

JUNE 1978

VOLUME 3, Number 6

\$2.00 in USA

\$2.40 in CANADA

BYTE

the small systems
journal



ROBERT
78 LINNEY

READY for BUSINESS

We've got it all together—the cost effectiveness and reliability of our 6800 computer system with a high capacity 1.2 megabyte floppy disk system. . . PLUS—an outstanding new DOS and file management system.



1 MEGABYTE DISK SYSTEM

DMAF1 introduces a new level of capability to small computer systems. This disk system features two standard size floppy disk drives using the new double sided disk and two heads per drive. Usable storage space of over 600 kilobytes per drive, giving a total of over 1.0 megabyte of storage on line at all times. Ideal for small business applications, or for personal "super" systems.

DMA CONTROLLER

The controller occupies one main memory slot in an SS-50 bus and uses the Motorola MC-6844 DMA controller. The combination of a DMA

type controller and double sided disks give the system speed of data transfer unobtainable with smaller drives.

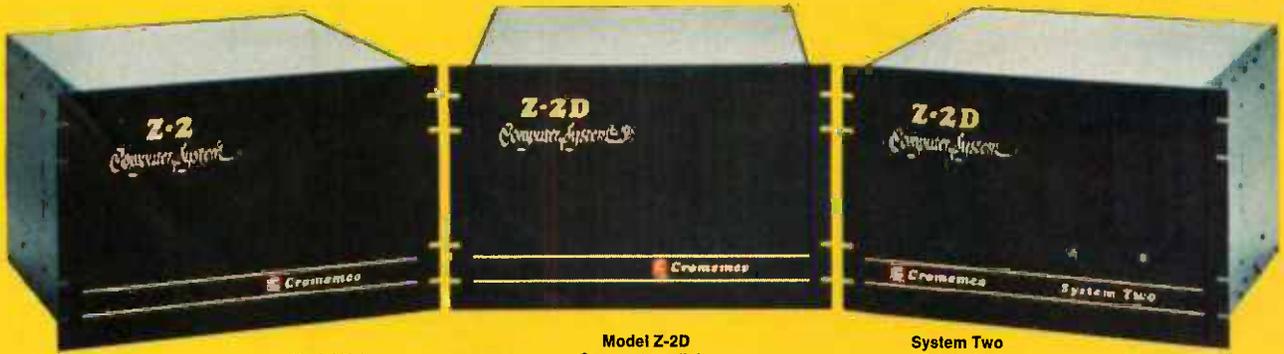
OPERATING SYSTEM

To compliment this outstanding hardware we are supplying equally superior software. The disk operating system and file management system is called FLEX. It is one of the most flexible and complete DOS's available for small systems, but just as important; it is easy to use. No one can match the variety of compatible peripherals offered by Southwest Technical Products for the SS-50 bus and the 6800 computer system. Now more than ever there is no reason to settle for less.

DMAF1 Disk System (assembled)	\$2,095.00
DMAF1 Disk System (kit).	\$2,000.00
68/2 Computer with 40K of memory (assembled)	\$1,195.00



SOUTHWEST TECHNICAL PRODUCTS CORPORATION
219 W. RHAPSODY
SAN ANTONIO, TEXAS 78216



Model Z-2
Up to 512K of RAM/ROM

Model Z-2D
One or two disks
Up to 512K of RAM/ROM
Up to 184K of disk

System Two
Dual disk
Up to 512K of RAM/ROM
Up to 184K of disk

Fill your computer needs with the industry's most professional microcomputers

#1 IN RELIABILITY

When you choose Cromemco you get not only the industry's finest microcomputers but also the industry's widest microcomputer selection.

What's more, you get a computer from the manufacturer that computer dealers rate #1 in product reliability.*

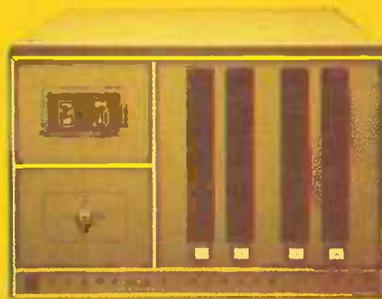
Your range of choice includes our advanced System Three with up to four 8" disk drives. Or choose from the System Two and Z-2D with 5" drives. Then for ROM-based work there's the Z2. Each of these computers further offers up to 1/2 megabyte of RAM (or ROM).

We say these are the industry's most professional microcomputers because they have outstanding features like these:

- **Z-80A microprocessor** — operates at 250 nano second cycle time — nearly twice the speed of most others.

*Rated in *The 1977 Computer Store Survey* by Image Resources, Westlake Village, CA.

Up to 512 kilobytes of RAM and 1 megabyte of disk storage



System Three
Two to four disks
Up to 512K of RAM/ROM
Up to 1 megabyte of disk

- **21 card slots** to allow for unparalleled system expansion using industry-standard S-100 cards.
- **S-100 bus** — don't overlook how important this is. It has the industry's widest support and Cromemco has professionally implemented it in a fully-shielded design.

- **Cromemco card support** of more than a dozen circuit cards for process control, business systems, and data acquisition including cards for A-D and D-A conversion, for interfacing daisy-wheel or dot-matrix printers, even a card for programming PROMs.
- **The industry's most professional software support**, including FORTRAN IV, 16K Disk-Extended BASIC, Z-80 Macro Assembler, Cromemco Multi-User Operating System — and more coming.
- **Rugged, professional all-metal construction** for rack (or bench or floor cabinet) mounting. Cabinets available.

FOR TODAY AND TOMORROW

Cromemco computers will meet your needs now and in the future because of their unquestioned technical leadership, professionalism and enormous expandability.

See them today at your dealer.

There's no substitute for getting the best.

see next
page



Cromemco
i n c o r p o r a t e d
Specialists in computers and peripherals

280 BERNARDO AVE., MOUNTAIN VIEW, CA 94040 • (415) 964-7400

SEE YOUR LOCAL DEALER

Anchorage, AK 99502
ALASKA DIVERSIFIED DIGITAL
1700 West Hatcher Avenue
(907) 277-6312

Huntsville, AL 35805
COMPUTERLAND OF HUNTSVILLE
3020 University Drive, N.W.
(205) 539-1200

Little Rock, AR 72206
COMPUTER PRODUCTS UNLIMITED
2412 South Broadway
(501) 371-0449

Phoenix, AZ 85029
BYTE SHOP PHOENIX
12654 North 26th Drive
(602) 942-7300

Phoenix, AZ 85021
COMPUTER RESEARCH CORP.
2225 W. Min. View Road - No. 6
(602) 943-8719

Phoenix, AZ 85029
COMPUTER WORLD
2230 West Lakeside
(602) 943-8925

Phoenix, AZ 85281
BYTE SHOPS OF ARIZONA
2 West Camelback
(602) 967-1421

Tucson, AZ 85716
BYTE SHOP TUCSON
2612 East Broadway
(602) 943-8925

Berkeley, CA 94703
BYTE SHOP OF BERKELEY
1514 University Avenue
(415) 845-6366

Carson, CA 90746
SUNSHINE COMPUTER COMPANY
20710 South Leavewood Avenue
(310) 327-2118

Citrus Heights, CA 95610
BYTE SHOP SACRAMENTO
6041 Greenback Lane
(916) 961-BYTE

El Cerrito, CA 94530
COMPUTERLAND EL CERRITO
11074 San Pablo Avenue
(415) 233-5010

Fountain Valley, CA 92708
ADVENTURES IN COMPUTING
8756 Warner Avenue
(714) 848-8388

Fresno, CA 93703
BYTE SHOP OF FRESNO
3135 E. McKinley Avenue
(209) 485-2417

Hayward, CA 94542
COMPUTERLAND OF HAYWARD
22834 Foothill Boulevard
(415) 538-8080

Huntington Beach, CA 92647
ALGORITHM PERSONAL COMPUTERS
7561 Rhine Drive
(714) 751-8000

Inglewood, CA 90302
COMPUTERLAND OF W. LOS ANGELES
6840 La Cienega Boulevard
(310) 716-8080

Lawndale, CA 92060
BYTE SHOP OF LAWNDALE
6508 Hawthorne Boulevard
(310) 371-2121

Loomis, CA 95650
KINGDOM ENTERPRISES, INC.
9900 King Road
(916) 988-8189

Los Angeles, CA 90025
AMERICAN RECORDER COMPANY
1655 Sawtelle Boulevard
(213) 477-2063

Menlo Park, CA 94025
COMPUTER DATA PROCESSING SERVICE
2225 Sharon Road - No. 224
(415) 692-0525

Mission Viejo, CA 92630
COMPUTERLAND SADDLEBACK VLY
24001 Via Fabricante - No. 504
(714) 770-0131

Mountain View, CA 94040
BYTE OF MT. VIEW
1063 W. El Camino Real
(415) 969-5464

Orange, CA 92667
COMPUTER MART
633-B West Katella Boulevard
(714) 633-1222

Palo Alto, CA 94306
BYTE SHOP PALO ALTO
2227 El Camino Real
(415) 327-8080

Palo Alto, CA 94301
MICROTECH EXPORTS
912 Cowper Street
(415) 328-1712

Pasadena, CA 91101
BYTE SHOP PASADENA
496 South Lake Avenue
(213) 684-3111

Sacramento, CA 95816
MICROCOMPUTER APPLICATIONS SYS
2322 Capital Avenue
(916) 433-4944

San Diego, CA 92211
COMPUTERLAND OF SAN DIEGO
4233 Convey Street
(714) 560-9912

San Diego, CA 92111
THE COMPUTER CENTER
8205 Koonen Road
(714) 292-5302

San Francisco, CA 94118
THE NETWORK
493 Third Avenue - No. 8
(415) 221-1112

San Francisco, CA 94103
COMPUTER STORE OF S.F.
1093 Mission Street
(415) 431-0640

San Francisco, CA 94105
COMPUTERLAND OF S.F.
117 Fremont Street

San Jose, CA 95124
BYTE SHOP #3 of SAN JOSE
1065 Underwood Avenue
(408) 377-4687

San Jose, CA 95123
THE COMPUTER ROOM
124-H Blossom Hill Road
(408) 266-8383

San Jose, CA 95132
COMPUTER TERMINAL
309 S. San Mateo Drive
(415) 347-9894

San Jose, CA 95132
COMPUTER TERMINAL
309 S. San Mateo Drive
(415) 347-9894

Santa Ana, CA 92705
ADVANCED MICROCOMPUTER PROD.
1111-B East Edinger
(714) 558-8813

Santa Clara, CA 95051
THE BYTE SHOP OF SANTA CLARA
3400 El Camino Real
(408) 249-4221

Santa Monica, CA 90401
THE COMPUTER STORE
820 Broadway
(310) 451-0713

Sunnyvale, CA 94086
RECREATIONAL COMPUTER CENTER
1324 South Mary Avenue
(408) 732-3108

Tustin, CA 92680
COMPUTERLAND OF TUSTIN
104 West First Street
(714) 544-0542

Van Nuys, CA 91411
COMPUTER COMPONENTS
5648 Sepulveda Boulevard

Walnut Creek, CA 94596
BYTE SHOP COMPUTERS OF DIABLO VLY
2939 N. Main Street
(415) 933-6252

Englewood, CO 80110
THE BYTE SHOP OF ARAPAHO COUNTY
3463 South Acoma Street
(303) 761-6322

Fairfield, CA 06430
COMPUTERLAND OF FAIRFIELD
2473 Black Rock Turnpike
(510) 374-2227

Windsor Locks, CT 06096
THE COMPUTER STORE
63 South Main Street
(203) 627-0188

Neward, DE 17111
COMPUTERLAND OF NEW CASTLE CITY
Aqua Shopping Center, Kirkwood Highway
(302) 738-9625

Fl. Lauderdale, FL 33312
COMPUTERS FOR YOU, INC.
3608 W. Broward Blvd.
(305) 581-8948

Fl. Lauderdale, FL 33334
BYTE OF FT. LAUDERDALE
1044 E. Oakland Blvd.
(305) 561-2983

Fl. Meyers, FL 33901
MICRO COMPUTER SYSTEMS, INC.
1801 U.S. 41 South
(813) 481-3376

Plantation, FL 33317
COMPUTER AGE
4400 S.W. 70th Avenue
(305) 791-8080

Tampa, FL 33609
MICRO COMPUTER SYSTEMS
144 S. Dale Mabry Avenue
(813) 879-4225

Atlanta, GA 30340
ATLANTA COMPUTER MART
5091-B Buford Highway
(404) 455-0645

Marlatta, CA 30060
ERUCATIONAL DATA SERVICES
79 Oxford Road

Halku, Maui, HI 96708
CAPACITY, INC.
P.O. Box A
(808) 575-2930

Honolulu, HI 48103
COMPACT COMPUTERS
P.O. Box 10096
(808) 373-2751

Kailua, Oahu, HI 96734
MICROCOMPUTER ENTERPRISES
1450 Mokulua Drive
(808) 261-3281

Arlington Heights, IL 60004
COMPUTERLAND ARLINGTON HTS.
50 East Rand Road
(312) 255-6488

Champaign, IL 61820
BYTE SHOP CHAMPAIGN
1802 S. Neil Street
(217) 352-2323

Chicago, IL 60632
BRONSON & BRATTON, INC.
5161 S. Millard Avenue
(312) 735-6200

Lisle, IL 60532
COMPUTER & CONTROL AFFILIATE
4315 Azalea - No. 401
(312) 690-3221

Lombard, IL 60148
MIDWEST MICROCOMPUTERS, INC.
708 South Main Street
(312) 495-9889

Naperville, IL 60540
ILLINOIS MICROCOMPUTERS
612 East Ogden Avenue
(312) 420-8813

Niles, IL 60068
COMPUTERLAND NILES
9511 N. Milwaukee Avenue
(312) 967-1714

Oak Brook, IL 60521
MICRO PLAZA, INC.
600 Enterprise Drive, Suite 203
(312) 832-6337

Oak Lawn, IL 60453
COMPUTERLAND OF OAK LAWN
1095 South Cicero Avenue
(312) 422-8080

Rockford, IL 61101
IMPERIAL COMPUTER SYSTEMS
2105 - 23rd Avenue
(815) 226-8200

Schaumburg, IL 60195
PLANE DOMAIN SCHLAUMBURG
1612 East Algonquin Road
(312) 397-8700

Bloomington, IN 47401
DATA DOMAIN
409 South College Avenue
(812) 334-3607

Fort Wayne, IN 46805
DATA DOMAIN OF FORT WAYNE
2805 East State Boulevard
(219) 847-7611

Indianapolis, IN 46268
DATA DOMAIN OF INDIANAPOLIS
7027 Michels Road
(317) 251-1139

West Lafayette, IN 47906
DATA DOMAIN OF WEST LAFAYETTE
3819 W. 80th Street
(317) 743-3951

Mississ, KS 66202
COMPUTER CENTER
5815 Johnson Drive
(913) 432-2983

Overland Park, KS 66206
PERSONAL COMPUTER CENTER, INC.
3819 W. 80th Street
(913) 649-5942

Lexington, KY 40501
OATA DOMAIN OF LEXINGTON
366-1/2 Euclid Avenue
(606) 233-2446

Louisville, KY 40222
COMPUTERLAND OF LOUISVILLE
813-B Lyndon Lane
(502) 425-8308

Louisville, KY 40220
DATA DOMAIN OF LOUISVILLE
3028 Huminger Lane
(502) 456-5242

Louisville, KY 40206
PRAGMA TECH
2310 Hillwood Avenue
(502) 895-1230

Burlington, MA 01803
THE COMPUTER STORE
120 Cambridge Street
(617) 272-8770

College Park, MD 20740
INTELLIGENT BUSINESS MACHINES
1203 Baltimore Avenue, Suite 200
(301) 778-7928

Pittsfield, MA 01208
MOULAR SYSTEMS INC.
4005 Seven Mile Lane
(301) 484-6322

Rockville, MD 20852
COMPUTER WORKSHOP
1776 East Jefferson
(301) 468-0463

Rockville, MD 20855
COMPUTERLAND OF GAITHERSBURG
1601 S. Frederick Road, Route 355
(301) 948-7676

Silver Spring, MD 20901
C.A.M. ENGINEERING, INC.
9318 Westh Avenue
(301) 685-3779

Towson, MD 21204
COMPUTERS ETC
13-A Allegheny Avenue
(301) 290-0520

Ann Arbor, MI 48104
COMPUTER MART, INC.
1250 North Main Street
(313) 994-4445

Ann Arbor, MI 48104
THE COMPUTER STORE
310 East Washington
(313) 995-7616

Ann Arbor, MI 48104
UNITED MICROSYSTEMS CORP.
2601 South State Street
(313) 668-6806

Berlin Springs, MI 49103
THE ABACUS
Route No. 1, Box 193, (Niles Avenue)
(616) 429-3074

Grand Rapids, MI 49508
JEPSON GROUP K
4706 Morningstar Drive S.E.
(616) 698-9037

Royal Oak, MI 48073
COMPUTER MART OF ROYAL OAK
1800 West 14 Mile Road
(313) 576-0900

Edina, MN 55435
COMPUTER DEPOT, INC.
3515 West 70th Street
(612) 927-5601

Chesterfield, MO 63017
COMPUTER SYSTEMS CTR. ST. LOUIS
13461 Olive Boulevard
(314) 576-5020

Nashua, NH 03060
COMPUTERLAND OF NASHUA
413 Amherst
(603) 889-7538

Hoboken, NJ 07030
HOBOKEN COMPUTER WORKS
NO. 20 Hudson Place
(201) 420-1644

Belleville, NJ 08830
COMPUTER MART OF NEW JERSEY
501 Route No. 27
(201) 283-0600

Morristown, NJ 07960
COMPUTERLAND OF MORRISTOWN
2 De Hart Street
(201) 430-4077

Albuquerque, NM 87110
THE COMPUTER SHACK
3120 San Mateo, N.E.
(505) 883-8282

Reno, NV 89502
BYTE SHOP OF RENO
4104 S. Nevada Lane
(702) 826-8080

Buffalo, NY 14250
COMPUTERLAND OF BUFFALO
1612 Niagara Falls Boulevard
(716) 836-0511

De Wilt, NY 13214
COMPUTER ENTERPRISES
3470 Erie Boulevard East
(315) 446-1284

Buffalo, NY 14226
CORSON COMPUTER CORP., INC.
1834 Main Street
(716) 832-0662

Hollis, NY 11423
SYNCHRO-SOUND ENTERPRISES
(212) 468-7067

Ithaca, NY 14850
COMPUTERLAND OF ITHACA
225 Elmira Road
(607) 274-6888

New York City, NY 10016
BYTE SHOP EAST
130 E. 40th Street
(212) 889-4204

Rochester, NY 14609
COMPUTER HOUSE, INC.
721 Atlantic Avenue
(716) 654-9238

Cincinnati, OH 45409
DATA DOMAIN OF CINCINNATI
1819 W. 90th Street (Madiera)
(513) 561-6733

Columbus, OH 43201
MIDWESTERN DIGITAL ELECTRONICS
80 West Lane Avenue, Suite 11
(614) 292-4466

Dayton, OH 45409
DATA DOMAIN OF DAYTON
1932 Brown Street
(513) 233-2348

Kent, OH 44240
OHIO OREGON SYSTEMS
233 South Water Street
(216) 678-2022

Mayfield Heights, OH 44124
COMPUTERLAND OF CLEVELAND EAST
1888 Sun Center Road
(216) 461-1200

Oklahoma City, OK 73106
HIGH TECHNOLOGY
1611 Northwest 23rd Street
(405) 928-8008

Beaverton, OR 97005
BYTE SHOP OF BEAVERTON
3482 S.W. Cedar Hills Boulevard
(503) 644-2687

Eugene, OR 97401
REAL OREGON COMPUTER CO.
205 West Tenth Street, P.O. Box 52
(503) 484-1040

Tualatin, OR 97062
CREATIVE SYSTEMS
8101 S.W. Nyberg Road
(503) 638-8406

Huntington Valley, PA 19006
MARKETLINE SYSTEMS, INC.
2331 Philadelphia Avenue
(215) 947-6676

King of Prussia, PA 19406
COMPUTER MART OF PENNSYLVANIA
550 De Kalb Pike (Route 202)
(215) 265-2800

Pittsburgh, PA 15237
ELECTRONICS PLACE
7250 McNight Road
(412) 947-6676

Warwick, RI 02886
COMPUTER POWER, INC.
1800 Fruit Road
(401) 738-4477

Columbia, SC 29205
BYTE SHOP OF COLUMBIA
2018 Green Street
(803) 771-7824

Nashville, TN 37206
COMPUTER WORLD
625 Main Street
(615) 244-6094

Nashville, TN 37211
SURYA CORPORATION
5755 Nolensville Road
(615) 834-5638

Austin, TX 78731
COMPUTERS'N THINGS
7524 Hancock Drive
(512) 453-5970

Corpus Christi, TX 78411
MICRO SYSTEMS SERVICES, INC.
5101 Embury, Space H - P.O. Box 6535
(512) 855-4516

Dallas, TX 75243
COMPUSHOP
211 Keydon Park, 13933 North Central
(214) 234-3472

Houston, TX 77087
COMPUTERLAND OF S.W. HOUSTON
6439 Westheimer
(713) 977-0909

Houston, TX 77098
THE MDS
1853 Richmond Avenue
(713) 527-8008

Houston, TX 77006
ELECTROTREX
2300 Richmond Avenue
(713) 526-6394

Houston, TX 77036
INTERACTIVE COMPUTERS
7646-1/2 Dabwood, P.O. Box 36584
(713) 977-7037

Richardson, TX 75080
THE MICRO STORE
634 South Central Expressway
(214) 231-1096

Provo, UT 84601
THE COMPUTER WORKS
735 South State Street, P.O. Box N
(801) 373-7522

Alexandria, VA 22304
COMPUTERS PLUS, INC.
678 S. Pickett Street
(703) 751-5656

McLean, VA 22101
COMPUTER SYSTEMS STORE
1984 Chain Bridge Road
(703) 821-8333

Bellingham, WA 98225
THE PACIFIC COMPUTER STORE
410 W. Champion Street
(604) 438-3282

Seattle, WA 98115
THE RETAIL COMPUTER STORE
410 N.E. 72nd Street
(206) 524-4101

Appleton, WI 54911
SOUND WORLD, INC.
3015 W. Wisconsin Avenue
(414) 734-7698

Madison, WI 53711
THE MADISON COMPUTER STORE
1863 Monroev Street
(608) 255-5552

Milwaukee, WI 53208
MILWAUKEE COMPUTER STORE
4770 West North Avenue
(414) 445-4280

Racine, WI 53405
COLTRON TV
2111 Lathrop Avenue
(414) 637-2003

Caregile, Vic, Australia
COMPUTER INSTRUMENTS
17 Araratia Street
360-0358

INTERNATIONAL

Perman Hills, N.S.W. 2120 Australia
DYANETICS PTY. LTD.
425 East Perman Hills Road
848-9055

Croydon, Vic, Australia, 3136
COMPUTER ART & EDUCATION
2 Stephon Crescent

Prathea, Victoria, Australia, 3181
GEMINI MICRO COMPUTERS
P.O. Box 99

West Perth, 6005, W. Aust'ia
AUSTRALIAN COMPUTER PRODUCTS
1300 Hay Street
(09) 322-6497

A-2401 Fishamend, Austria
KREBS GES. M.B.H.
Hainburger Strasse 34
022326818223

Calgary, Alberta, Canada
ROBO-TRONICS
509-16 Avenue N.W.
(403) 282-9496

Montreal, Quebec, Can. H3C 3B9
FITUR BYTE, INC.
1191 Phillips Square
(514) 863-3120

Toronto, Ont., Can. M4G 3B5
COMPUTER MART, LTD.
1543 Bayview Avenue
(416) 484-9708

Toronto, Ont., Can. M4R 1A1
FIRST CANADIAN COMPUTER STORE
444 Eglinton Avenue West
(416) 482-8080

Toronto, Ont., Can. M5V 1Z1
TRINTECHNICS LTD.
178 Queen Street West
(416) 598-0260

Calgary, Alberta, Can. T2T 4T9
THE COMPUTER SHOP
3515 Eighteenth Street, S.W.
(403) 243-0301

Little Paxton, Huntingdon
Camb., England PE19 4N
COMARK LIMITED
24A Market Square
0480-215-005

Paris 75017, France
COMPUTER BOUTIQUE
149 Avenue de Wagram

Chiyoda-Ky, Tokyo 101, Japan
BYTE SHOP SOGOH
1-6-5, Sotomachi
03-225-1984

Kashiwa City Chiba Pr. 277, Japan
BELLKEY TEC. INC.
5-2, Chome Kaga
(03) 585-4516

Tokyo 106, Japan
IEE CORPORATION
4-3-3, Chome, Roppongi, Minatoka
(03) 585-2333

Mexico 18, D.F. Mexico
INTELEX, S.A.
P.A. De Los Santos 70
9051 516-9870

10652 Sorsholm 20, Sweden
DATASIKRINGEN KONSULT AB
Fack 2

4053 Basel, Switzerland
EUREX, INC.
Reinwiler Str. 13
061-337069

8003 Zurich, Switzerland
COMICRO AC
Badenerstrasse 281

Hilppur 4400, Munster, W. Germany
BASIS MICROCOMPUTER VERTRIEB
Von-Floer-Strasse 5
02561-4800

2000 Wedel, Hosten, W. Germany
DIGITRONIC COMPUTERSYSTEME
Bei Der Doppelteich 3-5
04103-7333

* DENOTES 'SYSTEM THREE' DEALER



Foreground

- 14 A PROGRAMMABLE CHARACTER GENERATOR, Part 2: Software
Software—Weinstein
- 28 A PROGRAMMABLE IC TESTER
Test Equipment—Thorson
- 140 MORE MUSIC FOR THE 6502
Software, Music—O'Haver
- 142 TALK TO ME: Add a Voice to Your Computer for \$35
Speech Synthesis—Ciarcia
- 153 A THEATRICAL LIGHTING GRAPHICS PACKAGE
Video Displays—Hemsath-Seawright-Ghent-Garrard
- 158 GRAPH: A SYSTEM FOR TELEVISION GRAPHICS: Part 2
Software, Video Graphics—Webster-Young
- 166 AUDIO PROCESSING WITH A MICROPROCESSOR
Real Time Applications—O'Haver

Background

- 38 NATURAL LANGUAGE PROCESSING AND SMALL SYSTEMS
Tutorial—Tennant
- 56 GIVE AN EAR TO YOUR COMPUTER: A Speech Recognition Primer
Artificial Intelligence—Georgiou
- 112 THE HP-67 AND HP-97: Hewlett-Packard's Personal Computers
Product Review—Pearce
- 138 NOTES ON TEACHING WITH MICROCOMPUTERS
Education—Norton
- 174 A LOOK AT SHUGART'S NEW FIXED DISK DRIVE
Product Description—Morgan

Nucleus

- 4 In This BYTE
- 6 Memory: The Growth of a Resource
- 11 Letters
- 94 BYTE's Bugs
- 100 BYTE's Bits
- 105 Ask BYTE
- 106 Clubs, Newsletters
- 109 Programming Quickies
- 118 Book Reviews
- 122 Languages Forum
- 128 Technical Forum
- 178 What's New?
- 206 Unclassified Ads
- 208 BOMB
- 208 Reader Service



BYTE is published monthly by BYTE Publications Inc, 70 Main St, Peterborough NH 03458. Address all mail except subscriptions to above address: phone (603) 924-7217. Address all editorial correspondence to the editor at the above address. Unacceptable manuscripts will be returned if accompanied by sufficient first class postage. Not responsible for lost manuscripts or photos. Opinions expressed by the authors are not necessarily those of BYTE. Address all subscriptions, change of address, Form 3579, and fulfillment complaints to BYTE Subscriptions, PO Box 590, Martinsville NJ 08836. Second class postage paid at Peterborough NH 03458 and at additional mailing offices—USPS Publication No. 102410. Canadian second class registration No. 9321. Subscriptions are \$15 for one year, \$27 for two years, and \$39 for three years in the USA and its possessions. In Canada and Mexico, \$17.50 for one year, \$32 for two years, and \$46.50 for three years. \$25 for a one year subscription by surface mail worldwide. Air delivery to selected areas at additional rates available upon request. \$25 for a one year subscription by air delivery to Europe. Single copy price is \$2.00 in the USA and its possessions, \$2.40 in Canada and Mexico, \$3.50 in Europe, and \$4.00 elsewhere. Foreign subscriptions and sales should be remitted in United States funds. Printed in United States of America. Each separate contribution to this issue and the issue as a collective work copyright © 1978 by BYTE Publication Inc. All rights reserved.

NEW! Subscription WATS Line: (800) 258-5485

PUBLISHER
Virginia Peschke Londner
EDITOR IN CHIEF
Carl T Helmers Jr
PRODUCTION MANAGER
Judith Havey
ADVERTISING DIRECTOR
Debra Boudricau
CIRCULATION MANAGER
Gregory Spitzfaden
COMPTROLLER
Michael Galan
EDITORS
Blaise W Liffick
Christopher P Morgan
CO-OP EDITORS
Raymond Cote
Scott Morrow
ASSISTANT PRODUCTION MANAGER
Karen Gregory
PRODUCTION EDITORS
David William Hayward
Nancy Salmon
EDITORIAL ASSISTANTS
Laura A Hanson
Becky Liffick
ADVERTISING
Noreen Bardsley
Jill Callihan
Patricia Clark
PRODUCTION ASSISTANT
Cheryl Hurd
CIRCULATION ASSISTANTS
Sarah Bauhan
Pamela R Heaslip
DEALER SALES
Ginnie F Boudricau
TRAFFIC MANAGERS
Thomas Harvey
Edmond C Kelly Jr
ART
Stephen Kruse
Wai Chiu Li
Dorothy Shamonsky
Ellen Shamonsky
RECEPTIONIST
Jacqueline Earnshaw
CLUBS AND NEWSLETTERS
David Wozmak
DRAFTING
Douglas Glen
Stephen Kruse
Lynn Malo
Bill Morello
TYPOGRAPHY
Goodway Graphics
PHOTOGRAPHY
Ed Crabtree
PRINTING
George Banta Company
ASSOCIATES
Walter Banks
Steve Ciarcia
David Fylstra
Portia Isaacson
BITS INC
Dennis Bliem
Janice Dolan
Floyd W Rehling
Medellin Stephens
Jeremy Youst

ADVERTISING SALES REPRESENTATIVES:
EAST, MIDWEST
Hajar Associates Inc
17 Durant St
West Roxbury MA 02132
(617) 325-5380
100 W Chicago Ave
Chicago IL 60610
(312) 337-8008
WEST, SOUTHWEST
Buckley/Boris Associates Inc
912 South Barrington, Suite 202
Los Angeles CA 90049
(213) 826-4621
DISTRIBUTORS:
EASTERN CANADA
RS-232 Distribution Company
186 Queen St W, Suite 232
Toronto ONTARIO
WESTERN CANADA
Kitronic Ltd
26236 26th Av RR 5
Aldergrove BC V0X 1A0

About the Cover:

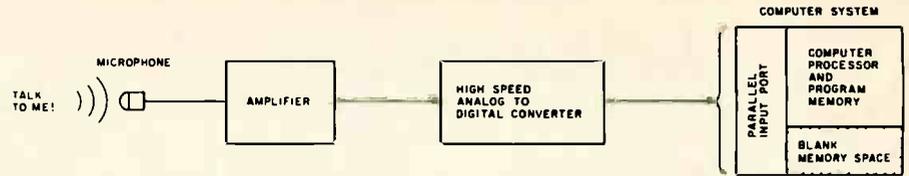
Robert Tinney's cover painting this month was inspired by the article, **A Theatrical Lighting Graphics Package** by William Hemsath, James Seawright, Emmanuel Ghent and Mimi Garrard. While Cyrano soliloquizes, the technical director in the wings keeps track of the lights with the aid of an ingenious graphics system. For more information see page 153.

In This BYTE

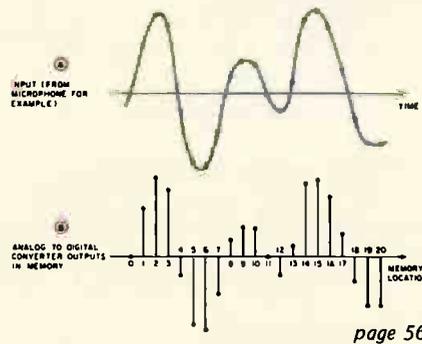
Last month, Larry Weinstein described the hardware for a programmable character generator. This month, read **A Programmable Character Generator Part 2: Software** and find out how to program your own special characters for APL programming, music graphics, and so on. *page 14*

Many computer experimenters buy surplus integrated circuits and have the sometimes tedious job of testing them to see if they work. Mark Thorson offers an elegant way around this problem with **A Programmable IC Tester**. For relatively little expense, readers can now construct a black box that will put virtually any TTL integrated circuit through its paces quickly and accurately. *page 28*

Since the introduction of the computer over 30 years ago, we have been forced to use difficult, archaic, near alien languages in order to communicate our wishes to the machine. The development of a system which understands the human language has been slow in coming. Now, Harry Tennant takes the naturally "speaking" machine out of the realm of science fiction and places it right in the lap of the home experimenter. But don't you need a huge machine to do that sort of thing, you protest? Read **Natural Language Processing and Small Systems** and discover the answer for yourself. *page 38*



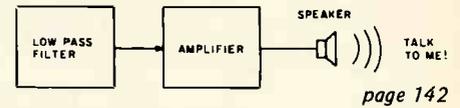
Speech recognition is a key component of any software and hardware design for interesting systems ranging from mobile robots to the interactive and responsive house. To provide some background information on the complexities of the subject, Bill Georgiou has written an article entitled **Give an Ear to Your Computer**. *page 56*



Craig A Pearce reviews two programmable calculators from Hewlett-Packard in **The HP-67 and HP-97: Hewlett-Packard's Personal Computers** and describes Pinball Wizard, a simulation game he wrote to show off the two units. *page 112*

Dr William H Norton discusses the potential impact of using microcomputers on computer curricula in **Notes on Teaching with Microcomputers**. His own experiences using the KIM-1 microprocessor for one of his own courses at Marycrest College, Davenport IA, illustrate their practicality, ease of use, and positive effect. Just as hand calculators revolutionized many types of instruction, so too will micros eventually be used to enhance computer education. *page 138*

If you would like your computer to compose music for you, read Tom O'Haver's **More Music for the 6502**. There you will find a simple way to use the complicated sounding technique of first order stochastic control to create your own software sonatas and FIFO fugues. *page 140*



Would you like to try your hand at speech synthesis on your computer? Steve Ciarcia shows you how to make use of your programmable memory to store and play back digitized speech in **Talk to Me! Add a Voice to Your Computer for \$35**. *page 142*

An unusual and creative use of microcomputers and video displays is described in **A Theatrical Lighting Graphics Package** by William Hemsath, James Seawright, Emmanuel Ghent and Mimi Garrard. The authors' system consists of a simple modification to a Processor Technology VDM-1 video display enabling it to simultaneously display five graphs of theatre lighting intensity versus time. *page 153*

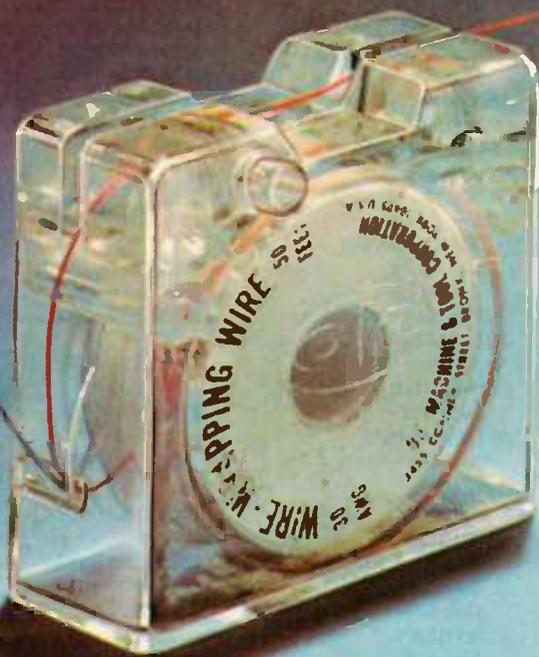
In part 2 of **GRAPH: A System for Television Graphics** authors John Webster and John Young complete their discussion of a package for use with videotape studio equipment in educational audio visual contexts. *page 158*

Does your computer have high fidelity? We don't mean to imply that it lacks character if it doesn't, but as Tom O'Haver shows in his article on **Audio Processing with a Microcomputer** it is possible to use the capabilities of a personal computer to do some interesting real time audio processing tasks such as reverberation, phlanging and "fuzz." *page 166*

The fixed disk may soon become a fixture in personal computing, and the ability to store 30 megabytes of memory on line will have a major effect on the way we look at software. Read **A Look at Shugart's New Fixed Disk Drive** by Senior Editor Chris Morgan. *page 174*

TRI-COLOR

WIRE CUTTING AND STRIPPING DISPENSER



Model No. **WD-30-TRI**
Patent Pending

- 3 Rolls of wire in one convenient dispenser
- 3 Colors, Blue/White/Red, 50 ft. (15m) of each color
- AWG 30 (0,25mm) KYNAR® insulated wire
- Built-in cutting plunger cuts wire to desired length
- Built-in stripper strips 1" of insulation
- Easily refillable
- For wire-wrapping and other applications.

WD-30-TRI	DISPENSER WITH WIRE	\$5.95
R-30-TRI	TRI-COLOR REPLACEMENT SPOOLS	\$3.95

Kynar® Pennwalt

MINIMUM BILLING \$2500 / ADD SHIPPING CHARGE \$100 / NEW YORK STATE RESIDENT ADD APPLICABLE TAX



MACHINE & TOOL CORPORATION 3455 CONNER ST. BRONX, N.Y. 10475 (212) 994-6600/Telex 125091

Circle 287 on inquiry card

BYTE June 1978 5

Editorial

Memory: The Growth of a Resource

By Carl Helmers

Once upon a time, I had a telephone conversation with a gentleman whose name I cannot recall. This gentleman was an ardent experimenter, both personally and professionally, and was working on the development of a personal microprocessor system. He knew electronics inside and out, understood the principles of integrated circuits, could predict whether or not a given wire would have to be analyzed as a transmission line or could be treated simply as an interconnection, and knew how to calculate worst case conditions in a circuit. He was getting into microprocessors with the intent of learning enough about computing to enable him to incorporate them into his designs. I must have talked to him shortly after he had begun his project, but certainly before it had been completed to the state of a "working" processor. Given this background, he was able to come up with the statement, "Nobody will ever need more than 1 K bytes of memory for the personal computer. To use any more would indicate a lack of efficiency in the design."

I don't believe that this gentleman still holds this opinion, especially if he has proceeded into the world of programming and using a computer.

Then a little bit later in my experiences, I was having a conversation with a friend of over a decade's acquaintance concerning various topics of small computer design and utilization. Now this friend of mine has had a quite thorough background not in engineering, but in systems software, and is quite familiar with the process of allocating memory on a large system in lumps of 100 K bytes or more if the occasion arises. He's lately been enamored of the concept of interpretive languages with dynamic symbol

Articles Policy

BYTE is continually seeking quality manuscripts written by individuals who are applying personal computer systems, designing such systems, or who have knowledge which will prove useful to our readers. For a more formal description of procedures and requirements, potential authors should send a self-addressed, stamped envelope to BYTE Authors' Guide, 70 Main St., Peterborough NH 03458.

Articles which are accepted are purchased with a rate of up to \$50 per magazine page, based on technical quality and suitability for BYTE's readership. Each month, the authors of the two leading articles in the reader poll (BYTE's Ongoing Monitor Box or "BOMB") are presented with bonus checks of \$100 and \$50. Unsolicited materials should be accompanied by full name and address, as well as return postage. ■

44 GREAT LOCATIONS

ComputerLand™

NOW OPEN:

ALABAMA	
Huntsville	(205) 539-1200
CALIFORNIA	
Dublin	(415) 828-8090
El Cerrito	(415) 233-5010
Hayward	(415) 538-8080
Los Angeles	(213) 776-8080
Mission Viejo	(714) 770-0131
Mountain View	Call Directory Assistance
San Diego	(714) 560-9912
San Francisco	(415) 546-1592
San Jose	Call Directory Assistance
San Mateo	(415) 572-8080
Santa Rosa	Call Directory Assistance
Thousand Oaks	(805) 495-3554
Lawndale	(213) 371-7144
Tustin	(714) 544-0542
Walnut Creek	(415) 935-6502
COLORADO	
Denver	(303) 759-4685
CONNECTICUT	
Fairfield	(203) 374-2227
DELAWARE	
Newark	(302) 738-9656
GEORGIA	
Atlanta	(404) 953-0406
ILLINOIS	
Arlington Heights	(312) 255-6488
Niles	(312) 967-1714
Oak Lawn	(312) 422-8080
KENTUCKY	
Louisville	(502) 425-8308
MARYLAND	
Rockville	(301) 948-7676
MICHIGAN	
Grand Rapids	(616) 942-2931
Detroit	(313) 356-8111
MINNESOTA	
Minneapolis	Call Directory Assistance
NEW HAMPSHIRE	
Nashua	(603) 889-5238
NEW JERSEY	
Cherry Hill	Call Directory Assistance
Fair Lawn	Call Directory Assistance
Morristown	(201) 539-4077
NEW YORK	
Buffalo	(716) 836-6511
Ithaca	(607) 277-4888
OHIO	
Cleveland	(216) 461-1200
OREGON	
Portland	(503) 620-6170
TEXAS	
Austin	(512) 452-5701
Houston	(713) 977-0909
WASHINGTON	
Bellevue	(206) 746-2070
Federal Way	(206) 838-9363
Tacoma	(206) 581-0388
WASHINGTON, D.C.	Call Directory Assistance
WISCONSIN	
Madison	Call Directory Assistance
INTERNATIONAL	
Sydney, NSW Australia	29-3753

Continued on page 120

Rated G

The Best Game in Town.

Welcome to ComputerLand. An incredible adventure into the world of personal computers. A one-of-a-kind shopping experience.

Each ComputerLand store presents everything you ever wanted to know about computers. And then some.

Take our Game Room, for starters. You'll find excitement for the whole family in our endless variety of challenging computer games. You can battle the Klingons in an out-of-this-world game of Star Trek. Create an electronic work of art with a computer controlled TV. Test your skill in a game of computerized hangman.

You can even plot your biorhythm.

But we're more than just fun and games. Each ComputerLand store offers a knowledgeable and personable staff of professionals



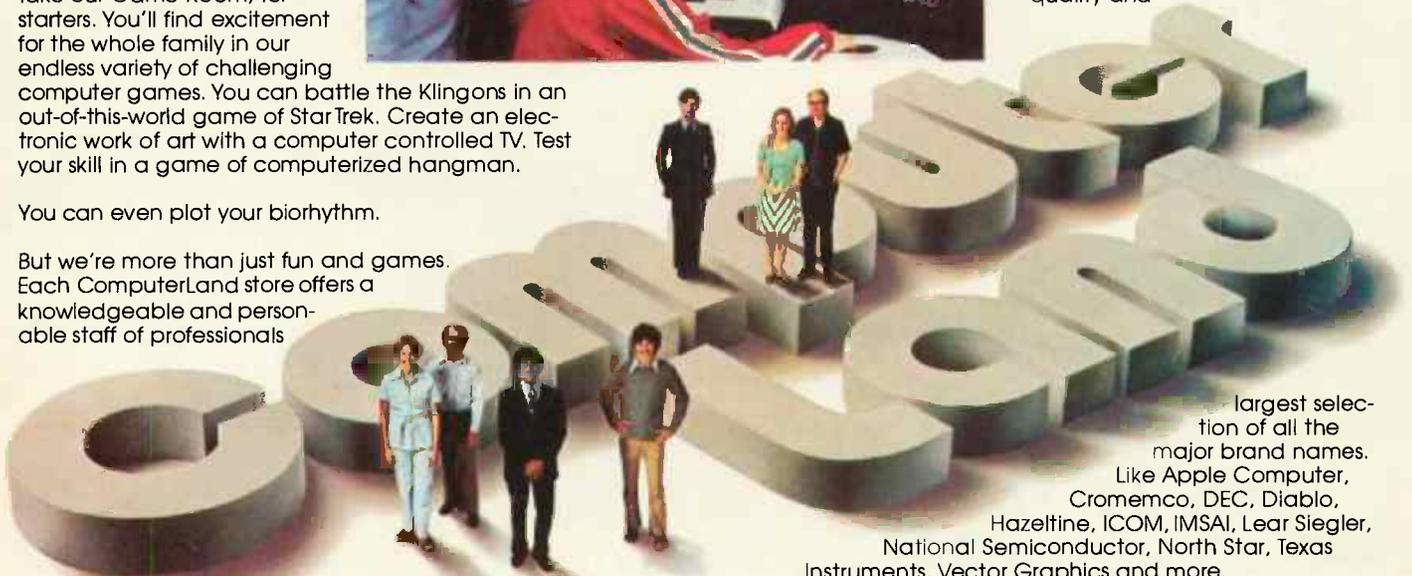
And if your system breaks down, our in-store service department will get you back up and running.

Right now!

Great Selection.

Your first stop at ComputerLand may well be your last stop.

ComputerLand offers the finest quality and



largest selection of all the major brand names. Like Apple Computer, Cromemco, DEC, Diablo, Hazeltine, ICOM, IMSAI, Lear Siegler, National Semiconductor, North Star, Texas Instruments, Vector Graphics and more.

to serve you.

Plus the greatest available selection of micro components. Whether it's a data processing system for your business or a computer controlled sprinkler system for your home, you'll find whatever you need at ComputerLand.

Plus a complete inventory of tools, books and accessories.

What's more, at ComputerLand, we deal in product. Not promises. Our inventory is on our own shelves. Rather than the manufacturer's. So you can take delivery on tomorrow's components today.



Read on.

Genuine Service.

We want to supply you with the one system that's right. Rather than a complete system that isn't. Or a limited system that is.

That's why, at ComputerLand, you deal with real professionals who are also real people. People who speak your language

... in addition to BASIC, COBOL or FORTRAN.

People, in short, who can offer both the novice and the old hand the same expert guidance in selecting the optimum system he or she needs.

Yet, assisting in the purchase is only the beginning of ComputerLand's service. If the kit you bought requires a little more do-it-yourself than you yourself can do, we provide assembly assistance.

If that complex program proves to be just that, we provide programming assistance.

Circle 75 on inquiry card.

Which means, simply put, that at ComputerLand, you get exactly what you want.

Exactly when you want it.

Be Our Guest.

Begin with the grand tour of our exhibit areas. "Test-drive" any of our individual systems.

Then tell us your needs. We'll sit down and talk about the system that's right for you. It's as easy as that at ComputerLand.

The great computer store. RATED G.

Call or write for the address of the ComputerLand store nearest you. Franchise opportunities available.

ComputerLand™

14400 Catalina Street, San Leandro, CA 94577 (415) 895-9363



The answer is a

It's the serious solution to the small computer question.

Sol Systems are the key to effective, economical small computer power. Sol Systems give you the force of a powerful general purpose computer, the problem solving capability of high level languages and the operational simplicity of everyday office equipment.

From the ground up, Sol Systems were designed to do a complete job without adding a load of costly extras. In fact, when you compare the "everything included" price of a quality, field proven Sol System with anything else on the market, you'll be happily surprised to find out how little the extra performance and convenience costs.

For example, complete Sol Systems with 16,384 bytes of RAM memory start at less than \$2500*. Expanded systems with 49,152 bytes of RAM memory, 1.5 million bytes of on-line disk memory, disk operating system and Extended Disk BASIC cost less than \$8000*. Both systems are fully assembled, burned-in, tested and ready to go.

Sol Compatibility

Sol Systems feature the S-100 bus for pin-to-pin compatibility with a wide variety of add-on devices such as voice input and computer graphics. Standard Sol parallel and serial interfaces will drive most standard printers, modems and other peripherals.

A word about languages

No system is complete without software, and at Processor Technology we have tailored a group of high level languages, an assembler and other packages to suit the wide capabilities of our hardware.

Take a look at our exclusive Extended BASIC as an example. In cassette form, this BASIC features string and advanced

*U.S. prices only.



Sol System.

file handling, special screen commands, timed input, complete matrix, logarithmic and trigonometric functions, exponential numbers, 8 digit precision and square root. The language handles serial access files, provides tape rewind and offers cursor control for graphics capability.

The disk version has all the number crunching talents of the cassette BASIC plus instant access to data and programs on floppy disks. It includes random as well as sequential files and a unique ability to update sequential data in place.

Processor Technology FORTRAN is similar to FORTRAN IV and has a full set of extensions designed for the "stand alone" computer environment. Thousands of special application programs available through books and periodicals have already been written in this well established language.

Processor Technology PILOT is an excellent language for teachers. It is a string-oriented language designed expressly for interactive applications such as programmed instruction, drill and testing.

No wonder we call it the serious solution to the small computer question.

It's the small computer system to do the general ledger and

the payroll. Solve engineering and scientific problems. Use it for word processing. Program it for computer aided instruction. Use it anywhere you want versatile computer power!

Sold and serviced only by the best dealers.

Sol Systems are sold and serviced by an outstanding group of conveniently located computer stores throughout the United States and Canada. They are also available in Australia, Europe, the United Kingdom, Central America, South America, Japan and Singapore.

For more information contact your nearest dealer listed on the following page. Or write Department B, Processor Technology Corporation, 7100 Johnson Industrial Drive, Pleasanton, CA 94566. Phone (415) 829-2600.

Circle 305 on inquiry card.

ProcessorTechnology

See Sol at all these fine computer centers.

ALABAMA

Birmingham ICP—Computerland
(205) 979-0707

CALIFORNIA

Costa Mesa Orange County
Computer Center (714) 646-0221

Hayward The Byte Shop
(415) 537-2983

Hayward Computerland of
Hayward (415) 538-8080

Lawndale The Byte Shop
(213) 371-2421

Modesto Computer Magic
(209) 527-5156

Mountain View Digital Deli
(415) 961-2670

San Rafael The Byte Shop
(415) 457-9311

Tarzana Byte Shop of Tarzana
(213) 343-3919

Walnut Creek The Byte Shop
(415) 933-6252

COLORADO

Boulder The Byte Shop
(303) 444-6550

Denver The Byte Shop
(303) 399-8995

FLORIDA

Ft. Lauderdale Byte Shop of
Ft. Lauderdale (305) 561-2983

Miami Byte Shop of Miami
(305) 264-2983

Tampa Microcomputer
Systems Inc. (813) 879-4301

GEORGIA

Atlanta Atlanta Computer Mart
(404) 455-0647

ILLINOIS

Schaumburg The Data Domain
(312) 397-8700

IOWA

Davenport The Computer Store
of Davenport (319) 386-3330

MARYLAND

Towson Computers, Etc.
(301) 296-0520

MICHIGAN

Ann Arbor The Computer Store of
Ann Arbor (313) 995-7616

MINNESOTA

Minneapolis Computer Depot
(612) 927-5601

NEVADA

Reno Byte Shop of Reno
(702) 826-8080

NEW JERSEY

Cherry Hill Computer Emporium
(609) 667-7555

Iselin The Computer Mart of
New Jersey (201) 283-0600

NEW YORK

Endwell The Computer Tree
(607) 748-1223

New York The Computer Mart of
New York (212) 686-7923

White Plains The Computer
Corner (914) 949-3282

NORTH CAROLINA

Raleigh ROMs 'N' RAMs
(919) 781-0003

OHIO

Akron Basic Computer Shop
(216) 867-0808

Columbus The Byte Shop
(614) 486-7761

Dayton Computer Mart of
Dayton (513) 296-1248

OREGON

Beaverton Byte Shop Computer
Store (503) 644-2486

Eugene The Real Oregon
Computer Co. (503) 484-1040

Portland Byte Shop Computer
Store (503) 223-3496

RHODE ISLAND

Warwick Computer Power, Inc.
(401) 738-4477

SOUTH CAROLINA

Columbia The Byte Shop
(803) 771-7824

TENNESSEE

Kingsport Microproducts &
Systems (615) 245-8081

TEXAS

Arlington Computer Port
(817) 469-1502

Houston Interactive Computers
(713) 772-5257

Lubbock Neighborhood Computer
Store (806) 797-1468

VIRGINIA

McLean The Computer Systems
Store (703) 821-8333

WASHINGTON

Bellevue Byte Shop Computer
Store (206) 746-0651

WISCONSIN

Madison The Madison Computer
Store (608) 255-5552

Milwaukee The Milwaukee
Computer Store (414) 259-9140

WASHINGTON, D.C.

Washington, D.C. Georgetown
Computer Store (202) 362-2127

CANADA

London, Ontario The Computer
Circuit Ltd. (519) 672-9370

Toronto, Ontario Computer
Mart Ltd. (416) 484-9708

Vancouver, B.C. Basic Computer
Group Ltd. (604) 736-7474

Vancouver, B.C. Pacific Computer
Store (604) 438-3282

AUSTRALIA

Victoria Sontron Instruments
(03) 569.7867

PHILIPPINES

San Juan, Metro Manila Integrated
Computer Systems, Inc.

JAPAN

Tokyo Moon base Shinjuku
(03) 375-5078.5079

Processor Technology

Letters

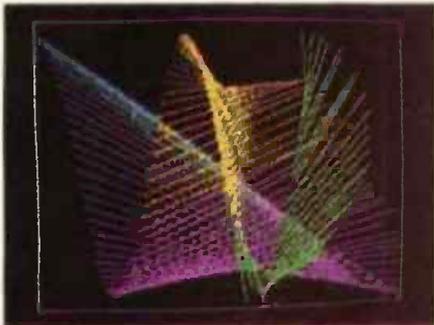
THE IMPORTANCE OF COLOR GRAPHICS

The editorial about the importance of color graphics (October 1977 BYTE) touched on some issues that go much deeper than most people suspect. The story about the professional who asked,

Photo 1.



Photo 2.

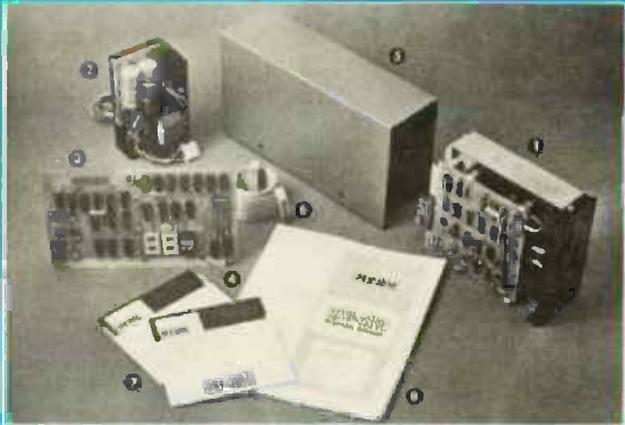


"Why would anyone ever want a personal computer?" has several variations that further illustrate the misunderstandings that can arise. For example, there is the listener to a computer based music system who asks, "Isn't that just a fancy new kind of record player?" Aside from obvious acoustic differences (our system plays real organ pipes—talk about hi fi!), the answer is, "Yes, if all you do is listen." But that's not the purpose of the system at all—it's meant to be manipulated, to be used by creative experimenters, that is, by artists.

A good example of the consequence of this creative viewpoint is the work of a high school physics teacher (Mike

Continued on page 98

For Your SWTP 6800 Computer ...



PERCOM's™ Assembled and Tested FLOPPY DISK SYSTEM the LFD-400

only **\$599⁹⁵** shipping paid

The LFD-400 is ready to plug in and run the moment you receive it. Nothing else to buy! Not even extra memory!

YOU GET:

- ① The popular Shugart SA 400 minifloppy™ drive. Drive alignment is double checked by PerCom before shipment.
- ② The drive power supply—fully assembled and tested.
- ③ LFD-400 Controller/Interface—plugs into the SS-50 bus • accommodates three 2708 EPROMs • fully assembled and tested.
- ④ MINIDOS™—the remarkable LFD-400 disk operating system on a 2708 EPROM • plugs into the LFD-400 Controller card • no extra memory required • no "booting" needed.
- ⑤ Attractive metal enclosure.
- ⑥ Interconnecting cable—fully assembled and tested.
- ⑦ Two diskettes— one blank, the other containing numerous software routines including patches for SWTP 8K BASIC and the TSC Editor/Assembler.
- ⑧ 70-page instruction manual—includes operating instructions, schematics, service procedures, and the complete listing of MINIDOS™.
- ⑨ Technical Memo updates—helpful hints which supplement the manual instructions.
- ⑩ 90-day limited warranty.

Minifloppy is a trademark of Shugart Associates.
MINIDOS is a trademark of PERCOM Data Company, Inc.

The LFD-400 is readily expanded to either two or three drives. Write for details. Send for our free brochure for more information about the LFD-400 Floppy Disk System and LFD-400 software.

To save you money, the LFD-400 Floppy Disk System is available only from PerCom. Because of the special pricing, group and dealer discounts are not available.

MC and VISA welcome. COD orders require 30% deposit plus 5% handling charge. Allow three extra weeks if payment is by personal check. The LFD-400 Floppy Disk System is available immediately. Allow three weeks for testing and transportation. Texas residents add 5% sales tax.

PERCOM™

PERCOM DATA COMPANY, INC.

Dept B 318 BARNES • GARLAND, TX. 75042

(214) 272-3421

PERCOM™ 'peripherals for personal computing'

Why Apple II is the world's best selling personal computer.

enjoy the real satisfaction a personal computer can bring, today and in the future.

15 colors & hi-resolution graphics, too.

Don't settle for a black and white display! Connect your Apple to a color TV and BASIC gives you instant command of three display modes: Text, 40h x 48v Color-graphics in 15 colors, and a 280h x 192v High Resolution array that lets you plot graphs and compose 3-D images. Apple gives you the added capability of combining text and graphics, too.

Back to basics, and assembly language too.

Apple speaks three languages: fast integer BASIC, floating point BASIC for scientific and financial applications, and 6502 assembly language. That's maximum programming flexibility. And, to preserve user's space, both integer BASIC and monitor are permanently stored in 8K bytes of ROM, so you have an easy to use, universal language instantly available. BASIC gives you graphic commands: COLOR=, VLIN, HLIN, PLOT and SCRIN. And direct memory access, with PEEK, POKE and CALL commands.

Software: Ours and yours.

There's a growing selection of pre-programmed software from the Apple Software Bank—Basic Finance, Checkbook, High Resolution Graphics and more. Now there's a User Section in our bank, to make it easy for you to obtain programs developed

Which personal computer will be most enjoyable and rewarding for you? Since we delivered our first Apple® II in April, 1977, more people have chosen our computer than all other personal computers combined. Here are the reasons Apple has become such an overwhelming favorite.

Apple is a fully tested and assembled mainframe computer. You won't need to spend weeks and months in assembly. Just take an Apple home, plug it in, hook up your color TV* and any cassette tape deck — and the fun begins.

To ensure that the fun never stops, and to keep Apple working hard, we've spent the last year expanding the Apple system. There are new peripherals, new software, and a 16-chapter Owner's Manual on "How to Program in BASIC." There's even a free Apple magazine to keep owners on top of what's new.

Apple is so powerful and easy to use that you'll find dozens of applications.

There are Apples in major universities, helping teach computer skills. There are Apples in the office, where they're being programmed to control inventories, chart stocks and balance the books. And there are Apples at home, where they can help manage the family budget, control your home's environment, teach arithmetic and foreign languages and, of course, enable you to create hundreds of sound and action video games.

When you buy an Apple II you're investing in the leading edge of technology. Apple was the first computer to come with BASIC in ROM, for example. And the first computer with up to 48K bytes RAM on one board, using advanced, high density 16K devices. We're working to keep Apple the most up-to-date personal computer money can buy. Apple II delivers the features you need to



by other Apple owners. Our Software Bank is your link to Apple owners all over the world.

Alive with the sound of music.

Apple's exclusive built-in speaker delivers the added dimension of sound to your programs. Sound to compose electronic music. Sound to liven up games and educational programs. Sound, so that any program can "talk" back to you. That's an example of Apple's "people compatible" design. Another is its light, durable injection molded case, so you can take Apple with you. And the professional quality, typewriter-style keyboard has n-key rollover, for fast, error-free operator interaction.

Apple is the proven computer.

Apple is a state-of-the-art single board computer, with advanced LSI design to keep component count to a minimum. That makes it more reliable. If glitches do occur, the fully socketed board and built-in diagnostics simplify troubleshooting. In fact, on our assembly line, we use Apples to test new Apples.

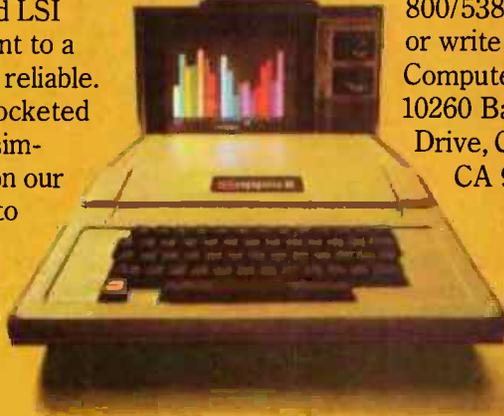


Apple peripherals are smart peripherals.

Watch the far right column of this ad each month for the latest in our growing family of peripherals. We call them "intelligent interfaces." They're smart peripherals, so you can plug them in and run them from BASIC without having to develop custom software. No other personal computer comes close to Apple's expandability. In addition to the built-in video interface, cassette I/O, two A/D game paddles, and two more A/D inputs, Apple has eight peripheral slots, three TTL inputs and four TTL outputs. Plus a powerful, state-of-the-art switching power supply that can drive all your Apple peripherals, including two disks.

Available now.

Apple is in stock and ready for delivery at a store near you. Call us for the dealer nearest you. Or, for more details and a copy of our "Consumer Guide to Personal Computers," call 800/538-9696 or write Apple Computer, Inc., 10260 Bandle Drive, Cupertino CA 95014.



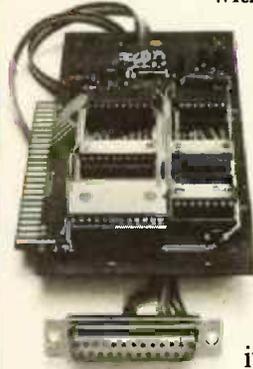
Programming is a snap! I'm halfway through Apple's BASIC manual and already I've programmed my own Star Wars game.

Those math programs I wrote last week - I just rewrote them using Apple's mini-assembler and got them to run a hundred times faster.

New from Apple.

Introducing the Apple Communication Interface

Apples of the world unite! Now you can, with our new intelligent communication interface card. Just plug it in and it turns your Apple into an intelligent terminal that can go on line with other terminals,



time-sharing computers and, especially, with other Apples. You can even play Tele-Pong! Everything you need is on one small card.

With a modem, it enables your Apple to communicate by phone at 110/300 baud RS232 full duplex I/O. The card is fully assembled and tested and has all required software in on board ROM. It's controlled by simple BASIC commands. And it's available from stock.

Peripherals in stock

Hobby Board, Parallel Printer Interface, Communication Interface.

Coming soon

High speed serial printer interface, General purpose serial interface, Printer II, Printer IIA, Disk II, Monitor II.

* Apple II plugs into any standard TV using an inexpensive modulator (not included).

Circle 15 on inquiry card.

Apple's smart peripherals make expansion easy. Just plug 'em in and they're ready to run. I've already added two disks, a printer and the communications card.



A Programmable

Character Generator

Part 2: Software

Larry Weinstein
Objective Design Inc
POB 20325
Tallahassee FL 32304

In part 1 last month (page 79), we saw that a programmable memory could be substituted for the character generator read only memory in a video display to create and use special character sets for special computer applications. With a small amount of additional software overhead, it is also possible to control high resolution screen graphics. The techniques for using the programmable character generator are detailed this month, and examples are presented.

Modes of Operation

Each character to be portrayed by a typical video display generator is represented by an 8 bit binary code, labeled B0 to B7. B7 often is not used for character selection, but rather serves a special hardware func-

tion: to key in reverse video, in the Processor Technology VDM-1, for example. The remaining seven bits are used to select from the 128 possible ASCII characters. These 128 characters are shown in figure 1. The programmable character generator allows the user to substitute, for some or all of these, characters created by the user (see figure 2). In each case the 7 bit code is used as an address in the character memory.

Programmable character generator circuitry selects the character data according to information present in the code itself and the operation mode. There are five such modes: fixed normal, fixed graphics, command, programmed, and automatic (part 1 of this article gave details on the selection process). In fixed normal, the programmable memory is never accessed. For the fixed graphics, command, and programmed modes, there is a simple connection between the character code and the programmable memory locations used to describe the characters.

Figure 1: The ASCII character set. The seven bits of the ASCII code indicate which of the 128 possible characters will be generated. The data used for producing these characters is usually stored in a character generator read only memory.

		LOW 4 BITS OF ASCII CODE																
		0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	
UPPER CASE SET	HIGH 4 BITS 0	N	S	S	E	E	E	A	B	B	H	L	V	F	C	S	S	
		U	H	X	X	T	Q	K	L	S	T	F	T	F	R	O	S	
	1	D	D	D	D	D	N	S	CONTROL			E	S	E	F	G	R	U
		L	1	2	3	4	K	Y	B	N	M	B	C	S	S	S	S	S
	2		"	#	\$	%	&	'	()		+	,	=	.	/		
	3	0	1	2	3	4	5	6	7	8	9		;	<	=	>	?	
	4	@	A	B	C	D	E	F	G	H		J	K	L	M	N	O	
	5	P	Q	R	S	T	U	V	W	X	Y	Z	[/]	^	_	
6		a	b	c	d	e	f	g	h	i		k		m	n	o		
7	p	q	r	s	t	u	v	w	x	y	z	{		}	~			

THIS FLOPPY IS NO FAIRY TALE.

It can be confusing to choose the right floppy disk system for your micro. All those fanciful yarns of capabilities, specs, and delivery. Some would put Uncle Remus or Scheherazade to shame.

Meet EXP—our no-nonsense, down-to-earth, full-sized floppy system. Check its benefit list. Then make inquiries with a technical advisor or your friendly computer shop before making a buying decision. Our Macro EXP Disk System offers you:

1. A Darned Good Price for What You Get.

Here's a complete dual-drive floppy with full-sized 8" diskettes for under \$2,000. No high-priced options; great standard features. Why not pay a little more now for a lot later?

2. Rapid-fire Delivery.

Get a fully assembled, tested floppy system in four weeks or less—not in several months, maybe.

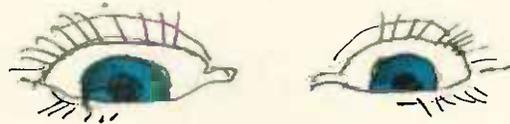


3. Super Expandability.

EXP Memorex drives are the only ones you can convert to double-headed later (cost: \$300 each). Our optional double-density controller (also \$300) doubles the disk's density. Increase your original dual-drive system's capacity to over two megabytes!

4. Unmatched Reliability.

Our super-reliable Memorex EXP drives carry a six-month warranty. No other competitor can make that statement.



5. Up to Your Eyes in Software.

Our floppy's disk controller features IBM 3740 compatibility and CP/M* formatting (the industry standard). Choose between BASIC and FORTRAN, or complete business application and word processing packages.

6. Fabulous Flexibility.

Our floppy gets along with everybody. Optional I/O drivers for the SOL let you get started now with an industry standard floppy disk system.



7. We Like to Keep It Simple.

EXP's no kit. It's assembled, tested and raring to go to work. A serial I/O port on our controller makes it a snap to bring the system up. No patching or fussing. Just hit the button.

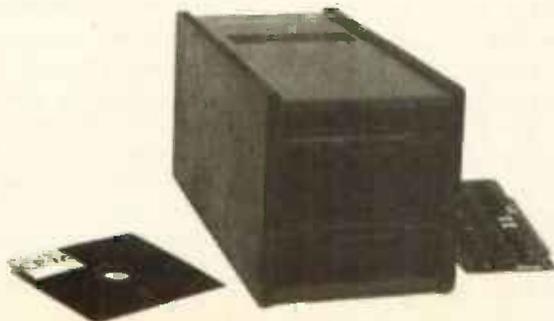
8. Comfy Compatibility.

All EXP's are fully compatible with S-100 bus systems with at least 16K of memory.

Never fear. EXP's here—with the whole floppy for under \$2K. Don't be timid or "mini-minded." Get the best now—for today and tomorrow. We'll take care of the technical stuff. You do the rest. For details, contact your nearest dealer or query us direct.

P.S. Be sure to ask about "Z-Plus"—our sensational new computer system that includes a Z-80 processor with 32K of memory, serial I/O ports and EXP series drives—with prices starting below \$4,000.

* CP/M is a trademark of Digital Research, Inc.



Where there's always more in store.

MICROMATION

524 UNION STREET
SAN FRANCISCO, CA. 94133

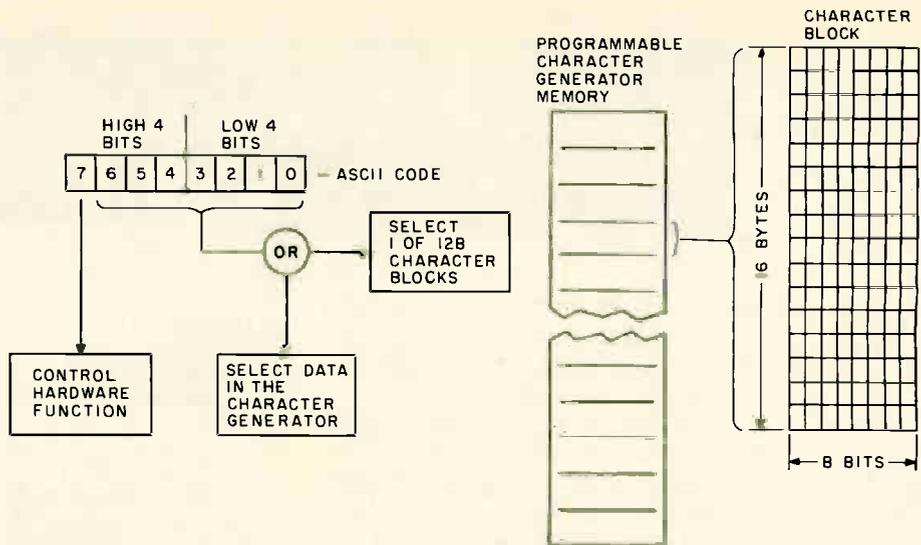


Figure 2: Decoding the code byte. The highest order bit of the 8 bit code is used for control hardware functions (such as reverse video). The remaining seven bits select character blocks in the character generator read only memory, the programmable character generator, or both (depending on what mode of operation is being used). Each data block consists of 16 bytes with eight bits. The 1s and 0s are converted to screen dots and spaces by the hardware.

The programmable memory is divided into 128 blocks of 16 bytes each, proceeding from low to high memory address. The seven code bits, from hexadecimal 00 to 7F, locate the block of 16 bytes used to describe the character. This is expressed by the simple formula for the address in memory of the first byte of a character block:

$$\text{Address} = \text{Base address} + [16 \times \text{code}]$$

where "base address" is the lowest address of the programmable character generator memory, and "code" is interpreted as a number.

Each byte represents one row of the screen dots that form the character. Row 0 is the first byte (lowest address) in the block, and row 15 is the last byte (highest address). We are tempted at this point to say that row 0 appears at the top of a character space on the screen and row 15 at the bottom. But this is not always true, due to some hardware tricks in the various video display devices. For instance, in the Processor Technology VDM-1, row 15 is on the top, followed by row 0 and the other rows in order to 12. Since row 15 is always blank when generated by the character generator, this is not normally apparent. With programmable character generator characters, though, it will have an effect and must be dealt with in the hardware or software. We will assume, for now, that the rows are projected in numerical order.

The division of the programmable character generator's memory is slightly altered

for the automatic mode (see figure 3). In this mode the 128 codes are split between the character generator and the programmable memory, with 64 characters being generated from each. The character generator produces all of those characters in what is normally known as the "upper case set." The remaining characters come from the programmable memory.

It is unfortunate that the split does not

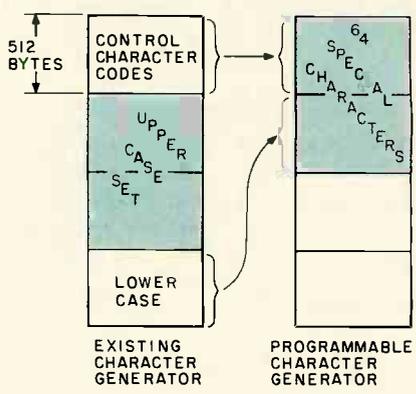


Figure 3: Automatic mode. In this mode, the upper case characters come from the existing character generator while the control character and lower case codes automatically reference 64 special characters in the programmable character generator memory. This is probably the most convenient mode of operation for many applications, since the normal upper case character set is available along with the special graphics characters.

HORIZON

THE COMPLETE COMPUTER



Look To The North Star HORIZON Computer.

HORIZON™— a complete, high-performance microprocessor system with integrated floppy disk memory. HORIZON is attractive, professionally engineered, and ideal for business, educational and personal applications.

To begin programming in extended BASIC, merely add a CRT or hard-copy terminal. HORIZON-1 includes a Z80A processor, 16K RAM, minifloppy™ disk and 12-slot S-100 motherboard with serial terminal interface — all standard equipment.

WHAT ABOUT PERFORMANCE?

The Z80A processor operates at 4MHZ — double the power of the 8080. And our 16K RAM board lets the Z80A execute at *full speed*. HORIZON can load or save a 10K byte disk program in less than 2 seconds. Each diskette can store 90K bytes.

AND SOFTWARE, TOO

HORIZON includes the North Star Disk Operating System and full extended BASIC on diskette ready at power-on. Our BASIC, now in widespread use, has everything desired in a BASIC, including sequential and random disk files, formatted output, a powerful line editor, strings, machine language CALL and more.

EXPAND YOUR HORIZON

Also available—Hardware floating point board (FPB); additional 16K memory boards with parity option. Add a second disk drive and you have HORIZON-2. Economical serial and parallel I/O ports may be installed on the motherboard. Many widely available S-100 bus peripheral boards can be added to HORIZON.

QUALITY AT THE RIGHT PRICE

HORIZON processor board, RAM, FPB and MICRO DISK SYSTEM can be bought separately for either Z80 or 8080 S-100 bus systems.

HORIZON-1 \$1599 kit; \$1899 assembled.

HORIZON-2 \$1999 kit; \$2349 assembled.

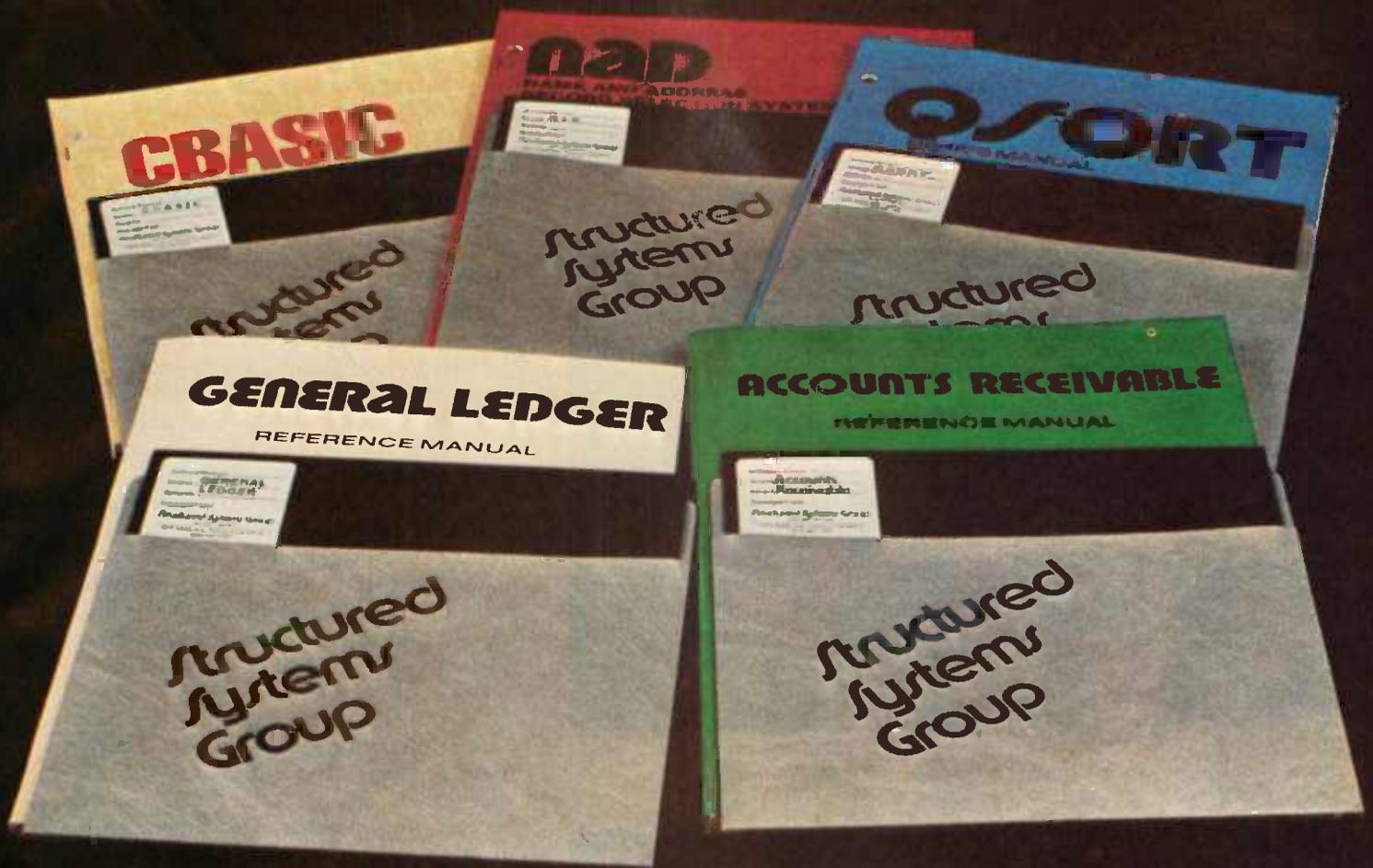
16K RAM—\$399 kit; \$459 assembled; Parity option \$39 kit; \$59 assembled. FPB \$259 kit; \$359 assembled. Z80 board \$199 kit; \$259 assembled. Prices subject to change. HORIZON offered in choice of wood or blue metal cover at no extra charge.

Write for free color catalogue or visit your local computer store.

NORTH STAR ★ COMPUTERS

2547 Ninth Street • Berkeley, California 94710 • (415) 549-0858

"Our goal was to produce 100% reliable business programs."



"What do we mean by reliable programs? Three things: good program design, documentation, and full support.

DESIGN Good program design meets a wide variety of customer needs without reprogramming.

Our programs are comprehensive yet retain their flexibility. They allow convenient backup, are easy to use and have been thoroughly tested and field proven.

DOCUMENTATION We consider the quality of the documentation to be as important as the programs themselves. That's why our manuals are clear, concise and complete.

SUPPORT And when it comes to support we're second to none. We release periodic updates, answer your questions and are available to provide technical assistance. Now *that's* reliable."

Our growing Business Systems series currently includes: **GENERAL LEDGER**, **ACCOUNTS RECEIVABLE**, **NAD** (Name and Address File system), **QSORT** (full disk sort/merge), and **CBASIC** (a powerful business Basic). For details, contact our sales manager, Richard Ellman.



Keith Parsons, President
Alan Cooper, VP, Systems Development

Circle 352 on inquiry card.

Structured Systems Group

5615 KALIS AVE. DEPT. B6 OAKLAND, CA 94618 (415) 547-1567

All systems are compatible with any Z-80 or 8080 CP/M™ system.

with a simple grid. The automatic mode is used for the entire alphabet since the upper case character set is still needed. Placement in the programmable character generator's memory determines the keyboard code (and therefore, which keys) the characters will match with, so using the SHIFT and CTRL keys with the upper case set will cause special characters to be displayed. The user can easily add labels to a key set to produce a full APL terminal (minus all of the programming, of course).

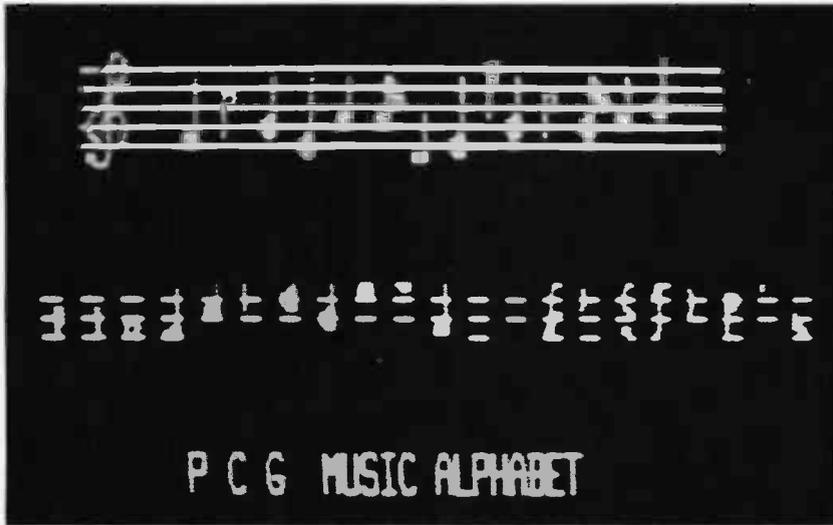


Photo 2: A special music alphabet created in the graphics mode.

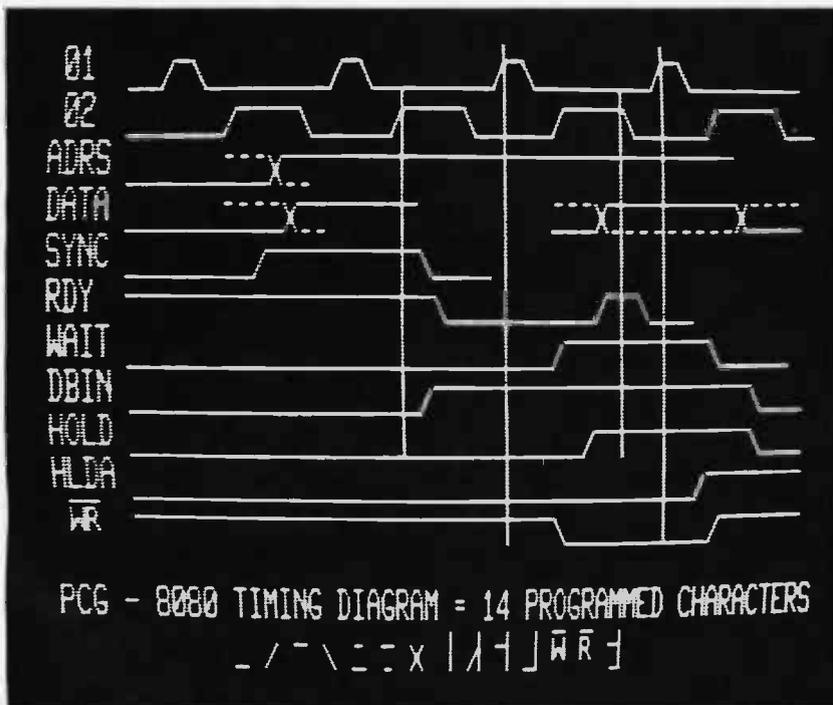


Photo 3: Timing diagram created in the automatic mode of the programmable character generator.

From this example, it should be obvious that any character set that will fit on the 9 by 7 (or larger, to 16 by 8) matrix used by the character generator can be generated. Also, multiple character sets can be stored in memory and swapped in as needed. In cases where more than 128 different characters are required, but all characters do not have to appear on the screen at one time, it is possible to dynamically create them. In this instance, a subset, possibly with only one element, of the set is swapped as required.

Graphics

The ability to create character sets implies some graphics capabilities. The simplest form of graphics will use an unusual character set, but still be handled as an alphabet. A good example is a set of musical notes (see photo 2). Each character is a single note, projected on the musical staff. The software overhead to create such a picture is very small, taking up less than half of the programmable character generator memory. Using a high resolution point by point graphic display, the amount of time and software overhead required to generate such a picture might be much larger.

At the next level of graphics, the hardware restrictions on the video display device begin to tighten. The ideal display is one in which there are no forced blank sections between the characters. This will enable us to build pictures from individual character elements. The next example is a timing diagram (see photo 3). In this case it is one for the 8080. The video display device used forces a single blank dot column between characters, which goes almost unnoticed. The diagram uses very few characters, but repeats them many times. Those who are applications oriented should note that storing this picture, or any picture constructed from this character set, requires only 1 K bytes for the screen memory and less than 256 bytes for the characters. Even a system with limited mass storage could hold all of the 8080 timing diagrams and information on the signals.

The bar graph picture in photo 4 is similar. However, its hardware restriction is mainly in the vertical direction. In this case it is best to eliminate the blanks between rows of characters as much as possible. Finally in the logic set (photo 5), the restrictions are tight in both horizontal and vertical directions. It should be remembered that while the human eye is capable of noticing even the smallest flaw in a picture, the human brain will "inte-



The Computer for the Professional

The 8813 was built with you, the professional, in mind. It quickly and easily processes cost estimates, payrolls, accounts, inventory, patient/client records and much more. You can write reports, briefs, and proposals on the 8813's typewriter keyboard, see them on the video screen, and instantly correct, revise, or print them.

Using the 8813, one person can process what would normally require many secretaries, several bookkeepers, and a great deal of *time*. And data storage takes a small fraction of the *space* used by previous methods.

You don't need to learn complicated computer languages. The 8813 understands commands in English. If you want to write your own programs, the 8813 includes a simple computer language, BASIC, that you can master in a few days. The 8813 slashes the professional's overhead. It's a powerful time and money-saving ally. Prices for complete systems including printer start at less than \$8,000.

See the 8813 at your local dealer or contact PolyMorphic Systems, 460 Ward Drive, Santa Barbara, California, 93111, (805) 967-0468, for the name of the dealer nearest you.

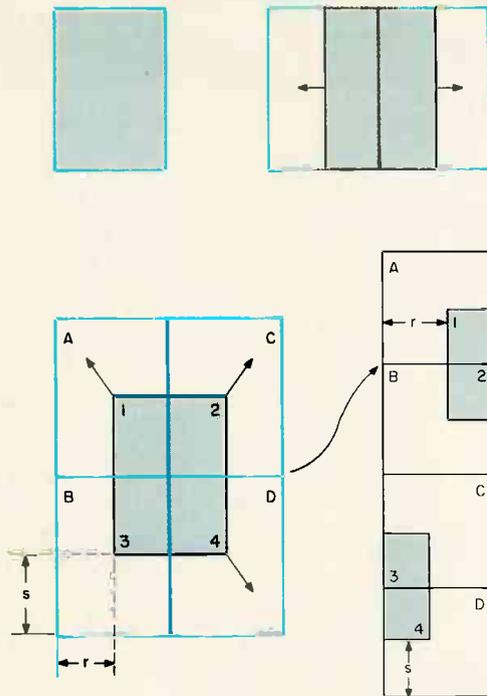


Figure 5: Dynamic generation. The user can cause a special character (such as a spaceship) to move smoothly across the screen by using the technique of dynamic generation. During its travel, the character can overlap up to four screen locations (the character is shown in color). Although the total number of characters needed to portray parts of the ship as it moves across the screen is quite large, only a maximum of four are needed at any time. These characters are generated by mapping the image onto the programmable character generator memory, with the mapping function determined by the screen position.

grate" the available information and make up for most imperfections.

Dynamic Generation

The previous examples have utilized a simple character set with frequently repeated elements. Now let us consider a case where this is not sufficient. We have a figure (it could be a spaceship) which must move smoothly across the screen. Assuming it is the same size as a single letter, it may overlap as many as four screen spaces at one time (see figure 5). Although the total number of different characters used to portray parts of the ship as it moves on the screen is quite large, only four are needed at one time. The total information on the screen appearance of the ship is contained in a single picture, requiring perhaps 8 to 12 bytes. The trick then is to dynamically create the one, two, or four characters needed at any one time from the basic ship picture bytes. This is done by mapping the image onto the programmable character generator's memory, with the mapping function determined by the screen position. For a changing object that also moves across the screen, it is only necessary to maintain different sets of picture "masters" from which to perform the mapping. If pictures larger than a single character space are required, they can be created by a repetition of the same process.

The applications of the programmable character generator are as varied and numerous as the characters it creates. Once its use is mastered, there is virtually no character set or graphic that cannot be portrayed with very low overhead in cost, memory, and programming effort. The examples I've shown in these two articles are but the first doodlings I've done with a flexible and powerful kind of display hardware. Users of this technique will find their displays limited only by imagination. ■

Photo 4: Bar graph created by the programmable character generator.

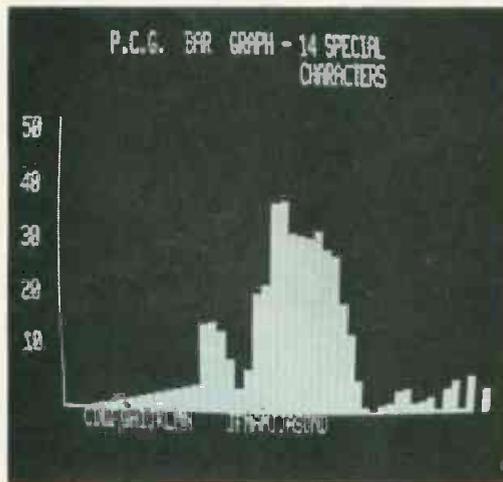
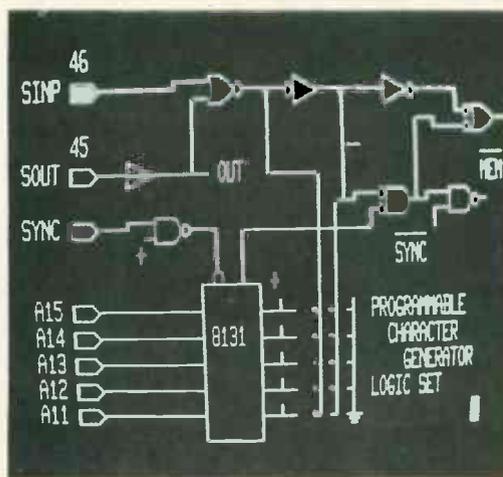


Photo 5: A logic diagram generated with the programmable character generator.



Build a whole new world with **The Blues**.



The future belongs to those with **The Blues** from Cybercom.

