROBOTICS

THE COMPLETE HANDBOOK OF ROBOTICS
TAB No.1071 **$13.45**
All the information you need to build a walking, talking mechanical friend appears in this book. Your robot can take many forms and various options — light, sound, and proximity sensors — are covered in depth.

HOW TO BUILD YOUR OWN SELF PROGRAMMING ROBOT
TAB No.1241 **$13.45**
A practical guide on how to build a robot capable of learning how to adapt to a changing enviroment. The creature developed in the book, Rodney, is fully self programming, can develop theories to deal with situations and apply those theories in future circumstances.

BUILD YOUR OWN WORKING ROBOT
TAB No.841 **$11.45**
Contains complete plans — mechanical, schematics, logic diagrams and wiring diagrams — for building Buster. Buster is a sophisticated experiment in cyhernetics you can build in stages. There are two phases involved: first Buster is leash led, dependent on his creator for guidance; the second phase makes Buster more independent and able to get out of tough situations.

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Ace 100 Review

What's sweeter than an Apple? Some say an ACE. Have you ever bitten into an ACE. . . you get cardboard between your teeth most of the time. By Steve Rimmer.

The ACE 100 doesn't look all that much like an Apple II. . . until you get the cover off. Then the resemblance is more than passing. The main circuit board has some definite parentage in that of the Apple. Franklin Computers, the manufacturer of the ACE, however, has never tried to disguise the fact that the ACE is an Apple in sheep's clothing.

The Apple II has become something of a standard among users of small and medium sized systems, not only for home use, but in business as well. It is not unusual to find large companies that put an Apple on every desk. It is a workable marriage between versatile hardware and well written software. However, it is not without its drawbacks.

Chief among these is that, in its pristine state, the Apple II cannot manage lower case characters. There are several lower case adapters around for the Apple, however, these entail some drawbacks of their own. Secondly, the Apple's internal power supply, while more than adequate to power the computer itself, can get a little strained if asked to run a full house of peripherals and gadgets.

It is to these limitations that the ACE speaks. . . with a two inch speaker glued to the bottom of its case, actualy.

A Short Look

Franklin was not willing to loan us an ACE for the minimum two weeks that we usually require to do a thorough review of a system. . . we got it for three days. Apparently, these things are selling rather quickly, and are in very short supply. As such, we have not had a chance to check out all the features of the thing. If you're up for getting an ACE of your own, it might be a good trip to check out an Apple II, as the operating systems are, as near as we could tell, identical.

To assess just how identical the firmware was between the two machines, we used the LIST (Disassembly) function of the Autostart ROM monitor to display some chucks of the ROMs' contents as source code. The ones we looked at were dead on the same. The folks at Franklin claim that anything that will run on or plug into an Apple II will be quite content with an ACE, and this would suggest that it's true.

Plus, of course, applications such as word processing don't entail any extra hardware or software to get a full character set. The ACE also has a separate numeric keypad for data entry and specialized keys to run VisiCalc.

Physically, the ACE seems to be very ruggedly put together. The case is of very thick plastic, and doesn't twist or bend at all. The top is held on with five bolts, as opposed to that of the Apple, which snaps on and off. This is a bit less convenient for plugging and unplugging cards, but one does not usually do a lot of this in the day to day use of one's computer.

The circuitry of the ACE is, obviously, not exactly the same as that of the Apple. For one thing, there seems to be room for six additional ROMs, although the PCB positions for them have not been filled in with blank sockets. There are fewer small scale chips. . . presumably because the ACE is of more recent design.

One important difference is that, because of some Apple patents in this area, the Ace does not have colour. Not a drag if you have a green monitor, of course.

While the ads for the ACE claim that it has 64K of RAM, this is a bit misleading. There is 48K on board, just like the Apple's, and a 16K RAM card plugged into one of the bus slots. In fact, you can do the same thing with an Apple; 16K cards are available from a number of sources. Also keep in mind that from this total comes the video RAM, the operating system RAM, the ROMs and, if you use a language other than the BASIC in ROM, quite a lot of RAM is occupied by this.