Join the growing number of users worldwide who are discovering the exceptional quality, plus prompt delivery and significant cost savings. And the new year holds even more promise now with our MB6A 8K RAM board (450 NS) reduced to just \$165, and our MB7 16K RAM board now only \$449. Also, you might want to check out our new I/O-4 board that offers two serial I/O ports (2-I and 2-O) and two parallel ports (2-I and

2-O), eliminating jumpers, priced at \$149.50. Seek out Cybercom's full and versatile line at your local computer hobbyist store, or contact us directly, if you want to build a world of the future today.



A Division of Solid State Music
2102A Walsh Avenue
Santa Clara, CA 95050
Telephone (408) 246-2707



MB7 16K
RAM board.

Ask for **The True Blues**.

Basic systems for personal computing

If you are just getting into personal computing and are looking for a starter system, you have two choices: a computer kit with RAM memory only or a fully assembled computer with BASIC-in-ROM. From reading this magazine and talking to computer buffs it should be obvious that it is desirable to have a computer capable of communicating in the programming language BASIC: This language allows you to instruct the computer in English-like phrases and to use any of the thousands of standard programs written in BASIC (there are probably several in this magazine).

If you purchase a (RAM-only) computer kit you will have to buy additional RAM (4K to 8K), a terminal, and cassette interface for a total cost of about \$1000 to run BASIC after you get the kit together and working. Your reward for this endeavor will be a wait of about 15 minutes every time you turn the computer on just to load BASIC into the machine!

Your other alternative is a BASIC-in-ROM computer. These machines have BASIC built in so that it is there whenever the computer is turned on. BASIC-in-ROM computers are also usually fully assembled and cost far less than the RAM-only kits because they are mass-produced by the thousands.

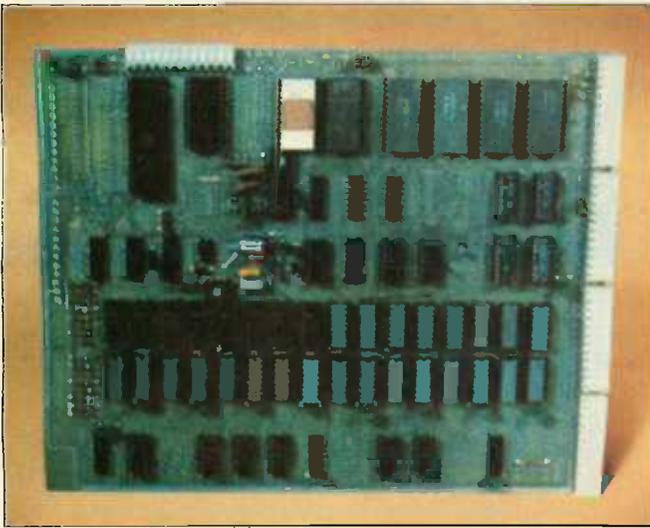
But, you must be careful when selecting a BASIC-in-ROM computer. Some models do not have full-feature BASIC. Instead they have Tiny BASIC or 4K BASIC which cannot run most of the standard BASIC programs available. Still others have other shortcomings such as a small calculator-style keyboard which makes program entry difficult, or most important, lack of expansion capability, preventing the computer from growing with you.

Ohio Scientific offers you a line of expandable computers with full-feature 8K BASIC-in-ROM. They all come fully assembled and tested, but give you the option of economizing by supplying the simple things — power supply, keyboard and TV, if desired, so that you get the most computer power for your dollar.

Compare Ohio Scientific's \$298 BASIC-in-ROM Model 500 Board (1MHz clock), which has our Version 3.3 BASIC, against other small computers, as in the independent article "BASIC Timing Comparisons" (Kilobaud, Oct. 1977, p. 23). In this test, the Model 500 excelled over all our personal computing competitors, and was second in performance only to our Challenger disk systems, compared against twenty-eight other computer systems. And the Model 500 is our lowest-cost machine! Our larger models are even more dramatic in a comparison with any competitive models.

Having the fastest full-feature BASIC ROMs certainly isn't the only criterion necessary for a superior computer system, but it sure helps. Ohio Scientific offers all the other features necessary, including a full line of computer accessories complete with 15 accessory boards available in over 40 configurations. Many Ohio Scientific accessories are so innovative that no one else in the industry has them — such as dual port memory boards, multi-processing CPU's and big disks.

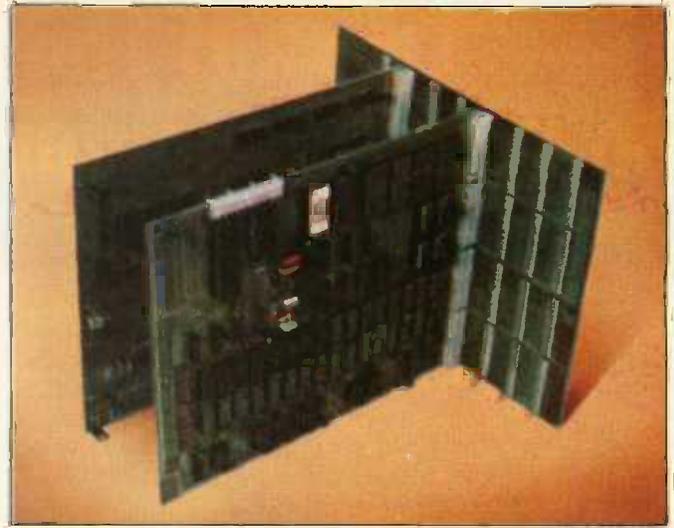
Ohio Scientific has other unique features for the personal computerist. For instance, there is Ohio Scientific's *Small Systems Journal*, published bi-monthly, a full magazine aimed specifically at the owners of Ohio Scientific computers. If you are looking for a personal computer, be sure to look carefully at Ohio Scientific. We think you will find that we have the system for you.



Model 500 Board

A full 8K BASIC-in-ROM computer on a board. This unit contains a 6502 microprocessor with our powerful 8K BASIC-in-ROM, 4K of RAM memory, and a serial port which can be jumpered for 20ma current loop or RS-232. The board can be plugged into any standard OSI-backplane and expanded by our full line of accessory boards. The user must simply supply +5V and -9V power and the serial terminal to be up and running in BASIC.

\$298.00



Super Kit

An ideal starter computer system. The Super Kit includes a Model 500 CPU Board with 8K BASIC in ROM, CPU, and 4K of RAM, full buffering for expansion, an eight-slot backplane board, and a Model 440 Video I/O Board. Model 440 provides full CRT functions when connected to a video monitor or modified television set and a standard ASCII keyboard. The user must simply provide +5V and -9V power, an ASCII keyboard, and a modified television set or monitor to have a full computer system with 8K BASIC-in-ROM, 4K user space and a CRT terminal with scrolling.

\$398.00



Challenger II-P

Our very popular fully packaged BASIC-in-ROM computer. Challenger IIP contains the Model 500 CPU Board with 4K of RAM, our new 540 32x64 character video display, keyboard and complete audio cassette interface. The unit also has internal power supplies and a four-slot backplane with two open slots for expansion. The user has only to connect a monitor or modified television set to its output, and he is ready to program in BASIC. To store programs and data files, he needs only to connect a conventional audio cassette recorder to the built-in audio cassette interface. The unit is fully assembled and ready to go.

\$598.00



Challenger II Disk Systems

The ultimate in personal computing offered by Ohio Scientific is the Challenger II system with single- or dual-drive full-sized floppy disk. Each floppy stores 250,000 characters. The Challenger II is available as a video system with keyboard so that all the user needs is a television or monitor for operation; or as a serial version where the user must supply his own terminal. Challenger II disk systems automatically load in BASIC and now have an extensive library of high-performance programs. The programs are ideal for the advanced hobbyist, educational users, industrial development and small business applications. Challenger II disk systems are very economical. For instance, a 16K disk system with 250,000 bytes of disk storage starts at under **\$2000.00**

OHIO SCIENTIFIC

1333 S. Chillicothe Road • Aurora, Ohio 44202
(216) 562-3101

For more information contact an Ohio Scientific dealer or send \$1 for our 64-page buyers' guide.

OS-65U The New Standard in Micro Computer Operating Systems

System design goals: Create a simple, concise crash proof operating system which is easy for business programmers to utilize and simple for office workers (and other non-computerists) to use. The system *must* have the highest performance in the microcomputer industry and must be able to support present day floppy and hard disks as well as tomorrow's CCD and bubble memories *without any user program modifications*.

This may sound outlandish but we developed just such a system and here's how:

First, we started with a fresh copy of Microsoft's super fast 9½ digit BASIC for the 6502. (This BASIC out benchmarks every other microcomputer BASIC using the 7 Kilobaud benchmarks except for our own ultra fast 6 digit BASIC.)

We knew that all operating system commands and features should be an integral part of this BASIC language so we put them right in the BASIC itself. This means that all OS features can be accessed in the immediate or command mode and as part of BASIC programs. All syntax such as file names can be literal strings or BASIC variables.

We started with some simple but powerful extensions to BASIC to make the business system programmer happy—like \$L,\$R,INPUT #(D),and PRINT #(D).\$L and \$R are PRINT subcommands which automatically output numeric data in dollars and whole cents in neat columns just like "PRINT USING" only simpler and quicker.

The optional # specifier in LIST, INPUT and PRINT statements allows the user to route I/O directly to the console, 16 RS-232 ports, a cassette port, RS-232 and parallel printer ports and word processing printers, not to mention video displays and parallel keyboards.

We then added a continuous memory file system—the real achievement of OS-65U. This file system has no tracks, sectors or records. The user simply allocates storage capacity to each file when he creates it. (On a CD-74 Hard Disk this can be over 72,000,000 bytes or characters.) The user can then directly address every entry in the file with no awareness of any block, sector or track structures. Data files can simultaneously contain strings and pure numeric data. Files can be accessed sequentially *and* randomly.

Data files are handled with standard syntax including OPEN "File", CLOSE (File), PRINT % (File) and INPUT % (File) and the very special INDEX (File). INDEX is a special BASIC variable/function which specifies the file address of the next entry to be input or output to that file. If you leave it alone, it operates sequentially. However, you can change it at any time to force a random access. This remarkable function can be on either side of a BASIC equation and can take on any value within the storage range of an opened file. For example, all of the following are legal in OS-65U:

INDEX (1) = INDEX(1) + 10 (Causes 10 characters to be skipped)

B = INDEX (1) (Sets B = current index)

INDEX (3) = INDEX(8) / 2 (Equates two file positions, useful in sorts and merges)

INDEX (5) = A*50 (Sets up a random access on an array with 50 character elements)

Where (N) is a channel number or shorthand notation for an open file, and is assigned by the OPEN command.

This may seem exotic but it is really super simple and incredibly powerful. Besides your files always automatically revert to simple sequential operation if you choose to ignore indexes.

And, finally, for those of you who would really hate to give up plain old sequential files, we added a FIND command. FIND searches for up to a 32 character string with optional "don't care" characters and will automatically scan any file from the beginning or other specified index. The FIND command is implemented in straight line page zero 6502 code (the fastest programming technique on the fastest micro) and searches files at over 250,000 bits per second.

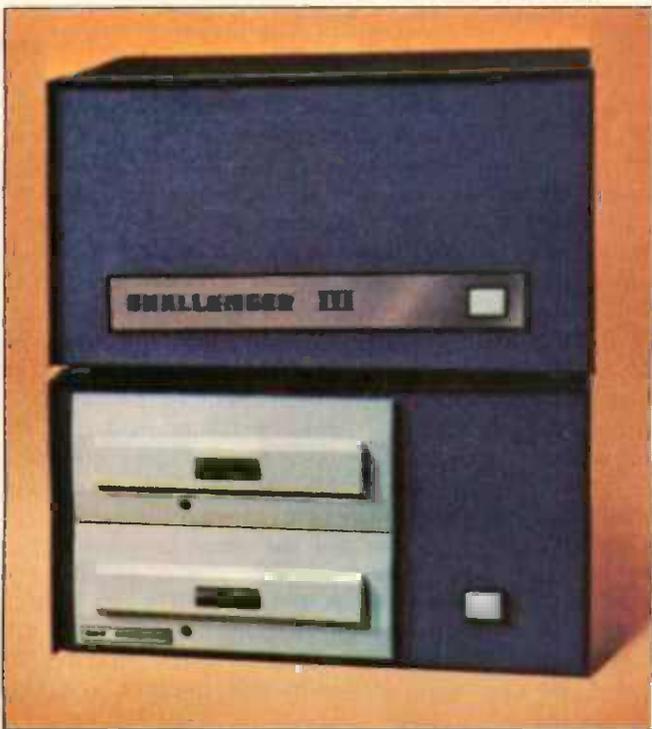
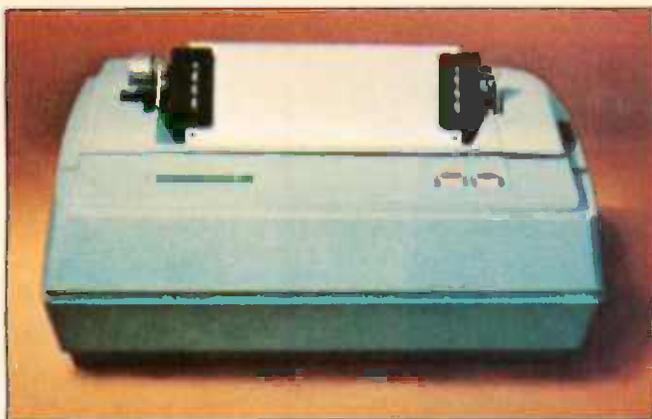
Only three statements are needed to support a sequential file in a BASIC program; only four to support a random file. A mere seven statements are required to use an indexed sequential file system as part of a program!

A Benchmark: A Challenger III equipped with a CD-74 running OS-65U can access any account entry in a 500 account one million byte randomly ordered ledger file by an alphabetic key string up to 32 characters long in less than 40 milliseconds (typically) using a simple two level ISAM file structure supported by a total program only 10 statements long. That's performance!

OS-65U also hosts multilevel passwords, elaborate error checking, programmable error recovery and end user niceties like warnings and automatic recovery when an "off" or non-existent peripheral is accessed. Programs and files in OS-65U can be fully secured so that they cannot be listed, copied or even accessed if desired.

OS-65U is available now for use on any Ohio Scientific floppy or hard disk based computer with 32K of RAM or more. At \$199, it's quite possibly the best computer investment you'll ever make.

The Challenger III System



- Designed for small business computing.
- Uses the 510 triple processor CPU Board, runs 6502, 6800, 8080 and Z-80 programs.
- Available with up to 1 Megabyte of RAM memory; high reliability static RAM is standard; low-cost dynamic RAM is optional.
- Single- or dual-drive floppy disks store 250,000 characters per surface — 3 to 4 times the storage of mini-floppies.
- Supports our ultra-fast 6-digit BASIC (see "BASIC Timing Comparisons," Kilobaud, Oct. 1977, p. 23, where Ohio Scientific out-benchmarks all of our competitors) and our new super-fast 9-digit business BASIC.
- Powerful operating systems support all standard I/O ports including multiple terminals, line printers, video display and disk.
- Disk supports: sequential, random and index sequential files.
- Applications software, including:
 - WP-1, a powerful disk-based Word Processor.
 - DMS, a unique data-base management system which supports continuous disk addressing of up to 250,000 characters per file.
- Complete business packages including Accounts Receivable, Accounts Payable, Ledger, Payroll, Inventory and Taxes.
- Two factory-supported terminal options and two factory-supported line printer options.
- Optional 74-Megabyte hard disk for \$6000. Reel-to-reel mag tape coming soon.
- Optional 16-user operating system with time share and distributed processing capabilities.
- Optional rack mounting and rack enclosures.
- Leasing programs and maintenance contracts available through many dealers. Optional nationwide field service coming soon.
- Challenger III systems have extremely high performance-to-cost ratios. For example, a system complete with triple processor CPU, 32K bytes of static RAM, a serial I/O port, dual drive floppy disks (500K bytes of on-line storage), fully assembled, plus DOS, BASIC and a demonstration program library costs \$3590 fully assembled.

DEALERS

- | | | | |
|--|--|--|---|
| <p>The Abacus
Niles Rd.
Berrien Springs, MI 49103
(616) 429-3034</p> <p>American Microprocessors
Equipment & Supply Corp.
20 N. Milwaukee Ave.
Parsippany, IL 60069
(312) 634-0076</p> <p>Computer Mart of New York
118 Madison Ave.
New York, NY 10010
(212) 686-7923</p> <p>Computer Place
RD #4
Box 910
Joplin, MO 64801
(417) 781-1986</p> <p>Computer Power
P.O. Box 28193
San Diego, CA 92128
(714) 746-2064</p> <p>Computer Shop (Aircorn)
288 Norfolk St.
Cambridge, MA 02139
(617) 661-2670</p> | <p>Oglaware Microsystems
92 E. Main St. #1
Newark, DE 19711
(302) 738-3700</p> <p>Great Lakes Photo, Inc.
5001 Eastman Rd.
Midland, MI 48640
(517) 631-5461</p> <p>H/B Computers
217 East Main St.
Charlottesville, VA 22903
(804) 295-1975</p> <p>Microcomp
P.O. Box 1221
Fonc. Du Lac, WI 54935
(414) 922-2515</p> <p>Microcomputer Workshop
234 Tennyson Terr.
Williamsville, NY 14221
(716) 632-8270</p> <p>Micro Computer World
213 Michigan St.
Grand Rapids, MI 49503
(616) 451-8972</p> <p>Small Computer Systems
4450 Irwin Avenue
Salt Lake City, UT 84120
(801) 967-7635</p> | <p>Abacus Data
P.O. Box 276
Oil City, PA 16301</p> <p>Associates Consultants
33 Ogden Ave.
East Williston, NY 11596
(516) 746-1079</p> <p>BRAG Microcomputers
19 Cambridge St.
Rochester, NY 14607
(716) 442-5861</p> <p>Byte Shop
2432 Chester Lane
Columbus, OH 43221
(614) 486-7761</p> <p>Computer Business
P.O. Box 171
LaPorte, IN 46350
(219) 362-5812</p> <p>Custom Computer Systems, Inc.
1823 Lowry Ave. - North
Minneapolis, MN 55411
(612) 588-3944</p> <p>Johnson Computer
P.O. Box 529
Medina, OH 44256
(216) 725-4560</p> <p>Omega Computing, Ltd.
Box 220 Station P
Toronto, Ont. M5S 2S7
(416) 425-9200</p> | <p>Pan Atlantic Computer Systems, GmbH
61 Darmstadt
Frankfurterstrasse 78
West Germany
(08102) 3206</p> <p>Secom Systems
5411 New Peach Tree Rd.
Chamblee, GA 30341
(404) 934-3272</p> <p>Small Computer Systems
3140 Waiatae Ave.
Honolulu, HI 96816
(808) 732-5246</p> <p>Systems Engineering Enterprises
Suite 307
1749 Rockville Pike
Rockville, MD 20852
(301) 468-1822</p> <p>Tek-Aids, Inc.
1513 Cran St.
Evanston, IL 60202
(312) 328-0110</p> <p>Total Data Systems
125 Fairway Lane
Fort Collins, CO 80521
(303) 482-8215</p> <p>Tricom, Inc.
18 Alameda Square
Denver, CO 80223
(303) 935-1100</p> <p>Yingco, Inc.
2 World Trade Cntr.
Penthouse 107th Floor
New York, NY 10048
(212) 775-1184</p> |
|--|--|--|---|

REPRESENTATIVES

OHIO SCIENTIFIC

1333 S. Chillicothe Road • Aurora, Ohio 44202
(216) 562-3101

For more information contact an Ohio Scientific dealer or the factory. Be sure to specify your interest in business systems.

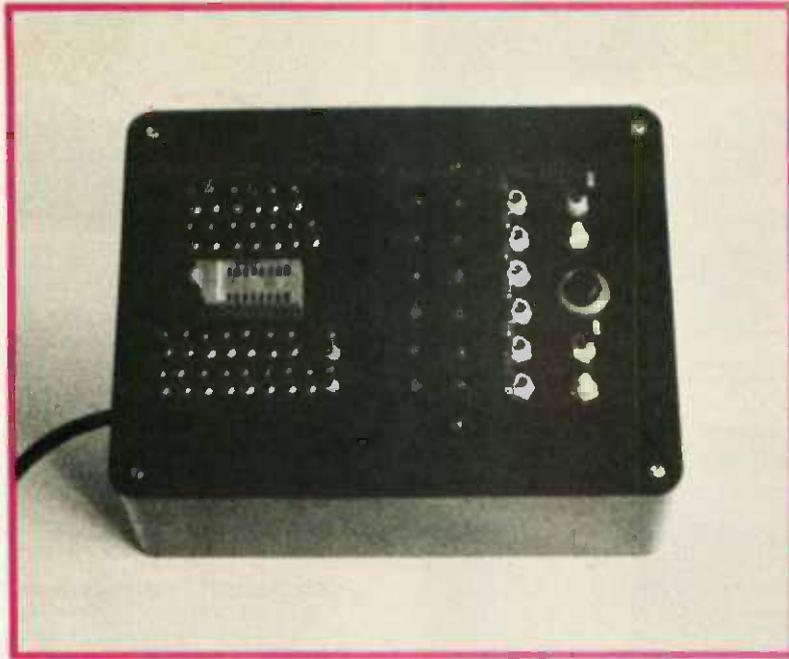


Photo 1: The prototype for the author's IC tester. The LEDs shown were not included in the final design of figure 1.

A Programmable IC Tester

Mark Thorson
1505 Spruce St
Berkeley CA 94709

The high cost of digital components can be significantly reduced by the construction of this simple test instrument. While components of questionable reliability have long been available for a fraction of their value, the experimenter has been unable to take full advantage of them for lack of an adequate means of component testing. This circuit, however, now offers such a means for the rapid and accurate screening of bargain components.

Conventional component testing generally takes the form of either building a prototype circuit and substituting devices until it works, or setting up a rig of lights and switches and testing each gate or flip flop on the chip individually. Although these procedures are sufficient for the construction of trivial circuits employing a small number of integrated circuits, neither is exacting enough nor fast enough to provide the quantity or quality of parts required for a well stocked electronics lab.

The main weakness of both approaches is their failure to check the devices in question under *all* possible conditions of data. As an example, consider the 7400 quad NAND gate with the failure condition of an internal short between the input on pin 4 and the output on pin 3. If this device is either tested in a circuit employing the quad NAND gate without using the input on pin 4, or tested in a rig in which each gate is tested individually, then the device will be passed without the failure conditions ever having been met. To be certain of testing all possible failure modes of this device, all 256 possible data conditions on the eight device inputs must be checked, a prohibitive requirement for manual testing.

To this end, the circuit shown in figure 1 has been designed to provide an automatic, instantaneous and exhaustive test of most SSI and MSI components. [SSI (small scale integration) refers to gates, inverters, flip flops, etc, while MSI (medium scale integration) refers to counters, latches, shift registers, etc.] The circuit operates by sending eight lines of input data to the device under test (DUT) and receiving six lines of output. Upon depression of

About the Author

Mark Thorson is currently an undergraduate at the University of California at Berkeley majoring in neurobiology, and has been working with digital logic since sixth grade. (Early efforts involved discrete components and incandescent lamps.)

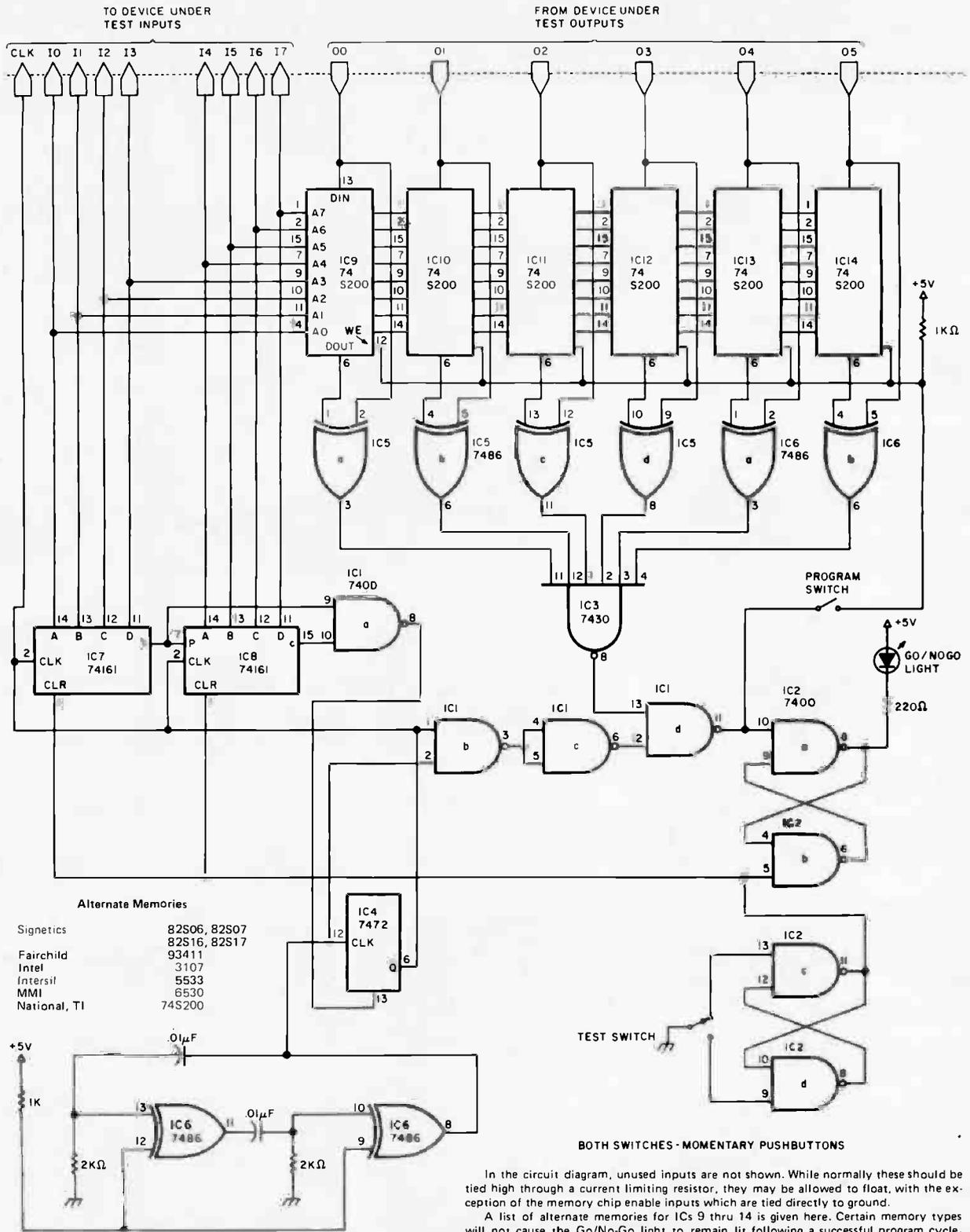
Nobody does it bigger!



Hardware. Software. Peripherals.
We've got the best in the business!

the digital group

P.O. Box 6528 Denver, CO 80206 (303) 777-7133



In the circuit diagram, unused inputs are not shown. While normally these should be tied high through a current limiting resistor, they may be allowed to float, with the exception of the memory chip enable inputs which are tied directly to ground.

A list of alternate memories for ICs 9 thru 14 is given here. Certain memory types will not cause the Go/No-Go light to remain lit following a successful program cycle. This is because some memories lock out their data outputs while being written into. This can be remedied by running a test cycle after the program cycle. The Go/No-Go light will remain lit following the test of a known good device if the data in the memories is accurate.

Figure 1: The author's automatic integrated circuit tester. The unit is connected by probes to the inputs of the integrated circuit under test (up to eight inputs can be accommodated). 256 different combinations of logic levels are sent to the integrated circuit, and a running comparison of up to six data outputs from the device is made with a set of results stored in memory for another integrated circuit of the same type that is known to be good. Any deviation from the accepted pattern causes an LED to be lit. The unit is capable of testing both combinatorial ICs, such as logic gates, and sequential ICs, such as flip flops. A learn mode allows the tester to store the characteristics of virtually any TTL integrated circuit in memory for testing.



FOUR STAR PERFORMERS FOR THE S-100 BUS

Meet The North Star Family

THE NORTH STAR S-100 FAMILY—four high performance products at attractive low prices. Our boards are designed for use in the North Star HORIZON computer and other S-100 bus computers using 8080 or Z80 processors. Visit your computer store for a demonstration, or write for our free color catalog.

16K RAM BOARD

No other S-100 bus memory can match the performance of the North Star 16K RAM at any price. This low-power board has been designed to work at full speed (no wait states), even at 4MHz with both Z80 and 8080 systems. Memory refresh is invisible to the processor, bank switching is provided and addressability is switch selectable in two 8K sections. Best of all, a parity check option is available. Kit: \$399. Assembled: \$459. Parity Option — kit: \$39. Assembled: \$59.

MICRO DISK SYSTEM

The North Star MDS is a complete floppy disk system with all hardware and software needed to add floppy disk memory and a powerful disk BASIC to S-100 bus computers. The North Star MDS is widely considered one of the best designed and most complete S-100 bus products

available. The MDS includes the S-100 interface board with on-board PROM for system startup, Shugart mini-floppy disk drive, cabling and connectors, and DOS and BASIC software on diskette. Kit: \$699. Assembled: \$799. Additional drive — Kit: \$400. Assembled: \$450. Single Drive Cabinet: \$39. Optional Power Supply: \$39.

Z80A PROCESSOR BOARD

The North Star ZPB brings the full speed, 4MHz Z80A microprocessor to the S-100 bus. Execution is more than twice the speed of an 8080, and the ZPB operates in systems both with and without front panels. The ZPB includes vectored interrupts, auto-jump startup, and space for 1K of on-board EPROM. Kit: \$199. Assembled: \$259. EPROM Option — kit: \$49. Assembled: \$69.

HARDWARE FLOATING POINT BOARD

If you do number crunching, then this board is for you. The FPB performs high-speed floating point add, subtract, multiply and divide with selectable precision up to 14 decimal digits. Arithmetic is up to 50 times faster than 8080 software, and BASIC programs can execute up to 10 times faster. A version of North Star BASIC is included. Kit: \$259. Assembled: \$359. Prices subject to change.

NORTH STAR  COMPUTERS

2547 Ninth Street • Berkeley, California 94710 • (415) 549-0858

Number	Type	+5 V Pin	Gnd Pin
IC 1	7400	14	7
IC 2	7400	14	7
IC 3	7430	14	7
IC 4	7472	14	7
IC 5	7486	14	7
IC 6	7486	14	7
IC 7	74161	16	8
IC 8	74161	16	8
IC 9 thru IC 14	74S200 (or equivalent)	16	8

Table 1: Power wiring table for figure 1. See figure 1 for alternate memory ICs for IC9 thru 14.

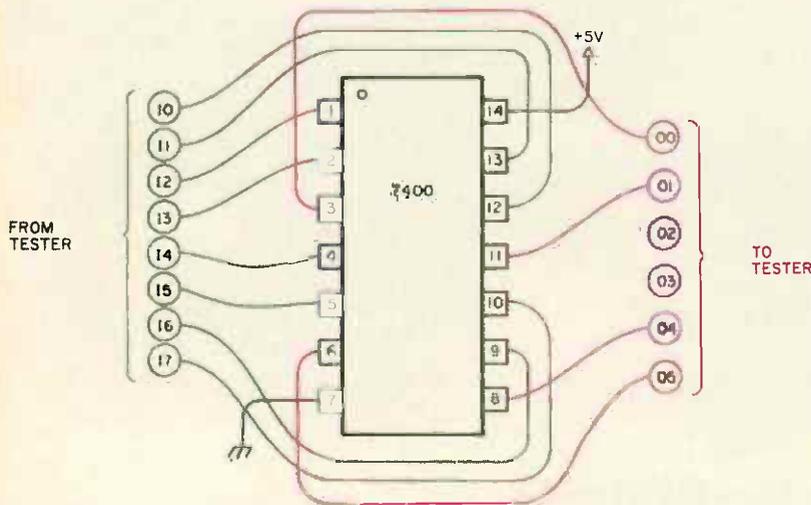


Figure 2: One method of hooking the tester up to a 7400 TTL integrated circuit.

the Test button, the binary counter driving the DUT input lines is cleared and the flip flop driving the Go/No-Go light is set. Upon release, the counter increments through all 256 input conditions to the DUT. Between counts, the data on the six DUT output lines is compared with the data stored in memory, and if any mismatch occurs, the Go/No-Go flip flop is cleared. Once the counter reaches its terminal count, the clear input to the clock oscillator flip flop is driven low, thereby inhibiting further counts until the Test button is hit again. At this time, if the Go/No-Go light has remained lit, the component has passed the test. Programming is accomplished by holding the Program button down during a test cycle of a known good device. During this time, data on the DUT outputs is loaded into memory between counts on the DUT input lines. Once the PROGRAM button is released, data in the memory is protected by a pull-up resistor on its read/write line.

Combinatorial integrated circuits, that is,

integrated circuits such as gates or comparators which do not contain storage elements such as flip flops, are tested by connecting all device inputs to lines I₀ to I₇ and all device outputs to lines O₀ to O₅. Any ordering of the connections is satisfactory, because the tester will run through all possible input conditions despite the arrangement used. Sequential integrated circuits, however, require special consideration due to their internal data states. A device such as the 74161 4 bit binary counter, for example, will require its clock input to change at least 32 times faster than its clear input to insure the completion of a full counting cycle before being cleared. To aid in the testing of sequential integrated circuits with several clear, preset, inhibit, and other combinatorial inputs, the clock input has been provided which toggles twice as fast as I₀. This input is useful for connecting to the clock input of counters, flip flops, and shift registers, but should not be used with combinatorial devices or the combinatorial inputs of sequential devices.

As an example of the use of the tester, consider again the 7400 quad NAND gate. This device has a total of eight data inputs and four data outputs to be connected. An example of one possible configuration of the connections is shown in figure 2. It should be noted that two DUT outputs are allowed to float. This is permissible, because the same data will be present during a test cycle as when the tester is programmed. It is also acceptable to use less than eight DUT inputs, because the tester will still run through all possible data conditions on the remaining inputs. Once the proper connections have been made, the tester is programmed by inserting a known good device into the DUT socket and holding the Program button down while momentarily depressing the Test button. If the tester has accurately stored the characteristic output of the device, the Go/No-Go light will remain lit following the release of the Test button. The Program button may now be released and tests performed by inserting a questionable device and depressing the Test button. If the Go/No-Go light remains lit upon release of the Test button, the device has passed.

As an example of the testing of a sequential device, consider the 74161 4 bit binary counter. An example of one possible configuration of its connections is shown in figure 3. Unlike the case of the quad NAND gate, the ordering of the DUT input connections is very important. Combinatorial inputs such as clear, load, and inhibit are

NEW



AN INTRODUCTION TO PERSONAL AND BUSINESS COMPUTING

Rodnay Zaks - Austin Lesea Ref C200 **\$6.95**

This introductory text is aimed at answering the basic question: "What do I need in order to...?" It covers applications, peripherals, existing systems, how to assemble them. How to choose. The real cost of a system. The software. Is a floppy sufficient for a mailing list? Build or buy?

A MICROPROGRAMMED APL IMPLEMENTATION

Rodnay Zaks 320 pp., ref Z-10 **\$25.00**
The complete design of a real APL interpreter, including theory, parsing, operators, dynamic block management, actual listing.

MICROPROCESSOR LEXICON

\$2.95

110 pp., pocket-size, ref X1
ALL THE DEFINITIONS AND ACRONYMS
A complete dictionary, PLUS: part numbers, signals, for S100, RS232, IEEE 488, addresses.



SELF-STUDY COURSES

Each course includes a book plus 2 cassettes (can be played on any cassette recorder at home, in the car, at the office.)

- S1-INTRODUCTION TO MICROPROCESSORS** **\$29.95**
2½ hours. Basic introductory course.
- S2-PROGRAMMING MICROPROCESSORS** **\$29.95**
2½ hours. Basic introduction to programming.

HERE IS WHAT THEY SAY

"Microprocessor Interfacing Techniques" is an exceptional book. There is nothing like it on the marketplace. It meets a real need. **Jeffrey McKeever, Chairman of the Board, Phoenix Group Inc.; President, Micro-Age; Publisher, Byte-Shopper**

"Microprocessors" is phenomenal. There is nothing in the industry which explains computers for people who understand electronics, but not computers. It is excellent. I qualify the author's style as phenomenal. I am extremely pleased with it. After reading it from cover to cover, I recommended it to ten friends who went to the BYTE SHOP and bought them out. I will be more than happy to tell anyone. **Rick Prine, Rocklin, Ca.**

After reading "Microprocessors, from chips to systems" by Rodney Zaks, I was very impressed with the simple yet thorough approach which Mr. Zaks has taken in explaining the microprocessor. Bally, Manufacturing Corporation has begun its entry into the personal computer field, and, due to the great amount of information that is needed by our service people, I feel this book should be an essential part of our service technician's libraries. **Richard Shultz, Bally, Consumer Products Division**

I read both books, and I learnt more from them than anything I have read. **Gavin Craig, General Electric Corp.**



MICROPROCESSORS FROM CHIPS TO SYSTEMS

Rodnay Zaks **\$9.95**
420pp, 150 illustr, ref C201

Our Bestseller. This book is the result of the author's experience in teaching microprocessors to more than 2000 persons. It presents a comprehensive introduction to all the aspects of microprocessors, from the components to the assembly of a system. The difficulty of each chapter is graduated from the basic concepts to the actual technical details. It is read by students, technicians, managers, engineers, educators, doctors and by all those who wish to

understand rapidly and efficiently all the important aspects of microprocessor use, selection, or application.

CONTENTS: Fundamental Concepts... Internal Operation of a Microprocessor... System Components... Comparative Microprocessor Evaluation... System Interconnect... Microprocessor Applications... Interfacing Techniques... Microprocessor Programming... System Development... The Future...

MICROPROCESSOR INTERFACING TECHNIQUES

Austin Lesea, Rodnay Zaks **\$9.95**
420 pp, 320 illustr, ref C207

FROM KEYBOARD TO FLOPPY DISK... All the basic concepts and techniques... A complete microcomputer system... presented in detail, with over 320 illustrations, including tele-type keyboard, disk, CRT display, and... One chapter is dedicated to standards, including S100... the chapter to testing and...

CONTENTS: Introduction... Assembling the Central Processing Unit... Input/Output... Interfacing the Peripherals... Analog Conversion... Standards... Case-study: a 32-channel Multiplexer... Debugging... Trouble-Shooting... Conclusion-Evolution.



DISTRIBUTION / TRANSLATION INQUIRIES INVITED

NAME _____ POSITION _____
 COMPANY _____
 ADDRESS _____
 CITY _____ STATE / ZIP _____
 Send me: C201 C207 Other: _____
 Payment enclosed Bill company Bill me
ADD \$1.00 / BOOK FOR FAST SHIPPING
 charge my Visa Master charge
 Number _____ Exp date _____
 Signature _____ Send catalog.

TO ORDER

- **BY PHONE:** call (415) 848-8233
BankAmericard/Mastercharge accepted
- **SHIPPING:** no charge when payment included.
ADD: \$1.00/book for fast shipping.
- **TAX:** in California, add sales tax.
- **OVERSEAS:**
SYBEX-EUROPE, 313 rue Lecourbe
75015 - PARIS, France Tel:(1)8282502



2020 Milvia St.
Berkeley,
Calif 94704

we're looking for someone serious about personal computing!



8-bit? 16-bit? The better of the two? The question is elemental — hardly worth consideration. What matters is your "machine's" CPU, its "architecture," and most importantly its instruction set. That's where the power is and that's exactly why we're telling you about the KD11-F.

The KD11-F is the CPU we chose for the Heath H11. It's built by DEC, is the same CPU that's the cornerstone of the popular LSI-11 family, and is the main reason our 16-bit is the most powerful 16-bit in its price class! Bells and whistles? Hardly!

Fact: The KD11-F has eight registers. Six of which are general-purpose and non-dedicated! That alone means virtually unlimited programmer flexibility!

Fact: Most computers in the 16-bit class use three types of instructions (memory reference, operate or accumulator control, and I/O instructions). The KD11-F accomplishes all data manipulations with a single set of instructions — which results in very efficient operation!

Fact: The KD11-F's PDP-11 instruction set has the most

powerful repertoire of instructions of any computer in its price class.

What it all boils down to is that the Heathkit H11 gives you fantastic flexibility, unparalleled high-speed program execution, and unmatched performance!

Our H11 CPU isn't for everyone. It's for someone serious about computing... someone like you!

Heathkit Computers



FREE Heathkit Catalog



Read about nearly 400 money-saving, fun-to-build electronic kits.

Use coupon to send for your mail order catalog or bring coupon to a Heathkit Electronic Center for your catalog.

Send the coupon or visit the Heathkit Electronic Center nearest you today!

Units of Schlumberger Products Corporation. Retail prices on some products may be slightly higher.

ARIZONA — Phoenix, 2727 W. Indian School Rd. (602) 279-6247.

CALIFORNIA — Anaheim, 330 E. Ball Rd. (714) 776-9420; El Cerrito, 6000 Potrero Ave. (415) 236-8870; Los Angeles, 2309 S. Flower St. (213) 749-0261; Pomona, 1555 Orange Grove Ave. N. (714) 623-3543; Redwood City, 2001 Middlefield Rd. (415) 365-8155; Sacramento, 1860 Fulton Ave. (916) 486-1575; San Diego (La Mesa), 8363 Center Dr. (714) 461-0110; San Jose (Campbell), 2350 S. Bascom Ave. (408) 377-8920; Woodland Hills, 22504 Ventura Blvd. (213) 882-0531.

COLORADO — Denver, 5940 W. 38th Ave. (303) 422-3408.

CONNECTICUT — Hartford (Avon), 395 W. Main St. (Rte. 44) (203) 678-0323.

FLORIDA — Miami (Hialeah), 4705 W. 16th Ave. (305) 823-2280; Tampa, 4019 West Hillsborough Ave. (813) 886-2541.

GEORGIA — Atlanta, 5285 Roswell Rd. (404) 252-4341.

ILLINOIS — Chicago, 3462-66 W. Devon Ave. (312) 583-3920; Chicago (Downers Grove), 224 Ogden Ave. (312) 852-1304.

INDIANA — Indianapolis, 2112 E. 62nd St. (317) 257-4321.

KANSAS — Kansas City (Mission), 5960 Lamar Ave. (913) 362-4486.

KENTUCKY — Louisville, 12401 Shelbyville Rd. (502) 245-7811.

LOUISIANA — New Orleans (Kenner), 1900 Veterans Memorial Hwy. (504) 722-6321.

MARYLAND — Baltimore, 1713 E. Joppa Rd. (301) 661-4446; Rockville, 5542 Nicholson Lane (301) 881-5420.

MASSACHUSETTS — Boston (Peabody), 242 Andover St. (617) 531-9330; Boston (Wellesley), 165 Worcester Ave. (Rte. 9 just west of Rt. 128) (617) 237-1510.

MICHIGAN — Detroit, 18645 W. Eight Mile Rd. (313) 535-6480; E. Detroit, 18149 E. Eight Mile Rd. (313) 772-0416.

MINNESOTA — Minneapolis (Hopkins), 101 Shady Oak Rd. (612) 938-6371.

MISSOURI — St. Louis, (Bridgeton), 3794 McKelvey Rd. (314) 291-1850.

NEBRASKA — Omaha, 9207 Maple St. (402) 391-2071.

NEW JERSEY — Fair Lawn, 35-07 Broadway (Rte. 4) (201) 791-6935; Ocean, 1013 State Hwy. 35 (201) 775-1231.

NEW YORK — Buffalo (Amherst), 3476 Sheridan Dr. (716) 835-3090; Jericho, Long Island, 15 Jericho Turnpike (516) 334-8181; Rochester, 937 Jefferson Rd. (716) 244-5470; White Plains (North White Plains), 7 Reservoir Rd. (914) 761-7690.

OHIO — Cincinnati (Woodlawn), 10133 Springfield Pike (513) 771-8850; Cleveland, 5444 Pearl Rd. (216) 886-2590; Columbus, 2500 Morse Rd. (614) 475-7200; Toledo, 48 S. Byrne Rd. (419) 537-1887.

PENNSYLVANIA — Philadelphia, 6318 Roosevelt Blvd. (215) 288-0180; Frazer (Chester Co.), 630 Lancaster Pike (Rt. 30) (215) 647-5555; Pittsburgh, 3482 Wm. Penn Hwy. (412) 824-3564.

RHODE ISLAND — Providence (Warwick), 558 Greenwich Ave. (401) 738-5150.

TEXAS — Dallas, 2715 Ross Ave. (214) 826-4053; Houston, 3705 Westheimer (713) 623-2090. San Antonio, 7111 Blanco Rd. (512) 341-8876

VIRGINIA — Alexandria, 6201 Richmond Hwy. (703) 765-5515; Norfolk (Virginia Beach), 1055 Independence Blvd. (804) 460-0997.

WASHINGTON — Seattle, 505 8th Ave. North (206) 682-2172.

WISCONSIN — Milwaukee, 5215 W. Fond du Lac (414) 873-8250.

HEATH

Heath Company, Dept. 334-420
Benton Harbor, MI 49022

Please send me my FREE Catalog. I am not on your mailing list.

Name _____

Address _____

City _____ State _____

CP-149 _____ Zip _____

put on the more slowly toggling lines 14 to 17, and the sequential inputs are put on the faster lines 10 to 13. This example also illustrates the use of the clock line for the clock. It should be noted that there is a minimum separation of four lines between the clock and any combinatorial input. As previously stated, this is necessary to allow the counter to complete a full counting cycle. Strictly speaking, the pre-setting inputs to the counter are also combinatorial inputs, but they do not interfere with the counting cycle, so they may be placed within four lines of the clock. They are, however, synchronous inputs and as such may not be placed on a DUT input line which toggles faster than the clock. Also, while the ordering of the DUT inputs is important (for reasons just explained), there are no restrictions whatsoever on the ordering of the DUT output connections. Connections between the integrated circuit tester and the DUT socket should be made via banana plugs, matrix switches, or other forms of connection which readily permit modification. The DUT socket itself should be a zero insertion force (ZIF) type socket (Textool or equivalent).

Expansion of the testing capacity of the unit can be achieved by extending the counter length or the memory size, but it has been my experience that the combination of eight inputs and six outputs has proven ideal for testing most standard TTL components. In my first prototype (see photo 1), a single step feature was provided by switching in a debounced push-button switch in place of the oscillator, and placing LED indicator lights on the DUT inputs and on the memory data outputs. This made it possible to examine the memory once it had been programmed and verify that the tester was really doing what it was supposed to do. This feature was also necessary because the original version had to be programmed manually, but the 10 to 15 minutes required to program the tester for even a device as simple as a quad NAND gate made the advantages of autoprogrammability quite apparent. Nevertheless, the single step feature may prove useful to the hobbyist who may wish to use this instrument as a logic analyzer. Other features that may prove useful would be the addition of low power TTL buffers on the DUT outputs to permit testing of CMOS integrated circuits, miniaturized construction for portable operation, and installation of an ammeter in series with the DUT socket power input pin to provide a measure of power dissipation. ■

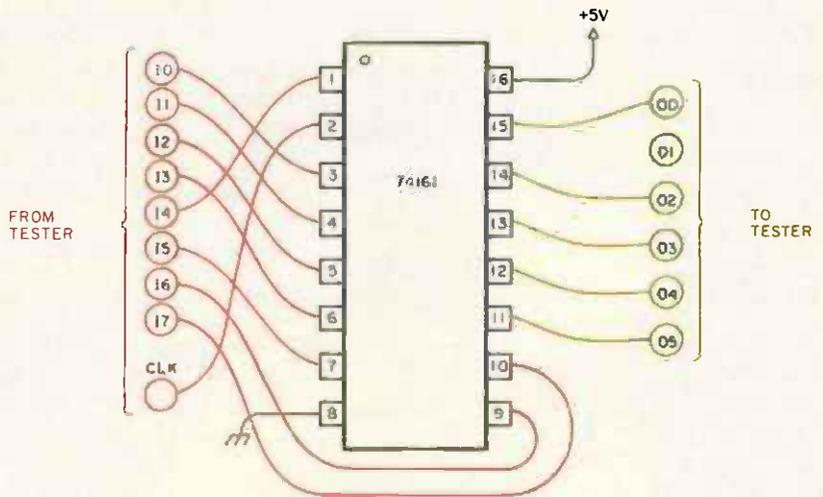
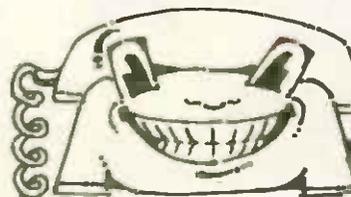


Figure 3: Tester hookup for a TTL 74161 integrated circuit. Note the use of the clock line coming from the tester. This is to ensure that the integrated circuit receives clock signals of the proper speed relative to the other test input lines.



FINALLY, A TELEPHONE WITH BYTE!

6800 AUTOMATIC TELEPHONE DIALER PROGRAM \$9.95 postpaid

Have your 6800 system dial your phone • Uses only 5 external components • Stores 650 variable length phone numbers • Operates in less than 1K bytes of memory

Includes: Paper tape in Mikbug® format and object code • Circuit diagram and instructions • Instructions for adapting to other 6800 systems

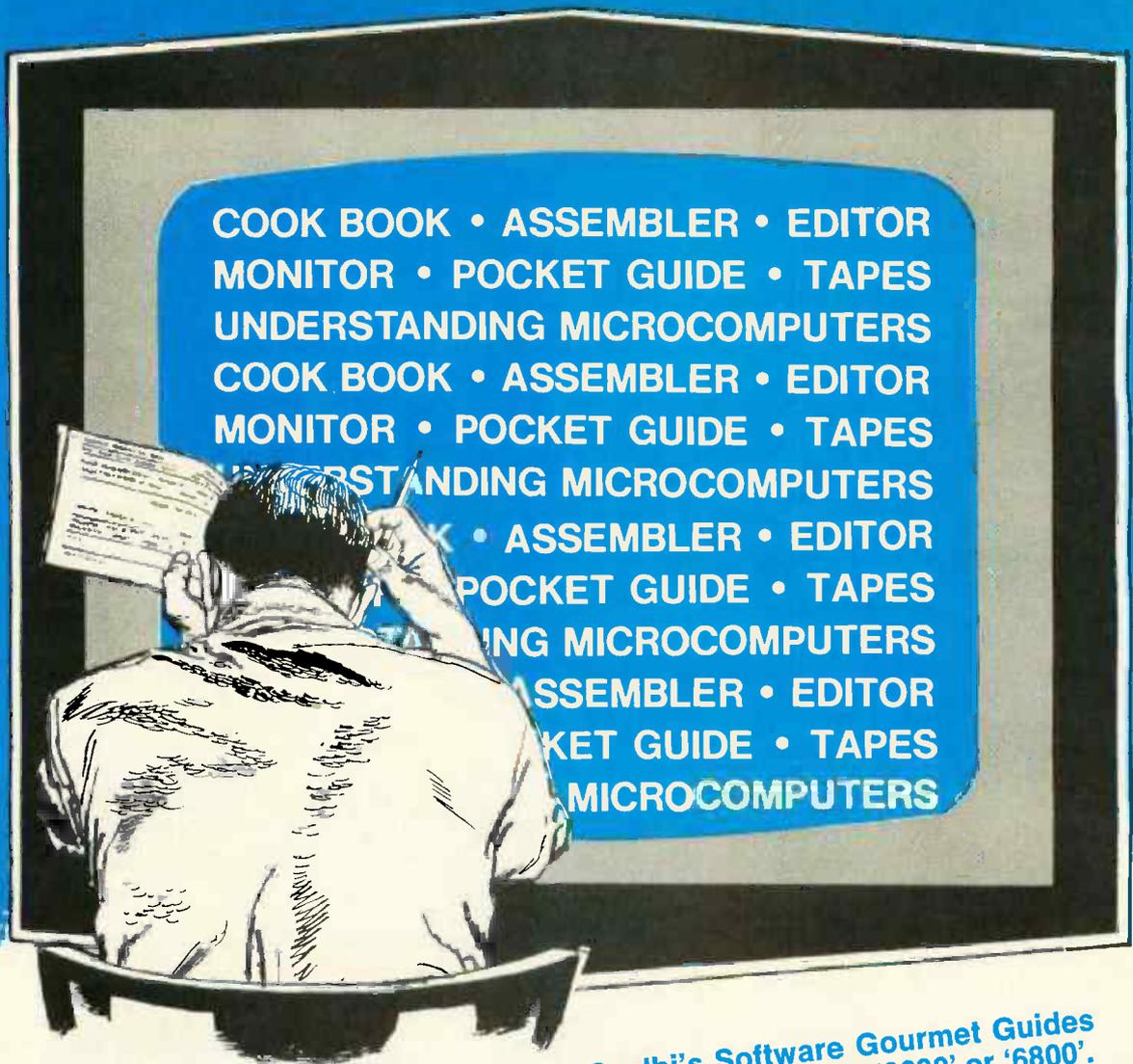
6800 TELEPHONE ANSWERING DEVICE PROGRAM \$4.95 postpaid

Have your 6800 system answer your phone and record messages automatically. Compatible with any 6800 system.

Includes: Assembly listing and object code • Circuit diagram and instructions

Write to: **SOFTWARE EXCHANGE**
2681 PETERBORO
W. BLOOMFIELD, MICH. 48033

Mikbug® is a registered trademark of Motorola Inc.



Scelbi's Software Gourmet Guides and Cookbooks for '8080' or '6800'.
 Now you can cook up mouth-watering programs. Delectable "how to" facts include '8080' or '6800' instruction sets. How to manipulate stacks. Flow charts. Source listings. General purpose routines for multiple precision operation. Programming time delays for real time. And much, much more. Includes floating point arithmetic routines. Order your copies today! Specify '8080' or '6800'.
 '8080' Paperback: **\$10.95;**
 Vinyl: **\$12.95;** Hardcover: **\$14.95.**
 '6800' (Paperback only): **\$10.95.**

Order your SCELBI Personal Computer Books and Tapes today! They are "must" items for your collection. And, they make ideal special occasion gifts for that computer buddy too!



SCELBI COMPUTER CONSULTING INC.

Post Office Box 133 PP STN, Department B, Milford, CT 06460

Prices shown for North American customers. Master Charge, VISA, Postal and Bank Money Orders preferred. Personal checks delay shipping up to 4 weeks. Pricing, specifications, availability subject to change without notice. **IMPORTANT!** Include 75¢ postage/handling for each item delivered by U.S. Mail Book Rate; or \$2 for each item shipped First Class or UPS.

Scelbi Software

Outstanding books for the personal computer user. Recognized, authoritative texts and tapes that add new dimensions of fun and skill to your computer.



Scelbi's '8080' Standard Assembler assembles programs written in symbolic language for '8080'. Describes operation of assembler. Detailed discussions of all major routines. Contains 2 completely assembled listings — hexadecimal and octal. Operating instructions. Even includes routine for loading programs produced by the assembler. All memory references are labeled; can re-assemble to reside in ROM. (Some RAM required) **\$19.95**. Optional object code on punched paper tape, specify 8080SA-OPT: **\$10.00**. Optional commented source listing on punched paper tape, specify 8080SA-SPT: **\$39.00**.



Scelbi's '8080' Standard Editor is an efficient way to edit text when preparing program source listings or other text material. Operates in 2 modes: Text Entry and Command. Memory references labeled for easy reassembly into any general area of memory; e.g. reassemble to reside in just 1K of ROM. (Some RAM required) **\$12.95**. Optional object code on punched paper tape, specify 8080ED-OPT: **\$6.00**. Optional commented source listing on paper tape too. Specify 8080ED-SPT, **\$20.00**.



Scelbi's '8080' Standard Monitor. Describes "Monitor Control" package to control operation from external "keyboard". Routines to examine and modify memory locations, CPU registers, continuous 2-point "bug" status report, control bulk storage, I/O devices. And more. **\$9.95**. Optional object code on punched paper tape, specify 8080SM-OPT: **\$5.00**. Optional commented source listing on punched paper tape, specify 8080SM-SPT: **\$15.00**.

Understanding Micro-Computers and Small Computer Systems. A profusely illustrated, easy-reading "must" book explaining fundamental concepts behind operation of microcomputers in simple English. Gives extra knowledge



The '8080' Programmer's Pocket Guide. A compact 3 x 4½", ever-ready, instant reference for

octal or hexadecimal codes, that explains instruction set in detail. Order your copy today. Keep one in your pocket. One near your computer. A "must"! **Only \$2.95 each.**

ADVANCE NOTICE!!!

Watch for the all new Scelbi's First Book of BASIC Programs! Coming soon!

Want to be on Scelbi's exclusive mailing list? Want to know about upcoming Scelbi Books? Don't use the "BINGO" Card — but write us DIRECTLY. It identifies you as a "truly interested" customer who is worthy of special handling!

for reading and understanding computer magazines and manufacturers' literature. Makes you feel "at home" around computers. Accepted as the standard for the neophyte, you must own this 300-page no-nonsense, easy-reading text. Includes simple-to-use glossary of key microcomputer-oriented words. Order now. Hard cover: **\$14.95**. Soft cover: **\$9.95**.

Natural Language Processing and Small Systems

Harry Tennant
1001 W Oregon # 1
Urbana IL 61820

Introduction

What can possibly be said about the use of natural languages, that is the languages people use, with small systems? Where research is done on natural language processing, it is done on the largest computers available. To many computer scientists, the problem of enabling computers to understand natural languages at a reasonable level of competence is beyond the current technology. Consider what are probably the two best natural language processors yet produced by computer scientists: William Woods' LUNAR system which answered questions about rocks brought back from the moon, and Terry Winograd's system which manipulated blocks on a table in response to English commands; both are quite large programs. LUNAR uses one task with 256 K 36 bit words to discover the meaning of the user's query, then uses another task of 256 K words to answer the question. One question could take from three to 20 seconds to answer. Winograd's system did not need the quantity of data that Woods' system needed, but it still required 60 K words of 36 bits to operate in its limited world, consisting of a few blocks on a table. These are just two examples of the many natural language processing projects which have been conducted in recent years. These two (from the early 1970s) and nearly all the others since then share the property that they are large projects done on large machines

using large amounts of memory. So what can possibly be said about natural language processing and small systems?

The small system user is severely limited: he or she has comparatively little memory to work with, few languages to choose from (and those languages are not particularly suited to the needs of natural language processing), and usually few aids to software development, such as secondary storage, editing facilities, and debugging facilities. But among small systems users, there is a growing interest in the application areas of artificial intelligence: intelligent game playing, math, science and engineering aids, robotics, and natural language processing. In this article the general problems of computer based understanding of natural language are discussed briefly, and a few techniques that can be used on small systems to do a limited amount of natural language processing are presented.

Attempts have been made since nearly the dawn of computer history to make it possible for computers to understand the languages of people. It began as translation between natural languages, for example, from Russian to English. That kind of work was not successful. Later, research moved into the areas of natural language query of data bases and the study of the structure of human thought and memory through the modelling of human language behavior on computers. This is the work that is being done today. It looks promising, but it is still too early to tell if the work will actually provide users with the ability to communicate their thoughts to computers as efficiently as humans communicate with one another.

GET THE **REAL** LOW DOWN BEFORE YOU BUY

SO YOU WANT TO BUY A COMPUTER??

This new book presents an objective look at the top 24 micro systems sold throughout the world.

It discusses the Pros and Cons of each system in No Uncertain Terms and takes a straightforward look at the micro computer industry as it relates to YOU.

Written especially for the layman in a language he can understand. Profit from the mistakes of others.

Includes hundreds of references.

Table of Contents

1. Introduction
2. Don't get hung up on the chips
3. Which category do you fit into
4. Now - About the Hardware
5. Peripherals that plug in?
6. What? No Software!
7. Helpful Suggestions before spending money
8. Addresses

SCIENTIFIC RESEARCH

P.O. Box 490099-B

Key Biscayne, Florida 33149

Phone Orders Call 800-327-6543

\$4.50 per Volume

Volume discounts available



Add \$1 handling, all domestic shipments sent U.P.S. except APO and P.O. Box which go parcel post. Foreign orders add \$4 for air shipment and make payable in U.S. funds.

Natural Language Understanding on Computers

A conversation between two humans could proceed something like this:

Sam: Joe, how's your micro coming?

Joe: OK. I've moved on to the video cards.

Sam: When did you finish the cassette interface?

Joe: Last week. It took long enough for the chip to come.

Sam: Yeah, that's why I always deal with the fastest companies.

Joe: What do you think of the new video timing generator?

Sam: It will save some board space and maybe some money, too.

We do not know much about Joe and Sam, but we do know from this conversation that they both know something about microprocessors. We know that Joe is building one and that Sam knows quite a bit about it. When asked how his micro is coming, Joe thought of his computer, the problems he's had on it, the last section that he has been working on, the sections that have already been built . . . in other words, a great deal of information about his computer came to mind. Joe then thought of what Sam knew of the computer, and chose a relevant piece of information that Joe thought Sam did not know, and said that he was working on the video section. Now, Sam knows a lot about the computer, too. He is thinking about it just as Joe is. And so the conversation proceeds. Both Joe and Sam know a great deal about the computer. Both know about the problems of building a microprocessor, parts availability, etc. Their conversation is short, it uses few words, but it manipulates very large information structures in each of their minds as the conversation takes place. The conversation is not just a trickle of words between Joe and Sam, but it is mainly an activity inside their brains involving a great deal of information. The trickle of words is not what is really going on, it just triggers what is going on. The real activity is happening in the minds of Joe and Sam.

Now, what about a conversation with a computer? If it were to happen as the conversation above did, the computer would need to know a lot about the microcomputer that is being built. In other words, the computer would need knowledge very much like Joe's and Sam's. It would have to have some way of representing information about microcomputers: what they are made of; how they are built; the particular microcomputer being discussed; its state of completion; and so on. In addition to this, there

must be some way for the computer to discover what the words in the conversation are referring to. How does it know that the conversation is about microcomputers, for instance? The word "micro" could refer to a microbiology program. As if that were not enough, let's say that the computer did interpret the first question correctly, did have information about the microcomputer, and decided on something to tell the questioner. It then has the task of presenting the information to the questioner in a form that he will understand. Add to this problem that humans converse on a wide range of topics, and learn about new topics without even trying, and the problem of enabling a computer to converse like a human becomes a large problem indeed. A full solution to the problem is a long way off, and quite possibly will require hardware beyond what is available today (a HAL 9000, perhaps?). But there are many steps toward natural language processing that can be done without a HAL 9000 and without 30 years of research and development.

As mentioned above, there are three main problem areas in natural language processing:

1. Representation of knowledge
2. Associating words with ideas
3. Presenting ideas

The problem of presentation of ideas by a computer will not be considered explicitly. Representation of knowledge and associating words with ideas will be considered in the next sections.

Representation of Knowledge

Before we approach the problem of representing knowledge on a computer, it may help to decide how to represent knowledge on a piece of paper. The first thing to decide is exactly what we want to represent.

Consider the microcomputer systems in figure 1. If we want to be able to converse with a computer about such systems, we need some way of storing what is known about them. Some of the things we know about System 1 are:

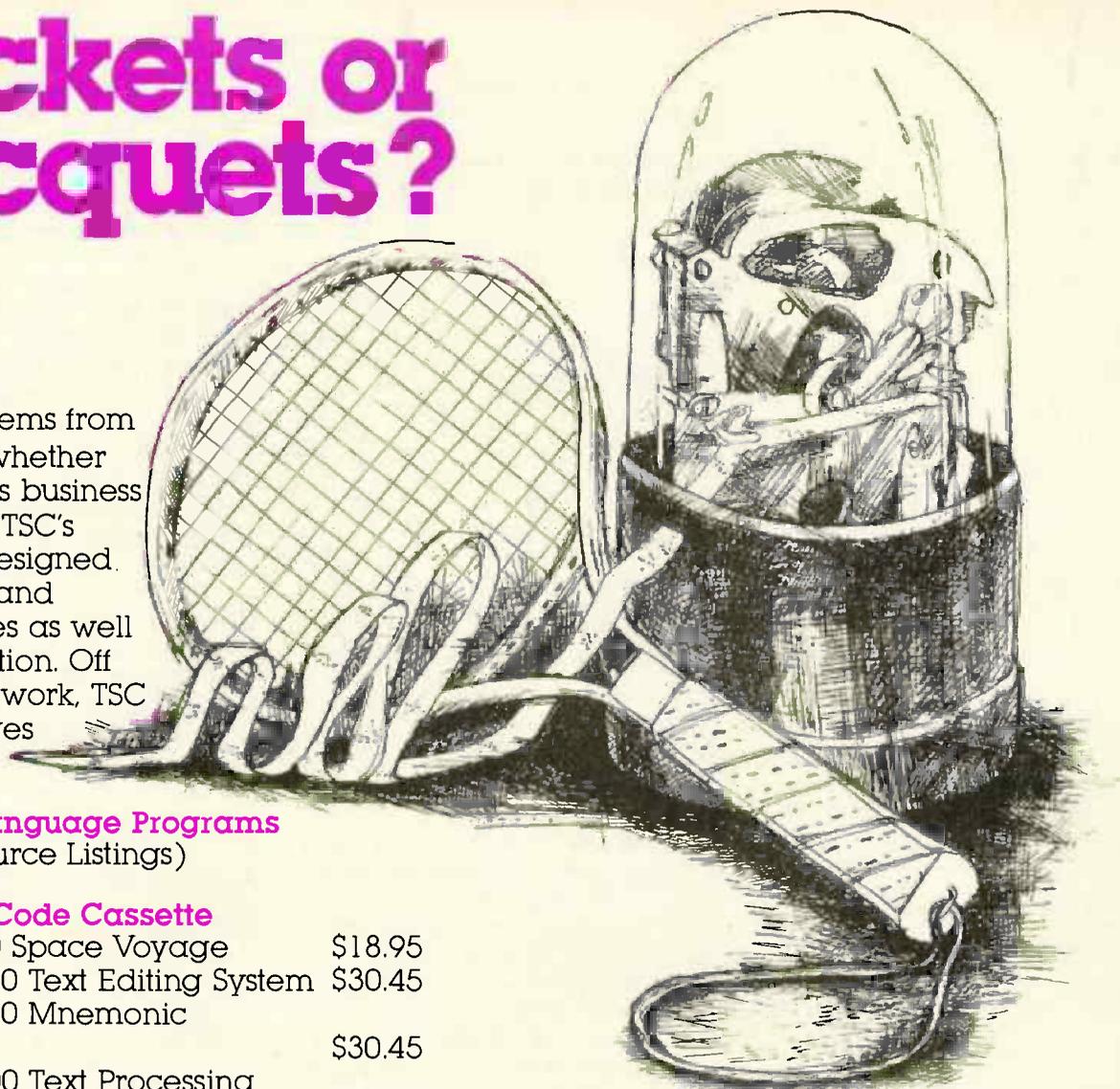
1. It has an 8080 microprocessor.
2. It has 1 K of read only memory.
3. It has 2 K of programmable memory.
4. Its only output is lights.
5. Its only input is a keyboard.

We know the following about System 2:

1. It has an 8080 microprocessor.
2. It has 1 K of read only memory and 1 K of programmable memory.
3. It has a scale as an input device (it is a digital scale).
4. It has a small keyboard as input.

Rackets or Racquets?

Software systems from TSC serve – whether your racket is business or pleasure. TSC's software is designed for business and industrial uses as well as for recreation. Off the job or at work, TSC software serves your needs.



Assembly Language Programs (Includes Source Listings)

With Object Code Cassette

SL68-5C 6800 Space Voyage	\$18.95
SL68-24C 6800 Text Editing System	\$30.45
SL68-26C 6800 Mnemonic Assembler	\$30.45
SL68-29C 6800 Text Processing System	\$38.95

With Object Code Paper Tape

SL68-24P 6800 Text Editing System	\$31.50
SL68-26P 6800 Mnemonic Assembler	\$31.50
SL68-29P 6800 Text Processing System	\$40.00
SL80-10P 8080 Text Editing System	\$37.50
SL80-11P 8080 Text Processing System	\$41.00

Cassettes are in the Kansas City Standard format. Many other programs are available. Send 25¢ for a complete catalog.



**Technical Systems
Consultants, Inc.**

Box 2574
W. Lafayette, Indiana 47906
317-423-5465

Specialists in Software & Hardware for Industry & the Hobbyist

Circle 370 on inquiry card.

To Order: Include 3% postage, \$1.00 handling on orders under \$10.00, and Indiana residents add 4% sales tax. Check your dealer!

TSC Monthly Feature:

Disk Based 6800 Software

Now TSC software is available on disk. The Text Editing System, Mnemonic Assembler, and Text Processing System have been adapted to run under the FLEX disk operating system found on the Southwest Technical Products Corp. mini-disk system. All three systems work with named files. A single file may be as large as the disk even though your RAM filespace is limited. This software gives your micro the power of the best program development or word processing systems.

SL68-24D 6800 Text Editing System	\$31.50
SL68-26D 6800 Mnemonic Assembler	\$31.50
SL68-29D 6800 Text Processing System	\$40.00

- It has as output a display of decimal digits.

The system can be represented hierarchically (in outline form) as:

System 1

- Processor
8080
- Memory
1 K read only memory
2 K programmable memory
- Output
Lights
- Input
Keyboard

System 2

- Processor
8080
- Memory
1 K read only memory
1 K programmable memory
- Input
Scale
Keyboard
- Output
Decimal display

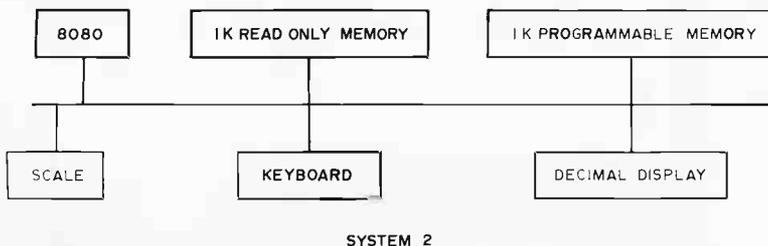
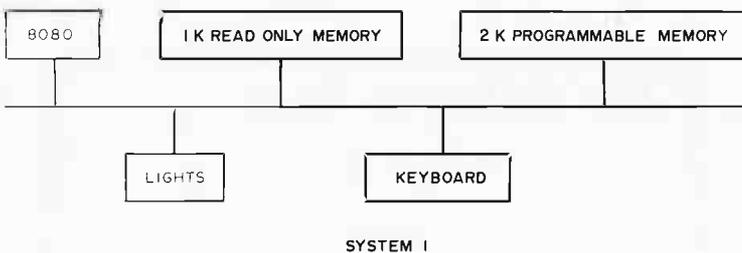
Now suppose we want to use this data base to answer questions about System 1 and System 2. (Note that a data base like this could be extended to include many other similar systems. It can be extended to as many as memory will allow. But, consider how trivial it is in detail and breadth compared to a human's knowledge. For this reason, one cannot expect the computer to respond with anything like the intelligence of a human. The relevant questions are 1) is there enough data in the data base to

make it worth doing and, 2) is the English interface to the data good enough to warrant making it.) When asked what the processor is for System 1, we consult our outline of System 1, look under "Processor," and reply that it is an 8080. When asked what the output for System 2 is, we consult the outline for System 2, look under the output to find "Decimal display," and we return that. When asked about the inputs to System 2, we respond that they are a scale and a keyboard. But note that a more complicated problem arises if we ask what kind of processor is in the system that uses the scale. First we must find all systems that use scales (we may not even realize that a scale is an input device). For all the systems using scales, we must then find what their processors are, and return that information. This is not a problem if we have only two systems, as in the example. But if we had many systems whose outline descriptions filled many sheets of paper, searching all the descriptions for the ones that use scales could be a major effort. One of the advantages of natural language is that items can be referred to by their descriptions instead of their names. We referred to System 2 not by its name, but by its description, ie: the system that uses a scale. Because this is such an important feature of natural language, it is very important to be able to deal with it. One way of doing so is to make a new set of outlines for each of the items mentioned in the original outlines. For example:

8080

- Processor in
 - System 1
 - System 2
- 1 K Read only memory
 - Memory in
 - System 1
 - System 2
- 1 K Programmable memory
 - Memory in
 - System 2
- 2 K Programmable memory
 - Memory in
 - System 1
- Lights
 - Output of
 - System 1
- Scale
 - Input of
 - System 2
- Keyboard
 - Input of
 - System 1
 - System 2
- Decimal display
 - Output of
 - System 2

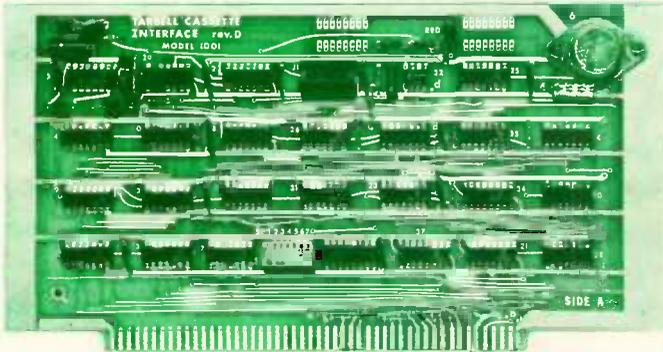
Figure 1: System 1 and System 2 diagrammed as components connected to a common bus.



TARBELL SETS STANDARDS

For Hobbyists and Systems Developers

Sales to thousands of hobbyists over the past two years have proven the Tarbell Cassette Interface to be a microcomputer industry standard. Tarbell Electronics continues research and development to produce new and efficient components to fill hobbyists' changing needs.

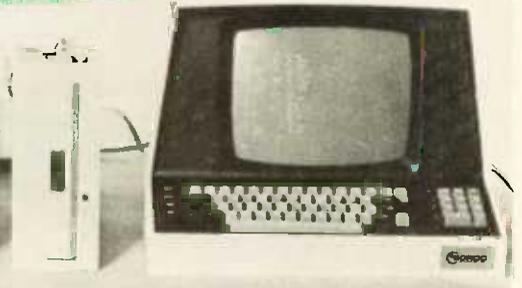
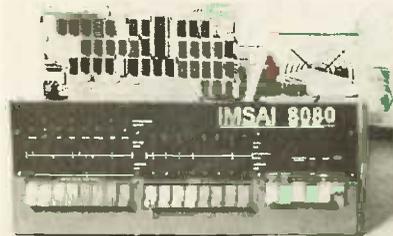


TARBELL CASSETTE INTERFACE

- Plugs directly into your IMSAI or ALTAIR*
- Fastest transfer rate: 187 (standard) to 540 bytes/second
- Extremely Reliable—Phase encoded (self-clocking)
- 4 Extra Status Lines, 4 Extra Control Lines
- 37-page manual included
- Device Code Selectable by DIP-switch
- Capable of Generating Kansas City tapes also
- No modification required on audio cassette recorder
- Complete kit \$120, Assembled \$175, Manual \$4
- Full 6 month warranty on kit and assembled units

TARBELL FLOPPY DISC INTERFACE

- Plugs directly into your IMSAI or ALTAIR* and handles up to 4 standard single drives in daisy-chain.
- Operates at standard 250K bits per second on normal disc format capacity of 256K bytes.
- Works with modified CP/M* Operating System and BASIC-E Compiler.
- Hardware includes 4 extra IC slots, built-in phantom bootstrap and on-board crystal clock. Uses WD 1771 LSI Chip.
- Full 6-month warranty and extensive documentation.
- PRICE:
Kit \$190 Assembled \$265



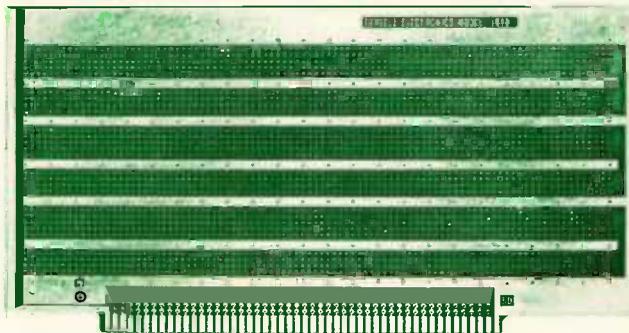
CP/M with BASIC-E
and manuals: \$100

Compatible Disc Drives

Ask about our disc drives priced as low as \$525.

TARBELL PROTOTYPE BOARD

Model 1010



- Gold plated edge pins
- Takes 33 14-pin ICs or
- Mix 40-pin, 18-pin, 16-pin and 14-pin ICs
- Location for 5 volt regulator
- Suitable for solder and wire wrap
- ALTAIR/IMSAI compatible
- Price: \$28.00

For fast, off the shelf delivery, all Tarbell Electronics products may be purchased from computer store dealers across the country. Or write Tarbell Electronics direct for complete information.

*ALTAIR is a trademark/tradename of MITS, Inc.
CP/M is a trademark/tradename of Digital Research

Tarbell
Electronics

20620 South Leapwood Avenue, Suite P
Carson, California 90746
(213) 538-4251

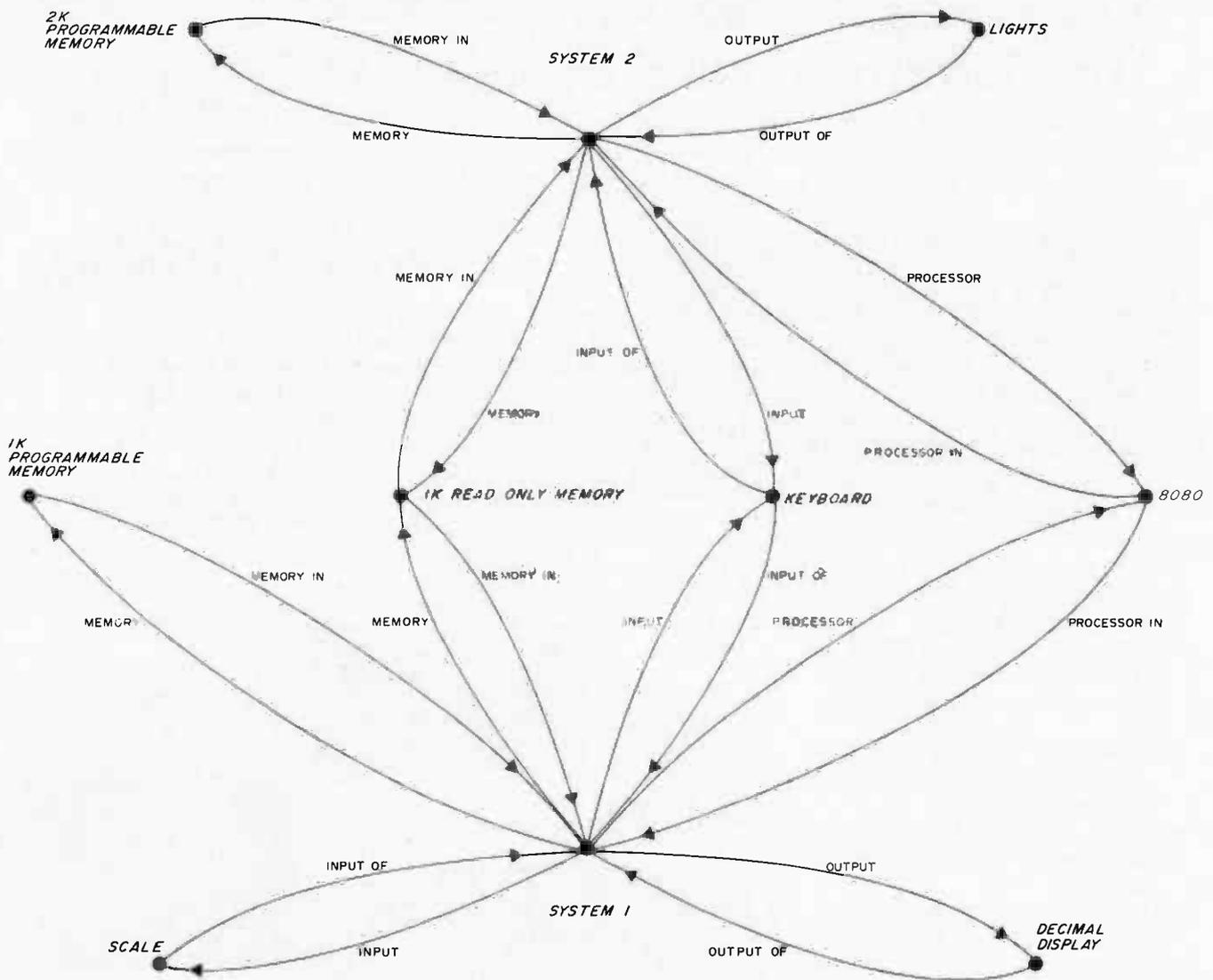


Figure 2: Simple semantic net. This net represents the connections of the components of System 1 and System 2. Each component is represented by a node. The nodes are related to one another through labelled links. Notice that the names chosen for the links and nodes are largely at the discretion of the net designer.

Now, think again about representing a large number of systems in this way. It will take more memory, but it will provide access to items such as scale or 8080. If a hundred systems are represented on sheets of paper, we would probably have an index or table of contents to direct us to the appropriate page to find the outline we seek, thus speeding up the response. I have not forgotten that in many small systems the trade-offs between memory and processing time often are in favor of saving memory space. What is presented here is intended to illustrate the trade-offs, not to make the decisions for the user.

It is easier to see this type of representation when it is presented in graphic form. The representation used in figure 2 is called a semantic net. Each outline is represented

by a node and the relationships between nodes are represented by directed labelled arcs. The idea of a semantic net is that nodes are entities and arcs are relations between entities. The net shown in figure 2 is not the way most natural language researchers would represent the information about our two systems. For example, "System 2" is the name of something, it is not the thing itself. An 8080 is a part of the thing whose name is "System 1," and that thing that is called an 8080 has the function of "Processor" in the thing called "System 1." A diagram of representation like this is shown in figure 3. It is more explicit and more correct than the representation of figure 2, but is harder to build, more difficult to interpret, and requires more memory to represent.

Semantic nets, in whatever form one

COMPUTER SOFTWARE

For Homeowners, Businessmen, Engineers, Hobbyists, Doctors, Lawyers, Men and Women

We have been in business for over nine years building a reputation for providing a quality product at nominal prices — NOT what the traffic will bear. Our software is:

- **Versatile** — as most programs allow for multiple modes of operation.
- **Tutorial** — as each program is self-promoting and leads you through the program (most have very detailed instructions contained right in their source code).
- **Comprehensive** — as an example our PSD program not only computes Power Spectral Densities but also includes FFT's, Inverse-transforms, Windowing, Sliding Windows, simultaneous FFT's variable data sizes, etc. and as a last word our software is:
- **Readable** — as all of our programs are reproduced full size for ease in reading.
- **Virtually Machine Independent** — these programs are written in a subset of Dartmouth Basic but are not oriented for any one particular system. Just in case your Basic might not use one of our particular system. Just in case your Basic might not use one of our functions we have included an appendix in Volume V which gives conversion algorithms for 19 different Basic's; that's right, just look it up and make the substitution for your particular version. If you would like to convert your favorite program to Fortran or APL or any other language, the appendix in Volume II will define the statements and their parameters as used in our programs.

Over 85% of our programs in the first five volumes will execute in most 8K Basic's with 16K of free user RAM. If you only have 4K Basic, because of its lack of string functions only about 60% of our programs in Volumes I through V would be useable, however they should execute in only 8K of user RAM.

For those that have specific needs, we can tailor any of our program for you or we can write one to fit your specific needs.

Vol. I — \$24.95 Bookkeeping Games Pictures	Vol. II — \$24.95 Math/Engineering Plotting/Statistics Basic Statement Def.
Vol. III — \$39.95 Advanced Business Billing, Inventory Investments Payroll	Vol. IV — \$9.95 General Purpose
Vol. V — \$9.95 Experimenter's Program	Vol. VI — \$49.95 Mini-Ledger
Vol. VII — \$39.95 Professional Programs	Vol. VIII — \$19.95 Homeowner's Programs

Vol. I Business & Personal Bookkeeping Programs Bond Building Compound Cyclic Decision 1 Decision 2 Depreciation Efficient Flow Installment Interest Investments Mortgage Optimize Order Pert Tree Rate Return 1 Return 2 Schedule 1	Games & Pictures Animals Four Astronaut Bagel Bio Cycle Cannons Checkers Craps Dogfight Golf Judy Line Up Pony Roulette Sky Diver Teach Me Teach Me Pictures A. Newman J.F.K. Linus Ms. Santa Nixon Noel Noel Nude Peace Policeman Santa's Sleigh Snoopy Virgin	Vol. II Binomial Chi-Sq. Coeff Confidence 1 Confidence 2 Correlations Curve Differences Dual Plot Exp-Distri Least Squares Paired Plot Plotpts Polynomial Fit Regression Stat 1 Stat 2 T-Distribution Unpaired Variance 1 Variance 2 XY APPENDIX A	Vol. III Billing Inventory Payroll Risk Schedule 2 Shipping Stocks Switch	Vol. IV Bingo Bonds Bull Enterprise Football Funds 1 Funds 2 Go-Moku Jack Life Loans Mazes Poker Popul Profits Cubic Rates Retire Savings SBA Tic-Tac-Toe	Vol. V Andy Cap Baseball Compare Confid 10 Descrip Differ Engine Fouler Horse Integers Logic Playboy Primes Probal Quadrac Red Baron Regression 2 Road Runner Roulette Santa Stat 10 Stat 11 Steel Top Vary Xmas
--	--	---	--	---	---

Vol. VI Ledger
Maintaining company accounts and generates financial reports. Includes routines for Pyl Inv, Depr, A/R, A/P.
ACBS rev: 80 Use: Manual

Vol. VII Chess
Designed to challenge the average player, fairly comprehensive. Great fun for all, offers a unique opportunity for beginners in need of an opponent.

Medical
For Doctors and Dentists alike, a complete patient billing system which also permits the maintaining of a patient history record.

Wordproc
Wordprocessing for lawyers, publishers, writers, etc. Write, store, and change from rough draft to final copy in a variety of formats.

Utility
Disk utility program with memory testing.

Vol. VIII
1040-Tax
Balance
Checkbook
Inst1078
Deprec2
Taxpayers return itemized deductions or standard
Reconciles bank statements
Balances your checkbook
Computes real cost on bank financed items; cars, boats, etc.
Computes depreciation, 4 methods, any time period

APPENDIX C — FAVORITE PROGRAM CONVERSIONS



SCIENTIFIC RESEARCH
P.O. Box 490099-B, Key Biscayne, FL 33149
Phone orders call 800-327-6543
Information — (305) 361-1153

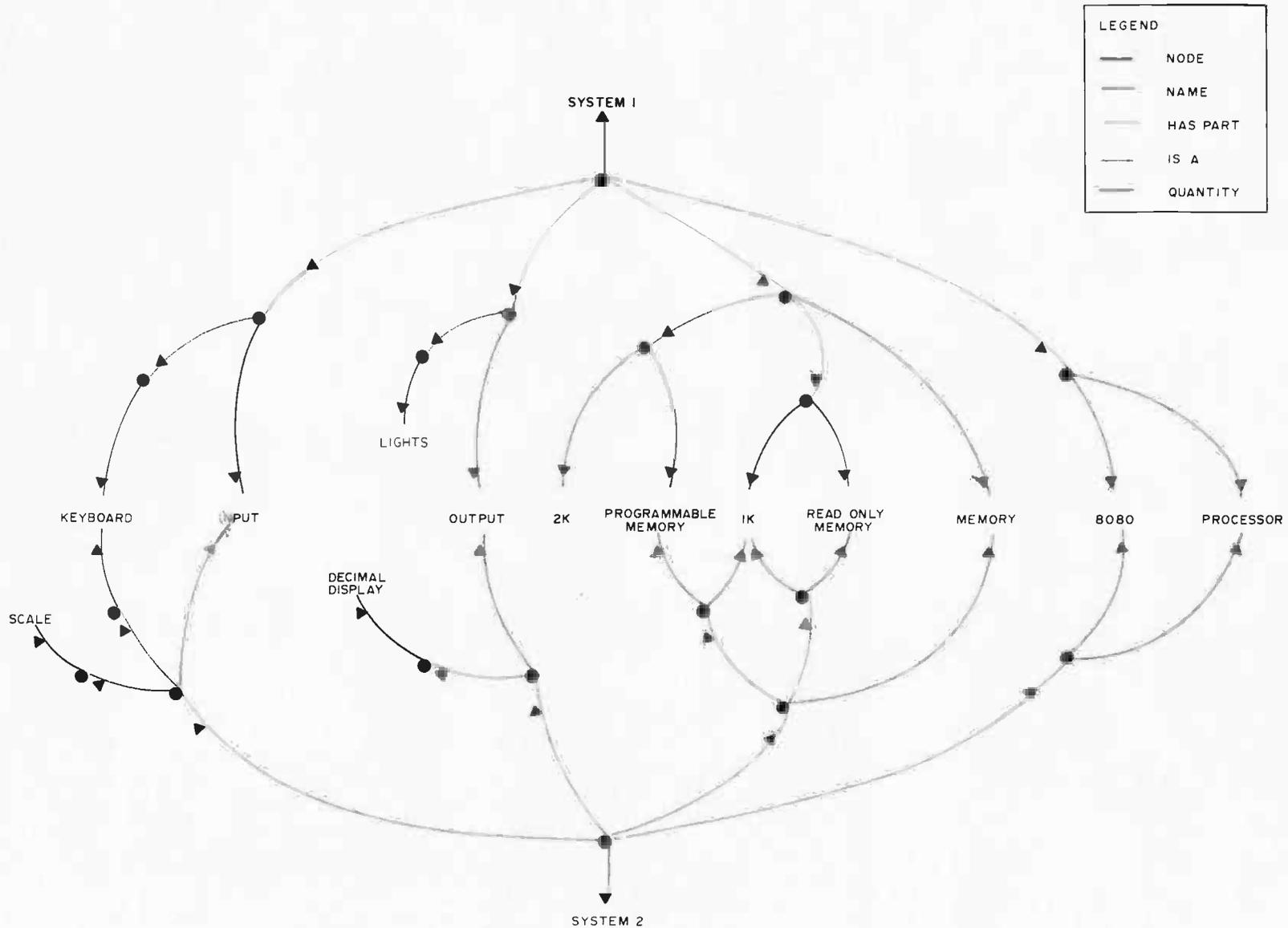
Add \$1.50 per volume handling, all domestic shipments sent U.P.S. except APO and P.O. Box which go parcel post. Foreign orders add \$8.00/volume for air shipment and make payable in U.S. dollars only.

AVAILABLE AT MOST COMPUTER STORES

Master Charge and Bank Americard accepted.

Our Software is copyrighted and may not be reproduced or sold.

Figure 3: More complex semantic net. This semantic net represents the same systems as the net in figure 2, but in a more detailed fashion. In this net, each node represents an entity. For example, one of the parts of System 2 is an entity called the MEMORY. It is composed of two parts, the entity called the READ ONLY MEMORY and the entity called the PROGRAMMABLE MEMORY. As in the other semantic net, there is some flexibility in what to call the links and nodes. For example, "IS A" suggests that the 8080 is a member of the category of things called PROCESSORS. One could also say that a READ ONLY MEMORY is a member of a category of things called MEMORY, but in this net, READ ONLY MEMORY is represented as a part of a thing named MEMORY. A fine distinction, but it may be significant when the net is interpreted by a program. Notice that reverse links (ie: NAME OF, PART OF, QUANTITY OF, EXAMPLE OF) are not shown.



prefers, are a flexible and easily accessed way to represent knowledge. They simulate associative memory, as humans seem to have. But how are they represented on a computer? The answer to this comes in three parts:

1. Outlines can be represented by lists.
2. Lists can be represented on computers.
3. The index or table of contents to outlines can be represented as a hashed table.

Nodes can be represented in lists by having alternate elements be arc labels and related nodes. We must first reduce each multiple word node name and arc label to single word names, then just list them as follows:

```
8080 (Processor-in (System1 System2))
System 1 (Processor (8080) Memory (1 K Read
only memory, 1 K Programmable
memory) Output (Lights) Input (Key-
board))
Keyboard (Input-of (System1 System2))
```

Most natural language projects are written in LISP because of its ability to handle list processing better than most other languages. Lists are represented in LISP in the following way: A list is composed of cells. Each cell has two parts, as shown in figure 4a. The two parts are called the CAR and the CDR of the cell. Each entity (node in the semantic net) is represented by a unique cell. A list of words would be represented by a string of cells. The CAR of each cell points to a node cell and the CDR points to the next cell in the string. The CDR of the last word has an end of list marker in it. A list of words ("The power surge exploded my 8080 chip") is shown in figure 4b.

A list can be represented within another list by having a CAR point to the first element of the inside list, instead of pointing to a node cell. A list within a list (My power supply (a home brew affair) was not protected) is shown in figure 4c.

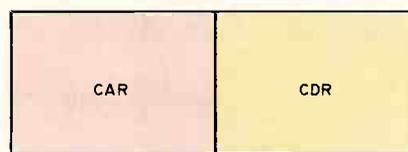
The index table for finding node names is provided automatically in LISP. The table is called the OBLIST or OBARRAY and the lists are called PROPERTY LISTS. If you do not happen to have LISP, the index table can be built as a hashed table of node cells with associated pointers to the property list associated with that name. A diagram representative of the whole configuration is shown in figure 5.

If the cell is a node cell, the CAR points to a location where the name of the cell (the character string) is held. The CDR points to another cell which is the beginning of the property list of the node. In cells that are

not node cells, CARs and CDRs are both just addresses that point to other cells. (One exception is the cells that represent the relationships between nodes. These will also be on the OBLIST as "node cells," but their CDRs will contain end of list markers instead of pointers to property lists.) In LISP, a special bit is set to designate whether a cell is a node cell (called an ATOM in LISP) or just a regular cell. The amount of memory that needs to be addressed by the CAR and CDR of each cell determines the number of bytes that each cell must be composed of.

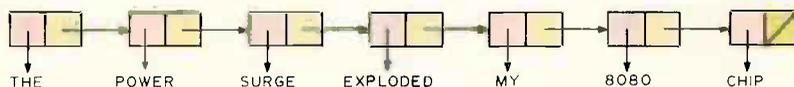
Associating Words with Ideas

The process of understanding natural languages certainly has something to do with

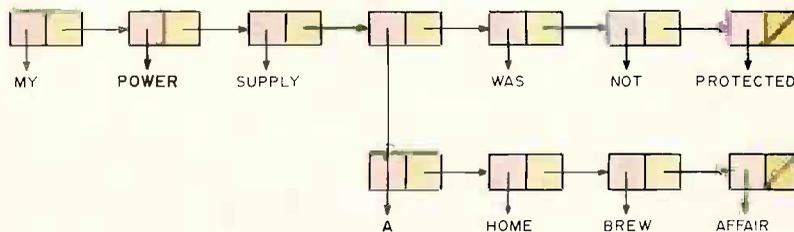


LISP CELL

(a)



(b)



(c)

Figure 4: LISP cells. In (a) a LISP cell is shown. In an actual implementation there may be some additional bits in the CAR and CDR to carry information about how the cell is used (whether it is an atom, for instance). In (b) the list of words (THE POWER SURGE EXPLODED MY 8080 CHIP) is shown as a string of cells. The pointers that point to the words are actually pointing to the cells that represent those words (see figure 5). In (c) the cell representation of an embedded list is shown. The list is (MY POWER SUPPLY (A HOME BREW AFFAIR) WAS NOT PROTECTED).

associating words with ideas. It should be stressed from the beginning, however, that when humans understand something it is a process that uses much more than just word definitions. The process of understanding in humans involves interpreting the words they hear or see with the various meanings for those words, all viewed in the context of the current conversation, the environment of the conversationalists, and other factors. For example, the sentence, "I'll take a

pancake," can be assumed to mean very different things depending on whether it is heard in Uncle John's Pancake House, or in a store that sells fans for relay racks (a pancake fan), or if it is said at a cosmetic counter (pancake makeup). The various conflicting meanings of "pancake" do not even occur to the people in question. A waitress would be unique indeed if she asked her customer if she preferred the pancake on a plate or on her face!

The problem of multiple meanings, contexts and other details of understanding will be ignored for the time being. In a small system there are limits to what can be done linguistically (in this respect, all contemporary systems seem small!). But a step toward natural language can be taken, however small. The goal we will assume is that an inexperienced user will be able to address the natural language processor in language that the user is most fluent in, and that the language processor will respond in a manner that the user finds appropriate.

We will be considering a situation in which natural language is being used as an interface language between a user and either procedures or data in a computer. The user types a sentence and the computer interprets the sentence and does what it is understood (by the computer) to mean. For example, say the computer holds a data base about various microprocessor systems like the one that was described above. The user asks questions about the systems and the computer provides answers.

Keywords

The simplest method of interpreting a sentence is to look for particular words, called keywords. If a keyword is found, a response is output. For our system, a useful set of keywords would be the names of all the nodes in the semantic net. For a response the system could print the property list which represents how that node is related to other nodes in the net. For example:

```
User: Tell me all about system1
Computer: System1
Processor
8080
Memory
1 K Read only memory
1 K Programmable memory
Output
Lights
Input
Keyboard
User: What information do you have on lights
Computer: Lights
Output-of
System1
```

These responses would be quite appropriate

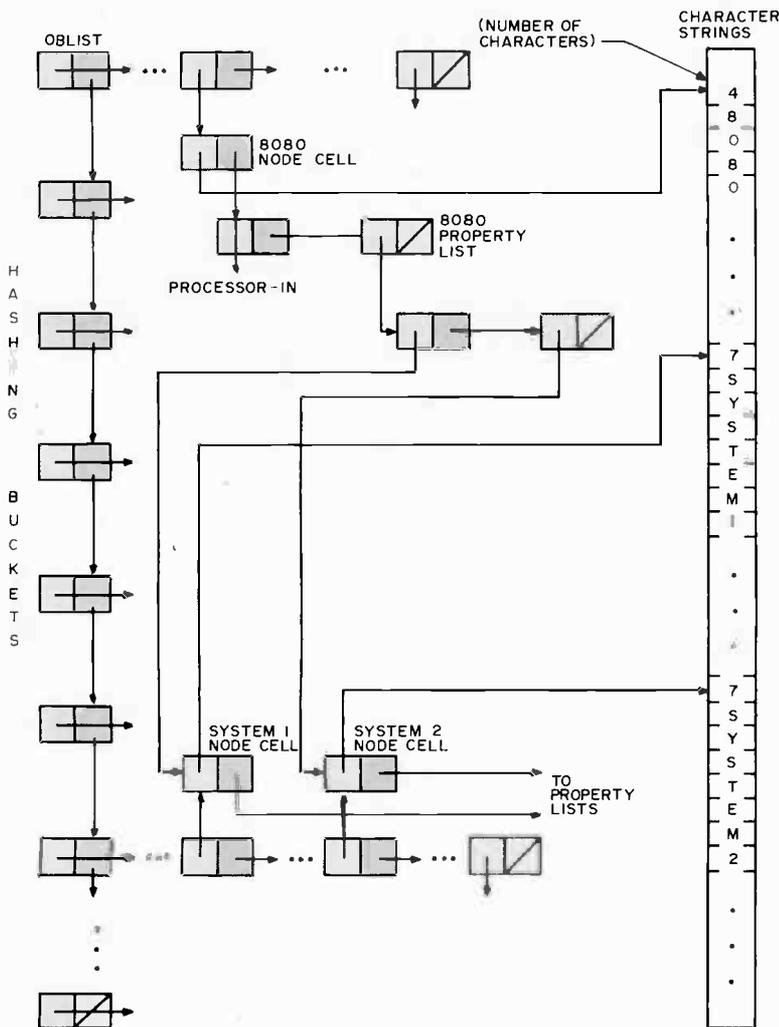


Figure 5: Representation of atoms. Each node in the system is represented by a unique cell, here called a node cell. In this figure the node cells for three nodes are shown, for 8080, SYSTEM1, and SYSTEM2. The CAR of each node cell points to a place in memory where the character string of the name of the cell is stored. The CDR of each node cell points to the property list of the node. The property list of the 8080 node is shown. The pointers to words shown in figure 4 are actually pointers to the node cells of the words. All node cells are chained together by the OBLIST. The character string names of the nodes are stored in a part of memory that has not been divided into cells. The CARs of the node cells point to an address that specifies the number of the characters that follow that are included in the character string of the name of the node. Links have cells on the OBLIST, just as nodes do. The only difference is that links do not need property lists. The pointer to Processor-in would actually be a pointer to the cell that represents Processor-in.

Jim-pak[®] One-Stop Component Center

electronic components

NEW!! EXPANDED PRODUCT LINE...

TTL 7400 7490 7402 7492 7404 7493 7408 74107 7410 74121 7420 74122 7430 74123 7432 74125 (DM8093) 7442 74154 7447 74181 (DM8316) 7473 74176 (DM8280) 7474 74177 (DM8281) 7475 74192 7485 74193 7486 74367 (DM8097)	LINEAR LM301V LM567V LM303V LM732N LM339K LM739N LM311V LM741V LM330K-5 (7905) LM747N LM320T-5 (7905) LM1488V (9588V) LM320T-12 (7912) LM1488N LM320T-15 (7915) LM1488P LM339N LM1559V LM340T-5 (7805) XR2206 LM340T-12 (7812) CA3080 LM340T-15 (7815) CA3135 LM555V CA3140 LM556N LM3900N (CA3401)	CAPACITORS Aluminum Electrolytic 1mf 50V 100mf 50V 4.7mf 50V 22mf 50V 10mf 50V 47mf 50V 22mf 50V 100mf 25V 47mf 50V 220mf 16V Ceramic Disc 10pf 50V .001mf 50V 47pf 50V .0047mf 50V 100pf 50V .01mf 50V 220pf 50V .022mf 50V 330pf 50V .047mf 50V 470pf 50V .1mf 50V Dipped Tantalum .1mf 35V 2.2mf 25V .22mf 35V 3.3mf 25V .33mf 35V 4.7mf 25V .47mf 35V 6.8mf 25V .68mf 35V 10mf 25V 1mf 35V 15mf 25V 1.5mf 35V 33mf 25V Polyester Mylar .001mf 100V .022mf 100V .0015mf 100V .047mf 100V .002mf 100V .1mf 100V .0047mf 100V .22mf 100V .01mf 100V	P.C. POTENTIOMETERS Single-Turn 15-Turn 840P1K 830P1K 840P5K 830P5K 840P10K 830P10K 840P50K 830P50K 840P100K 830P100K 840P1meg 830P1meg DIODES IN751 IN4148(IN914) IN4733 IN4001 IN4734 IN4004 IN4742 IN4007 IN4744 MDA-890-3 TRANSISTORS C106B1 2N3055 2N2222A 2N3904 2N3906 2N3906 MJE2955 2N5129 MJE3055 2N5139 CONNECTORS DB25P Plug DB25S Socket DATA BOOKS* 7400/74LS Data Book CMOS/Linear Data Book Microprocessor/LED Data Book *JIM-PAK Products only
Low Power TTL Schottky 74LS00 74LS73 74LS109 74LS02 74LS74 74LS123 74LS04 74LS75 74LS136 74LS08 74LS93 74LS138 74LS10 74LS85 74LS151 74LS20 74LS86 74LS176 74LS30 74LS90 74LS367 74LS32	MICROPROCESSOR Z80 2101 8080A 2102 8032 81102 8224 7489 8228 MMS262 6800 1702A 6801 82523 6805L8 2708 A.V.S.1013 DM838N 2512/2140 N8T97 MMS3141(Clack Chip)	SOCKETS 8 pin low profile 14 pin wire wrap 14 pin low profile 16 pin wire wrap 16 pin low profile 24 pin wire wrap 24 pin low profile 40 pin wire wrap 40 pin low profile TO-3 Socket 14 pin plug TO-3 Socket 16 pin plug Molex Pins	SWITCHES Dipswitches Slide Toggle Push Button Subminiature Push Button
C/MOS 4000 4001 4050 4001 4023 4051 4010 4024 4069 4011 4029 4071 4013 4044 4081 4016 4046 4511 4017 4049	Display LEDs Discrete MAND2 XC556 Red DL704 XC556 Green DL707 XC556 Yellow DL747 CLPLITES-Red, DL750 Green, Yellow	FUSE HOLDERS BKP3AG	HEAT SINKS 1/2 Watt 5% 50 P.C. Assortments



A new component product line of over 260 items developed for the independent dealer. Guaranteed nationally advertised products. Complete JIM-PAK program includes national advertising, direct mail programs, store display racks, stock rotation plan and return policy. For dealer information, write or call JIM-PAK, 1021 Howard Avenue, San Carlos, CA 94070 (415) 592-8097.



SEE YOUR LOCAL Jim-pak[®] DEALER TODAY...

- | | | | | | |
|--|---|---|--|--|--|
| ALABAMA
<i>Mobile</i>
ALASKA
<i> Anchorage</i>
ARIZONA
<i> Fountain Hills</i>
<i> Tempe</i>
<i> Yuma</i>
CALIFORNIA
<i> Bellflower</i>
<i> Berkeley</i>
<i> Buena Park</i>
<i> Fontana</i>
<i> Fullerton</i>
<i> Long Beach</i>
<i> Mission Viejo</i>
<i> Monterey</i>
<i> Oceanside</i>
<i> Oxnard</i>
<i> Palo Alto</i>
<i> Pasadena</i>
<i> Sacramento</i>
<i> Sacramento</i>
<i> San Carlos</i>
<i> San Diego</i>
<i> San Fernando</i>
<i> San Francisco</i>
<i> San Jose</i>
<i> San Luis Obispo</i>
<i> Santa Cruz</i>
<i> Santa Monica</i>
<i> Sunnyvale</i>
<i> Vallejo</i>
<i> Walnut Creek</i>
CANADA
<i> Alberta (Calgary)</i>
<i> Montreal (Quebec)</i>
<i> Ontario (Willowdale)</i>
COLORADO
<i> Aurora</i>
<i> Steamboat Springs</i>
CONNECTICUT
<i> Bridgeport</i>
FLORIDA
<i> Ft. Lauderdale</i>
<i> Lakeland</i>
<i> Orlando</i>
<i> Tampa</i>
<i> Tampa</i>
FRANCE
<i> Paris</i>
GEORGIA
<i> Atlanta</i>
HAWAII
<i> Aiea</i>
<i> Honolulu</i>
IDAHO
<i> Idaho Falls</i> | <i>Lafayette Radio Electronics</i>
<i> Electronics Corp. of Alaska</i>
<i>P & C Communications</i>
<i> Computerworld Inc.</i>
<i> Yuma Electronics</i>
<i>Earl's Hobby Shop</i>
<i>Al Lasher Electronics</i>
<i>SJ Electronics</i>
<i>Fontana Electronics</i>
<i>Orvac Electronics Inc.</i>
<i>Scott Radio Supply</i>
<i>Tower Electronics Corp.</i>
<i>Zackit</i>
<i>Electronic Center</i>
<i>Dow Radio Inc.</i>
<i>Zack Electronics</i>
<i>Dow Radio Inc.</i>
<i>The Radio Place</i>
<i>Zackit</i>
<i>J & H Outlet Store</i>
<i>Radio Shack A.S.C. Mira Mesa</i>
<i>San Fernando Electronics</i>
<i>Zack Electronics</i>
<i>Ouement Electronics</i>
<i>Mid-State Electronics</i>
<i>Santa Cruz Electronics</i>
<i>Mission Control</i>
<i>Sunnyvale Electronics</i>
<i>Zackit</i>
<i>Byte Shop Computer Store</i>
<i>The Computer Shop</i>
<i>Wang's Microcenter</i>
<i>Home Computer Centre</i>
<i>Com Co Electronics</i>
<i>Norm's TV & Electronics</i>
<i>Bridgeport Computer</i>
<i>Computers For You</i>
<i>Lakeland Specialty Electronics</i>
<i>Altair Computer Center of Orlando</i>
<i>AMF Electronics</i>
<i>Microcomputer Systems</i>
<i>Computer Boutique</i>
<i>Atlanta Computer Mart</i>
<i>Delcoms Hawaii</i>
<i>Integrated Circuit Supply</i>
<i>Audiotronics</i> | ILLINOIS
<i>Evanston</i>
<i>Evanston</i>
<i>Greenville</i>
<i>Mount Prospect</i>
<i>Oak Park</i>
<i>Schaumburg</i>
<i>East Chicago</i>
<i>Hammond</i>
IOWA
<i>Indianola</i>
KANSAS
<i>Wichita</i>
KENTUCKY
<i>Lexington</i>
LOUISIANA
<i>Baton Rouge</i>
MARYLAND
<i>Baltimore</i>
<i>Baltimore</i>
<i>Lavale</i>
<i>Rockville</i>
<i>Towson</i>
MASSACHUSETTS
<i>Medford</i>
<i>North Adams</i>
<i>Waltham</i>
MICHIGAN
<i>Flint</i>
<i>Grand Rapids</i>
<i>Lansing</i>
<i>Mt. Clemens</i>
MINNESOTA
<i>Duluth</i>
<i>Eagan</i>
MISSOURI
<i>El Dorado Springs</i>
<i>Parkville</i>
MONTANA
<i>Billings</i>
NEBRASKA
<i>Lincoln</i>
<i>Omaha</i>
NEVADA
<i>Las Vegas</i>
NEW JERSEY
<i>Bayville</i>
<i>Cherry Hill</i>
<i>Hoboken</i>
<i>Pompton Lakes</i>
<i>Ramsey</i>
NEW YORK
<i>Albany</i>
<i>New York</i>
<i>Troy</i>
<i>White Plains</i> | <i>Tri-State Electronics</i>
<i>Itty Bitty Machine Co.</i>
<i>Meyer Electronics</i>
<i>Tri-State Electronics</i>
<i>Spectronics</i>
<i>Data Domain</i>
<i>Acro Electronics</i>
<i>Quantum Computer Works</i>
<i>Electronix Limited</i>
<i>Amateur Radio Equipment Co.</i>
<i>Radio-Electronic Equipment Co.</i>
<i>Davis Electronics Supply</i>
<i>Computer Workshop of Baltimore</i>
<i>Everything Electronic</i>
<i>J & M Electronics</i>
<i>Computer Workshop</i>
<i>Baynesville Electronics</i>
<i>Computers, Etc.</i>
<i>Tufts Electronics</i>
<i>Electronics Supply Center</i>
<i>Computer Mart Inc.</i>
<i>Hobby Electronic Center</i>
<i>Micro Computer World</i>
<i>Fulton Radio Supply</i>
<i>The Computer Store</i>
<i>Northwest Radio of Duluth</i>
<i>Computer Room Inc.</i>
<i>Beckman Electronics</i>
<i>Computer Workshop of Kansas City</i>
<i>Canley Radio Supply</i>
<i>Altair Computer Center</i>
<i>Omaha Computer Store</i>
<i>Century 23</i>
<i>A. R. S. Communications Services</i>
<i>Computer Emporium</i>
<i>Hoboken Computer Works</i>
<i>Computer Corner</i>
<i>of New Jersey</i>
<i>Typronon Computer Store</i>
<i>Fort Orange Electronics</i>
<i>Computer Mart of New York</i>
<i>Trojan Electronics</i>
<i>The Computer Corner</i> | NORTH CAROLINA
<i>Durham</i>
<i>Greensboro</i>
<i>Raleigh</i>
OHIO
<i>Bucyrus</i>
<i>Cincinnati</i>
<i>Dayton</i>
<i>Reynoldsburg</i>
<i>Staubenville</i>
OKLAHOMA
<i>Guyton</i>
<i>Oklahoma City</i>
OREGON
<i>Beaverton</i>
<i>Coos Bay</i>
<i>Ontario</i>
<i>Salem</i>
PANAMA
<i>Panama City</i>
PENNSYLVANIA
<i>Hershey</i>
<i>Murrysville</i>
RHODE ISLAND
<i>Cranston</i>
<i>Pawtucket</i>
SINGAPORE
SOUTH CAROLINA
<i>No. Charleston</i>
TENNESSEE
<i>Clarksville</i>
<i>Knoxville</i>
<i>Memphis</i>
<i>Oak Ridge</i>
TEXAS
<i>Amarillo</i>
<i>Dallas</i>
<i>Houston</i>
<i>Houston</i>
<i>San Antonio</i>
UTAH
<i>Provo</i>
VIRGINIA
<i>Alexandria</i>
<i>Charlottesville</i>
<i>Charlottesville</i>
<i>Richmond</i>
<i>Springfield</i>
<i>Virginia Beach</i>
WASHINGTON
<i>Bellevue</i>
<i>Longview</i>
<i>Pasco</i>
<i>Seattle</i>
<i>Seattle</i>
<i>Spokane</i>
WEST VIRGINIA
<i>Morgantown</i>
<i>Morgantown</i> | <i>Futureworld</i>
<i>Byte Shop of Greensboro</i>
<i>Byte Shop of Raleigh</i>
<i>Mead Electronics</i>
<i>Digital Design</i>
<i>Altair Computer Center</i>
<i>Universal Amateur Radio</i>
<i>Hasefelt Electronics</i>
<i>Sound Service</i>
<i>Bits, Bytes & Micros</i>
<i>Altair Computer Center</i>
<i>Herrick Electronics</i>
<i>Miller Electronics</i>
<i>Computer Pathways</i>
<i>Sanitel, S.A.</i>
<i>Microcomputer Systems Inc.</i>
<i>Computer Workshop of Pittsburgh</i>
<i>Jabbour Electronics City</i>
<i>Jabbour Electronics City</i>
<i>Intertrade (PTE) Ltd.</i>
<i>Technical Services Inc.</i>
<i>Mastrosini</i>
<i>Byte Shop of Knoxville</i>
<i>Sere-Rose & Spencer Electronics</i>
<i>Computer Denn</i>
<i>Computer Encounters Inc.</i>
<i>CompusShop</i>
<i>Altair Computer Center</i>
<i>Interactive Computers</i>
<i>Sherman Electronics Supply</i>
<i>Alpine Electronic Supply Co.</i>
<i>Computer Hardware Store</i>
<i>Computers Plus</i>
<i>Lafayette Electronics</i>
<i>Computers-To-Go</i>
<i>Computer Workshop of North Virginia</i>
<i>Heathkit Electronics Center</i>
<i>Altair Computer Center</i>
<i>Progress Electronics</i>
<i>Riverview Electronics</i>
<i>C-Cam</i>
<i>Empire Electronics</i>
<i>Personal Computers</i>
<i>The Computer Corner</i>
<i>Electro Distributing Co.</i> |
|--|---|---|--|--|--|

for the questions asked. Major improvements can be had by a few simple changes, however. First, what would happen to "Tell me what you know about keyboards"? The language processor would not recognize keyboards as the same as "keyboard", so no information would be found. The easiest way around this problem is to strip the Ss off all the node names when building the semantic net, then strip them off all the words input by the user. However, this procedure runs into problems for words that end in S, like "process". Another problem is words ending in "es", like "processes". Actually, there are algorithms for analyzing word endings that correctly reduce words to their roots for nearly all the special cases like these.

The whole problem of word endings can be avoided by using a universal character. A universal character is one that matches all other characters. If # were a universal character, the node names could be written as "light#" and "process#". These would match "light" and "lights", "process" and "processes". Tricks like this can help, but may produce problems by also matching "lightning" and "lighter", "processor" and "processing". Therefore, universal characters must be used with care.

Another improvement deals with nodes that have multiple word names. A user would probably ask about "system 1" instead of "system1". Multiple word names can be handled by more property lists, one for each first word in multiple word names. These property lists would contain a list of the words of the multiple word name, followed by the corresponding node name in the semantic net. For example, system1 and system2 could be referred to by:

```
System (Mult-wrd-names ((1) System1 (One)
System1 (2) System2)).
```

This property list signals the language processor that "system 1", "system one" and "system1" are all to be interpreted as "system1". Also, "system 2" means the same as "system2".

The same mechanism can be used to allow synonyms. System 1 may be affectionately known as the "Bit Byter", "Old Smokey" (for its power supply problems), or "Zapper". These names can be interpreted as the same as "system1" with the following property lists:

```
Bit (mult-wrd-names ((Byter) System1))
Old (Mult-wrd-names ((Smokey) System1))
Zapper (Mult-wrd-names (() System1)).
```

Just as universal characters can be used, universal words and phrases can simplify specifying a large set of synonyms. For example, the multiple word name (President # Washington) would match all phrases that begin with "President" and end with "Washington". This would match (President Washington), (President George Washington), (President G Washington and also (President Ford never met George Washington).

A relevant question is: What good is putting the keyword in the middle of a sentence? Why not just have the user type keywords and forget about the rest of the sentence? There probably are few if any good reasons for trying to create an illusion of natural language understanding in this way other than that it is a fun trick.

Nodes and Links

The keyword approach to natural language processing is imprecise, and so it is prone to many errors and misinterpretations. There is an approach that is somewhat more precise, and allows correct interpretation of much more complex sentences without being much more complicated. This method involves identifying both node names and link names from the semantic net, then combining them to print only the parts of the semantic net desired by the user. The link names in our example are processor, memory, input, output, processor in, memory in, input of, and output of. There will usually be many fewer link names than node names. A user's sentence is processed by collecting node names, then link names, as in:

Give me the Old Smokey processor and output.

Using a previously mentioned definition this is seen by the processor as:

```
xxx xxx xxxx system1 processor xxx output
          (node) (link)                (link)
```

to which the appropriate response is:

```
System1
  Processor
    8080
  Output
    Lights.
```

The response is formed by searching the property list of the node mentioned for each link named. Then the node name, the link name, and the names of the nodes pointed to by the link are printed in outline format.

If link names are found to the left of node names in the sentence, the inverse link

ARTEC CRAFTSMANSHIP HAS CREATED

The First Truly Silent Motherboard

Noise in your bus lines means errors in your programs. The Artec shielded Motherboard totally eliminates noise.

At 4MHz, the Artec shielded Motherboard is free from spurious noise. No ringing in your bus lines. No errors in your programs.

This Motherboard offers you engineering and craftsmanship never before available in the small computer field. Outstanding as either a replacement for your present Motherboard or as the heart of a new system. Consider these features:

- 1/8th inch thick—more than twice as thick as most Motherboards.
- Totally shielded—all holes plated through; full bus terminations.
- Fits easily into any standard chassis.
- Masterite edge connectors—the finest quality connectors available.
- Reflowed solder circuitry.
- No soldering required.
- Designed for the S-100 bus.

The Motherboard price is: \$150(KIT)
\$190 (ASSEMBLED)

Five years of experience in every card

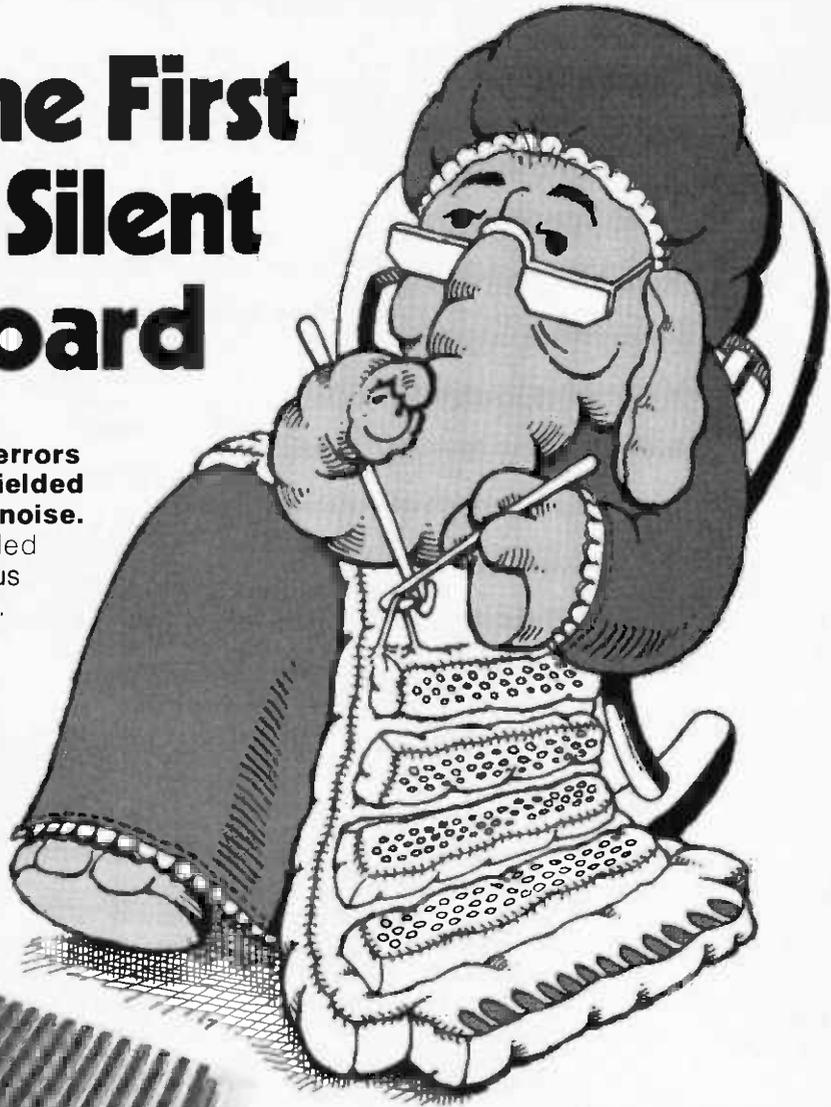
For five years, Artec has worked hard to develop a complete line of custom, prototype and off-the-shelf printed circuit boards. And in five years of tough industrial use, Artec boards have proven themselves among the most reliable boards available anywhere.

NEW! DEC® and Heath Compatible LSI Boards

The new Artec WW11 lets you adapt or add onto your DEC LSI-11 or Heathkit LSI mini-computer. Can accommodate 14 and 16 pin DIPs plus all necessary passive components.

FULL CARD \$75
(10.45" x 8.4")

HALF CARD \$35
(5.225" x 8.4")



® Trademark of Digital Equipment Corporation

Order today!

Put an Artec board to work for you. Use your Mastercharge or Visa. Or just send along a money order. We can accept only U.S. currency. Please include \$3 handling on all orders. California residents add 6% sales tax.

Please send me: (include quantity)

___ Shielded Motherboard ___ Full WW11 Card ___ Half WW11 Card

I've enclosed a money order for \$ _____

Mastercharge Visa (number) _____ (exp. date) _____

Name _____

Address _____

City _____ State _____ Zip _____

Calif. Res. add 6% sales tax. Encl. \$3 handling. 10% discount for students and computer club members. (Please enclose name of club or school)

ARTEC ELECTRONICS, INC.

Artec Electronics, Inc. • 605 Old County Rd. • San Carlos, CA 94070
(415) 592-2740

names must be substituted. For example,

What are the input of and processor in system 2

is seen as:

xxxxx xxx xxx input-of xxx processor-in system2
(link) (link) (node).

The reverse links are used, and the sentence is reinterpreted as:

system2 input processor.

The property list of system2 is checked for input and processor links and the following is printed:

System2
Input
Scale
Keyboard
Processor
8080.

This process is diagrammed in figure 6. This technique will allow quite complicated sentences to be interpreted if synonyms are chosen judiciously for nodes and links. Users on a natural language processing system tend to use very short and incomplete sentences if they can, which is also allowed with this system.

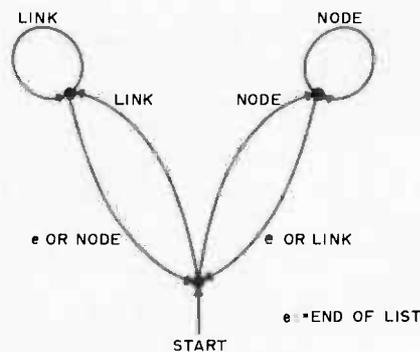


Figure 6: Node and link interpretation. This simplified method of interpreting which nodes and links mentioned in a sentence should be associated will often assume the proper interpretation to the input sentence. However, node and link names and synonyms must be chosen with care. A more successful method requires greater attention to words other than those in node and link names, particularly conjunctions, prepositions and relative pronouns.

Conclusions

There is naturally a lot that keyword based systems cannot do that humans can. For instance, keyword systems cannot understand pronouns, or when to use different word meanings (like pancake). Humans have little trouble using these. The difference is, of course, in all the information that keyword systems throw out when they disregard all words that are not keywords. Also, words carry with them more than just a definition. Most words say things about the words that are surrounding them. The word "the" says that the word to its right is either a noun or a noun modifier. In the system described above, the keyword "input of" tells us that either some kind of input device has preceded this phrase in the sentence, or a reference to a system will follow it ("what is the input of system 2"), or both ("a keyboard is input of system 2").

Natural language research today has moved far beyond the realm of keyword analysis to use not only knowledge about words, but knowledge about the things and events that the words refer to, and knowledge about the way text and conversations are structured. In a data base like the microcomputer data base used here, the system would retain information about the components that every system would probably have, the probable uses of systems, more detailed information about each of the components, and so on. The information that a human uses when discussing microcomputers would be collected and added to the knowledge base to be used when the computer is discussing microcomputers. This information is grouped into collections and the collections are associated with the concepts they describe.

It is nearly impossible to discuss how well such a system can work. We do not yet have any kind of scale for measuring natural language performance if it falls into the subhuman range. The only really useful measure is whether or not it does what it is supposed to. Unfortunately, that too is difficult to ascertain. I have implemented a system like the link and node system described here, but it was quite a bit more complex. It attempted to account for every word in the sentence in order to



At last.

Finally, the macro maker of computer printers has gone micro. With a high-speed, desk-top, non-impact printer complete with parallel interface (Model P-1) that's perfect for the home, hobby and small business user. A complete 80-column printer for less than \$600.

The new Centronics microprinter is big on performance. It prints clean, clear dot matrix characters at a rate of 150 lines per minute. Yet it's quiet, compact, comes fully warranted and is backed by Centronics' worldwide service. It's even available in a serial interface version (Model S-1) for remote applications.

Of course, buying your small systems printer from the industry's leading producer of printers is simply a better buy. You get the security, support and systems flexibility only Centronics can bring. Plus the targeted technology that brings out the best in any computer.

So when you think small printers, think big. Think Centronics. For more information, just clip and mail the coupon below.

Centronics Data Computer Corp.
Hudson, NH 03051

Gentlemen: Tell me more about your new microprinters.

Name _____

Address _____

Town _____

State _____ Zip _____

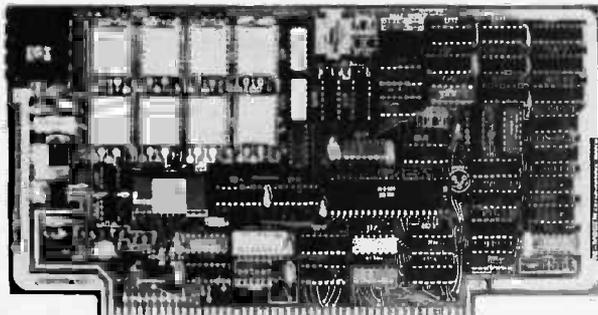
B-6-78

CENTRONICS® PRINTERS
Simply Better

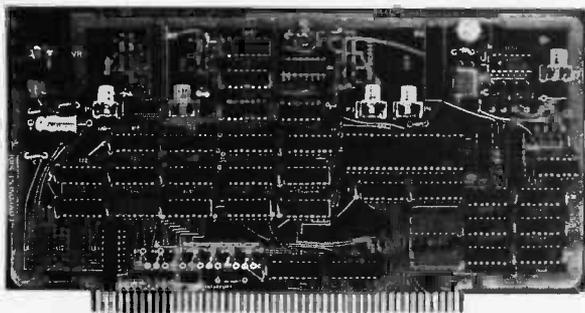
IDS INTERNATIONAL DATA SYSTEMS, INC.

400 North Washington Street, Suite 200, Falls Church, Virginia 22046 U.S.A.

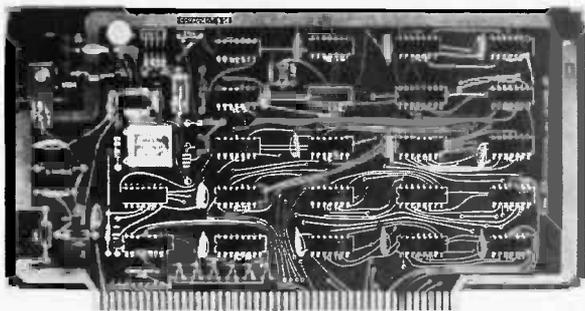
Telephone (703) 536-7373



88-MODEM: A complete serial I/O port and an Originate/Answer MODEM on an S100 bus compatible board. The 88-MODEM features automatic auto-dialer (not software timed), operates at any software selected baud rate between 66 and 600 baud, has separate 8-pole transmit and receive active filters, and all functions are software selected. The 88-MODEM provides communication to -58 dbm and is intended for use with either a CBS (1001D) or CBT Data Access Arrangement for connection to the telephone system. The kit price is \$245.00.



88-UFC UNIVERSAL FREQUENCY COUNTER: The 88-UFC is an S100 compatible frequency and period measurement module. The 88-UFC has four software selected inputs. Frequency measurement to above 600MHz and period measurement to 1/10th microsecond are standard. The counter provides nine digits of readout and is priced at \$179.00 in kit form.



88-SPM CLOCK MODULE: The 88-SPM provides a time of day clock and an independent realtime clock on one S100 compatible module. Provisions are included for battery backup so the 88-SPM can maintain the time during power-off conditions. \$96.00 kit

1001D (Type CBT) Data Access Arrangement	\$125.00
88-RCB 16 Channel Relay Control Board Kit	\$179.00
MCTK Morse Code Trainer/Keyer Kit	29.00
TSM Temperature Sensing Module Kit	24.00
DAC-8 8-Bit Digital to Analog Converter Kit	19.00
88-TCXO Temperature Compensated Crystal Oscillator for 88-UFC	145.00
88-XTAL Crystal Timebase option for 88-SPM	25.00

TERMS: Payment with order shipped prepaid, added for COD, Master Charge accepted

prevent misinterpretations. It handled pronouns fairly successfully and was good at identifying items by their description. It responded to the user in full sentences and in outline form. It also required a large system to run on, primarily because it had a fairly large data base. With all this, it still usually took a new user several examples before he could communicate with the system in a useful way.

With this experience, what do I think natural language systems can do on small systems? The question is vague, so the answer is vague: a little bit, but not too much. That not-very-helpful answer means that one must decide why he or she wants a natural language processor, then consider the techniques described in this article to decide if they will meet his or her needs. These techniques must then be compared to nonnatural language techniques.

The benefit of the language understanding techniques described here is primarily based on the power of the semantic net representation. Semantic nets have one advantage over other representations in that concepts are associated in a way similar to the way they seem to be associated in human memory. An important aspect of using natural language as an interaction language between humans and computers is that, if it works, it allows the user to state his requests in the same way that he thinks about his requests. A user using natural language to interact with a computer is manipulating an enormous amount of information in his or her mind, encoding a small part of that knowledge into the words of the conversation, assuming that the listener (the computer) can use these few words to manipulate its large information structures. On a small system, the information structures that the computer has to manipulate can not be nearly as large as the human's. The words of the conversation can be associated with ideas, but not on the lavish scale of association available to humans. Finally, most of the words of the conversation are thrown away using the techniques that a small system can support. What natural language processing can be done on small systems? Not enough to be able to compare it to natural language processing in humans, but perhaps enough to allow a user to learn to communicate effectively with the computer in a way that is close to the way the human brain thinks: through associations and descriptions. ■

SELECTRA-TERM™

Formerly SELECTERM

The SELECTRIC II Printer You Can Trust.

You may have considered a Selectric II as ideal for your application but have been skeptical about reconditioned units and kits.

Set your skepticism aside with the SELECTRA-TERM. Because it's brand new, and fully assembled and tested before you take delivery. We convert factory new IBM Selectrics and test them non-stop for up to 24 hours before shipping. And our factory applique' has been approved for use with all compu-

ters. So you receive IBM's factory warranty, and yearly service agreements for the typewriter are available. In addition, we offer full warranty protection on the electronics conversion.

The SELECTRA-TERM may be connected to your computer within minutes of taking it out of the carton.

It's that easy! And that reliable!



NOW!
Interface available
for direct connection to
Apple II, Heathkit H8 and TRS 80.

THE BEST SELECTRIC II* PRINTER GOING For *Any* Computer

FEATURES

- Complete ASCII character set in standard element.
- Full upper/lower case alphanumeric character set and keyboard.
- Tab command, index (vertical tab), backspace, bell—all under computer control.
- Parallel interface, standard.

ALL ELECTRONICS INCLUDED

- Power supply, electronics and cable sets included to permit immediate connection to the parallel port of any computer, at standard TTL level.

SOFTWARE

- All necessary conversion software in PROM to handle ASCII input directly.

PRINTER or TYPEWRITER

- May be used as a standard typewriter when not in use with your computer.

OPTIONS

- Dual pitch \$125.00
- Correction feature \$125.00
- Tractor feed platen \$250.00
- Noise reduction feature \$ 50.00
- RS-232 interface \$195.00
- Export models available

PRICE and DELIVERY

- Assembled and tested **\$1,750**
- Available from dealers nationwide
- Delivery 3 to 4 weeks from receipt of order
- Quantity delivery to OEMs within 30 days

micro
computer
devices
inc.



960 E. Orangethorpe, Bldg. F
Anaheim, California 92801
Telephone (714) 992-2270

*Registered trademark of IBM Corp.

"Innovators to the Microcomputer Industry"

Give an Ear to Your Computer

Bill Georgiou
Dept of EE
California State University
Sacramento CA 95819

You pick up the phone and slowly and clearly you pronounce into the microphone: "Number one two one three five five five one two one two verify." You listen as out of the earpiece an awkward but quite intelligible voice repeats what you just have said. Then you say "Dial number." The sounds of dialing follow, then a ringing in the distance and you find yourself talking to the directory assistance operator in Los Angeles. A sequel to 2001 with personal HALs? Not quite. Just plain old 1977 reality. A couple of cards in your computer and some programming can do it. Speech recognition and voice control have come a long way from the "Open Sesame!" of the Arabian tales. Its technical foundations were laid in the 1950s and 1960s. The microprocessor revolution has brought it within the reach of any computer experimenter, opening up a fascinating frontier of voice control and spoken communication between human and machine.

In the following pages I will try to give you an introduction to speech processing and pattern recognition. To demonstrate the principles involved, we will go into some details of the workings of a speech recognizer suitable for a small personal computer. I hope the material to be presented will be enough to give you an idea of what speech recognition is, how it is done and what are its present limitations. It is left to the reader to get excited, read the literature to find more about speech recognition and then buy, borrow or build a recognizer and start using it imaginatively.

A Speech Recognition Primer for Computer Experimenters

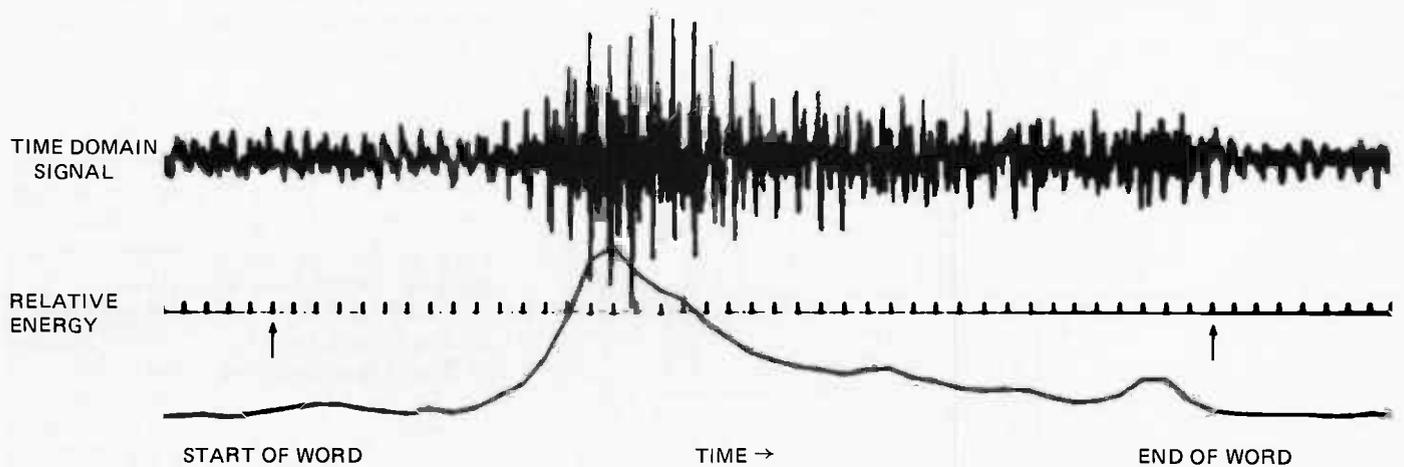


Figure 1: A time domain voice waveform and its energy. The top trace is the time domain signal for the word "three." The bottom trace is the energy in the above signal computed every 10 ms. Note that the signal before and after the word (arrows mark the beginning and end of the word) is not zero. This is due to background noise picked up by the microphone, in this case computer cooling fans and air conditioning noise.

The Speech Signal

If we connect a microphone to an oscilloscope and then speak into it, we will get a jittery trace similar to the one shown in figure 1. The vertical axis represents voltage, the output of the microphone. The horizontal axis is time and for this reason such a representation of speech is called a "time domain" representation.

You may ask can we use a time domain representation for speech recognition? It would be nice if we could because it is so easy to get; all we need is a microphone. The voltage in the output leads of the mike is, by definition, the time domain signal. Of course we would like to input this signal into our computer. Since it is an analog signal and our computer is a digital machine we will need an analog to digital converter (ADC). The analog to digital converter gives a binary number that corresponds to the amplitude of the signal at the particular time when the measurement is made. This process is called sampling. If we take and store equally spaced samples often enough so that the signal does not change very much between samples we will have a fairly accurate representation of the time domain signal in our computer's memory. Figure 2 shows such a situation, in which an arbitrary input waveform is sampled over some time interval, and the results of conversion

are stored as values in successive memory locations.

It has been mathematically proven (the sampling theorem) that if we are to have an accurate representation of the signal, the sampling frequency should be at least twice the highest frequency in the signal. It is then called the Nyquist frequency and it is the lowest usable sampling frequency. One could sample at higher than Nyquist frequency but this would not give a more accurate representation of the signal. Instead there would be a lot more data words to deal with, an unwelcome situation. If we try to apply the Nyquist theorem to speech we are faced with the question: what is the highest frequency in speech? Well, for high fidelity sound a bandwidth of 20 to 20,000 Hz is necessary. This means that speech has frequencies up to this limit, perhaps even higher. On the other hand, telephone speech is band limited to 3200 Hz and it is still quite intelligible. Since in speech recognition we are interested in what has been said rather than the quality of the sound, if we limit the signal using a filter with a cutoff at 3200 Hz we will retain the information needed for recognition. Then we can use Nyquist's theorem to get a practical sampling rate since we will know that the highest frequency in the signal is 3200 Hz, due to the filter. Sampling at twice that frequency we will get 6400 samples

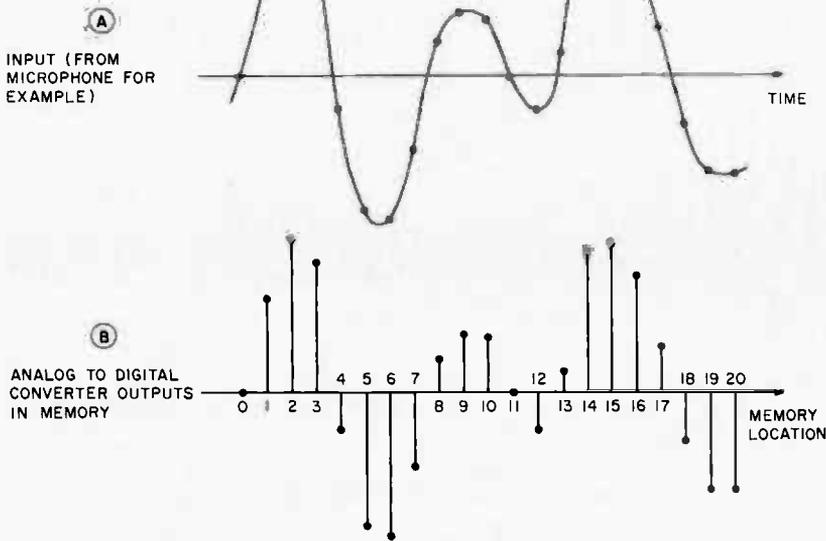


Figure 2: Sampling in the time domain. Waveform A is a time domain signal. If we sample it at equally spaced intervals we will retain the amplitude of the waveform at the dotted points and the signal will be zero between these points, as shown in waveform B. Although A and B look very different, if the sampling is done with a frequency higher than the Nyquist frequency (see text), both signals will contain exactly the same information.

per second of speech. Assuming our word length is eight bits which is about the minimum usable for speech and that the average word duration is about half a second, we will need 3.2 K bytes of memory space per word. If we had a 20 word vocabulary and we wished to store each word in main memory once to be used as reference, we would run out of memory space in any micro and most minis.

Using the time domain signal is out of the question because of the huge amounts of memory required to store it. This is not the only disadvantage of the time domain signal. Assuming we had enough memory to store the data, processing it would take too much processor time because every operation we would perform on the data would have to be performed on such a great number of data points. Real time operation (processing the signal as it occurs such that there is no appreciable time lag between the moment the signal ends and the time the recognizer decides which word has been said) would be out of the question. Yet real time operation is highly desirable in most situations in speech recognition. Another basic disadvantage of the time domain signal is its variability between different pronunciations of the same word. People do not repeat words exactly the same, down to the minute

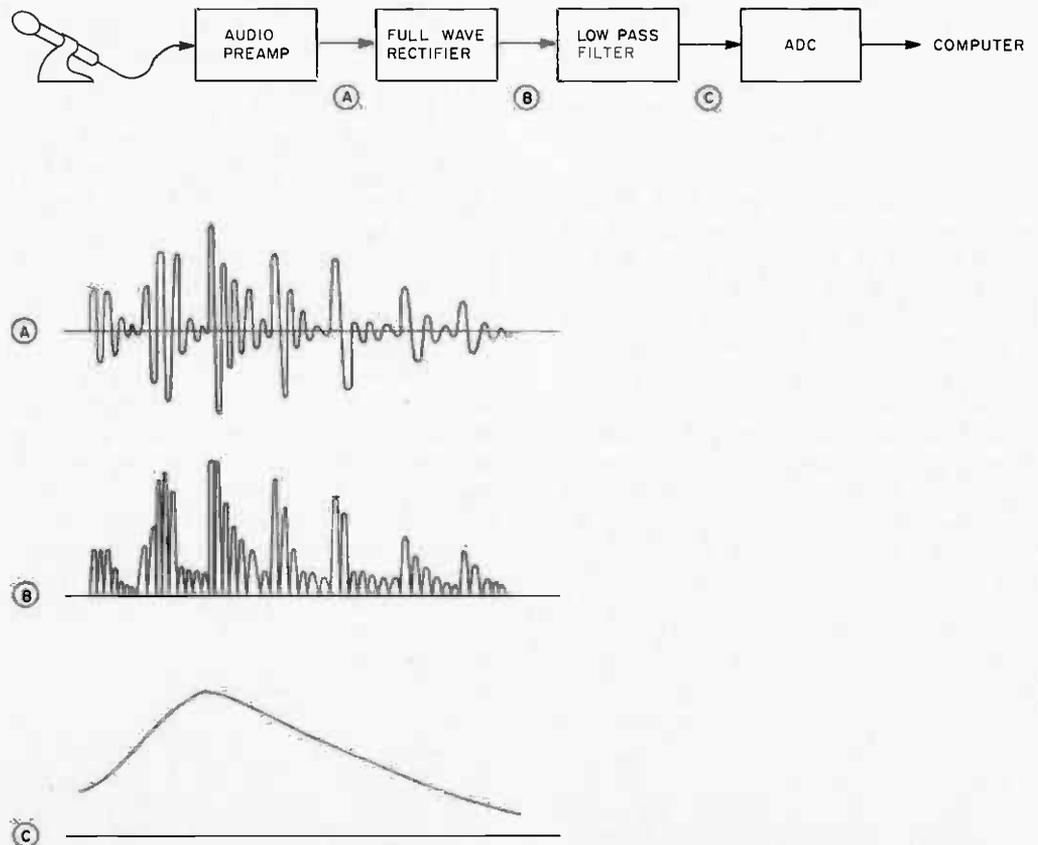


Figure 3: Rectifying the microphone signal at A we obtain signal B which contains a slowly varying DC component proportional to the volume of the signal and various high frequency components due to the formants. The low pass filter separates these and the analog to digital converter (ADC) sees only the volume signal.

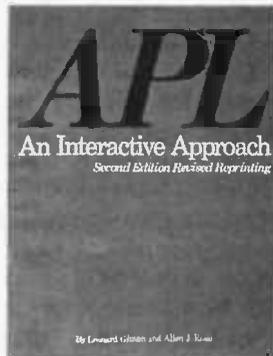
A BIT OF Everything

___The Best of Creative Computing Volume I

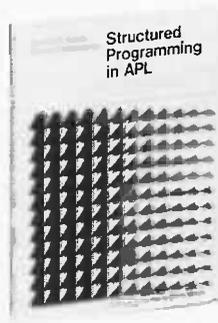
___The Best of Creative Computing Volume II. Culled from pages of Creative Computing Magazine, these two volumes provide fiction, fun, foolishness, and plenty of nuts and bolts commentary and programming information for anyone curious or serious about the wonderful world of personal computing. \$8.95 per volume.



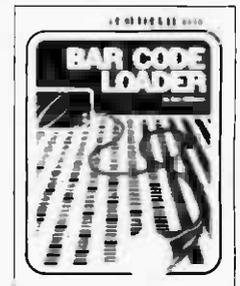
___Structured Programming in APL by Dennis P Geller and Daniel P Freedman "....Our approach is to present the fundamentals of structured programming in APL. Students may go on from here to learn to write faster programs or more compact programs, or more aesthetic programs; this we hope is where they learn to write working programs." From the Preface. \$9.95.



___APL—An Interactive Approach Second Edition, Revised, by Gilman and Rose. Here's an excellent way to introduce yourself to the APL language. APL is rapidly becoming one of the most popular high level languages in the computer field because of its clarity and conciseness. Gilman and Rose have extensively updated their popular book to include the latest information about the language and the various forms of it which are now in use. Since the examples are all carefully spelled out, **APL—An Interactive Approach** is particularly recommended for those who do not have access to an APL terminal. Answers to all problems are included. \$13.00.



___How to Program Microcomputers by William Barden, Jr. Here is a guide to assembly language programming of the Intel 8080, Motorola MC6800, and MOS Technology MCS6502 microprocessors. It is written especially for beginning programmers with hobbyist microcomputers based on one of these three chips. The topics covered range from data manipulations at the bit level up to handling of tables and lists and from simple adds and subtracts up to floating point operations. \$8.95.



___Bar Code Loader by Ken Budnick is the key that unlocks the door to Paperbyte™ Software Books. Included in this publication is a brief history of bar codes, a look at the Paperbyte™ Bar Code format including flowcharts, and a general bar code loader algorithm. Well documented programs with complete implementation and checkout procedures are included for 6800, 6502 and 8080/Z-80 based systems. Individuals with computers based on these processors can use the software directly. Individuals with other processors can use the provided functional specifications and detail examples to create equivalent programs. \$2.00.

DIAL YOUR BANK CARD ORDERS ON THE BITS TOLL FREE HOT LINE: 1-800-258-5477.
In New Hampshire, call: 924-3355.

Send to:
BITS, Inc.
70 Main Street
Peterborough, NH 03458



Check payment method:
___My check is enclosed.
___Bill my MC No. _____
___Bill my BAC/Visa No. _____

Exp. date _____
Exp. date _____

Name _____
Address _____
City _____ State _____ Zip Code _____
Signature _____

Total for all books checked \$ _____
Postage, \$.75 per book for _____ books \$ _____
Outside U.S. \$1.00 per book for _____ books \$ _____
Grand Total \$ _____

You may photocopy this page if you wish to keep your BYTE intact.

Prices shown are subject to change without notice.

details of amplitude. Quite the contrary; there is a tremendous amount of variation in the time domain signal even for the same person within several consecutive pronunciations of the same word.

In speech recognition we would like to transform the time domain signal into some other signal or representation with low data rate and which remains more or less invariant as long as the same word is pronounced. This is easier said than done. If we try to reduce the data rate we run the risk of throwing away important information. For example suppose that before going into the analog to digital converter we rectify the signal, then process it with a low pass filter. A block diagram of this operation is shown in figure 3 together with the resulting waveforms. Such an operation will extract the envelope (c) of the signal. The highest frequency of interest in the envelope is only about 50 Hz. This is due to constraints imposed by the mechanism that produces speech. We can thus set the low pass filter to 50 Hz and sample at 100 Hz, the Nyquist frequency. That gives us a very

reasonable data rate, 100 words per second and well within the capabilities of all machines.

Yet, if we try to build a recognizer using only this information we would get very poor performance. The reason is that we have thrown away a lot if not most of the information in the speech wave in the process of rectification. The information that remains is quite variable between different pronunciations of the same word, further degrading recognition. But it is not totally useless. If we select a vocabulary of a few words carefully so their envelopes have distinct characteristics we may get usable performance out of a very simple recognizer. We could select for example the words "one," "three," "zero." Typical envelopes for those words are shown in figure 4. We note that the envelope for "one" consists of one hump. "Zero" has two humps and "three" has one main hump preceded by a small peak that corresponds to the sound "th." Based on these observations we can write a simple program that would examine the input data and decide which one of the three words has been said.

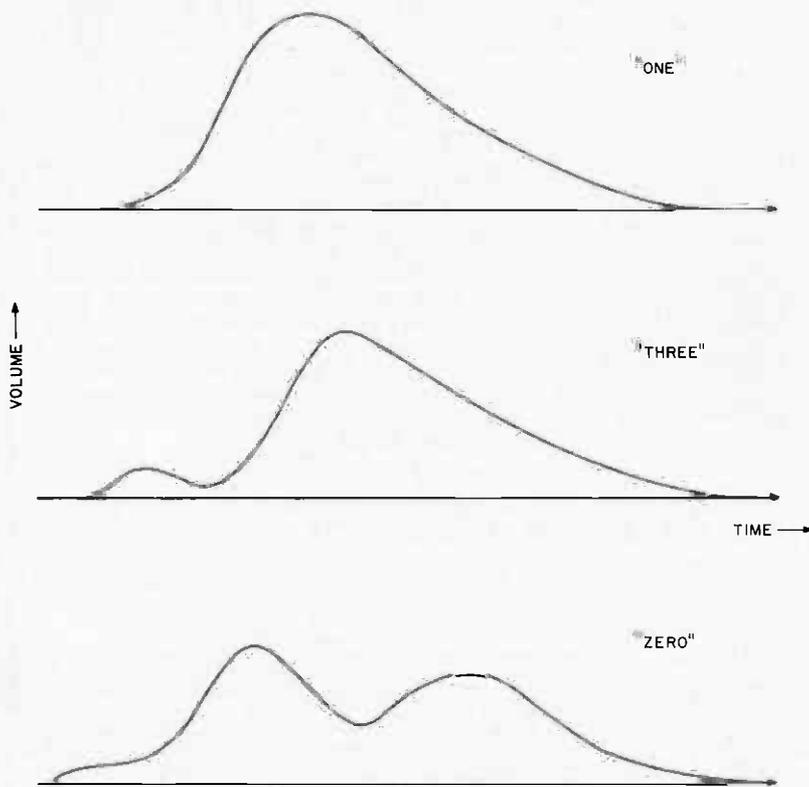


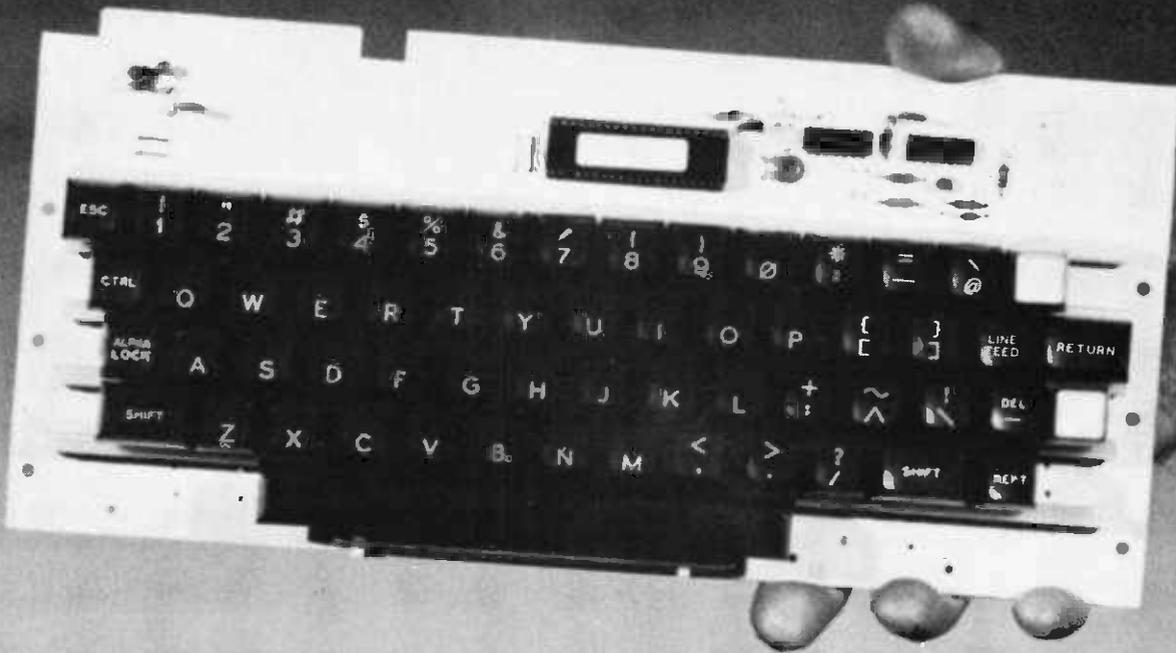
Figure 4: Amplitude envelopes of the words "one," "three," "zero." Note that "one" has one hump while "three" has two. The smaller one corresponds to "th" and the larger one to "ee." In "zero," "z" is the low amplitude area in the beginning. The dip corresponds to "r" and the humps to "e" and "o." Vowels always have high amplitude because they are produced with the mouth open and with strong excitation.

Feature Extraction

The process of extracting a set of slowly varying parameters that represent a word is called feature extraction. It has two objectives: First, as we have seen, it tries to reduce the amount of data necessary to process for recognition. This is a very important consideration for any practical implementation. Second (and extremely important), the features extracted must contain the relevant information in the signal. The speech signal conveys a lot of information about the sex, age, regional origin and emotional state of the speaker. Also it contains a lot of technical information incidental to speech production such as phasing and power spectra of the glottal pulses. All this information is related but not relevant to the meaning of the word pronounced. Ideally the features will contain as little as possible of this extraneous information.

A good feature extraction scheme will reduce the data rate in the recognizer by throwing away all the unnecessary information and retaining the information useful to the recognizer. The information pertaining to the meaning conveyed by speech is estimated to be from 15 to 30 bits per second, or about three orders of magnitude less than the data rate of the unprocessed speech signal. Practical feature extractors are not even close to the theoretical data

meet max!



Now you can buy a complete operational keyboard with full ASCII code capabilities, built to commercial standards, yet priced for the personal user who needs only one. This is not a surplus unit or a manufacturer's overrun, it's a new board designed specifically for the personal computer user.

MAX is MOS/LSI encoded, and includes all 128 ASCII characters, two-key rollover protection and two non-encoded keys with relegendable keytops for user assignment. Everything you need to start entering data immediately.

Individual keys for CARRIAGE RETURN, LINE FEED and ESCAPE are provided to give you these important functions without multiple key closures. A low-cost MAX option kit (Part No. 620002) lets you add four CURSOR keys and a HOME key if you need those functions. Coding is already provided.

MAX low-profile switches have gold contacts with wiping action for long life and reliability, and plunging action that is smooth and precise.

Maxi-Switch is a leading supplier of keyboard products to the data terminal industry, and MAX comes from a fine family. Get the full story on the new MAX keyboard for personal computing.

MAX is sold only through authorized dealers such as Century Marketing. To order your MAX, use the coupon supplied.

Send to: Century Marketing
P.O. Box 35192
Edina, MN 55435

Enclosed is \$69.95 (plus \$5.00 shipping and handling) per MAX keyboard. (For Cursor Kit, add \$3.95.) Please send

_____ MAX keyboards to _____

Address _____

City _____

State _____ Zip _____

THE *Maxi-Switch* CO.

9697 EAST RIVER ROAD • MINNEAPOLIS, MINNESOTA 55433

(612) 755-7660

TWX 910-576-2690



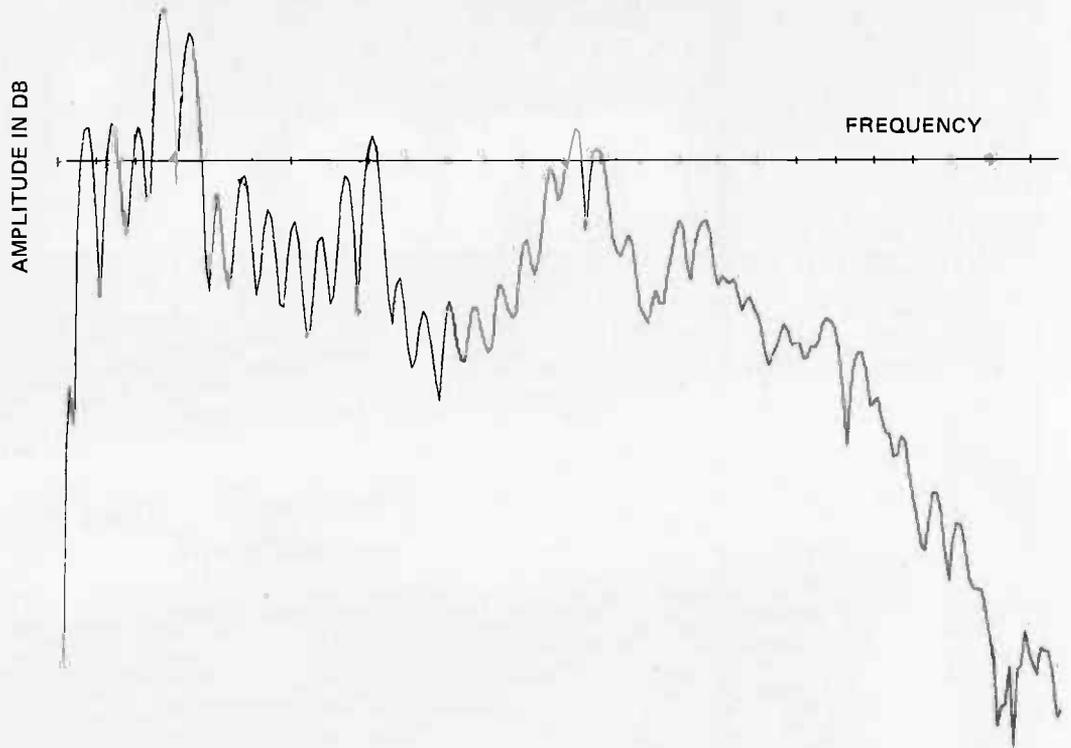


Figure 5: The frequency (logarithmic magnitude) spectrum of a 25 ms segment of speech. It covers the frequencies from 0 to 3.2 kHz. The major peaks correspond to the formant frequencies while the smaller, regularly spaced peaks are harmonics of the glottal frequency. In this case it is obvious that the sound is voiced both from the harmonics of glottal frequency which are highly visible and from the fact that the lower frequencies have more energy than the higher ones.

rate and, most important, they tend to throw away significant amounts of the useful information. An example of a very inept feature extractor is, of course, the envelope detector mentioned previously. But it does have the advantage of extreme simplicity.

In order to design more sophisticated feature extractors some knowledge about speech production is necessary. Knowledge about speech perception would also be very useful but at this point we have no concrete information as to how people are perceiving speech. In contrast, the mechanism that produces speech is well understood and rather simple. It has been previously explained in the August 1976 BYTE (page 16) in connection with speech synthesis. To summarize, speech is produced by exciting the vocal tract with either glottal pulses or noise while its shape is varied by controlling the position of the tongue and the jaws. Noise excitation produces unvoiced sounds. Glottal excitation produces voiced sounds, for example vowels. The movement of the articulators (tongue and jaws) changes the resonant frequencies of the vocal tract, called formants. It is well known that the first three formants, designated F1, F2, F3,

carry most if not all meaning in speech together with timing considerations and type of voicing. The glottal frequency, although very important in speech synthesis because it carries information about the particular speaker, carries no information about meaning. This rather surprising fact is easy to ascertain in two ways: First, synthetic speech is equally well understood whether the pitch (another name for glottal frequency) varies according to rules or remains constant. Second, whispered speech, which does not contain any glottal excitation, is well understood.

It seems then that a good set of features for speech recognition would be the formant values. Information as to whether speech is voiced or unvoiced would be useful but not necessary. Unfortunately at this point it is not possible to experimentally either assert or refute this statement, simply because it is not possible to reliably and accurately extract the formants all the time. In addition, the best formant extraction methods known are at this point out of the reach of any imaginable personal computing machine. They involve digital signal processing methods which for real time process-

The first Four-Headed Diskette Drive. PerSci stays a generation ahead.

PerSci has done it. Now the industry's only diskette drive with voice coil positioning comes equipped with four heads reading and writing both sides of two eight inch diskettes to provide superior random access capabilities in microcomputer and minicomputer applications. The new PerSci Model 299 dual-head, dual diskette drive offers the highest data capacity, reliability and the fastest access speeds available among small storage peripherals. It is the first drive to advance diskette capability to the level of hard discs.

8 Times More Capacity...

Employing double density encoding on both sides of two diskettes, the PerSci 299 records up to 3.2 Mbytes of unformatted data—eight times the capacity of a standard, single density drive. This unmatched single drive capacity provides the basis for an independent low cost data management system. For maximum media interchangeability with other drives, the 299 will also read and/or write one or two single sided diskettes. Up to eight 299 drives (32 read/write heads) can be daisy chained to achieve a total formatted system capacity as high as 16 Mbytes. Data can be handled in a single density IBM 3740 type format, in IBM 2D compatible double density or in other expanded soft and hard sectored formats.

And Voice Coil Positioning For 6 Times More Speed...

Only PerSci, Inc., has engineered voice coil head positioning for diskette drives. This design innovation gives the PerSci 299 drive the lowest average seek time of any floppy—33 ms including settle. The full 76 track access speed of the Model 299 is under 100 ms.

In A Single Small Size Drive...

While the 299 provides the data capacity and access speed of a hard disc drive, it is the

size of a standard floppy—only 4.38" x 8.72" x 15.4"! Up to four 299 drives can be mounted vertically or two horizontally in a 19" rack.

With Superior Reliability And Ease Of Operation.

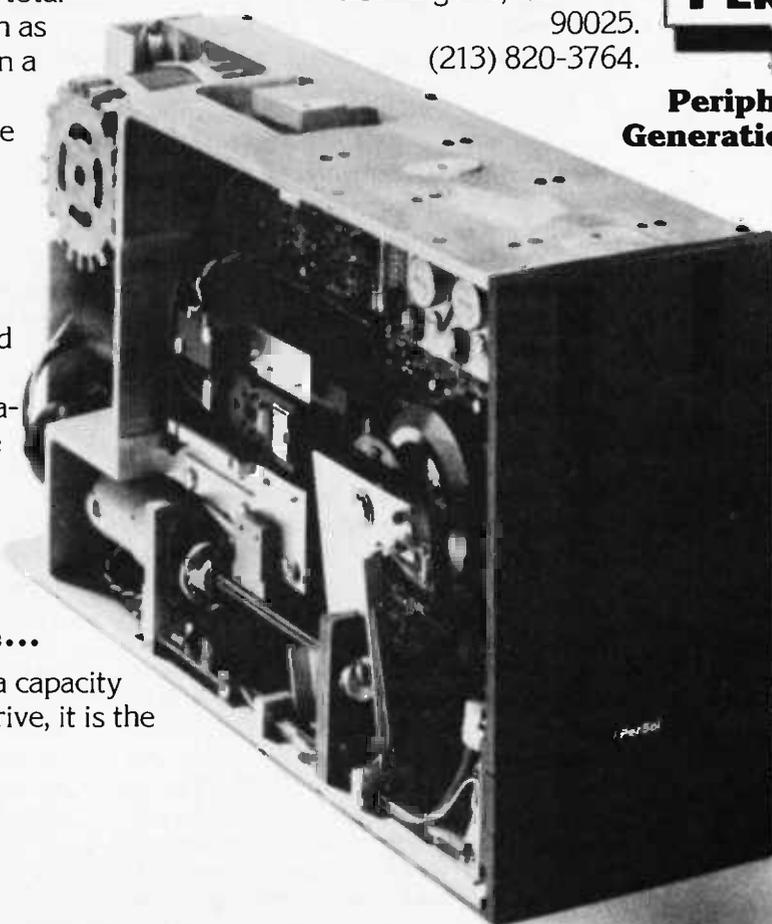
Mechanical and data reliability equal or superior to single headed drives—6000 hour MTBF and a soft error rate of 1 in 10^9 —are made possible by PerSci's advanced drive design. A write protect feature guards against operator error, while front panel lights indicate the diskette selected. Electric diskette autoloader protects diskettes from damage and allows drive unload by remote control.

Join The Next Generation... Now.

Get PerSci's four-headed diskette drive and get the speed, capacity and reliability of hard disc drives at a fraction of the size... and cost. Call or write for full information from PerSci, Inc., 12210 Nebraska Avenue, West Los Angeles, California 90025. (213) 820-3764.



**Peripherals a
Generation Ahead.**



See us at NCC, Booth 1239

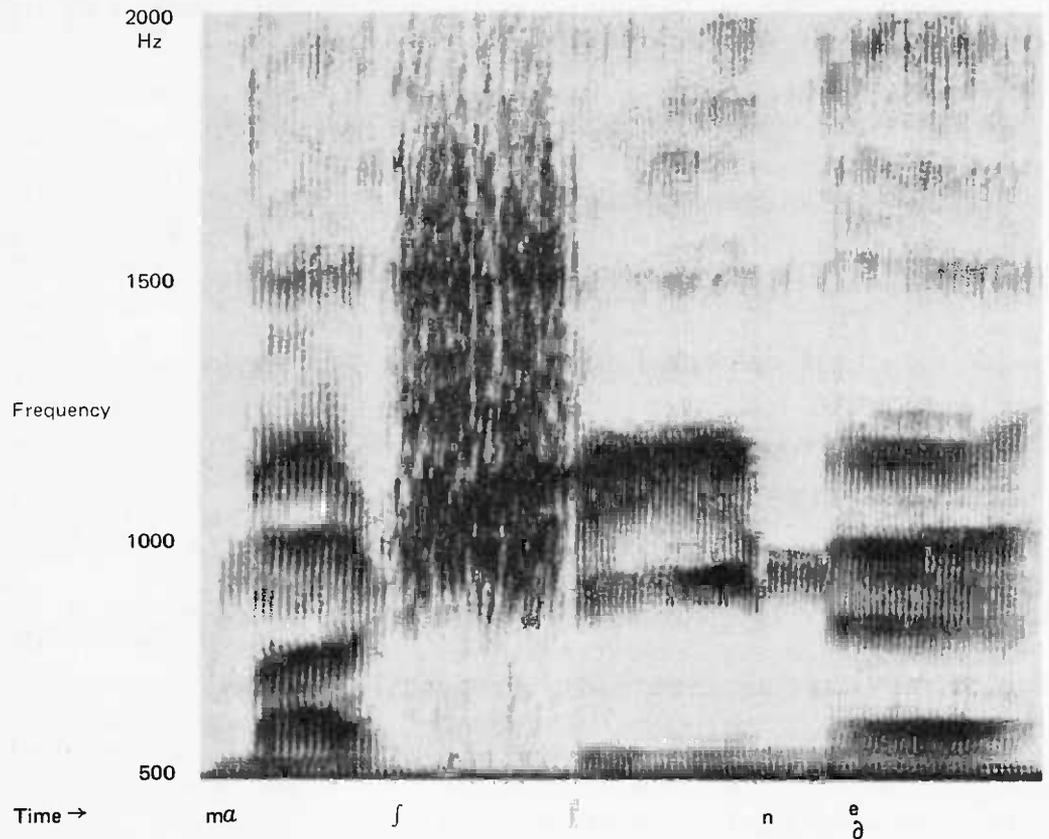


Figure 6: A typical Sonagram of an utterance. In a Sonagram the dark areas represent high intensity. This example represents the word "machine." The vertical (y) axis is frequency and the horizontal axis is time. The formants are seen as the dark bands that change with time. The large dark area about 1/5 of the way into the pattern corresponds to the sound of the "ch" in machine.

ing strain the computational capabilities of even the big number crunching computers. There is a lesson to be learned from the above analysis: Speech is intimately related to the resonances of a time varying resonator (the vocal tract) and perhaps it is more reasonable to expect to find better features in a frequency domain representation of speech rather than in a time domain one.

Frequency Domain Analysis

A usual frequency domain representation of a signal is its spectrum (amplitude versus frequency). It can be obtained from the time domain representation by applying what is called the Fourier Transform to it. Figure 5 shows the Fourier Transform of a speech signal 25 ms long. Note that in the time domain signal the horizontal axis of a plot is time whereas in the frequency domain representation the horizontal axis is frequency. A drawback of the Fourier Transform is that it is a digital signal processing method and as such it operates on the sampled waveform directly, requiring very fast computers for real time operation.

If we are willing to settle for less accurate results, there exist analog methods which can give us spectral representations in real time using relatively simple hardware. An interesting spectral representation, based on analog methods, is the sound spectrogram or "Sonagram" obtained using a device called the "Sonagraph." This device has been in existence since the late 1940s and has been widely used in speech research. It gives a three-dimensional display of frequency in the y axis (vertical), time in the x axis (horizontal), and intensity on the z axis. The z axis is actually represented by shades of black since we are using two-dimensional paper. Figure 6 shows a Sonagram. The dark areas correspond to areas of high intensity and the evolution of formants can be observed as dark bands changing with time. The Sonagraph is a useful tool in speech research and it is mentioned here because it is widely referred to in the literature. It is of no value as a feature extractor to a practical speech recognizer because it is not a real time machine and because it costs thousands of dollars.

Everything you've ever wanted to know about microcomputers in ONE complete book for only \$10.95

Over 400 pages. Full 8½" x 11" size.



The ultimate book about microcomputers. Written by experts ... SCELBI and BYTE. Over 400 pages. A collector's item, featuring The Basics from the first 16 issues of BYTE and SCELBI's classic library of books. Your microcomputer bookshelf is incomplete without this priceless edition.

You can't buy information organized like this anywhere. This is the book that everyone who is into microcomputers needs for reference, for ideas, for clues to problem solving. It is a truly authoritative text, featuring easy-to-read, easy-to-understand articles by more than 50 recognized professional authors, who know and love microcomputers from the ground up. Logical and complete, it features many glossaries, and is illuminated with profuse illustrations and photographs.

The **Scelbi/BYTE Primer** is divided into four logical sections, that take you from point "0" through building and programming your own computer ... step-by-step-by-step.

What can you do with a microcomputer? Checkbook balancing. Recipe converting and food inventory. Heating and air conditioning control. Home and business security and management. Playing the ponies. Analysis of the stock market. Maintaining massive data banks. Self-instruction. Toys and games. Small business accounting and inventory. And lots, lots more.

How does a microcomputer do it? Lots of "how to" theory. Introducing you to microcomputer operation. 6800, 6502, Z80 CPU chip capabilities. RAM and ROM memories. Addressing methods.

THE SCELBI/BYTE PRIMER

Over 400 pages. Selected articles from BYTE and SCELBI books. Profusely illustrated. Many photographs. \$10.95, plus \$1 shipping and handling.

How to control peripherals. Transmission of information to and from computers. Magnetic recording devices for bulk storage. Analog to digital conversion. How a computer can talk. Other I/O techniques. And more.

Order your copy today!

SCELBI COMPUTER CONSULTING INC.
Post Office Box 133 PP STN
Dept. B
Milford, CT 06460

BITS
70 Main Street
Peterborough, NH
03458
1-800-258-5477

Prices shown for North American customers. Master Charge. Postal and bank Money Orders preferred. Personal checks delay shipping up to 4 weeks. Pricing, specifications, availability subject to change without notice.

All about building a microcomputer system. Over 12 complete construction articles. Flip-flops. LED devices. Recycling used ICs. Modular construction. Making your own p.c. boards. Prototype board construction. Make your own logic probes. Construction plans for 6800 and Z80 computers. Building plans for I/Os — TV and CRT displays, cassette interfaces, etc. Mathematics functions. ROM programmer. Plus much, much more.

How to program a microcomputer. Programming for the beginner. Assembling programs by hand. Monitoring programs. Number conversions. Game of Hexpawn. Design your own assembler. Lots more.

And that's only the beginning! Others have spent millions acquiring the type of microcomputer information found within the 400 pages of **The Scelbi/BYTE Primer**. But, it costs you only \$10.95, plus \$1 for postage and handling, complete! You know the quality of Scelbi and BYTE. This is your assurance of excellence throughout this **MUST** text. Order your copy today! And, get one for a friend!

Using Filter Banks for Feature Extraction

A less accurate yet simple and inexpensive method for obtaining a spectral representation is a filter bank. It is widely used in existing speech recognition machines, including the most successful commercial speech recognition system. As shown in figure 7, a filter bank consists of a number of bandpass filters, covering adjacent frequency bands. The output of each filter is full wave rectified, then smoothed and sampled by an analog to digital converter for computer input. The output of the converter for any given filter is related to the energy present in the frequencies of the filter's passband.

A filter bank is a useful tool for feature extraction. It should be obvious that the speech spectrum can change only as fast as we can move our articulators. The constraints here are about the same as in the case of volume changes mentioned before. That is, a bandwidth of about 50 Hz is sufficient to accurately represent spectral changes. This gives us a sampling frequency of 100 Hz. Assuming eight filters in our filter bank, we get 800 digital words per second of speech. If the converter is accurate to eight bits, the data rate is 6400 bits per second, quite reasonable for the degree of accuracy retained. What makes a filter bank even more exciting for feature extraction is that a number of parameters are available that can be manipulated to get various tradeoffs of data rate versus accuracy. Thus both simple and sophisticated systems can be built using the same type of hardware. The parameters available for experimentation are:

- Number of bandpass filters.
- Bandpass filter bandwidth and center frequency.
- Bandpass filter skirt (selectivity) characteristics.
- Amplitude compression.
- Smoothing cutoff frequency (sampling rate).

It should be obvious that the more filters we have, the more accurate the spectral representation. A filter acts as an averaging device over the frequency in its bandpass and thus it destroys local information. By increasing the number of filters and restricting their passbands this averaging is done over a smaller frequency range.

The bandwidth of the bandpass filters can be the same for all filters but usually it varies depending on the filter's center frequency. It has been shown that the ability of the ear to discriminate between closely spaced frequencies decreases when these closely spaced frequencies are high. Based on this observation, the bandwidth of the filters in a filter bank is rarely, if ever, the same. Instead it is set so that the higher the center frequency of the bandpass filter, the wider its bandwidth. The setting of a bandwidth for a given center frequency is done usually on the basis of experience in an effort to have enough filters covering the areas of greatest importance. Once a setting is decided upon, based on some criteria, experimentation may be required to optimize that particular filter bank. Another approach is to decide on some rule for setting the bandwidths. For example, a successful recognition system has been built using filter banks of third octave bandpass filters

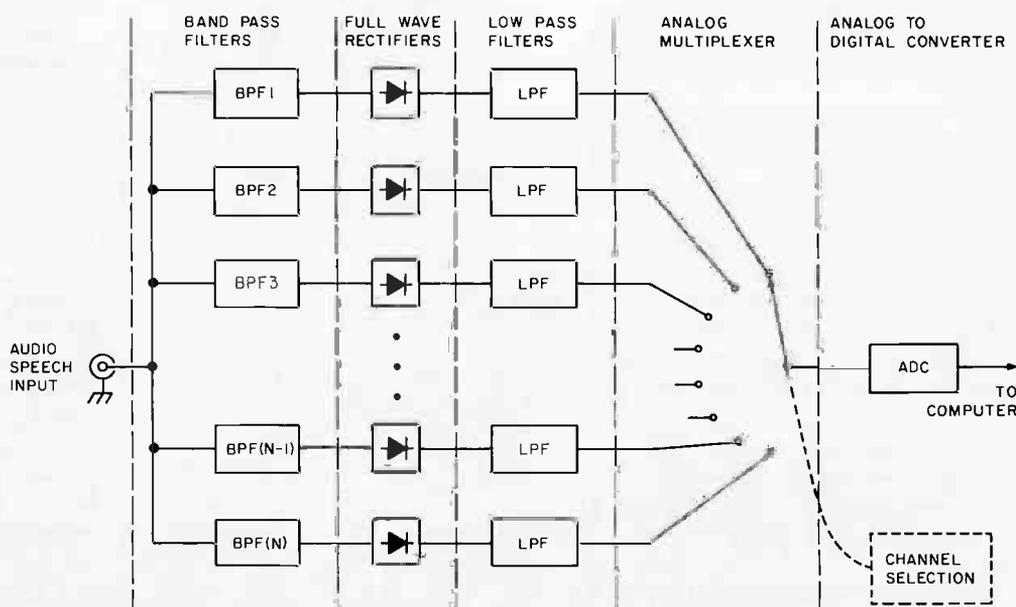
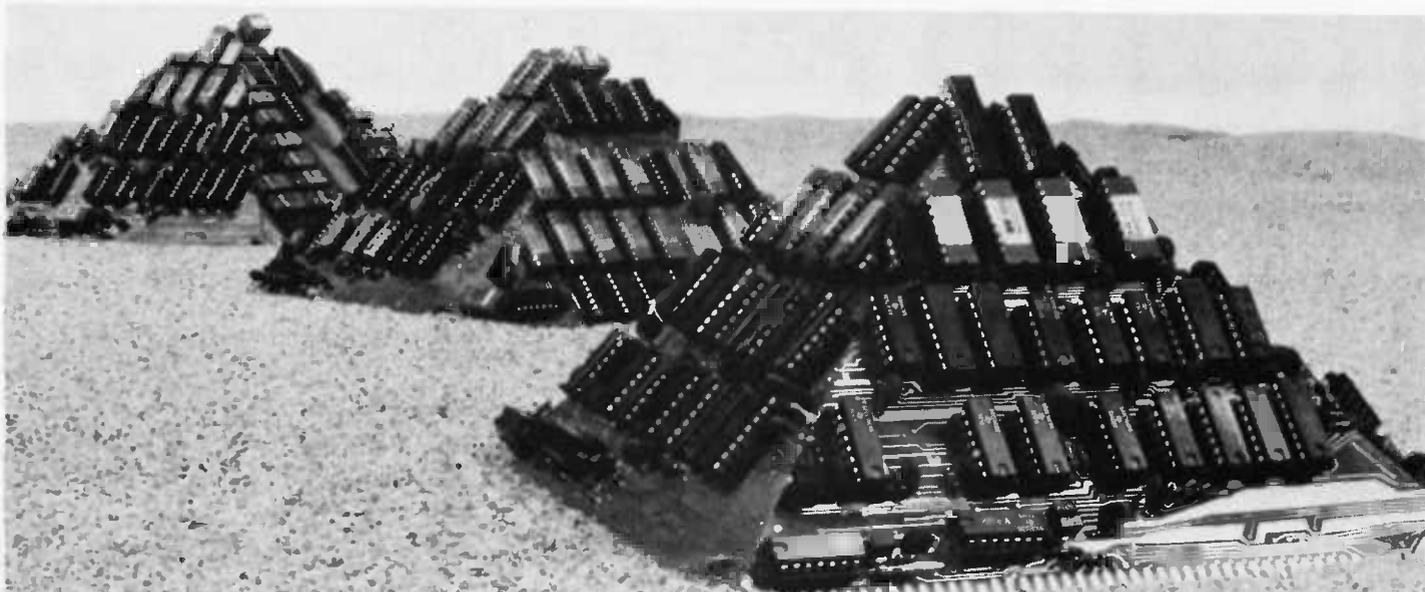


Figure 7: A filter bank feature extractor consists of a number of bandpass filters (BPF1 to BPF(N)) covering the range from about 100 to 10 kHz. The output of the filters is rectified and low pass filtered (LPF). Then it is multiplexed and digitized by the analog to digital converter for input into the computer.



Now Dynabyte builds three Great Memories

New! 16k and 32k fully static RAM's. With either 250 ns. or 450 ns. typical access time. Assembled. Tested. Burned in. Guaranteed.
Like our 16k dynamic RAM. Built as solid as the 4,400 year-old pyramids.

Ancient Egyptians didn't stop with just one pyramid. The Great Pyramid stands on the Plain of Gizeh with two other monuments erected for kings and queens.