The ACE we were given came with one disk drive and a disk (you'd expect that) having both Applesoft and Interger BASICs. These functioned just like the software for a real Apple. We sort of suspected they would. There were several disk utilities also provided.

Five Aces?

There are some very good trips involved in the ACE. It's a bit cheaper than an Apple. It has several attractive features that the Apple doesn't have. It will run all of the Apple's software, and it seems to be more suited to heavy use, as in business applications or for people who like to go on programming binges for three days straight. Its larger, fan cooled power supply is a nice touch for peripheral collectors.

We were unable to evaluate the ACE's documentation, as it was inadvertantly left out of our review sample. (You do normally get the appropriate paperwork, and we are told that much attention has been lavished upon it. We don't hold this oversight against Combitec; something always goes wrong when you are trying to get a system together to show off to someone. We're fairly grateful it didn't explode.)

Questions one might ask ones-self, however, prior to calling Visa for a two grand extension, are things like "Who is Franklin?", "Will they still be around next month if it should happen to croak?", and suchlike.

The history of Franklin is quite interesting. In fact, one of the dudes involved was, at one time, an Apple dealer who got pruned during one of Apple's merry distributor pogroms. At the time, Franklin was building a Z80 based, CP/M type business system. Seeing that Apple was doing a fair number of weirdnesses right then, they decided that there might be a place for a wax Apple. The rest is history; they became a rumour in their own time. . . bring down the expected legal unrest upon their heads in the process, of course, now largely settled.

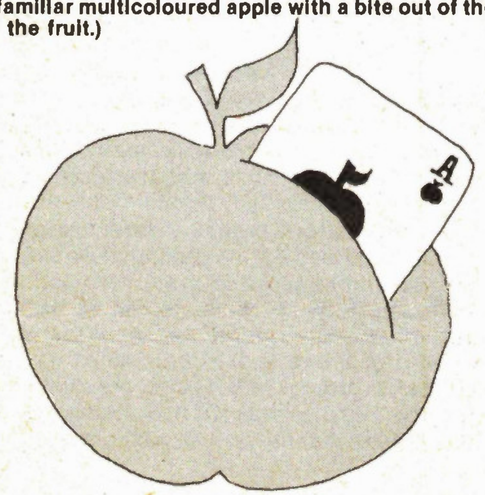
The ACE seems to be a good trip if you are considering an Apple II. It has great software, lots of gadgets and a tried design. It's sturdy, robustly build and, while not quite so aesthetically pleasing as an Apple. . . there is no fruit on it. . . it's still quite agreeable.

The price, behind door number three, is $2388, which is not small change. Bereft of its extra 16 K of RAM, it hails for $2188. Details and a peek under the hood can be arranged through Franklin, 1 Scarsdale Road, Don Mills, Ontario M3B 2R2

I don't know, though. . . I think I'd miss the fruit.

(Serious Apple observers may have noted that there have been quite a few candied Apples, plastic Apples, fallen Apples and otherwise non-Apple duplications of this popular system. We are informed by one fellow that there is a Japanese Apple copy (available only in Japan) which is identical to the Apple, right down to the case and logo. . . except that the latter consists of the familiar multicoloured apple with a bite out of the wrong side of the fruit.)

ETI



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variation in component values, expressed in statistical form is fed into the computer, which calculates the maximum percentage of stock items that can be utilised in this way while keeping the filter characteristics within tolerance. Finally, permissible combinations of component values are worked out and incorporated in the instructions for assembling the networks on the production line.

Experts Rule OK?