Dynabyte didn't stop with one 16k dynamic RAM, either. Now you can get 16k and 32k fully static RAM's that are built with the same unmatched engineering ability and manufacturing skill that went into Egypt's wonders of the ancient world.

When we say built, we mean completely built. Assembled, tested and burned in. We don't leave anything undone. That way, you can buy any Dynabyte memory and know that it is backed by a factory guarantee for one full year. Kits and semi-kits can't say that.

Our 16k static and our 32k static are available with either 250 ns. or 450 ns. access time. Our 250 ns. module is completely compatible with the 4MHz Z-80A processors. The 450 ns. modules are compatible with the 8080 and the faster 3MHz 8085 processors.

The Great 16k Static Memory. 250 ns., \$555. 450 ns., \$525.

- 4k block addressing along 4k boundaries

- Bank Select
- Write Protect with alarm for each 4k block
- Full Schmitt trigger buffering
- No DMA restrictions
- Complete S-100 bus compatibility, including the Alpha Micro and Z-2.

The Great 32K Static Memory. 250 ns., \$995. 450 ns., \$925.

- 4k boundary addressing
- Full Schmitt trigger buffering
- No DMA restrictions

- Conservative thermal design
- Complete S-100 compatibility, including the Alpha Micro and Z-2.

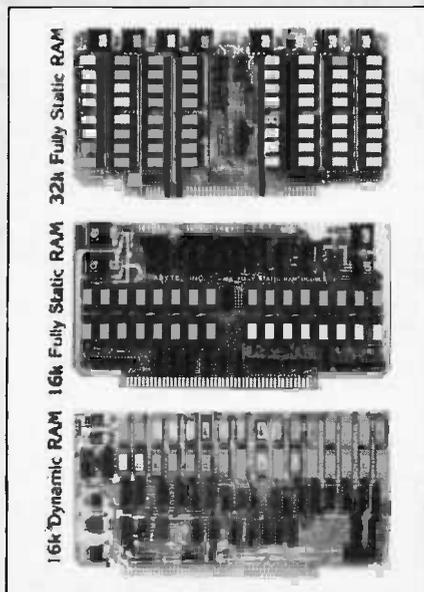
The Great 16k Dynamic Memory. \$399.

- Highly cost effective
- No wait states
- Transparent refresh
- 16k addressing boundaries
- Widest S-100 mainframe and disk system compatibility

All of Dynabyte's memories meet rigid industrial grade standards. Design, components, construction, testing and performance. But if a module ever needs repair, we provide factory service with 24 hour turnaround for both warranty and non-warranty work.

Ask for the Great Memories by Dynabyte at your local computer store. You can also pick up complete product information while you're there.

If you haven't got a local computer store, write Dynabyte, Inc., at its new address: 1005 Elwell Court, Palo Alto, CA 94303. Or call its new number (408) 965-1010.



DYNABYTE
Builders of Great Memories

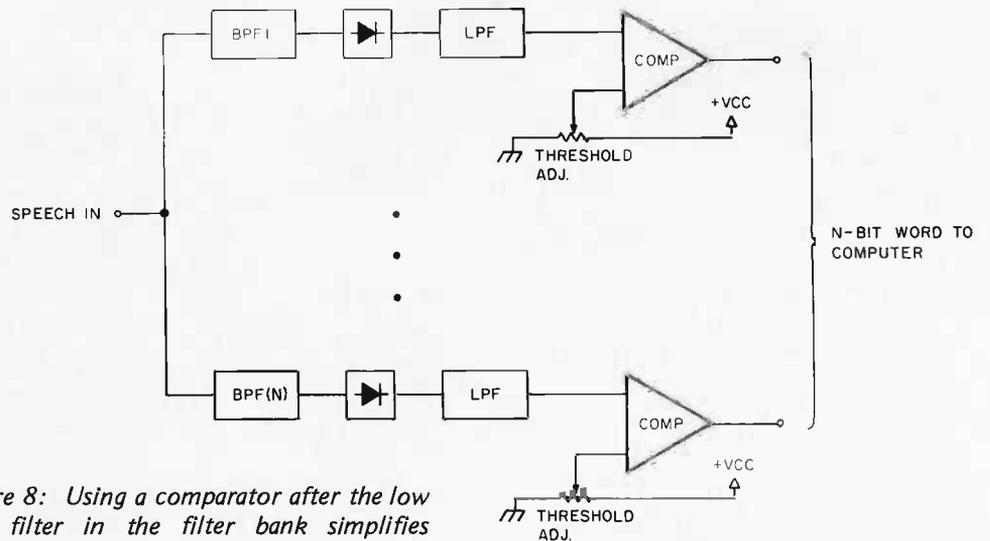


Figure 8: Using a comparator after the low pass filter in the filter bank simplifies hardware and reduces data rate at the cost of discarding useful information. The thresholds should be adjusted for the voice of each individual speaker. In addition, a good automatic gain control circuit should precede the filter bank to normalize the time domain signal.

covering the frequencies of 150 Hz to 10 kHz. Such filters are commercially available for audio work.

The skirt or cutoff characteristics of the filters in a filter bank is determined by the following factors:

- A steep skirt will give better frequency separation than a gently sloping one. It will also make for abrupt transitions from one filter to the other when a formant crosses the boundary. This is not necessarily bad but it might affect some systems. Both skirt types are used in practice.
- It is desirable that the filter exhibit linear phase shift in its passband. For a given filter order, that means that the skirts will be less steep than the case without phase restrictions. In general, this is not a serious consideration for a practical system.
- The cutoff characteristics depend on the order of the filter (the number of mathematical poles it has in its design equations). Higher order filters give steeper characteristics but require more poles and thus cost more.
- It is desirable that filters overlap at the three db points of their slopes.

The amplitude (volume) of the speech signal is dependent on two factors that cannot be controlled easily. These are the distance and orientation of the speaker with respect to the microphone and the loudness

of the voice at any given time. Volume also varies constantly within a given word as we have already seen. This can result in a 50 db range for the amplitude of the speech signal. The dynamic range of an 8 bit converter which is most likely to be used in the environment of computer experimenters is $20 \log (256) = 48.16$ db. This seems sufficient but it will give severe quantization errors for low amplitude signals. The lower the amplitude of the signal, the fewer bits will be used to encode it, thus throwing a lot of the information out. A 12 bit analog to digital converter would help but it costs too much and it wastes memory space in an 8 bit machine because it takes a word and a half to store its output.

A different approach would be to use some form of amplitude compression before the analog to digital conversion. An audio automatic gain control circuit can be inserted between the audio source and the filter bank. It will limit the dynamic range of the signal by the amount of compression it offers, usually in the range of 20 to 40 db. Such an automatic gain control circuit (AGC) should have very fast attack. Its release time should be about two to three times the lowest glottal period expected. It should not be less than that because then it will tend to distort the signal by compressing between glottal pulses. Amplitude compression can also be applied after the rectifier smoothing filters by taking the logarithm of the signal at that point. The logarithm operation is suggested by the fact that our ears (and all of our body sensors) respond to stimuli intensity in a logarithmic fashion. This fact is utilized in every audio amplifier in the design of the volume control potentiometer which is made logarithmic so sound will

**A PROFESSIONAL
COMPUTER TERMINAL
FOR THE SERIOUS
HOBBYIST**

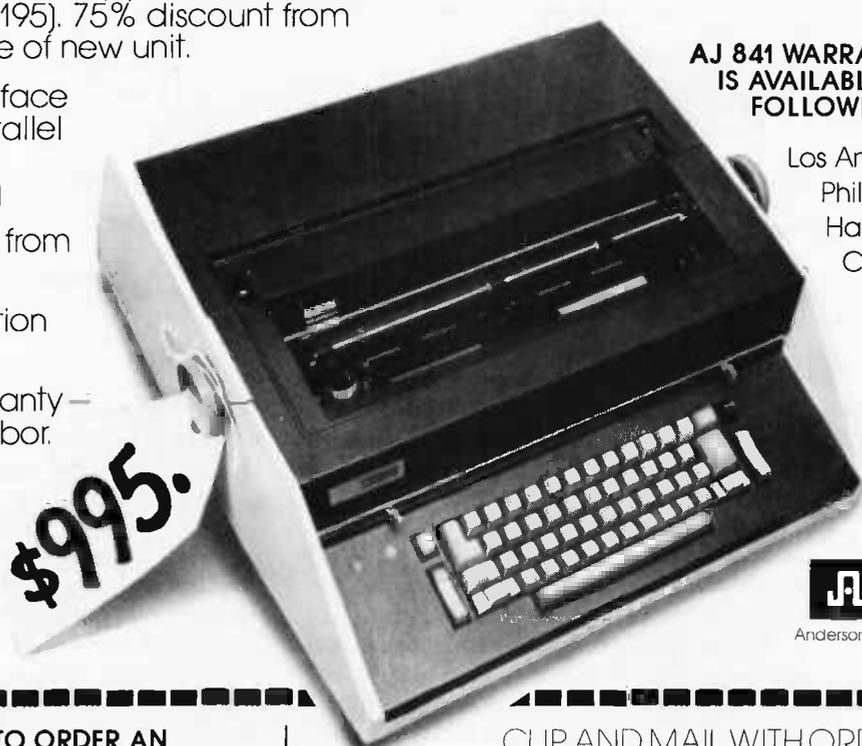
The AJ 841 I/O.

A completely refurbished IBM Selectric Terminal with built-in ASCII interface. Just \$995.

FEATURES:

- ASCII code.
- 14.9 characters per second printout.
- Special introductory price – \$995 (regularly \$1,195). 75% discount from original price of new unit.
- Parallel Interface (requires parallel port for I/O transmission)
- Order direct from factory.
- Documentation included.
- 30-day warranty – parts and labor.
- High quality Selectric printing.
- Full warranty information available upon request!

- Reliable, heavy duty Selectric mechanism.
- Off-line use as typewriter.



AJ 841 WARRANTY AND SERVICE IS AVAILABLE IN THE FOLLOWING CITIES:

Los Angeles / Cincinnati
Philadelphia / Detroit
Hackensack / Dallas
Columbus / Houston
Cleveland / Atlanta
San Jose / Chicago
Boston / New York
Washington, D.C.

For further information call
(408) 263-8520

ANDERSON JACOBSON

Anderson Jacobson, Inc., 521 Charcot Avenue
San Jose, California 95131

HOW TO ORDER AN AJ 841 I/O TERMINAL

1. Make cashier's check or money order payable to:
ANDERSON JACOBSON, INC.
Address your request to:
Personal Computer Terminal
ANDERSON JACOBSON, INC.
521 Charcot Avenue
San Jose, CA 95131
2. Upon written notification, pick up your terminal at the AJ service office located in one of the above cities. Allow six to eight weeks for delivery.
3. A final check of your unit will be made at the local AJ service office at time of pickup.
4. For warranty or repair service, return unit to designated service location.
5. Available in U.S. only.

CLIP AND MAIL WITH ORDER

SELECT EITHER: EBCD keyboard Correspondence keyboard

Number of units _____ @ \$995 each \$ _____

Sales tax at delivery location \$ _____

Shipping and handling \$35 each (excluding San Jose) \$ _____

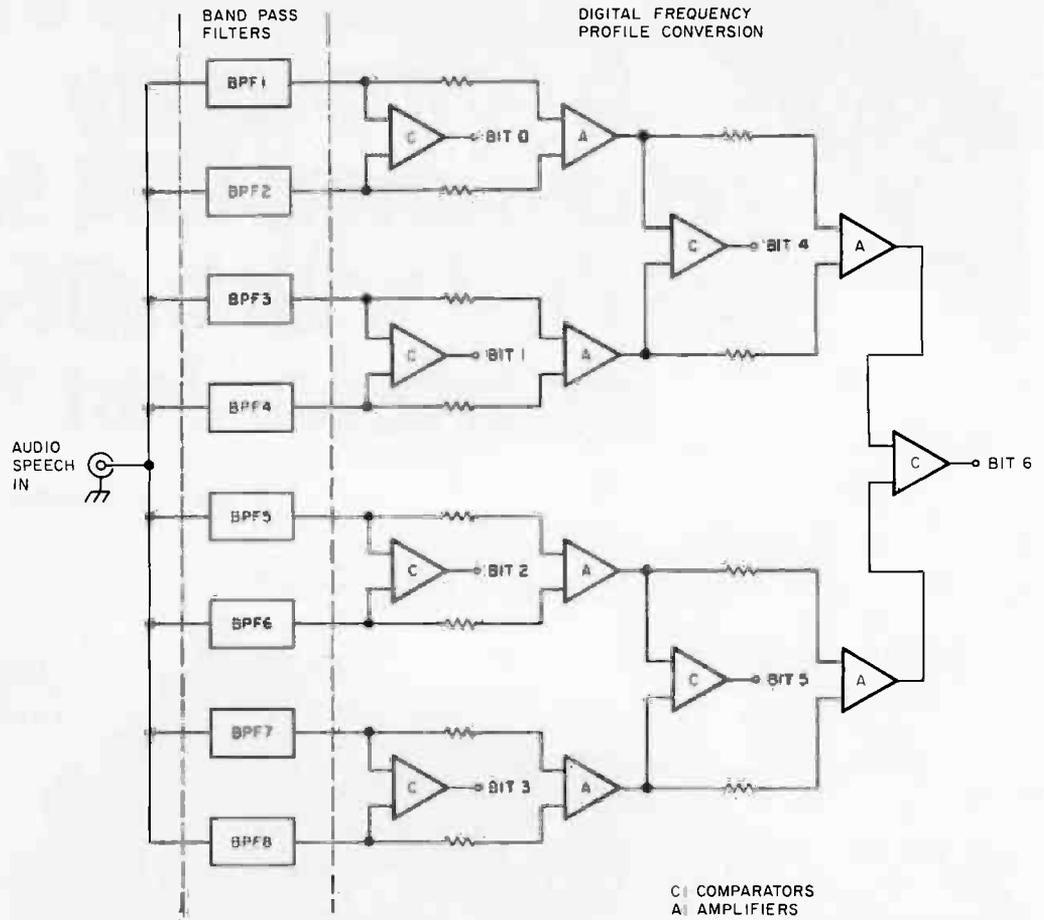
TOTAL \$ _____

NAME _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____

PHONE (_____) _____



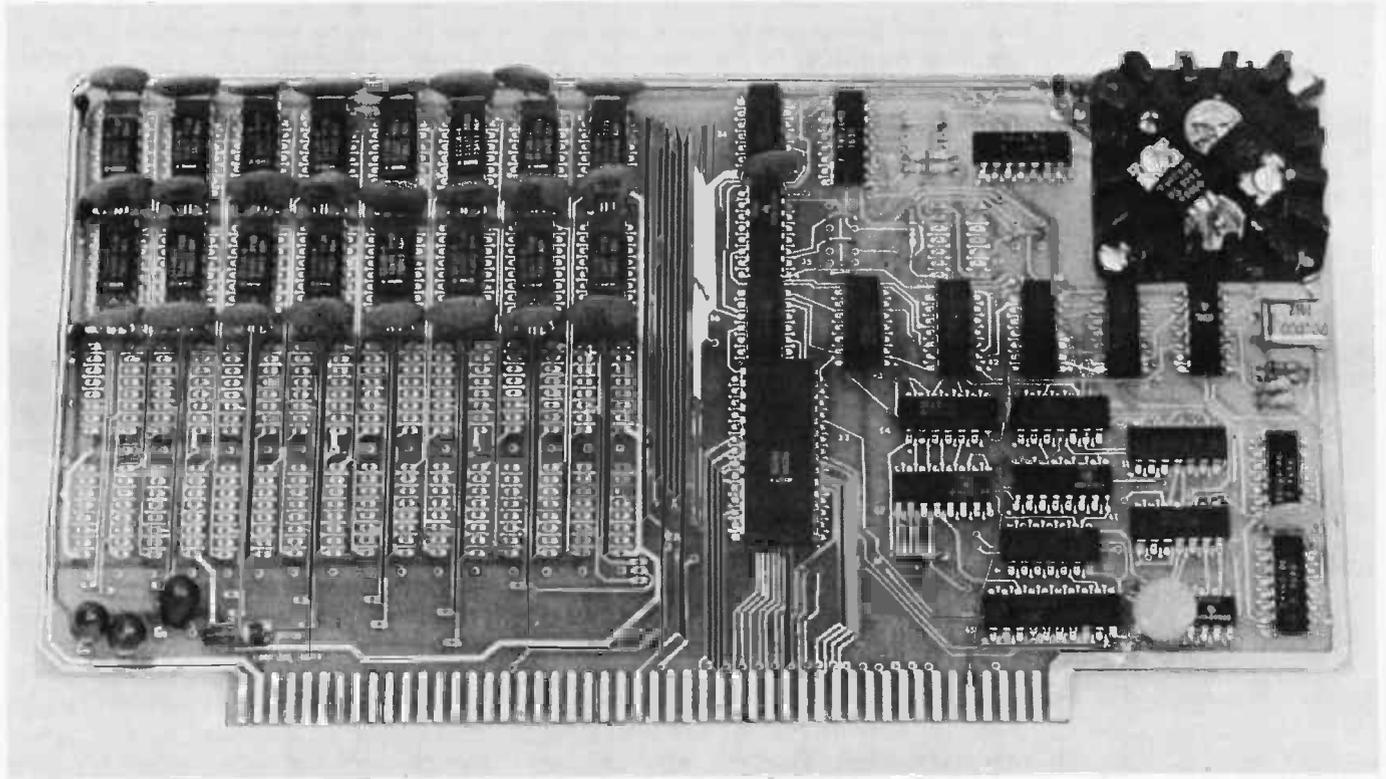
seem to increase linearly with shaft rotation. The disadvantage of taking the logarithm of the smoothed signal is of course the number of required log circuits which is equal to the number of the filters in the filter bank. The logarithm can also be taken by having an analog to digital converter that converts logarithmically. There is such a product available from Precision Monolithics Inc. It is the DAC-76 companding digital to analog converter that can be used to build an 8 bit logarithmic analog to digital converter.

As a final note to amplitude processing we should mention a method used in a number of small systems. In its simplest form it consists of using in the place of the multiplexer and the analog to digital converter a number of comparators which change state when the input voltage exceeds a preset threshold as shown in figure 8. The output of the comparators forms an N bit binary word where N is the number of the filters in the filter bank. This gives a significant reduction in data rate and works for small vocabularies of the order of 8 to 12 words. It requires a good automatic gain control before the filter bank, and its major weakness is that the comparator thresholds have to be manually adjusted for each individual speaker. A variation of this

Figure 9: The differential comparator feature extractor detects which one of two adjacent bandpass filters has the highest energy. The output of each pair of filters is summed together and compared with the sum of the next pair of filters, yielding another, coarser comparison from the frequency viewpoint. In this example, the output of eight filters (we assume that the output of the blocks labeled BPF is the rectified and smoothed output of the bandpass filters) is encoded into a 7 bit digital word. The computer performs pattern recognition on time varying sequences of these 7 bit words.

method is used in a commercial recognizer made by Scope Electronics (US Patent #3,812,291). In that system the comparators are connected between two consecutive filter outputs to detect the slope or frequency profile. Figure 9 shows this differential comparator connection. Compared to the fixed threshold method it has the advantage that no adjustment for the individual talker is needed and the automatic gain control before the filter bank is not necessary. Its disadvantage is that it throws away more information than the fixed threshold method.

Memory Makes the Computer, Central Data Makes the Memory



Memory is an important part of a computer system. So don't even think of settling for a poor quality RAM board. Central Data offers carefully engineered 16K, 24K and 32K RAM boards to suit your needs. We take our RAM boards seriously, so should you.

Reliability. Each one of our boards comes completely assembled, tested and burned in. No fiddling with an infinite number of parts from a kit or costly investment in equipment to test your board. Each one of our boards is backed by a one year warranty to insure your satisfaction.

Expandability. We offer a 16K RAM board with capacity to 32K. You can purchase a 16K board and expand later or buy a full 32K.

Performance. Unlike some dynamic memory boards, ours uses an invisible refresh that inserts refresh cycles between your computer's normal memory access cycles. This eliminates loss in performance of your computer with lengthy refresh cycles.

Power. Our board uses less than one-half the power of a static RAM.

Price. You can buy a 16K RAM board, completely ready to use, for only \$289. A full 32K RAM board is available for \$475, or you can add on later for only \$200.

When you buy our memory board, you'll be buying the best equipment at the best price. Order yours today by mail or phone.

Please send me the following:

- 16K RAM board (\$289)
- 32K RAM board (\$475)
- additional information

I enclose \$ _____.

Ill. residents add sales tax.

Central Data P.O. Box 2484, Sta. A Champaign, Il 61820

Name _____

Address _____

City _____

State _____

Zip _____

Central data

P.O. Box 2484, Sta. A
Champaign, Il 61820
(217) 359-8010

The final parameter that can be adjusted in the filter bank feature extractor is the cutoff frequency of the smoothing filters. Reducing it reduces the data rate. Depending on the amount of reduction significant information may or may not be lost in this step. Sampling the output of the filters every 20 to 30 ms is tolerable in small vocabulary systems. The main consideration here is to find a combination of number of filters, analog to digital conversion quantization and sampling rate that will maximize the information retained and minimize the data rate of the pattern.

In summary, a filter bank offers a good yet inexpensive real time feature extractor which can be utilized in a speech recognition system. Properly used, it has performance similar to systems based on linear prediction residuals, a state of the art digital signal processing technique.

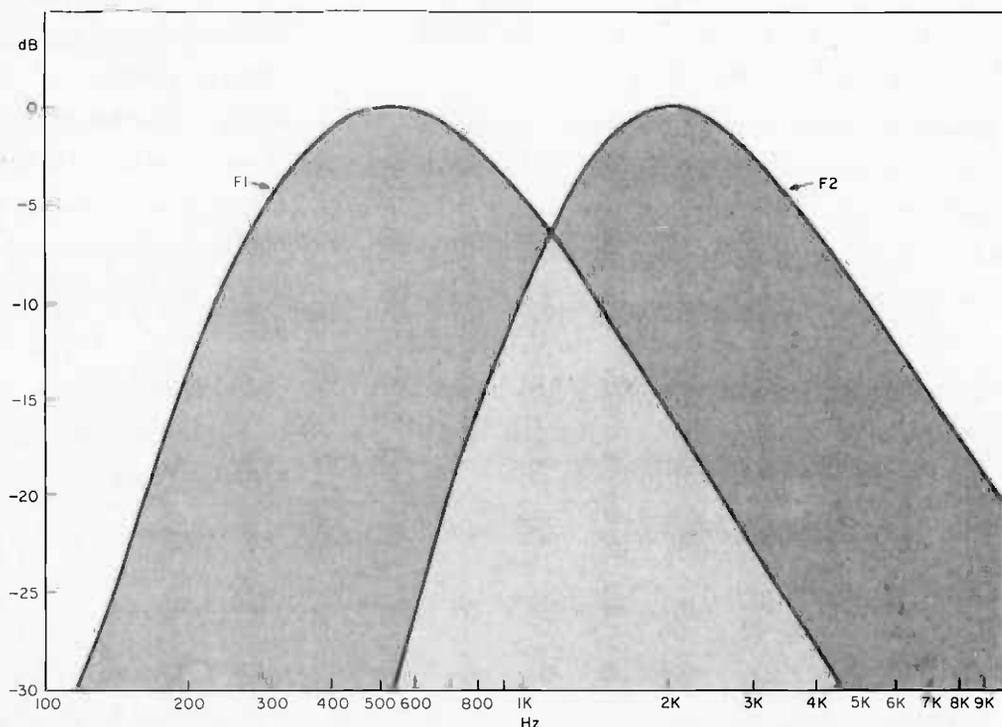
Zero Crossing Detectors

Another feature extraction technique that was popular for its simplicity in the early days of speech recognition is formant tracking using zero crossings. It is interesting to note that probably the first widely known speech recognizer capable of recognizing the digits was built in 1952 at Bell Labs using formant tracking based on zero crossing measurements. The contraption was grotesque by today's standards, using vacuum tubes as active elements and capacitors for memory. It was claimed that it achieved

97 percent recognition accuracy. Its formant tracker was based on two well known principles: First F1 and F2 formants span two different frequency ranges, that is F1 moves roughly between 200 and 1000 Hz and F2 moves between 800 and 3500 Hz. There are cases for which this is not true but for about 98 percent of the time this holds for any speaker, man or woman. Second, F1 and F2 of a given speaker for a given vowel remain about the same day after day of testing. (This is not true for the same vowel pronounced by different speakers and thus the machine has to be trained to a given speaker before it can recognize his or her speech.) This means that we could isolate the first two formants and they would be useful as features. Two bandpass filters centered around the respective formant regions would separate the formants except when they are in the overlapping area of 800 to 1000 Hz.

It turns out that when we highly amplify, then clip a signal to obtain the instances when the signal crosses zero, the problem is taken care of automatically. If the bandpass filters slope in the overlap region as shown in figure 10, F1 will always be stronger than F2 at the output of the F1 filter and vice versa. The clipper has a property called "capture" which means that any signal that is a few db or more stronger than another will swamp out the weaker signal and the output of the clipper will contain only the strong signal. This phenomenon occurs also in FM radio

Figure 10: The frequency response of the two filters is designed to separate F1 and F2, when used in a zero crossing based formant detector. The filter characteristics overlap in the region of formant overlap but their slopes are designed to separate the two formants.



Radio Shack's personal computer system? This ad just might make you a believer.

You can't beat
the 4K system at
\$599



- TRS-80 "Breakthru"**
- TRS-80 microcomputer
 - 12" video display
 - Professional keyboard
 - Power supply
 - Cassette tape recorder
 - 4K RAM, Level-I BASIC
 - 232-page manual
 - 2 game cassettes

... or the step-up
16K system at
\$899



- TRS-80 "Sweet 16"**
- Above, except includes 16K RAM

... or the fast
4K/printer system at
\$1198



- TRS-80 "Educator"**
- Above, except includes 4K RAM and screen printer

... or the Level-II
16K/printer/disk
system at
\$2385



- TRS-80 "Professional"**
- Above, except includes 16K RAM, disk drive, expansion interface, and Level-II BASIC

**So how are you gonna beat the system that
does this much for this little? No way!**

... The amazing new
32K/Level-II/2-disk/
line printer system at
\$3874

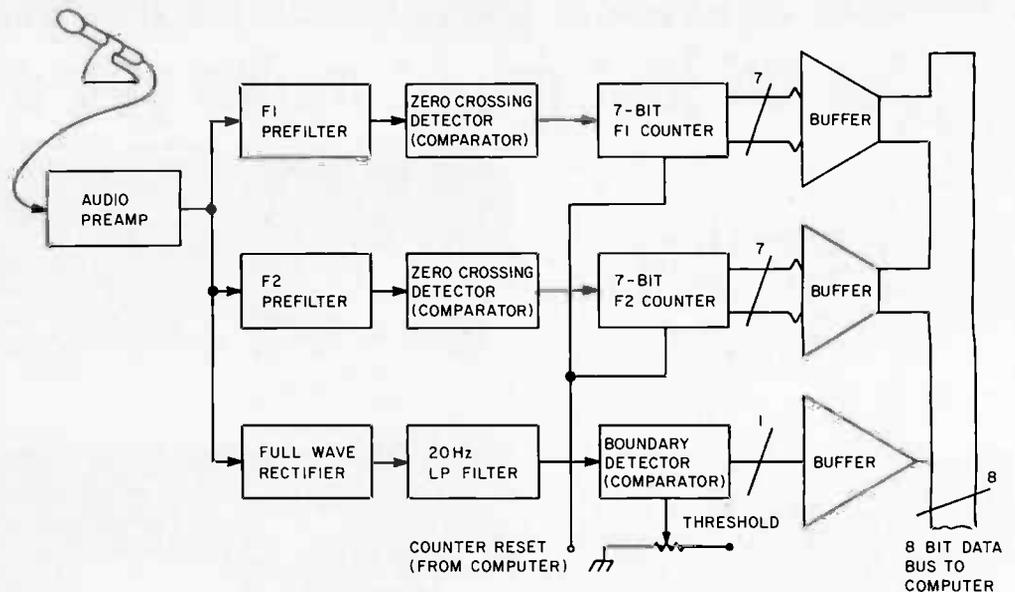


- TRS-80 "Business"**
- Above, except includes 32K RAM, line printer, and two disk drives

Get details and order now at Radio Shack stores and dealers in the USA, Canada, UK, Australia, Belgium, Holland, France, Japan. Write Radio Shack, Division of Tandy Corporation, Dept. C-002, 1400 One Tandy Center, Fort Worth, Texas 76102. Ask for Catalog TRS-80.

Radio Shack®
The biggest name in little computers

Prices May Vary at Individual Stores and Dealers



reception with a limiting (clipping) intermediate frequency (IF) stage. It is one of the reasons FM was chosen for quality broadcasting, ie: it is not susceptible to interference from other weaker stations or interference from noise. Filtering and capture ensure that the output of the clipper contains only one frequency, the formant we are tracking. Determining what that frequency is requires nothing more than counting how many times the square wave output of the clipper crosses zero within a given interval, perhaps 20 ms. The data rate of the zero crossing formant extractor (see figure 11) is quite low, about 50 samples per second consisting of two 8 bit words per sample, a total of 800 bits per second.

In practice it works well with vowels, especially if there is no significant F1 and F2 overlap. Formant overlap and noise do affect its performance and thus limit its applicability. It is perhaps the simplest viable feature extractor that can be used and it does not contain any critical analog circuitry. One word of caution about the implementation, learned the hard way: an 8080 processor running with interrupts generated by the rising and falling edges of the clipped F1 and F2 signals is not fast enough to keep up with the pace in some cases and data is lost. Rather than trying an all software approach, I recommend that two hardware counters be used, read and reset by the computer every 20 ms. These counters are shown in figure 11.

Pattern Recognition

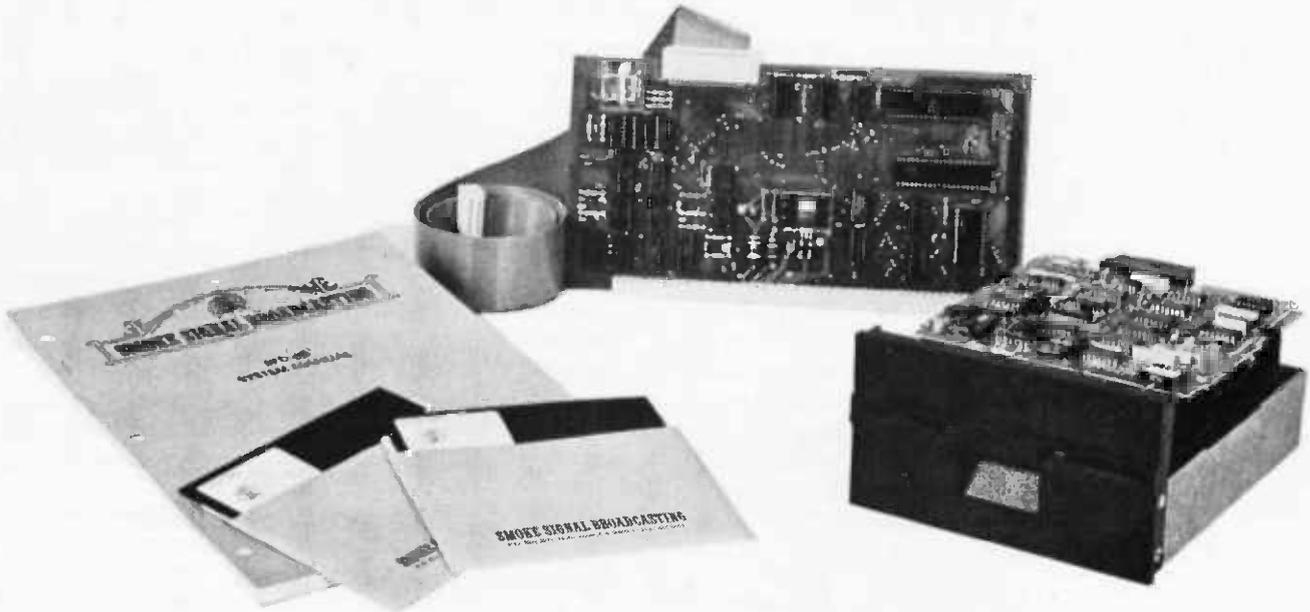
A set of features representing a word is a pattern corresponding to this word. Pattern recognition is the process by which, given an unknown pattern, we decide which word

Figure 11: A zero crossing formant extractor. The zero crossing method of formant extraction uses two special bandpass filters to separate the formants. The output of the filters is passed through a zero crossing detector (a comparator whose threshold is set to zero) that puts out a logical "1" or a "0" depending on whether its input is positive or negative. The output is fed into a counter for each formant and the number of "0" to "1" transitions is counted for 20 ms. Then the counters are read by the computer and reset to start the next 20 ms counting period. An envelope detector (rectifier followed by a low pass filter) feeds a comparator whose threshold is set to detect word beginnings and endings.

this pattern represents. An alternate term is pattern classification. A basic process of pattern recognition is template matching. The unknown pattern is compared to a number of reference patterns stored in memory and the differences between the unknown and the references are noted. Obviously the smallest difference indicates a best match and the unknown word is the word that corresponds to the reference pattern that gave the smallest difference.

There exist many ways to compare two patterns. Since features are represented by numbers, the most straightforward way is to compute the numerical difference between corresponding samples and then sum all those differences. That sum would be a measure of similarity between the patterns. There is a small precaution to be taken in practice when computing the sum of the differences. All differences should be positive. Otherwise when we sum them, negative differences will cancel positive ones and the

THE SSB \$150 FLOPPY DISCOUNT



Affordable

The tribe at Smoke Signal Broadcasting took our BFD-68 disk system and scalped the price, but not the features to create the ABFD-68 (Affordable Basic Floppy Disk). We appreciate the fact that the computer hobbyist gave us our start and we haven't forgotten you.

\$649 Assembled

Compare Price. Our SS-50 bus compatible disk system is \$150 less than the assembled price of the leading S-100 disk system. And you can at least double that savings when you buy one of the computers manufactured by MSI or SWTPC that use the superior 6800 microprocessor.

Programmable

The BFD-68 is well known for its fine software. The system comes with the best disk operating system available and we offer a multitude of other compatible software products. These include a BASIC interpreter with disk file handling capability. By the way, our DOS now easily handles true random access files as well as sequential. Also, we have a super fast BASIC compiler for business applications. In addition, a Text Editor, 2 Assemblers, a

Trace Disassembler useful for program debugging and an Object to Source Code Generator are all stock items available for immediate delivery. A word processor will be available very soon.

Reliable

We delivered our first mini-floppy disk system a year ago — 6 months ahead of any other 6800 based mini system. Thus, we've had twice the experience in building reliability into the system. Our NEW disk controller was designed using all we have learned in the past year about system reliability.

The ABFD-68 contains all the built in reliability of our regular BFD-68 plus you save money by supplying your own cabinet and power supply for the disk.

Available

We've shipped literally tons of our BFD-68 disk system in the past year and have learned to keep our production up with demand. Give us a call and chances are we'll be able to ship you the new ABFD-68 from stock and charge it to your Master Charge or Visa card. Better yet, ask us for the name of the computer store nearest you that carries our complete line of computer products.



SMOKE SIGNAL BROADCASTING

P.O. Box 2017, Hollywood, CA 90028 • (213) 462-5652

effect would be a smaller total difference than is actually the case. To make sure that all differences are positive we can take the absolute value of the differences before we sum them. This is done simply by making any negative distances positive and leaving the positive ones alone. A fancy name for the absolute value of feature differences is "Chebyshev distance." "Euclidean distance" is another fancy name used to denote the square root of the sum of the squares of individual differences. The square of a number is always a positive number and this overcomes the problem of adding differences with different signs. Squaring takes much more time than finding the absolute value and it turns out it is no better than the absolute value as an indicator of degree of match.

Another pattern recognition technique not based on template matching is "linear discrimination." It is not very useful in practice but it excites people's mathematical instincts enough to write papers about it so we will mention it for the sake of completeness. If we view the features as dimensions in a multidimensional space (also called hyperspace), a pattern becomes a point in that space. If the points for all pronunciations of a word cluster together in a region of this hyperspace and regions corresponding to different words do not overlap, we can define hyperplanes that separate these regions. To classify a pattern then we can check to see if it is in a region enclosed by a given set of hyperplanes and keep checking until we find which region it corresponds to. If the regions cannot be separated by hyperplanes the feature space is not linearly separable which means that we can try to enclose the regions in sections of hyperplanes. It often turns out to be a matter of luck whether the feature space turns out to be even non-linearly separable. The net result is that linear discrimination is often difficult if not impossible to use in practice.

Pattern recognition can also be achieved using a set of tests on a pattern to decide which word it represents. A simple example of that method is the rules used in the previously mentioned case of the volume signal to determine which one of the three words acceptable to the system has been pronounced. In a more complex system it is not very easy or accurate to do all the recognition by rule. Too many rules might be required and mistakes in the application of key rules might cause misrecognition or rejection. This last problem does not occur in template matching because each feature has equal say in the decision process; therefore a few bad features do not affect the result.

Rules can be used successfully together with template matching to speed up the

matching procedure or to act as an additional accuracy check. For example, in a recognition system that accepts the digits 0 to 9, we might recognize a word as "six" by template matching but we may not be very sure that it is actually a "six": while the distance from the reference corresponding to "six" was the smallest it might also be too close to the threshold for a conclusive determination. Applying the rule that both the beginning and end of "six" have to be unvoiced we can either confirm our recognition or increase the suspicion that something is wrong, depending on the outcome of the test. In another situation we might check before template matching to see if the volume of the word has two approximately equal humps. If this test is passed we can then do template matching on the words "seven" and "zero" which are most likely to exhibit a 2 humped volume pattern. If template matching on one of these words gives a very good match well below threshold, we could accept it without further testing of the other patterns, thus saving testing time.

An interesting hybrid (template matching combined with discrimination by rule) recognition scheme is phonemic pattern recognition. It is based on the observation of phoneticians that human words are made up of a limited number of building blocks called phonemes. In English there are about 50 distinguishable phonemes. These phonemes were designated mainly by listening tests. Trying to automatically extract the phonemes is very difficult because our machines do not even approach the generalizing capabilities of the ear when it comes to speech. Proposals have been made to use from 200 to 700 basic units of speech for machine recognition in the hope that it will be easier to discriminate between those less general "phonemes." Reducing a word to a sequence of phonemes gives us a very low data rate pattern and simplifies pattern recognition, assuming of course that phoneme extraction is accurate. Phoneme extraction can be done using template matching, and recognition of a phonemic sequence can be done by rule.

Unfortunately in real life things are not that easy. The number of individual phonemes a machine can recognize depends on the type and number of features its preprocessor extracts. There exists no way to find out for sure what are the essential features that determine the phonemes for a given system except by tedious trial and error. In addition, coarticulation effects tend to change the pattern of phonemes depending on the phonemes that come before and after it. These effects can generate quite drastic

LOADED WITH EXTRAS
AT NO EXTRA COST

- Microprocessor controller
- Serial RS232C interface
- Parallel TTL level interface
- Full upper and lower case ASCII character set (96 characters)
- Full 8½ inch wide paper
- Line length of 80 columns at 10 characters per inch
- Impact printing
- 7 x 7 dot matrix
- Ordinary paper — roll, fanfold, or sheet
- Serial baud rate to 1200 bits per second
- Multiple line buffer of 256 characters
- Built-in self test mode
- Instantaneous print rate to 100 characters per second
- Sustained throughput to 50 characters per second
- Multiple copies without adjustment
- Reinking ribbon mechanism
- Expected ribbon life of 10 million characters
- Front panel operator controls
- Attractive table top console

Check the impressive features on Integral's new IP-125 Impact Printer only \$799

Complete, ready-to-operate ...
the first impact printer to offer
big printer performance at a
mini-printer cost.

Write for complete information
or call (617) 926-1011



Integral Data Systems

INC

5 BRIDGE STREET
WATERTOWN, MASS. 02172

... AND FOR VERY LITTLE MORE

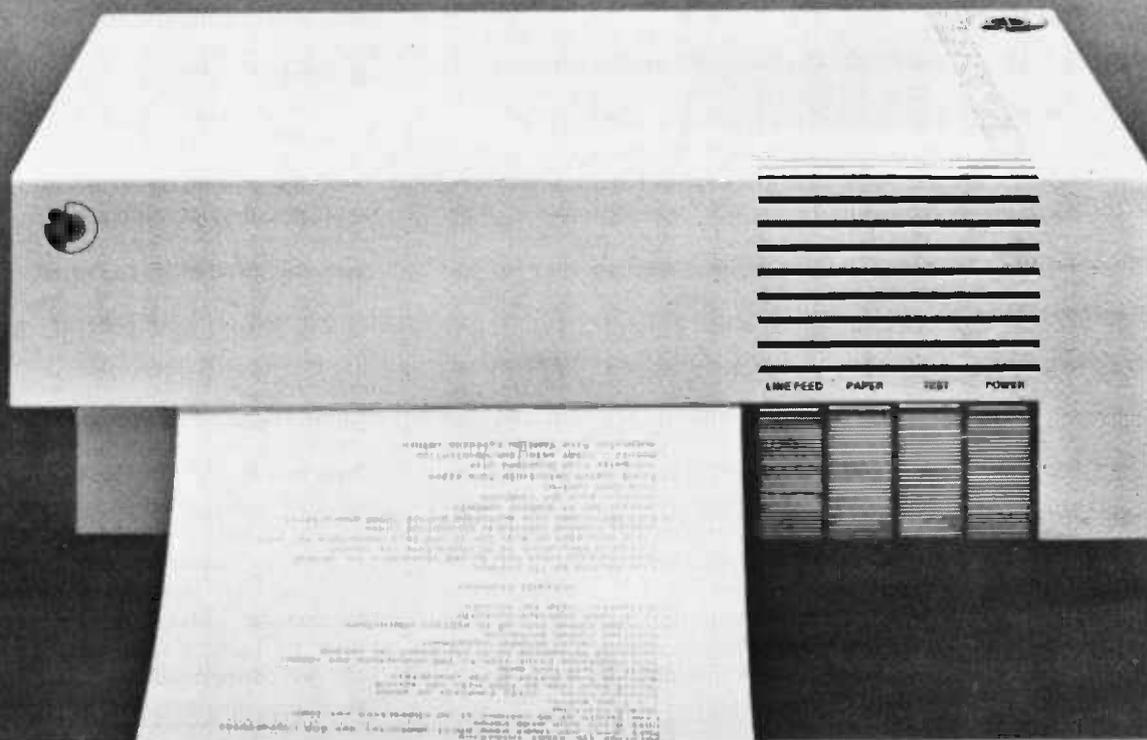
- Line lengths to 132 columns
- Instantaneous print rate to 165 characters per second
- Sustained throughput to 80 characters per second
- Print densities of 8.3, 10, 12 and 16.5 characters per inch
- Options program selectable by control codes
- Full CRT screen size multiline buffer (2048 characters)
- Special set of graphic symbols
- Graphics mode dot plotting
- Form feed control
- Eight switch selectable form sizes
- Automatic page boundary skip
- Remote printer selection/deselection
- Automatic line feed on carriage return

IP-225

"The Tractor Impact"

only \$949

the pin feed version of the IP-125 with tractor drive forms control plus all the standard features of the IP-125.



changes in the pattern of a phoneme to the point that template matching is useless for recognition. In those cases some form of recognition by rule should be applied to separate the phonemes.

These problems are compounded by the fact that when we decide which phoneme represents a segment of speech we throw away all the features that make up the pattern for that speech segment. As a result, if our decision was mistaken for some reason, we have lost that portion of the speech pattern and even worse, we have substituted a potentially confusing phoneme. This is always a problem when we compress data too much. A piece of bad information can have very unpleasant consequences because due to the high compression factor there is not very much information available on which to base alternate decisions. A way around this problem would be to store the raw data until the final decision is made. If we are not confident in our decision for some reason we could go back and check the point of dispute. This is an example of the hypothesize and test method where on the basis of incomplete information a hypothesis is made as to what the word is and then the data is checked closely to either verify or reject the hypothesis. A disadvantage of this method is that it is time consuming computationally. The alternative to storing thousands of reference patterns in memory for template matching on a large vocabulary is cumbersome, to say the least. Finding a best match with templates when the vocabulary is big will take too much time even on very fast computers. Training the machine by storing reference patterns is still another disadvantage of template matching when the vocabulary is large because it takes a lot of user time to pronounce the training words.

Recognition of connected speech cannot be done using a simple template matching recognizer for two reasons that also complicate recognition of phonemes: First, it is very difficult to find word beginnings and endings in connected speech. Second, adjacent words affect pronunciation because of coarticulation. Practical recognizers at this time are limited to isolated word recognition and they require that each word be spoken individually. This is not as restrictive as it might seem because, with practice, words can be pronounced in sequence quite rapidly, up to 70 words per minute. Other usual restrictions on current pattern recognizers are the need for low ambient noise and a cooperative speaker. Cooperative here means a speaker who is willing to pronounce the words clearly, evenly, and with a conscious attempt at uniformity.

An Example of a Speech Recognizer

The basic components of any speech recognizer are the feature extractor and the pattern recognizer. The feature extractor is also called the "front end" or "preprocessor" and it is usually made up of analog circuits. The pattern recognizer nowadays is always a digital computer. We have seen an overview of what these two basic functions are, how they relate to the speech signal and how they are usually implemented. It is time now to give a block diagram of a speech recognition system using a particular method and go into greater detail about the functions and implementation of the various elements. I have chosen for this example a filter bank analyzer because I believe this particular approach will give the best results with the 8 bit microprocessors popular with computer amateurs. It is also a well known and proven approach, thus more likely to give consistent results than any other method. It is not the simplest possible approach and I expect to see a number of simple recognizers for personal computing machines based on zero crossing detection methods or combinations of zero crossing analysis and some sort of filtering. While it is possible that unusual feature extractors could give surprising results, the chances of something like that happening are very small. Speech recognition has a history about 30 years long and during that time many schemes have been tried, none of which gave better results in practical real time situations than the filterbank feature extractor.

Figure 12 is a block diagram of a complete filter bank feature extractor. Let us pay close attention to the specifics of its elements.

Microphone

If the system is to operate in a quiet room, the only consideration for the microphone would be a reasonably flat frequency response extending to about 8 kHz. In practice a quiet room is rarely the case. Radios, passing cars, the TV, the Teletype, the phone ringing, people talking are all usual sources of background noise which might trigger the recognition system or interfere with the words to be recognized. Once this background noise mixes with the desirable signal there is not very much we can do to separate them. The most benefit in a noisy situation can be derived by achieving high signal to noise ratio at the microphone. This can be accomplished either by using a close talking microphone like the ones used by aircraft pilots or telephone operators or by using a direc-

TWO BYTES ARE
BETTER THAN ONE

COMPARE 16-BIT COMPUTERS

THE TECHNICO SUPER STARTER SYSTEM AND SUPER SYSTEM 16

V.S.

THE HEATH H-11

SAVE OVER \$1000

SEND FOR FREE BROCHURE



TECHNICO 1-800-638-2893

9130 RED BRANCH RD. COLUMBIA, MD 21045
CIRCLE INQUIRY NO.

TWO BYTES ARE
BETTER THAN ONE

COMPARE \$ PRICE \$

SAVE \$\$\$

IN STORE PRICE	TECHNICO SYSTEM 16	HEATH* H-11
MINIMUM KIT	\$299	\$1,350
WITH POWER SUPPLY AND I-O	\$442	\$1,550
WITH ASSEM- BLY LANGUAGE	\$491	\$1,845
WITH MEMORY FOR FULL SOFTWARE	\$968	\$2,140

*FOR COMPLETE COMPARISON SEE HEATH
AND SEND FOR TECHNICO PRICE LIST
CIRCLE INQUIRY NO.

TWO BYTES ARE
BETTER THAN ONE

COMPARE PROCESSORS

MICRO- PROCESSOR FEATURES	TMS-9900 TECHNICO SUPER SYSTEM 16	LSI-11 HEATH H-11
SINGLE CHIP CPU	YES	NO
WITH HOW. MULT.-DIV. INCL'D.	YES	NO
COMMUNI- CATIONS REG- ISTER UNIT	YES	NO
16- REGISTERS	YES	NO

*FOR COMPLETE COMPARISON CONTACT
DEC. FOR 9900 CONTACT
TEXAS INSTRUMENTS OR TECHNICO
CIRCLE INQUIRY NO.

TWO BYTES ARE
BETTER THAN ONE

COMPARE 16-BIT COMPUTERS

HARDWARE FEATURES	TECHNICO SYSTEM 16	HEATH H-11
DUAL FLOPPY'S	YES	NO
CASSETTES	YES	NO
VIDEO BOARD	YES	NO
E-PROM PROGRAMMER	YES	NO

*FOR COMPLETE COMPARISON SEE
HEATH LITERATURE AND CONTACT
TECHNICO FOR FREE CATALOG
CIRCLE INQUIRY NO.

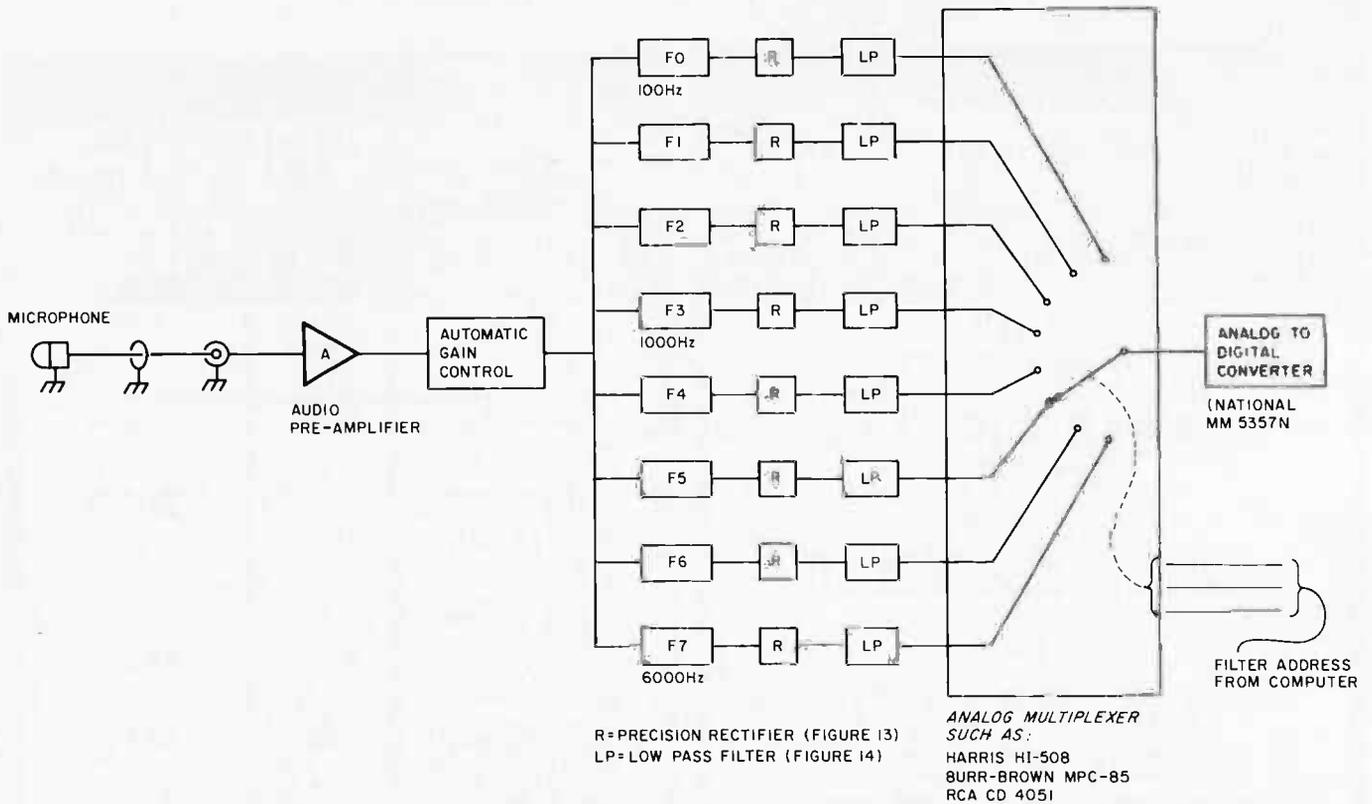


Figure 12: A detailed block diagram of a filter bank feature extractor. The output of the eight bandpass filters is sampled and digitized every 10 ms. Spectral information as well as word boundaries can be extracted from this set of data. See text for an extensive description of this particular implementation.

tional microphone. A directional microphone such as a cardioid will work best when the speaker is facing the noise source and there is no sound reflecting surface behind him. This last point is easy to overlook when using a directional mike so it is very important to remember that noise can get to the mike in its sensitive direction by reflection. A close talking mike depends basically on its distance from the speaker's mouth to separate between noise and speech and it is most helpful when the speaker moves unpredictably with respect to the noise source and when the environment is very noisy and reflective. The microphone should be positioned close to the mouth using a headphone strap or an eyeglass clip. This may or may not be a disadvantage depending on the application.

Audio Preamplifier

The audio preamplifier is quite straightforward in design being just a low level audio amplifier with flat frequency response unless it is used to equalize the response of the mike. There should be provisions to adjust its gain so that it can be matched to different mikes or background noise conditions. This is an infrequent adjustment and it should be hidden from the casual user.

Changing the gain of the preamp affects the point at which the automatic gain control starts compressing and it should be done carefully.

Automatic Gain Control

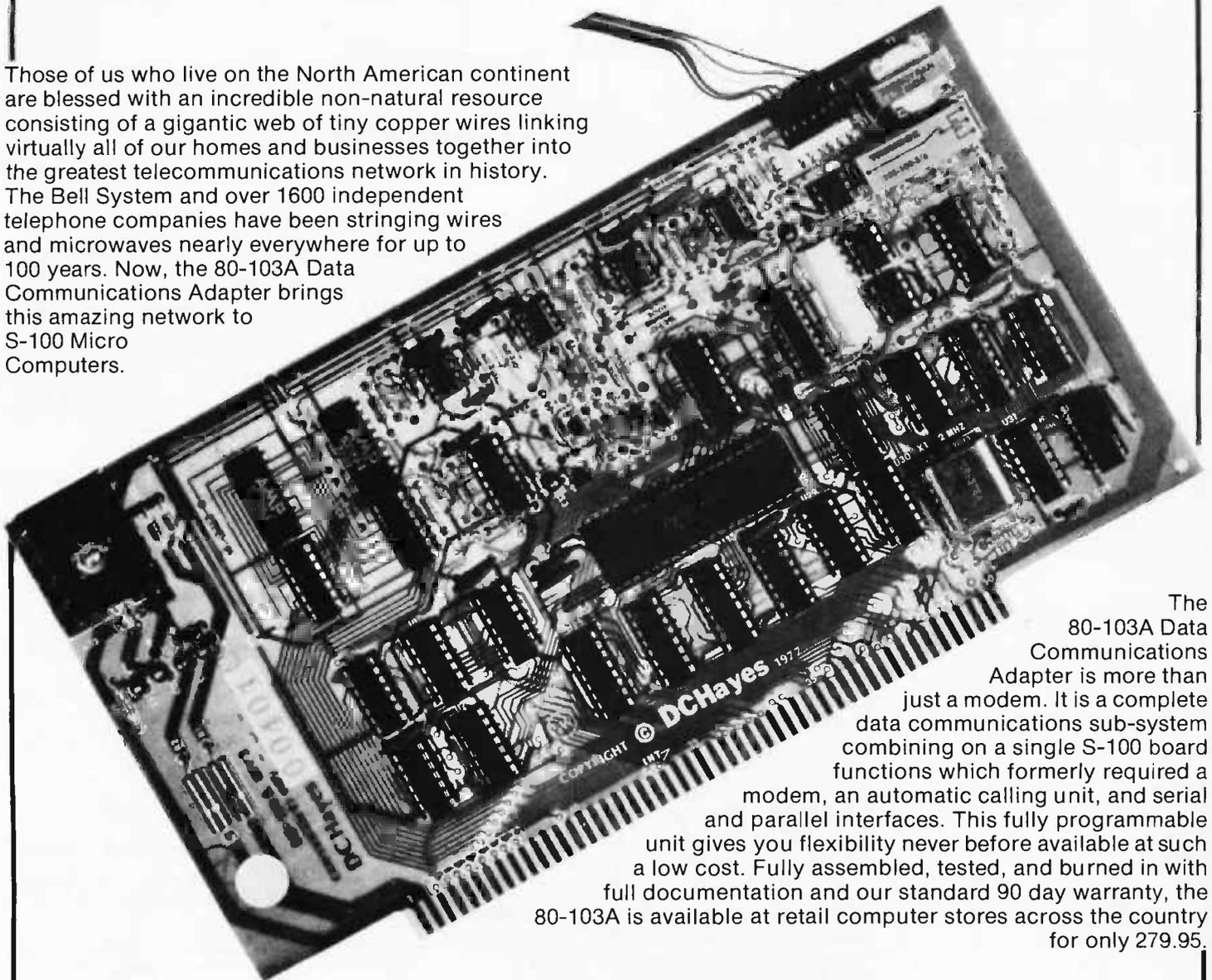
As mentioned previously, the AGC should have very fast attack because in many instances the volume of speech increases very rapidly. Its release time should be 30 to 60 ms, fast enough to follow instances of quick decaying speech volume but not so fast that it will compress between glottal periods. If the AGC has a compression range of about 40 db it functions as amplitude normalizer so we do not have to do any normalization of the filter outputs in the computer.

Filter Bank

Eight filters were chosen for the filter bank simply because analog multiplexers are available with either 8 or 16 inputs and 16 filters are just too many. Another reason is that a workable system can be made with six filters as shown by George White (see references) and eight will certainly give adequate performance. There is a compromise made here between cost

modem / 'mo • dəm / [modulator + demodulator] *n* - *s* : a device for transmission of digital information via an analog channel such as a telephone circuit.

Those of us who live on the North American continent are blessed with an incredible non-natural resource consisting of a gigantic web of tiny copper wires linking virtually all of our homes and businesses together into the greatest telecommunications network in history. The Bell System and over 1600 independent telephone companies have been stringing wires and microwaves nearly everywhere for up to 100 years. Now, the 80-103A Data Communications Adapter brings this amazing network to S-100 Micro Computers.



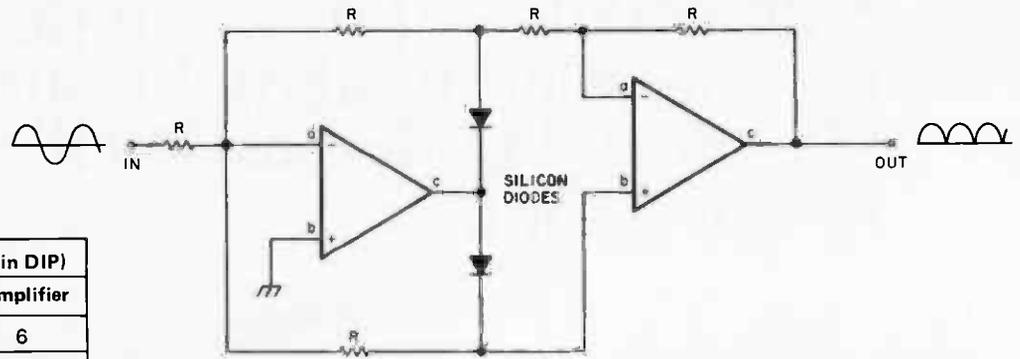
The 80-103A Data Communications Adapter is more than just a modem. It is a complete data communications sub-system combining on a single S-100 board functions which formerly required a modem, an automatic calling unit, and serial and parallel interfaces. This fully programmable unit gives you flexibility never before available at such a low cost. Fully assembled, tested, and burned in with full documentation and our standard 90 day warranty, the 80-103A is available at retail computer stores across the country for only 279.95.

D.C. Hayes Associates Inc.

P.O. BOX 9884 • ATLANTA, GA. 30319 • (404) 231-0574

Distributed in Canada by TRINTRONICS LIMITED, Toronto

Figure 13: A precision full wave rectifier (R) used to rectify the output of each bandpass filter in figure 12.



558 Dual Op Amp Wiring Table (8 Pin DIP)		
Pin	Amplifier A	Amplifier
a	2	6
b	3	5
c	1	7
Power: +12 V Pin 8 -12 V Pin 4		

R=10K A=1/2 558
(ALTERNATE AMPLIFIERS INCLUDE 741, 747, ETC.)

required storage and processing time on one hand and frequency resolution on the other. An interesting study will be to vary the number of filters in a given recognition system from let's say 1 to 16 and plot the recognition accuracy versus the number of filters. The center frequencies and the bandwidths given for the filters are merely an educated guess, based on knowledge of where the "action" is in the speech spectrum and on experimental results published so far. In a practical system some "tweaking" is highly recommended to achieve best results and to the true experimenter it should be irresistible anyway. The skirt characteristics of the filters should be from 24 to 48 db per octave. Steeper slopes require more poles in the filter which in turn require precision components so the desire for steeper slopes should be traded off with the realities of implementation. There are basically two approaches to implementing the filters: First hybrid active filters using the biquad configuration such as the National AF-100 or the Kinetics Technology FS-50 or the Burr-Brown UAF-31 can be used. They are quite easy to use but they have the disadvantage that they cost a lot. Second, one can build filters out of operational amplifiers. Since we are dealing with low audio frequencies, under 5 kHz, inexpensive 741 type op amps can be used as active elements. This will be less expensive than the previous approach but you will have to build the filters yourself, not necessarily the kind of trade-off everyone likes.

Rectifiers and Low Pass Filters

The use of relatively low level signals in the system makes the use of a precision rectifier after the bandpass filters mandatory.

In precision rectifier circuits op amps are used to eliminate the forward voltage drop of the silicon diodes, that is 0.7 V, thus making the circuit behave like an ideal diode. Full wave rectification is desirable to give low ripple. A suitable precision rectifier circuit is shown in figure 13. A low pass filter is suggested to smooth the output of the rectifier. A 2 pole Butterworth filter with a cutoff frequency at about 20 Hz will work well and is shown in figure 14. Instead of the low pass filter we could use an integrator that is reset every time it is read by the analog to digital converter. The integrator output would be proportional to the average of the energy in the frequency band of the given filter during the period between reads. This of course is more complicated than using just a low pass filter and it is questionable whether it will give better results. It has been used in the past though and it is covered by a patent for use in vocoders.

Multiplexer and Analog to Digital Converter

There are several monolithic 8 channel analog multiplexers such as the Harris HI 508 or the Burr-Brown MPC-85 but the RCA CD4051 is the best choice, costing only \$1 in single quantities compared to around \$15 for the others. There is no need for a sample and hold because the preceding low pass filter assures that the signal does not change quickly. An excellent choice for the analog to digital converter is the National MM5357N which at \$11.95 is three times cheaper than the competition. Making your own analog to digital converter from scratch using an 8 bit digital to analog converter could cost half as much assuming you do not count your time.



THE MICROCOMPUTER SOFTWARE STANDARD

CP/M™ OPERATING SYSTEM

- Editor, Assembler, Debugger, and Utilities
- For 8080 and Z-80 Systems
- Up to four IBM-compatible floppy disks
- Documentation includes:
 - CP/M Features and Facilities
 - CP/M Editor Manual
 - CP/M Assembler Manual
 - CP/M Debugger Manual
 - CP/M Interface Guide
 - CP/M Alteration Guide

MAC™ MACRO ASSEMBLER

- Compatible with new Intel Macro standard
- Complete guide to Macro Applications

SID™ SYMBOLIC INSTRUCTION DEBUGGER

- Symbolic memory reference
- Built-in assembler/disassembler

TEX™ TEXT FORMATTER

- Powerful text formatting capabilities
- Text prepared using CP/M™ Editor

 **DIGITAL RESEARCH**

Please send me the following:

- CP/M™ System Diskette and Documentation (Set of 6 manuals for \$100.
- CP/M™ Documentation (Set of 6 manuals) only for \$25.
- MAC™ Diskette and Manual for \$90.
- SID™ Diskette and Manual for \$75.
- TEX Diskette and Manual for \$75.
- Send information on CP/M User's Group, high level languages and optional packages.

NOTE: Due to the proprietary nature of CP/M™ software, please enclose your CP/M Serial No. when ordering MAC, SID, or TEX without the CP/M diskette. CP/M™ Serial No. _____

BankAmericard No. _____ Exp. Date _____

Master Charge No. _____ Exp. Date _____

Check or M.O. enclosed.

California residents add 6% sales tax.

Total amount of purchase \$ _____

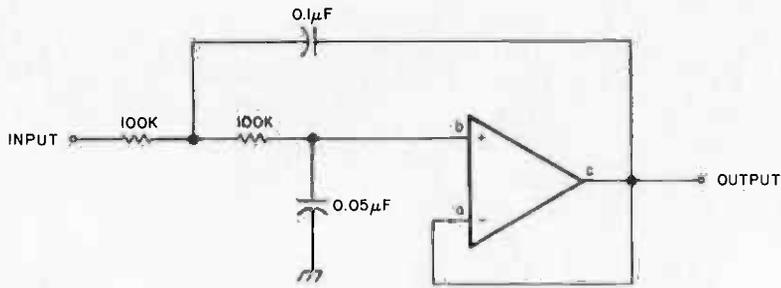
Name _____

Address _____

City _____ State _____ Zip _____

 **DIGITAL RESEARCH**

Post Office Box 579 • Pacific Grove, California 93950 • (408) 649-3896



1/2 558 (SEE FIG. 13 FOR PINOUTS)

ALTERNATE AMPLIFIERS INCLUDE: 741, 747, ETC.

Figure 14: A 2 pole 20 Hz low pass filter (LPF) suitable for smoothing rectified speech audio in figure 12.

You will notice that neither volume nor information as to whether the signal is voiced or unvoiced is explicitly extracted by the feature extractor of figure 12. These features are not lost. They are buried in the output of the filters. The sum of the filter outputs, for instance, at any sample point in time is the volume for that sample. A voiced sound has most of its energy under 1000 Hz and the opposite is true for unvoiced sounds. If we divide the sum of the outputs of the four higher frequency filters by the sum of the outputs of the four lower frequency filters we will get the ratio of the energy in the 1000 to 6000 Hz band to the energy in the 100 to 1000 Hz band. If this ratio is less than 1, the sound is voiced; otherwise it is unvoiced.

There are many ways of utilizing the features extracted by the filter bank feature extractor in a pattern recognizer. Actually this versatility is one of the desirable characteristics of the filter bank. Here I will describe only one possible approach to illustrate the various principles involved. Since all pattern recognition is done in software, experimentation in this area is easy and fun since you don't have to buy or build additional hardware to improve your recognizer. A pattern recognizer has two basic modes of operation: training and recognition. During training it performs the following functions:

- Word boundary detection (beginning and end).
- Pattern input and normalization.
- Reference pattern storage.

In the recognition mode, reference pattern storage is replaced by pattern matching (classification). Training is required to generate reference patterns for the words that form the vocabulary of the recognizer. When a different speaker wants to use the system, retraining is necessary to generate reference patterns for the new speaker's

pronunciation of the words. Implicit in our discussion is the assumption that we limit our recognizer to isolated word recognition. Moreover, these words are to be drawn from a limited vocabulary of about 10 to 30 words in size.

Word Boundaries and Normalization

In operation, the word boundary detection module reads the output of the filter bank every 10 ms and stores it in a temporary storage area. To do this an input routine sequences the multiplexer, starts the analog to digital converter and reads the data into memory. A simple and usable means of detecting word beginnings and endings is to sum the output of the filters and compare it to a given threshold. If the energy exceeds the threshold, a word has begun. There is a precaution to be taken however when using volume for word boundary detection. Certain consonants called plosives or stops (p,t,k,b,d,g) are generated by building up pressure and then suddenly releasing it. While the pressure is being built up no sound is generated and this silence period or "stop gap" can last up to 150 ms. If this occurs in the middle of a word as in "ago" for example, the simple boundary detector will be fooled to think that two separate words occurred. This can be corrected easily by considering any "words" less than 200 ms apart to be parts of one word. Another problem arises when a noise pulse occurs without any word being said as in the case where something is dropped on the table. To prevent the word boundary detector from accepting such noise as a word, we define any sound with duration less than 150 ms as noise because words are not that short. These modifications will make the boundary detector quite successful for operation in a quiet room with a careful speaker. For any other situation considerable additional sophistication might be necessary. In a noisy environment the threshold for word detection has to be increased so that the detector will not trigger on background noise. But increasing the threshold will tend to chop off the low amplitude beginnings and endings of some words and this can affect recognition significantly. If the speaker is careless or he is physically strained when he speaks because, for example, he is lifting something heavy, breathing noises will tend to be considered as part of the word being said, further degrading recognition. In these situations a sophisticated boundary detector is very helpful in maintaining system performance. Once the beginning of a word is detected, the pattern input starts. Every 10 ms the output of the filters is sampled and stored in

OSBORNE & ASSOCIATES, INC.

The World Leaders In Microprocessor Books

If you want information on microprocessors, begin with the Osborne books.

ORDER NOW
Prices increase July 1

PROGRAM BOOKS WRITTEN IN BASIC

**Payroll With Cost Accounting
Accounts Payable And Accounts
Receivable
General Ledger**

These books may be used independently, or implemented together as a complete accounting system. Each contains program listings, user's manual and thorough documentation. Written in an extended version of BASIC.

#22002 (400 pages), #23002*, #24002*



Some Common BASIC Programs

76 short practical programs, most of which can be used on any microcomputer with any version of BASIC. Complete with program descriptions, listings, remarks and examples.

#21002 (200 pages)



AN INTRODUCTION TO MICROCOMPUTERS

Volume 0 - The Beginner's Book

If you know nothing about computers, then this is the book for you. It introduces computer logic and terminology in language a beginner can understand. Computer software, hardware and component parts are described, and simple explanations are given for how they work. Text is supplemented with creative illustrations and numerous photographs. Volume 0 prepares the novice for Volume I.

#6001 (300 pages)



Volume I - Basic Concepts

This best selling text describes hardware and programming concepts common to all microprocessors. These concepts are explained clearly and thoroughly, beginning at an elementary level. Worldwide, Volume I has a greater yearly sales volume than any other computer text.

#2001 (350 pages)



Volume II - Some Real Products (revised June 1977)

Every common microprocessor and all support devices are described. Only data sheets are copied from manufacturers. Major chip slice products are also discussed.

#3001A (1250 pages)



ASSEMBLY LANGUAGE PROGRAMMING

**8080A/8085 Assembly Language Programming
6800 Assembly Language Programming**

These books describe how to program a microcomputer using assembly language. They discuss classical programming techniques, and contain simplified programming examples relevant to today's microcomputer applications.

#31003, 32003 (400 pages each)



PROGRAMMING FOR LOGIC DESIGN

**8080 Programming For Logic Design
6800 Programming For Logic Design
Z80 Programming For Logic Design**

These books describe the meeting ground of programmers and logic designers; written for both, they provide detailed examples to illustrate effective usage of microprocessors in traditional digital applications.

#4001, #5001, #7001 (300 pages each)



OSBORNE & ASSOCIATES, INC. • P.O. Box 2036 • DEPT. 19 • Berkeley, California 94702 • (415) 548-2805 TWX 910-366-7277
9:00 a.m. - 5:00 p.m. Pacific Time

Price applies to orders postmarked by June 30, 1978.		PRICE	QTY	AMT
6001	Volume 0 - The Beginner's Book	\$ 7.50		
2001	Volume I - Basic Concepts	7.50		
3001A	Volume II - Some Real Products (1977 edition)	15.00		
4001	8080 Programming For Logic Design	7.50		
5001	6800 Programming For Logic Design	7.50		
7001	Z80 Programming For Logic Design	7.50		
31003	8080A/8085 Assembly Language Programming	7.50		
32003	6800 Assembly Language Programming	7.50		
21002	Some Common BASIC Programs	7.50		
22002	Payroll With Cost Accounting	12.50		

NAME _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____ PHONE _____

SHIPPING CHARGES Shipping charges for bulk orders to be arranged.

- 4th class (no charge, allow 3-4 weeks within USA, not applicable to discounted orders)
- \$.50 per book, UPS (allow 10 days) in the U.S.
- \$1.50 per book, special rush shipment by air in the U.S.
- All foreign orders, \$3.00 per book, for air shipment

*These books are scheduled to be published during 1978.

Please notify me when they are available:

- 23002 Accounts Payable and Accounts Receivable
- 24002 General Ledger

Please send information on:

- pricing, ordering, and titles available after 6/30/78
- initial dealer consignments
- dealer and school discounts
- foreign distributors

New price list effective July 1, 1978

F8

• 6-1/2% SF Bay Area residents only
• 6% California residents outside SF Bay Area
• Payment must be enclosed for orders of 10 books or less.
• I have enclosed:

check money order

TOTAL AMOUNT OF PURCHASE

TOTAL

Sales Tax (Calif. residents only)

Shipping Charges

consecutive memory locations in the buffer area. The duration of the longest word can be expected to be less than 1.2 seconds, giving us a maximum of 120 samples to store in the buffer. Thus a 1 K buffer will be sufficient.

Upon detection of the end of the word, some form of time normalization is required before the next step. This need arises from the fact that people do not time their pronunciations the same every time. They may say "zero" one time and "zeroo" the next. Before we can do template matching, if we are to be successful, these timing variations should be removed. Linear time normalization is a technique of doing just that. To demonstrate the principle assume that the normalized word length is 16 8 byte samples and that our buffer contains 65 8 byte samples. To do time normalization, all that is necessary is to retain every fourth sample and throw away the rest, as shown in figure 15. If the number of samples in the buffer is not a multiple of 16 plus 1 ($16 \cdot N + 1$), a number of rules can be implemented to resolve the problem. For example, if there are up to four less samples than $(16 \cdot N) + 1$, then samples in areas of high amplitude can be duplicated to reach a number of samples that is exactly $(16 \cdot N) + 1$. The assumption here is that in areas of high amplitude interesting things exist. It is not necessarily a correct assumption but it can give an idea of what can be done to adjust the length of the word

without resorting to linear interpolation. Larger discrepancies can be treated similarly but duplication should occur throughout the word to avoid stretching only a part of it. Omission of samples can be used as well, to adjust the length. Insertions and deletions can be made in a number of locations in the word based on criteria other than local amplitude. For example, deletions in the beginning or ending of words, or slow spectral changes are other possibilities. The best guide as to what works for any given system is some experimentation with various techniques.

In usual practice, all words in a vocabulary for a given system are normalized to the same length, regardless of their actual length. It might be useful, though, if a large proportion of the words of the vocabulary are distinctly different in length from the rest, for example "yes," "no," "on," "off" compared to "television," "instrument," "telephone," to have two normalization lengths. An added benefit to the obvious savings in pattern storage memory would be a reduction in classification time because there is no point in trying to find a match between a long and a short word.

A more advanced form of time normalization is based on dynamic programming techniques. It is basically a systematic approach to stretching and compressing the unknown word in time until it best fits the reference pattern. It gives excellent results but it has two drawbacks: It is time consuming and it requires storing all the input samples for a given word as reference patterns. Despite its shortcomings, its superior performance makes it a very interesting technique. Its detailed analysis is not within the scope of this article.

The final phase of the processing of the unknown word depends on whether we are in the training mode or the recognition mode. In the training mode all that is necessary after time normalization is to store the resulting pattern in memory in an area designated for the word pronounced. To improve performance two or more reference patterns may be used for a given word to account for variations in pronunciation. For example the speaker may be required to pronounce each word in the vocabulary twice (although not one immediately after the other to avoid similarity as much as possible) so that two references will be generated and stored for each word. Variations of this scheme include making the speaker repeat a word until it is sufficiently different from the first reference or changing the second reference adaptively as the system is used. In the recognition mode the normalized unknown word is compared to

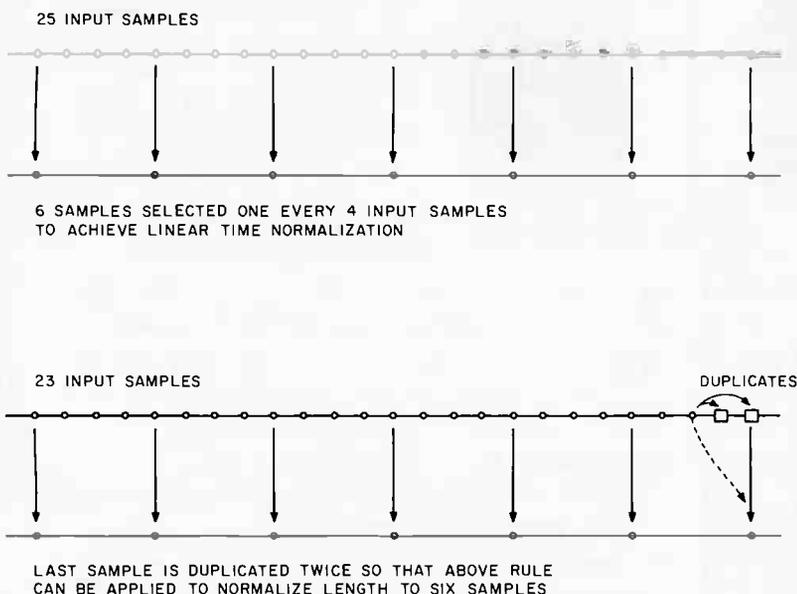


Figure 15: Linear time normalization compresses the stream of input samples to a fixed number of samples (in this case six) by selecting a sample at regular intervals. The resulting fixed length for all words facilitates feature matching for pattern recognition. Various techniques (such as duplicating samples) are used to make the number of inputs fit the selection rule.

The LATEST in Tape Systems



MODEL CC-8
\$185.00 (4800 Baud)
\$195.00 (9600 Baud and 220V/50 Hz)

9600 BAUD CASSETTE RECORDER

An ASYNCHRONOUS NRZ type Recorder with remote motor start/stop. Error rate 10^8 at 4800 BAUD. Can be used from 110 to 9600 BAUD into a UART — no clocking required. This is not an audio recorder. It takes RS232 or TTL signals from the terminal or computer and gives back the same signals. No audio interface is used. Motor start/stop is manual or through TTL or RS232 signals.

Tape speeds are 1.6" / 3.0" and 6.0" per second. 110 volt, 60 Hz, 5 watts. (220 Volts on special order). Can use high quality audio cassettes (Philips Type) or certified data cassettes. Can be used in remote locations from a 12 Volt battery.

Recommended for DATA LOGGING, WORD PROCESSING, COMPUTER PROGRAM RELOADING and DATA STORAGE. Manual control except for motor start/stop. 6800, 8080 or Z80 software for file or record searching available on request with order. Used by major computer manufacturers, Bell Telephone and U.S. Government for program reloading and field servicing.

AVAILABILITY — Off the shelf.

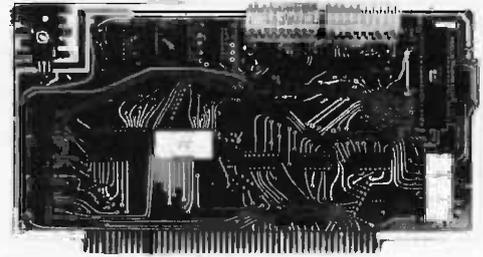
PROVIDES MONITOR AND TAPE SOFTWARE in ROM. TERMINAL and TAPE PORTS on SAME BOARD. CONTROLS ONE or TWO TAPE UNITS (CC-8 or 3M3B).

This is a complete 8080, 8085, or Z80 system controller. It provides the terminal I/O (RS232, 20 mA or TTL) and the data cartridge I/O, plus the motor controlling parallel I/O latches. Two kilobytes of on board ROM provide turn on and go control of your Altair or IMSAI. NO MORE BOOTSTRAPPING. Loads and Dumps memory in hex on the terminal, formats tape cartridge files, has word processing and paper tape routines. Best of all, it has the search routines to locate files and records by means of six, five, and four letter strings. Just type in the file name and the recorder and software do the rest. Can be used in the BiSync (IBM), BiPhase (Phase encoded) or NRZ modes with suitable recorders, interfaces and software.

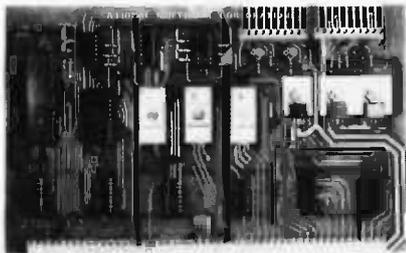
This is Revision 8 of this controller. This version features 2708 type EPROM's so that you can write your own software or relocate it as desired. One 2708 preprogrammed is supplied with the board. A socket is available for the second ROM allowing up to a full 2K of monitor programs.

Fits all S100 bus computers using 8080 or Z80 MPU's. Requires 2 MHz clock from bus. Cannot be used with audio cassettes without an interface. Cassette or cartridge inputs are TTL or RS232 level.

AVAILABILITY — Off the shelf.



2SIO (R) CONTROLLER
\$190.00 (\$160.00, Kit)



6800 CONTROLLER for SWTP
\$190.00, Tested & Assmb. (\$160.00, Kit)

PROVIDES MONITOR AND TAPE SOFTWARE in EPROM. EXPANDS MIKBUG with 1K of ADDITIONAL ROM PROGRAM

This is a complete tape controller for the SWTP 6800 system. Has 3K of EPROM space for your own programs. A 1 K ROM (2708) is provided with all tape and monitor functions. The ROM program is identical to our extensive 8080 ROM program.

Has one ACIA for one or two tape drives, one UART for an additional Serial port and a 4 bit parallel port for motor control. Will control one or two CC-8 or 3M3B drives with the software provided. Can be used with other tape drives controllable with 4 TTL bits if appropriate software changes are made.

Extra serial port is provided for your use with a second terminal or printer (RS232, TTL or 20 ma).

The ROM program supplements the MIKbug program and is entered automatically on reset. SWTPbug compatible ROM is also available.

AVAILABILITY — Off the shelf.

Z 80 BOARD for SWTP COMPUTER

Now you can use the 8080/Z80 software programs in your SWTP 6800 machine. Replaces your MPU board with a Z80 and ROM so that you are up and running with your present SWTP memory and MPS card. 1 K ROM on board replaces MIKBUG.

AVAILABILITY — Off the shelf.



\$190.00, Tested & Assmb.

For U.P.S. delivery, add \$3.00. Overseas and air shipments charges collect, N.J. Residents add 5% Sales Tax. WRITE or CALL for further information. Phone Orders on Master Charge and BankAmericard accepted.

National Multiplex Corporation

3474 Rand Avenue, South Plainfield NJ 07080 Box 288 Phone (201) 561-3600 TWX 710-997-9530

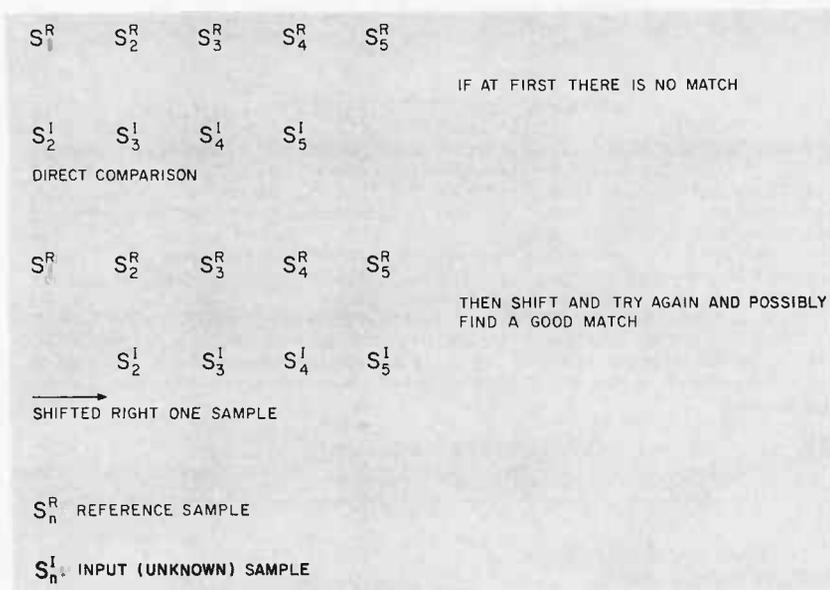


Figure 16: Shifting the unknown left and then right one position helps prevent mismatches due to missing ends or beginnings. In this case the right shift gave a good match. This test has been simplified to one parameter (S) which might be the output of one filter in a filter bank.

each reference pattern by computing the sum of the absolute values of the differences of the features. The smallest sum indicates the best match between the unknown and that reference. This alone is not sufficient for recognition because a word that does not belong to the vocabulary of the system will always give a best match because one of the reference patterns is bound to be more like it than the others. To avoid "recognizing" words that are not in the vocabulary, we impose the restriction that successful recognition requires that the smallest difference measure will be smaller than a given threshold. This threshold has to be found experimentally for any given vocabulary. If it is too high, it will allow for acceptance of words that are not part of the vocabulary. If it is too small, words that are in the vocabulary but not pronounced very close to the stored references will be rejected.

Word beginnings and endings usually have low amplitude and it is possible that the word boundary detector could chop them off. If that happens, it will most likely happen only occasionally and as a result there will be instances where the reference and unknown patterns are shifted with respect to each other in time. For this reason, if computer time is available, the unknown may be shifted to the right one position and the difference calculated and then to the left and the difference computed again as shown symbolically in figure 16. The smallest of the three differences thus computed is to be used as the indicator of match quality.

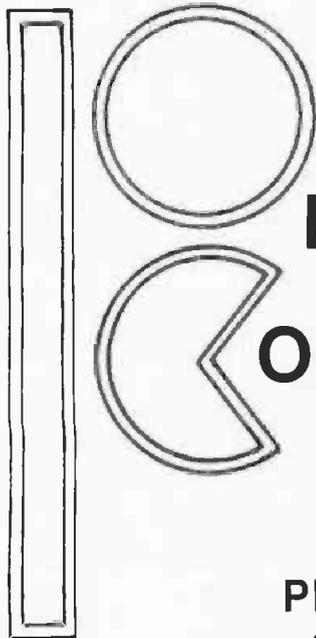
When a word is recognized it can be used directly to perform a function which could be, for example, the equivalent of pushing a key on a calculator. In some instances it is necessary or desirable that more than one word be used to perform a single function. For example the sequence of the words "light on" can perform the function of turning on the lights in a room. In these cases there should be a subroutine to check if the word sequence is correct. For example, the word "light" should be followed by the words "on" or "off." If the word "radio" follows, we know that either "radio" or "light" has been misrecognized. These syntactical constraints decrease the probability that an incorrectly recognized word will cause something undesirable to happen. This is due to the fact that for a sentence to be correct, all the words that form it have to be correct, at least syntactically. Syntactic constraints of course do not help when the words have the proper sequence but are still not correct. For example, if we are controlling a vehicle of sorts and we say "forward faster," if "faster" is recognized as "slower" the sentence will be syntactically correct but it will not do what we want.

Performance

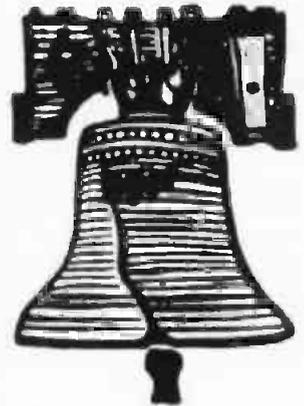
The performance of a recognizer is evaluated on the basis of the percentage of the words it recognizes correctly out of the total pronounced. For a given recognizer the recognition score will vary from speaker to speaker, with the speaker's emotional condition and with the level of background noise, to mention some of the variables. Recognition scores quoted in articles and advertisements are likely to be the ones obtained with best conditions and they are not necessarily indicative of the performance of the recognizer under actual conditions. There exist three types of recognition errors: failure to recognize a given word, substitution (recognizing one word for another) and misrecognition (recognizing a word not in the vocabulary). The first type of error is in most cases merely an annoyance requiring that the user repeat the word. The last two types of error can cause problems because the recognizer will give a response which is wrong. Failure to recognize will occur when the recognition threshold (the maximum that the smallest difference sum can be to recognize a word) is set too low. Setting the threshold too high will result in misrecognition, as mentioned previously. Substitution becomes a problem when the vocabulary size is increased. To avoid substitution the vocabulary can be divided in two segments and a shift word used to switch between the two segments of the

Good-bye, Atlantic City

Hello, PHILADELPHIA



**PERSONAL
COMPUTING '78** TM



THIRD YEAR — LARGEST YET

**PHILADELPHIA CIVIC CENTER
AUGUST 24, 25, 26, 27**

FOUR FULL DAYS

August 24

Industry Trade Show

for Dealers, the Industry
and Exhibitors Guests

AND

A complete lineup of
seminars and meetings.

August 25, 26, 27

PERSONAL COMPUTER SHOW

New Products • Seminars • Forums • Technical Talks

The largest, with 300 booths. The longest, at
four days, of any computing show.

Don't Miss



**PERSONAL COMPUTING COLLEGE™ • over 80 hours
of in-depth seminars - ALL FREE**

PLUS FUN ACTIVITIES

Art Show • Music Festival • Banquet
Computerized Mouse Maze

Save Money!
Make reservations
now!

Exhibitors reserve your
space now!

PRODUCED BY

PERSONAL COMPUTING INC. • John H. Dilks, President
Rt. 1 • Box 242 • Mays Landing, NJ 08330 • Information 609-653-1188

vocabulary. The shift word can be "shift" or "change" for example. This would correspond to the shift key on a typewriter or the function ("f") key on a calculator. The user will have to remember in what segment he currently is and when a word from the other vocabulary has to be pronounced he should preface it with the shift word. The system can provide the user with an indication such as an LED to remind him of the current segment. Using a number of different shift words it is possible to extend the technique to several segments of a large vocabulary.

Advanced Systems

The hottest areas in speech recognition today are feature extraction using digital speech processing and speech understanding systems. Unfortunately both are out of the reach of the capabilities of the usual amateur computing experimenter's machines. In addition they tend to be involved theoretically so we will only briefly mention them here. Digital speech processing involves operating directly on the sampled time domain waveform and as it was mentioned earlier it requires very fast computers. One of the most usual operations is the Fourier Transform. It is computed using a fast algorithm called the FFT for Fast Fourier Transform and the result is the spectrum of the signal as was shown in the example of figure 5 (actually figure 5 is the log of the magnitude of the spectrum). Its advantage over output of a filter bank is resolution and accuracy. A typical FFT derived speech spectrum is made up of 128 frequencies spanning the range from 0 to 5 kHz. The amplitude at each frequency is specified with 12 to 16 bit accuracy. Such performance is very difficult to achieve using analog components and certainly not economical. The output of the FFT can be used directly by making different measurements on it to extract features, such as the formants. IBM is using this approach in their research effort in speech recognition which, by the way, is very well funded, in the range of millions of dollars per year.

Another digital method for speech processing is "linear prediction." It is a method by which the impulse response of the vocal tract can be extracted from the speech signal. It is basically a time domain operation and it involves predicting the next sample of the waveform on the basis of a linear combination of the N previous samples. It can be used for formant extraction but it is at times quite sensitive to minor aspects of the input signal so it is not as reliable as might be desired. When it works it gives excellent results and therefore it has a lot

of promise as a formant tracking tool. It has also been used in isolated word speech recognition by storing the vocal tract impulse response it generates as reference pattern and then comparing it with the impulse response of the unknown. It gave very good results in a vocabulary of 200 words. As it would be expected, this method yields results very similar to the filter bank approach because they are very similar in substance although totally different in implementation.

Formant extraction can also be achieved with "cepstral" analysis which is based on the Fast Fourier Transform. The cepstrum is the spectrum of the logarithm of a spectrum. These operations separate the impulse response of the vocal tract from the driving function. Its name is derived from the word spectrum spelled more or less backwards because the operations involved in obtaining it are very similar to spectral analysis of a time domain signal. It gives very good results when used for pitch extraction but when used for formant extraction it is not very reliable. It tends to fail in different ways than the linear prediction methods so perhaps the two methods combined will yield good results.

All these methods will become more commonly used as computer technology advances decrease the cost of very fast computers. Because of their accuracy (at least when the data is to their liking) these algorithms are bound to play a significant role in feature extraction of future recognizers.

Speech Understanding

Speech understanding systems differ from speech recognition systems in that they do not just recognize sequences of words but instead they use knowledge about the subject of discussion to check if the word sequences make sense. They use syntactical analysis as previously mentioned as well as context analysis to improve recognition. For example, a speech understanding system used to input the moves of a chess player to the computer (an experimental system doing just that has been built at Carnegie-Mellon University) checks the recognized sentences for syntax errors and then checks whether the sentence gives a legal chess move for the particular situation. Speech understanding systems are usually designed with a specific problem domain in mind for which the semantics are known. The US Defense Department's Advanced Research Project Agency (ARPA) has spent about \$30 million on the development of a speech understanding system in the last

five years. The results have not been too exciting, an indication that high performance speech recognizers are hard to build.

Commercial Systems

Threshold Technology Inc, Dialog Inc, Perception Technology and Scope Electronics all offer commercial speech recognition systems capable of recognizing isolated words from 16 to 32 word vocabularies. Of these, Threshold Technology is by far the most successful commercially and their systems are used in a variety of industrial applications, such as baggage handling in airports (the destination is spoken to the system which in turn routes the baggage) and quality control inspection (the inspector uses his or her hands to hold a micrometer and take measurements which then are spoken to the recognizer and entered in a computer for report generation). The Threshold Technology machine uses an LSI-11 and their feature extractor consists of a bank of 16 filters. It costs about \$10,000. Threshold Technology claims 99.6 percent recognition rate and operation in noisy environments.

At the time of this writing (April 1977) Heuristics Inc has announced an Altair (S-100) compatible recognizer. It sells for \$249 in kit form and a detailed description of its hardware appears in the May 1977 issue of *Popular Electronics*. It is a simple device consisting of three bandpass filters and a zero crossing detector. The filters cover the range of 150 Hz to 5 kHz. Their output is peak detected and averaged and then quantized with six bits resolution. They claim 90 percent correct recognition in a quiet environment with a cooperative speaker.

Addresses of Commercial Speech Recognition System Manufacturers

1. Threshold Technology Inc
1829 Underwood Blvd
Delran NJ 08075
2. Heuristics Inc
900 N San Antonio Rd (Suite C-1)
Los Altos CA 94022
3. Dialog Systems Inc
639 Massachusetts Av
Cambridge MA 02139
4. Scope Electronics Inc
Reston VA 22070
5. Perception Technology Inc
Winchester MA 01890

As a final remark, a note on recognizer performance is in order. It was mentioned before that quoted performance figures are usually the best obtained with a given system under ideal conditions. This optimistic approach reflects more than anything the difficulty of making a very good recognizer. People choose to present the best results because the bad results may look terrible and the average unimpressive. While recognition scores can be taken with a grain of salt, it would be a mistake to view speech recognizers in the same light. The correct approach is to see them as a challenge to find applications in which they are useful despite their present shortcomings. You certainly would not want to control your car with a recognizer that has a 90 percent recognition score. Yet I have seen a recognizer with an average 80 percent score do a very good job in controlling the electric wheelchair of a paralyzed patient. Think how important this is if you can only move your head and speak and the rest of the body is paralyzed totally.

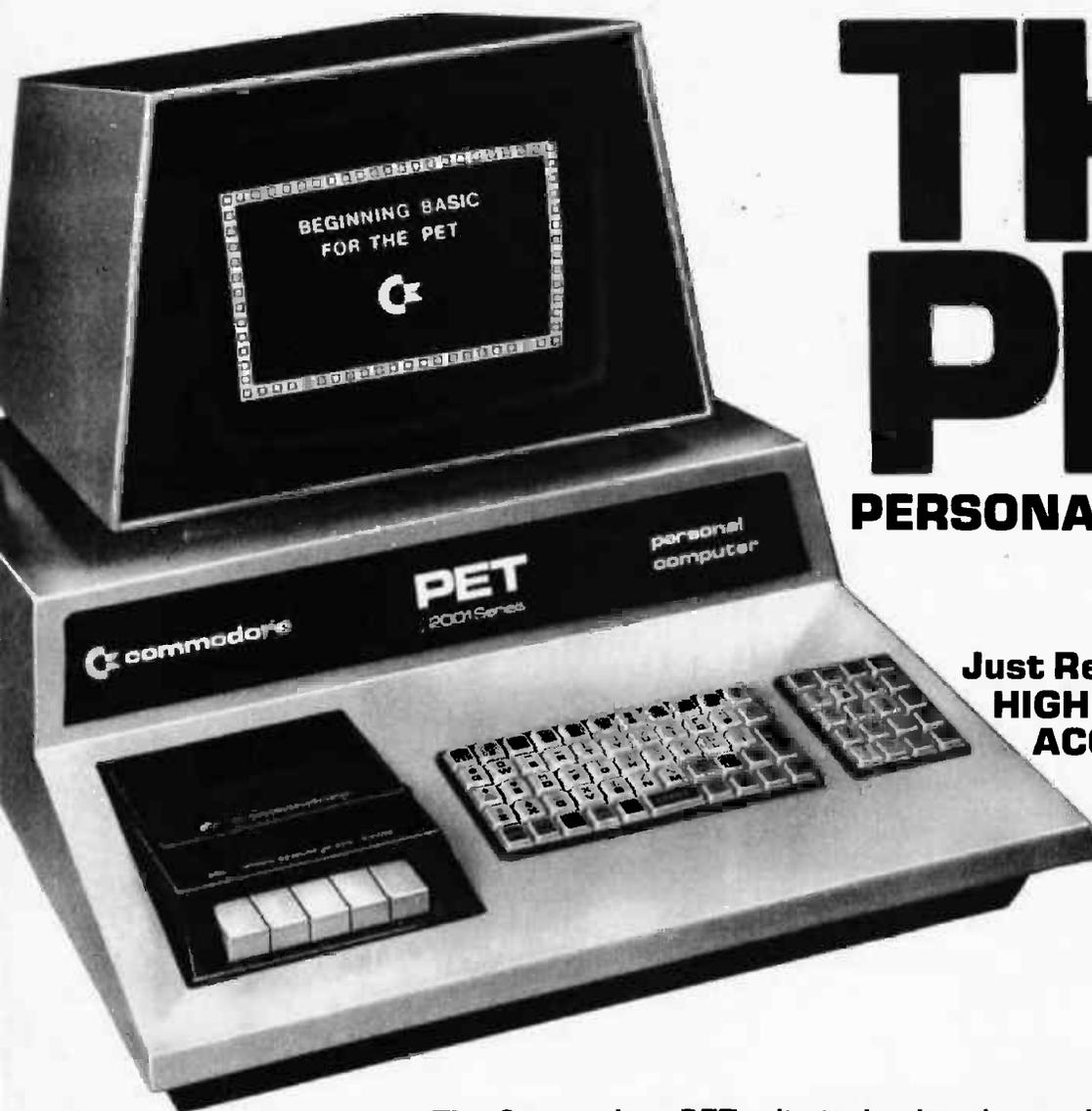
I am sure that a great number of applications can be found for existing systems that I just haven't thought of yet, or that I would never imagine. Given the thousands of computer enthusiasts and their different backgrounds and the computer power they command, I wonder if there will be any stones left unturned in the applications area now that we can talk to our own speech recognizers. ■

REFERENCES

1. Lindgren, Nilo, "Machine Recognition of Human Language," *IEEE Spectrum*, March and April 1965. A somewhat antique review of the field. This article covers history and some principles in rather nontechnical language.
2. Otten, Klaus, "Approaches to the Machine Recognition of Conversational Speech," *Advances in Computers*, vol 11, Academic Press, NY, 1971. Easily readable, a less antique review than Lindgren's.
3. White, George, "Speech Recognition: A Tutorial Overview," *IEEE Computer*, May 1976. A very up to date review, rather technical at points but quite readable.
4. Martin, Thomas: "Practical Applications of Voice Input to Machines," *Proceedings of the IEEE*, April 1976. The author is president of Threshold Technology and from that vantage point reviews the practical side of speech recognition.

The reference lists at the end of each of the above papers are good sources of additional information.

Available for immediate delivery from Contemporary Marketing
The Original, "Industry Awakening Advance in Personal Computers"



THE PET™ PERSONAL COMPUTER

**Just Released
HIGH SPEED PRINTER
ACCESSORY**

**Featuring an
IEEE-488 BUS**

The Commodore PET -- Its technology is so advanced; its concept, so remarkable; its ease of operation, so utterly simple, and its cost so incredibly low, that overnight it has given rise to a brand new era -- The Age of the Personal Computer.

THE PET has become the standard for the emerging personal computer industry. Computer magazines, trade journals, consumer and business publications have lauded its discovery. POPULAR SCIENCE put THE PET on its October, 1977 cover, in full color, and devoted a feature news story to the coming revolution in personal and office computing. PLAYBOY, February, 1978, gave full color coverage to the "mind-boggling" PET.

IN A LEAGUE WITH IBM, HP AND WANG MINICOMPUTERS

THE PET should not be confused with game products that hook up to household T.V.'s. It is a minicomputer. What sets THE PET light years apart from other computers is its price. While the others cost from \$11,000 to \$20,000 and more, THE PET, with similar capabilities and power, costs only \$795.00.

One extremely important capability shared with HP's minicomputer, and full size computers, is its IEEE-488 Bus. This standard data/control channel means your PET can be directly connected to a variety of peripherals and laboratory measuring

equipment. Over 120 pieces of compatible equipment such as counters, timers, spectrum analyzers, digital voltmeters and printer plotters from manufacturers such as HP, Phillips, Fluke, and Tectronix are currently available.

ROM Magazine, January 1978, writes, "THE PET comes out of the box, plugs into the wall, and is ready to use." It is equipped with a CRT video display with reverse and blink features, an alphanumeric keyboard with complete graphics and a built-in standard cassette tape deck.

THE PET is an exceptionally powerful think tank with 8K bytes of RAM (User Memory). Optional equipment, permits expansion to 32K. The system contains 14K bytes of ROM (Program Memory).

THE PET COMMUNICATES IN THE EASIEST COMPUTER LANGUAGE

Computers talk in many languages. The easiest is BASIC or English-like words. If THE PET wants you to press a key, it will flash, "Press such and such", right on the display. You speak back to THE PET through its full size 73-key keyboard.

EXTENSIVE CHARACTER ORIENTED GRAPHICS

The unit features a 9-inch, high resolution, 1000 character CRT. Characters are arranged 40 columns by 25 lines on an 8 x 8 matrix for superb graphics.

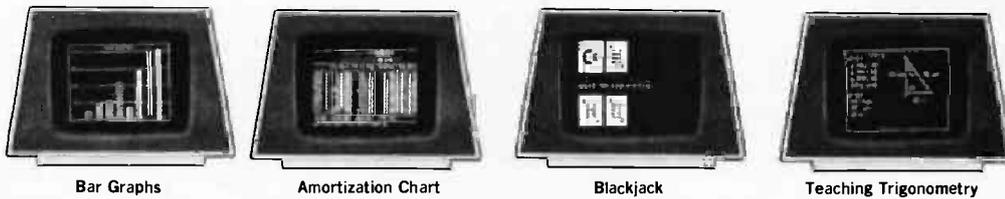
WHAT IS THE PET REALLY FOR?

It is the single most important teaching device for any computer related subject. It can help a youngster learn number facts, or help a med student do tissue analyses. It will entertain the most sophisticated data application, or the simplest inquiry-response assignment.

IN THE LAB it handles instrumentation, process monitoring, computer aided instructions, and more. A number of Fortune 500 companies have already made PETS an integral part of their lab and general office system.

As a **BUSINESS TOOL** it will; Maintain ledgers. Illustrate cash flow charts. Keep payroll records. Create P & L's. Control inventory. Store and analyze sales data. Draw bar graphs. Issue invoices. Do statistical work. Hook up to on-line computer system.

THE PET is the only totally integrated, self-contained, personal computing system. It measures a compact 16½" wide; 18½" deep; 14" high, and weighs just 44 pounds.



Bar Graphs

Amortization Chart

Blackjack

Teaching Trigonometry

As an AT-HOME TOOL it will; Compute state and federal tax returns. Make heat and insulation analyses. Keep Christmas lists. Keep checkbook and finances up to date. Programs are even being developed to store recipes and to compute larger or smaller portion requirements.

WHO IS THE PET FOR?

Engineers, scientists, doctors, educators, students of computer science, attorneys, stock brokers, realtors, insurance people, list brokers, home economists, churches, grocery store owners, automobile dealers, sales people, organizations.

JUST FOR FUN

There is hardly a game, from Blackjack to Master Chess, that cannot be programmed into the unit. A variety of game programs is currently available.

ANNOUNCING THE PET PRINTER

This powerful word processing accessory lets you print hardcopies, invoices, and computer correspondence. Faster than an IBM Selectric, THE PET Printer delivers 60 characters per second at a sustained rate - or 3,600 characters every minute - with upper and lower case capability. Characters are 1/8" tall and printed in a 7 x 8 dot matrix. The printer uses a standard 8½" wide paper roll. And, most unbelievable - it is only \$599.95.

PERIPHERAL SECOND CASSETTE

This optional component expands storage and increases flexibility. Only \$99.95.

MILES OF SOFTWARE

Listed below is a sampling of currently available PET programs. "BASIC BASIC" shows you how to write a program for the unit. You can actually develop your own programs to meet personal requirements.

GAME PROGRAMS ARE \$9.95 EACH:

- Black Jack Draw Poker Galaxy Games
- Space Flight Target Bong, Off-The-Wall
- Lunar Lander, Wumpus, Rotate, Tic-Tac-Toe
- Osero, Reverse Spacetrek Kingdom

PROGRAMS AT \$14.95 EACH:

- Mortgage Analysis Diet Planner and Biorhythm
- Basic Basic-by Lodewyck and James

PROGRAMS AT \$24.95 EACH:

- Basic Investment Analysis-loans, annuities, return on regular and irregular sequences of payments, calendar calculations Stock Portfolio Recordkeeping and Analysis-keeps track of buys, sells, and dividends. Calculates current value, rates of return Checkbook Recordkeeping and Analysis-keeps track of checks and deposits. Analyzes expenses by date and type

PROGRAMS AT \$29.95 EACH:

- Basic Math Package-matrix addition, multiplication, determinants and inverses to 16 x 16, solution of simultaneous linear equations, vector and plane geometry calculations, integration by trapezoidal, Simpson's rule or Gaussian quadrature, differentiation
- Basic Statistics Package-mean, median, variance, standard deviation, skewness, kurtosis, frequency distribution, linear regression, T-tests, correlation analyses

FREE ORIENTATION PACKAGE

Your PET comes complete with two programs and an easy-to-follow instruction manual. By working through the routines you will quickly discover how easy it is to gain command of your personal computer.

SERVICE WORLDWIDE

THE PET is made in the United States by Commodore International, a worldwide, vertically-integrated manufacturer of electronic products for home and industry. Because your PET is self-contained and compact, professional factory service is never far away. If ever major service is required, the unit can simply be returned by UPS to an authorized factory PET clinic.

You can order your PET by sending a check or money order for \$795.00 plus \$20.00 for shipping and insurance. To order the PET Printer, add \$599.95 plus \$12.00 for shipping and insurance. The Second Cassette is \$99.95. No shipping and insurance charges are required when ordering a second cassette or programs with your PET. Credit card orders are invited to call our toll free number below. Orders will be accepted on our TELEX, No. 25-5268.

CONTEMPORARY MARKETING

Contemporary Marketing is a major source for advanced electronic products. Our commitment to this exciting industry is the reason why Contemporary was selected to bring THE PET to you. In comparison with other full-fledged computers, it is an incredible value. Nevertheless, we recognize that it is a substantial investment for any company or individual. Please be assured that we are pledged to protect your investment. As a Contemporary PET owner, we will see to it that you are kept abreast of all new peripherals and software, as they are developed. We want you to use THE PET with complete confidence. If, for any reason, you are not satisfied with your PET, simply return it within 30 days for a prompt and courteous refund.

THE PET is perhaps the most exciting discovery in many years, and demand is enthusiastic. If our lines are busy, please call again.

ORDER DIRECT

**CREDIT CARD ORDERS CALL TOLL FREE
800-323-2272**

**ILLINOIS RESIDENTS CALL: 312-595-0461
TELEX ORDERS: 25-5268**

Order your PET, Printer Accessory, Second Cassette and Programs from Contemporary Marketing at:

**790 MAPLE LANE DEPT. BT 6
BENSENVILLE, ILLINOIS 60106**

TECHNICAL SPECIFICATIONS

MEMORY

Random Access Memory (user memory); 8K internal, expandable to 32K bytes

Read Only Memory (operating system resident in the computer); 14K bytes

8K-BASIC interpreter program

4K-Operating system

1K-Diagnostic routine

1K-Machine language monitor

VIDEO DISPLAY UNIT

9" enclosed, black & white, high resolution CRT

1000 character display, arranged 40 columns by 25 lines

8 x 8 dot matrix for characters and continuous graphics

Automatic scrolling from bottom of screen

Winking cursor with full motion control

Reverse field on all characters (white on black black on white)

64 standard ASCII characters; 64 graphic characters

KEYBOARD

9½" wide x 3" deep; 73 keys

All 64 ASCII characters available without shift.

Calculator style numeric key pad

All 64 graphic and reverse field characters accessible from keyboard (with shift)

Screen Control: Clear and erase

Editing: Character insertion and deletion

CASSETTE STORAGE

Fast Commodore designed redundant-recording scheme, assuring reliable data recovery

Cassette drive modified by Commodore for much higher reliability of recording and record retention

High noise immunity, error detection, and correction

Uses standard audio cassette tapes

Tape files, named

OPERATING SYSTEM

Supports multiple languages (BASIC resident)

Machine language accessibility

File management in operating system

Cursor control, reverse field, and graphics under simple BASIC control

Cassette file management from BASIC

True random number generation or pseudo random sequence

INPUT/OUTPUT

All other I/O supported through IEEE-488 instrument interface for peripherals

I/O automatically managed by operating system software

Single character I/O with GET command

Easy screen line-edit capability

Flexible I/O structure for BASIC expansion with peripherals

BASIC INTERPRETER

8K BASIC; 20% faster than most other 8K BASICS

Upward expansion from BASIC language

Strings, integers, multiple dimension arrays

10 significant digits; floating point

Direct memory access: PEEK and POKE commands

Contemporary
Marketing Inc.

©CMI 1978/84

BYTE's Bugs

Caught Microprocessor Programming

John W Langner, 411 Monterey Blvd, Apt B, Hermosa Beach CA 90254, sent us a letter pointing out a relatively gross terminological faux pas which we allowed to stand in an article entitled "Take a Course in Microprogramming" by Richard Mac Millan on page 168 of the March 1978 BYTE. The terminological ambiguity of the "micro" in the common name for large scale integration computer processors comes from the

fact that the term "microprogramming" is not the same as "programming a computer implemented with a microprocessor." The article should have been edited so that the term "microprogramming" never appeared in the course of its text; the title might better have been changed to "Take a Course in Microprocessor Programming." ■

Bug Bug

In the March 1978 BYTE's Bugs (page 46) we reported on some bugs in figure 1a of David Allen's "A Floppy Disk Interface," January 1978 BYTE, page 61. One more item should be added to the list: disconnect the line presently going to pin 9 of IC3c (the NAND gate which feeds into the \overline{CE} line of IC4). In

its place run a line from pin 9 of IC3c to pin 4 of IC12b (the latter pin is also connected to pin 5 of IC3b). This change is necessary so that IC4 will be addressed when the QC and QD outputs of IC5 are at low and high levels, respectively. We thank Howard Oels of Phoenix AZ for discovering this bug in the bug. ■

Moving Violation

The 6800 program relocater presented on page 197 of the November 1977 BYTE should more properly be called a move routine for use with self-relocatable code only, since it obviously will not fix the internal references of three byte jump instructions. Our thanks to Ed Smith of Ed Smith's Software Works for this information. ■

Your MicroComputer can be a Money-Making Machine with SOFTWARE from SYNCHRO-SOUND

Here are two Software packages that enable you to profitably make full use of the potential in your small computer system: Synchro-Sound's interactive business systems designed for use on an 8080- or Z80-based microcomputer with floppy disks and a hard-copy printer. Written in Microsoft Basic (known as Altair Basic*), the software supports file maintenance, query and reporting functions. This support includes creation, modification and deletion of customer records and processing of transactions to be posted against the files.

ACCOUNTS RECEIVABLE PACKAGE

The A/R module creates a history file of charges, credit and payment records for audit purposes. Payments can be applied to a particular invoice, or to the oldest open items. Batch Mode for monthly statements, aged receivables schedule, and delinquency notice as well as on-line inquiry mode for specific information are both fully implemented.

Operators Manual & Disk—Single Copy

\$500.00

INVENTORY PACKAGE

The inventory system maintains a current listing of stock items featuring on-line transaction processing. Reporting functions include a master inventory listing with price and cost data, reorder alerts, vendor specification, and summary valuations. Year-to-date usage records are kept for each inventory item to facilitate sales analysis.

Operators Manual & Disk—Single Copy

\$500.00

Operators Manual only— **\$35.00** refundable upon purchase of Software Package.

Microsoft Disk Basic—Single Copy **\$350.00**



WRITE OR CALL FOR FURTHER INFORMATION

Full Software-Hardware Systems are now available and additional Software Packages will be available in the near future

*Altair is a trademark of MITS, Inc.

SYNCHRO-SOUND Enterprises, Inc.



193-25 Jamaica Avenue
Jamaica, New York 11423
212/468-7067 TWX 710-582-5886

Hours 9-4 Daily
and Saturday

Working Systems
on display

Dept. B5

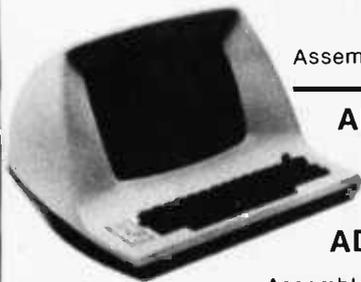
BankAmericard/Master Charge

SYNCHRO-SOUND

ENTERPRISES, INC.

Everything you need in small computer systems!

LEAR SIEGLER ADM 3A TERMINAL



Kit **\$759.95**
Assembled **\$854.95**

ADM 1A TERMINAL

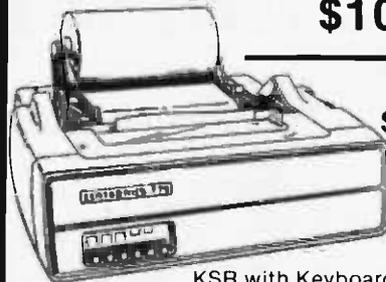
Assembled **\$1529.00**

ADM 2 TERMINAL

Assembled **\$1995.00**

NEW! CENTRONICS 779 PRINTER

\$1099.00



703
SERIAL PRINTER

\$2805.00

761 PRINTER

\$1895.00

KSR with Keyboard

HAZELTINE 1500 VIDEO TERMINAL

Assembled **\$1149.00**
Kit also available



MODULAR 1 INTELLIGENT TERMINAL

Assembled **\$1659.00**

OKIDATA MODEL 110 LINE PRINTER

Friction Feed
\$1199.00



Tractor Feed
\$1349.00

RS 232C Serial Interface
\$260.00

IMSAI 8080 MICROCOMPUTER



With 22 slot
\$649.95

MODEL 22 LINE PRINTER

Tractor Feed **\$2449.00**

TELETYPE MODEL
43 PRINTER
\$1299.00



SPECIAL BUYS

IMSAI Double Density Percsi Drive	\$2295.00
Sorac IQ 120 Video Terminal	959.00
DIGITAL Systems Dual Density Floppy	2745.00
Compucolor 8001 Color Computer	2595.00
ICOM Microfloppy System	989.00
North Star Microfloppy Disk Kit	599.00
Cromemco Z-2 Kit	565.25
Javelin 9" Video Monitor	159.95
Micropolis Model 1053MOD 2	1799.00
IMSAI AP44-44 Col. Printer Kit	329.00
TDL Xitan Alpha 1 Computer Kit	699.00
ICOM Model FD 3712	2795.00

IMSAI PC S-80/15 8085 COMPUTER



Kit
\$749.00

Assembled
\$929.00

We carry a full line of the following: TDL, Centronics, Seals, Hazeltine, Micropolis, Hayden, IMSAI, Cromemco, Compucolor, Icom, Lear Siegler, Okidata, DEC, Javelin, North Star, Peripheral Vision. Same day delivery and shipping on most items. Full modern repair facilities on premises for complete servicing of everything we sell.



SYNCHRO-SOUND ENTERPRISES, INC.

The Computer People

193-25 Jamaica Avenue,
Jamaica, New York 11423

212/468-7067

TWX: 710-582-5886

Hours 9-4 daily
and Saturday

Visit our new showroom
Working units on display

Dept. BBB

BankAmericard • Master Charge

MORE

RECENT ARRIVALS



DIAL YOUR BANK CARD ORDERS ON THE BITS TOLL FREE HOT LINE: 1-800-258-5477.
 In New Hampshire, call: 924-3355.

Send to:
BITS, Inc.
 70 Main Street
 Peterborough, NH 03458



Check payment method:
 My check is enclosed.
 Bill my MC No. _____
 Bill my BAC/Visa No. _____

Exp. date _____
 Exp. date _____

Name _____

Total for all books checked \$ _____

Address _____

Postage, \$.75 per book for _____ books \$ _____

City _____ State _____ Zip Code _____

Outside U.S. \$1.00 per book for _____ books \$ _____

Signature _____

Grand Total \$ _____

You may photocopy this page if you wish to keep your BYTE intact.

Prices shown are subject to change without notice.

— **Periodical Guide for Computerists**, January-December 1977, by E. Berg Publications. This is a comprehensive index of all the articles, book reviews, editorials, letters, record reviews, and miscellaneous small inserts and notes from the top 25 magazines in the field. Several thousand articles are grouped into over 60 subject categories that are listed alphabetically for easy reference. At the back is an author index, including the major areas of their expertise. An indispensable guide for anyone in the fields of personal computing, amateur radio, and electronics. 72 pp. \$5.00.

— **Robots on Your Doorstep** by Nels Winkless and Iben Browning. "This book will amaze you, frighten you, nauseate you, excite you...it will probably make you think about things you have never contemplated before," states the introduction to this clever and well-written account of robots: past, present, and future. Intelligence, artificial intelligence, brain structure and simulation, and characteristics of robots are only a few of the areas explored. One chapter is devoted to the personal computer revolution and how it has brought robots into the amateur's workshop. 179 pp. \$6.95.

— **Programming in PASCAL** by Peter Grogono. This book is an excellent introduction to one of the fastest growing programming languages today. The text is arranged as a tutorial containing both examples and exercises to increase reader proficiency in PASCAL. Besides sections on procedures and files, there is a chapter on dynamic data structures such as trees and linked lists. These concepts are put to use in an example bus service simulation. Other examples range from the Tower of Hanoi problem to circumscribing a circle about a triangle. **Programming in PASCAL** is sure to hold the reader's interest. 359 pp. \$9.95.

— **Z80 Programming for Logic Design** by Adam Osborne, Jerry Kane, Russell Rector, and Susanna Jacobson. Here's the book we've all been waiting for! It's third in the series of Osborne's programming for logic design books (the 8080 and 6800 books). Written for both programmers and logic designers, it explains how an assembly language program can replace non-programmable logic devices—with direct reference to the Z80 microcomputer. 352 pp. \$7.50.

There will be a one dollar price increase on July 1, 1978, so order now and save!

— **8080A/8085 Assembly Language Programming** by Lance A. Leventhal. This book provides an introduction to assembly language programming for the 8080A and the 8085 processors. Included are sections on the instruction sets for the two processors, assemblers, simple program examples, code conversion, tables and lists, subroutines, IO, interrupts, program design, and debugging. Many examples and illustrations are included to cover critical points. 467 pp. \$7.50.

There will be a one dollar price increase on July 1, 1978, so order now and save!

— **How to Profit from your Personal Computer** by Ted G. Lewis. If you have wanted to use your personal computer in a profitable manner, and you feel you need some help planning programming techniques for common business applications, this book is for you. Enjoyable and readable, it contains suggestions for accounting, payroll handling, inventory management, and sorting mailing lists. Many terms and notations are explained. Sample programs in BASIC, the use of blueprints to design program structure, and a full glossary of terms are a few of this book's special features. 191 pp. \$7.95.

— **Microcomputer Primer** by Mitchell Waite and Michael Pardee. Here's a microprocessor tutorial for readers having some electronics background. **Microcomputer Primer** concentrates on the hardware of microcomputers (although there are sections dealing with software) with chapters on basic computer concepts, hardware, programming, memories, and number systems. A full complement of photos and schematics accompanies the text. 224 pp. \$7.95.

— **Programming a Microcomputer: 6502**. This informal, well-written book may be just what you need to enter the world of microcomputers. Caxton C. Foster uses the 6502 as a basis for discussing the techniques of writing programs. The chapters include simple, practical example programs for creating a Morse Code oscillator, combination lock, tune player, digital clock, and more. The emphasis is on clarity, and the many illustrations and flowcharts help get the author's points across. 231 pp. \$9.95.

— **Programmable Calculators** by Charles J. Sippl and Roger J. Sippl. This large (526 pages) book is an exhaustive survey of the programmable calculator field covering its history and present status. Chapters deal with the basic calculator, advanced handheld products, RPN (Reverse Polish Notation) versus algebraic notation, desktop calculators, and programming the programmable calculator. Examples and illustrations abound in this useful reference work. \$14.95.

Here are two big packages of fascinating information and practical guidelines from the symposiums held at the 1977 and 1978 West Coast Computer Faires.

— **The First West Coast Computer Faire Conference Proceedings**, edited by Jim C. Warren, Jr., contains 336 pages covering such topics as: tutorials for the computer novice, human aspects of system design, robots (including the text of a talk by science fiction writer Fred Pohl), computers for the physically disabled, education, electronic mail, music with computers, hardware, software—the list goes on. \$12.00.

— **The Second West Coast Computer Faire Conference Proceedings**, edited by Jim C. Warren, Jr., is 505 pages and covers many of the above topics plus others such as: computers for the visually handicapped, exotic computer games, high level design for microprocessors, computer articles for business and crafts, homebrewed equipment, and speech input and output. You can't miss for only \$13.00.

— **Up your Own Organization!** by Donald M. Dible. A great handbook on how to start and finance a new business, this is the most comprehensive reference we've seen on the subject. For the programmer-consultant or the basement homebrewer-turned-entrepreneur, this is your book. It is recommended in the *Bank of America Small Business Reporter* and *Changing Times* magazines. 372 pp. Available for \$14.95 in hardcover.

— **Fundamentals of Recordkeeping and Finance for the Small Business** by Robert C. Ragan, CPA, and Jack Zwick, Ph.D. Once you have your organization or business up and running, records must be kept. What should I keep, and how do I record them? This book on fundamentals will give you a helpful start. Section One deals with maintaining records, protecting assets, and providing a basis for planning. Section Two provides a starting point for owner-managers who want to sharpen their financial management skills. 196 pp. Only \$10.00 in hardcover.

Dealer orders on quantity purchases invited.

BITS The Microcomputer Bookstore

Continued from page 11

Shore) who decided to feed the output from his orbital motion program into our music system (instead of data that represented conventional music). The results were very intriguing, and quite modernly musical. They helped us all see the power of allowing human imagination to work with objects that represent a new kind of clay or paint—in this case algorithms for solving differential equations! The designer of the music system (Jeff Lederer) had obviously developed a use of technology that was radically different from the fanciest of "record players."

The same ideas apply to color graphics. Photo 1 shows a very simple example of using an algorithm as a creative adjunct. The first slide shows a static use of the medium. The artist simply used a light pen to "paint" a bouquet of flowers on the screen of a Compucolor 8051. Photo 2 shows what happens when the computer is no longer static. In this case it uses two algorithms: one to draw nothing more than the simple elegance of a sine curve, the other to join the artist's light pen input to the computer's sine curve with vectors. Our

feeling is that the second mode is great for people (including very young kids) who haven't yet developed the techniques needed for painting a bouquet of flowers or composing a two-dimensional space abstractly (which is what the sine function does in this context). From the point of view of technical competence, the first mode (static computer) is the more advanced one. The function of the second mode is to get the user thinking creatively so that he or she can eventually go beyond what the machine helped start.

Translating this idea into a general philosophy of "Why personal computing?" gives the unexpected but heartening answer: "To help people do things computers can never do."

Tom Dwyer
Margot Critchfield
325 N Craig St
Pittsburgh PA 15213

Tom Dwyer and Margot Critchfield's article, "Color Graphics on the Compucolor 8051," appeared on page 32 of BYTE May 1978.

TEXT EDITING DREAMS AND REALITIES WITH AN AM-100

This is in response to your March 1978 editorial. A friend of mine asked me two years ago to create a keyboard especially for him. He was at that time employed as a phototypesetter for the *Los Angeles Free Press*. As a result I got heavily involved in the discrepancies between the needs of a typesetter and the available [Singer-Friden-Burroughs-IBM-3%&†*(\$+&!&%)] word processors! Therefore, your editorial on the desire for a truly sophisticated editor stirred some painful memories of TTS book codes, incompatible character sets and paper tape format, TTL logic, etc. The project never did "fly" right.

However, since that time I've come across (and purchased) a system that I am surprised you haven't given heavier mention of in your magazine. I am referring to the Alpha Microsystems AM-100. Let me explain why I feel it could result in the editor you are searching for.

The AM-100 processor is a two board realization designed to interface with a parallel operating 8080/Z-80 CPU on the Altair (S-100) bus. It uses the Western Digital WD-16 chip set, which is an extended version of the DEC LSI-11, but using special microcoding to create a more powerful instruction set. Using this, Mr Wilcox has made an operating system similar to UNIX, with some features of DECsystem 10. Included in the software bundled with the processor is the operating system (it supports eight users with full timesharing protocols), a powerful macro assembler, BASIC, LISP, and a system EDIT.PRG, all disk oriented. For a preliminary feel for what this means, read *Dr Dobb's Journal*, volume 2, number 1, page 3. The AM-100 system manuals comprise, at present, over 250 pages of closely packed information.

Robert Williams
President, Cheesy Operations
Micromouse Enterprises
POB 69
Hollywood CA 90028



IMPROVING RELATIVE ADDRESSING FOR THE 8080

I read with great pleasure Mr Gaskell's article on "Relative Addressing for the 8080" in the December 1977 BYTE. The approach to implementing the relative jumps was superb.

However, having been working with microcomputer applications for several years, I have learned that any program can be made shorter and faster with a little effort! Moreover, optimization in the case of the relative addressing routine is even more critical than usual since the code will be executed with

Announcing . . .

SMALL BUSINESS COMPUTERS Magazine

The magazine for users and potential users of small business computer products and services

- The monthly magazine for businessmen in the process of purchasing or installing their first computers.
- The practical *how-to* publication written in non-technical language and stressing business applications for small computer systems. Each monthly issue includes:

FEATURE SURVEY REPORTS: Such as, *Software Packages for Small Business Applications*, *Small Manufacturing Systems*, *Inventory Control Systems*, *Microcomputer Business Applications*, and so on.

APPLICATION STORIES: Real-life examples of computer applications in the small business environment — capabilities, benefits, what to watch for, and much more of direct interest to the small businessman.

COMPUTER PROFILES • IDEAS AND INNOVATIONS • INFORMATIVE ADS

SPECIAL CHARTER SUBSCRIPTION
12 issues @ 50% off

Receive the next 12 issues of **Small Business Computer Magazine** for just \$9. 50% off the cover price

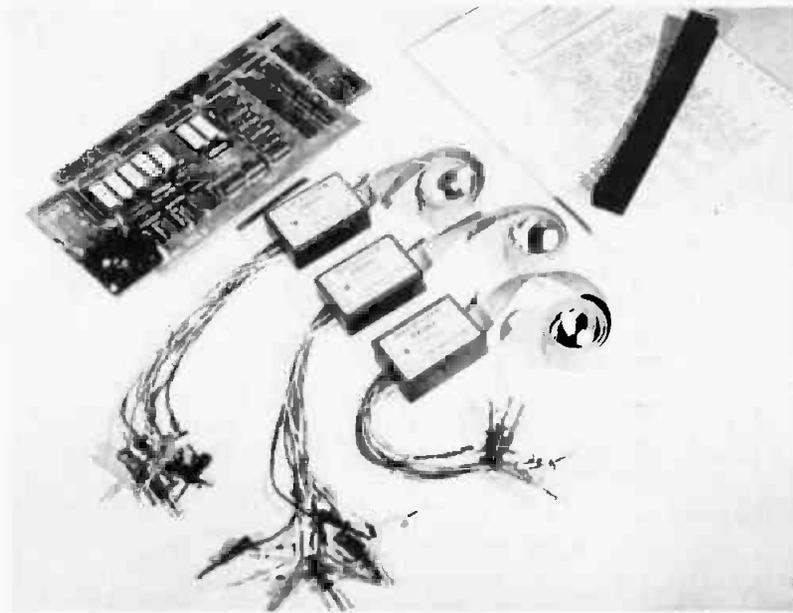
Mail the coupon today to: **SMALL BUSINESS COMPUTERS Magazine**
33 Watchung Plaza • Montclair, NJ 07042

SMALL BUSINESS COMPUTERS Magazine • 33 Watchung Plaza • Montclair, NJ 07042

- YES. Enter my charter subscription at the 1/2-price cost of \$9 for 12 monthly issues.
- Check enclosed. Bill me.

Name _____
Organization _____
Address _____
City/State _____ Zip _____

DATALYZER . . . a 24 channel Logic Analyzer for your S100 Bus



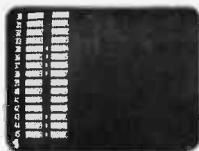
24 Channel LOGIC ANALYZER, complete with 2 cards and 3 sets of probes.

Features

- 24 channels with 256 samples each.
- Display of disassembled program flow.
- Dual mode operation — external mode analyses any external logic system. Internal mode monitors users data and address bus.
- Selectable trigger point anywhere in the 256 samples.
- 0-16 bit trigger word format or external qualifier.
- 8MHz sample rate
- Synchronous clock sample with coincident or delayed clock mode.
- User defined reference memory.
- Displays and system control through keyboard entry.
- TTL Logic level compatible (15 pf and 15 μ a typical input loading.)



Displays in Binary



Displays in Hex



Display of disassembled program flow.

The DATALYZER

Designed to plug easily into your S-100 Bus, the DATALYZER is a complete system — for only \$595. Display of disassembled program flow is a standard feature, not an extra. And the low price includes 30 logic probes, so you can hook up immediately, without additional expense.

The DATALYZER is available in kit form (\$595), and as a fully assembled device on two PCB's (\$695). Operators' manual \$7.50. A substantial warranty, and the Databyte, Inc. commitment to service make the DATALYZER a worthwhile investment.

Databyte, Inc.

7433 Hubbard Avenue
Middleton, Wisconsin 53562
Tel: (608) 831-7666

BYTE's Bits

ACM Seeks Nominations for Annual Grace Murray Hopper Award

The Association for Computing Machinery is seeking nominations for its Grace Murray Hopper Award, given each year to the outstanding young computer professional selected on the basis of a single recent major technical or service contribution to the computer industry. In order to qualify, candidates must have been 30 years of age or less at the time the qualifying contribution was made.

The award will be presented at the opening session of the association's Annual Conference on December 4 1978, in Washington DC. The award is in the amount of \$1000, donated by the Univac Division of Sperry Rand, and is accompanied by a certificate.

While the award is given to the outstanding young "computer" professional, emphasis for the 1978 award will be placed on contributions in the fields of business data processing and personal computing. The committee felt that these fields have not been adequately rewarded for outstanding contributions in the past.

The last three winners of the Grace Murray Hopper Award were: Edward A Shortliffe, for his development of a program that consults with physicians about diagnosis and treatment of infection; Allen L Scherr, for his pioneering study in quantitative computer performance analysis; and George N Baird for the development and implementation of the U S Navy's COBOL compiler evaluation system.

Nominations, which may be made by the nominees themselves, should be sent to:

Richard G Canning
Chairman, ACM Grace Murray
Hopper Award Committee
925 Anza Av
Vista CA 92083

In order to be considered for the 1978 award, nominations should be received by Mr Canning no later than June 30 1978.

Please include the following information.

1. Name, address and phone number of the person making the nomination.
2. Name, address and phone number of the nominee.
3. A statement (200 to 500 words) on why the candidate deserves the award, describing the contribution.
4. The date of birth of the nominee and the date on which the qualifying work was completed. ■

Carnegie-Mellon Sponsors a Workshop

Carnegie-Mellon University will sponsor an intensive five day microcomputer workshop June 5 thru 9 1978 on the CMU campus. The program will include hands on experience for those who have a serious interest in applying microprocessor systems to a practical problem. It is intended to provide a foundation of theoretical knowledge and practical experience about the capabilities and limitations of microcomputers and what it takes to apply them on the job.

The concepts and techniques introduced in class are implemented by more than 12 hours of hands on problem solving experience. The workshop format emphasizes opportunities to review and discuss the sample problems and their alternative solutions with the faculty and other class members.

For more information call Gerry Cohen at (412) 578-2207 or write Post College Professional Education, Carnegie Institute of Technology, Carnegie-Mellon University, Schenley Park, Pittsburgh PA 15213. ■

Harvard University Announces International Computer Graphics Week

Harvard University has announced an international Computer Graphics Week July 23-28 1978, to be sponsored by the school's Laboratory for Computer Graphics and Spatial Analysis.

The event will focus on the Laboratory's International Users Conference on Computer Mapping Software and Data Bases: Application and Dissemination. At the conference over 100 speakers and numerous exhibits from the commercial, educational and governmental sectors will show how computer mapping is being used in city and regional planning, social services, public safety, transportation and engineering, ecology and the environment, energy, public health, marketing, research and development, management information systems and university research and instruction.

In addition there will be an in-depth review of currently available computer mapping software and data bases, as well as sessions on thematic map design principles and a hands-on workshop at the Harvard Laboratory. Among special features will be a session on software and data base distribution and marketing and an executive briefing seminar to discuss the relevance and projected impact of computer mapping in the commercial sector. For more information, contact Ira Alterman at the Center for Management Research, Executive Plaza, 850 Boylston St, Chestnut Hill MA 02167, (617) 738-5027. ■



Hobbyists! Engineers! Technicians! Students!

Write and run machine language programs at home, display video graphics on your TV set and design microprocessor circuits—the very first night—even if you've never used a computer before!

ELF II featuring RCA COSMAC microprocessor/mini-computer

\$99⁹⁵

Get "hands on" experience with a computer for just \$99.95. Then, once you've mastered computer fundamentals, expand ELF II with low cost add-ons and you've got an advanced personal computer powerful enough to solve business, industrial or scientific problems.



ELF II by NETRONICS as featured in POPULAR ELECTRONICS shown with optional 4k Memory Boards, GIANT BOARD™, Kluge Board and ASCII Keyboard

Learning Breakthrough! A Short Course On Microprocessor And Computer Programming

Written for anyone! Minimal background needed!

Using advanced computers is now as easy as driving a car with an automatic transmission. We will teach you, step by step, instruction by instruction, how to use an RCA COSMAC computer.

Not only does our short course explain computers, it helps anyone write and run programs and solve complex problems requiring a computer. Knowing how a computer works can help you.

(1) Spot situations where a computer can assist you in business, industry, personal applications, etc. (2) Select the most economical computer (or microprocessor) and related hardware for your specific needs; (3) Write and run the programs you need; and (4) Keep your computer costs down.

This course was written for ELF II users but... it's a blockbuster for every RCA COSMAC user or owner!

Stop reading about computers and get your hands on one. ELF II is an outstanding trainer for anyone who needs to use a computer to maximize his or her personal effectiveness. But ELF II isn't just a trainer. Expanded, it becomes the heart of a powerful computer system.

For \$99.95 You Get All This—

No other small personal computer offers video output and ELF II's expansion capabilities for anywhere near \$99.95. ELF II can create graphics on your TV screen and play electronic games! It pays for itself over and over again in the fun it provides for your whole family. Engineers and hobbyists can use ELF II in microprocessor-based circuits as a counter, alarm, lock, thermostat, timer, telephone dialer, etc. The possibilities are endless!

The ELF II Explodes Into A Giant!

Once you've mastered computer fundamentals, ELF II can give you POWER! Plug in the GIANT BOARD™ and you can record and play back your programs, edit and debug programs, communicate with remote devices and make things happen in the real world. Add Kluge Board to solve specific problems such as operating a more complex alarm system or controlling a printing press. 4k memory units let you write longer programs and solve even more sophisticated business, industrial, scientific and personal finance problems.

Add ELF II Tiny BASIC And Keyboard!

To make ELF II easier to use, we've developed ELF II Tiny Basic. It lets you program ELF II with simple words you can type out on a keyboard such as PRINT, RUN and LOAD. ELF II responds by displaying answers on your printer, video monitor or TV screen.

Write And Run Programs The Very First Night!

The ELF II kit includes all components and everything you need to write and run your own programs plus the new Pixie Graphics chip that lets you display any 256 byte segment of memory on a video monitor or TV screen. No wonder ELF II is now being used as a trainer in many high schools and universities.

Easy instructions get you started right away, even if you've never used a computer before. The newly expanded ELF II Manual covers assembly, testing, programming, video graphics and games.

ELF II can be assembled in a single evening and you'll still have time to run programs including games, video graphics, etc. before going to bed!

SEND TODAY!

NETRONICS R&D LTD., Dept. BY-6 (203) 354-9375
333 Litchfield Road, New Milford, CT 06776

- YES! I want to run programs at home and have enclosed: \$99.95 plus \$3 p&h for RCA COSMAC ELF II kit. \$4.95 for power supply, required for ELF II kit. \$5.00 for RCA 1802 User's Manual.
- \$4.95 for Short Course on Microprocessor & Computer Programming.
- ELF II connects to the video input of your TV set. If you prefer to connect ELF II to your antenna terminals instead, enclose \$8.95 for RF Modulator.
- \$39.95 plus \$2 p&h for ELF GIANT BOARD™ kit.
- 4k Static RAM kit, \$89.95 ea. plus \$3 p&h.
- \$17.00 plus \$1 p&h for Prototype (Kluge) Board.
- \$34.95 plus \$2 p&h for Expansion Power Supply kit.
- Gold plated 86-pin connectors at \$5.70 ea.
- \$64.95 plus \$2 p&h for ASCII Keyboard kit.
- \$14.95 for ELF II Tiny BASIC cassette.
- I want my ELF II wired and tested with the power transformer, RCA 1802 User's Manual and Short Course on Microprocessor & Computer Programming for \$149.95 plus \$3 p&h.

Total enclosed (Conn. res. add tax) \$ _____ Check here if you are enclosing Money Order or Cashier's Check to expedite shipment.

NAME _____
ADDRESS _____
CITY _____
STATE _____ ZIP _____

DEALER INQUIRIES INVITED

SPECIFICATIONS

ELF II features and RCA COSMAC COS/MOS 8-bit microprocessor addressable to 64k bytes with DMA, interrupt, 16 registers, ALU, 256 byte RAM, full hex keyboard, two digit hex output display, 5 slot plug-in expansion bus (less connectors), stable crystal clock for timing purposes and a double-sided, plated-through PC board plus RCA 1801 video IC to display any segment of memory on a video monitor or TV screen.

EXPANSION OPTIONS

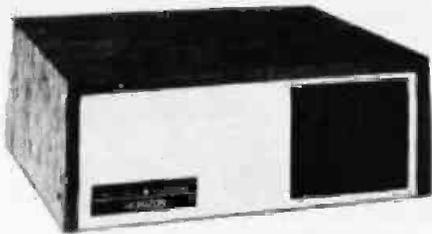
- **ELF II GIANT BOARD™** with cassette I/O, RS 232-C/TTY I/O, 8-bit P I/O, decoders for 14 separate I/O instructions and a system monitor/editor. Turns ELF II into the heart of a full-size system with massive computing power! \$39.95 kit.
- **4k Static RAM.** Addressable to any 4k page to 64k. Uses low power 2102's. Chip select circuit allows original 256 bytes to be used. Fully buffered. Onboard 5 volt regulator. \$89.95 kit.
- **Prototype (Kluge) Board** accepts up to 36 I.C.'s including 40, 24, 22, 18, 16, 14 pin. Space available for onboard regulator \$17.00.
- **Gold plated 86-pin connector.** \$5.70.
- **ELF II Full ASCII Keyboard.** Upper and lower case. \$64.95 kit.
- **5 amp Expansion Power Supply.** Powers the entire ELF II (Not required unless adding 4k RAM boards.) \$34.95 kit.

All of the above PC boards plug directly into ELF II's expansion bus.

ELF II TINY BASIC

Communicate with ELF II in BASIC! ELF II Tiny BASIC is compatible with either ASCII keyboard and TV screen or standard teletype/video terminal utilizing RS 232-C or 20 mil TTY interface. Commands include SAVE and LOAD for storing programs on standard cassettes, a plot command to display graphic information and special commands for controlling ELF II I/O devices. 16-bit integer arithmetic, +, -, ×, ÷, (). 26 variables A-Z. Other commands include LET, IF/THEN, INPUT, PRINT, GO TO, GO SUB, RETURN, END, REM, CLEAR, LIST, RUN, PLOT, PEEK, POKE. Comes with maintenance documentation and excellent user's manual that allows even beginners to use ELF II for sophisticated applications. (4k memory required.) \$14.95 on cassette tape.

Coming Soon . . . D-A, A-D Converter • Controller Board • Cabinet • Light Pen (Lets you write or draw anything on a TV screen. Imagine having a "magic wand" that writes like a crayon!)



NORTH STAR

Z-80 BEST VALUE — SAVE 15%

Complete Minifloppy Disk System w/BASIC and drive. Kit List \$699... **SPECIAL \$599**
 Assembled List \$799 689
 16K Dynamic RAM, Kit List \$399... 329
 Assembled List \$459 379
 4 MHz Z-80 CPU Board, Kit List \$199 169⁹⁵
 Assembled List \$259 209
 CPM Disk Operating Sys. Conversion Pkg. for North Star (latest version) 145
 TDL Package A Software for North Star on North Star Disk (specify if for TDL System Monitor Board use) 249

HORIZONS

— ALL MODELS —

ABSOLUTELY BEST PRICES
 AND BEST DELIVERIES
 CALL FOR INFORMATION

Horizon-1, Kit List \$1599 \$ 1349
 Assembled and tested List \$1899... 1599
 Horizon-2 (with 2 drives) Kit List \$1999 1699
 Assembled and tested List \$2349 1939

CROMEMCO

TOP-SHELF Z-80 SYSTEM

SAVE 15% — and more!

System 2 List \$3990 \$ 3490.00
 System 3 List \$5990 4999.95
 Z-2 Kit List \$595 505.00
 Assembled List \$995 845.00
 Z16KZ-K 16K RAM Board, Kit ONLY 399.00
 Assembled List \$795 599.00
 CROMEMCO BOARDS LESS 10%

INQUIRE ABOUT NEW CROMEMCO
 MULTI-USER BASIC SYSTEM!

**TDL — SAVE UP TO 50%
 EXTREMELY VERSATILE!**

System Monitor Board, less Zapple Monitor ROM and on-board RAM, Kit, formerly \$295 \$ 147.50
 Assembled, formerly \$395 197.50
 Board as supplied features power-on jump, parallel I/O port, two serial I/O ports, plus cassette interface.

Zapple Monitor ROM or 1K RAM for above 29.95

Xitan Alpha 1 List \$993 **SUPER BUY 789.00**
 SUBSTANTIAL SAVINGS — ALL XITANS

ALL TDL HARDWARE AND SOFTWARE
 AT LEAST 15% OFF!

BARGAIN SYSTEM

SAVE OVER \$500

Contact us for a system equal to a Xitan!

For Handling, shipping, and insurance, add \$10 per mainframe, \$3 per disk drive, \$2 per board.

— SEND FOR FREE CATALOG —

MiniMicroMart, Inc.

1618 James Street
 Syracuse, New York 13203
 Phone: (315) 422-4467

National Bureau of Standards Symposia: Microcomputers

Current and future benefits of micro-computer technology will be weighed at the Symposium on Microcomputer Based Instrumentation, to be held at the National Bureau of Standards (NBS), Gaithersburg MD, on June 12 and 13 1978. Sessions in four major areas, each highlighted by an overview presentation, will focus, respectively, on microcomputer technology, applications to scientific instrumentation, microcomputer interface standards, and applications to industrial process control. This symposium, cosponsored by NBS, the Institute of Electrical and Electronics Engineers (IEEE) Computer Society, and the IEEE Group on Instrumentation and Measurement, will mark the opening of a series on Challenges in Science and Technology.

The symposia series, instituted by NBS Director Dr Ernest Ambler, is intended to encourage a cross-fertilization of ideas from many disciplines. Participating scientists of diverse backgrounds will jointly assess current trends and future needs. Each symposium will feature contributed or invited papers from within and outside the bureau.

Major papers at the June 12 and 13 symposium will include:

- Microcomputers for Biomedical and Clinical Applications
- Microprocessor Based Satellite Controlled Clock
- Fault Tolerance in Distributed Architectures
- Microcomputers in the Linear World
- Control of a 1 Gigahertz CCD Transient Digitizer
- Automating Analytical Instrumentation

For more information on sessions or schedules of the microcomputer symposium, contact Bradford M Smith, Room A130 Technology, National Bureau of Standards, Washington DC 20234, (301) 921-2381.

The second event in the series will be the Symposium on Atomic and Molecular Science and Technology, September 7 and 8 1978. For details contact Dr Stephen J Smith, Joint Institute for Laboratory Astrophysics (JILA), National Bureau of Standards, Boulder CO 80303, (303) 499-1000, extension 3631.

Tentatively scheduled for January 1979 is the third in the series, the Symposium on Mathematical Modeling. For details contact Dr J R Rosenblatt, NBS Applied Mathematics Division, Room A337 Administration, Washington DC 20234, (301) 921-2315.

Coordinating the Symposia on Challenges in Science and Technology is Dr Helmut Hellwig, NBS Time and Frequency Division, Boulder CO 80303, (303) 499-1000, extension 3277. ■



PROFESSIONAL TERMINAL

INTERTUBE® — The fantastic new video terminal with 12" screen, 24x80, 128 upper-lower case ASCII characters, 16 programmable function keys, 14-key numerical key pad, protective fields, and much, much more... compare with ADM, Soroc, Hazeltine... **FANTASTIC PRICE: ONLY \$ 784**

COMPLETE BUSINESS SYSTEM

With keyboard and video terminal, Z-80 processor, 32K memory, dual minifloppy disks (286 kilobytes), Teletype 43 printer (30 cps pin-feed platen), Extended BASIC Software, assembled and tested with interfaces ready to use — ALL for...

\$3,995⁰⁰

S-100 MEMORY BOARDS

Dynabyte* 16K Dynamic RAM Module List \$390 \$ 319
 Dynabyte* 16K Fully Static RAM Module Model 1625, 250ns List \$555 444
 Model 1645, 450ns List \$525 420
 Dynabyte* 32K Fully Static RAM Module Model 3225, 250ns List \$995 796
 Model 3245, 450ns List \$925 740
 * ASSEMBLED AND TESTED — ONE YEAR WARRANTY
 SD 32K Dynamic w/8K, Kit 149
 SD 32K Dynamic w/16K, Kit 249
 SD 32K Dynamic w/32K, Kit 449
 16K Static (Famous Brand) formerly sold at \$699 **SUPER SPECIAL: \$399**
 TDL VDB 25x80 Video Display Board, assem/tested reg. \$369 **NOW 314**

ASCII KEYBOARDS in enclosure (surplus) **STARTING AT: \$ 44.95**
 IBM 735 I/O SELECTRICS (used) from: \$395
 TELETYPESS (immediate delivery)
 KSR-33 (used) as low as \$ 495
 ASR-33 (used) as low as 695
 NEW MODEL 43, 30 cps. starting at 995
 Famous DECwriter II (new) 1490
 ALL PRICES PLUS SHIPPING
 SEND FOR FREE CATALOG

MiniMicroMart, Inc.

1618 James Street
 Syracuse, New York 13203
 Phone: (315) 422-4467

MUMPS Group to Meet in San Francisco

MUMPS Users' Group (MUG) will meet in San Francisco CA on June 7 thru 9 1978, at the Jack Tar Hotel. The conference includes all day tutorials on programming in MUMPS, ambulatory care information systems, technical aspects of ANSI Standard MUMPS, formal presentations of medical and nonmedical applications, panel and discussions on applications on computers in medicine. The conference is the same week as the NCC in Anaheim CA. For more information contact Pat Zimmerman, Dept of Biometry, Wearn Research Bldg, University Hospitals, Cleveland OH 44106. ■

What Might Be Called CACHE's On Line Graffiti (COG)

In a recent phone conversation with Ward Christensen, confirmed by a copy of *The CACHE Flash* newsletter, I learned about an experiment called the Computerized Bulletin Board System. This system was implemented over a weekend by Ward and another member of CACHE, Randy Suess. It is an 8080 computer system, floppy disk and auto answer modem running 24 hours a day just to see what happens. According to its originators, all you do is call (312) 528-7141 with a 110 bps or 300 bps modem handy, connected to your terminal (or your computer emulating a terminal). When the tone is heard (assuming you don't find a busy signal because of all the other people reading this notice who are trying the same operation) you connect your modem and proceed with an interactive sequence. A session begins when you slowly type a series of isolated carriage returns (ASCII hexadecimal code 0D) which enable the system to determine the speed of your terminal. After that, the system provides the caller with interactive prompting about its various functions. The system has been running since early this year; according to Ward people have been calling and leaving messages from all over the country. It represents a practical implementation of some of the networking concepts which people are talking and writing about for use with personal computers. For those unfamiliar with the organization, CACHE is the Chicago Area Computer Hobbyist Exchange, located at POB 52, South Holland IL 60473, with meetings once a month on the third Sunday of the month. For more information call Dave Jaffe, (312) 849-1132.

Bulletin Board System

The interactive Bulletin Board system implemented by Ward Christensen and

Introducing Bit Pad.

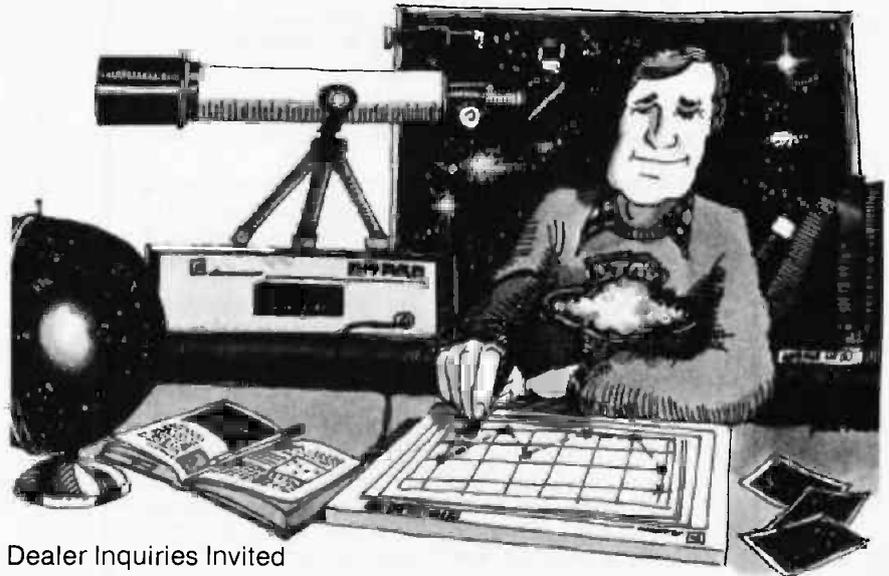
The new,
low-cost digitizer for
small computer systems.

Bit Pad is the newest product from Summagraphics, the leading producer of professional digitizers. It has a small 11-inch active area and a small \$555 price tag. But the list of applications is as big as your imagination.

Better than a joystick or keyboard for entering graphic information, it converts any point on a page, any vector, any distance into its digital equivalents. It's also a menu for data entry. You assign a value, or an instruction to any location on the pad. At the touch of a stylus, it's entered into your system.

Who can use it? Anyone from the educator and the engineer to the hobbyist and the computer games enthusiast. The data structure is byte oriented for easy compatibility with small computers, so you can add a power supply, stand-alone display, cross-hair cursor and many other options.

\$1,000.00 creativity prize. You can also add \$1,000.00 to your bank account as a reward for your inventiveness. Just write an article on an original Bit Pad application and submit it to any national small-computer periodical. If the editors publish it — and the decision is solely theirs — Summagraphics will pay you \$1,000.00. Contact Summagraphics for rules concerning this offer.



Dealer Inquiries Invited



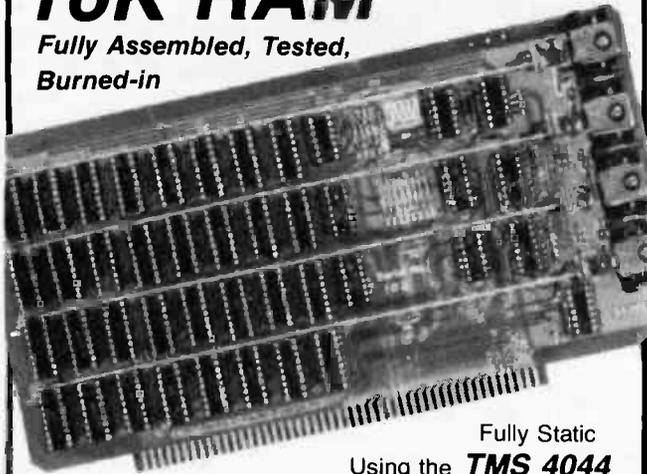
Summagraphics
corporation

35 Brentwood Ave., Box 781, Fairfield, CT 06430
Phone (203) 384-1344. TELEX 96-4348

Visit us at NCC Booth Nos. 1760 and 1762

16K RAM

Fully Assembled, Tested,
Burned-in



Fully Static
Using the **TMS 4044**

250 nsec. chips—\$425

Z-80A 4 Mhz. Fast—This fully assembled and tested 16K board was designed to operate without wait states in a 4 Mhz. Z-80A system allowing over-generous time for CPU board buffers.

450 nsec. chips—\$375

For 2 Mhz. Systems—Same circuit as above but priced lower because of less expensive memory chips. It is fully assembled, burned-in, tested and guaranteed.

8K Versions Also Available

Both boards available fully assembled with sockets for all 32 MOS chips but supplied with only 8K of chips. 8K—250 nsec.—\$265. 4K chip set—\$95. 8K-450 nsec.—\$235. 4K chip set—\$85.

Fully Static is Best—Both boards use the state-of-the-art Texas Instruments TMS 4044 which requires no complicated and critical clocks or refresh. The fully static memory chip allows a straight-forward, "clean" design for the board ensuring DMA compatibility. They use a single 8 volt power supply at 1.7 amps nominal.

Fully S-100 Bus Compatible—Each 4K addressable to any 4K slot and separately protected by DIP switches.

Commercial Quality Components—First quality factory parts, fully socketed, buffered, board masked on both sides, silk-screened, gold contacts, bus bars for lower noise.

Guaranteed—Parts and labor guaranteed for one full year. You may return undamaged board within ten days for a full refund. (Factory orders only—dealer return policy may vary).

Check your local computer store first

Factory Orders — You may phone for MC, VISA. Cashier's check, M.O. speed shipment for mail orders. Personal check OK. Shipped prepaid with cross country orders sent by air. Shipping — Stock to 72 hours normal. We will confirm order and give expected shipping date for delays beyond this. Washington residents add 5.4% tax. Spec. sheet, schematic, warranty statement sent upon request.



Seattle Computer Products, Inc.

16611 111th S.E., Renton, Washington 98055
(206) 255-0750

Randy Suess produces this hard copy upon signing on. The entire system is interactive, so that all the instructions and prompting information a user needs can in principle be obtained by interacting with it. This text printout was obtained by answering "y" for yes to a number of the prompting queries. We only show a small excerpt of what can be a long and fascinating interactive communications session.

```
#1  TERMINAL NEED NULLS? TYPE CTL-N WHILE THIS TYPES:
    *** WELCOME TO WARD AND RANDY'S ***
    *** COMPUTERIZED BULLETIN BOARD SYSTEM ***

2--> CONTROL CHARACTERS ACCEPTED BY THIS SYSTEM:
DEL/RHROUT  ERASES LAST CHAR. TYPED (AND ECHOS IT)
CTL-C       CANCEL CURRENT PRINTING
CTL-K       'KILLS' CURRENT FUNCTION, RETURNS TO MENU
CTL-N       SEND 5 NULLS AFTER CR/LF
CTL-R       RETYPES CURRENT INPUT LINE (AFTER DEL)
CTL-S       STOP/START OUTPUT (FOR VIDEO TERMINAL)
CTL-U       ERASE CURRENT INPUT LINE

----- BULLETIN -----
PROBLEMS WITH THE SYSTEM??
FOR HARDWARE CALL RANDY AT (312) 935-3356
FOR SOFTWARE CALL WARD AT (312) 849-6279
)
----- BULLETIN -----
MARCH CASHIE MEETING, SUN, THE 19TH.  DETAILS IN MSG. 101
)

Y/N: IS THIS YOUR FIRST TIME ON THE SYSTEM?Y
Y/N: CAN YOUR TERMINAL RECEIVE LOWER CASE CHARACTERS?Y
File last updated 3/14/78

When you are asked a question, answer with Y for yes,
or N for no.
Are you using a video terminal (not a printer)?y
When the system is typing, you can use control-S to stop
the output to look at it, then again to continue. This will
allow you to see what is sent before it scrolls off.

Want summary of system functions?y
The system has only three major functions:
  > Entering messages
  > Retrieving message summaries
  > Retrieving messages

Want to know purpose of this system?y
It was conceived, financed, and is run by Ward Christensen
and Randy Suess for message communication between computer
hobbyists. Typical message subjects include: 'something for
sale', 'need help with something', 'club meeting notice',
or just sharing ideas. Feel free to leave a message on
any hobbyist computer related subject.

Want to know what hardware makes up the system?y
The hardware consists of:
Vector/1 mother board
Card cage
Vector Reset and Go Prom/Ram board
IMSAI 8080 CPU board
24K of various memory
Tarbell floppy disk controller
Innovex floppy disk
DC Hayes modem board
Polymorphic VTI video board
SWTPC keyboard
Processor Tech. 3P+S
ASR-33 for message logging

Want a quick summary of what to do your first time?y
1. S - Use the S function to retrieve message summaries
  * Start with message 1
  * Use control-S to stop/start output.
  * Write down message numbers you want to see.
  * Use control-K to kill the summary, return to menu
2. R - Use R function to retrieve messages of interest.
3. G - Use the G (good bye) function when you are done.

Remember to use the H (Help) function for details.
WHAT IS YOUR FIRST NAME?new
WHAT IS YOUR LAST NAME?user

LOGGING NAME TO DISK...
FUNCTION: B,C,O,E,G,H,N,R,S,W, (OR ? IF NOT KNOWN)??

FUNCTIONS SUPPORTED:
R=PRINT BULLETIN
C=CASE SWITCH (UPPER/LOWER)
D=DUPLEX SWITCH (ECHO/NO ECHO)
E=ENTER MSG INTO SYSTEM
G=GOOD BYE (LEAVE SYSTEM)
H=HELP WITH FUNCTIONS
I=NULLS: SET 0 TO 9 AS REQUIRED
R=RETRIEVE MSG
S=SUMMARIZE MSGS
W=TYPE WELCOME

FUNCTION: B,C,O,E,G,H,N,R,S,W, (OR ? IF NOT KNOWN)?h'u'
?s
STARTING MESSAGE NUMBER (C/R TO RETURN TO MENU)?169
USE CTL-K TO ABORT, CTL-C TO SKIP, CTL-S TO PAUSE.

NO. SIZE --DATE-- --FROM-- --TO--
169 16 3/19/78 WARD CHRISTENSEN IMSAI OWNERS
```

Survey Contest Results

The 1978 BYTE Reader Survey, mailed to 5000 randomly selected addresses on our mailing list on January 15 1978, featured an informal incentive contest drawing from among those individuals who returned completed survey forms. The drawing was held on March 15 1978 in our offices, with the names of the three winners documented here:

First Place (the first name drawn) was a \$500 check sent to T L Balog of Cleveland OH.

Second Place (awarded to the second two names drawn) was a \$250 check sent to J Edward Potzler of Brookfield IL and another \$250 check sent to Robin Sutton-Brown of Fresno CA.

We wish to thank all the individuals who participated in this survey for-

Ask BYTE

SPECIFICATIONS SOURCES

Can you tell me where a beginning hacker can get transistor and integrated circuit specifications? Where I shop, one or two ratings are readily available, but more detailed characteristics under varying conditions are not.

James Howard
3600 Parker Av
Louisville KY 40212

Several mail order parts suppliers make available engineering documentation for the common integrated circuits. In our work at BYTE, the most frequently referenced books are those of Texas Instruments. This series of books includes one or two textbooks and manuals of specifications on subjects ranging from TTL integrated circuits to memory parts to optoelectronics to discrete transistors and linear integrated circuits. (These books are marketed by BITS Inc, 70 Main St, Peterborough NH 03458.) The next most frequently referenced compendium of technical specifications for integrated circuits is the set of documentation put out by National Semiconductor, but this set is much less readily available. For other manufacturers and parts not covered in these two libraries, we have to rely on a random collection of individual specification sheets, since books don't seem to be available. ■

turning the filled out forms. The results are being tallied as this is written (March 29 1978) and are expected to be summarized in BYTE towards the end of this coming summer as well as being made available in more complete form as a report available on request. ■

A Metamorphosis

Recently we received the first copy of a journal with which we have long been familiar under a previous name and format. The *PPC Journal* is the new format and name for the HP-65 Users Club publication formerly called *65 Notes*. (The group is not affiliated with Hewlett-Packard.) This publication is the work of Richard J Nelson, 2541 W Camden Pl, Santa Ana CA 92704. Quoting from fine print in the volume 5 number 1 issue, "The Club is a volunteer, non-profit, loosely organized, independent, worldwide group of Hewlett-Packard personal programmable calculator users. The official Club publication, *PPC Journal*, formerly *65 Notes*, disseminates user information related to applications, programs, programming techniques, problems, hardware, innovations,

any information related to the selection, care, use and application of Hewlett-Packard Personal Programmable Calculators."

The first issue of the new format contains 36 pages of material in a saddle stitched booklet form with three hole punching that enables the user to accumulate issues in an ordinary three ring binder. The materials in this issue include the following titles:

- "Sampling Without Replacement"
- "Calculator Wish List"
- "Calculator Patents & Programs"
- "Adjusting HP-97 Print Density"
- "Uneven & Irregular Cash Flows"
- "The Games of King & Hammurabi"
- "Beginners' Programming Tricks"
- "Calendar Algorithms"
- "HP-67 Circuit Details"
- "HP-67 Modifications"

If you are a user or prospective user of the calculator products of Hewlett-Packard, this grass roots user phenomenon (independent of HP) will provide valuable information not available from any other source. The price of the *PPC Journal* is \$15 in the US, and membership is open to anyone anywhere in the world who uses HP calculators. ■

Free 48-page catalog to help you increase computer room efficiency.

The Minicomputer Accessories' new 1978 Summer Catalog is yours for the asking. Our same-day shipment policy means you get your order when you need it. And a full, no-nonsense guarantee on every product assures your satisfaction.

9 pages give you practical, reasonably priced media storage alternatives.

Pages 38-44 are full of cables/connectors you can order today and receive tomorrow.

Pages 11-19 give you same-day shipment on guaranteed media while saving you money.

Page 3 introduces you to an all-new software calculator.

Pages 24-25 show you how to increase keying operator productivity.

Pages 34-35 offer you 9 ways to improve your software designs.



For your free catalog circle No. on inquiry card.

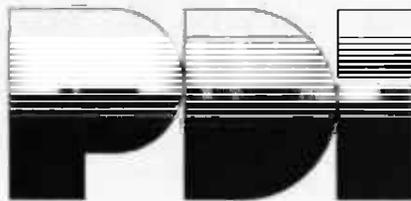
130 S. Wolfe Rd. • P.O. Box 9004
Sunnyvale, CA 94086 • (408)737-7777

Clubs and Newsletters

NCCN

The Northwest Computer Society Inc meets at the Pacific Science Center in Seattle on the first and third Thursday of each month at 7:30 PM. The first meeting of the month is usually more formal with a featured speaker or a demonstration. The second meeting of the month is less formal, with freewheeling discussion and problem solving. To contact the Northwest Computer Society write *Northwest Computer Club News*, POB 242, Renton WA 98055.

Conducted by
David Wozmak



TURN YOUR COMPUTER INTO A TEACHING MACHINE

The staff at Program Design did not learn about educational technology from a book—we wrote the book! We have been innovators in such teaching materials as programmed instruction and multimedia presentations. We also belong to that minority in education who actually test materials to see that people can learn from them.

Now Program Design brings this experience to the personal computer field. PDI is developing a line of educational and game programs for the whole family—from preschool child to adults.

Program Design educational software uses the computer's full teaching potential in exciting and effective ways. Programs are simple to use and memory efficient, and most important  they teach!

TAPES NOW AVAILABLE FOR THE TRS-80, PET, APPLE II

SAMPLE OUR SOFTWARE FOR \$1.49. Send us \$1.49, your name, address, and type of computer, and we'll send you a tape for your computer with actual samples of our programs.

Or circle our number on the reply card for a printed catalog.

Department 200 PROGRAM DESIGN, INC. 11 IDAR COURT GREENWICH, CONN 06830

PET User Group

The newsletter of this Pennsylvania based group contains a veritable treasure trove of information and interesting facts about the Commodore PET. On the hardware side it has information about operating modems with PET, interfacing to an Altair (S-100) mother board, available peripherals, and more. In the software section there is a PET Errors and Bugs column, which offers solutions for the few bugs which have been found. There are also a number of columns by various contributors on the subject of PET programming.

PET User Notes is published six or more times a year by Gene Beals, PET User Group, POB 371, Montgomeryville PA 18936. Membership/subscription is \$5 per year in the US and Canada, \$10 in other countries.

APPLE

An Apple II users group has recently been formed in the Seattle Washington area, with membership open to all. The primary function of the group is the exchange of ideas and programs, which is accomplished through the medium of *Call Apple*, a monthly newsletter. For a sample copy of the newsletter and an application blank, send an SASE to APPLE, c/o Val J Golding, 6708 39th Av SW, Seattle WA 98136.

Theater Computer Users Group

The Theater Computer Users Group (TCUG) exists to provide a method of exchange of information about uses of computers in theater. The primary medium of communication is a periodic newsletter which is supported with a \$4 fee. Topics of interest include special programs for specific theater jobs such as set design and inventory, cutting lists and ticket sales and special uses of hardware for things like stage lighting and management of production cuing. Other areas of interest include ticket sales, mailing list and patron records, actors/casting lists, volunteer crew management, financial records and a number of inventory and management functions.

Material in the newsletter includes comments from theater people, descriptions of programs and problems and analysis of new products that might have special uses in theater. Book reviews and reports of past or upcoming meetings of interest are also included. Contact Mike Firth, Theater Sources Inc, TCUG-TSI, 104 N St Mary, Dallas TX 75214, (214) 827-7734.

TRS-80 User Group of Eastern Massachusetts . . .

The TRS-80 Users Group of Eastern Mass was formed in January 1978 to link the growing numbers of users of the new Radio Shack TRS-80. With thousands of these Z-80 based systems delivered since October 1977 and new peripherals and software becoming available each month, the group expects to be a popular and useful clearinghouse and generator of activities concerning effective use of the TRS-80. Interested TRS-80 users are invited to attend meetings, held at 7:30 PM on the second Wednesday of each month. For further information, write TRS-80 Users Group of Eastern Mass, c/o Miller, 61 Lake Shore Rd, Natick MA 01760.

. . . and Wisconsin

Hardware is the specialty of this group. Only the TRS-80, by Radio Shack, is dealt with. The aim of this group is to develop, jointly with members, hardware and interfaces to existing, lower cost peripheral units. Software will be handled via exchange. Hardware and software exchange pays a small royalty to developer. The newsletter *TRS-80 User Notes* is sent monthly. Membership cost is \$17 the first year, \$12 per year thereafter. For more information and a sample newsletter send a SASE to John P Marsh, 621 13th Av S, Onalaska WI 54650.

. . . and North Carolina

The TRS-80 Users Group of North Carolina has a newsletter which is packed with programs for such things as: bio-rhythms, math quiz, card games, wumpus, lunar lander, UFO and so on. There is also hardware information on the TRS-80. For more information contact R Gordon Lloyd, TRS-80 Users Group, 7554 Southgate Rd, Fayetteville NC 28304.

Computer Club of Western New York

The Computer Club of Western New York is an organization in the greater Buffalo area providing computer hobbyists, professionals and students the chance for hands on experience with the latest in microcomputers. The club presently has two Cromemco Z-80A microprocessors with up to 64 K core memory each, an 8 inch dual disk drive, tape cassette storage, a Teletype several CRTs, and is always adding more. Classes in BASIC, FORTRAN IV, assembly, and microcomputer engineering are held on a rotating basis.

Software

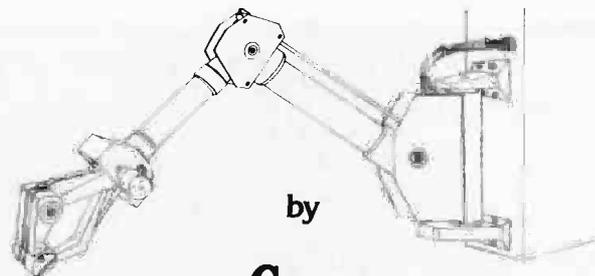
- Games • **CRAPS** (Las Vegas style) \$6.00
- **MULTIPLE LUNAR LANDER** \$8.00
- **SLOT MACHINE** \$6.00
- **GAME PACKAGE:** Russian Roulette, Mad Scientist, and ABM \$8.00
- Graphics • **PICTURE MAKER** with AMP'L ANNY \$12.00
- **GRAPHICS PACKAGE I:** Laser Beam, Space Shuttle, and Blast Off \$10.00
- **GRAPHICS PACKAGE II:** Rain in Greece, Flea, Textwriter, Random Walk \$10.00
- Scientific • **FOURIER FIT:** Does curve fitting \$15.00
- Systems • **RANDOM NUMBER GENERATOR TEST** \$5.00
- **HEX MEMORY LOADER** \$10.00
- **MEMORY DUMP PROGRAM** \$10.00
- **MEMORY SEARCH** \$5.00

All Programs Written in **BASIC**
Complete Easy to Read Documentation
Programs Completely Tested

SOFTWARE RECORDS

P.O. BOX 8401-B
UNIVERSAL CITY, CA 91608
(cal residents add 6% sales tax)

ROBOTICS



by

GRI

MODULAR ROBOTS for Industrial and Personal Application

Send for complete brochure:
GALLAHER RESEARCH, INC.
P.O. Box 10767
Salem Station
Winston-Salem, N.C. 27108

Club meetings are on the first Tuesday of every month at 7 PM, and a newsletter is being planned. Dues are \$20 for students, \$25 for nonstudents, with group discounts available on both memberships and computer time. For more information, write Computer Club of Western New York, 3834 Main St, Eggertsville NY 14226.

BUSS

Edited by Charles Floto, *Buss* is the independent newsletter of Heath Company computers. It contains Heath product information and user reports. The contact address for BUSS is Charles Floto, 325 Pennsylvania Av SE, Washington DC 20003.

COM-3

COM-3 is a huge newsletter (approximately 45 pages) from Victoria AUSTRALIA. Edited by Timothy Mowchanuk, this newsletter covers just about everything from calculators to PROM data rewrites. The name COM-3 is taken from the first three letters of the words computer, community and communication, and symbolizes the growing interaction between these things. To contact COM-3 write to Timothy Mowchanuk, editor, c/o Essendon Grammar School, POB 138, Essendon, Victoria 3040, AUSTRALIA.

Alpha Micro Systems AM-100 User Group

A program exchange and monthly newsletter is being established for users, owners and persons interested in the Alpha Micro Systems AM-100 computer system.

The newsletter will contain descriptions

of the programs that have been submitted by users. In addition, it is planned to include short announcements of programs that are in the process of being developed as well as other items of interest.

The distribution medium of the programs and their support files will be via floppy diskettes written in the IBM compatible AMOS format. For further information concerning membership and details of program submission contact Lefford F Lowden, 616 Long Pond Rd, Rochester NY 14612.

DG Users Group Formed

An independent users group has been formed to act as a clearinghouse for exchange of Digital Group information. The first issue of the group's newsletter features an evaluation of Micro Com software, an interface for a Selectric (hardware and software), a discussion of problems in expanding past 26 K, a flea market section, and so on. For information write to DG Users Group, POB 316, Woodmere NY 11598.

Tri-State Computer Club

The Tri-State Computer Club is a newly formed club with one main purpose in mind, to provide a common source of information and help to those interested in computers and other related equipment. Meetings are held every other Tuesday evening at 7:30 PM at 22 Beechurst Av. Anyone interested is invited to attend. For more information contact Randy Crowe at Rte 3, Box 84, Morgantown WV 26505 or phone (304) 292-1915 or (304) 292-9700.■



\$95 Stand Alone Video Terminal

aB75eBc\pvtπIφψωΩo123°±÷@[]|++↑↑
 !"#%&'() *+,-./012456789:;<=>?
 @ABCDEFGHIJKLMNPOQRSTUVWXYZ[\]^_
 `abcdefghijklmnopqrstuvwxyz{|}~

SCT-100 FEATURES:

- 64 X 16 line format with 128 displayable characters
- Serial ASCII or BAUDOT with multiple Baud rates
- \$187 Assembled or \$157 Kit (Partial Kit \$95)
- Full cursor control with scrolling and paging
- On board power supply
- Many additional features

Call or write today. MC/VISA accepted

XITEX CORP. P.O. Box #20887
 Dallas, Texas, 75220 ● Phone (214) 620-2993
 Overseas orders and dealer inquiries welcome

Those Calculating Romans

Laurence G Dishman
5525 Metropolitan Pky
Sterling Heights MI 48077

Remember learning about Roman numerals and all the fun you had with the ungainly numbers? Now you can let your computer have fun with them too! The program in listing 1 is a 4 function Roman numeral calculator that displays intermediate values in Arabic notation. A slash (/) preceding a Roman numeral is substituted for a bar above the numeral. The slash signifies multiplication by 1000. The program was written in North Star BASIC and uses the variables shown in table 1. Table 2 is a brief description of the program.

The examples in listing 2 are, of course, addition, subtraction, multiplication and division. The program prompting is reminiscent of many old mathematics texts which are arranged as conversations between teacher and pupil. One interesting aspect of the program is that if a nonstandard Roman expression is entered in addition mode and nothing is added to it, the result will be a Roman expression in standard form.

```

1  FILL 51207,01
2  DIM N$(40),N(40)
3  FOR P1=1 TO 40:N$(P1)="":NEXT P1
4  PRINT TAB(30),"CENTURION"
5  FOR P1=1 TO 3:PRINT:NEXT P1
6  INPUT "  ENTER FUNCTION (A,S,M,D) :".F#
7  IF F#<>"A" THEN 180
8  PRINT TAB(10),"ENTER @=1 FOR SUM."
9  S=0
10 PRINT TAB(10),"ADDEND ",
11 GOSUB 590
12 IF N#<>"=" THEN S=S+N1 ELSE 130
13 GOTO 90
14 PRINT TAB(10),S," = ",
15 A=S
16 GOSUB 850
17 PRINT N#
18 GOTO 1920
19 IF F#<>"S" THEN 300
20 PRINT TAB(10),"MINUEND ",
21 S=0
22 GOSUB 590
23 S=N1
24 PRINT TAB(10),"SUBTRAHEND ",
25 GOSUB 590
26 A=S-N1
27 PRINT TAB(10),A," = ",
28 GOSUB 850
29 PRINT N#
30 GOTO 1920
31 IF F#<>"M" THEN 420
32 PRINT TAB(10),"FACTOR #",
33 S=0
34 GOSUB 590
35 S=N1
36 PRINT TAB(10),"FACTOR ",
37 GOSUB 590
38 A=S*N1
39 PRINT TAB(10),A," = ",
40 GOSUB 850
41 PRINT N#
42 GOTO 1920
43 IF F#<>"D" THEN 540
44 PRINT TAB(10),"DIVIDEND ",
45 S=0
46 GOSUB 590
47 S=N1
48 PRINT TAB(10),"DIVISOR ",
49 GOSUB 590
50 A=INT(S/N1)
51 PRINT TAB(10),A," = ",
52 GOSUB 850
53 PRINT N#
54 GOTO 1920
55 PRINT TAB(17),"ET TU BRUTE...THEN SYSTEM CRASHES"
56 GOTO 1920
57 GOTO 750
58 GOTO 1290
59 INPUT "ENTER ROMAN NUMERAL :".N#
60 IF N#="" THEN RETURN
61 FOR P1=1 TO 40:N$(P1)=N:NEXT P1

```

Listing 1: Roman numeral mathematics program written in North Star BASIC. Listing 1 continues on pages 110-111.

MICRO-PROCESSOR PROGRAMS VIA PHONE LINES

DIAL-A-PROGRAM

- Why spend time waiting for expensive software by mail when you can obtain low cost software in minutes on our Toll Free Phone Lines.
- This unique Software Service makes available to its subscribers a wide selection of Micro-Processor Programs via conventional phone lines.
- This system is TRS-80 and Kansas City Standard compatible.
- Call Toll Free for More Information between 9:00 a.m. and 11:00 p.m. EDT. Fla. residents call (904) 269-4406.



A Division of Micro Systems Services, Inc., P. O. Box 1444, Orange Park, FL 32073

All Rights Reserved

Listing 1, continued:

```

620 N1=0
630 P=LEN(N$)
640 FOR P1=P TO 1 STEP -1
650 IF N$(P1)="/" THEN NEXT P1
660 GOSUB 750
670 NEXT P1
680 N1=N(P)
690 FOR P1=P-1 TO 1 STEP -1
700 IF N(P1+1)=0 THEN P2=P1+2 ELSE P2=P1+1
710 IF N(P1)>N(P2) THEN N1=N1+N(P1) ELSE N1=N1-N(P1)
720 NEXT P1
730 PRINT TAB(15),N$," = ",N1
740 RETURN
750 IF N$(P1,P1)="I" THEN N(P1)=1
760 IF N$(P1,P1)="V" THEN N(P1)=5
770 IF N$(P1,P1)="X" THEN N(P1)=10
780 IF N$(P1,P1)="L" THEN N(P1)=50
790 IF N$(P1,P1)="C" THEN N(P1)=100
800 IF N$(P1,P1)="D" THEN N(P1)=500
810 IF N$(P1,P1)="M" THEN N(P1)=1000
820 IF P1=1 THEN RETURN
830 IF N$(P1-1,P1-1)="/" THEN N(P1)=N(P1)*1000
840 RETURN
850 N$=""
860 P=1
870 IF A/1000000 < 1 THEN 920
880 N$(P,P+1)="/"M"
890 A=A-1000000
900 P=P+2
910 GOTO 870
920 IF A/900000 < 1 THEN 960
930 N$(P,P+3)="/"C/M"
940 A=A-900000
950 P=P+4
960 IF A/500000 < 1 THEN 1000
970 N$(P,P+1)="/"D"
980 A=A-500000
990 P=P+2
1000 IF A/400000 < 1 THEN 1040
1010 N$(P,P+3)="/"C/D"
1020 A=A-400000
1030 P=P+4
1040 IF A/100000 < 1 THEN 1090
1050 N$(P,P+1)="/"C"
1060 A=A-100000
1070 P=P+2
1080 GOTO 1040
1090 IF A/90000 < 1 THEN 1130
1100 N$(P,P+3)="/"X/C"
1110 A=A-90000
1120 P=P+4
1130 IF A/50000 < 1 THEN 1170
1140 N$(P,P+1)="/"L"
1150 A=A-50000
1160 P=P+2
1170 IF A/40000 < 1 THEN 1210
1180 N$(P,P+3)="/"X/L"
1190 A=A-40000

```

Table 1: Variables used in Roman mathematics program.

A	Intermediate Arabic value for later conversion to Roman
F\$	Character value indicating function desired
N	Array holding the Arabic value of each Roman numeral in the expression
N\$	Array holding the Roman numeral expression
N1	Returned Arabic number after conversion
P, P1, P2	Pointer variables
S	Intermediate Arabic value used in calculations

Table 2: Brief description of program broken down by line number.

Statement	Commentary
1	Switches from CRT to Printer mode in my system.
10-50	Inputs desired function.
60-530	Based on which function is desired, the computer calls for the inputting of a Roman expression and calls the appropriate subroutines. Then prints the values and answer.
540	If no legal function is inputted, the program aborts.
560-580	Were used for diagnostics during program preparation. May be omitted.
590-740	Input Roman expression and evaluates it back to front using the subroutine at 750.
750-840	Checks for value of Roman numeral then check to see if it is preceded by a slash. If so, multiplies by 1000.
850	Set the output array equal to 40 blanks.
860-1910	Is a common assembly line approach to assembling the standard Roman expression of the Arabic value calculated.
1920	Prints QED "It is finished."