It will now be clear why the standard of reproduction potentially attainable with a modern high-quality system cannot be realised by the home constructor with an assemblage of ready-made networks and drive units selected simply on the basis of their nominal frequency range, impedance and sensitivity ratings. Attempts have been made to improve this situation by publishing descriptions of complete loudspeakers incorporating commerically available drive units, and giving circuit details of the filters to be used. The success of such designs, however, depends on the extent to which the author has taken into account all the factors referred to and has been able to measure the electro-acoustic characteristics of each type of unit specified allowing for manufacturing tolerances before attempting to determine the appropriate network parameters.

On the other hand, those manufacturers who have good facilities for acoustic measurement are usually well aware of the various pitfalls in filter design, and by means of computerised data-handling methods are able to produce the components of a multi-way loudspeaker in matched sets. These techniques ensure that the end product, whether in the form of a kit for assembly in an enclosure of prescribed construction(such as the four-way loudspeaker project in ETI), or a complete system, represents the best combination of performance and cost-effectiveness that modern technology can provide. ETI

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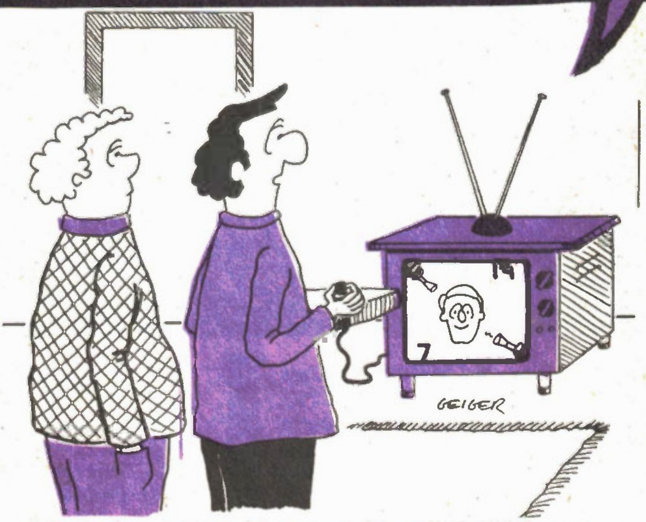
Peanuts By Charles Schulz

The Fun of Electronics



It's the latest atari video game. It's called 'Kill George Plimpton'.

"Now that I've finished building the computer I discover I've had the plans upside-down! I'll have to start all over again."

"You seem to have misinterpreted me when I said we needed more RAM."

We've got to move his crib farther from your radio. He spoke his first words to day; he said "dit dit dah dit dah dit."

"The plans to build the computer were so complicated we had to buy a computer to figure them out."

"Is it wishful thinking to want a 50 MHz portable scope with 1 mV/div sensitivity for under $2,600?"

HITACHI HEARD YOU.

Not since Hitachi introduced the dual trace, delayed sweep V-509. For only $2,590 you get a dynamic range of 8 full divisions. Sensitivity to 1 mV/div at 10 MHz. And sweep times down to 10 ns/div. For today's sophisticated electronics, computers and VTRs, it's the perfect field service tool.

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Hitachi's human engineering is evident in every facet of V-509 design. Its bright, 3.5" diagonal CRT is easy to read. Functionally grouped front-panel controls make for fast, efficient use.

Also from Hitachi is the V-209, list price $1,450. A 20 MHz, dual trace, mini-portable scope with many of the same performance and ease-of-use features as the V-509.

So if you're thinking about purchasing a mini-portable scope, you know who to think of.

Hitachi Denshi Ltd. (Canada)
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A public exhibition of consumer electronic technology for the home, school and office.