MORE 6800 SOLUTIONS:

FOR SWTPC 6800

AS-1 ANALOG INTERFACE MODULE

- FAST, ACCURATE A/D, D/A CONVERSIONS
- EIGHT ANALOG INPUT CHANNELS
- ONE HIGH-SPEED ANALOG OUTPUT
- OCCUPIES ONE I/O SLOT
- \$90.00 KIT \$125.00 ASSM.

SC-1 SERIAL INTERFACE CARD

- RS-232 SERIAL INTERFACE
- FULL CONTROL SIGNALS IMPLEMENTED
- MOST VERSATILE SERIAL I/O AVAILABLE
- \$40.00 KIT \$50.00 ASSM.

FOR MOTOROLA "D2"

DA-1 UPGRADE KIT

- CONVERTS D2 TO TERMINAL I/O
- RETAINS FULL CASSETTE I/O CAPABILITY
- INCLUDES RT/68MX ROM - MONITOR/O.S.
- ALLOWS USE OF BASIC, EDITORS, ASSEMBLERS, ETC.
- RS-232 SERIAL INTERFACE
- DA1 w/70 p. MANUAL \$70.00

MOTOROLA MMS68104 16K RAM

- 16K BYTES DYNAMIC RAM
- ENGINEERED SPECIFICALLY FOR "D2"
- EXORCISOR — TYPE BUSS
- \$395.00 ASSEMBLED

M6800 SOFTWARE

A/BASIC COMPILER

- 8K EXTENDED BASIC COMPILER
- CONVERTS BASIC PROGRAMS TO FAST, MEMORY EFFICIENT MACHINE LANGUAGE
- DESIGNED FOR RT/68 — SUPPORTS MULTIPROGRAMMING
- EXTREMELY VERSATILE I/O
- KC CASSETTE + MANUAL — \$50.00

RT/68MX OPERATING SYSTEM

- EXPANDED CONSOLE MONITOR ROM
- REAL TIME OPERATING SYSTEM
- DIRECT MICRO G. REPLACEMENT
- PIA OR MULTI-ACIA I/O
- RT/68MX ROM w/ MANUAL \$55.00

Master Charge & VISA Welcome

Write or call for Free Catalog

MICROWARE SYSTEMS CORPORATION

P.O. BOX 954 • DES MOINES, IOWA 50304 • (515) 265-6121

Listing 1, continued:

```

1200 P=P+4
1210 IF A/10000 < 1 THEN 1260
1220 N$(P,P+1)="X"
1230 A=A-10000
1240 P=P+2
1250 GOTO 1210
1260 IF A/9000 < 1 THEN 1300
1270 N$(P,P+2)="M/X"
1280 A=A-9000
1290 P=P+3
1300 IF A/5000 < 1 THEN 1340
1310 N$(P,P+1)="V"
1320 A=A-5000
1330 P=P+2
1340 IF A/4000 < 1 THEN 1380
1350 N$(P,P+2)="M/V"
1360 A=A-4000
1370 P=P+3
1380 IF A/1000 < 1 THEN 1430
1390 N$(P)="H"
1400 A=A-1000
1410 P=P+1
1420 GOTO 1380
1430 IF A/900 < 1 THEN 1470
1440 N$(P,P+1)="CM"
1450 A=A-900
1460 P=P+2
1470 IF A/500 < 1 THEN 1510
1480 N$(P)="D"
1490 A=A-500
1500 P=P+1
1510 IF A/400 < 1 THEN 1550
1520 N$(P,P+1)="CD"
1530 A=A-400
1540 P=P+2
1550 IF A/100 < 1 THEN 1600
1560 N$(P)="C"
1570 A=A-100
1580 P=P+1
1590 GOTO 1550
1600 IF A/90 < 1 THEN 1640
1610 N$(P,P+1)="XC"
1620 A=A-90
1630 P=P+2
1640 IF A/50 < 1 THEN 1680
1650 N$(P)="L"
1660 A=A-50
1670 P=P+1
1680 IF A/40 < 1 THEN 1720
1690 N$(P,P+1)="XL"
1700 A=A-40
1710 P=P+2
1720 IF A/10 < 1 THEN 1770
1730 N$(P)="X"
1740 A=A-10
1750 P=P+1
1760 GOTO 1720
1770 IF A/9 < 1 THEN 1800
1780 N$(P,P+1)="IX"
1790 RETURN
1800 IF A/5 < 1 THEN 1840
1810 N$(P)="V"
1820 A=A-5
1830 P=P+1
1840 IF A/4 < 1 THEN 1870
1850 N$(P,P+1)="IV"
1860 RETURN
1870 IF A = 0 THEN RETURN
1880 N$(P)="I"
1890 A=A-1
1900 P=P+1
1910 GOTO 1870
1920 PRINT TAB(30),"QED"
READY

```

Listing 2: Examples of the four arithmetic functions which are arranged in the form of Roman mathematics texts.

```

CENTURION
ENTER FUNCTION (A;S,M,D) :A
ENTER @=" FOR SUM.
ADDEND ENTER ROMAN NUMERAL :/M/M/MMCMLXIV
/M/M/MMCMLXIV = 3002964
ADDEND ENTER ROMAN NUMERAL :/C/C/CCMCCV
/C/C/CCMCCV = 302295
ADDEND ENTER ROMAN NUMERAL :/MCII
/MCII = 1000102
ADDEND ENTER ROMAN NUMERAL :=
4305271 = /M/M/M/M/C/C/C/VCCCLXXI
QED
READY
RUN

CENTURION
ENTER FUNCTION (A;S,M,D) :S
MINUEND ENTER ROMAN NUMERAL :MCMCLXXVII
MCMCLXXVII = 1277
SUBTRAHEND ENTER ROMAN NUMERAL :CMXCIX
CMXCIX = 999
978 = CMLXXVII
QED
READY
RUN

CENTURION
ENTER FUNCTION (A;S,M,D) :M
FACTOR ENTER ROMAN NUMERAL :MDCXII
MDCXII = 1612
FACTOR ENTER ROMAN NUMERAL :LVI
LVI = 56
90272 = /X/CCCLXXII
QED
READY
RUN

CENTURION
ENTER FUNCTION (A;S,M,D) :D
DIVIDEND ENTER ROMAN NUMERAL :/M/M/C/X/XM/XCCLVI
/M/M/C/X/XM/XCCLVI = 212256
DIVISOR ENTER ROMAN NUMERAL :DXIX
DXIX = 519
4102 = M/VCII
QED
READY
RUN

CENTURION
ENTER FUNCTION (A;S,M,D) :A
ENTER @=" FOR SUM.
ADDEND ENTER ROMAN NUMERAL :CMMMLXIX
CMMMLXIX = 2969
ADDEND ENTER ROMAN NUMERAL :=
2969 = MMCMLXIX
QED ■

```

AAA C.C.C. 6800 Systems Specialists
Dealer in the complete
GIMIX® GHOST™ line

This month's feature:

16K software addressable STATIC RAM board for the SS-50 bus

- Uses TMS 4044s
- Fully socketed.
- Assembled and tested.
- Separated into 4 independent 4K memory blocks
- CPU can read status of the software control registers.

Each block can be:



- Separately addressed
- Separately enabled or disabled
- Separately protected

Features above are under both software and hardware control.

Facilitates multi-programming and time sharing. **\$495**

Editor — Text Processor with complete file handling capabilities, mailing lists and labels, right and left margin justification, up to 10 tabs, block move and copy for contract writing, easy enough for your secretary to use.

\$100

Ask about our programs for payroll \$400, inventory \$400, stock club-market evaluation with tax reports \$75. Power supply modification kit for SWTPC computer \$20

AAA Chicago Computer Center
Specialists in 6800 Systems

- Smoke Signal • SWTPC • Percom
- **GIMIX** • Motorola D2

3007½ W. Waveland Avenue
Chicago, IL 60618 (312) 539-5833

The HP-67 and HP-97

Hewlett-Packard's Personal Computers

Craig A Pearce
2529 S Home Av
Brewyn IL 60402

Photo 1: The Hewlett-Packard HP-67 programmable calculator. Magnetic cards containing programs are inserted into the slot on the side of the unit. (Photo courtesy Hewlett-Packard Co.)

Manufactured by Hewlett-Packard, the HP-97 and its software compatible younger brother the HP-67 are considered by many to be two of the best programmable calculators available.

The HP-97 costs \$750, compared with \$450 for the HP-67. Both feature a full complement of mathematical functions and statistical functions for two sets of variables; additional features include: Reverse Polish

Notation; 26 data storage registers (one of which is used for indirect and relative addressing); register arithmetic; 224 program steps (all fully merged, with no 2 or 3 keystroke instructions); the ability to record programs or data on magnetic cards; a pause feature that opens the keyboard up for user input during a running program; and a smart card reader.

Smart Card Reader

One of the HP-67's most interesting features is its "smart" card reader. When a card is fed into the unit, the reader begins accepting 28 byte blocks of data from the cards. The first block tells the calculator if the card being read is a program card (which means the remaining bytes are to be read into program memory), or if the card contains numerical data that must be fed into the data registers. The card, if it is a program card, will also set the display mode (fixed, scientific, or engineering, zero through nine places showing), the trigonometry mode (degrees, radians or gradians) and the calculator's four user flags (on or off). If side 2 of the card (containing steps 113 through 224) is fed into the reader first, they will be placed in the correct position, just as if side 1 had been fed in first (containing steps 1 through 112). When a card like this exists (that is to say, a program is recorded with more than 112 steps, or more than one side of the card), the calculator displays the word "Crd" as a prompt to the user that the second side of the card is required.

The same holds true for the data card. Side 1 contains the contents of the 16 primary registers. If data is also present in the secondary ten registers, the user is again prompted with "Crd." The contents of these





Photo 2: The Hewlett-Packard HP-97 programmable desk top calculator with printer. (Photo courtesy Hewlett-Packard Co.)

registers are contained on the second side of the data card.

A card may also contain data on one side and a program on the other. By placing data on side 1 and using a clever trick, the user can also get "Crd" when reading in one of these "half and half" cards. The card reader motor is under firmware control and will not switch on with a card present in the slot, if a program is running. However, the user does have the keyboard option of merging programs and data, or just feeding in 112 steps of program, under software control. Thus, with a 112 step card in the slot and a 224 step program running, all the user need do in order to feed in (overlay paging) those next 112 steps is to call for the keyboard active pause, which will cause the card reader to turn on and feed in that next card. Without

any user intervention the HP-97 or HP-67 can run 336 steps of program automatically.

The Active Pause

Another powerful feature of these calculators is the "active pause" feature. Pause gives the user the ability to momentarily stop a running program and display the answer currently on the screen for one second or so. It also unlocks the keyboard for user use and accepts any cards fed in at this point.

Normally, pressing any key on an HP programmable calculator causes the program to halt immediately. This is not the case during the pause feature. When pausing, any key, including one of the ten user definable label keys, can be pressed and that function will be carried out. After this the pause will be

extended an additional second, and the program will then continue. If a user definable key is pressed, that program is called as a subroutine (three levels of subroutines are available on the HP-97 and HP-67), and, if that subroutine ends with the "RTN" (return) command, program control is returned to the original pausing point in the main routine.

Data Entry Flag

In addition to being a general purpose, test clearable flag, the fourth flag (FLG 3) is also a data entry flag. When any of the digit keys is pressed, flag 3 switches to the on state. Thus the program, if so written, can sense the input of data, much like testing the status register on a full blown micro-computer, for keyboard input.

With this flag the user can define the ten keys for more than one function. A simple

example is the programming of the formula $\text{distance} = \text{rate} \times \text{time}$. Each of three keys can accept data input if the third flag is on; if the third flag is off, the key just pressed can calculate the unknown variable. This feature is indispensable when writing games.

Other Features

Naturally the user has the ability to manually or automatically record data or programs on the 1 by 7 cm program cards. A write protect feature is available on the cards by clipping off the corners.

The HP-97 comes with its own built in thermal printer, and can print out the displayed value manually or during a running program without halting it. Because of the 7 level key buffer, a single print command will not even slow down the running program. Of course, the buffer works in the manual mode as well. The HP-97 can also list the contents of the 4 level Reverse Polish Notation (RPN) stack and give a complete program listing with line number, mnemonics, and an on and off switchable key code as well. There is even a trace mode of operation for program debugging or for keeping a detailed record of a manual operation. A "Normal" position is also available to keep a record of all numbers entered during a manual problem along with all the key mnemonics, but without the final answer, in case the user might want just a keystroke record of the steps taken.

The HP-67 is the pocket version of the HP-97. All the functions of the HP-97 are duplicated on the HP-67, including the print features. When a program with printing commands is run on some calculators, the commands are skipped over as though they were NOP when no printer is available. But in the same situation the HP-67 will pause for 5 seconds and blink the decimal point to show that a print statement is being executed. At this point the user can either stop the program and hand copy the answer displayed or just let the program run, since 5 seconds is usually enough time to get the answer written.

Although of no use on the HP-67, the paper spacing key is provided so that full control is possible when a HP-67 program is run on an HP-97.

Both machines come with huge manuals containing some of the clearest, most detailed documentation in the programmable calculator market. A standard "PAC" of blank and prerecorded program cards is also provided. These prerecorded cards cover dozens of various applications and include their own manual of several dozen more detailed pages. The latter gives programming

Listing 1: Pinball Wizard, a game for the Hewlett-Packard HP-67 and HP-97 programmable calculators.

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS			
001	F FRAC	16 44			R ↓	-31				
	F π	16-24			DSP 0	-63 00				
	X ≥ y	-41			RTN	24				
	F X=0?	16-43		060 *	LBL B	21 12				
	*	-55	NOTE: * indicates the location of a label address.		RCL 1	36 01				
	F FRAC	16 44			F X=0?	16-43				
	STO E	35 15			GTO f a	22 16 11				
	5	05			1	01				
	0	00			STO - 1	35-45 01				
010	STO B	35 12			-	-45				
	1	01			PRINT X	-14				
	0	00			0	00				
	STO A	35 11			STO 0	36 00				
	X ²	53		070	5	05				
	STO C	35 13			STO 3	35 03				
	CLX	-51			* LBL f b	21 16 12				
	STO 0	35 00			F CLF 0	16 22 00				
	STO 1	35 01			DSP 0	-63 00				
	STO 2	35 02			3	03				
020	GTO f a	22 16 11			STO 7	35 07				
	* LBL f e	21 16 15			EEX	-23				
	RCL E	36 15			3	03				
	9	09			STO 6	35 06				
	9	09		080 *	LBL f c	16 21 13				
	7	07			f CLF 3	16 22 03				
	x	-35			RCL 3	36 03				
	F FRAC	16 44			F X=0?	16-43				
	STO E	35 15			GTO f a	22 16 11				
	RTN	24			f PAUSE	16 51				
030 *	LBL A	21 11			f F? 3	16 23 03				
	2	02			f F? 3	16 23 03				
	STO + 1	35-55 01			GTO f c	22 16 13				
		-62			1	01				
	2	02		090	STO - 3	35-45 03				
	5	05			DSP 1	-63 01				
	STO 2	35-45 02			X ≥ y	-41				
	RCL 1	36 01			* LBL f d	21 16 14				
	PRINT X	-14			GSB f e	23 16 15				
	* LBL f a	21 16 11			1	01				
040	2	02			2	02				
	CHS	-22			x	-35				
	STO I	35 46			f INT	16 34				
	RCL 0	36 00			3	03				
	5	05		100	-	-45				
	EEX	-23			f X=Y?	16-33				
	4	04			GTO f d	22 16 14				
	÷	-24			f X>0?	16-44				
	f INT	16 34			GTO E	22 15				
	STO + 1	35-55 01			f PAUSE	16 51				
050	RCL 0	36 00			f X=0?	16-43				
	f PAUSE	16 51			GTO 0	22 00				
	GTO (i)	22 45			f F? 3	16 23 03				
	* LBL C	21 13			f F? 3	16 23 03				
	DSP 2	-63 02		110	GTO 0	22 00				
	RCL 2	36 02			CHS	-22				
	f PAUSE	16 51			f X#Y?	16-32				
REGISTERS										
0	1	2	3	4	5	6	7	8	9	
score	games	\$\$\$	balls			bonus	targets			
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9	
A	10 (constant)	B	50 (constant)	C	100 (constant)	D	E	seed	I	used

tips and lists techniques about how certain of the prerecorded cards were written.

As with all of Hewlett-Packard's calculators, the units run on rechargeable nickel cadmium batteries, or from AC through an adapter that recharges the batteries whether the machine is in use or not. A carrying case is also standard with the machines.

For all owners who join, an extensive users' library of contributed programs is available. A user can send a favorite brainchild and get free programs and blank magnetic cards in exchange. Even for those who do not write programs the library is of great importance, since dozens of widely different programming areas are covered.

HP-65, 67 and 97 owners receive free issues of *Keynotes*, a newsletter edited by Henry Horn. *Keynotes* keeps the user up to date about all the changes or corrections to the several PACs of preprogrammed cards available, as well as listing some of the newer programs submitted between library catalog updates.

Unsupported Features

As with the HP-65 (and later the Texas Instruments' SR-52), HP-67 and 97 users have managed to locate and use quite a number of features that Hewlett Packard had not originally intended to document.

Through the efforts of Louis Cargile, a member of PPC, an independently run users' group, the limited alphanumeric codes of the machines (both can form: r, C, o, d, E), have been brought under user control along with the ability to view internal registers, create moving marquee type displays, animation and dozens of other ingenious outputs. Even the hexadecimal representations for all the internal codes have been mapped and printed in *PPC Journal*, the newsletter of PPC. These codes include the six unused codes, formally unavailable to the user. (The HP-97 and 67 use 8 bit instructions, but only a total of 250 different commands, thus leaving six unused.)

One clever program by Cargile is called "Ilda/Gerald/Ella." Through the use of an alphabetic overlay of the keys it allows the user to spell out mathematical functions and commands to the units and carry on a running dialogue with them.

Example Program

Of course, the proof of the ability of these machines lies in how intricate a program can be run on them. I offer a version of a program I wrote, called "Pinball Wizard," which duplicates many of the features on a standard pinball machine

including dual flipper action, out hole bonus, and even an optional tilt feature for the wizards among you. It is playable on either the HP-67 or 97, but the keystrokes and codes shown in the program listing correspond to those of the HP-97. They can all be converted over to the HP-67 by using the manual's back pages, which list the various keystroke differences between the machines for example, the key sequence: f (a shift key) followed by FRAC (fractional truncation), will be converted to g frac on the 67.

As always, a card recorded on the 97 will show the corrected codes when read into a 67, and vice versa.

This article by no means explores all the intricate and complex programming capabilities of the HP-67 and HP-97, but I hope the reader now has a better idea of the sophistication these desk top wonders have to offer.

Listing 1, continued:

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
	GTO 0	22 00		180	f PAUSE	16 51	
2		02			f PAUSE	16 51	
	CHS	-22			GTO f d	22 16 14	
	f X ² Y	16-32			LBL 1	21 01	
	GTO f d	22 16 14			f F? 0	16 23 00	
	GSB f e	23 16 15			GTO 1	22 01	
3		03			f STF 0	16 21 00	
180	X	-35			DSP 9	-63 09	
	f INT	16 34			RCL A	36 11	
	f X=0?	16-43			GTO D	22 14	
	GTO f b	22 16 12			LBL 1	21 01	
	GTO f d	22 16 14		180	DSP 1	-63 01	
	LBL E	21 15			f CLP 0	16 22 00	
	STO I	35 46			RCL A	36 11	
	GTO (i)	22 45			GTO D	22 14	
	LBL 0	21 00			LBL 3	21 03	
	B	08			RCL C	36 13	
190	CHS	-22			RCL A	36 11	
	STO I	35 46			GTO 3	22 03	
	RCL 0	36 00			LBL 4	21 04	
	f X ² 0?	16-42			RCL E	36 06	
	GTO 0	22 00		190	2	02	
	1	01			5	05	
	STO + 3	35-55 03			LBL 3	21 03	
	DSP 0	-63 00			GSB f e	23 16 15	
	GTO f c	22 16 13				-35	
	LBL 0	21 16			I	01	
200	1	01				-55	
	f F? 0	16 23 00			f INT	16 34	
	2	02			X	-35	
	STO x 6	35-35 06		200	GTO 9	22 09	
	RCL 0	36 00			LBL 5	21 05	
	f PAUSE	16 51			RCL B	36 12	
	EEX	-23			GTO 9	22 09	
	3	03			LBL 2	21 02	
	STO - 6	35-45 06			LBL 6	21 06	
	STO + 0	35-55 00			EEX	-23	
190	RCL 0	36 00			3	03	
	f PAUSE	16 51			STO + 6	35-55 06	
	RCL 6	36 06			RCL C	36 13	
	f X ² 0?	16-42			GTO 9	22 09	
	GTO (i)	22 45		210	LBL 7	21 07	
	R ↓	-31			RCL A	36 11	
	f PAUSE	16 51			f DSZ (i)	16 25 45	
	GTO f b	22 16 12			GTO 9	22 09	
	LBL 9	21 09			3	03	
	f F? 0	16 23 00			STO 7	35 07	
160	RCL A	36 11			1	01	
	f F? 0	16 23 00			STO + 3	35-55 03	
	X	-35			RCL C	36 13	
	LBL D	21 14			GTO 9	22 09	
	STO + 0	35-55 00		220	LBL B	21 08	
	RCL I	36 46			RCL A	36 11	
	RCL A	36 11			GTO D	22 14	
		-24					
		-55					

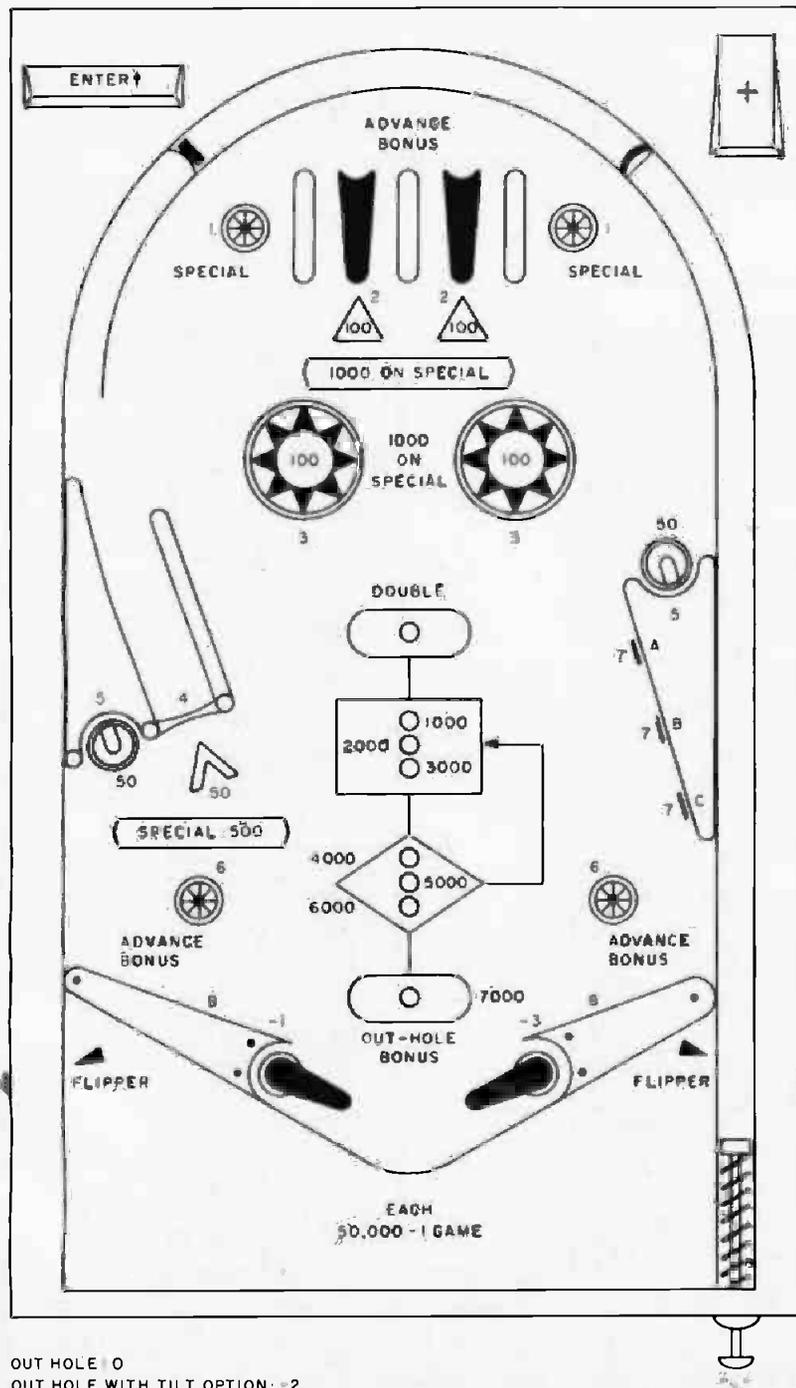
LABELS					FLAGS		SET STATUS		
A	B	C	D	E	0	SPECIAL	ON OFF	TRIG	DISP
a used	b CREDIT	c RCL S	d used	e used	1	=	0 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	DEG <input type="checkbox"/>	FIX <input type="checkbox"/>
out hole	SPECIAL	2 roll over	3 thumpers	4 rnd# gener	2	-	1 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	GRAD <input type="checkbox"/>	SCI <input type="checkbox"/>
kick out	bonus adv.	drop targ.	5 slibg-shot	9 used	3	used	2 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	RAD <input type="checkbox"/>	ENG <input type="checkbox"/>
							3 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>		n_0

Note: PPC (not affiliated with the Hewlett-Packard Company) is an independently run users' group started for and by users of Hewlett-Packard programmable calculators. It is the largest calculator club in the world, with over 2500 members worldwide. The address is: PPC, Richard J Nelson, editor, *PPC Journal*, 2541 W Camden Pl, Santa Ana CA 92704.

Pinball Wizard:
A Game for the HP-67 and HP-97

This program duplicates the play of standard pinball machines including features like out hole bonus points, "Special" for higher scoring, two thumper-bumpers, a spinner gate, three drop targets for a free ball, bonus advance roll overs, kick out holes, two flippers, and a tilt option for putting the ball into play in two out of three chances. The program is meant to be left running at all times, with all input from the

Figure 1: Model pinball machine layout used in the game of Pinball Wizard (see listings 1 and 2).



user occurring during the active keyboard pause feature of the HP-67 or HP-97.

There are eight different scoring devices on the play field (see figure 1) and each device is given an identification number. When a score is made on a device, the display pauses twice, showing the amount of points just made to the left of the decimal point, and the device identification number to the right of the decimal point. The score to the left of the decimal point is added to the player's total score, which will be displayed at the end of each round of play. The various devices are:

Device #1: Consists of two star roll overs (buttons) on the play field which, when hit, will add ten points to the player's score and switch on the "Special" scoring (which is indicated by turning on all the trailing zeroes after the device ID number). When this occurs, all devices so listed will score ten times higher than normal. Hitting device #1 repeatedly will alternately switch the Special scoring on and off.

Device #2: Consists of two top roll over lanes which score either 100 (or 1000 points if Special is lit), and advance the out hole bonus by 1000 points.

Device #3: Consists of two thumper (jet) bumpers. Each scores 100 points (or 1000 when Special is lit) whenever the "ball" strikes them. The ball can bounce between them up to ten times, so scores from 100 to 1000 (1000 to 10,000) can be made.

Device #4: This is a spinner gate that will score 50 (or 500 points for Special) each time it spins one turn. The gate can spin from one to 25 times.

Device #5: Consists of two kick out holes where the ball drops in, scores either 50 (or 500 points again depending on the state of Special), and is kicked back out.

Device #6: Consists of two bonus advance roll over stars and functions in the same manner as device number 2.

Device #7: Consists of three drop targets. Each time device 7 is hit, one target drops away and the player receives ten points added to his score. On the third hit, however, the player receives 100 points and is credited with a free ball. The targets are reset to try again. Special scoring increases the point value by ten times.

Device #8: Consists merely of two slingshot kickers giving a score of only ten points, whether or not Special is lit.

A "0" on the display means that the ball

has rolled past the flippers and through the out hole. At this point the player's score so far is shown on the display and the out hole bonus points accumulated during the game are added onto the player's score, 1000 points at a time. The display pauses for viewing each time. At the end of this scoring, the final total, is flashed once more and the display goes back to blinking the remaining number of balls (if any) in the game. If none remain, the final score is flashed. If Special was lit when the ball rolled out, the out hole bonus is doubled.

To shoot a ball, the player keys the decimal point (.) when the remaining number of balls left to play is flashed on the display.

Pressing key "A" adds two games to the "credit wheel" and deducts 25¢ from the player's cash register (no pun intended). The amount of money spent can be viewed by pressing key "C" during a pause at any time.

Pressing key "B" deducts a game from the credit wheel, and starts a new game.

Caveats

If a "-1" shows on the display, it means that the ball has reached the left flipper and requires the user to key in a "1" (pressing the left flipper button) in one second or the ball will roll out. Likewise, if a "-3" is displayed, the ball is at the right flipper, and requires an immediate input of the digit "3" from the user, or again the ball will roll out through the out hole.

When a "-2" appears on the display, it means the ball will miss both flippers, but the user has the option of keying in a "2" which effectly will "tilt" the machine, and, in two out of three cases, put the ball back in play. Be warned, however! If you should fail in the tilt attempt (that is, the machine has been tilted), you lose all collected bonus points and the next ball is immediately displayed, without a score review.

For each 50,000 points made, the player is credited with a free game. When a score over 50,000 is made, please refrain from pressing the "A" key.

Special note: If, on the first ball, before any score is made, you should lose the ball, it will be returned to you for reshooting, as in most pinball machines. (A failure at a tilt will not return the ball, however.)

Example of Play:

- Initialize game by inputting a seed number such that 0<seed<1. For this example, let's use 0.1541790869.
- Press: RTN R/S Display will flash "0."

- Obtain credit of two games and spend one quarter: press A . (A "2" will be displayed, confirming a credit of two games.)
- Start first game: press B . (A "1" is displayed to show that there is one game remaining. Next, 5 is flashed on the display to show that there are five balls left to shoot.)
- Shoot first ball: press . . See displayed:
 - 50.5 (50 points on a kick out hole)
 - 10.10000000 (10 points and Special is on)
 - 1000.60000000 (device 6 advances bonus and gives player 1000 points)
 - 2.00000000 (a tilt option has come up)

Try tilting the machine by inputting a 2 from the keyboard during the pause window. A flashing 4 will be displayed to show that there are four balls remaining to shoot. The machine was tilted and all bonus points were lost.

You can continue to play out this game in the same manner. Good luck.■

(Note: Pinball Wizard is reprinted with the permission of PPC.)

Listing 2: User instructions for Pinball Wizard.

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Enter program			
2	Input seed (s) such that 0<(s)<1	seed	RTN R/S	0 *
3	To obtain credit of 2 additional games (and spend 25¢): The number printed/paused, will show the number of games the player has credit for.		A	2 ***
4	To start one game (which is deducted from the credit register): The first number printed/paused will be the remaining games left. The next number flashed will be the remaining balls left to shoot.		B	1 *** 5 *
5	To shoot current ball, displayed, during a 1 second pause 'window': Scoring begins as described in the program description on the previous pages.			
6	When '-1' is displayed, to use the left flipper during a 1 second pause 'window', input: -OR- When '-3' is displayed, to use the right flipper during a 1 second pause 'window', input: -OR- When '-2' is displayed, to attempt to 'tilt' the machine and chance putting the 'ball' back in play, input: If the tilt was successful, the scoring will continue. If the machine 'tilted', the remaining number of balls will be flashed (if any) or the final score will be flashed, if the game is over.		1 3 2	
7	To shoot any remaining balls, go to step 5.			
8	If no balls remain, to start a new game, go to step 4.			
9	If no games remain on the 'credit wheel', go to step 3.			
***	--Indicates a printed number, on the 97 or a number paused for 5 seconds on the 67			
!	--Indicates a number flashed (paused for 1 sec.)			

Book Reviews

Z-80 Programming Manual (publication number MK78515)

MOSTEK
Carrollton TX 75006
300 pages
\$7.50



Although much has been published about the differences between the Z-80 and the 8080, the *Z-80 Programming Manual* is the first reference I have found that gives a detailed description of all the Z-80 instructions. The bulk of the book consists of one or two pages of description for each instruction. The preface accurately notes that this book is for those with some programming experience. It will not teach you when to use a certain instruction; rather it will confirm exactly what an instruction does.

When this manual arrived I was struggling to use the block search instruction for the first time. The detailed explanation of the instruction sequence and a detailed example are a far cry from the terse description in

the *Z-80 Technical Manual*. In contrast, the explicitness of MOSTEK's programming manual continues to the level of triviality required to work at machine level coding. One note points out that the instruction "EX AF, AF'" does indeed mean exchange registers A and F with registers A' and F'. MOSTEK states that this manual is the standard for Z-80 assembly language.

There is no description of hardware other than a brief outline of the architecture. The printing is only of fair quality and the book is not an eye catcher. However, for those programming in an isolated environment, with no one nearby to quibble on fine points, this book will prove to be a useful source.

If it is not available at your local computer store, it should be available from your nearest MOSTEK distributor.

David Clapp
POB 111
Wellsville PA 17365

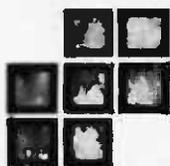
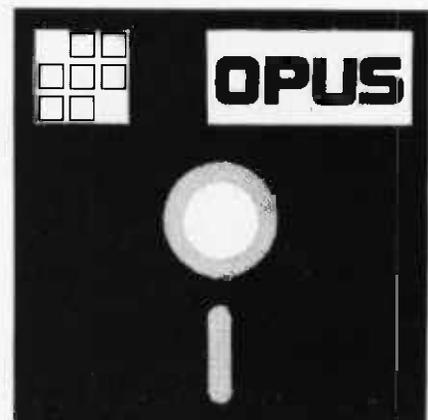
BASIC is BASIC is ...

And **BASIC** does what it should. But if you're ready to step up from **Beginner's All-purpose Symbolic Instruction Code**, look at **OPUS**, the high-level 8080/Z80 language from A.S.I. ... roots in **BASIC**, but *designed* for business applications. **OPUS** gives you the capabilities you need, like extended precision, string handling, and easy formatting. **OPUS/TWO** takes up where **OPUS/ONE** leaves off, allowing subroutines, overlays, and extended disc file management.

But we didn't stop there. **OPUS** programs and data are directly upward-compatible, all the way up through **TEMPOS**, A.S.I.'s multi-user, multi-tasking operating system.

Ask your dealer, or contact A.S.I. We'd like to tell you more.

OPUS/ONE	\$99.00	OPUS/TWO	\$195.00
S.O.S.	\$385.00	TEMPOS	\$785.00



ADMINISTRATIVE SYSTEMS, INC.
222 Milwaukee, Suite 102
Denver, CO 80206 (303) 321-2473

ORDER A MANUAL NOW and we'll apply the price toward your software purchase.

OPUS User's Manual	\$12.50
S.O.S. Manual Set (includes OPUS Manual)	\$20.00
TEMPOS Manual Set (includes OPUS Manual) ..	\$20.00

MASTER CHARGE and **VISA** accepted.

Add \$1.50 per manual (set) for shipping/handling in U.S.

Motorola 6800 Microprocessor Course
Technical Training Department
Mail Stop 56-113
Motorola Semiconductor
5005 McDowell Rd
Phoenix AZ 85003
\$25 (1-9 copies); \$20 (more than 10)

The Motorola 6800 microprocessor course is the 3 ring notebook used at the 3 day seminars given by Motorola. For those of us who don't have \$400 to spend on learning about the 6800 by attending the seminars, this \$25 book is a reasonable alternative.

The first part of the book consists of sections on number systems, the 6800 processor, programmable and read only memory, the 6820 peripheral interface adapter, and a discussion of the six addressing modes used by the 6800. Following this is a section on assembler techniques and sections which contain various sample programs. This part of the manual, along with the 6800 programming manual, should get you up to speed on 6800 assembly language programming

if you have background in another assembly language.

The remainder of the manual is concerned with hardware design. There is a section on system configuration followed by the data sheets on all the 6800 family chips, some other integrated circuits used in most systems, and a copy of the M6800 EXORciser users guide. Also included is an M6800 reference card and a pad of graph paper.

Who should buy this book? If you are seriously looking at a 6800 system or have a system and want to start assembly language work with it, this book contains a lot of good information. Also, if you plan to do your own hardware design, this book would be very helpful. Those people who already own a SwTPC system have most of this information in the documentation package which comes with the system.



Phil Hughes
POB 2847
Olympia WA 98507

FASTEST KIT IN TOWN!

**Just pliers and screwdriver . . . no soldering!
 Now just plug it in and turn it on!**

Ask your Dad to buy one at your local computer store.



Hazeltine Puts Performance Into Economy Terminals.

Hazeltine Corporation, Greenlawn, N.Y. 11740



The GENERAL IS COMING



The Computer Mart of Massachusetts proudly announces the advent of a major new microcomputer system: the General from Technical Design Laboratories.

The General is a complete floppy disk - based system with a built in CRT, keyboard, and plenty of RAM and ROM memory. It comes fully assembled, tested and burned in, with all components in a single cabinet.

The General is a general purpose programming system with top-ranking hardware and software...at an affordable price. In fact, it has the best price/performance ratio of any disk-based system on the market.

To assure a steady supply for our customers, the Computer Mart has purchased a significant portion of TDL's planned production. However, we expect these units to sell very fast, so place your order early for early delivery. We are making the General available for mail order, and have a special Buyer Protection Plan to help guarantee satisfaction for our mail order customers.

PRELIMINARY FEATURES (PARTIAL LISTING):

COST: \$ **3500** (approx.)

SPECIAL INTRODUCTORY OFFER: **5% off** for pre-paid orders placed before August 15, 1978

DELIVERY: First units...August 1, 1978

HARDWARE:

- 4MHz Z-80A CPU
- 32K RAM memory
- 80x25 upper/lower case video with high resolution graphics
- 12" built in high resolution video monitor
- one floppy disk - capacity 350,000 bytes (2nd disk optional)
- one serial port, two parallel ports
- high quality keyboard with cursor controls, numeric pad and function keys

SOFTWARE:

- TDL's new disk BASIC with extensive data file handling
- TDL's new WORD PROCESSOR with full screen editing
- Optional : assembler, editor, debugger etc.

PERIPHERAL SUPPORT:

- low cost dot matrix printer
- X,Y Plotter
- Diablo Hytype II printer

FOR MORE DETAILS: on the General, the special introductory offer, and our Buyer Protection Plan, contact:

Computer Mart of Massachusetts
1097 Lexington St., Waltham Mass., 02154
(617) 899-4540

"We carry the largest selection of microcomputer systems of any computer retailer in New England."

Continued from page 6

tables and reverse Polish operand notation for use on his personal computers. What surprised me to no end, though, was when I heard from him words to the effect that, "With this language we've developed no one would really ever need more than 16 K bytes of memory."

It sounded vaguely familiar, as if the engineer's statement had merely been updated by a hexadecimal order of magnitude. (Of course the particular system involved did use a floppy disk secondary storage medium, so the memory limit of 16 K obviously applied only to resident capacity.)

Reflecting on both of these incidents, it is obvious that memory as a resource has become quite inexpensive yet people do not fully realize quite how inexpensive it has really become. Both points of view are in a sense equally valid, but based upon an economic impression formed when memory was dear and had to be economized much more than is currently the case.

Ten years ago people were still seriously talking about the expense of semiconductor memory relative to the existing core memory technology. Would semiconductor memory really catch on? Could it be made for the same price of core? Core memory, as a technology, has in many respects gone the way of the buggy whips in the automobile era. Except for the limited contexts in which its nonvolatility is useful, I would be surprised to find any engineer seriously considering it for a new design in view of the cost savings to be attained by using semiconductor memory parts. Semiconductor memory is basically a mass production item by comparison with core. The number of delicate manual operations required is independent of the number of bits for the most part, depending only on the number of pins in the package; for core memory, virtually every bit required a manual operation of some form during assembly by stringing cores on wires in a complicated braided pattern. The mass production of memory using silicon technology has changed the whole attitude which is appropriate toward memory as a system resource.

In short the era of memory riches is now upon us. All it takes now to add 16 K bytes of dynamic memory to a system is eight integrated circuits at a price of about \$50 per circuit in small quantities, and in another year the prices will be even lower as the parts progress further on the "learning

curve" of semiconductor manufacturers. We find the single board microcomputer of contemporary "state of the art" design supplies enough sockets (both for read only and for volatile memory) to completely fill address space in a typical 8 bit microprocessor's design. And the trend toward lower cost will continue, of course, as the technology of the 64 K bit memory chip approaches marketability.

Reflecting this change in costs, the newer microprocessor designs are taking into account the need for additional memory address space so that more memory than 64 K bytes can be employed. The second generation 6800, 6502, 8080 and Z-80 machines are proving easy to saturate now that personal computers are using these processors as general purpose machines. As a result of this saturation, we find, for example, that the new Intel 8086 design is capable of addressing 20 bits worth of memory address space (more than one million bytes). As was strongly hinted at a recent IEEE Comcon session on microprocessor architecture, the

new Zilog Z8000 may have some 23 bits worth of address space in its radical new design, allowing some eight million bytes of memory if one cares to implement it.

By this time, three years from now, I can almost expect the \$50 memory chip to have 64 K bits capacity. The personal computer of 1981 and 1982 will have one processor, one video display and keyboard interface chip, one floppy disk controller chip, eight 64 K memory chips, and one read only memory chip with a kernel of systems software including a P-code interpreter. Based on information from various manufacturers, we can expect this dual minifloppy disk system with 64 K memory still to retail at around \$2000 continuing the deflationary growth of the personal computer field. With a total of only about 12 integrated circuits, the electronics will certainly be simple enough. And returning to the theme which started this commentary, if you have 64 K available, I guarantee that as a user your programs and data will expand to fill the available memory. ■

THE MICRO THAT DWARFS THE COMPETITION

PASCAL

Here at last is your chance to see and operate a full PASCAL compiler/interpreter working with an 8085 CPU.

- Full language implementation
 - Fast compiler (750 lpm)
 - Powerful debugging tools

THE PROGRAMMERS WORKBENCH!!!



NORTHWEST
MICROCOMPUTER
SYSTEMS

Main Office

121 EAST ELEVENTH AVE.
EUGENE, OREGON 97401
PHONE (503) 485-0626

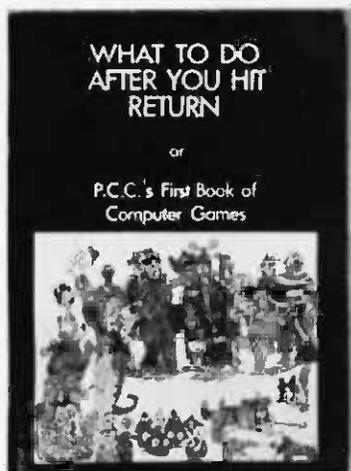
See us at the
Personal Computing
Festival at N.C.C. in Anaheim!

85/P = 8085 + PASCAL

Fun and Games from BITS



101 BASIC Computer Games by David Ahl. A treasure store of games and simulations, 101 all written in BASIC. It contains both a complete listing and a sample run, along with a descriptive write-up. 256 pages, \$7.50.



What to Do After You Hit Return or P.C.C.'s First Book of Computer Games. This is P.C.C.'s first book of computer games, a compendium which includes descriptions of numerous games, and listings of 37 selected BASIC games. New second edition, \$8.

BITS Inc
70 Main St
Peterborough NH 03458

For ease in ordering, please use the coupon on page 96, writing in the names of the books you want. Dial your bank card orders on the BITS toll free hot line: 1-800-258-5477

Please note that processing may exceed 30 days in unusual cases.

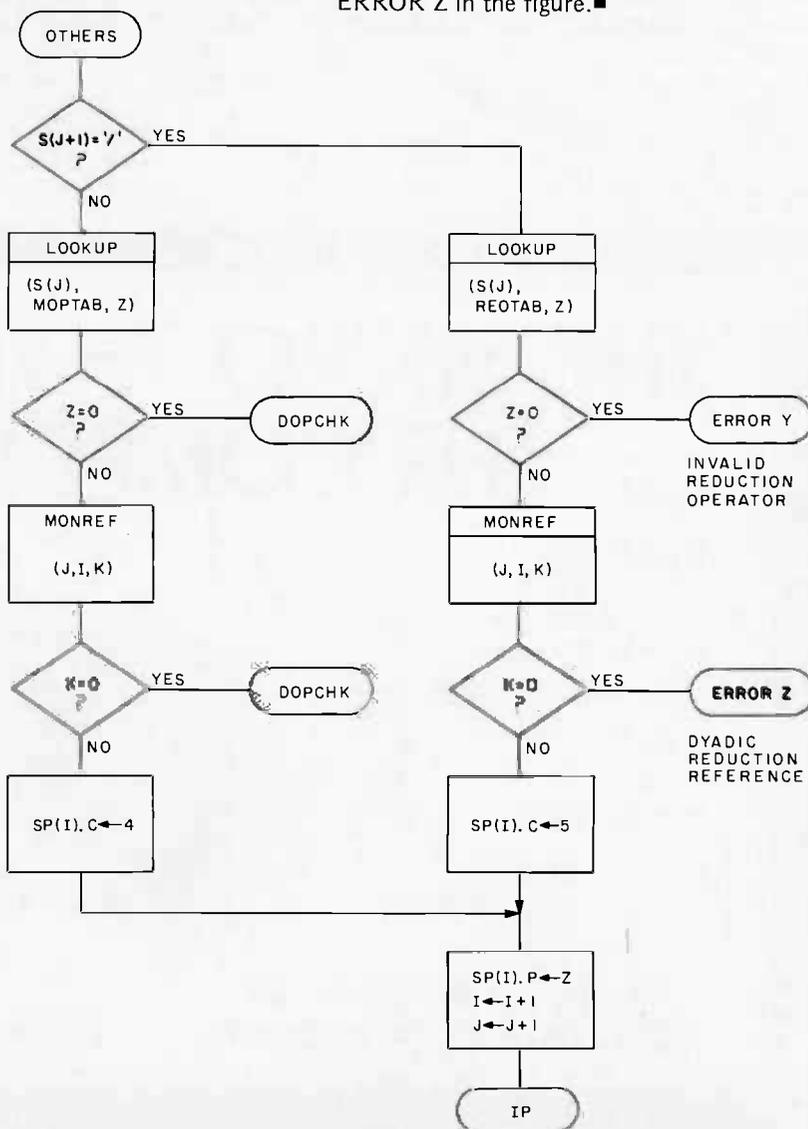
An APL Interpreter: Further Thoughts

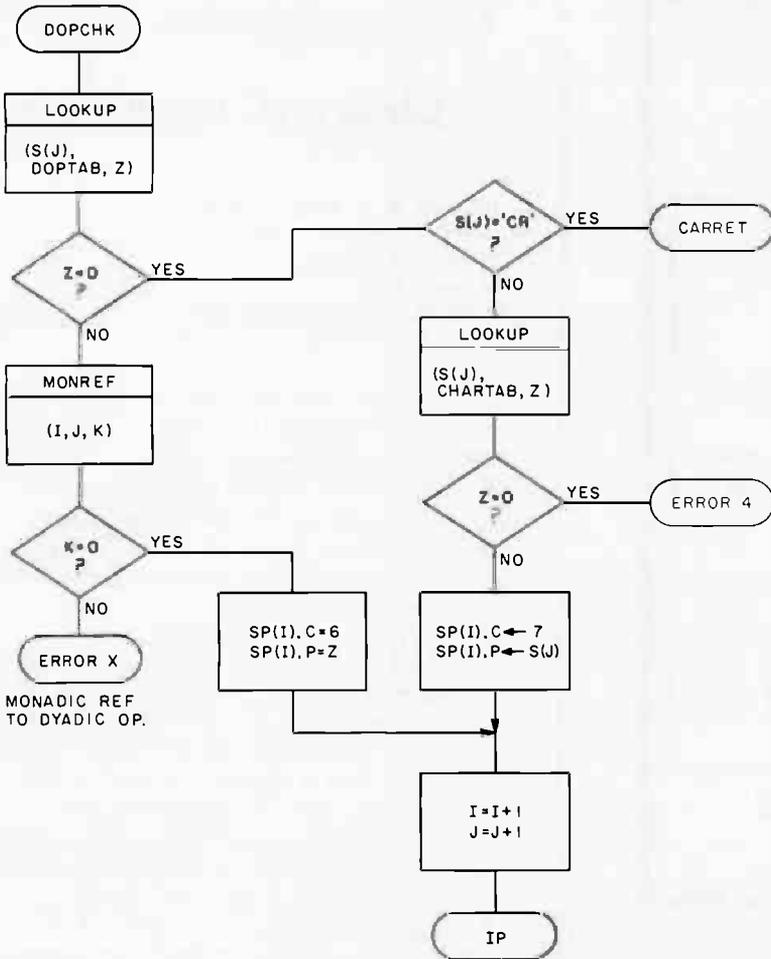
Languages Forum

Tom Brightman
Texas Instruments
504 Totten Pond Rd
Waltham MA 02154

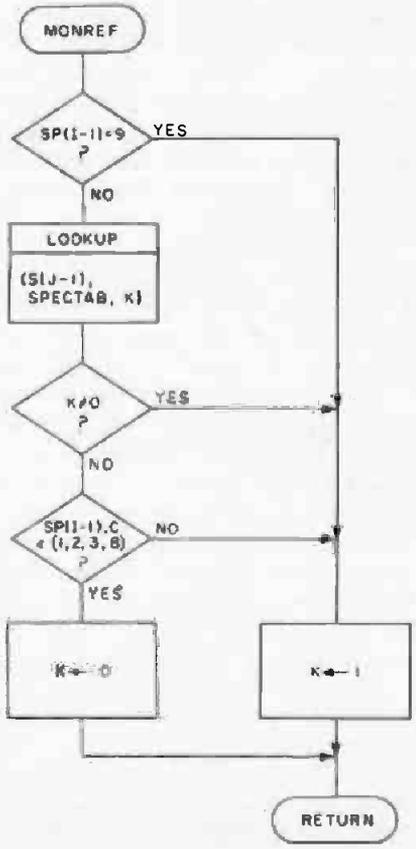
Here is a possible solution to the problem of resolving monadic, dyadic, and reduction operation references in Mike Wimble's article "An APL Interpreter For Microcomputers, Part 1," August 1977 BYTE, page 62. The subroutine MONREF has been added to perform context checking for operator references. MONREF returns its third call parameter = 0 for dyadic contexts and = 1 for monadic contexts.

Since most reductions are monadic, the logic enclosed requires reductions to occur in a monadic context. However, ceiling, floor, and log reductions could be meaningful (and legal) in a dyadic context. They can be implemented simply by checking for appropriate tokens at the point marked ERROR Z in the figure. ■





MONADIC REF TO DYADIC OP.



now
SORT
 with
CP/M*

IN CUSTOMER USE FOR OVER ONE YEAR

Full file sort for **variable** length records, arbitrary length key(s). Ascending or descending order.

Single-key **\$95**
 Multi-key **\$145**

Runs on 16K or larger system. Uses all available memory.

FILE INDEX

Produce cross-index of file names sorted alphabetically across all diskettes in a collection.

\$45

To order or for more information, write

Rothenberg
 INFORMATION SYSTEMS, INC.

260 Sheridan Avenue
 Palo Alto, CA 94306
 (415) 324-8850

Please provide your CP/M Serial #
 California purchasers add Sales Tax
 Pre-paid only. Immediate delivery.

Dealer inquiries invited

*CP/M is a trademark of Digital Research

TRS-80
SOFTWARE EXCHANGE

SOLICITING:
User prepared software in RS Basic Level I or II
READY to LOAD.
Topics-Any that you feel would be of interest to others.

COMPENSATION:
In descending order of preference, and generosity and ascending order of quality standards applied - services, or commissions, or cash.

APPLICATIONS:
Accepted programs are catalogued and grouped in logical categories into volumes (60 minute tapes) for loan.

MECHANIC OF SERVICE:
• Volumes will be LENT for 3 week periods (including time in the mails).
• Deposit \$20 for each volume borrowed. Deposit refunded, less any late charges when cassette is returned.
• Usage Fee of \$3 (not refunded) for each volume borrowed.
• Sample catalog of software upon request.
• Catalog subscription \$3 per year.

Write: **TRS-80 SOFTWARE EXCHANGE**
17 Briar Cliff Drive
Milford, N. H. 03055

The Importance of Choice of Languages

I R MacCallum, Senior Lecturer
Dept of Computer Science
University of Essex
Wivenhoe Park
Colchester C04 3SQ ENGLAND

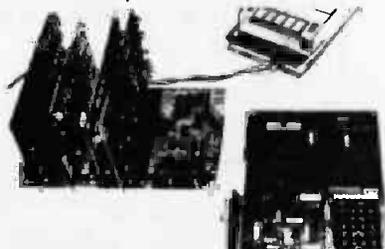
It is good to see that structured programming is permeating the field of personal computing. However, David Higgins (October 1977 BYTE, page 147) should really know better than to reduce Dijkstra's contribution to the art of programming to a statement that "(he) simply observed that the more GOTOs that were in a program, the less likely it was to run correctly."

I doubt whether the great man himself ever uttered such words. What he did say, in a celebrated letter to the editor of the *Communications of the ACM* (March 1969) was that "For a number of years I have been familiar with the observation that the quality of programmers is a decreasing function of the density of GOTO statements in the programs they produce." Please note, Mr Higgins, that with 11 GOTOs in your Bug Program, Dijkstra's remarks cast doubt, not upon the quality of your program, but upon you! There have been reams of correspondence around the world on the vexed question of GOTOs, most of which, I believe, was settled by Donald Knuth in his constructive article in the December 1974 edition of *ACM Computing Surveys*, entitled, "Structured Programming with GOTO Statements."

To leave the matter there would ignore Dijkstra's principal contribution to the art of programming. In 1972 in a paper which forms part of the book *Structured Programming* (Academic Press), he discusses at great length, and with deep insight, the methods of top down step-wise program construction. The principals which he described, and the set of primitive control functions which he advocated have had a profound influence on modern high level programming languages. What Warnier and Orr have done is simply to offer a notation for writing down the top down step-wise construction of a program. This notation is not unique. Michael Jackson's approach is similar, but his diagrams are rotated through 90°.

Finally, I believe your readers should be warned concerning the choice of language. David Higgins suggests that it does

KIMSI



The KIM to S-100 bus Interface/Motherboard

- Combines the power of the 6502 with the flexibility of the S-100 bus
- Attaches to any unmodified KIM
- Complete interface logic and fully buffered motherboard in one unit
- On-board regulation of power for KIM
- Eight slots of S-100 compatibility for additional RAM, Video and I/O boards, PROM Programmers, Speech processors
- Includes all parts, sockets for ICs, one 100 pin connector, and full Assembly/Operating documentation

♦ Kit \$125, Assembled \$165
♦ All units shipped from stock

FORETHOUGHT PRODUCTS
P.O. Box 386-F
Coburg, OR 97401




not matter. It does. He ought to be the first to admit that his Bug Program would have looked far better in ALGOL or PL/I, where the use of compound statements would have removed the necessity for his GOTOs, and would have resulted in a program rather closer to the Warnier-Orr diagram. When personal computers are offered with a richer selection of languages, the "structured" programmer would do well to select his or her language with due care. ■

Toward a Common Pseudocode for Expression of Programs

Richard Wingarter
1780 Westwood Av
Alliance OH 44601

I have been reading with interest the "flurry" of articles and correspondence concerning languages for small computers. I would like to pass on to readers some hints which I've picked up from literature that might be helpful in choosing a language, designing a language, or even using a language.

A large amount of work has been done in computer language design. One of the results of this work is the *Revised Report on the Algorithmic Language ALGOL 68* (A van Wijngaarden et al, Springer Verlag, New York, 1976). While we don't, of course, need to adopt all of their conclusions, ie: ALGOL 68, we might wish to consider several criteria they enumerate, especially if we design a language from scratch (as Glen Taylor suggested in November 1977 BYTE). They accepted the following aims:

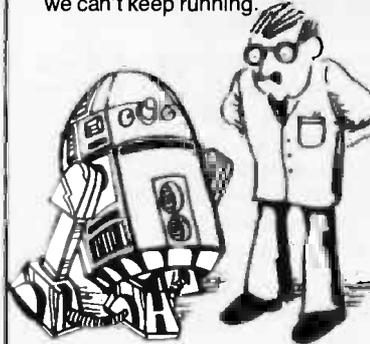
1. Completeness and clarity of description
2. Orthogonal design
3. Security
4. Efficiency
5. Static mode checking
6. Mode independent parsing
7. Independent compilation
8. Loop optimization
9. Representations made possible in a minimal character set

In other words, a computer language should be simple and clear (1). It should be

We speak your language

And we're giving you what you want.

- **a comprehensive product line.** Hardware, assembled or kits, and software from major manufacturers. Plus books and current literature. Financing available.
- **a trained, enthusiastic staff.** We'll help you choose or design the system that's right for you. No high pressure here.
- **service when you need it.** We won't sell you something we can't keep running.



- **a brand new facility in Pennsylvania.** We'll be able to serve our South Jersey-Pennsylvania customers more efficiently now.
- **a bigger, better New Jersey store.** We've enlarged our showroom in Iselin. Now there are more displays you can try out. There's more room to stock the products you need.

The Microcomputer People.™



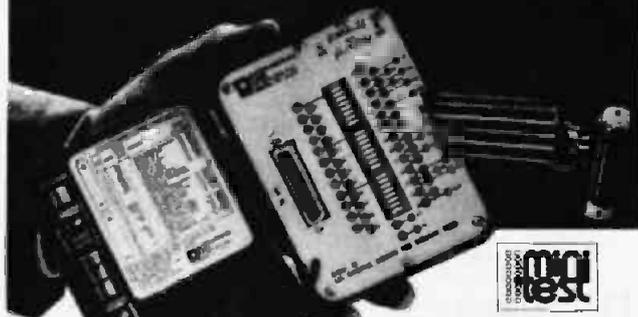
Computer Mart of New Jersey
Computer Mart of Pennsylvania

New Jersey Store
501 Route 27
Iselin, NJ 08830
201-283-0600
Tue Sat. 10:00-6:00
Tue. & Thur. til 9:00

Pennsylvania Store
550 DeKalb Pike
King of Prussia, PA 19406
215-265-2580
Tue.-Thur. 11:00-9:00
Fri. & Sat. 10:00-6:00

(our only locations)

INTRODUCING OUR MODEM AND TERMINAL INTERFACE POCKET ANALYZER.



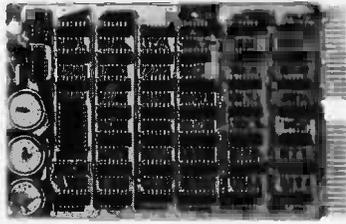
IDS MODEL 60

Our new Model 60 packs in the most testing capabilities per dollar cost. Pinpoints the source of trouble between the MODEM and TERMINAL. Provides access to all 25 lines of the EIA RS 232 interface. Has 12 monitoring LED's plus two voltage-sensing LED's. 24 miniature switches allow isolated testing and observation of all signals. Mini-jumpers included for crosspatching and signal monitoring. Sturdy 10 oz. unit has hard plastic case, and is battery powered. Immediate delivery.

INTERNATIONAL DATA SCIENCES, INC.
ADVANCED TECHNIQUES IN DATA COMMUNICATIONS

100 Nashua St., Prov., R.I. 02904. Tel. (401) 274-5100. TWX 710-381-0285
EXPORT: EMEC, BOX 1285, HALLANDALE, FLORIDA 33009

LSI-11 TIME



It's **TIME** you brought your LSI-11 up to **DATE**. **TIME** and **DATE**, two important parameters in the computer world, are available to your LSI-11 on one **DUAL SIZE BOARD**. When requested, the TCU-50D will present you with the date (month and day), time (hour and minutes), and seconds. Turn your computer off and forget about the time — your battery supported TCU-50D won't, not for 3 months anyway. The correct date and time will be there when you power up.

The TCU-50D is shipped preset to your local time, but can be set to any time you want by a simple software routine.

AT \$295 YOU CAN'T AFFORD TO IGNORE TIME

Time is only one way we can help you upgrade your LSI-11 or PDP-11 system. We'd also like to tell you about the others. So contact Digital Pathways if you're into -11's. **We are too.**



DIGITAL PATHWAYS INC.
4151 Middlefield Road • Palo Alto,
California 94306 • Telephone (415) 493-5544

built on the smallest number of primitive concepts that can assure a powerful and expressive language, and those concepts should not overlap or cause "side effects" when combined (2). Syntactical and logic errors should be easy to find and should not propagate through the program (3). The compilation should not result in a kludge, nor should the compilation take too long (4). As much as possible, the data "types" should allow checking during compilation (5), and they should not be treated differently in similar constructs (6), ie: one ought not to have "Number 1 := Number 2" for integral values, but rather, "Move String 1 to String 2" for strings in the same language. Furthermore, the language should allow procedures (routines) to be compiled separately (7). The syntax should allow optimization of loops (8) and should allow for language to operate with a minimal character set (9), such as 64 character ASCII.

To these I might add that the syntax should suggest logical possibilities so that the programmer is not apt to forget to include things. To this end, the "If... then... [else]... fi" format is better than the limited "IF condition THEN statement" form, because in using the former, the programmer is reminded to think about the "else" possibility, which he might otherwise overlook. In other words, the language should support the programmer's thinking. [Here the token "fi" is used as an "end-if" marker... CH.]

It might seem, by now, that we should pitch all of our current languages, and possibly give up in despair. But I don't believe we will. Most of us are saddled with "outdated" languages with no real hope of ever getting away from them. However, it may be possible to have the best of both worlds.

The great boon in using a "good" computer language is that it permits us to think easily. Since we are using, say, BASIC to program our computers, we tend to fall out of the habit of thinking in English and into the habit of thinking in BASIC. But BASIC is not necessarily a good language to think in. It lacks good control structures and good data structures. One cannot easily express complex ideas with it. And yet, I must program in it and many other users probably do, too.

Actually, I don't program *in* it; I program *into* it from another language, one which is convenient to think in. And I believe that if we would think and communicate in a language or group of languages which are easy to think in, and program in whatever language was available, we could avoid being limited by our computer languages.

P.E.T. COMPUTER

Commodore



Personal Computer

Only **\$795**
8K RAM

- MOS 6502 Microprocessor Controlled
- Integrated CRT, ASCII Keyboard/Cassette
- Full 8K Extended BASIC in ROM
- 8K (Standard) to 32K RAM Expansion
- Peripherals (Printer/Floppy) Available-Summer
- Can be interfaced with S-100 BUS Devices
- Utilizes IEEE-488 BUS for intelligent control of Peripheral Devices
- 64 Built-in Graphics Char. for Games/Charts
- Full File Control under Operating System
- **TOO MANY OTHER FEATURES TO LIST!**

FOR ADDITIONAL INFO CALL
AND REQUEST OUR PET INFORMATION PACKAGE!

NEECO HAS A LARGE, EVER EXPANDING LIBRARY OF PROGRAMS FOR THE PET. CALL AND REQUEST OUR PET LIBRARY LISTINGS • SOFTWARE AUTHORS • NEECO OFFERS 25% ROYALTIES FOR ACCEPTABLE PET PROGRAMS!!!

THE KIM-1



\$245

- "Computer on a Board" - Instant Delivery
- 6502 Microprocessor Controlled
 - 13 Addressing Modes, Multiple Interrupts
 - 65K Bytes Address Range
 - 2-MCS 6530 with 1024 Bytes ROM each, 64 Bytes RAM, 15 I/O Pins, timer. Monitor and Operating Programs are in ROM.
 - TTY and Cassette Interface • 23 Key Pad and 6 Character LED display • 15 Bi-Directional TTL lines. **MUCH MORE!** "Attach a power supply and enter the world of Microcomputers and the future" **Commodore**

MOST MAJOR BRANDS OF CALCULATORS TOO!

NEW ENGLAND ELECTRONICS CO.
248 Bridge Street Area Code (413)
Springfield, Mass. **739-9626**

"Authorized PET Sales & Service"
"Guaranteed Delivery"
Schedules for all of our
PET Customers. Call
for our PET Package.

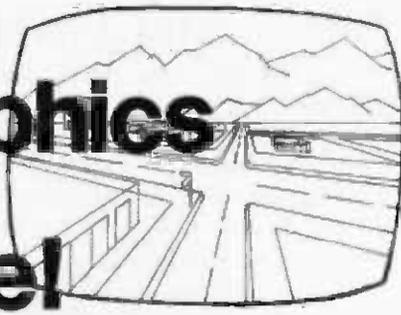
This would have many advantages. The basic ones would be that we could apply the latest techniques to our communication language much more easily than to implemented languages, and that we wouldn't need to develop any new language at all. We'd need only choose the language(s) we wish to use for thinking and communicating, and request that routines submitted for publication be in one of them. Or we could set criteria for the communication language and ask that submitted routines be translated into some language that meets the criteria.

There would be one disadvantage to this method that I can foresee: it may be slower to work out and code a routine this way. Effectively, we would have to hand translate each procedure into whatever language we have implemented. But I should point out that some of this disadvantage would be mitigated by the gains due to faster design, less debugging, and easier communication of routines. My experience is that it may be worth the trouble, but this is no guarantee that everyone would find it so. I might note that "into" programming is recommended in its own right by Roy F Keller in "On Control Constructs for Constructing Programs" (*SIGPLAN Notices*, ACM Special Interest Group on Programming Languages, volume 12, #9, September 1977, pages 36 to 44), so I am not alone.

I hope that some readers might consider this approach, as it might be very helpful. Expecting people to throw away their BASIC, FORTRAN, or what have you, is not really practical, as we know from the experience of those with larger computers. But expecting them to communicate in a common language especially suited for that purpose is reasonable. ■

Languages Forum is a feature which is intended as an interactive dialog about the design and implementation of languages for personal computing. Statements and opinions submitted to this forum can be on any subject relevant to its purpose of fostering discussion and communication among BYTE readers on the subject of languages. We ask that all correspondents supply their full names and addresses to be printed with their commentaries. We also ask that correspondents supply their telephone numbers, which will be printed unless we are explicitly asked to omit them.

3D graphics are here!

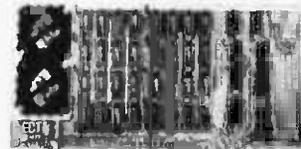


the most powerful 3D software yet for your 8080 and Z80.

- 10 projection modes, 500 lines/second
- Interfaces to any S100 display device
- Uses 8K memory
- Only \$30 for Tarbell tape and documentation. (MATROX interface program included.)

Write to us for more details and a complete catalog of 8080, Z80, 6800, and BASIC graphic systems.

Box 3442
sub LOGIC
 Culver City, CA 90230



16K RAM

FULLY STATIC
 INTRODUCTORY
\$450 KIT PRICE

10 SLOT MAINFRAME
 TT-10...KIT \$325

10 SLOT TABLE TOP
 MICROCOMPUTERS
 TT-8080...KIT \$440

SYSTEM WITH 16K & I/O
 TT-8080-S...KIT \$1050

CARD CAGE &
 MOTHER BOARD
 ECT-100...KIT \$100

CCMB-10...KIT \$75

WITH CONNECTORS
 & GUIDES
 ECT-100-F...KIT \$200

CCMB-10-F...KIT \$125

CPU'S, MEMORY
 MOTHER BOARDS
 PROTOTYPING BOARDS
 EXTENDER CARDS
 POWER SUPPLIES

SHIPPING EXTRA
 DEALER INQUIRIES INVITED



ELECTRONIC CONTROL TECHNOLOGY

FACTORY ADDRESS:
 763 RAMSEY AVENUE
 HILLSIDE, N. J. 07205

MAILING ADDRESS:
 P. O. BOX 6
 UNION, N. J. 07083

(201) 686-8080

do at some point, either through hardware fatigue or software and operator errors) there arises a problem of data recuperation. In removable disk systems, external backups can be made and remounted. Data loss is limited to entries made since the backup's creation. Start-up time is the time it takes to get the disk back on the drive and running. A fixed disk system calls for backup onto an external device, which can be a very slow process, or by 100 percent redundancy (namely, buying two drives and using one for backup purposes).

Due to the impracticality of copying ten to 100 megabytes of data on diskette or cassette, the only practical solution is redundancy. The problem is that the low cost of these drives will open whole new markets of unsophisticated users who will not see the need for buying two drives until they call to cancel orders or sue because they have lost valuable data. Nobody needs this kind of aggravation. In order to protect both the users and the industry, I think such drives should be designed with at least a backup surface for data recovery.

Second, a 100 megabyte drive is a 100 megabyte drive and the software must be treated as such. Inadequate disk management systems are inexcusable, since the necessary software tools already exist. These devices will have to be provided with the proper routines (ie: dynamic disk allocation, catalogs and catalog path file allocation, binary files, spool and random access files, hash/sequential and multikey indexed/sequential files (with keys in separate files) record oriented IO and cylindrical allocations in multisurface systems).

The most sensible solution is to take the standard routines and some diagnostic routines, put them in read only memory with a dedicated microprocessor (thereby making the device intelligent) and to offer the controllers with serial, parallel and DMA interfaces for the major bus configurations (that includes the Altair (S-100) bus). Even if these steps triple the price of the drive, they will still result in a vast improvement over present prices. These steps also will ensure the smooth and painless creation of new and lucrative markets as well as rapid acceptance by existing markets.

I hope the manufacturers will act on my recommendations as I write this not as criticism, but merely with a critical eye. The only problems which don't occur are the ones that are foreseen and prevented. ■

→ 2708
 → μPD 458
 → TMS 2716

PRAMMER III by xybek

The Ultimate EPROM Memory Board For Your S100-Bus Computer

- ★ Accommodates from 1k to 30k of the above EPROMs, in any combination, each addressable on any 1k (2k for 2716) boundary within the board's 32k address space.
- ★ 1k of scratch-pad RAM.
- ★ On-board programming for all three EPROM types.
- ★ Tri-state buffers on all address and data lines.
- ★ Empty EPROM sockets do not require address space.
- ★ Assembled, tested, ready to run — only \$369.50

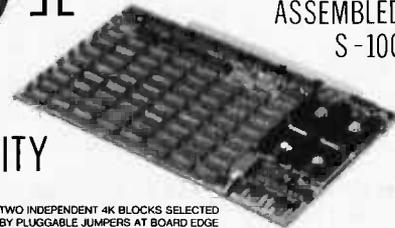
xybek • P.O. Box 4925 • Stanford, CA 94305
 Telephone: (408) 296-8188

Pacific
 DIGITAL

8KRS

8K STATIC RAM
 ASSEMBLED
 S-100

RELIABILITY
 QUALITY
 DEPENDABILITY



ADDRESSING
 PROTECT
 BUFFERING
 LOW POWER
 WAIT STATES
 QUALITY
 GUARANTEE
 DELIVERY
 PHANTOM
 TESTING

TWO INDEPENDENT 4K BLOCKS SELECTED BY PLUGGABLE JUMPERS AT BOARD EDGE

ON-BOARD SWITCH WRITE PROTECTS/UNPROTECTS ALL 8K OR EACH 4K BLOCK CAN BE PROTECTED VIA FRONT PANEL

ALL S-100 BUS LINES ARE FULLY BUFFERED ONE LS-TTL LOAD PER LINE

21L02 RAMS - THE 8KRS TYPICALLY REQUIRES 1.5 AMPS AT 8 VOLTS - 4 ON-BOARD 5 VOLT REGULATORS

0, 1, OR 2 WAIT STATES MAY BE SELECTED VIA A PLUGGABLE JUMPER

THE BOARD IS GLASS EPOXY WITH SILK SCREEN LEGEND, FULL SOLDER MASKS ON BOTH SIDES, FLOW SOLDERING, GOLD CONTACTS

IF NOT SATISFIED RETURN THE UNDAMAGED 8KRS WITHIN 10 DAYS FOR FULL REFUND - ALSO 90 DAY LIMITED WARRANTY

STOCK TO 30 DAYS - CALL BETWEEN 8:30 AND 6:00 TO RESERVE YOUR 8KRS OR FOR MORE INFORMATION

MEMORY DISABLE IS IMPLEMENTED VIA PHANTOM (PIN 67)

COMPLETE TESTING NOT ONLY OF ALL MEMORY CELLS BUT ALSO OF ALL SUPPORT CIRCUITRY AND OPTIONS

SPECIAL

INTRODUCTORY
 PRICE
 ASSEMBLED / TESTED

450 ns 250 ns
 \$14995 \$18995

CALIFORNIA RESIDENTS ADD 6% TAX

(714) 992-5540
 2555 E. CHAPMAN AVE.
 SUITE 604
 FULLERTON, CA 92631

Pacific
 DIGITAL

THE PROM SETTER

- WRITE and READ EPROMs 1702A, 2704/2708
- Can be arranged to do 1702A, 2716TI or 2708, 2716TI and with a few additional parts 2716INTEL, 5204, 6834
- Plugs directly into your ALTAIR/IMSAI Computer
- No External Supplies. Your Computer does it ALL

KIT - \$210
ASSEMBLED - \$375

RAM N ROM

- Operates in S-100 BUS
- 16 EPROM* sockets with own address select and up to 4 waite states
- Can be wired for any EPROM (in 8/16 unit operation) 1702A, 2704, 2708, 2716INTEL, 2716TI, 5204, 6834
- IK RAM independently address, takes precedence over ROM
- POWER ON JUMP & RUN (Computer With/Without Front Panels)

*EPROMs not included

KIT - \$117
ASSEMBLED - \$168

Delivery Less Than 60 Days

SZERLIP ENTERPRISES

1414 W. 259th St. - Harbor City, California 90710

California residents please add 6% sales tax

NORTH STAR BASIC PROGRAMS

HUNDREDS SOLD, EACH SYSTEM COMPLETE ON DISKETTE READY TO RUN. WORD PROCESSING, NORTH STAR TUTORIAL I, NORTH STAR TUTORIAL II (TEACHES NORTH STAR BASIC), ACCOUNTS PAYABLE, ACCOUNTS RECEIVABLE, PAYROLL, GENERAL LEDGER, MEDICAL-PROFESSIONAL, BILLING, SALES WITH SALES ANALYSIS AND GROSS PROFIT, INVENTORY, HISTOGRAM GENERATOR. \$35.00 each.

SOFTWARE LOCATER (LOCATE, INDEX-FREE SOFTWARE), CHECKBOOK BALANCING, BOWLING-GOLF HANDICAPPER, COIN COLLECTION INVENTORY, IMPORTANT DOCUMENT LOCATER, BUDGET PLANNER, GAME DISK. \$25.00 each.

IQ TESTER, COMPUTER MEMORY DIAGNOSTIC PERSONAL FINANCE, BUSINESS FINANCE, BIORHYTHM GENERATOR, DIET PLANNER, CRYPTOGRAPHIC ENCODER, MATH TUTOR. \$15.00 each.

EQUIPMENT REQUIRED, SINGLE DRIVE, 8K FREE MEMORY, PRINTER OPTIONAL.

TRS-80 LEVEL II (ON CASSETTE) STOCK MARKET ANALYSIS, GRAPHICS, TREND LINE ANALYSIS. \$15.00.

BLANK DISKETTES \$3.80 (UNDER TEN ORDERED, ADD \$2.00 FOR SHIPPING; OVER TEN SHIPPED POSTPAID).



SOFTWARE
DEPT. 11 P. O. BOX 2528
ORANGE, CA 92669

On Converting 60 Hz VDM-1s to 50 Hz Line Current

Timothy Mowchanuk
Editor of COM-3
Senior Chemistry Master
POB 268
Niddrie 3042 AUSTRALIA

I read Guy Burkill's letter in the June 1977 column of "Ask BYTE," page 60. The following is a modification to the Processor Technology VDM-1 board that may prove useful. (By the way, I have built two VDM-1 boards and they both work perfectly. I can strongly recommend them.)

Modify IC8 (93L16). Cut the land between pins 5 and 6, and connect pin 5 to ground (pins 3 and 4 of the same IC are handy). This will alter the field and line frequencies to suit 50 Hz main frequencies. The video levels may be inverted, but this can be changed using the switches on the VDM-1. The inversion problem depends on the particular TV standard and the method of input to the television. This modification will work with the PAL-D television system. It will not work with the French television standard. (PAL-D is the British standard.)

You may wish to publish this information for your foreign readers. ■

The Need for Relocating Loaders

K P Pielmeier
Albstr 33
D-7014 Kornwestheim
W GERMANY

I would like to make some suggestions. Today most machine code programs for personal computers are produced for fixed memory assignment and are relocatable

only after changing the source code and reassembling or recompiling. As program libraries grow, the drawback of reassembly becomes more and more obstructive.

It would be quite nice to have relocatable modules, and it would be even nicer to have one standard defined for any type of processor. (There are other ways to produce relocatable modules; see Borrmann's excellent "Relocatability and the Long Branch," page 26, in the October 1977 BYTE. This method produces programs which are slower and a little longer.) From my experience with IBM's linkage editor and loader I can say that this is a valuable tool: any translator (assembler or compiler) can produce its code in the required format and the code may be executed on any IBM system without change.

Of course I have a proposal at hand and I hope that it will not remain the only one, so that a satisfactory solution may be found. My suggestion is that a relocatable load module consist of four parts, which are:

1. The code part, which contains the machine instructions and the data. This part will need some changes in relocation.
2. The relocation directory part, which defines the points in the code part, which must be processed during relocation.
3. The entry point directory part, which defines the entry points in the code part, ie: the names and the addresses of items defined in this program which may be referenced by other programs.
4. The external reference directory part, which defines the external references in the code part, ie: the names of references in this program to items defined in other programs.

(If the names look like IBM, this is because I took them from there.)

I propose that each part should have the same format: a descriptor field and the part itself. As a minimum, the descriptor field should contain the identification of the part and its length.

To keep the loader program simple and small, I suggest that only one operation be allowed for relocation: one (and only one) constant will be added to all points designated by the relocation directory. This constant can be passed to the loader as a parameter and need not be defined in the relocation directory itself. To keep the

cañada
systems, inc.

Boards DO Something



CL2400
Real Time Clock

\$98—Kit \$135—Assembled

If your system needs to know what time it is, our CL2400 is the board for you. The present time in hours, minutes, and seconds is always available for input, and is continuously updated by the highly accurate 60 Hz power line frequency. Need periodic interrupts? The CL2400 can do that, too, at any of 6 rates. Reference manual with BASIC and assembly language software examples included.



PC3200
Power Control System

PC3232 \$299—Kit \$360—Assm.
PC3216 \$189—Kit \$240—Assm.
PC3202 \$39.50—Kit \$52—Assm.

If your system needs on/off control of lights, motors, appliances, etc., our PC3200 System components are for you. Control boards allow one I/O port to control 32 (PC3232) or 16 (PC3216) external Power Control Units, such as the PC3202 which controls 120 VAC loads to 400 Watts. Optically isolated, low voltage, current-limited control lines are standard in this growing product line.

cañada
systems, inc.
(formerly comptek)

P.O. Box 516
La Canada, CA 91011
(213) 790-7957

COMPUTER SHOPPING



FIND YOURS! — In the comprehensive index of computer firms, The Computer Data Directory. Contains profiles of over 600 manufacturers, stores, distributors, publishers, and electronic dealers. All addresses are up-to-date and at your finger tips! Products are cross-referenced to their manufacturers. Similar to a telephone directory. Definitely a useful reference source. Order yours today. All orders shipped on day received.

ORDER NOW!

Only
\$4.98

Postage Included

- SYSTEMS
- SOFTWARE
- PERIPHERALS
- ACCESSORIES
- EASY TO USE!
- COMPUTER STORES
- COMPUTER SERVICE
- ELECTRONIC PARTS/SERVICE
- BRAND NAME MANUFACTURERS
- WHERE TO WRITE FOR BROCHURES!

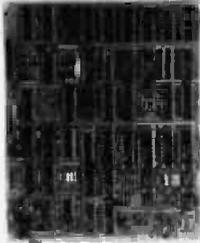
THE **Computer Data Directory**

BOX 598 · DEPT B

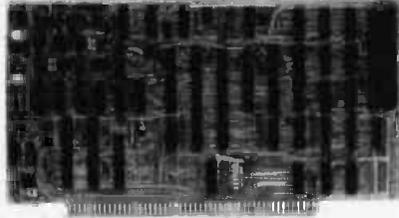
CLEVELAND, OHIO

44107

COMPUTER VOICE



M250



M188

Speech Technology voice generators operate from stored vocabularies — words, phrase, or messages of any length. Vocabularies are derived from real speech, thus preserving clarity and naturalness to a degree not obtained with other methods of low-data-rate synthesis. Average data rates for spoken messages are less than 120 bytes per second. Typically, only 8K bytes of memory are needed for 100 words and short phrases.

M188 is inserted into a slot in any S100 bus computer, including Z-80 systems. Only standard bus signals are used, and there is no interference with special bus assignments on some computers. M188 is readily adapted to Intel SBC and other buses. It operates from programmed transfers of unlimited vocabulary data in computer memory or with 2-byte access to limited vocabularies in on-board EPROMs. \$395 price includes fully assembled and tested M188, with comprehensive reference manual and 95-word vocabulary on digital cassette.

M250 featuring small size and fully operating power of 150 milliwatts is ideal for instruments and portable equipment. M250 operates with on-board PROM-stored vocabularies. Each word or phrase is selected by an external addressing byte and strobe. An end-of-message signal is supplied by the M250. Price with programmed vocabulary (up to 40 words) is \$395. Optional, larger capacity PROMs hold up to 80 words for \$565.

VOCABULARY LISTS / TECHNICAL INFORMATION — CONTACT:



SPEECH TECHNOLOGY CORPORATION

631 WILSHIRE BLVD., SANTA MONICA, CA 90401
(213) 393-0101

relocation directory small, I suggest that it should consist simply of 1 byte entries, each of which describes the offset from the last relocation point to the next, with 255 (=FFH) as an "advance and do nothing" indication. The relocation points must be presented in ascending order. For the entry/external directories I will only suggest that they should contain the name and the relative address of each reference.

I don't think it is reasonable to adopt a load module format very close to any external storage medium (as is the case with IBM's convention). It is better to separate the task of reading into internal memory and processing, so that a change in the external medium will not affect the processing part.

Unfortunately I have no knowledge of any existing relocatable load module format for personal computers. I have neither a translator program producing relocatable modules nor a loader program.

I think that many people have similar ideas, and I would like to discuss them to find a good and widely accepted solution. ■

**BET,
YOU DIDN'T KNOW!**

OAE'S new **PP-2708/16** PROM Programmer is the *only* programmer with all these features:

- Converts a PROM memory socket to a table top programmer. No complex interfacing to wire — just plug it into a 2708 memory socket*
- A short subroutine sends data over the address lines to program the PROM
- Programs 2 PROMS for less than the cost of a personality module. (2708s and TMS 2716s)
- Connect 2 or more in parallel — super for production programming
- Complete with DC to DC switching inverter and 10

turn cermet trimmers (for precision pulse width and amplitude alignment)

- All packaged in a handsome aluminum case

PP-2708/16 A & T \$295.

PP-2716 (Programs Intel's 2716) A & T \$295.

OAE

Oliver Advanced Engineering, Inc.
676 West Wilson Avenue
Glendale, Calif. 91203
(213) 240-0080

*Pat's Pending

Speeding Up MIKBUG IO Routines

T W Moore
Amateur Computer Club 6800 Library
24 College Rd
Maidenhead, Berkshire SL6 6BN
ENGLAND

The Motorola MIKBUG ROM is widely used by 6800 hackers. It contains two entry points, E1D1 and E1AC, which can be used by a user program as input or output routines; these routines use a single bit of a PIA and the data rate timing is determined by software and a programmable monostable (MC14536).

Because of the software nature of the timing, some jitter will be introduced in the output waveform and there will be a jitter component in the sampling point of the received waveform. This effectively results in a maximum data rate at which

MIKBUG can communicate with the outside world.

The jitter is caused by software loops in MIKBUG which wait for timeout of the monostable MC14536 but cannot quite catch the exact trailing edge of the monostable output. The following loop:

```
E1EF DEL TST 2,X (7 cycles)
E1F1 BPL DEL (4 cycles)
```

senses bit 7 of the PIA in a loop and exits when bit 7 is a logic "1." In practice, the program exits anywhere between 7 and 18 machine cycles after the leading edge of the signal into pin 7, since bit 7 is only sampled every 11 machine cycles.

The input routine (E1AC) looks for a start bit by continually sensing bit 7 of side A of the PIA in a short loop, jumping out into the main routine when a logic zero is detected indicating a start bit. The main routine starts the programmable monostable which is sensed on bit 7 of side B of the PIA. The monostable effectively times out 1.5 T, where T is 1/data rate, 3.33 ms for a data rate of 300 bps. After this, the first bit of data is sensed and rotated into the accumulator via the carry bit. This procedure is repeated eight times for all eight bits separated by a delay routine (DEL above) which waits for the monostable to timeout.

The output routine works in a similar manner but then outputs data from the accumulator by rotating it into bit 0 of side A of the PIA.

The effective input and output data rates are therefore determined by the time interval between samples or program loops, and mostly dependent on the monostable pulse width. The actual time between input samples in MIKBUG is:

$$T_{\text{mono}} + 28 \cdot T_{\text{cycle}} + \begin{bmatrix} 0 \\ 11 \end{bmatrix} \cdot T_{\text{cycle}}$$

where T_{mono} is the monostable delay, T_{cycle} is the 6800 machine cycle time and $\begin{bmatrix} 0 \\ 11 \end{bmatrix}$ is my notation for any number between 0 and 11.

The time between output samples is:

$$T_{\text{mono}} + 62 \cdot T_{\text{cycle}} + \begin{bmatrix} 0 \\ 11 \end{bmatrix} \cdot T_{\text{cycle}}$$

except for the width of the start bit which is:

$$T_{\text{mono}} + 56 \cdot T_{\text{cycle}} + \begin{bmatrix} 0 \\ 11 \end{bmatrix} \cdot T_{\text{cycle}}$$

Presenting a growing line of professional quality **S-100** COMPATIBLE **BLANK BOARDS**

8K BLANK RAM BOARD for 2102 type memory **\$25.00**
—with MEMORY PROTECT/UNPROTECT and SELECTABLE WAIT STATES

Z-80 CPU BOARD **\$35.00**
—with PROVISIONS for ONBOARD 2708 and POWER ON JUMP

PROTOBOARD **\$25.00**

(NEW) **2708/16 EPROM BOARD** **\$25.00**
—accepts up to 16K of 2708's or 32K of 2716's

ALL BOARDS FEATURE

- FULL BUFFERING on ALL DATA and ADDRESS LINES¹
- SOLDER MASKS and SILK SCREEN
- DIP SWITCH ADDRESSING¹
- GOLD EDGE CONNECTORS
- PLATED THROUGH HOLES

¹except for PROTOBOARD

WATCH FOR OUR 16/64K DYNAMIC RAM BOARD AND ADDITIONAL BOARDS TO BE ANNOUNCED FORTHWITH.

IMSAI 8080 Kit **\$560.00**
—with 22 Slot M.B. PLUS \$10.00 SHIPPING

Z-80 CPU CHIP.....\$22.00
Z-80A CPU CHIP.....\$25.00
2708 CHIP 450 ns.....\$12.00
PLEASE ADD \$2.00 SHIPPING PER ORDER

ithaca audio **PO BOX 91**
ITHACA, N.Y. 14850

PLEASE CALL (607) 273-3271
TO ORDER OR OBTAIN TECHNICAL ASSISTANCE.
OEM and quantity discounts available



WHATSIT™

A "DATA BASE MANAGER" FOR YOUR MICROCOMPUTER

Much of the untapped potential of computers lies in their ability to store "data bases" of constantly changing information, and to permit convenient, timely access to it through a one-to-one "conversation" with the person who needs it. Used as a "Data Base Manager," WHATSIT can support a disc-resident data base and process queries (as well as updates) in a real-time conversational mode.

APPLICATIONS

Easily implemented on a small desktop computer with as little as 24K of total memory, the WHATSIT system can be used in applications like these:

- A salesperson may need to store customer and prospect lists, buyers' names and phone numbers, current order status.
- A professional person may need to index client records, appointment schedules, or technical data needed for frequent reference.
- A contractor might want quick access to material prices and specifications.
- A manufacturer's data base might include customers and suppliers, and recent price quotations issued and received.
- An investor might want to keep tabs on a portfolio of securities, with purchase dates and tax basis information.

OPERATING SIMPLICITY

In response to pidgin English "Requests," WHATSIT can store, index, and retrieve information about one or several aspects of your business, hobby, or other application. You are free to intermix unrelated data on a single disc, or to "dedicate" an individual disc to each of a variety of applications.

Since file indexing and disc space allocation are performed automatically, the system can be used without learning complex procedures. And since both queries and updates are processed within a single program, there's no need for the inconvenience and delay of a "menu selector," or for manually switching from one program to another.

In contrast to many programs, WHATSIT does not require you to commit yourself in advance to particular data structures, or "record formats." The file structure is never frozen, but develops automatically to adapt to your requirements.

DYNAMIC FILE RESTRUCTURING

This "dynamic restructuring" of the data base takes place through normal use of the system, without operator intervention or reprogramming.

This is how it works: Whatever information you wish to store is automatically cross-indexed under "Subject" and "Tag" headings you designate. Using WHATSIT's pidgin English Requests, you may add or change headings, as well as data, at any time. Because the system maintains headings in disc storage, they may be changed readily by the program itself.

CONVERSATIONAL QUERY CAPABILITY

Data retrieval is equally easy. You can query the system directly about any data item on file, or you

may inquire about any heading. All that's required is a pidgin English "Request," such as "WHEN'S DR. JEKYLL'S APPOINTMENT?" System response time is usually a matter of seconds.

Up to two headings may be specified in a single Request, a capability that makes possible versatile cross-indexing within the data base.

INSTALLATION

For easy installation, the WHATSIT programs are supplied in the widely available North Star BASIC, and can be installed without modification on any S-100 bus (8080 or Z-80) computer equipped with a North Star disc system and at least 24K bytes of random access memory (RAM). For other disc systems or non-compatible computers, the programs would require modification.

SPECIFICATIONS

MODEL NS-3, Version 1

Hardware compatibility: Any S-100 Bus (8080 or Z-80) computer with one North Star disc system and 24K of RAM (random access memory).

Language: North Star BASIC, Version 6 Release 3.
Request types: Store, Scratch, Change, Add, Split (6 types including Indexed, Selective, and Analog), plus special Requests.