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Thursday, September 16	1 p.m. - 10 p.m.
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"QUALITY AND VALUE" QUANTITY IN THIS PAK 1 — DD-615 $2.	"DOUBLE DOLLAR PAKS" QUANTITY IN THIS PAK 1 — Adapter 3.5mm stereo plug to standard stereo phone jack — DD-677 $2.	"QUALITY AND VALUE" QUANTITY IN THIS PAK 1 — Adapter 3.5mm stereo jack to standard stereo phone plug — DD-678 $2.	"DOUBLE DOLLAR PAKS" QUANTITY IN THIS PAK 2 — SOLDER — DD-746 $2.	"QUALITY AND VALUE" QUANTITY IN THIS PAK 3 — MINI I.C. CLIP — DD-747 $2.	"QUALITY AND VALUE" QUANTITY IN THIS PAK 2 — 2N3055 — DD-865 $2.	"QUALITY AND VALUE" QUANTITY IN THIS PAK 3 — TIP29C NPN3A 100V — DD-867 $2.
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DD-S17 - 22K 5%
DD-S18 - 39K 5%
DD-S19 - 120K 5%
DD-S20 - 180K 5%
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"DOUBLE DOLLAR PAKS"

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Circle No.15 on Reader Service Card.

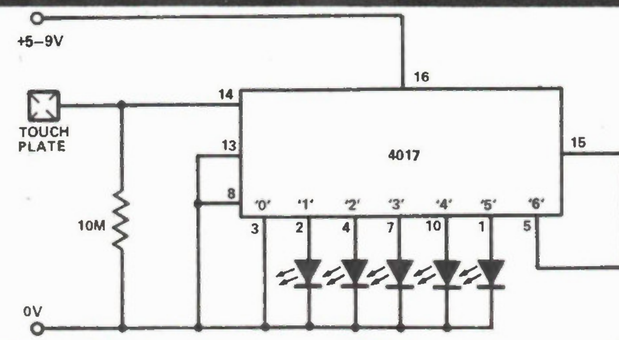
One IC Dice

P. Heap

This must surely be the simplest possible electronic dice; it uses one IC, one resistor and six LEDs. Operation of the circuit is as follows. Normally the resistor keeps the input to the 4017 low and one LED is illuminated. When the plate is touched, line hum is injected into the circuit by the finger. These input pulses are counted by the 4017, making the LEDs flash too quickly to see the number displayed. When the finger is removed the 4017 stops counting and a steady display is obtained.

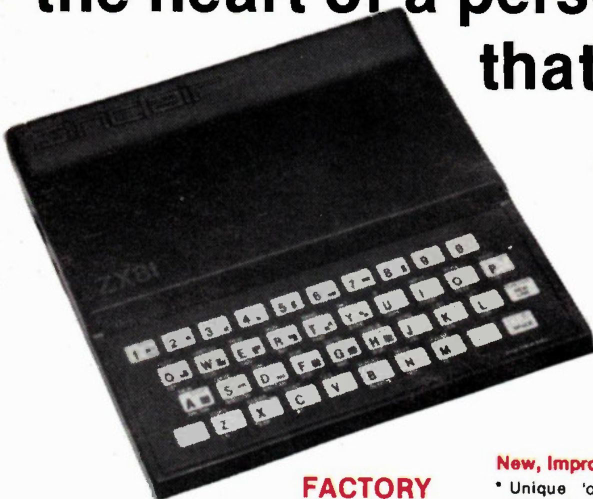
This principle has other applications: it could be used to clock a binary counter or applied to a gate and used to provide a general-purpose 60 Hz clock. If the resistor is removed and the touch plate made large enough, sufficient hum is picked up to cause the circuit to count on its own.

The outputs of the 4017 could easily be decoded, using a diode matrix, to produce a proper dice display. However, this increases circuit complexity and extra driver transistors would probably be needed.



Sinclair ZX81 Kit.

the heart of a personal computer system that grows with you.



EASY-TO-BUILD

Kit: $109.95

$169.95

FACTORY ASSEMBLED $159.95

Lower price: higher capability.

Sinclair's new ZX81 personal computer is a tremendous advance over the highly successful ZX80. It offers far more computer capability, yet Gladstone Electronics is able to offer the ZX81 in kit form at **half the ZX80 price!**

How is it possible? Quite simply, by design. The ZX81 uses only 4 chips (as opposed to 21 in the original ZX80). The secret lies in the totally new Master chip. Designed by and custom-manufactured for Sinclair, this unique chip replaces 18 chips from the ZX80.