Response time: Normally 3 to 10 seconds.
File capacity: 1500 to 3000 entries per disc, depending on average entry length.

Indexing: Every entry automatically indexed by Subject, Tag, Object.

Request length: Up to 100 characters.
Entry length: Up to 30 characters.

WHATSIT is available for \$75.00 as a Ready-to-Run System, including three programs on Northstar disc and a 100-page user's manual written in non-technical language. The manual may be optionally ordered for \$25.00. Besides detailed startup and operating instructions, the manual includes complete programs listings.

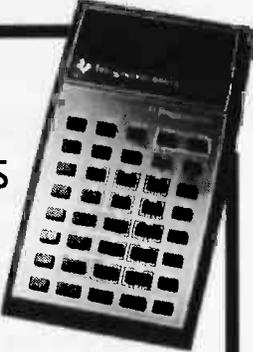
IN BASIC

INFORMATION UNLIMITED
698 W 70 St Private Rd
Hebron Ind 46341
(219) 986-4450



NEW

TEXAS INSTRUMENTS
CALCULATOR
for the
COMPUTER
PROGRAMMER



\$59.95

It calculates and converts in hexadecimal, decimal, and octal. Eliminates conversion tables and tedious longhand methods.

\$59.95 postpaid with battery pack, adapter/charger, case, and manual. 10 day return privilege. Phone orders, and bank cards accepted. Foreign orders invited. Also purchase orders from established companies. Immediate Delivery. Our toll-free credit card order line is 1-800-521-1534. Mail your order to address below.

Just say charge it! Which card?




NCE/Compumart 1250 N. Main St., Dept. BY68
P.O. Box 8610 Ann Arbor, Mi. 48107 (313) 994-4445

Assuming a 6800 machine cycle of 1 μ s, there will be a peak to peak jitter component of 11 μ s between bit samples. Unfortunately this jitter component is cumulative. If we refer the sample times of a waveform to the leading edge of the start bit, as most asynchronous devices operate, the trailing edge of the eighth bit can have a peak to peak jitter component of 88 μ s. Similarly, the MIKBUG input routine can sample the eighth bit anywhere within a 116 μ s window. These two figures are different since MIKBUG input routine adds an extra 39 μ s of jitter sensing the start bit.

At low data rates, such as 300 bps, the jitter is comparatively small. If we take a maximum allowable jitter of 25 percent of data rate as a deterministic bound on reliable communications, then with a 1 μ s cycle time (and no clock cycle stealing), the maximum data rate at which MIKBUG will operate without errors is $1/(4.88) \approx 2400$ bps. In practice, the jitter adds with a Gaussian envelope distribution and operation at 4800 bps, which for noncritical applications such as video displays, is quite possible with a few errors appearing.

For more critical applications, such as cassette program storage, reducing the data rate to 1200 bps should allow enough margin for jitter introduced by the rest of the system. In fact, MIKBUG operates very reliably at 1200 bps and I have used it to load programs from standard cassettes such as 8 K BASIC without any errors.

It should also be mentioned that at these high external clock rates, the output data rates from MIKBUG will be different from the input data rate. This is because of the different number of machine cycles taken in the input and output routines. In fact, the output routine produces an extra delay of 34 μ s between data edges. At 1200 bps this represents a disparity of 4 percent between input and output data rates.

A practical MIKBUG system configured for high speed would have say 4800 bps for video display output, 1200 bps for high speed cassette and 300 bps for standard Kansas City interface.

The circuit of figure 1 shows a typical configuration. Rather than switching the oscillator over such a wide range, the unused programming pins of the programmable monostable are used to give the required delays of 3.3 ms, 830 μ s, and 200 μ s. The oscillator shown is a separate 555 since this gives improved temperature stability, but is not essential. The oscillator frequency is around 50 kHz, but should be pulled slightly to compensate for the extra delays introduced by the 6800 cycle times.

MPI
QUALITY CONTROL TEST

KEYBOARD TEST 300 BAUD RS232 SERIAL PORT
KEYBOARD TEST 300 BAUD CURRENT LOOP
ON LINE TEST 9600 BAUD RS232 SERIAL PORT

BUFFER WRAP AROUND
1234567890123456789012345678901234567890
123456789012345678901234567890
1234567890123456789012345678901234567890

24 CHARACTER PATTERN
ABCDEFGHIJKLmnopqrst
01234567890123456789012345678901234567890
01234567890123456789012345678901234567890

12 CHARACTER PATTERN
ABCDEFGHIJKLmnopqrst
01234567890123456789012345678901234567890
01234567890123456789012345678901234567890

ONLINE TIMEOUT

Need Hard Copy?

TRY OUR SOFT PRICES

\$425

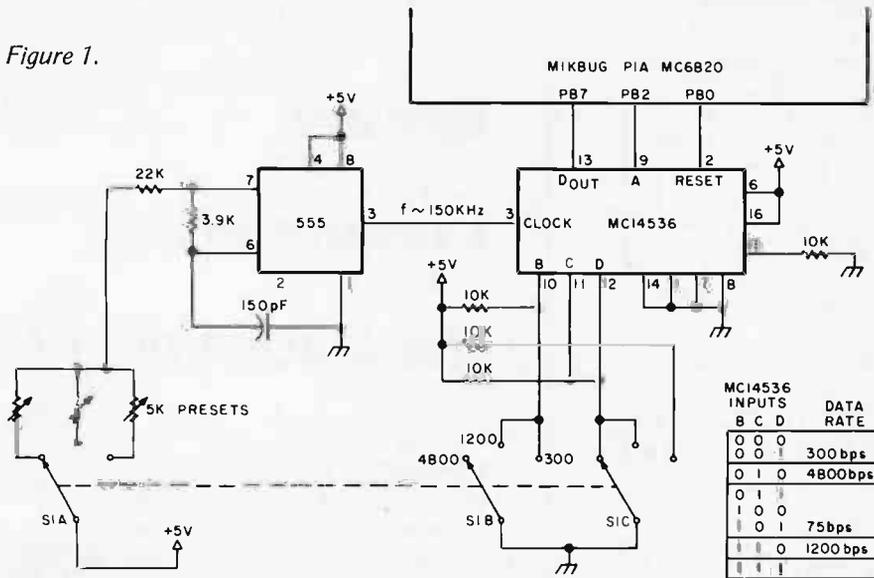
Complete standalone 40 column impact dot matrix printer with a 64 character ASCII set. Includes power supply, casework and interface electronics for connection to a mini-micro processor parallel port. Serial interface versions for RS232 current loop applications start at \$575 in single quantity.

SEND FOR FREE LITERATURE



Box 22101
Salt Lake City, Utah 84122
(801) 364-2411

Figure 1.



Wait No Longer!

The new educational programs are here.

Discover how to get more out of your computer.

Magnamedia has produced the innovative line of software products you've been waiting for. Designed for use both at home or in the classroom, these programs make learning an exciting experience.

This software comes in handsome two-cassette albums. Each cassette provides voice instruction on one side and a machine readable code on the other. Separate instruction booklets are provided in non-technical language.

PROGRAMS NOW AVAILABLE

All software is for Apple II. (Programs for other popular micro computers will be available soon).

● **Supermath™** (16K)—The computer teaches you to add, subtract, multiply and

divide on your own level—in color!

● **True/False Quiz** (8K)—Tells you how to enter your own quiz.

● **Variable Message**—You choose message and colors, the computer does the rest.

● **Matching Quiz** (8K)—Three changeable categories in each program. Match item on left correctly with one on right and they both disappear.

● **Don't Fall™** (8K)—The computer chooses a word—you try to guess the letters without falling off cliff. Then you give the computer a word.

● **Memory Aide** (8K)—Help memorizing facts, verses, lists. Computer prompts you, asks you to provide missing words, etc.

● **Study Aide** (8K)—The computer gives questions in random order. If you miss, it saves the question for a later try.

● **Keyboard Organ** (4K)—Turn your computer into a musical instrument. Play the keys like a piano!

● **Grading Routine** (16K)—Takes the drudgery out of finding class curves. Different categories, grading scales, etc.

● **Drawing** (4K)—Computer chooses word at random from list you supply.

Here's the best news of all—each package of two programs sells for only \$12.00! Individual programs are available for \$7.50. Include \$2.00 per order for shipping and handling. (California residents add 6%).

Magnamedia software is in stock at computer stores everywhere. (Dealers listed below). If not available yet at your store, order directly from us. Specify which programs and enclose your check.

DISTRIBUTORS

- Arizona**
Personal Computer Place, Mesa (602) 833-8949
- Arkansas**
Datacope, Little Rock (501) 686-8588
- California**
Byte Shop, Marina Del Rey (213) 530-3860
Byte Shop, Tustin (714) 731-1686
Byte Shop Computer Store, Walnut Creek (415) 933-6253
Byte Shop No. 8, Hayward (415) 537-2983
Computer Components, Westminster (714) 898-8330
Computerland, El Cerrito (415) 233-5010
Computerland, Mission Viejo (714) 770-0131
Computerland of West L.A., Inglewood (213) 776-8080
Computers Are Fun, Los Angeles (213) 475-0566
Recreational Computer Ctrs, Sunnyvale (408) 735-7480
The Computer Store, Santa Monica (213) 451-0713
- Colorado**
The Byte Shop, Inc., Englewood (303) 761-6232
- Connecticut**
Computerland, Fairfield (203) 374-2227
- Florida**
Byte Shop, Miami (305) 264-2983
- Georgia**
Byte Shop, Atlanta (404) 255-8984
Datamart Inc., Atlanta (404) 266-0336
Computerland of Atlanta, Smyrna (404) 953-0406

- Illinois**
Byte Shop, Champagne (217) 352-2323
Computerland, Arlington Heights (312) 255-6488
Imperial Computer Systems, Rockford (815) 226-8200
- Kansas**
Personal Computer Center, Overland Park (913) 649-5942
- Louisiana**
Computer Shoppe, Metairie (504) 454-6600
- Maryland**
Computerland, Rockville (301) 948-7676
- Massachusetts**
The Computer Store, Burlington (617) 272-8770
- Michigan**
Computerland of Grand Rapids, Kentwood (616) 942-2931
- New Hampshire**
Computerland, Nashua (603) 889-5238
- New Mexico**
Interactive Computers, Santa Fe (505) 892-9997

- New Jersey**
Computer Corner, Pompton Lanes (201) 835-7080
The Computer Emporium, Cherry Hill (609) 667-7555
- New York**
Computer Shop of Syracuse, De Witt (315) 446-1284
Computer Tree Inc., Endwell, (607) 748-1223
- North Carolina**
Byte Shop, Raleigh (919) 833-0210
- Ohio**
21st Century Shop, Cincinnati (513) 651-2111
- Oklahoma**
Microolithics Inc., Oklahoma City (405) 947-5646
- Texas**
Byte Shop, Richardson (214) 234-5955
CompuShop, Dallas (214) 234-3412
Computer Terminal, El Paso (915) 532-1777
Computerland, Austin (512) 452-5701
Computers 'n Things, Austin (512) 453-5970
Interactive Computers, Houston (713) 486-0291
Interactive Computers, Houston (713) 772-5257
Micro Computer Shop, Corpus Christi (512) 855-4516
- Washington**
Ye Olde Computer Shoppe, Richland (509) 946-3330
- Ontario, Canada**
The Computer Mart, Toronto (416) 484-9708

Write to:
Magnamedia
17845 Sky Park Circle, Suite H
Irvine, CA 92714 (714) 549-9122

M6800 SOFTWARE TOOLS

NEW for Relocating Assembler Users:

M6800 RELOCATABLE DISASSEMBLER AND SEGMENTED SOURCE TEXT GENERATOR. This software tool enables you to modify and adapt those large sized object programs (BASIC, Assemblers, etc.) and re-assemble them on your system without requiring enormous memory. This program will produce segmented source text files with all the external linkage information required for re-assembly using the Relocating Assembler. (Requires M68AS program for use.) **M68RS. \$35.00**

M6800 RELOCATING ASSEMBLER AND LINKING LOADER software for rapid program development and debugging. Some of its features are: RELOCATABLE CODE FULL ALPHABETIZED CROSS REFERENCE LISTING BOTH GLOBAL AND LOCAL LABELS LISTING OF EXECUTION TIME RELATIVE BRANCH TARGET ADDRESSES 8 CHARACTER LABELS CORESIDENT EDITOR ENGLISH ERROR MESSAGES 80 COLUMN LISTING USING PR-40 etc. See March BYTE for additional details. **M68AS. \$50.00**

The above two programs are furnished on cassette in relocatable formatted code with instruction manual and commented assembly listing. A short mini-loader program in standard Mikbug format is supplied to initially load the linking loader at any desired address.

The following programs are supplied on standard Mikbug formatted cassettes. See December BYTE.

M6800 DISASSEMBLER/TRACE. Our best selling program. It is a super powerful debugging tool that allows the user to examine, or examine and execute with full CPU status displays, any area of memory under complete operator control. **M68DT. \$20.00**

M6800 DISASSEMBLER SOURCE GENERATOR will produce compacted source code or an assembler styled program listing with symbolic labels and inst. mnemonics. **M68SG. \$25.00**

M6800 RELOCATE will take any contiguous area of memory and relocate it anywhere within RAM. **M68RL. \$15.00**

M6800 BINARY LOADER **M68BL. \$15.00**
SPECIAL OFFER. Programs M68DT, M68SG, M68RL, M68BL, as a package. **M68PK. \$55.00**

Get under Ed Smith's Software RUG (Relocating assembler Users Group). All RUG members will have use of a building software support library in relocatable format. Upcoming items are a Floating Point package and a Trig package.

Order direct by check. Specify system configuration if other than SwTPCo. California residents add 6% sales tax.

Ed Smith's SOFTWARE WORKS

P. O. Box 339
 Redondo Beach, CA 90277

Tom Pittman
 POB 23189
 San Jose CA 95153

Beware Compromising the Stack Pointer

In the November 1977 BYTE there are several articles on implementing real time clocks, and at least two of them suggest bringing the interrupts in on the NMI interrupt of the 6800 or 6502. I think your 6800 users should be warned that to do so *requires* (with no exceptions) a clean stack. This means *never* using the stack pointer for any other purpose.

I notice that SwTPC software is gaining wide acceptance in 6800 circles (especially among SwTPC users, naturally enough, but also elsewhere). By my count their 8 K BASIC (version 2.0) has no fewer than 13 places where the stack pointer is used to move a block of data. While this technique certainly works, it makes the software incompatible with interrupts such as those used by the various clock articles in the November BYTE. In two of these places the stack pointer is used to shift the user BASIC program over for line insertions and deletions, which tends to take a long time for large programs. This means that as you edit your BASIC program, little by little your real time clock will eat little holes in it, leaving debris which may cause the interpreter to self-destruct when you try to RUN. The SwTPC coresident editor and assembler does not even disable interrupts when fooling with the stack pointer, so *any* interrupt (NMI or IRQ) will compromise the data. I should remark here that the assembler part of this package appears to be a modified copy of the Motorola coresident assembler, and it is only the SwTPC modifications which compromise the stack.

The 6502 is less subject to such hazards because there is less temptation to use its 8 bit stack pointer for other purposes, and because its indirect addressing capabilities obviate the need for such machinations.

Both the 6800 and the 6502 are subject to a different hazard in the use of the NMI interrupt for a clock (or any other purpose, for that matter). This is the inherent conflict between the NMI and the other interrupts. You see, the NMI wins that conflict. In the case of an IRQ at the same time, this is not a

TERMINALS FROM TRANSNET

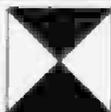
**PURCHASE
 12-24 MONTH FULL OWNERSHIP PLAN
 36 MONTH LEASE PLAN**

DESCRIPTION	PURCHASE PRICE	PER MONTH		
		12 MOS.	24 MOS.	36 MOS.
DECwriter II	\$1,495	\$145	\$ 75	\$ 52
DECwriter III	2,895	275	145	99
DECprinter I	2,495	240	125	86
VT52 DECscope	1,695	162	85	59
VT55 DECgraphic CRT	2,695	260	135	94
ADM 3A CRT	875	84	45	30
ADDS Regent 100	1,325	126	67	46
TI 745 Portable	1,875	175	94	65
TI 765 Bubble Mem.	2,995	285	152	99
TI 810 RO Printer	1,895	181	97	66
Data Products 2230	7,900	725	395	275
QUME, Ltr. Qual. KSR	3,195	306	163	112
QUME, Ltr. Qual. RO	2,795	268	143	98
FlexiFile 21, Flpy. Disk	1,995	190	102	70

FULL OWNERSHIP AFTER 12 OR 24 MONTHS
 10% PURCHASE OPTION AFTER 36 MONTHS

ACCESSORIES AND PERIPHERAL EQUIPMENT
 ACOUSTIC COUPLERS • MODEMS • THERMAL PAPER RIBBONS • INTERFACE MODULES • FLOPPY DISK UNITS

PROMPT DELIVERY • EFFICIENT SERVICE



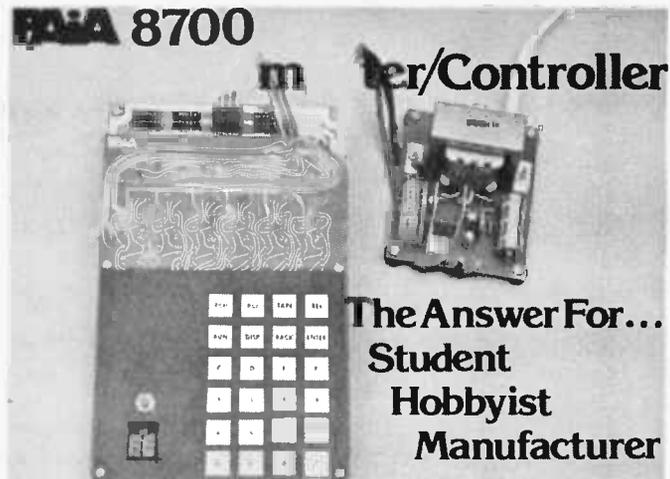
TRANSNET CORPORATION
 2005 ROUTE 22, UNION, N.J. 07083
201-688-7800

problem because the IRQ input to the CPU is level sensitive, and if the IRQ gets lost in the service of an NMI who cares? The interrupting device simply holds its level and when the NMI service is complete the IRQ is still waiting and gets its turn. But a software generated interrupt is a different matter. By the time this is decoded inside the processor, the program counter has already been incremented to point to the next instruction. But *it is not too late for an NMI to replace that interrupt*. When the NMI service completes, it returns to the next instruction after the SWI or BRK, just as if it were a NOP. This is true of both the 6800 and the 6502. I do not know it to be true of the Z-80, but it is a question worth asking.

What this means is that you cannot depend on SWI (or BRK) instructions in the same system that uses the NMI. Fortunately most present systems use these instructions for setting breakpoints in a program under test. If you want to be sure not to lose a breakpoint, put two in right next to each other; if you lose the first, the second will surely work. A few 6800 operating systems use the SWI as a monitor service call. Tough luck. The second byte of the service call (which identifies the monitor function to be performed) will occasionally be executed instead of being passed as data to the monitor.

By the way, in case you are thinking of a software fix like backing up the program counter, forget it. You have no way of knowing if a SWI got lost, or even if a SWI precedes the instruction the NMI returns to. You could bail out if all service calls were identified by an illegal op code after the SWI (or two bytes after the BRK in a 6502). Otherwise hardware is required to fix the problem. ■

Technical Forum is a feature intended as an interactive dialog on the technology of personal computing. The subject matter is open-ended, and the intent is to foster discussion and communication among readers of BYTE. We ask that all correspondents supply their full names and addresses to be printed with their commentaries. We also ask that correspondents supply their telephone numbers, which will be printed unless we are explicitly asked to omit them.



F&A 8700
Processor/Controller
**The Answer For...
 Student
 Hobbyist
 Manufacturer**

8700 Processor: 6503 MPU. Wear free "Active Keyboard". Micro-Diagnostic.[®] Extensive documentation. Fully Socketed.

Piebug Monitor: Relative address calculator. Pointer High-low. User Subroutines. Back-step key.

Cassette Interface: Load & Dump by file #. Tape motion control. Positive indication of operation.

Applications systems from \$90 (10 unit quantity)

Development systems from \$149 (single unit)

TELL ME MORE I want to see for myself that the 8700 is The Answer.

Please send documentation and price lists. \$10 enclosed. name: _____

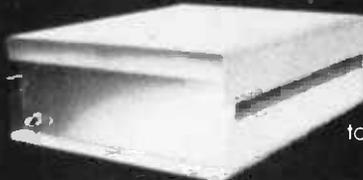
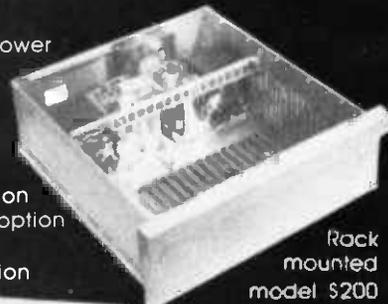
I don't need documentation please send price lists. address: _____

Please send FREE CATALOG. city: _____ state: _____ zip: _____

F&A ELECTRONICS DEPT. 6-B • 1020 W. Wilshire Blvd. • Oklahoma City, OK 73116 (405) 843-9626

\$100 MAINFRAME \$200
\$100 MAINFRAME \$200

- NOT A KIT
- 8v@15A, ±16v@3A power
- Rack mountable
- 15 slot motherboard
- Card cage
- Fan, line cord, fuse, switch, EMI filter
- Desk top version option
- 8v@30A, ±16v@10A option
- SS-50 bus option
- voltage monitor option



Write or call for a copy of our detailed brochure which includes our application note
BUILDING CHEAP COMPUTERS.

INTEGRAND

8474 Ave 296 • Visalia, CA 93277 • (209) 733-9288

We accept BankAmericard/Visa and Master Charge

Notes on Teaching with Microcomputers

Dr William H Norton
RR 6, Box 7
Iowa City IA 52240

The microcomputer in a classroom is worth a thousand words. The visual demonstrations of computer function and design enable students to grasp ideas that would otherwise have to be abstract verbal constructs. The ability to help student understanding of computers reach a more profound level faster using microcomputer demonstrations opens up many possibilities for the instructor. The newness of microcomputers and probable future applications, such as energy conservation, lend interest to the subject for both student and teacher.

The Teaching Tool

We recently purchased a KIM-1 from MOS Technology for use in the computer science program at Marycrest College in Davenport IA. Our conventional computer facilities consist of a remote line to the IBM 360/65 at the University of Iowa about 60 miles away. The KIM-1 compensates for the remoteness of the IBM computer and opens new possibilities for computer use as well.

As a teaching tool the microcomputer has several strong advantages over the larger computer systems:

- It is portable enough to be moved into a classroom.
- It is small enough to be nonthreatening to students.
- Students can get actual hands-on experience programming it.
- Small schools can afford to purchase a microcomputer system.

A whole microcomputer system with basic language facilities can provide an excellent computer facility for many small school systems and colleges. In the future a microcomputer system with a modest amount of bubble memory may finally make computer assisted instruction (CAI) a reality. Thus educational uses for microcomputer technology look very promising.

Talking to a class about computers is really different when you have one in your hand. It is almost like adding another dimension to the teaching situation. The KIM-1 we are using has the added advantage that programs can be stepped through one instruction at a time. This allows registers, addresses, op codes and data to be inspected after each instruction. We have even displayed voltages on a DVM and oscilloscope. These activities make computing a visible reality for the student; that seems to be an important part of learning.

My goal in setting up the computer curriculum has been to make it practical and career oriented rather than a theoretical science. The term "software engineering" is closer to describing the intended approach than is traditional computer science. The microcomputer fits nicely into this scheme. It enables me to base teaching software techniques on known hardware mechanisms

1976/1977

1976/1977

BYTE

Back Issues for sale

Cover Price * plus postage and handling

The following issues available:

'76	'77
2950 July	330 March
60 August	700 May
200 October	950 June
300 November	950 July
500 December	1450 August
	2550 September
	300 November
	700 December

*Cover price for all issues thru August 1977 is \$1.50 (\$3.50 foreign) plus \$.25 postage and handling. September '77 thru December '77 issues are \$2.00 (\$4.00 foreign) plus \$.50 postage and handling.

Send requests to: **BYTE Magazine**
70 Main St
Peterborough NH 03458
Attn: Back Issues

Back Issues For Sale

rather than on abstract mathematical theories. Hopefully this will increase the range of students who can become good programmers.

The Microcomputer as a Friend

Students seem to have gotten used to the idea of the calculator as a friend. Big computers with flashing lights and noisy IO devices are totally beyond the understanding of many students, especially those in the introductory courses. The microcomputer seems to fit in the same category as the calculator: it somehow has to be understandable because it is so small. This is a significant contribution toward overcoming student fear of technological monsters.

Not only is it less threatening for the beginning student, but it is a thrill to make it actually work for the more advanced student. We are using the microcomputer as the basis for a course in large computer organization. The basic architecture of micros is similar enough to large scale computers so that actual hands-on experience is applicable to understanding most computer systems. In addition, by the time the students currently enrolled in this course graduate, microcomputing jobs may be plentiful, enabling them to apply their microcomputer experience directly to a career situation. Either way the students come out ahead.

But Is It Affordable?

Current prices put microcomputers within the range of most school systems and colleges as well as affluent students. According to *Datamation* (January 1977) the University of California and Pasadena Polytechnic High School are among the first users of microsystems. Computer Power and Light Inc of Studio City CA is a new business engaged in selling micro-computer systems to schools. Schoolwork on home computer systems as we have seen in BYTE is now a reality.

Computer assisted instruction requires little computing power and lots of memory. The ideal solution might be a micro with a video display and a bubble memory module containing the course to be learned. Perhaps a micro could integrate the verbal material with a visual display on a television using video tape.

Thus microcomputers are an ideal tool for teaching students about computers and hold much promise for deeper involvement in education in the future. This means many more marketing and occupational opportunities in microprogramming. ■

S-100 BUS Needs?

Computer Enterprises Fills Them Quickly, Inexpensively And Of Course, Courteously.

- * Main Frames
- * Disk Systems
- * Memory Boards
- * Interface Boards



	Credit Card Price	Cash Discount Price
Dynabyte 250ns 16K RAM (assembled)	\$520.	\$500.
Dynabyte Naked Terminal (assembled)	\$328.	\$315.
Cromemco 250ns 16K RAM Kit	\$464.	\$446.
Cromemco Bytesaver Kit	\$136.	\$131.
Cromemco Z-2 Computer Kit	\$557.	\$536.
Cromemco Z-2D Computer Kit	\$1399.	\$1345.
IMSAI PCS-80/18 Kit	\$731.	\$703.
IMSAI PIO 6-6 Kit	\$155.	\$149.
IMSAI MIO Kit	\$166.	\$160.
IMSAI 8080 Kit with 22-slot M.B.	\$593.	\$570.
IMSAI VIO-C Kit	\$297.	\$286.
Trace 16K Static RAM (assembled on 32K board)	\$529.	\$509.
Trace 32K Static RAM (assembled)	\$883.	\$849.
Trace 16K RAM Expansion	\$441.	\$424.
North Star Micro Disk System Kit	\$623.	\$599.
North Star MDS Second drive Kit	\$395.	\$350.
North Star Horizon 1 Computer Kit	\$1497.	\$1439.
North Star Horizon Second Drive	\$395.	\$380.
North Star Horizon 1 (assembled)	\$1777.	\$1709.
TDL ZPU (assembled)	\$183.	\$176.
TDL D-32 RAM (assembled)	\$789.	\$739.
TDL Software Package A (for North Star disk)	\$228.	\$219.
Lear Siegler ADM-3A Kit	write or call for prices	
Seals Electronics 8K 250NS RAM (assembled)	\$187.	\$180.
George Risk Model 786 ASC II keyboard Kit	\$60.	\$58.
George Risk Model 786 ASC II keyboard (assembled)	\$71.	\$68.
Metal Cabinet for Model 786 keyboard	\$28.	\$27.



Shipping charges: \$10 per CPU on larger units; \$1.50 per kit. \$2.00 min. per order.

Delivery is stock to 30 days on most items. Shipment is immediate for payment by cashier's check, money order or charge card. Allow 3 weeks for personal checks to clear. N.Y. State residents add approx. sales tax. Availability, prices and specs may change without notice.

Write or Call
computer enterprises™

P.O. Box 71
 Fayetteville, N.Y. 13066
 Phone **(315) 637-6208** Today!

Operating Hours:
 M-W 10-5 E.S.T.
 Th-F 10-9 E.S.T.
 Closed Sat. & Sun.

More Music

for the 6502

T C O'Haver
Dept of Chemistry
University of Maryland
College Park MD 20742

The following zero page locations must be loaded before execution:

000E	BEAT	bass downbeat rate. Typical value = 08.
000F	MASK	determines largest table increment used. Typical value = 0F.
0012	TEMPO	determines duration of shortest note; controls tempo. Typical value = 0D.

Other labels used:

0010	INCR	Table increment (harmonic number)
0011	CNTRL	Inner loop counter (wraparound)
0013	BCNTR	Downbeat counter
0014	CNTRH	Outer loop counter
0300	TABLE	Starting address of waveform table
F900	DAC	Address of output port connected to DAC

0200	A0 00	LDY 0	y index is the note counter
0202	98	NOTE TYA	split y into upper and lower halves.
0203	29 F0	AND 11110000	
0205	4A	LSR A	
0206	4A	LSR A	
0207	4A	LSR A	
0208	4A	LSR A	
0209	85 10	STA INCR	
020B	98	TYA	
020C	29 0F	AND 00001111	
020E	25 10	AND INCR	AND the two halves
0210	65 10	ADC INCR	and add to lower half.
0212	25 0F	AND MASK	MASK out upper half.
0214	85 10	STA INCR	Store result for use as table increment.
0216	A2 00	RESET LDX 0	X is waveform table pointer
0218	A5 12	LDA TEMPO	Reset tempo counter.
021A	85 14	LDA CNTRH	
021C	BD 00 03 LOOP	LDA TABLE	Get Xth byte of table and send to DAC
021F	8D 00 F9	STA DAC	
0222	8A	TXA	Add the table increment INCR to X.
0223	18	CLC	
0224	65 10	ADC INCR	
0226	AA	TAX	
0227	C6 11	DEC CNTRL	Repeat until 256 X TEMPO table bytes are output
0229	D0 06	BNE RPEAT	(which constitutes one note)
022B	C6 14	DEC CNTRH	
022D	D0 ED	BNE LOOP	
022F	F0 04	BEQ NEXT	
0231	EA	RPEAT NOP	Waste as much time as it takes to decrement CNTRL
0232	18	CLC	
0233	90 E7	BCC LOOP	
0235	C8	NEXT INY	Go on to next note.
0236	C6 13	DEC BEAT	
0238	D0 C8	BNE NOTE	
023A	A5 0E	LDA BEAT	
0231	85 13	STA BCNTR	
0233	A9 01	LDA #01	
0235	85 10	STA INCR	
0237	18	CLC	
0238	90 D1	BCC RESET	

Listing 1: A program written for the 6502 which generates first order tone sequences. The program can reside in any 70 consecutive memory locations. It requires a 256 byte waveform table on page 03 and an 8 bit digital to analog converter address at F900. The program uses the X and Y registers and zero page locations 0E thru 14. This program was hand assembled and is reproduced here from the author's typed listing.

Here is a simple "music" composition and generation program which should provide some fun for the experimentally inclined. In September 1977 BYTE, page 12, Hal Taylor wrote about rules describing the style and structure of computer generated music. He described *zeroth order stochastic control*, in which the note sequences and durations are completely random. This sort of thing is very easily implemented with a micro-computer, and I suspect many of you have already done so just for fun, but the novelty wears off very quickly. More interesting is *first order control*, in which the pitches (or more precisely the transitions between pitches, or intervals) and rhythms are governed by some set of rules derived from conventional music (or from mathematics, poetry, etc, according to Hal Taylor).

The algorithm given here generates a monotonic tone sequence under first order control based on simple arithmetic and Boolean relations. The tone generation itself is done by the conventional sampled waveform approach with a stored waveform and variable table increment (see Hal Chamberlin's article cited at the end of this article for explanation). In the conventional technique, the table increments which determine the pitches are stored in a table, which forces the computer to play a pre-determined tune. In the system described here, though, the table increments are calculated in real time by means of a simple pattern generating algorithm. The result is music which is "natural," at least from the computer's point of view, because the elements of the pattern algorithm are simple binary machine operations such as increment, shift, AND, OR and add. While you might not consider the results serious competition for the top ten, I think you will find that the computer's idea of music has many elements in common with our own.

The hardware requirements are minimal: an MOS Technology 6502 based computer with 1 K of programmable memory, a simple 8 bit latched output port, and an 8 bit digital to analog converter (DAC). A KIM-1, Ebka 6502, PAIA 8700, or an OSI 400

board should be able to run this program by simply changing the output instruction (locations 021F to 0221) to the address of your output port (F900 on my Ebka).

The complete program is given in the accompanying listing. It is written to occupy the first 70 bytes of page 02, but is relocatable without change. The 256 byte waveform table is on page 03. Page zero locations 0E to 14 are used. The pattern generating routine (hexadecimal addresses 0202 to 0213) produces a 4 bit integer table increment (INCR) from the value in the y index register, which is initialized to 0 and is incremented by 1 for each successive note (at location 0235). Then code at locations 0216 to 0234 generates the note with the duration determined by TEMPO. To add a rhythmic touch, locations 0236 to 0241 force the fundamental (lowest) frequency to be played every eight notes: a sort of bass drone effect.

The waveform table can be anything you like. Of the simple waveforms, a triangular wave sounds pleasant. Or you can use a more complex waveform such as the one given by Hal Chamberlin in his September 1977 BYTE article, page 62.

In addition to the waveform, several other variables can be changed for experimental purposes, including TEMPO, MASK, BEAT, and, most interestingly, the pattern generator itself. For example by changing the AND and ADC operations at 020E and 0210 to ORA, EOR, SBC, etc, a variety of other patterns can be generated.

Note that, since only integer table increments are used, the pitches obtained will be a "natural" harmonic series resulting in a so-called "scale of just intonation" rather than the equally tempered scale more familiar in post 17th century Western music (see Olsen's book in the references). The difference is slight for the first few harmonics, so for that reason the harmonic numbers (table increments) are limited by the MASK applied at 020B. ■

REFERENCES

1. Hal Taylor, "Scortos: Implementation of a Music Language," September 1977 BYTE, page 12.
2. Hal Chamberlin, "A Sampling of Techniques for the Computer Performance of Music," September 1977 BYTE, page 62.
3. H F Olson, *Music, Physics, and Engineering*, second edition, Dover, New York, 1967.

Harmonic Number	Note	Interval
1	C ₂	—
2	C ₃	Octave
3	G ₃	Perfect 5th above C ₃
4	C ₄	Next octave
5	E ₄	Major 3rd above C ₄
6	G ₄	Perfect 5th above C ₄
7	B ₄ ^b	Harmonic minor 7th
8	C ₅	Next octave

Table 1: The harmonic series based on the note C₂. (C₂ is two octaves below middle C.)



Microprocessor Lexicon, Acronyms and Definitions, by SYBEX. 110 pp. This little book is a necessity to anyone who wants an explanation of those hard-to-fathom acronyms and other micro terms. At 4¼" x 5½" it can be pocketed easily. For only \$2.95 every microcomputerphile should have a copy.

Microprocessor Interfacing Techniques (2nd expanded edition) by Austin Lesea and Rodnay Zaks. Now available is this newly revised edition featuring: new material on "useful circuits," an enlarged floppy disk section with new double density controllers, updates on LSI controllers—and *much* more. Including basic concepts and techniques, this book is a very comprehensive handbook on interfacing. 416 pp. \$9.95.

Microprocessors: From Chips to Systems by Rodnay Zaks. 416 pp. \$9.95.

[For convenience, please use the coupon on page 96, writing in this book's title. Processing may occasionally exceed 30 days.]

Send now to: BITS, Inc, 70 Main St, Peterborough, NH 03458.

Master Charge and BankAmericard/VISA welcome.

Add a Voice to Your Computer for \$35

Talk to Me!

Steve Ciarcia
POB 582
Glastonbury CT 06033

"Talk to me! Talk to me!"

"OK! I'll talk to you if you need it that much!" Ken called out as he descended the stairs into my cellar workshop. "You sure you aren't going a little buggy?"

I looked up from the video monitor and parted the piles of cassette tapes and printouts. Ken was a good neighbor and I knew his comment was only in jest. I hit the carriage return and the speaker said, "Talk to me!"

Ken smiled when he realized I was just exercising the voice synthesizer option I had previously added to my system.

"This synthesizer is part of the reason I'm here this evening," he said.

"What's the problem?" I asked.

"No problem really. We just got a micro-computer in my company's R and D lab and I've been playing with it lately. It's pretty sophisticated and has plenty of memory space. What would it cost to put that type of synthesized voice on our computer? I can probably raise \$50 among the technicians for it. They'd get a kick out of it."

"Well, depending on the manufacturer and the particular interface, they usually run from \$400 to \$800 and up." I looked at the startled expression on Ken's face. It was what I normally call "peripheral face," the look you get when you tell someone that it'll cost \$1100 for a video terminal to communicate with the computer he just bought for \$250.

"So much for that idea. How's the weather been lately?"

"Wait!" I interjected. "How much memory do you have on your lab microcomputer?"

"40 K, I believe. Why?"

"How much of a vocabulary do you need?"

"I suspect we'd only need the numbers 0 through 9 and a few letters. We want to monitor data and verbally record channel number and input value. But at that price it's far too expensive to justify."

"How about digitized speech? You prob-

ably have enough memory for that."

"What's that?"

"It's a process to record speech digitally. For all practical purposes it's like a tape recorder, but instead of magnetic tape for the storage medium it uses the computer's programmable memory. The tape recorder uses an analog storage method while the computer stores the information digitally."

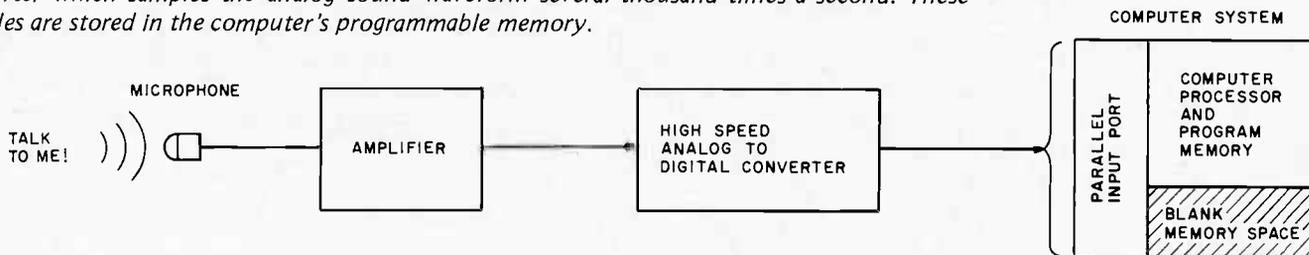
"If it's that simple why don't more people use it?"

"It's mostly because it's not very memory efficient. A voice synthesizer is an analog voltage generator that creates the speech phoneme sounds through a hard wired circuit. In its most advanced form a single 8 bit byte can be used to tell the synthesizer what discrete sound it should make. By sending it a series of byte codes, words can be made from the discrete sounds. That's the way my Votrax synthesizer works." I pulled out a pad to sketch my explanation. "In digitized speech the analog voice input is sampled very quickly with a high speed analog to digital converter, and the samples are stored in memory. To reconvert to analog or "say" the words, the stored digital data is sent to a digital to analog converter at the same rate and in the same order the samples were taken. The concept of digitized speech has been around for a long time, but up until recently the cost of a system dedicated to this was prohibitive. You already have the computer and enough memory for limited applications. All you need is the high speed analog to digital and digital to analog converters and the knowledge to do it."

"And what is that going to cost me, \$500?" Ken was still skeptical.

I opened a drawer under the bench. It was my "junk box" (in my case one corner of my cellar is a junk room). I rummaged through the prototype boards from previous experiments and pulled out a particular one. "Ah, here we are. You remember a few months ago when I designed that 8 channel digital voltmeter (December 1977 BYTE, page 76, and January 1978 BYTE, page 37).

Figure 1a: Block diagram of a digital speech recording system. Speech is picked up as sound waves by the microphone and is amplified and processed through a high speed analog to digital converter which samples the analog sound waveform several thousand times a second. These samples are stored in the computer's programmable memory.



I needed it to troubleshoot this board. This is all you need for digitized speech." I tossed the board to Ken. "It contains a 100,000 sample per second 8 bit analog to digital converter and an equivalent speed digital to analog converter. And now the beauty part: It cost less than \$35 to build."

"Great! Tell me how to use it. How much memory does it need? What kind of program does it use? Can you tell me how to use it so I can borrow it for work tomorrow?"

"Well, let's go over the concept in more detail. . . ."

What is Digitized Speech?

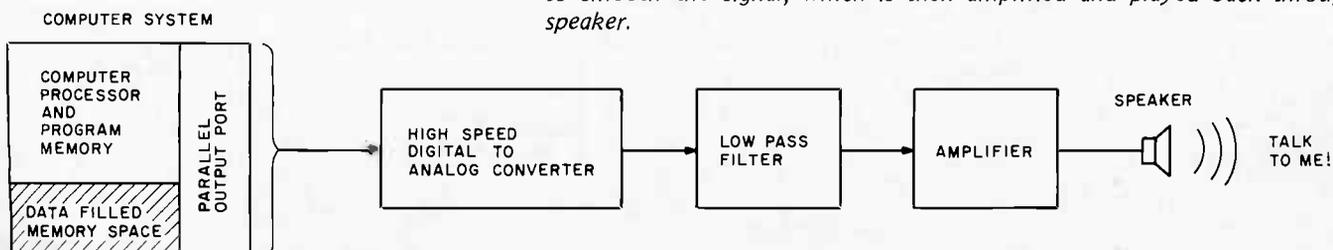
Digitized speech is simply a standard data acquisition technique with a new definition. For years people have been using computers to scan analog to digital input converters and store the results in memory. Often, in high speed applications such as wind tunnels and nuclear experiments, the sample rates can exceed thousands of samples a second. In cases where the critical event is of short duration, these thousands of samples are stored directly into memory to increase system throughput capabilities. When the event has passed and sampling has stopped, the computer memory contains a record of that event in discretely timed intervals. The stored data is now available to be reduced, analyzed or listed. It's often listed in "slow motion." This technique employs an analog

pen recorder and a digital to analog converter. Each sample is successively processed through a digital to analog converter at a slow rate to the pen recorder. The result is an expanded view of a short event.

An alternative method for utilizing this stored data is to play it back in real time. In this case the computer outputs the stored data to the digital to analog converter at the same rate the data is taken. The output of the converter would then exactly duplicate the values of the event previously recorded (at the times the samples were taken).

Digitized speech is a specific application of this type of data recording technique. Your voice, when applied to a microphone and amplifier, creates a fluctuating analog voltage that varies at the frequency rate of the sound. If this analog signal is applied to the input of a high speed (greater than 10,000 samples per second) analog to digital converter and stored in memory, the computer won't care whether the source is speech or a nuclear reaction. The analog fluctuations are "digitized" at discrete sampling intervals and stored (figure 1a). If the stored memory table is sent to a digital to analog converter at the same rate it was initially sampled, the speech is reproduced exactly. Of course there are trade-offs and limitations that have to be considered to produce a usable system (figure 1b). We will consider them in detail later.

Figure 1b: Block diagram of a digital speech playback system. Digital sample points stored by the system in figure 1a are converted by a high speed digital to analog converter into an analog speech waveform. A low pass filter is used to smooth the signal, which is then amplified and played back through a speaker.



A digitized speech system creates its output waveform by digital to analog conversion rather than by completely analog generation as in the case of a voice synthesizer. The major consideration that limits the usefulness of digital speech is the vast quantity of data which must be stored to reproduce a single spoken word.

Choosing the Correct Sampling Rate

The 8 channel digital voltmeter mentioned earlier has a maximum sampling rate of 25 conversions a second. A slow speed analog to digital converter of this type is of no value in this application. The normal human voice occupies a bandwidth of 4000 Hz, and taking

Figure 2a: A waveform (considerably simplified) which is characteristic of the voice.

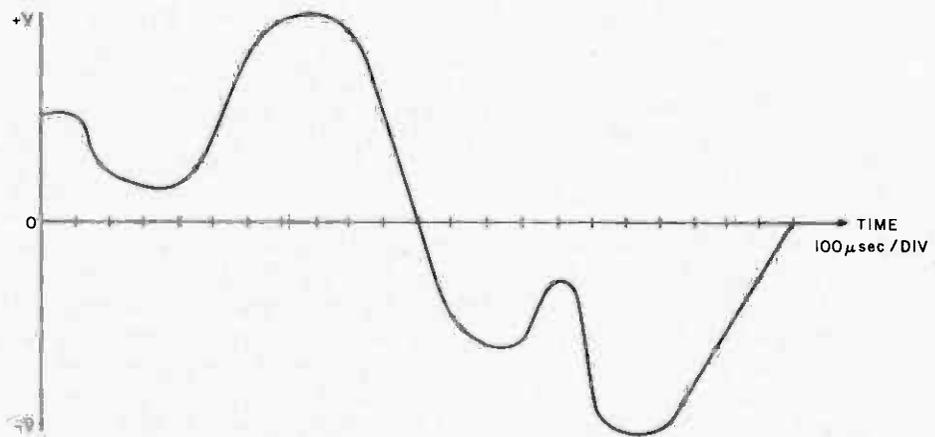


Figure 2b: Waveform in figure 2a after being processed through a digital to analog converter at a sample rate of 5000 samples per second.

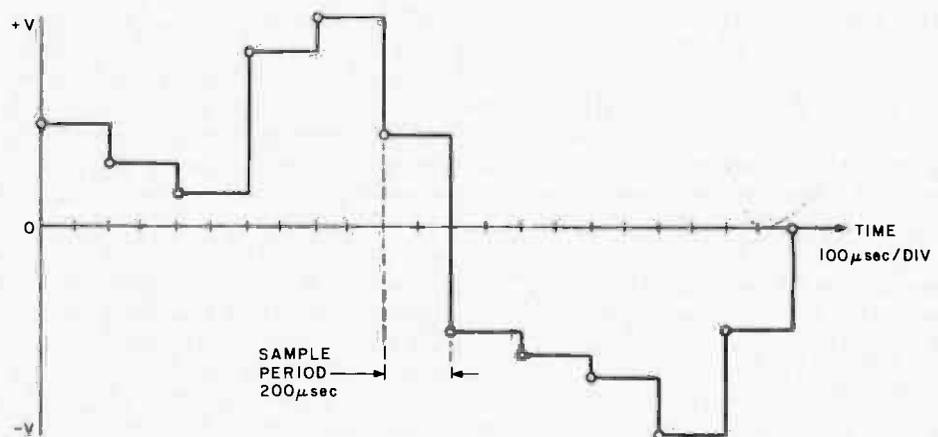
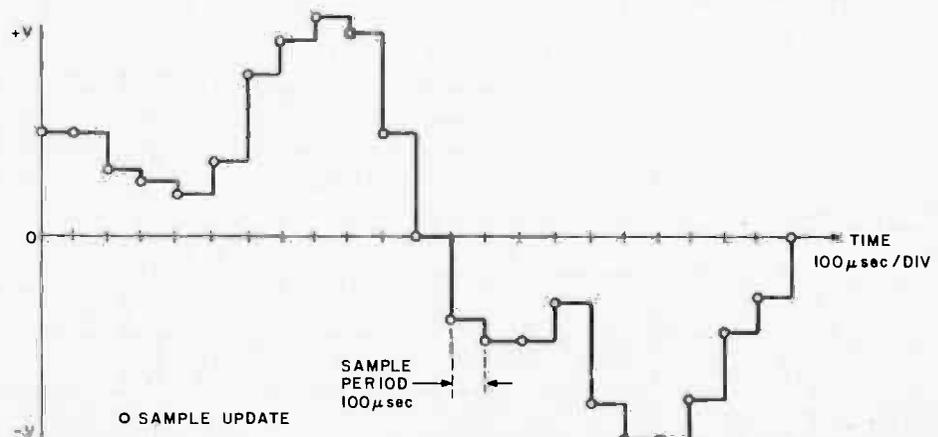


Figure 2c: Waveform in figure 2a after being processed through a digital to analog converter at a sample rate of 10,000 samples per second.



25 samples within a period of one second could not effectively record the event. At what sampling rate should audio speech be digitized?

There is a specific law used to determine this rate, called the Nyquist criterion. It states that, at the very minimum, the sampling rate of the digitizer must be twice the maximum frequency of the input sample. If human voice extends to 4 kHz, the minimum sample rate should be 8 kHz. This presumes that there is an ideal low pass filter on the output of the converter. Ideal filters are something like perpetual motion, impossible to attain. In reality the sampling rate should be three or four times the highest input frequency. This means that to digitize voice fully you need a sample rate of from 12 to 16 kHz.

It is easier to explain the digitization process visually. Figure 2 illustrates an expanded view of a typical speechlike waveform. Voice waveforms are complex: the majority of the voice sounds exist below 1500 Hz, but intonation and accent occupy the higher frequencies. It is these added harmonics and inflections that make one voice different

from another, and capturing and recording them is an important consideration. The waveform in figure 2 has been digitized at two different rates for comparison. Figure 2a is the original waveform which consists of a fundamental frequency of approximately 500 Hz and some added components of higher frequency. If this waveform is "digitized" or sampled at a 5000 samples per second rate and the stored values are sent to a digital to analog converter, the resultant waveform would be that shown in figure 2b. It is easy to see that only a vague representation of the original waveform would be recorded. Even though this output is filtered before being amplified, the higher frequency components of the original input would be lost. Increasing the sampling rate to 10,000 samples per second as in figure 2c gives a better record of the higher frequencies. The addition of a good low pass filter would eliminate the sharp transitions between samples.

Tradeoffs to be Considered

The benefits associated with the reduced cost of the voice input and output circuitry



**OUTSTANDING
TERMINAL
EQUIPMENT
VALUE**

IBM 2741 – compatible or standard ASCII (with Break and Control code features), RS232-C interface.

RECONDITIONED SELECTRIC TERMINALS

CONTACT KEN PAYNE

Dal-Data Inc. • 1111 W. Mockingbird Lane
Suite 1400 • Dallas, Texas 75247 • 214-630-9711

IBM Correspondence or BCD Code ~~\$795.00~~ **\$495.00**

- IBM 2741 Compatible
- RS232C Interface

ASC II Code ~~\$995.00~~ **\$849.00**

- 300 Baud 200 Character Print Buffer
- RS232C Interface
- Break and Control Code features

**30 DAY WARRANTY
NATIONAL SERVICE AVAILABLE**

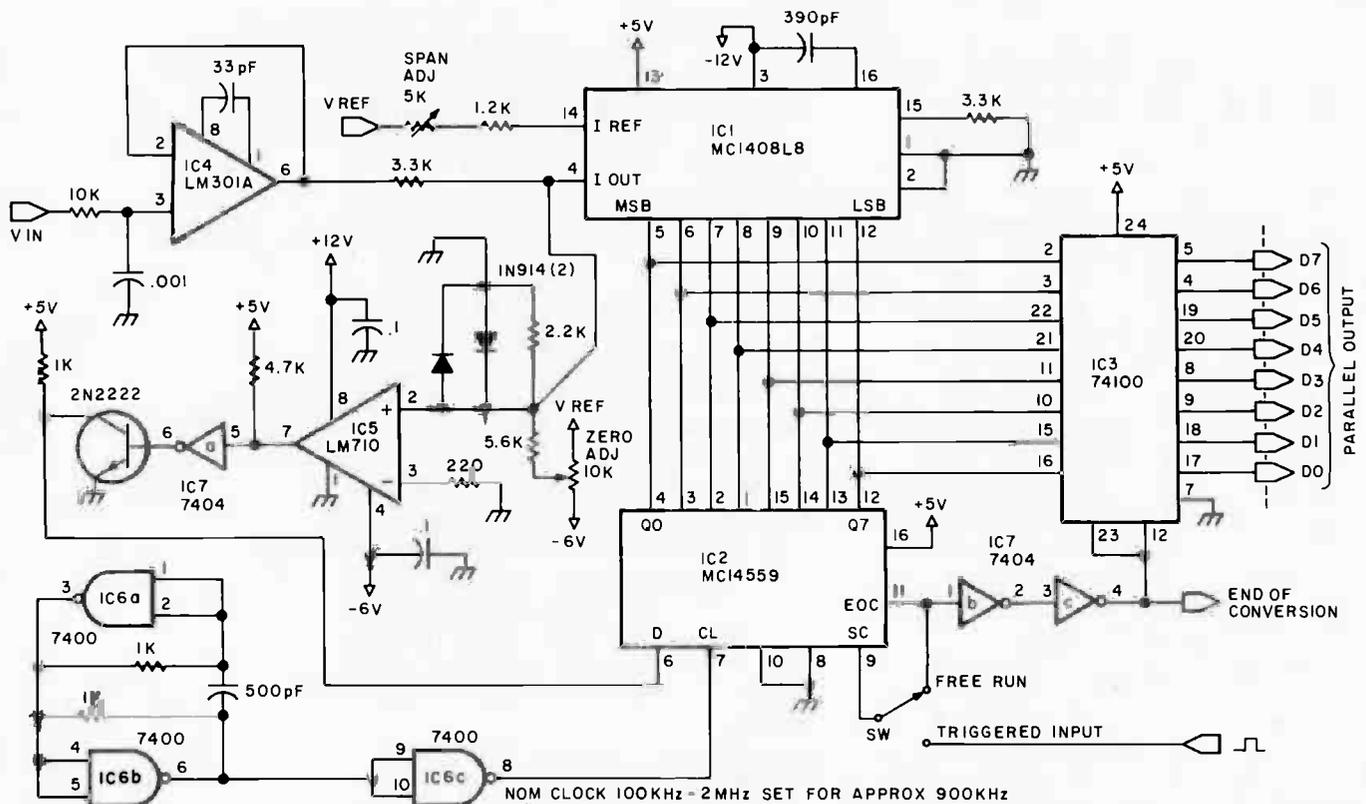


Figure 3a: An 8 bit successive approximation analog to digital converter.

are counteracted by the increased memory requirements. Digitized speech uses a lot of memory. In the previous example, if the voice input is sampled at 10,000 samples per second, the table in memory needed to store one second of data would be 10,000 bytes long (presuming an 8 bit analog to digital converter). If increased fidelity is required and the sampling rate is set for 16 kHz, the table would fill up at a rate of 16,000 bytes per second.

Obviously, systems like my own, which already have considerable amounts of programmable memory, would be easy to use for experimenting with digital speech. I do not recommend buying additional memory just to store a few words, but, if you have it, you'll be surprised at the results.

Building a Voice Digitizer

To experiment fully with digitized speech, it is necessary to have a high speed analog to digital converter to store the analog input and a high speed digital to analog converter to reconstruct the analog output.

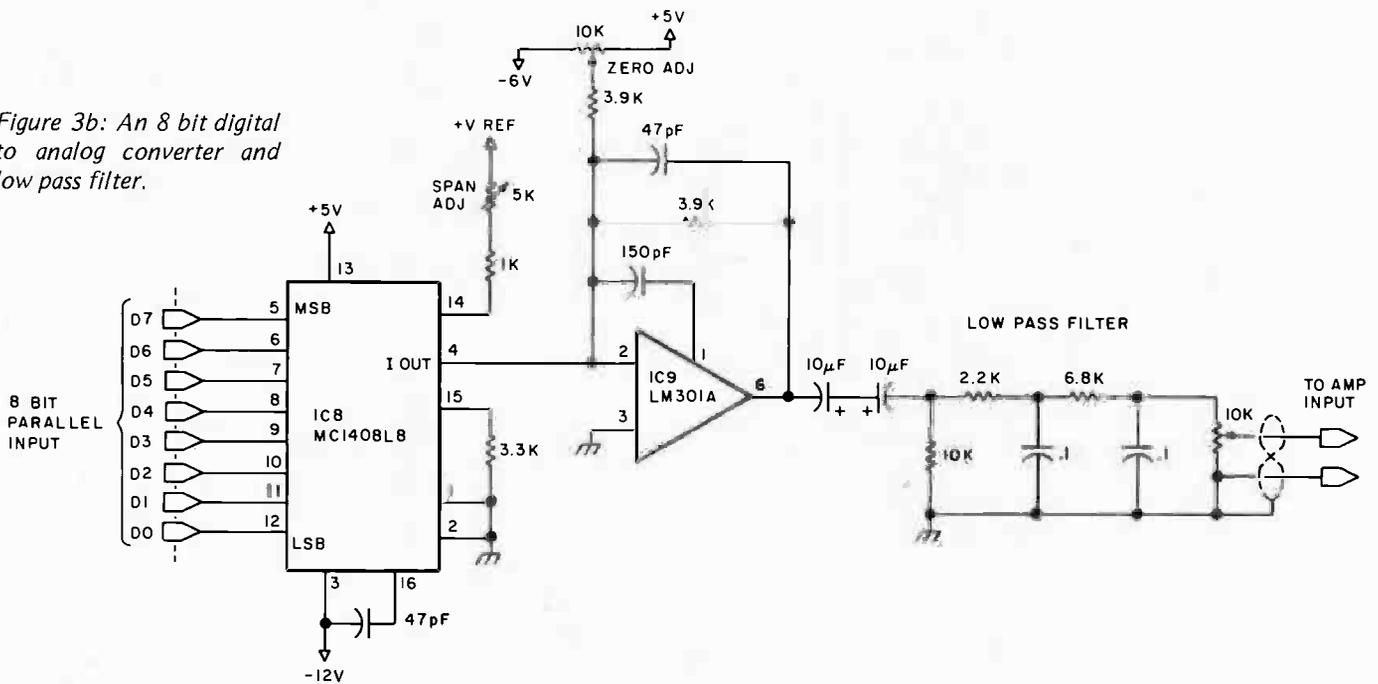
Figure 3a shows the schematic of an 8 bit analog to digital converter capable of sample rates in excess of 200,000 samples per second. With an 900 kHz clock rate it will run at a modest 100,000 samples per second. Figure 3b shows an 8 bit digital to analog converter and low pass filter with similar capabilities. The estimated total cost for parts is \$35.

The analog to digital converter is a general purpose high speed 8 bit converter that can

Table 1: Power wiring table for figures 3a and 3b.

IC Number	Type	+5 V	Gnd	+12 V	-12 V	-6 V
IC1	MC1408L8	13	1		3	
IC2	MC14559	16	8			
IC3	74100	24	7			
IC4	LM301A			7		4
IC5	LM710			8		4
IC6	7400	14	7			
IC7	7404	14	7			
IC8	MC1408L8	13	1		3	
IC9	LM301A			7		4

Figure 3b: An 8 bit digital to analog converter and low pass filter.



be used for any data acquisition application requiring high speed. The technique used to attain this speed is called successive approximation. The circular logic of successive approximation is best explained in a block diagram (see figure 4).

Initially, the output of the Successive Approximation Register (SAR) and mutually connected digital to analog converter is at a zero level. After a start conversion pulse, the register enables the output bits one at a time starting with the most significant bit (MSB). As each bit is enabled, the comparator gives an output signifying whether the amplitude of the input signal is greater

than or less than the amplitude of the converter. If the converter output is greater, that particular bit is set equal to 0; if less than, it is set to 1. The register moves successively to the next least significant bit (retaining the setting on the previously tested bit or bits) and performs the same test. After all the bits of the converter have been tested, an EOC is output and then the conversion cycle is complete. The entire conversion period takes only nine clock cycles, and

Notes for Figures 3a, 3b and 3c:

1. All resistors are 1/4 W 5% unless otherwise indicated.
2. All capacitors are 100 V ceramic unless otherwise indicated.
3. With components shown, clock frequency is 900 kHz. This is 100,000 conversions per second in free run mode.
4. The following circuit can be added to each output pin of IC3 if a visual indicator is desired:
5. Clock rate is not critical. A slower clock of 100 kHz (about 9 K samples per second) may be quite adequate.

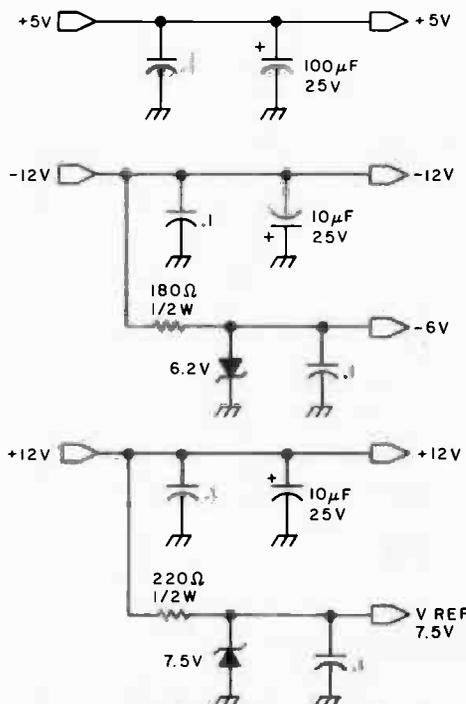
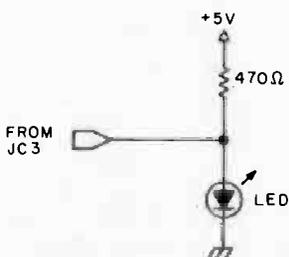


Figure 3c: Power supply circuitry for figures 3a and 3b.

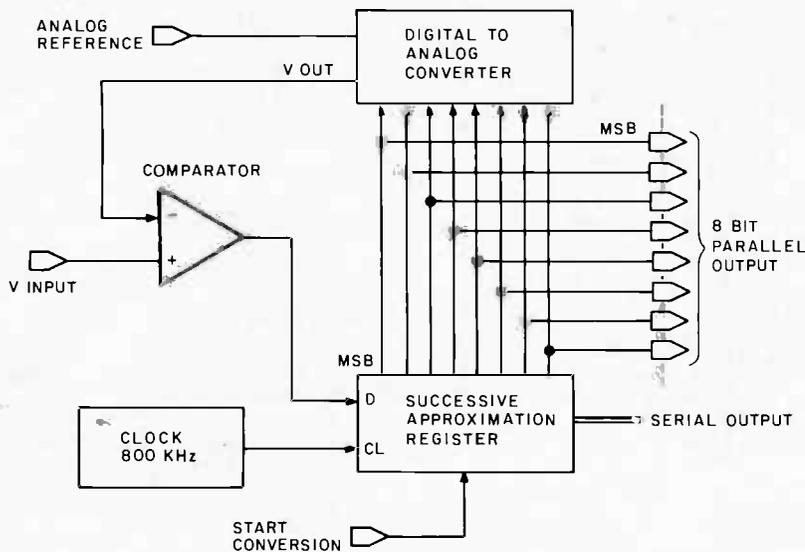


Figure 4: Block diagram of a typical successive approximation analog to digital converter. The device uses a digital to analog converter to perform its function. The successive approximation register is initially set to 0. After a start conversion pulse, the register enables the output bits one at a time, starting with the most significant bit (MSB). As each bit is enabled, the comparator gives an output signifying whether the amplitude of the input signal is greater than or less than the amplitude of the digital to analog converter. If the converter output is greater, the bit in question is set equal to 0. Otherwise it is set to 1. The process continues for the remaining bits until the conversion is complete.

another conversion begins on the next clock pulse when in free run mode. To retain the 8 bit value between conversions, an 8 bit register (IC3) has been added (see "Control the World," September 1977 BYTE, page 30, for a complete description of MC1408 digital to analog converter operation).

Assembly and Testing

1. Component types and values are chosen to allow high speed operation. Substitution of slower devices may compromise overall performance.
2. Assemble components on a prototype board as neatly as possible. Keep wires between components short and direct. The MC14559 is a CMOS device and it should be handled carefully. Sockets are suggested for all integrated circuits.
3. Check power supply voltage before inserting integrated circuits. Then insert clock oscillator IC6. The clock frequency should be around 900 kHz.
4. Insert the rest of the integrated circuits and ground the V input connection of IC4. Slowly rotate the zero adjust pot until the parallel output of IC3 reads binary 10000000. This output can be read either through a computer program which scans and displays this value or with LEDs attached to the output pins. In practice, the LEDs are easier in the long run.
5. Remove the short on V input and apply a voltage of +2 V. Adjust the span adjust pot until the displayed output is 11111111. The result of this procedure is an analog to digital converter with an input range of -2 to +2 V represented by binary 00000000 and 11111111 patterns respectively. 0 V is represented by 10000000. Any voltage span between + and -5 V can be set on this circuit using this method.
6. The digital to analog converter section should be assembled with the same care. Insert all ICs. With all parallel input pins at a logic zero level, adjust the zero pot until IC9 pin 6 reads 0 V.
7. With all parallel input pins at a logic 1 level, adjust the span pot until the output at IC9 pin 6 equals the +V setting of the analog to digital converter, or as in the example (2 V).
8. The low pass filter in the schematic is optimized for the speech samples in the text, but can be experimentally determined. The optimum cut off frequency of the low pass filter should be the sampling rate frequency. (ie: 10 kHz cut off for 10 kHz sample rate).

Micro Business Software

- Complete interactive, double entry accounting system
- 51 programs with 120 pages of documentation
- Written in Northstar BASIC (other variations available)
- General ledger, accounts receivable, accounts payable, inventory and payroll
- Only 24K of memory
- Single diskette can hold 400 customer listings, 50 vendors, 400 line items of inventory, 25 employees, 60 general ledger accounts.
- Only \$200.00

Send check or money order (Calif. residents add 6% sales tax) plus \$2.50 to cover postage and handling to:

Computer Products Of America

A Division of The Computer Mart
633 West Katella Avenue
Orange, CA 92667
(714) 633-1222

Dealer and OEM prices upon request

THE FOLLOWING LIST HAS THE ADDRESS LOCATION IN DECIMAL
ALL MEMORY BYTE VALUES ARE GIVEN IN OCTAL NOTATION

32768	277	307	320	250	177	140	077	037	001	000
32778	000	000	000	027	101	220	274	303	300	260
32788	213	210	174	147	100	054	007	001	014	007
32798	003	030	047	040	050	037	050	060	077	140
32808	170	234	203	170	156	117	060	037	047	060
32818	034	003	040	076	077	140	150	127	053	060
32828	037	040	077	137	113	060	077	117	060	057
32838	043	060	076	067	120	077	157	200	174	137
32848	160	140	077	107	077	067	060	070	057	041
32858	044	037	041	034	017	027	040	037	023	060
32868	070	043	060	054	047	060	056	037	040	070
32878	047	045	074	037	060	074	077	140	077	037
32888	377	370	004	123	220	274	127	000	136	047
32898	000	000	000	000	000	077	377	260	000	100
32908	176	377	107	000	077	357	240	017	000	240
32918	130	000	000	000	000	000	377	377	000	000
32928	177	263	320	000	000	240	357	133	000	036
32938	327	020	000	017	000	000	227	377	130	000
32948	101	240	317	061	000	077	377	120	057	043
32958	140	077	000	020	007	000	000	377	377	000
32968	000	277	300	220	000	000	330	314	000	077
32978	137	067	040	016	023	000	000	000	377	377
32988	000	000	344	257	120	000	000	363	174	000
32998	147	140	037	027	030	017	000	000	077	377
33008	240	000	067	340	224	047	000	076	377	040
33018	000	177	063	050	017	003	010	000	000	377
33028	377	000	000	277	237	150	000	000	311	274
33038	000	140	170	037	040	034	017	000	000	037
33048	377	300	000	107	320	230	043	000	137	377
33058	000	056	157	040	074	007	020	004	000	000
33068	377	377	000	050	316	227	140	000	027	370
33078	074	057	101	077	077	000	054	003	000	000
33088	377	377	000	017	221	260	234	000	030	356
33098	147	060	034	147	060	000	067	000	000	000
33108	377	377	000	017	210	237	213	000	077	303
33118	140	037	047	140	014	007	074	000	007	040
33128	000	377	245	000	237	067	220	117	013	200
33138	016	113	060	017	047	020	077	017	074	077
33148	017	140	177	157	141	130	137	120	120	077
33158	047	070	057	057	060	057	047	070	077	073
33168	076	077	107	120	134	117	100	077	077	060
33178	064	027	020	036	037	040	074	067	120	120
33188	077	120	076	137	061	130	077	067	120	077
33198	107	100	077	077	120	130	200	120	120	136
33208	103	130	077	077	120	077	077	071	077	077
33218	100	077	077	100	076	077	070	074	067	060
33228	070	057	061	070	057	060	070	057	060	070
33238	057	061	074	077	100	076	077	077	076	077
33248	073	074	077	067	070	077	067	074	077	067
33258	100	077	077	100	077	077	100	077	077	073
33268	076	077	101	076	077	101	120	077	077	100
33278	077	077	100	077	077	075	077	077	101	077
33288	077	101	077	077	075	076	077	077	076	077
33298	073	070	077	067	074	077	067	074	077	073
33308	074	077	077	074	077	077	073	077	077	075
33318	077	077	073	076	077	071	076	077	070	076
33328	077	061	074	057	061	076	067	061	074	067
33338	063	074	077	063	074	077	067	076	077	067
33348	074	077	067	074	077	067	074	077	073	100
33358	077	077	100	077	077	100	077	077	101	077
33368	077	101	076	077	101	076	077	077	110	077
33378	077	110	077	077	101	077	077	101	077	077
33388	101	077	077	077	076	077	073	076	077	077
33398	076	077	077	074	077	077	074	077	077	074
33408	077	073	074	077	077	074	077	077	071	077
33418	077	070	076	067	070	076	067	070	076	067
33428	060	074	067	061	076	067	063	074	067	063
33438	074	067	063	074	077	071	074	077	067	074
33448	077	067	074	077	067	074	077	067	074	077
33458	073	074	077	077	100	077	077	100	077	077
33468	101	076	077	101	076	077	101	120	077	077
33478	120	077	077	103	077	077	103	077	077	077
33488	110	077	077	110	077	077	076	077	077	076
33498	077	077	074	077	077	071	076	077	071	076
33508	077	071	076	077	071	076	077	071	076	077
33518	065	074	077	067	074	077	065	074	077	063
33528	074	077	063	074	077	063	070	077	063	074
33538	077	063	074	077	063	074	077	067	074	077
33548	067	074	077	067	070	077	067	070	077	073
33558	100	077	077	100	077	077	101	077	077	073
33568	120	077	077	110	077	077	110	077	077	120
33578	077	077	110	077	077	103	077	077	077	110
33588	077	077	100	077	077	100	077	077	100	077
33598	077	100	077	077	073	077	077	071	076	077
33608	073	076	077	071	077	077	061	140	217	143
33618	076	057	053	140	077	013	040	077	063	020
33628	074	057	060	077	077	101	057	027	020	060
33638	027	060	077	143	120	077	077	120	130	077
33648	107	070	076	067	120	137	147	140	077	077
33658	120	134	077	140	130	077	120	074	077	063
33668	077	077	027	060	077	123	074	074	021	030
33678	057	007	070	037	027	040	077	127	140	137
33688	137	200	150	077	060	040	037	020	030	017
33698	013	060	057	063	100	077	107	140	137	137
33708	140	144	147	140	134	077	063	074	047	040
33718	036	037	043	074	077	100	074	077	100	140
33728	137	137	140	134	077	070	074	047	070	077
33738	117	111	120	077	121	140	137	161	174	156
33748	117	074	076	047	040	037	017	020	003	000
33758	000	277	317	320	174	077	010	040	077	121
33768	076	017	073	070	077	051	070	027	000	000
33778	002	000	000	017	147	370	276	147	040	077
33788	077	200	140	117	000	040	017	121	140	167
33798	043	060	017	023	000	000	000	000	157	243
33808	360	260	107	010	134	157	200	130	077	000
33818	030	037	101	077	157	133	074	057	073	060
33828	007	000	000	000	027	220	277	227	103	077
33838	067	140	160	147	043	040	017	040	060	077
33848	073	150	137	127	060	077	043	020	007	001
33858	000	034	147	200	230	177	140	130	117	127
33868	077	077	053	050	037	041	060	076	101	130
33878	077	107	120	077	067	060	056	037	040	037
33888	057	100	150	147	160	160	137	121	120	077
33898	073	070	074	043	060	057	053	100	077	117
33908	120	120	077	061	070	037	040	054	037	071

Listing 3: A listing of the digital samples making up the phrase, "Talk to me" spoken by the author. This somewhat bandwidth limited signal allows interested readers to reproduce the message through an 8 bit digital to analog converter without having to build the analog to digital converter.

More Advanced Applications

I don't want you to finish this article and think that digitized speech is as limited as I have represented it so far. It is possible to totally simulate the capabilities of an analog speech synthesizer with more involved software. If you realize that the analog synthesizer works by connecting strings of distinctly independent phonemes, it is not hard to consider that the same can be true for the

digital method. Each phoneme could be recorded separately and would occupy approximately 2 K bytes. As in the analog situation, a separate control program determines how these individual phonemes are to be connected together. Besides determining the type of phoneme to be used, the processor must also create the waveform. Such a system uses much more memory and takes considerably more processing time than something like the Votrax, but it is equally as versatile. ■

Listing 3, continued:

3391B	134	137	153	160	137	127	140	077	077	070
3392B	074	047	060	070	057	074	077	117	121	134
3393B	077	073	074	047	041	050	037	040	040	077
3394B	120	160	157	133	140	077	077	100	077	057
3395B	060	060	043	060	074	067	100	077	117	121
3396B	077	077	061	064	037	040	050	037	041	074
3397B	077	140	150	154	127	120	077	077	070	076
3398B	057	040	060	047	060	074	077	120	134	137
3399B	111	077	077	047	070	037	041	060	057	067
3400B	120	137	143	144	154	137	120	077	077	071
3401B	074	057	051	064	057	060	074	077	120	140
3402B	077	103	076	074	057	060	037	041	040	057
3403B	067	120	137	147	140	140	117	120	077	077
3404B	063	070	057	047	070	057	061	074	077	117
3405B	140	077	077	074	074	057	060	054	037	060
3406B	057	067	120	137	137	140	140	117	107	120
3407B	077	063	070	057	041	060	057	057	074	077
3408B	107	120	077	077	100	074	057	060	056	037
3409B	040	037	077	120	154	137	141	150	077	123
3410B	120	077	063	060	037	040	060	074	057	074
3411B	077	147	140	134	077	063	060	037	040	034
3412B	007	001	020	077	140	230	174	167	120	137
3413B	077	140	077	067	040	054	033	060	077	067
3414B	100	077	147	140	140	077	063	060	037	040
3415B	040	027	005	020	037	160	174	237	167	160
3416B	137	077	120	077	077	040	056	007	041	074
3417B	057	070	074	117	140	150	077	073	074	057
3418B	047	050	037	023	020	034	027	170	177	207
3419B	200	134	137	100	130	077	067	070	037	041
3420B	060	067	061	074	077	105	140	137	117	076
3421B	074	057	060	037	033	040	017	007	040	170
3422B	163	201	174	137	140	077	077	077	074	076
3423B	041	060	057	053	074	077	101	120	136	143
3424B	120	077	067	060	070	047	041	057	027	040
3425B	034	047	140	160	177	200	140	137	101	074
3426B	077	067	070	057	033	060	057	063	074	077
3427B	103	140	140	127	100	074	067	060	070	047
3428B	040	054	037	040	070	077	140	170	157	141
3429B	140	077	117	110	077	077	060	070	057	060
3430B	077	067	074	077	117	121	130	077	063	070
3431B	057	041	070	047	043	070	047	061	074	077
3432B	121	160	174	141	120	077	077	100	077	067
3433B	060	070	047	060	074	067	100	077	117	121
3434B	120	077	063	070	047	043	070	057	061	060
3435B	057	061	120	137	147	160	137	107	120	077
3436B	077	074	074	057	060	057	047	060	077	077
3437B	121	120	077	073	074	074	060	070	057	053
3438B	070	057	061	074	077	133	160	154	127	120
3439B	077	077	100	077	077	070	074	057	060	077
3440B	077	120	120	077	071	070	074	060	070	057
3441B	047	070	057	061	074	077	063	140	137	133
3442B	140	130	077	100	077	077	071	077	077	063
3443B	074	067	070	074	057	060	070	047	040	070
3444B	077	140	140	156	137	130	077	100	077	077
3445B	067	060	057	043	060	074	067	100	077	077
3446B	100	077	077	063	074	057	060	070	067	061
3447B	074	077	100	077	077	103	120	077	117	120
3448B	077	077	107	077	077	075	074	077	067	074
3449B	077	065	074	077	067	074	077	063	120	137
3450B	123	140	134	107	100	077	067	070	074	057
3451B	060	074	057	060	074	057	060	077	067	070
3452B	074	067	070	074	077	100	077	077	107	077
3453B	077	077	100	077	077	070	077	067	070	076
3454B	063	070	074	057	070	074	067	100	077	067
3455B	070	077	077	100	074	077	100	077	077	100
3456B	074	077	073	077	077	077	100	077	073	074
3457B	077	073	100	077	077	110	077	077	100	077
3458B	077	077	077	077	077	100	077	077	110	077
3459B	077	100	077	077	074	077	077	100	077	077
3460B	101	077	077	075	076	077	065	074	077	063
3461B	074	077	067	074	077	071	074	073	067	074
3462B	067	061	070	077	061	074	077	063	074	077
3463B	063	074	077	067	070	077	067	070	077	063
3464B	070	077	067	074	077	077	100	077	077	101
3465B	077	077	100	074	077	067	074	077	071	076
3466B	077	077	074	077	077	100	077	077	100	077
3467B	077	103	120	077	101	120	077	103	120	077
3468B	077	120	077	077	100	077	077	100	077	077
3469B	100	077	077	075	077	077	077	074	077	073
3470B	074	077	067	074	077	073	074	077	071	074
3471B	077	067	074	077	063	070	074	053	070	077
3472B	063	070	077	067	074	077	067	074	077	067
3473B	074	077	067	070	077	067	070	074	067	070
3474B	074	077	070	074	077	100	077	077	073	077
3475B	077	073	074	077	073	074	077	077	120	077
3476B	077	110	077	077	101	077	077	103	120	077
3477B	103	110	077	077	110	077	077	110	077	077
3478B	100	077	077	100	077	077	075	077	077	075
3479B	074	077	075	074	077	073	074	077	073	074
3480B	077	067	070	077	067	074	077	073	155	014

Next month: Keyboard
Function Decoder.

Please post or circulate

Make your reservations now for the

BUSINESS & PERSONAL COMPUTER EXHIBITION



3rd Annual Computerfest™ '78 June 23-25, 1978 Detroit, Michigan

Presented by the Midwest Affiliation of Computer Clubs

24 Hour **Computerfest™** Hotline phone number (313) 775-5320

The **Computerfest™ '78** to be held in the ultra new Detroit Renaissance Center, Detroit Plaza Hotel, June 23-25, will feature a *full scale* three day business and personal computer exhibition. The **Computerfest™** will include useful information on how to computerize your business, home or office. Bring your walking shoes to cover **over 100,000 square feet** of convention facilities!

*Only \$5.00 for all three days, or **save 20%** now by pre-registering*

Deadline for \$4.00 advance registration tickets is June 15, 1978

Use coupon below to get 20% pre-registration discount

- **Stupendous Hobbyist Exhibits**
- **Tours and Evening Activities**
- **Club Hospitality Suites**
- **Special Club Meetings**
- **Fabulous Programs**

Special events to feature:

- ★ **Tours of automotive facilities**
- ★ **Saturday evening Detroit/
Canada river cruise**

- **Manufacturer's Party**
- **Technical Sessions**
- **Giant Flea Market**
- **New Product Displays**
- **Seminars in computer applications for:**

**Education, Business systems,
Computers for the Handicapped,
Graphics/Art, Automotive,
Hobbyist, New Technology.**

Limited exhibit space is available!

For convention *booths* contact:

Mr. Jim Rarus - Chairperson

Computerfest™ '78

Box 9578 - Department PAT

Detroit, Michigan 48202 U.S.A.

or call 24 hours (313) 775-5320

For convention *advertising* contact:

Mr. Ken Ascher - Advertising Director

c/o Communications Electronics™

Box 1002 - Department DON

Ann Arbor, Michigan, 48106 U.S.A.

24 hour *Advertising* phone (313) 994-4441

**Mail this coupon and make your
check payable to:**

SEMCO/Computerfest™ '78

Box 9578 - Department ERIC

Detroit, Michigan 48202 U.S.A.

- send me ___ advance tickets at \$4.00 each
- please put me on your mailing list
- send me more **Computerfest™** information
- send information on special hotel rates
- please send exhibitors information
- please send advertising information

© 1978 South Eastern Michigan Computer Organization

William Hemsath
Dept of Psychology
Uris Hall, Cornell University
Ithaca NY 14853

James Seawright
Visual Arts Program
Princeton University
Princeton NJ 08540

Emmanuel Ghent
131 Prince St
New York NY 10012

Mimi Garrard
Mimi Garrard Dance Co Inc
155 Wooster St
New York NY 10012

A Theatrical Lighting Graphics Package

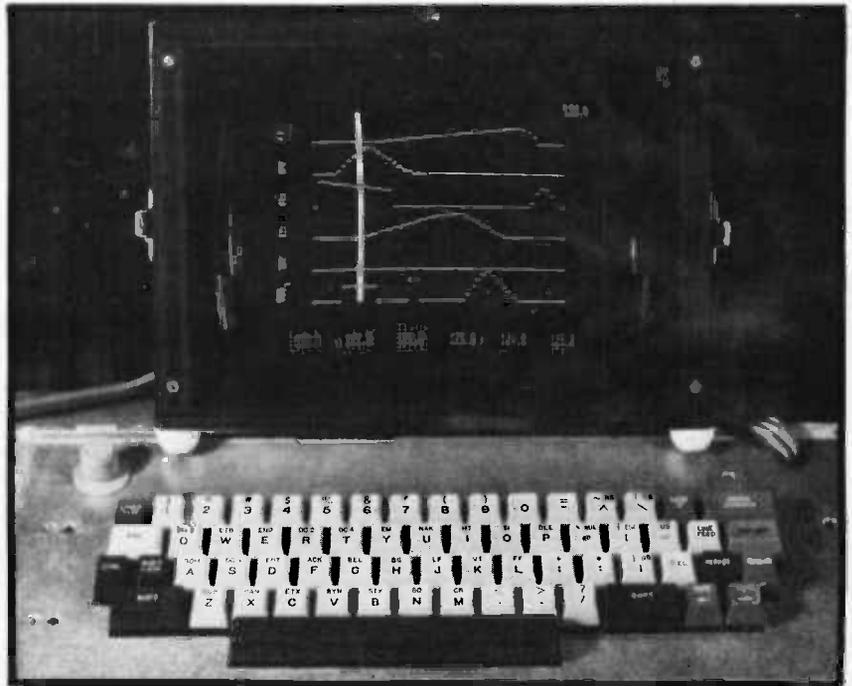
We recently developed an 8080 based composition and control system for theatrical lighting. This led us to the need for a way of displaying several time functions at once for examination and editing. Our system already made use of the Processor Technology VDM-1 display module, but the existing character set made it necessary to devote the entire screen to the display of one function in order to have useful resolution. Several functions could of course be superimposed, but this was awkward to program and left much to be desired in visual clarity.

Our first thought was to obtain a special read only memory integrated circuit to replace the control characters in the ASCII set with special characters consisting of a single scan line each, but the expense of this approach seemed impractical. Still, the improvement in resolution with such a character set was just what we needed, so we looked for other ways to modify the VDM-1 circuitry to achieve this; the results are detailed below.

Photo 1 shows our modified terminal with a typical display. Six functions of time are shown, each representing the brightness of a group of theatrical lights over a 5 second time span. The brightness values are stored in memory as full 8 bit values and are scaled to the 26 possible display values. Two adjacent rows of 13 scan lines each make up the 26 line display for each function. A cursor indicates current time. The various timing marks, channel designations, cursor time value, etc, show that the normal text display mode of the VDM-1 is unimpaired.

Photos 2a and 2b show a comparison between two variations of the basic display. Photo 2a shows the straight graphic mode with the cursor at a point in time and the value at that point shown in reverse video.

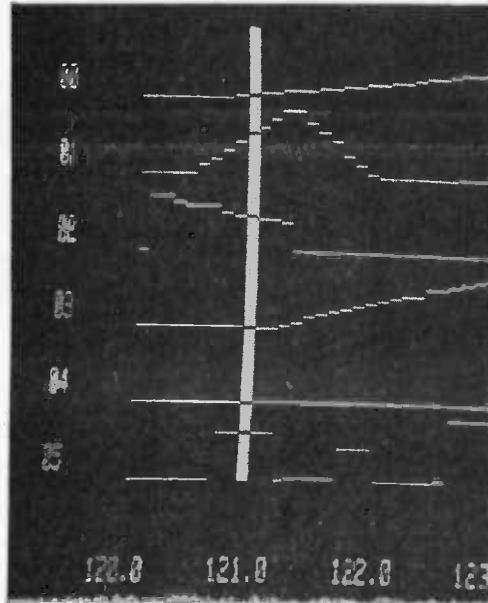
Photo 1: The authors' theatre lighting control graphics package in action. Six functions of time are shown displayed on a Processor Technology VDM-1 video display. Each function represents the brightness of a group of theatrical lights over a 5 second time span.



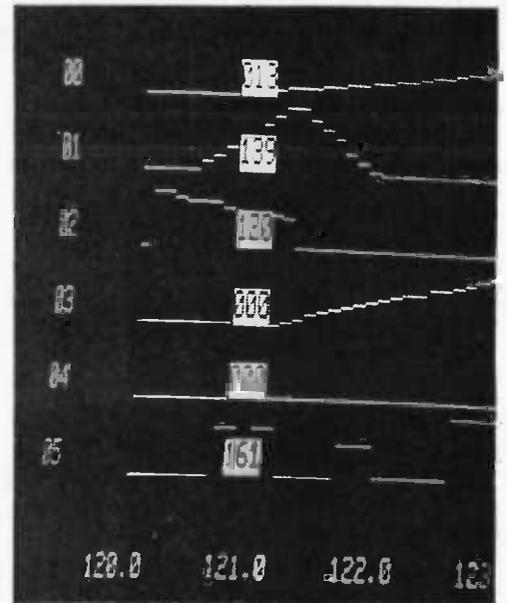
About The Authors

William Hemsath was formerly chief of electronic design with Robert Moog's music synthesizer company and is presently a design engineer and software specialist with Cornell University's Department of Psychology. James Seawright is Director of Visual Arts at Princeton University as well as the creator of electronically controlled sculpture. His wife Mimi Garrard has studied with Alwin Nikolais and is currently head of the Mimi Garrard Dance Company, a well known New York dance ensemble. She has been active in the design of new types of theatre lighting systems. Emmanuel Ghent is a composer in residence at Bell Labs and exponent of the GROOVE system, a computer driven electronic music studio, developed by Bell Labs.

(a)



(b)



Photos 2a and 2b: Two variations of the basic display. Photo 2a shows the straight graphics mode with the cursor at a point in time and the value at that point shown in reverse video. Photo 2b shows the numeric mode in which the cursor is replaced by the numerical value of the lighting intensity.

Photo 3: Installation of the authors' custom modification to the VDM-1 board. A small strip of breadboard containing the circuitry in figure 2 is mounted with spacers on the back of the VDM-1 board.

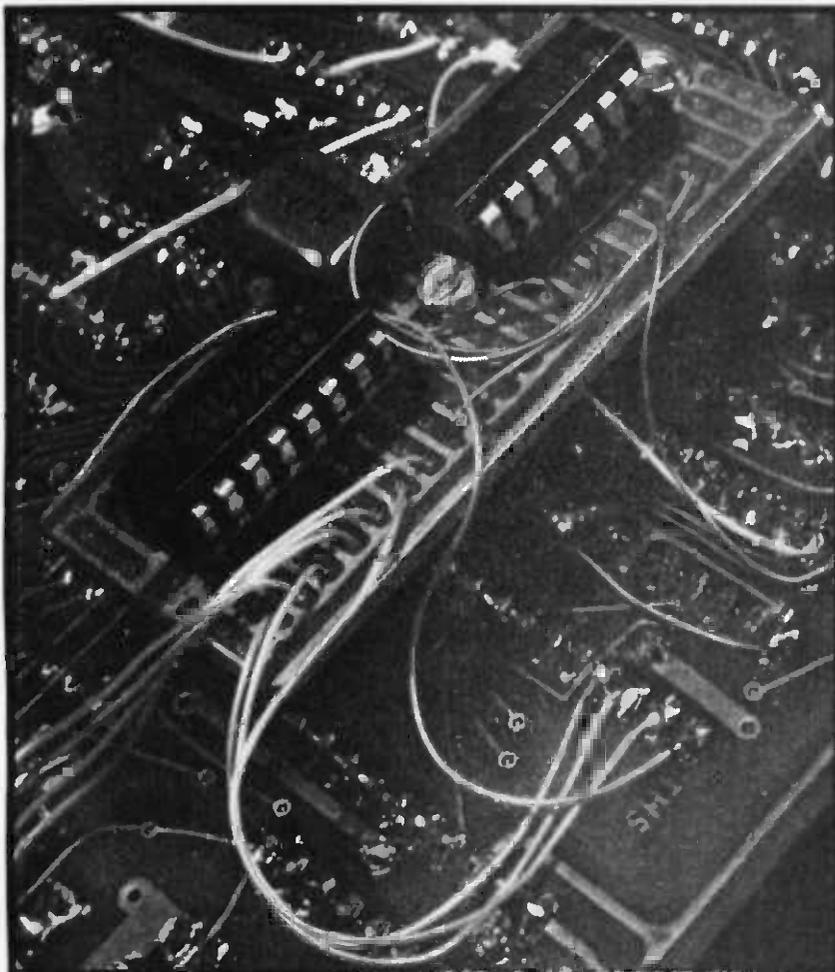


Photo 2b shows the numeric mode in which the cursor is replaced by a block containing the actual stored value from 0 to 255 for greater accuracy in reading or editing.

Before considering the modifications in detail, let's take a look at the operation of the VDM-1, referring to the partial schematic shown in figure 1. Character generation is accomplished as follows: Characters in the current line of the display are fetched in sequence from the screen memory and latched in two 4 bit registers, IC5 and IC6. A scan divider, IC2, counts through the 13 scan line values of each text line. These two sets of data are presented to the character generator read only memory, IC4, which outputs the correct pattern of seven dots for each scan line of every character. This pattern is parallel loaded into a shift register, IC3, when clocked by LOAD CLOCK, and clocked out serially by DOT CLOCK as the video output signal. Various gates and latches provide for blanking of certain characters or cursor blinking.