Easy-to-build Kit.

And because the chips have been reduced to only four, the kit is incredibly simple to build. A couple of hours work with a fine-tipped soldering iron and the ZX81 is ready to use.

The ZX81's advanced capability.

The ZX81 uses the same fast microprocessor (Z80A), but incorporates a new, more powerful 8K BASIC ROM — the "trained intelligence" of the computer. This chip works in decimals, handles logs and trig, allows you to plot graphs, and builds up animated displays. And the ZX81 incorporates other operation refinements — the facility to load and save named programs on cassette, or to select a program off a cassette through the keyboard.

New, improved specification.

- Unique 'one-touch' key word entry: the ZX81 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 funcions accurate to eight decimal places.
- 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.
- 1K-byte RAM expandable
- Full editing facilities.
- Able to drive the new Sinclair ZX Printer

Kit builder guarantee:

If for any reason should you be unable to complete your ZX81 kit, you may return it with a cheque for $25.00, and it will be completed and returned to you.

Uses standard TV & cassette.

Your ZX81 connects directly to colour or black & white television for a 32 character x 24 line display. You can store programs on a standard cassette recorder. All the connecting cables you require for TV and cassette are provided.

Sinclair ZX Printer

Designed exclusively for use with the ZX81 (and ZX80 with 8K basic ROM), the printer offers full alphanumerics and highly sophisticated graphics. COPY command prints out exactly what is on screen. At last you can have a hard copy of your program listing and results. Printing speed is 50 characters per second, with 32 characters per line and 9 lines per vertical inch. Connects to rear of ZX81 — using a stackable connector so you can use a RAM pack as well. A 65 ft paper roll, instructions included. Requires 9 volts, 1.2 amp power supply (option extra).

Sinclair 16K RAM Pack 99.95

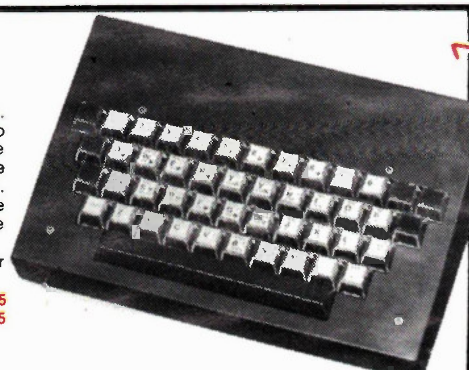
Provides massive add-on memory in a compact plug-in module via an edge connector. Can be used for program storage or as database. Yet it costs as little as half the price of competitive memory.

ZX81 Professional Keyboard and Case

A full-sized professional keyboard for the ZX81. Features 47 keys and a full-sized space bar. Connects to the ZX81 with no soldering required, via a plug-in flexible connector. You can purchase the keyboard only, or the optional metal case that holds both keyboard and ZX81. Expansion devices (i.e. RAM packs, etc) connect to the ZX81 edge-connector which extends from the rear of the cabinet.

A professional keyboard makes program entry easier and less error-prone.

Keyboard (KB-1) $119.95
Metal case for keyboard and ZX81 (MC-1) $29.95



ZX99 Tape Control System for the ZX81.

A sophisticated extension to the ZX81, providing the following additional capabilities:

- Full software control of up to four cassette recorders
- The ability to use tape as a storage medium for data files
- Automatic tape copy
- Output to printers using RS232C interface and ASCII character code
- Tape block skip without destroying the contents of memory
- Automatic program listing via the RS232C printer output.

The ZX99 has its own internal 2K ROM. Connects to ZX81 edge connector and provides connection for extension units (RAM packs, ZX Printer, etc). Complete with comprehensive manual.

ZX99 Tape Control System $219.95

NEW 32K RAM

•May be used with Sinclair 16K RAM to give a total system memory of 48K RAM! Unit simply plugs into back of ZX81 and existing 16K RAM "piggy backs" on. May also be used instead of 16K. Greatly extends the capacity of the ZX81 to store masses of data and longer programmes.

Memotech Memopak 32K $179.95

64K RAM.

The maximum the ZX81 can address. With 64K your ZX81 is transformed into an extremely powerful computer for business, leisure, and educational use, at a fraction of the cost of comparable systems.

Memotech Memopack 64K $259.95

MULTIFILE PLUS — Data Storage System

Newly upgraded to work with all ZX81 systems from 16 to 64K. Greater memory provides greater number of data files. User-definable headings in the most flexible and useful program available for ZX81. Complete with program tape, 3 data storage tapes, 8-page manual, and storage case. $44.95

AC Adapters (Optional extra)

AC-1	ZX81 only	$ 9.95
AC-2	ZX81 with memory	$19.95
MC-1	ZX81, memory printer, etc	$29.95

Circle No.28 on Reader Service Card.

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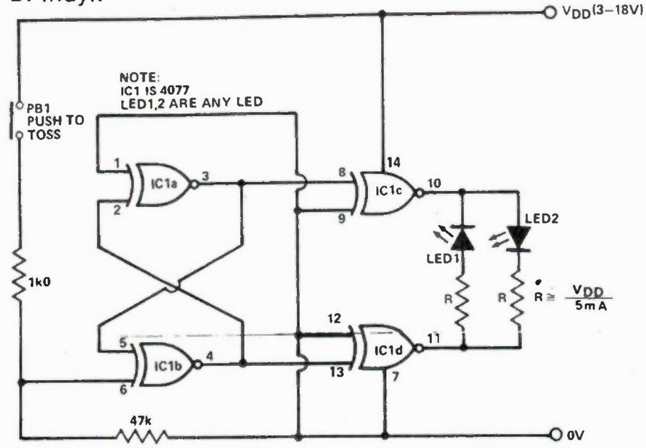
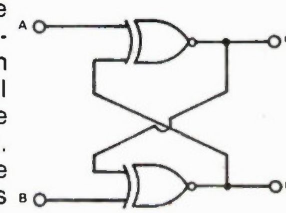
GLADSTONE ELECTRONICS

Heads Or Tails

D. Indyk

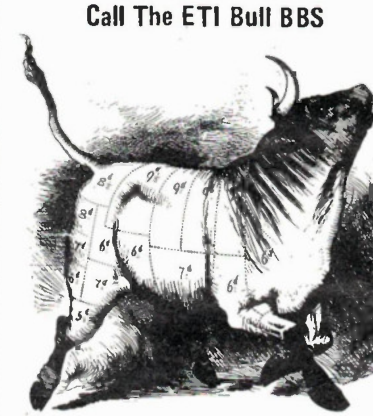


An ultra-simple heads or tails indicator can be built using a single 4077 EXNOR IC. The circuit is normally in a latched bistable mode; when the switch is closed the circuit will oscillate, ie toss the coin. The astable frequency is approximately 5-10 MHz. If desired a small push-to-make switch can be connected in series with the battery as an on/off switch, such that the battery will be disconnected from the circuit unless the device is being held. The LEDs can be any colour.



A	B	C	D	MODE
0	0	$\overline{D}$	$\overline{C}$	BISTABLE
0	1	$\overline{D}$	$\overline{C}$	ASTABLE
1	0	$\overline{D}$	$\overline{C}$	ASTABLE
1	1	D	C	BISTABLE

Call The ETI Bull BBS



The ETI Bull can be accessed by any 300 baud terminal, and offers a growing variety of files of information, news, ETI related news and, of course, lies and falsehoods to keep you up to date in the world of creative untruths. The Bull is active from 6:00 pm to 8:00 am on weekdays and all day on weekends and holidays on (416) 423-3265.

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