Since we didn't want to impair the normal display of letters, numbers, or frequently used punctuation marks, we decided to use the control characters to override the operation of the shift register and to supply a single line of dots, only once in the generation of a given character and on the scan line we want. One way of doing this is shown in figure 2. A new 7485 4 bit comparator (ICA) looks for agreement between the low order bits of a character and the current scan line value. In order to limit this to control characters only, IC11, the control character

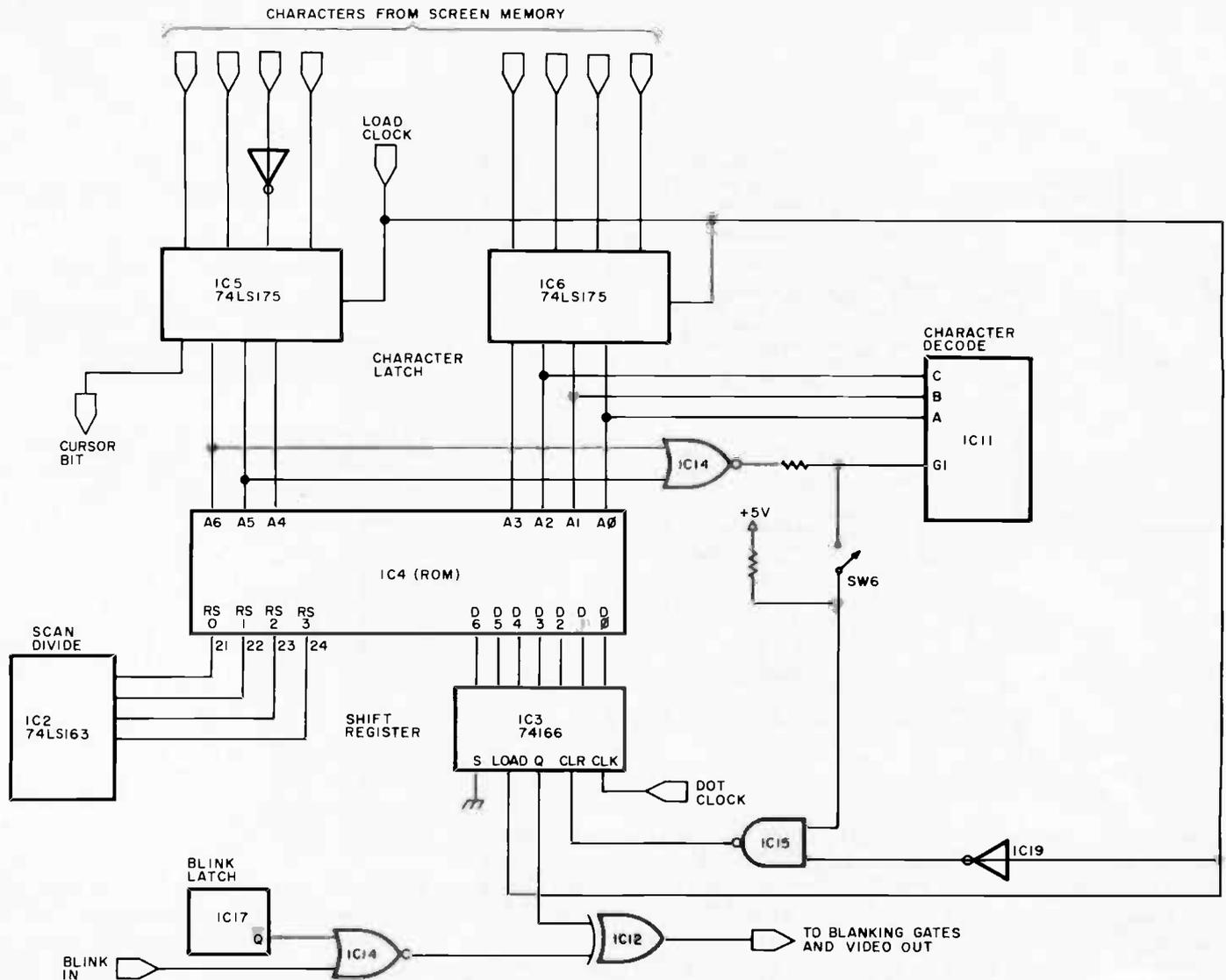


Figure 1: Partial schematic of the Processor Technology VDM-1 video display driver circuitry. Character generation is done by fetching the characters in the current line of the display in sequence from the screen memory in the form of 8 bit ASCII characters and latching them into two 4 bit registers, IC5 and IC6. This data and the scan line data from IC2 are presented to character generator IC4, a read only memory circuit. The latter outputs the correct pattern of seven dots for each scan line of every character; this information is routed through shift register IC3 to become the video output signal.

decoder, is modified to force a low state on the 0 output whenever the control character detector gate output goes high. (Control character blanking must be enabled with switch 6.) This modification will disable the automatic blanking from carriage return (CR) to end of line and from vertical tab (VT) to end of page, but if you're writing your own software this won't matter. Next, the control-character-low signal is inverted to enable the equals input of the 7485, and is ANDed with LOAD CLOCK in order to disable the shift register load when control characters are present. The comparator output supplies either a low (control character

present, but not the one for the scan line where we are now) or a high (control character present and the right one for this scan line) to the serial input of the shift register. The video output will then appear as a blank or a line of dots, accordingly, when clocked out by DOT CLOCK. (The first circuit modification we tried fed the output of the comparator directly into the video line. This allowed the single scan line character to appear one character position too early. By sending the signal through the shift register it is delayed by one character position and appears in its proper place in the display.) The shift register serial input is normally

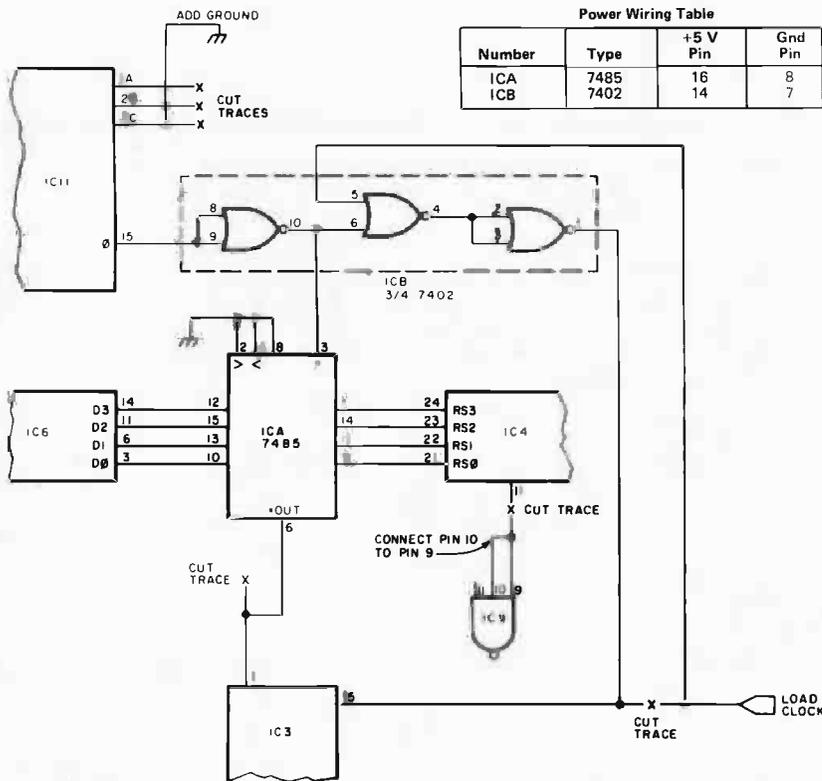


Figure 2: Modification to the VDM-1 circuitry enabling the software to generate single lines of dots when required for the theatre light control graphics package. The special display consists of two sets of adjacent parallel lines totalling 26 lines used to display lighting intensities as functions of time. Control characters are used to activate the new circuitry and produce a single line of dots only once in the generation of a given character and on the desired scan line. The new 7485 comparator (ICA) compares the low order bits of a character with the current scan line value and supplies either a low logic level output (indicating that a control character is present, but not the one for the current scan line), or a high level (control character present which is the correct one for the present scan line). The video output then appears as a blank line or a line of dots, respectively. Normal operation of the VDM-1 is not affected by these modifications.

low, grounded in the unmodified VDM-1. When we don't have control characters in the character latch it will still be low, and LOAD CLOCK will get through to parallel load the shift register with the read only memory output, for normal text display.

The additional circuitry may be mounted on a small strip of breadboard and attached by spacers to the back of the board, as shown in photo 3. Between the first and second columns of ICs near the top of the board, just above the read only memory socket, are several small areas where ground is on one side and no traces on the other. Small holes for spacers may carefully be drilled at this location.

;THE A REGISTER CONTAINS THE NUMBER OF THE LINE TO BE DISPLAYED
;THE BC REGISTER PAIR POINTS TO THE UPPER CHARACTER POSITION

```

BAR:  MOV    L,A
      MVI    H,0      ;HL CONTAINS LINE NUMBER
      DAD    H        ;TABLE CONTAINS DOUBLE BYTES
      LXI    0,TABLE ;GET ADDRESS OF LOOKUP TABLE
      DAD    D        ;HL POINTS TO ENTRY IN TABLE
      MOV    A,M      ;GET FIRST CONTROL CHARACTER
      STAX  B        ;PUT IN THE UPPER CHARACTER POSITION
      INX   B        ;POINT TO SECOND CONTROL CHARACTER
      MOV    A,M      ;GET IT
      LXI    H,64    ;LOWER CHARACTER POSITION IS
      DAD    B        ;64 CHARACTERS BEYOND UPPER ONE
      MOV    M,A      ;STORE LOWER CHARACTER
      RET
  
```

;THE FIRST ENTRY IN THE TABLE IS THE CONTROL CHARACTER FOR THE
;UPPER CHARACTER POSITION IN THE DISPLAY. THE SECOND ENTRY IS
;FOR THE LOWER POSITION.

```

TABLE: DB 01H,04H ;BOTTOM LINE (01 IS BLANK)
        DB 01H,05H
        DB 01H,06H
        DB 01H,07H
        DB 01H,08H
        DB 01H,09H
        DB 01H,0AH
        DB 01H,0BH
        DB 01H,0CH
        DB 01H,0DH
        DB 01H,0EH
        DB 01H,0FH
        DB 01H,00H
        DB 04H,01H
        DB 05H,01H
        DB 06H,01H
        DB 07H,01H
        DB 08H,01H
        DB 09H,01H
        DB 0AH,01H
        DB 0BH,01H
        DB 0CH,01H
        DB 0DH,01H
        DB 0EH,01H
        DB 0FH,01H
        DB 00H,01H ;TOP LINE
  
```

Listing 1: Display software used with the theatrical lighting graphics package. TABLE is a lookup table containing 26 pairs of control characters that turn on the proper line in a vertical pair of character positions.

Programming

The scan divider starts with a count of 0 (top line of character) and counts down (0, F, E, etc), until it reaches a count of 4 (bottom line of character). It is then reset and counts down again for the next text line of characters. This means that characters 01, 02, and 03 will never appear as bars on the display since the scan counter never generates these codes and the comparator can never detect them. Character 04 will light up the bottom line in a character position. Character 05 will light up the next line up, and so on. Character 0F will light up the line below the top line, and 00 the top line.

In our display software we use a lookup table containing 26 pairs of control characters to turn on the proper line in a vertical pair of character positions (note that the lower character position is 64 locations after the upper character position). Listing 1 shows the display routine we use. ■

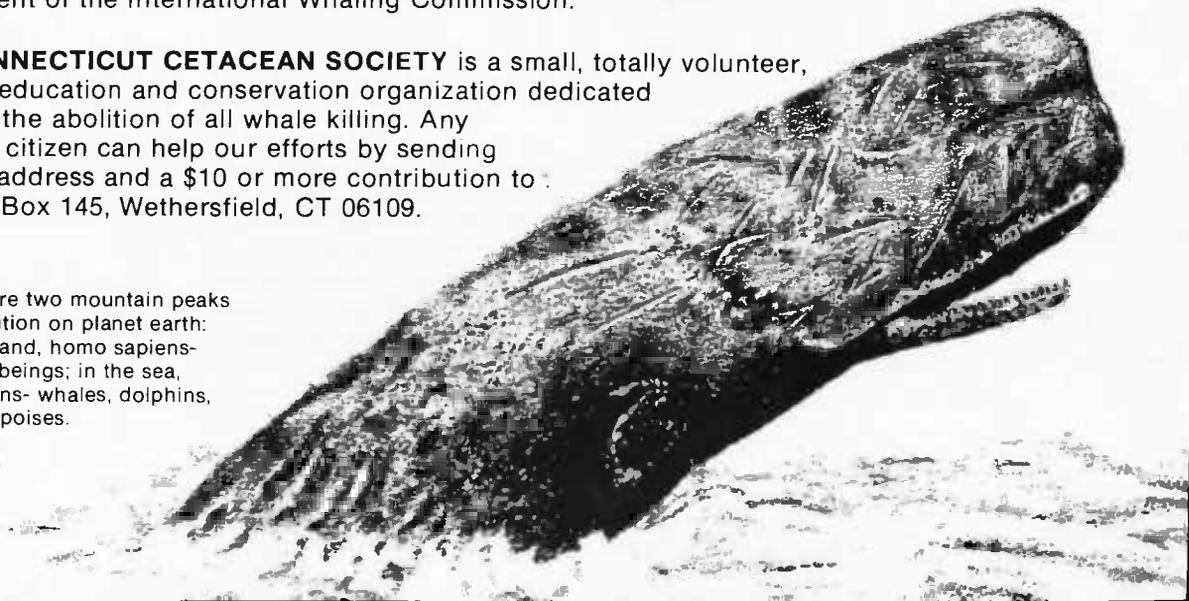
SAVE THE WHALE

The world's best computer may be inside a Sperm Whale's head.

The Sperm Whale has the largest brain of any creature that has ever existed on our planet. The brain of this 18-meter marine mammal weighs up to 9 kilograms. It uses echo-location to find giant squid at ocean depths of over 1,000 meters. More than 13,000 sperm whales are scheduled to be slaughtered this year by agreement of the International Whaling Commission.

The **CONNECTICUT CETACEAN SOCIETY** is a small, totally volunteer, non-profit education and conservation organization dedicated to seeking the abolition of all whale killing. Any concerned citizen can help our efforts by sending name and address and a \$10 or more contribution to: CCS, P.O. Box 145, Wethersfield, CT 06109.

There are two mountain peaks of evolution on planet earth: on the land, homo sapiens-human beings; in the sea, cetaceans- whales, dolphins, and porpoises.



Drawing by Don Straetz

Spring into Season with a BYTE T-shirt



At last! No more wardrobe crises! BYTE T-shirts are here! Now you have the perfect garb for computer club meetings, Altair Conventions, playing Shooting Stars and computer chess. (A pair of trousers from your own closet is suggested as an addition to the BYTE T-shirt. BITS can't do everything for you.)

BYTE T-shirts are of top quality 100% cotton or cotton-polyester. The original design, by artist Judy Lee Rehling, is silk-screened in red on white shirts with blue trim on collars and sleeves, or on blue heather shirts.

BITS, Inc. Dial charge card orders toll free 1-800-258-5477.
70 Main St.
Peterborough NH 03458

Please send me: extra large blue heather
 large white with blue trim
 medium and red letters
 small

T-shirts @ \$5.50 each
(includes postage and handling).

Total enclosed \$ _____
Bill MasterCard No. _____ Exp. Date _____
Bill BankAmericard No. _____ Exp. Date _____
Name _____
Address _____
City _____ State _____ Zip _____
Signature _____

In unusual cases, processing may exceed 30 days.
Prices shown are subject to change without notice.

GRAPH:

A System for Television Graphics

Part 2

John Webster
John Young
Audio Visual Services
University of New Brunswick
Keirstead Hall
Fredericton NB CANADA E3B 5A3

Last month, John Webster and John Young's article (page 62) on GRAPH, a television graphics package for the VDM-1 and other memory mapped video displays, began a discussion which we continue with the detail discussion of program functions. Listing 1 provides the detail 8080 code for the program. We continue the table numbering sequence begun in part 1.

Listing 1: The GRAPH program. GRAPH was assembled at 00 using Processor Technology's ALS-8 assembler. The notation \$ + n indicates a displacement of n beyond the next instruction address. For example, JMP \$ + 5 indicates an unconditional jump to the address 6 bytes along in the listing. Listing 1 continues on pages 159 thru 163.

```
GRAPH ASSEMBLY LISTING

ADDRESS  HEX CODE          LINE #
0000    C3 9D 02          0001 START JMP INIT
0003    21 00 CC          0002 HOME LXI H,0CC00H
0006    4E                0003 CURSOR MOV C,M
0007    3A FB 03          0004 LDA 03FBH
000A    31                0005 ADD C
000B    77                0006 MOV M,A
000C    3A F5 03          0007 LDA 03F5H
000F    B7                0008 ORA A
0010    C2 81 02          0009 JNZ REPT
0013    DB 00          0010 STATIN IN 00
0015    E6 40          0011 ANI 040H
0017    CA 15 00          0012 JZ STATIN
001A    DB 01          0013 DATIN IN 01H
001C    47                0014 MOV B,A
001D    3A F6 03          0015 LDA 03F6H
0020    B0                0016 ORA B
0021    47                0017 MOV B,A
0022    C3 C5 02          0018 JMP CTRLC
0025    70                0019 DISP MOV M,B
0026    3A F7 03          0020 LDA 03F7H
0029    B7                0021 ORA A
002A    C2 3A 00          0022 JNZ LFP
002D    23                0023 INX H
002E    3E D0          0024 MVI A,0D0H
0030    BC                0025 CPH H
0031    CA 03 00          0026 JZ HOME
0034    C3 06 00          0027 JMP CURSOR
0037    0E A0          0028 LFC MVI C,0A0H
0039    71                0029 LF MOV M,C
003A    11 40 00          0030 LFP LXI D,040H
003D    19                0031 DAD D
003E    3E D0          0032 MVI A,0D0H
0040    BC                0033 CPH H
0041    C2 46 00          0034 JNZ $+2
0044    26 CC          0035 MVI H,0CCH
0046    C3 06 00          0036 JMP CURSOR
0049    0E A0          0037 LRC MVI C,0A0H
004B    71                0038 LR MOV M,C
004C    11 C0 FF          0039 LRP LXI D,0FFC0H
004F    19                0040 DAD D
0050    3E CB          0041 MVI A,0CBH
```

Page Up

Page Up, Page Down, Page Right and Page Left are some of the more complex sub-routines in GRAPH.

Although the VDM-1 contains a scrolling feature which might, at first, seem useful for moving screen information up and down, it operates by changing the orientation of the display on the screen and not by actually moving data in memory. If, for example, the screen were scrolled halfway up or down, a character entered at hexadecimal CC00 would appear in the middle and not at the top. While this is a useful function in some driver applications, it does not allow information to be moved up or down on the screen and then stored away in its final configuration. Thus, to use GRAPH's store and recall functions properly, it is necessary to actually move data between memory locations within the 1 K byte screen programmable memory so that an image modified by a screen move up or down will be stored and recalled in its modified form. This function is useful for positioning complex drawings or charts which invariably turn out to be slightly off center when complete.

As in most other routines, Page Up first moves the contents of C to the present character position, thereby returning the screen to its original state and freeing register C for use. The contents of H and L are stored at hexadecimal locations 3FF and 3FE for future use. Because our program is designed

to co-reside with Processor Technology's ALS-8, and because this subroutine uses the stack pointer register, it is necessary to save the value of the stack pointer to allow a later jump back to the ALS-8. This probably applies to other resident monitors, too.

To accomplish this, H and L are loaded with hexadecimal 0000, the Stack Pointer is added to H and L (SPHL), and H and L are stored (SHLD) at hexadecimal memory locations 3FD and 3FC.

H and L are then initialized to hexadecimal CC00, D and E to hexadecimal 3C0, and the Stack Pointer to hexadecimal FFC0. The current character position is then hexadecimal CC00. Next, the program moves M to B (move contents of hexadecimal location CC00 to B) and adds D and E to H and L. Thus H and L becomes CC00 + 3C0 = hexadecimal CFC0 and this takes us to the first character position in the 16th line. (In Page Up and Page Down, information is moved on the screen by working in vertical rows rather than horizontal lines.)

The data in hexadecimal location CFC0 is moved to C, and B (old contents of hexadecimal CC00) is moved to M (hexadecimal position CFC0). This causes a wrap around from top to bottom. The contents of C are then moved to B and the Stack Pointer is added to H and L (CFC0 + FFC0 = hexadecimal CF80). At this point we compare H with hexadecimal CC to see if we are on one of the first four lines. If not (as in this case), we go through the cycle again: MOV M → C, MOV B → M, MOV C → B, and jump up one line by adding the Stack Pointer.

On the 13th cycle, H becomes hexadecimal CC. When H is compared with hexadecimal CC, the answer is zero so the cycle is not immediately repeated as before. Instead, L is compared with hexadecimal 3F, the last character position on the first line (hexadecimal CC3F). If L is greater than hexadecimal 3F the current position is in either line 2, 3 or 4. The cycle continues, checking L every time, since H is still hexadecimal CC.

If the current position is in line 4, then on the next cycle it will be in line 3, then line 2, and finally in line 1. At that point, when L is checked as described above, it will be less than hexadecimal 3F. Next, B is moved to M (which in this example will now be hexadecimal CC00). The entire vertical row has now been shifted up, with the top wrapping around to the bottom. Finally, H and L are incremented (to hexadecimal CC01), and the entire process is repeated for row 2. This is done 64 times, once for each vertical row.

On the last (ie: right-hand) row, however, when L is compared to hexadecimal 3F, it

ADDRESS	HEX CODE	LINE #
0052	BC	0042 CMP H
0053	C2 58 00	0043 JNZ \$+2
0056	26 CF	0044 MVI H,OCFH
0058	C3 06 00	0045 JMP CURSOR
* BACKSPACE *		
005B	0E A0	0046 BSC MVI C,0A0H
005D	71	0047 BS MOV M,C
005E	2B	0048 BSP DCX H
005F	3E CB	0049 MVI A,OCBH
0061	BC	0050 CMP H
0062	C2 67 00	0051 JNZ \$+2
0065	26 CF	0052 MVI H,OCFH
0067	C3 06 00	0053 JMP CURSOR
* FORWARD SPACE *		
006A	0E A0	0054 FSC MVI C,0A0H
006C	71	0055 FS MOV M,C
006D	23	0056 FSP INX H
006E	7C	0057 MOV A,H
006F	FE D0	0058 CPI 0D0H
0071	CA 03 00	0059 JZ HOME
0074	C3 06 00	0060 JMP CURSOR
* CRLF *		
0077	71	0061 CR MOV M,C
0078	7D	0062 MOV A,L
0079	FE 40	0063 CPI 040H
007B	D2 83 00	0064 JNC \$+5
007E	2E 40	0065 MVI L,040H
0080	C3 9C 00	0066 JMP OUT
0083	7D	0067 MOV A,L
0084	FE 80	0068 CPI 080H
0086	F2 8E 00	0069 JP \$+5
0089	2E 80	0070 MVI L,080H
008B	C3 9C 00	0071 JMP OUT
008E	7D	0072 MOV A,L
008F	FE C0	0073 CPI 0C0H
0091	F2 99 00	0074 JP \$+5
0094	2E C0	0075 MVI L,0C0H
0096	C3 9C 00	0076 JMP OUT
0099	24	0077 INR H
009A	2E 00	0078 MVI L,00
009C	3E D0	0079 OUT MVI A,OD0H
009E	BC	0080 CMP H
009F	C2 06 00	0081 JNZ CURSOR
00A2	C3 03 00	0082 JMP HOME
* PAGE UP *		
00A5	71	0083 PU MOV M,C
00A6	22 FE 03	0084 SHLD 03FEH
00A9	21 00 00	0085 LXI H,00
00AC	39	0086 DAD 6
00AD	22 FC 03	0087 SHLD 03FCH
00B0	21 00 CC	0088 LXI H,0CC0H
00B3	11 C0 03	0089 LXI D,03C0H
00B6	31 C0 FF	0090 LXI 6,0FFC0H
00B9	46	0091 ROWU MOV B,M
00BA	19	0092 DAD D
00BB	4E	0093 LINEU MOV C,M
00BC	70	0094 MOV M,B
00BD	41	0095 MOV B,C
00BE	39	0096 DAD 6
00BF	3E CC	0097 MVI A,0CCH
00C1	BC	0098 CMP H
00C2	C2 BB 00	0099 JNZ LINEU
00C5	3E 3F	0100 MVI A,03FH
00C7	BD	0101 CMP L
00C8	DA BB 00	0102 JC LINEU
00CB	CA D3 00	0103 JZ ENDU
00CE	70	0104 MOV M,B
00CF	23	0105 INX H
00D0	C3 B9 00	0106 JMP ROWU
00D3	70	0107 ENDU MOV M,B
00D4	2A FC 03	0108 LHLD 03FCH
00D7	F9	0109 SPHL
00D8	2A FE 03	0110 LHLD 03FEH
00DB	C3 4C 00	0111 JMP LRP
* PAGE DOWN *		
00DE	71	0112 PD MOV M,C
00DF	22 FE 03	0113 SHLD 03FEH
00E2	21 00 00	0114 LXI H,00
00E5	39	0115 DAD 6
00E6	22 FC 03	0116 SHLD 03FCH
00E9	21 FF CF	0117 LXI H,0CFFFH
00EC	11 40 FC	0118 LXI D,0FCA0H
00EF	31 40 00	0119 LXI 6,040H
00F2	46	0120 ROWU MOV B,M
00F3	19	0121 DAD D
00F4	4E	0122 LINED MOV C,M
00F5	70	0123 MOV M,B
00F6	41	0124 MOV B,C
00F7	39	0125 DAD 6
00F8	3E CF	0126 MVI A,OCFH
00FA	BC	0127 CMP H
00FB	C2 F4 00	0128 JNZ LINED
00FE	3E C0	0129 MVI A,0C0H
0100	BD	0130 CMP L

will be greater than hexadecimal 3F for three cycles, as above, but on the fourth compare it will be exactly hexadecimal 3F, instead of less, as before.

At this point the program moves B to M (hexadecimal CC3F), loads H and L with the value at hexadecimal locations 3FD and 3FC, and exchanges it with the contents of the stack pointer to restore the stack pointer address.

Then, H and L are loaded with the contents of hexadecimal locations 3FF and 3FE, which contain the values of H and L before Page Up was executed (ie: the address of the leading cursor before the page was moved up). Operation then jumps to a section of the Line Retract subroutine (LRP) which moves the cursor up one line to restore its relative position on the screen. From Line Retract, operation returns to CURSOR.

Page Down

Page Down works the same as Page Up except that it starts at the lower right-hand position, hexadecimal location CFFF. It then moves up to hexadecimal location CC3F, or the upper right-hand corner, by adding D and E (hexadecimal location FC40). Then the MOVE cycle begins, moving information down vertical rows and finally arriving at the lower left-hand corner.

To restore the leading cursor to its relative screen position, the program jumps to a section of Linefeed (LFP) upon termination of Page Down. As explained above, Linefeed ends with a jump to CURSOR.

Page Left

Page Left commences in the same way as the preceding two subroutines by moving C to M, saving H and L at hexadecimal locations 3FF and 3FE, and saving the stack pointer value at hexadecimal locations 3FD and 3FC.

It then loads the stack pointer with hexadecimal FFC1 (the value needed to move left one line length), D and E with hexadecimal 3F (the value needed to move right one line length), and H and L with hexadecimal CFC0 (the address of the lower left-hand corner position).

The cycle begins by storing the contents of hexadecimal location CFC0 in register B, and adds D and E to H and L moving the present position to lower right-hand corner (hexadecimal location CFFF). It then moves the contents of this location to register C, moves the contents of B to this location, and moves C to B, the same procedure as that found in the Page Up and Page Down subroutines.

ADDRESS	HEX CODE	LINE #
0101	CA 0C 01	0131 JZ ENDD
0104	D2 F4 00	0132 JNC LINED
0107	70	0133 MOV M,B
0108	2B	0134 DCX H
0109	C3 F2 00	0135 JMP ROWD
010C	70	0136 ENDD MOV M,B
010D	2A FC 03	0137 LHLD 03FCH
0110	F9	0138 SPHL
0111	2A FE 03	0139 LHLD 03FEH
0114	C3 3A 00	0140 JMP LFP
* PAGE LEFT *		
0117	71	0141 PL MOV M,C
0118	22 FE 03	0142 SHLD 03FEH
011B	21 00 00	0143 LXI H,00
011E	39	0144 DAD 6
011F	22 FC 03	0145 SHLD 03FCH
0122	31 C1 FF	0146 LXI 6,OFFC1H
0125	11 3F 00	0147 LXI D,03FH
0128	21 C0 CF	0148 LXI H,0CFC0H
012B	46	0149 LINEL MOV B,M
012C	19	0150 DAD D
012D	4E	0151 BGNL MOV C,M
012E	70	0152 MOV M,B
012F	41	0153 MOV B,C
0130	2B	0154 DCX H
0131	3E CB	0155 MVI A,0CBH
0133	BC	0156 CMP H
0134	CA 52 01	0157 JZ ENDL
0137	3E 3F	0158 MVI A,03FH
0139	BD	0159 CMP L
013A	CA 75 01	0160 JZ NEXTL
013D	3E 7F	0161 MVI A,07FH
013F	BD	0162 CMP L
0140	CA 75 01	0163 JZ NEXTL
0143	3E BF	0164 MVI A,0BFH
0145	BD	0165 CMP L
0146	CA 75 01	0166 JZ NEXTL
0149	3E FF	0167 MVI A,0FFH
014B	BD	0168 CMP L
014C	CA 75 01	0169 JZ NEXTL
014F	C3 2D 01	0170 JMP BGNL
0152	2A FC 03	0171 ENDL LHLD 03FCH
0155	F9	0172 SPHL
0156	2A FE 03	0173 LHLD 03FEH
0159	7D	0174 MOV A,L
015A	FE 00	0175 CPI 00
015C	CA 71 01	0176 JZ FIXL
015F	FE 40	0177 CPI 040H
0161	CA 71 01	0178 JZ FIXL
0164	FE 80	0179 CPI 080H
0166	CA 71 01	0180 JZ FIXL
0169	FE C0	0181 CPI 0C0H
016B	CA 71 01	0182 JZ FIXL
016E	C3 5E 00	0183 JMP BSP
0171	19	0184 FIXL DAD D
0172	C3 06 00	0185 JMP CURSOR
0175	39	0186 NEXTL DAD 6
0176	C3 2B 01	0187 JMP LINEL
* PAGE RIGHT *		
0179	71	0188 PR MOV M,C
017A	22 FE 03	0189 SHLD 03FEH
017D	21 00 00	0190 LXI H,00
0180	39	0191 DAD 6
0181	22 FC 03	0192 SHLD 03FCH
0184	31 3F 00	0193 LXI 6,03FH
0187	21 3F CC	0194 LXI H,0CC3FH
018A	11 C1 FF	0195 LXI D,OFFC1H
018D	46	0196 LINER MOV B,M
018E	19	0197 DAD D
018F	4E	0198 BGNR MOV C,M
0190	70	0199 MOV M,B
0191	41	0200 MOV B,C
0192	23	0201 INX H
0193	3E D0	0202 MVI A,0D0H
0195	BC	0203 CMP H
0196	CA B3 01	0204 JZ ENDR
0199	AF	0205 XRA A
019A	BD	0206 CMP L
019B	CA D6 01	0207 JZ NEXTR
019E	3E 40	0208 MVI A,040H
01A0	BD	0209 CMP L
01A1	CA D6 01	0210 JZ NEXTR
01A4	3E 80	0211 MVI A,080H
01A6	BD	0212 CMP L
01A7	CA D6 01	0213 JZ NEXTR
01AA	3E C0	0214 MVI A,0C0H
01AC	BD	0215 CMP L
01AD	CA D6 01	0216 JZ NEXTR
01B0	C3 8F 01	0217 JMP BGNR
01B3	2A FC 03	0218 ENDR LHLD 03FCH
01B6	F9	0219 SPHL
01B7	2A FE 03	0220 LHLD 03FEH
01BA	7D	0221 MOV A,L
01BB	FE 3F	0222 CPI 03FH

Next, it decrements H and L and compares H with hexadecimal CB to determine if this new value is still on the screen. When it is not, the operation is complete and the subroutine exists as explained later. However, if the new value is on the screen, L is compared with the hexadecimal values 3F, 7F, BF and FF, consecutively, to determine if the present cursor position is a right-hand end of a line. If not, the cycle is repeated by moving the contents of the line, space by space, to the left until the current character position becomes one of the above mentioned right-hand end of line positions. This will mean that we have decremented (moved left) all the way through our present line, and then decremented once more, moving up to the right-hand end of the line above. When a right-hand end of the line is found, the subroutine adds the Stack Pointer contents (hexadecimal FFC1) to H and L, having the effect of moving the current character position to the left-hand end of the new line. The value at this location is stored in B; D and E are added to H and L as before, and the cycle continues, moving line by line to the left one space at a time.

After the last screen memory location has been transferred, the decrement changes H from hexadecimal CC to CB. When this condition is sensed by an appropriate check, the program jumps out of the cycle. At this point, the subroutine restores the values of H and L and the Stack Pointer. H and L now contain the address of the leading cursor position before Page Left was executed. The cursor, in order to maintain its relative screen position, must now also be moved to the left.

Part of the complexity of the above program comes from the fact that it was designed so that characters disappearing off the left-hand side of the screen reappear on the right-hand side and on the same line that they were on, rather than on the next line up, as in the case of a simple decrement/move loop.

If the new leading cursor position is moved to the left off the screen, it should appear on the right-hand end of the same line. Hence, knowing the pre-"Page Left" value of the cursor, it is not sufficient to simply decrement it, since if the cursor is on the left-hand end of a line, it would appear on the right-hand end of the next line up, and its position would no longer be relative. To avoid this, the subroutine checks to see if the old leading cursor position is one of the four left end values (hexadecimal 00, 40, 80, or C0) and if it is, then D and E are added to this value in H and L and this simply shifts the cursor position to the right-hand end of the same line. The pro-

ADDRESS	HEX CODE	LINE #
01BD	CA D2 01	0223 JZ FIXR
01C0	FE 7F	0224 CPI 07FH
01C2	CA D2 01	0225 JZ FIXR
01C5	FE BF	0226 CPI 0BFH
01C7	CA D2 01	0227 JZ FIXR
01CA	FE FF	0228 CPI OFFH
01CC	CA D2 01	0229 JZ FIXR
01CF	C3 6D 00	0230 JMP FSP
01D2	19	0231 FIXR DAD D
01D3	C3 06 00	0232 JMP CURSOR
01D6	39	0233 NEXTR DAD 6
01D7	C3 8D 01	0234 JMP LINER
* PAGE STORE *		
01DA	22 F9 03	0235 PAGER SHLD 03F9H
01DD	71	0236 MOV M,C
01DE	21 00 CC	0237 LXI H,0CC00H
01E1	06 D0	0238 MVI B,0DOH
01E3	1E 00	0239 MVI E,00
01E5	3A F8 03	0240 LDA 03F8H
01E8	FE 00	0241 CPI 00
01EA	CA 2E 02	0242 JZ ONE
01ED	FE 01	0243 CPI 01H
01EF	CA 33 02	0244 JZ TWO
01F2	FE 02	0245 CPI 02H
01F4	CA 38 02	0246 JZ THREE
01F7	FE 03	0247 CPI 03H
01F9	CA 3D 02	0248 JZ FOUR
01FC	FE 04	0249 CPI 04H
01FE	CA 42 02	0250 JZ FIVE
0201	16 1C	0251 MVI D,01CH
0203	7E	0252 MOVI MOV A,M
0204	12	0253 STAX D
0205	23	0254 INX H
0206	13	0255 INX D
0207	7C	0256 MOV A,H
0208	B8	0257 CMP B
0209	C2 03 02	0258 JNZ MOV1
020C	3A F8 03	0259 LDA 03F8H
020F	3C	0260 INR A
0210	FE 06	0261 CPI 06H
0212	CA 18 02	0262 JZ RESET
0215	C3 1A 02	0263 JMP PLUG
0218	3E 00	0264 RESET MVI A,00
021A	32 F8 03	0265 PLUG STA 03F8H
021D	2A F9 03	0266 LHLD 03F9H
0220	4E	0267 MOV C,M
0221	3E CC	0268 MVI A,0CCH
0223	32 FA 03	0269 STA 03FAH
0226	3E 00	0270 MVI A,00
0228	32 F9 03	0271 STA 03F9H
022B	C3 13 00	0272 JMP STATIN
022E	16 08	0273 ONE MVI D,08H
0230	C3 03 02	0274 JMP MOV1
0233	16 0C	0275 TWO MVI D,0CH
0235	C3 03 02	0276 JMP MOV1
0238	16 10	0277 THREE MVI D,010H
023A	C3 03 02	0278 JMP MOV1
023D	16 14	0279 FOUR MVI D,014H
023F	C3 03 02	0280 JMP MOV1
0242	16 18	0281 FIVE MVI D,018H
0244	C3 03 02	0282 JMP MOV1
* PAGE RECALL *		
0247	21 00 08	0283 RCL1 LXI H,0800H
024A	06 0C	0284 MVI B,0CH
024C	11 00 CC	0285 LDPX LXI D,0CC00H
024F	3A F8 03	0286 LDA 03F8H
0252	3D	0287 DCR A
0253	32 F8 03	0288 STA 03F8H
0256	C3 03 02	0289 JMP MOV1
0259	21 00 0C	0290 RCL2 LXI H,0C00H
025C	06 10	0291 MVI B,010H
025E	C3 4C 02	0292 JMP LDPX
0261	21 00 10	0293 RCL3 LXI H,01000H
0264	06 14	0294 MVI B,014H
0266	C3 4C 02	0295 JMP LDPX
0269	21 00 14	0296 RCL4 LXI H,01400H
026C	06 18	0297 MVI B,018H
026E	C3 4C 02	0298 JMP LDPX
0271	21 00 18	0299 RCL5 LXI H,01800H
0274	06 1C	0300 MVI B,01CH
0276	C3 4C 02	0301 JMP LDPX
0279	21 00 1C	0302 RCL6 LXI H,01C00H
027C	06 20	0303 MVI B,020H
027E	C3 4C 02	0304 JMP LDPX
* REPEAT DELAY *		
0281	11 FF 10	0305 REPT LXI D,010FFH
0284	1D	0306 LOOK DCR E
0285	C2 84 02	0307 JNZ LOOK
0288	15	0308 DCR D
0289	C2 84 02	0309 JNZ LOOK
028C	DB 00	0310 IN 00
028E	E6 40	0311 ANI 040H
0290	CA 1A 00	0312 JZ DATIN
0293	DB 01	0313 IN 01H

gram then jumps to CURSOR. If it is not a left-hand end of line position, program operation jumps to a section of the Back-space subroutine which moves the cursor to the left one space, and displays it on the screen.

Page Right

Page Right is similar to Page Left in program structure. The Stack Pointer is loaded with hexadecimal with 03F to move from the left to the right-hand end of a line. The D and E pair are loaded with hexadecimal FFC1, to move from the right to the left-hand end of a line, and H and L are loaded with a starting value of hexadecimal CC3F which is the upper right-hand corner of the screen.

Operation causes the H and L value to shift from upper right-hand to upper left-hand by adding D and E, then simple increment loops move operations to the right step-by-step. The Stack Pointer is used to move from the left to the right-hand side whenever a left-hand end of line is encountered.

This subroutine uses all registers in the same way as Page Left except that they are loaded with different values necessary to move characters to the right. In finishing this subroutine, the old leading cursor position is checked for a right-hand end of line value and, if true, this value is changed to a left-hand end of the line value, again by adding D and E and jumping to CURSOR as in Page Left. If the old leading cursor position is not at the end of a line, the program operation jumps to a section of Forward Space which moves the cursor to the right one space and displays it, while maintaining its relative position.

Page Store

Page Store is a memory block program which moves the present contents of the screen to one of several allocated memory sectors. This process duplicates screen information somewhere else in memory for later use without destroying the present screen information.

Page Store and Recall require an additional 6 K bytes of programmable memory to allow storage of six full screens of data for later recall. The number 6 was chosen to satisfy our needs, but could be easily modified to any number up to 256 depending on available memory. Note: to expand the Next Store operation to define more than six memory sectors, additional control checks are needed in the Control/W section. Screen storage locations are addressed in GRAPH to reside in the area from 2 K to 8 K in programmable memory. If they are to be

ADDRESS	HEX CODE	LINE #
0295	3E 00	0314 MVI A,00
0297	32 F5 03	0315 STA 03F5H
029A	C3 13 00	0316 JMP STATIN
* INITIALIZE *		
029D	11 F5 03	0317 INIT LXI D,03F5H
02A0	AF	0318 XRA A
02A1	12	0319 STAX D
02A2	13	0320 INX D
02A3	12	0321 STAX D
02A4	13	0322 INX D
02A5	12	0323 STAX D
02A6	13	0324 INX D
02A7	12	0325 STAX D
02A8	13	0326 INX D
02A9	12	0327 STAX D
02AA	13	0328 INX D
02AB	3E CC	0329 MVI A,CCCH
02AD	12	0330 STAX D
02AE	13	0331 INX D
02AF	3E 80	0332 MVI A,080H
02B1	12	0333 STAX D
* CLEAR *		
02B2	3E 00	0334 CLEAR MVI A,00
02B4	D3 C8	0335 OUT 0C8H
02B6	21 00 CC	0336 LXI H,0CC00H
02B9	36 20	0337 BLANK MVI M,020H
02BB	23	0338 INX H
02BC	3E D0	0339 MVI A,0D0H
02BE	BC	0340 CMP H
02BF	C2 B9 02	0341 JNZ BLANK
02C2	C3 03 00	0342 JMP HOME
* CONTROL CHECK *		
02C5	FE 16	0343 CTRLC CPI 016H
02C7	CA 39 00	0344 JZ LF
02CA	FE 14	0345 CPI 014H
02CC	CA 4B 00	0346 JZ LR
02CF	FE 06	0347 CPI 06H
02D1	CA 5D 00	0348 JZ BS
02D4	FE 07	0349 CPI 07H
02D6	CA 6C 00	0350 JZ FS
02D9	FE 96	0351 CPI 096H
02DB	CA 37 00	0352 JZ LFC
02DE	FE 94	0353 CPI 094H
02E0	CA 49 00	0354 JZ LRC
02E3	FE 86	0355 CPI 086H
02E5	CA 5B 00	0356 JZ BSC
02E8	FE 87	0357 CPI 087H
02EA	CA 6A 00	0358 JZ FSC
02ED	E6 7F	0359 ANI 07FH
02EF	FE 0A	0360 CPI 0AH
02F1	CA 77 00	0361 JZ CR
02F4	FE 15	0362 CPI 015H
02F6	CA A5 00	0363 JZ PU
02F9	FE 0D	0364 CPI 0DH
02FB	CA DE 00	0365 JZ PD
02FE	FE 08	0366 CPI 08H
0300	CA 17 01	0367 JZ PL
0303	FE 0B	0368 CPI 0BH
0305	CA 79 01	0369 JZ PR
0308	FE 13	0370 CPI 013H
030A	CA DA 01	0371 JZ PAGER
030D	FE 10	0372 CPI 010H
030F	C2 3E 03	0373 JNZ CONT
0312	DB 00	0374 STIN IN 00
0314	E6 40	0375 ANI 040H
0316	CA 12 03	0376 JZ STIN
0319	DB 01	0377 IN 01H
031B	E6 7F	0378 ANI 07FH
031D	FE 31	0379 CPI 031H
031F	CA 47 02	0380 JZ RCL1
0322	FE 32	0381 CPI 032H
0324	CA 59 02	0382 JZ RCL2
0327	FE 33	0383 CPI 033H
0329	CA 61 02	0384 JZ RCL3
032C	FE 34	0385 CPI 034H
032E	CA 69 02	0386 JZ RCL4
0331	FE 35	0387 CPI 035H
0333	CA 71 02	0388 JZ RCL5
0336	FE 36	0389 CPI 036H
0338	CA 79 02	0390 JZ RCL6
033B	C3 13 00	0391 JMP STATIN
033E	FE 1C	0392 CONT CPI 01CH
0340	CA B2 02	0393 JZ CLEAR
0343	FE 1B	0394 CPI 01BH
0345	CA 60 E0	0395 JZ 0E060H
0348	FE 17	0396 CPI 017H
034A	CA 56 03	0397 JZ RINT
034D	FE 18	0398 CPI 018H
034F	C2 A5 03	0399 JNZ STBT
0352	71	0400 MOV M,C
0353	C3 03 00	0401 JMP HOME
0356	DB 00	0402 RINT IN 00
0358	E6 40	0403 ANI 040H
035A	CA 56 03	0404 JZ RINT

addressed elsewhere, it is only necessary to modify the start and end locations for each 1 K sector in the Store routine (see the Addressing and Memory Requirements Section).

A status word in hexadecimal memory location 3F8 is used as a counter to choose which sector is being accessed. The data in hexadecimal location 3F8 is initialized to zero at the beginning of the program, incremented every time a store is made, and checked by the program to determine where the next screen should be stored. Control/W allows this counter to set to any number from 0 to 5. This specifies one of six locations to which the next "STORE" will move the screen information. Otherwise, it will cycle automatically.

The information stored in each sector is recalled to the screen with a block move by entering Control/P followed by a number from 1 to 6. The information in the storage sector remains valid until written over by another store to that location. Thus stored information may be recalled as many times as desired.

The main block move operation in Page Store is also used by Page Recall, which changes certain parameter registers in order to move the information stored somewhere in memory back to the screen.

Upon entering the Page Store subroutine, the contents of H and L are stored at hexadecimal locations 3FA and 3F9. The contents of C are moved to the screen to restore the screen to pre-"leading" cursor state. Then, H and L are loaded with the screen starting hexadecimal location CC00, and B is loaded with the most significant byte of the first invalid location after the screen (hexadecimal D0).

Next, register E is loaded with zero for subsequent use with D, as a register pair. The accumulator is loaded with the contents of hexadecimal location 3F8, (a number from 0 to 5 denoting which of the six blocks in memory will contain this page).

To determine which of these six blocks is indicated, the accumulator contents are compared with these six numbers (0 thru 5), and a subsequent jump is made to a location governed by the results of the comparison.

If hexadecimal location 3F8 is found to be zero, the program loads register D with the most significant byte of the starting location of the memory to be used to store the screen information (hexadecimal 08). The actual move cycle then begins.

If the value is 1, 2, 3 or 4, the program jumps cause D to be loaded with the respective memory block starting address's most significant byte (hexadecimal 0C, 10, 14 or 18). If the value is 5, no jump is encountered,

ADDRESS	HEX CODE	LINE #
0350	DB 01	0405 IN 01H
035F	E6 7F	0406 ANI 07FH
0361	FE 1C	0407 CPI 01CH
0363	CA 9D 02	0408 JZ INIT
0366	FE 31	0409 CPI 031H
0368	C2 70 03	0410 JNZ \$+5
036B	3E 00	0411 MVI A,00
036D	32 F8 03	0412 STA 03F8H
0370	FE 32	0413 CPI 032H
0372	C2 7A 03	0414 JNZ \$+5
0375	3E 01	0415 MVI A,01H
0377	32 F8 03	0416 STA 03F8H
037A	FE 33	0417 CPI 033H
037C	C2 84 03	0418 JNZ \$+5
037F	3E 02	0419 MVI A,02H
0381	32 F8 03	0420 STA 03F8H
0384	FE 34	0421 CPI 034H
0386	C2 8E 03	0422 JNZ \$+5
0389	3E 03	0423 MVI A,03H
038B	32 F8 03	0424 STA 03F8H
038E	FE 35	0425 CPI 035H
0390	C2 98 03	0426 JNZ \$+5
0393	3E 04	0427 MVI A,04H
0395	32 F8 03	0428 STA 03F8H
0398	FE 36	0429 CPI 036H
039A	C2 A2 03	0430 JNZ \$+5
039D	3E 05	0431 MVI A,05H
039F	32 F8 03	0432 STA 03F8H
03A2	C3 13 00	0433 JMP STATIN
03A5	FE 12	0434 STBT CPI 012H
03A7	C2 B2 03	0435 JNZ \$+08H
03AA	3E 80	0436 MVI A,080H
03AC	32 F5 03	0437 STA 03F5H
03AF	C3 13 00	0438 JMP STATIN
03B2	FE 01	0439 CPI 01H
03B4	C2 C2 03	0440 JNZ \$+0BH
03B7	3A FB 03	0441 LDA 03FBH
03BA	C6 80	0442 ADI 080H
03BC	32 FB 03	0443 STA 03FBH
03BF	C3 13 00	0444 JMP STATIN
03C2	FE 1A	0445 CPI 01AH
03C4	C2 D2 03	0446 JNZ \$+0BH
03C7	3A F6 03	0447 LDA 03F6H
03CA	C6 80	0448 ADI 080H
03CC	32 F6 03	0449 STA 03F6H
03CF	C3 13 00	0450 JMP STATIN
03D2	FE 11	0451 CPI 011H
03D4	C2 E2 03	0452 JNZ \$+0BH
03D7	3A F7 03	0453 LDA 03F7H
03DA	C6 80	0454 ADI 080H
03DC	32 F7 03	0455 STA 03F7H
03DF	C3 13 00	0456 JMP STATIN
03E2	FE 7F	0457 CPI 07FH
03E4	C2 ED 03	0458 JNZ \$+6
03E7	3E 20	0459 MVI A,020H
03E9	77	0460 MOV M,A
03EA	C3 5E 00	0461 JMP BSP
03ED	C3 25 00	0462 END JMP DISP

but D is loaded with the appropriate value (hexadecimal 1C) at the next sequential program step.

After D is loaded, D and E are used as a register pair (E = 00). The move cycle moves the memory contents of the position specified by H and L to the accumulator (MOV A,M). This value is then stored in memory at the location indexed by D and E.

Next, D and E, and H and L are incremented, and the value of H is compared with the value in B (first invalid location) to see if the new value of H and L is still a valid screen position. If so, the cycle is repeated. When the comparison of H with B indicates that the new value of H and L is no longer a valid screen position, the entire screen has been transferred.

At this point A is again loaded with the value at hexadecimal location 3F8, the page store select number (0 to 5). This value is incremented and checked to see if it is equal

to 6. If so, the accumulator is loaded with 0 and stored at hexadecimal location 3F8. If not, the value in A is stored at hexadecimal location 3F8 unaltered.

The next time Page Store is entered, the page store select number will indicate that the screen is to be stored at the next memory block higher than the last screen was stored at. However, as described above, if the last screen is stored in page 6 (memory block 6, indicated by a 5 in this location) the program will have reset the location to 0 so that the next screen stored will be stored in page 1.

After the page number value has been determined and stored in hexadecimal location 3F8, H and L are loaded with their original prestore value (from hexadecimal locations 3FA and 3F9), and the value of M at this position is moved to C for use in any subsequent subroutine. Hexadecimal locations 3FA and 3F9 are then loaded with CC00 for subsequent use by page recall. Next, the program jumps back to the status input (STATIN) of the driver program. Hence, no cursor is on the screen after a store. This is a good way to see if you have already stored the present screen. A Page Store blanks the leading cursor.

Page Recall

Page Recall can be entered at six points, depending on which page the operator decides to recall. At each entry point, H and L are loaded with the value of the starting address of the page or block desired to be recalled, and B is loaded with the most significant byte of the first invalid address after this block of memory to be recalled. D and E are loaded with the screen starting location (hexadecimal CC00). Then A is loaded with the value of hexadecimal location 3F8 (the Page Store select value), decremented by 1 and deposited in hexadecimal location 3F8, since later on in the program it will be unavoidably incremented. (Thus a decrement followed by an increment leaves the Page Store select value at its original value.)

With D and E holding screen locations and H and L holding the page in memory locations, moving information indexed by H and L through the accumulator to positions indexed by D and E in effect moves information from the page in memory to the screen. Since the moves are accomplished by the move cycle in the Page Store routine, the program operation now jumps

to this cycle, which operates as described in Page Store. The result is that the selected page in memory now appears on the screen.

Notice that, when the move cycle in Page Store is used by Page Store, hexadecimal locations 3FA and 3F9 are used to contain the address of the present leading cursor position of the page being stored. When the move cycle in Page Store is used by Page Recall, these locations contain hexadecimal CC00 to initialize the cursor on the recalled page. Also, as in a Page Store, no leading cursor appears on the screen. Hence, a Page Recall will set the cursor position to the upper left-hand corner of the screen, even though the cursor is not visible, until some other function is executed.

Users who do not have a hard copy output device in their systems may find a way to use the Page Store and Page Recall routines outside the GRAPH program. Running BASIC or even an assembler or editor with only a video terminal means that you often run information off the top of the screen that would be useful for later reference. Resident Page Store and Recall subroutines might help to reduce this problem. If the BASIC input routines, for example, could be modified to incorporate control character checks for Page Store and Recall, these routines would be called to store the existing screen without interfering with the program currently running in BASIC. This approach would be cumbersome (unless universally accepted) because all the higher level programs would have to be modified separately.

Other alternatives might incorporate interrupts to exit from main programs that reside above the 8080's RST addresses, or even some sort of parallel processor that would "preprocess" input data and route it either to special service routines or to the main program.

Repeat

Repeat simply loads hexadecimal location 3F5 with hexadecimal 80 and jumps back to STATIN in the Driver. Hexadecimal location 3F5 is subsequently reset by the program as soon as a second key after CTRL/R is pressed, as explained in the Driver section.

Vertical Write

When the control check subroutine recognizes the code for vertical write, it loads the accumulator with the contents of hexadecimal location 3F7 (which determines

System Clear

When a CTRL/W followed by a Clear is detected in the Control Check Section, a jump is made to INITIALize and all system parameters are initialized. The screen is cleared and the cursor is moved to the upper left-hand corner.

System Clear is designed to be accessed by pressing CTRL/W and then Clear, to avoid accidental use. It is, however, occasionally handy to be able to reinitialize the entire program.

Clear Screen and Home Cursor

When only the Clear key is pressed, the program jumps to CLEAR. This clears the screen and returns the cursor to the upper left-hand corner. Memory status words are unchanged.

Home Cursor

When a CTRL/X is detected in the Control Check section, the program jumps to Home, which returns the cursor to the upper left-hand corner but does not affect the screen contents or the memory status words.

Escape

When the escape key (ESC) is pressed, it is detected by the Control Check section and a jump is made to hexadecimal memory address 345 where the program receives instructions for exit from GRAPH (see Program Function and Use).

Addressing and Memory Requirements

In its present assembly, GRAPH resides in hexadecimal memory locations 000 thru 3FFF and is designed to drive a VDM-1 addressed at hexadecimal CC00. VDM-1 status port (to reset scrolling) is addressed at hexadecimal C8.

In addition, six 1 K byte memory sectors are set aside for the STORE and RECALL functions (see table 3).

A keyboard inputs status information to IO port 00 (data present = bit 6 set) and data to IO port 01. ■

A 300 bps cassette of GRAPH in Kansas City, BYTE or Cuter formats with a CUTER header is available for \$5 (cash or money order) from UNB Audio Visual Services, UNB, Fredericton NB CANADA E3B 5A3.

Sector	Hexadecimal Beginning Address	Hexadecimal Locations of Begin Address in GRAPH Program	Hexadecimal End Address Plus One	Hexadecimal Location of End Address in GRAPH Program
1	0800	22F, 249 (08)	0C00	24B (0C)
2	0C00	234, 25B (0C)	1000	25D (10)
3	1000	239, 263 (10)	1400	265 (14)
4	1400	23E, 26B (14)	1800	26D (18)
5	1800	243, 273 (18)	1C00	275 (1C)
6	1C00	202, 27B (1C)	2000	270 (20)

Table 3: Six 1 K byte memory sectors which are set aside for the STORE and RECALL functions.

if the program is in the vertical write mode). It then adds the value 80 to the accumulator and deposits the result back into 3F7. This has the effect of alternately loading that location with hexadecimal 00 or 80 every time this routine is entered. Thus, one stroke of the appropriate key (CTRL/Q) puts you in the Vertical Write mode, and another stroke takes you out of that mode. Operation then jumps back to STATIN in the Driver.

Cursor (On/Off)

This operation works exactly the same as Vertical Write by alternately loading hexadecimal location 3FB with hexadecimal 00 or 80.

Cursor Write/Don't Write

Cursor write/don't write works exactly like Vertical Write, alternately loading location hexadecimal 3F6 with hexadecimal 00 or 80.

Next Store

When a CTRL/W and a number from 1 to 6 are detected (see Control Check Section), the Next Store routine is entered. This routine is actually only a series of comparisons in the Control Check Section which compare the input character with several ASCII hexadecimal values. For example, after CTRL/W and a numeral 1 are entered from the keyboard, the data input to the computer is hexadecimal 31. In this case a CPI 31 instruction would route the program to instructions that would load status word hexadecimal memory location 3F8 with hexadecimal 00, and when 3F8 is checked by the next STORE operation, it would store page 1 in the first memory sector. Entering a 3 would be detected by a CPI 33, which would load 3F8 with hexadecimal 02 and set up the next STORE operation for page 3.

Adding a Virtual Tape Loop

Audio Processing with a Microprocessor

Tom O'Haver
Dept of Chemistry
University of Maryland
College Park MD 20742

There is a lot of talk about digital audio processing, but talk is not the same as practical action. As the prices of microprocessor systems and interface devices continue to drop, such applications are sure to become quite common, even among amateurs. This article describes a few of the possibilities of the use of a small low cost microprocessor system for digital processing of audio signals. The effects described involve echo, reverb, fuzz, time delay, phase phlanging, mono-to-enhanced-stereo conversion, and frequency multiplication. These effects could also be quite useful for the experimentally inclined audio enthusiast or music group.

Hardware Requirements

To run the programs given here, you will need a 6502 (or equivalent) processor with from 1 K to 5 K bytes of programmable memory, an 8 bit input port connected to a fast 8 bit analog to digital converter (ADC), and a latched 8 bit output port connected to an 8 bit digital to analog converter (DAC). An additional output port and digital to analog converter are required for stereo applications. The basic hookup for a simple monaural system is shown in figure 1. The signal from the preamp is amplified, low pass filtered, converted to digital by the analog to digital converter, processed in the microcomputer, converted back into analog by the digital to analog converter, and then filtered some more before going to the power amp. The success of such a system in audio processing depends upon its ability to operate at ultrasonic speeds; that is, the rate at which the audio signal is digitized,

processed, and output must (or should) be as far above the upper limit of the audio spectrum as possible. Thus the speed of each of these steps is critical. We'll consider each step individually.

Next to the microcomputer itself, the analog to digital converter is really the most critical component. It must be a fast one; a conversion time of $50 \mu\text{s}$ or less is necessary to allow sufficiently high sampling rates. I have been using a Datal Model E8HB1, an 8 bit successive approximation analog to digital converter with a $4 \mu\text{s}$ conversion time (available from Datal Systems Inc, 1020G Turnpike St, Building S, Canton MA 02021, for \$85 in unit quantities). I recommend this unit. Its conversion time is probably faster than you will need, but at least you won't have to buy a new one when microsystems get faster (as they certainly will). In addition to speed, the Datal analog to digital converter has two other features you should look for in a converter. First, it is bipolar, which means it is capable of accepting both the positive and the negative excursions of the audio waveform. Otherwise, you would have to add some offset to the incoming signal. (The programs in this article assume offset binary coding.) Second, it *clips* on overload rather than wrapping around. That is, if the input audio signal exceeds the dynamic range of the analog to digital converter, the digital output simply stops at full scale rather than wrapping around or folding back to zero. The reason this is a useful feature is the fact that an audio signal contains many peaks and transients which greatly exceed the average signal amplitude. With only an 8 bit system, there is really no way to keep these transients

from exceeding the range of the converter, at least occasionally; if you try to prevent it by adjusting the average amplitude to a very low level, you'll get too much quantization noise. Clipping the peaks may offend the audio purist, but I'll guarantee you that it sounds a *lot* better than wrapping around. Of course, a better solution would be to use 12 bit converters and a 12 or 16 bit (or faster 8 bit) computer. Sufficiently fast 12 bit analog to digital converters are available for about \$150, and 12 bit digital to analog converters are typically about \$30. But without a 12 or 16 bit processor, all processing would have to be done in double precision, which might slow things down too much (unless you have a 4 MHz 6502, which I do not). Anyway, an 8 bit converter which clips is good enough for the time being.

Selection of a digital to analog converter is much easier, since several fast, low cost 8 bit units are available. The digital to analog converter needn't be bipolar, since a DC blocking capacitor can be added easily. The Hybrid Systems 371-8 at \$10 is a good choice, as is the Motorola MC 1408L8 at about \$5. I've used both successfully. The Hybrid Systems unit is more convenient because it has a built-in reference supply, while you will have to supply an external (2 V) reference for the Motorola unit. This must be very well filtered but not necessarily well regulated for audio applications. (An advantage of the Motorola units is that they can be used as multiplying digital to analog converters. If you drive the reference input of one converter from the output of another converter, then the output of the first converter will be the *product* of the digital inputs to the two converters. This allows you to obtain automatic level control, compression, expansion, fading, and amplitude modulation effects without relying on much slower software multiplication routines and without getting into trouble with quantization noise.)

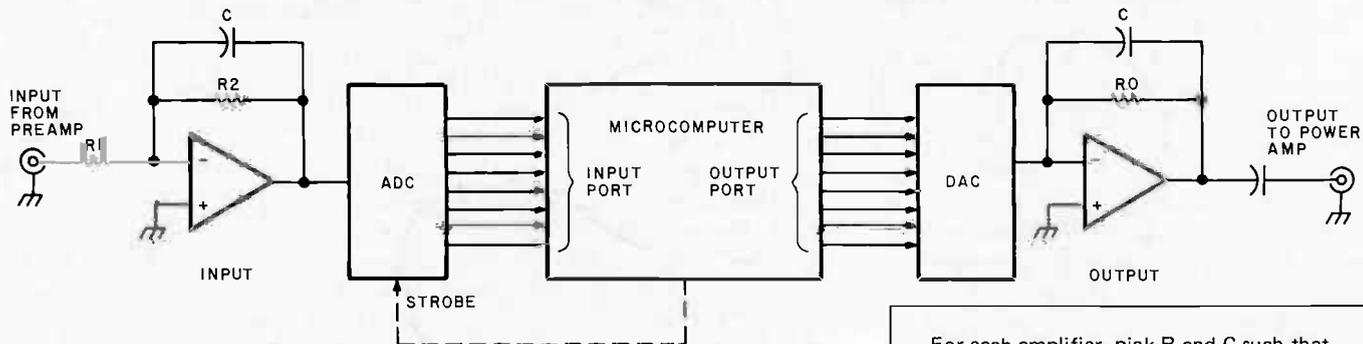
As for the processor itself, almost any 6502 system should do with the examples I've included in this article: KIM-1, Jolt, Ebka, OSI, PAIA, Apple-II, PET 2001, etc. I've used both the Ebka and the OSI systems with good results. OSI has a particularly convenient analog IO board (Model 430) which can be populated with two MC1408L8 8 bit digital to analog converters, an 8 bit analog to digital converter, and their associated latches and address decoding logic. The OSI Model 430 analog to digital converter circuit is of the synchronous tracking (up-down counter) type. Be warned, however, that this analog to digital converter wraps around on overrange. It also requires some individual tweaking of component values to

get it to work. If you want to use the OSI 430 board, I strongly recommend that you replace their analog to digital circuit with a better one, such as the Datel E8HB1. Other than that, the OSI board is just fine.

One very important concept which you must understand is the relation between sample rate, aliasing, and low pass filtering. If you don't understand these terms and their significance, then before you go on you should read the article by Hal Chamberlin on page 62 of the September 1977 issue of BYTE. For the programs presented in this article, the sampling rate will fall between 20 and 40 kHz with a 1 MHz processor clock frequency, assuming you are using a sufficiently fast analog to digital converter (less than 50 μ s sampling time). To control aliasing, you have to roll off the high frequency response of the *input* signal to the analog to digital converter at a frequency no higher than about 1/4 of the sampling frequency, ie: about 5 kHz for a 20 kHz sampling rate. This may not sound much like "hi-fi," but actually it sounds better than you might think. For better highs, you need faster processing and maybe a faster input converter. The 6502 is pretty good in this respect; it's available in versions at least up to 4 MHz. This would give you a sampling rate of 80 to 160 kHz for the programs given here and would extend the highs to the 20 to 40 kHz range. Now, *that's* a high fidelity computer!

The sampling rate therefore determines the frequency at which the response of the system must be rolled off (by means of appropriate low pass filters) in order to reduce aliasing to a tolerable level. In the simple circuit of figure 1, the only roll off is that provided by the capacitors in the feedback loops of the two op amps. Although this circuit is satisfactory for experimental purposes, the cutoff rate of the high frequency rolloff is not sharp enough for first class results. If you're really serious, you'll want more sophisticated, sharp cutoff filters. Hal Chamberlin gives the circuit of an excellent filter in his article in September 1977 BYTE, mentioned previously. The unpopulated printed circuit board, as well as an assembled and tested unit, is available from Hal. The cutoff frequency of this filter is 3 kHz, probably too low if you have a reasonably fast processor, so you might want to modify it or roll your own based on the designs in Don Lancaster's *Active Filter Cookbook* or other reference sources. Only one sharp cut filter is needed, between the preamplifier and the input analog to digital converter, to reduce aliasing. The filter on the output, between the digital to analog converter and the power

Figure 1: The system design of an audio processing test bed requires two simple peripheral devices and a computer. The input device is an analog to digital converter (ADC in this diagram) preceded by a filter. The output device is a digital to analog converter (DAC in this diagram) driving another filter. Source material from (for example) a broadcast program is input through the ADC, processed in real time by the program in the computer, then output in real time to the DAC where it (for example) goes to your audio power amplifier and speaker system. The program in the computer can be as simple as an unprocessed transfer from input to output, or as complex a transfer function as the constraints of real time will allow, given the speed of the computer.



amplifier, needn't have as sharp a cutoff, but it should have the same cutoff frequency as the input filter. For the simple filters in figure 1, the cutoff frequency is equal to $1/2\pi RC$, where R and C are the values of the feedback resistor and capacitor, respectively.

One last thing to consider about the hardware is the level (amplitude) of the audio signal. In order to avoid excessive quantization noise, the input signal must be amplified enough to utilize the whole dynamic range of the input analog to digital converter. In figure 1, the first op amp provides gain in addition to filtering. The gain of this amplifier, which is equal to R_2/R_1 , will have to be adjusted for your particular system. Given choices of R and C for filter cutoff, R_1 can be chosen given a desired gain level. For example, if your preamp provides a maximum output signal of 0.2 or 1 V peak-to-peak, and your input converter has an input voltage range of ± 5 V (10 V peak-to-peak), then a gain of $10 \text{ V}/1 \text{ V} = 10$ is appropriate. Also, the maximum output signal of the digital to analog converter must not be allowed to overload the power amplifier. This will dictate the selection of the feedback resistor R_0 of the output op amp in figure 1; the output voltage is directly proportional to the value of this resistor.

Software Considerations

So what about the software? First, let's see how to get data in from the input converter and out to the output converter without any processing at all. If your analog to digital conversion device (which I reference symbolically as CONV) is connected to an input port whose address is F800, then to load one sample of the audio signal into the

For each amplifier, pick R and C such that

$$f_c = \frac{1}{(2\pi RC)}$$

where

- f_c is cutoff frequency (kHz)
- R is kilohms
- C is microfarads

accumulator (A) register of a 6502 requires one instruction, thus:

LDA CONV

This is all you need if you're using a tracking converter such as that on the OSI board, but if you're using a strobed converter, you'll have to give the converter a strobe pulse first, allow it time to convert, then load the A register. The fastest way to do this is to assign the input conversion strobe to an unused address, decode that address, and use the address select line (address "strobe," as it is sometimes called) as the pulse which strobes the converter. I have used the latter approach for my strobed analog to digital converter and have (arbitrarily) assigned address EC00 (which I call STROBE symbolically) to the address strobe. With this arrangement the converter is strobed by any instruction which references that address; for example an STA as shown here:

STA STROBE

--- } several instructions executed
 --- } while conversion occurs.

LDA CONV

The above routine strobes the converter and then loads the data into the A register. The dashes represent intervening instructions which take up enough time to allow the

analog to digital converter to complete its conversion. This will always be a useful code, rather than just no operation instructions (NOPs) or a wait loop. Conversion times of commercial analog to digital converters vary all over the place. As I mentioned before, for audio processing you'll need a fast one which converts in a time of 50 μ s or better. Just make sure there are enough instructions between referencing STROBE and the loading from CONV to give the input converter time to convert.

To output one sample to the digital to analog converter (called DAC symbolically) is quite simple. For example, if the converter is connected to an output port whose address is F900, then all I have to do is store the sample:

```
8D 00 F9 STA DAC
```

To test the proper operation of the input and output converters we can write a "straight wire" program which simply transfers the data from the input to the output without change. Listing 1 shows 6502 position independent code for such a program.

Note that the input conversion strobe instruction is placed right *after* the load CONV instruction. This may seem backwards but it gives the analog to digital converter a total of seven machine cycles (an STA and a JMP) to convert before it will load into A. On a 1 MHz machine, this means the conversion time could be as long as 7 μ s. If your converter is slower than this, put some NOP instructions or a wait loop right before the CLC instruction. The other programs in this article execute much more code between strobing and loading the input analog to digital converter and will usually allow you to get by with no additional instructions intended specifically to slow down execution.

The program of listing 1 is good for testing out the hookup to your audio system. The sound quality of music played "through your computer" this way may be better than you would expect, considering that the audio waveforms are being sliced up into discrete samples, converted into binary numbers, and then converted back into an analog audio waveform!

So what kind of audio processing can you do? I'll resist the temptation to say that the applications are limited only by your imagination. They are not. They are limited by your programming skill, your processor speed, and your system's programmable memory capacity. You can never have too much of these. I'll not claim to have even scratched the surface of potential applications in this article. I'll just tell you about a

```
AD 00 F8 START LDA CONV      get new data from converter
8D 00 EC STA STROBE         strobe input conversion
8D 00 F9 STA DAC           output to DAC
18                CLC        unconditional
90 F4              BCC START  branch to START
```

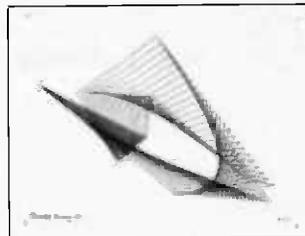
Listing 1: A 6502 "straight wire" program loop. In order to simply listen to the input data on the output channel without any processing, we must enter a tight machine coded loop which reads the input converter, then stores the input data into the output converter. This 6502 program assumes an input digital to analog converter at address space location F800 (CONV), an input conversion strobe which occurs on reference to address space location EC00 (STROBE) and an output digital to analog converter at location F900 in address space (DAC). These same assumptions about IO apply to listings 2 thru 6 as well. With hardware like figure 1, try running this program using an audio signal from your favorite record album. The results will probably be of higher quality than you might have expected.

few things I've done, mostly because they were easy to program. If you don't come up with better ideas than these I'll be disappointed.

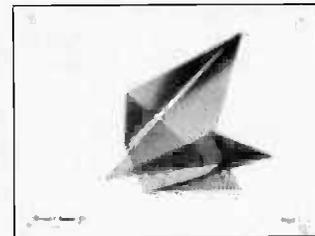
Waveform Modification

A very easy class of audio processing functions are those which are intended to distort the audio waveform. Believe it or not, distortion is actually considered desirable by musicians in some cases for obtain-

Art-by-Computertm is here!



File 1



File 3

Black-on-white, 9 3/4H by 12 3/4W reproductions of computer generated designs. See Jan 78 Byte or phone or write for a brochure. Set of 12 \$20.00; singles \$2.00 each. Minimum order: 2 prints. Orders less than \$10.00 and all orders from outside continental U.S. add \$2.00 postage and handling. Payment must be in U.S. dollars. California residents add 6% sales tax. Send check or money order to:

Leland C. Sheppard
PO Box 60051, Dept. B
Sunnyvale, California 94086

Also available at selected retail outlets.

© LCS, 1978

AE	00	F8	START LDX CONV	Put converter data into x register
8D	00	EC	STA STROBE	Strobe converter.
BD	00	03	LDA TABLE, X	Look up xth byte of TABLE
8D	00	F9	STA DAC	Output to DAC
18			CLC	Repeat
90	F1		BCC START	

Listing 2: Waveform modification. This 6502 program, obtained by modifying the program of listing 1 slightly, uses the input sample from the analog to digital converter (value 0 to 255) to look up the output sample in a "transfer function" table located at 0300 in memory and referenced with the name TABLE. The key to what the distorted output sounds like relative to the input is the data stored in TABLE (see text and figure 2).

ing special effects (such as "fuzz") with electric guitars and other electronic instruments. The computer can perform a rather elegant general purpose distortion function by utilizing a stored transfer function as illustrated in the program of listing 2.

To use this algorithm, you must set up a table in memory (on page 03 in this example) which serves as the *transfer function*. Each sample of the input waveform obtained from the input converter is used as an index to look up a corresponding byte in the table, which is then used as the output value. In this example the table is just 256 bytes long and is indexed by the 6502 processor's X register. Depending upon what we store in the table we can get any kind of distortion effect we want. A trivial case would be to use a straight line function, ie: put 00 in 0300, 01 in 0301, 02 in

0302... and FF in 03FF as shown in figure 2a. This would yield no effect at all; the output would be identical to the input as was the case with the program of listing 1. But if we use anything *other* than a straight line, we'll get distortion. Several possibilities are shown in figure 2. Figure 2b would give a square wave output while 2c would yield a somewhat less strongly distorted output. With the function shown in figure 2d, we would get a frequency doubling effect; that is, if the input were a sine wave of one frequency, the output would be an approximate sine wave of twice that frequency (one octave higher). With figure 2e, we'd get an output two octaves higher. This can be extended even further with the appropriate transfer function (eg: figure 2f). The effect on the sound of an electric guitar is quite remarkable, particularly as the frequency multiplication factor is a function of the amplitude of the input signal and changes as the input decays.

Quite apart from its potential uses in music recording or performance, the above technique is a neat way to teach (or learn) about the effect of transfer characteristic nonlinearity on audio distortion. Just put in the characteristic under consideration and listen to the effect it has on the audio.

Time Delay, Phase Shift and Reverb Effects

If we store digitized audio in an array in programmable memory, and read it out to the digital to analog converter at a later time, we have a time delay effect which can be used for phase shift and reverb. The maximum time delay you can achieve depends on the sampling rate and the amount of available memory; but even with only 256 bytes you can get some pretty good phase shift and phase "phlanging" effects. With 4 K bytes you can get a good reverb.

The essential programming technique behind all of these effects is quite simple: output a byte from the data buffer to the digital to analog converter; input a new sample from the analog to digital converter and put it in the same location in the data buffer as the byte just output; increment the pointer modulo the length of the buffer and repeat. (Thus, when you get to the end of the data buffer you reset the pointer to the beginning and continue.) By scaling and adding the new data from the input converter to the old data from the data buffer, we can generate a range of effects depending on the length of the time delay.

The routine of listing 3 adds the audio signal to a slightly delayed version of itself and outputs the scaled sum to the digital to analog converter. In this routine, page 03

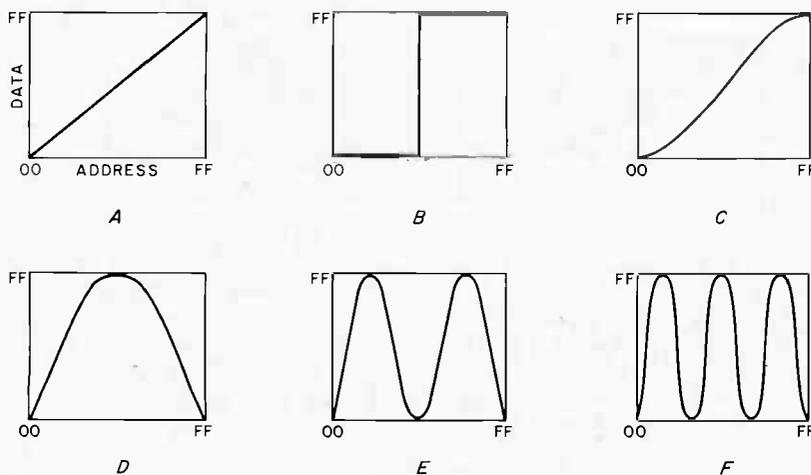


Figure 2: Examples of transfer functions for use with the waveform modification technique of listing 2. These curves are produced by plotting the data at an address versus the address within the table, with both values having a range of 00 to FF hexadecimal (eight bits worth). (A) is the simple linear transfer function. (B) is a transfer function which is equivalent to a saturated clipping amplifier: it puts out a square wave. (C) represents a slight distortion of the linear response of (A). (D) is a transfer function which effectively doubles the frequency of the input waveform, while (E) quadruples the input frequency and (F) multiplies the frequency by a factor of 8 (ie: three octaves higher).

serves as the data buffer and x as the pointer. The pointer is initialized to DELAY, decremented until it gets to zero, and then reset to DELAY. This results in a sort of circular data buffer which acts as a first in last out shift register. The new and old (delayed) data are added and sent to the output converter. (Note that to prevent overflow, the data are divided by two *before* adding.) The time delay, determined by DELAY, can be adjusted from 1 to 225 samples. Such short delays do not result in a perceptible echo. The effect is rather that of a "comb filter" with multiple peaks and dips distributed throughout the audio spectrum. This is due to the fact that there will be a cancellation at every frequency whose period is an integral multiple of twice the time delay and a reinforcement at every frequency whose period is an integral multiple of the time delay. This rearranges the amplitude and phase relationships of the harmonics of music and speech and has a quite noticeable effect on the sound, variously described as a "resonant" or "twangy" effect. (If you have a hum problem in your audio setup, you might try to find the value of DELAY which puts a dip right at the hum frequency.)

The above idea can be extended and the effect made much stronger by causing DELAY to change continuously in real time. This would cause the peaks and dips to sweep through the audio spectrum. This effect is called "phase phlanger" by some people. An easy way to do it (not necessarily the best way, however) is shown in listing 4. This is the same as the previous program except that the DEC DELAY instruction has been added to reset the buffer pointer to a different value each cycle through the buffer. The effect of this routine on voice and music is quite dramatic. With speech and solo singing it gives a kind of voice doubling effect, as if two people were speaking or singing in synchronization. It makes a 6 string guitar sound reminiscent of a 12 string guitar. A concert piano comes out distinctly like a questionably tuned honky tonk piano. The effect on organ music is unreal and unpleasant. If you play the guitar and sing, or think you do, try processing a tape recording of yourself this way. It will sound better, or at least different (which in my case is the same thing).

If you have two output ports and two digital to analog converters, you can generate two channels of audio output. For example, you can convert a monaural source to "pseudostereo" with a further

A6	10	RESET LDX DELAY	initialize pointer to buffer length
BD	00	03 NEXT LDA BUFFER, X	get oldest data
4A		LSR A	divide by 2
85	11	STA TEMP	keep
AD	00	F8 LDA CONV	get new data
8D	00	EC STA STROBE	(strobe converter)
9D	00	03 STA BUFFER, X	replace old data with new
4A		LSR A	divide by 2
18		CLC	
65	11	ADC TEMP	
8D	00	F9 STA DAC	output to DAC
CA		DEX	advance the buffer
D0	EF	BNE NEXT	pointer and repeat
18		CLC	
90	E2	BCC RESET	

Listing 3: Time delays are possible with a buffer. Using the memory located at hexadecimal 300 to 3FF as a 256 byte delay buffer, a number of interesting effects can be achieved. This program supports a delay of up to 255 inner loop periods, too short to be perceptible as a delay per se, but it does transform signals by adding the delayed sample's points to the new input samples, producing an interesting filtered result. The delay buffer length is set by the value loaded into the X index register from location DELAY in the first instruction of the program. As in all the examples of this article, this 6502 program is position independent and can be loaded at any arbitrary place in memory address space which contains programmable memory not conflicting with IO or data storage locations.

A6	10	RESET LDX DELAY	
BD	00	03 LDA BUFFER, X	
4A		LSR A	
85	11	STA TEMP	
AD	00	F8 LDA CONV	
8D	00	EC STA STROBE	
9D	00	03 STA BUFFER, X	
4A		LSR A	
18		CLC	
65	11	ADC TEMP	
8D	00	F9 STA DAC	
CA		DEX	
D0	E7	BNE NEXT	
C6	10	DEC DELAY	
18		CLC	
90	E0	BCC RESET	

Listing 4: Modifying the processing done by the delay program of listing 3 to sweep the time delay value results in this "phase phlanger" program. The difference between this program and that of listing 3 is the DEC instruction which changes the value of the delay parameter DELAY each time it is reloaded. The effects must be heard to be believed.

A6	10	RESET LDX	
BD	00	03 NEXT LDA BUFFER, X	
8D	00	EF STA DAC2	delayed sound to one channel
AD	00	F8 LDA CONV	
8D	00	EC STA STROBE	
9D	00	03 STA BUFFER, X	
8D	00	F9 STA DAC 1	direct sound to other channel
CA		DEX	
D0	EB	BNE NEXT	
C6	10	DEC DELAY	
18		CLC	
90	E4	BCC RESET	

Listing 5: Modifying the program of listing 4 to turn it into a pseudostereo processor. Here, the delayed data is sent to a second channel, with the amount of delay swept as it was with the phase phlanger approach. But instead of adding the two channels together, they are kept separate and sent to the left and right stereo speakers.

modification of the program in listing 3 (see listing 5).

In this example the additional DAC is connected to an output port whose address is EF00. Instead of being added together, the direct and delayed signals are simply sent to the two different channels. The result is a sort of stereo phase phlanging effect which sounds much like a "rechanneled for stereo" disk recording. Try this through stereo headphones. So now you can have a stereo electric guitar. Would anyone like to extend it to quadraphonic?

If you have at least 4 K bytes of memory available in your system for your buffer, then you can obtain echo and reverberation effects quite readily. The idea is basically the same as the phase shifter routines just

discussed, except that a much larger data buffer is used. Here we can use the indirect form of the LDA and STA instruction, and we maintain a 16 bit pointer in page zero (unlike the 6800, the 6502 has only 8 bit index registers). The routine of listing 6 yields a reverberation time which is adjustable up to about 0.5 seconds. The data buffer is assumed to be the 4 K byte block from addresses 2000 to 2FFF. On each cycle through the buffer, the old data is divided by two, added to the new data output, and returned to the buffer. Thus, the old signals (ie: the echo) die off by a factor of two each time they are heard. You can hear about five or six echos before they drop below audibility.

If START is set to 20, using the whole 4 K buffer, the effect is something like that of a large hall or perhaps an old railroad terminal. The difference is that the computer produces a clear, clean echo at very precisely timed intervals and with a precisely controlled decay rate. Compare this with either a natural reverberation situation or a mechanical unit: the result is a more mechanical sound, much like a tape loop reverb device, without the false resonances of a spring type device. The advantage over a tape loop device is, of course, that it will never wear out or get out of alignment.

Several useful modifications of this program can be made. For example, you could utilize a second digital to analog output and a stereophonic sound system to achieve spacial separation between the direct and "reflected" sound. You could then apply some filtering to the reflected sound channel to simulate selective absorption by the room furnishings. You could also improve the realism of this effect by writing the routine to provide more than one delay time, for example by maintaining two or more buffer pointers which would allow the incoming data to be added to several points in the data buffer. You'll need a fast processor to keep the sampling frequency up, however. Finally, by simply dropping the LSR and ADC instructions in the program of listing 6, you can get a simple time delay effect; say a word and it is repeated immediately. Great for language study; listen to and critique your pronunciation without wearing out your tape recorder. Or if you have lots of memory (at least 32 K), you can get delays long enough to allow you to sing a round with yourself! I won't comment on the frightening social significance of this.

AUDIO REVERB SIMULATION

LABELS

F800	CONV	Address of 8 bit analog to digital converter
EC00	STROBE	Converter strobe line
F900	DAC	Address of 8 bit digital to analog converter
0009	FIRST	Lowest page number in data buffer
0010	LAST	1 + highest page number in data buffer
00A0	PNTRL	Low half of data buffer pointer
00A1	PNTRH	High half of data buffer pointer
0011	TEMP	Temporary storage

PROGRAM CODE

A0	00	LDY #0	Set pointer to zeroth byte of page "FIRST".
A9	00	LDA #0	
85	A0	STA PNTRL	
A5	09	RESET LDA FIRST	
85	A1	STA PNTRH	
8D	00	EC NEXT STA STROBE	Strobe converter.
B1	A0	LDA (PNTR), Y	Get oldest byte.
4A		LSR A	Divide by 2.
85	11	STA TEMP	Save.
AD	00	F8 LDA CONV	Get new byte.
4A		LSR A	Divide by 2.
18		CLC	Add to oldest byte, and return to data buffer.
65	11	ADC TEMP	
91	A0	STA (PNTR), Y	
8D	00	F9 STA DAC	Output.
C8		INY	Go to next point.
D0	E9	BNE NEXT	Increment pointer (double precision).
E6	A1	INC PNTRH	
A5	10	LDA LAST	When end of data buffer is reached, reset pointer to FIRST and continue.
C5	A1	CMP PNTRH	
D0	E0	BNE NEXT	
18		CLC	
90	DA	BCC RESET	

Listing 6: The use of large amounts of memory can lead to interesting effects, for example this reverberation program. Here a 4 K byte buffer from address space locations 2000 to 2FFF is used to store delayed samples obtained from the input converter at location CONV. This code for the 6502 processor is position independent, provided it is not loaded in the same region as the delay buffer, the page zero constants, or the IO device addresses.

GLOSSARY

Analog to digital converter (often abbreviated **ADC**): Integrated circuit or hybrid module which converts an analog voltage into a parallel digital number, usually in a binary or binary coded decimal format; characterized principally by the number of bits of parallel binary output (the more the better) and the conversion time (the shorter the better). Most commercially available analog to digital converters have from six to 14 bits, convert in 0.5 μ s to 200 ms, and cost from \$12 to \$300 each.

Address decoding: Logic circuitry present in all microcomputer systems which looks for certain addresses on the address bus and outputs a pulse (address strobe) whenever those addresses occur. Used to select individual IO ports, sections of memory, and devices tied to the data bus.

Address strobe: A pulse or logic level generated by the address decode logic in response to the occurrence of a particular address or a range of addresses in a microcomputer.

Aliasing: An instrumental artifact, caused by sampling a periodic waveform less than twice per period, which results in an apparent reduction in the frequency of the waveform. (The effect is quite analogous to the use of a stroboscope to "slow down" the action of periodic mechanical motion.) In audio processing, aliasing sounds like a gross distortion.

Conversion time: The time it takes an analog to digital converter to convert an analog voltage to a binary number. Specifically, it is defined as the time between the strobe pulse and the instant that the digital output is valid.

Cut off frequency: The frequency at which a low or high pass filter *begins* to cut off a signal (which means to reduce its amplitude).

Cut off rate: Also called attenuation rate. The rate at which the response of a low or high pass filter increases attenuation as you go to higher or lower frequencies. The response of a simple single section low pass RC filter drops off only at the rate of a factor of two for every factor of two increase in frequency (called -6 dB per octave in engineering jargon). More sophisticated "active" filters employing operational amplifiers can have much faster cut off rates. These have the advantage of extending the high frequency response as far as possible while still reducing aliasing to an acceptable level.

Digital to analog converter (frequently abbreviated **DAC**): An integrated circuit or hybrid module which converts a parallel binary or binary coded decimal number to an analog voltage or current proportional to the number. Commercially available digital to analog converters have resolutions from eight to 16 bits and cost from \$5 to \$100.

Data buffer: A section of programmable memory used to store data, usually temporarily.

Fuzz: A kind of distortion occasionally used by electric guitarists for special effect.

Offset binary coding: An arrangement for operation of a bipolar analog to digital converter in which a zero input voltage corresponds to a mid-scale digital output. For an 8 bit converter with a ± 5 V input range, an input of 0 V would be converted to hexadecimal 80, -5 V to hexadecimal 00, and +4.96 V to hexadecimal FF. (This differs from two's complement coding.)

Peak-to-peak: The voltage difference between the average positive excursion and the average negative excursion of an AC signal.

Phase shift: A (usually small) time delay between two similar periodic waveforms.

Phlanging: An audio effect originally produced by playing duplicate tape or disk recordings in almost, but not quite exact, synchronization.

Quantization noise: The noise caused by the conversion of a smooth, continuous analog waveform into a "stair step" approximation in the process of digitization. It adds a "hiss" to audio signals, technically called "white noise." Like any other type of hiss, it can only be partially removed by filtering. The smaller the steps, the less the noise. Thus an 8 bit digitization, yielding 256 discrete steps or "quantization levels," results in a slightly noticeable quantization noise, but in a 12 bit conversion (4096 steps), the effect is quite negligible.

Sample rate: The rate at which the signal waveform is digitized. The larger the number of samples per period of the waveform, the closer the digitized waveform will be to the original analog waveform. The sample rate must be at *least* twice the highest frequency to be digitized in order to prevent aliasing. In this article, the sampling rates are determined by the execution times of the inner loops of the programs.

Strobe: In general, a pulse used for time synchronization of some event. In the context of an analog to digital converter, the term refers to the "start conversion" pulse applied to the converter to initiate the conversion process. In this article, the input conversion strobe is supplied by the microcomputer under software control.

Successive approximation: A popular type of analog to digital converter. Most fast converters are of this type. It performs the conversion bit by bit, starting with the most significant bit and progressing to the least significant bit. Although generally fine for audio processing applications, this type of converter can exhibit nonlinearity (and therefore distortion) if the input signal changes appreciably during conversion. To prevent this, a sample-and-hold circuit can be used ahead of the converter, or, as in this article, one can reduce the problem to insignificance by using a converter with a conversion time much less than the period of the highest frequency passed by the input low pass filter.

Tracking analog to digital converter: A low cost type of converter which uses an up-down binary counter to track or follow the analog input. Its advantage is that it requires no strobe pulse, as its output is always trying to keep up with the output. This type is often implemented in software when conversion time is not particularly important.

Transfer function (or characteristic): The functional relationship between the output and the input of a device.

Wrap around: What happens to your car's mileage indicator after you've driven 99999.9 miles. It "wraps around" to 00000.0. The same thing occurs in electronic counters; in an 8 bit device, the next count after hexadecimal FF wraps it around to 00. Some analog to digital converters do this when the input voltage exceeds full scale. It must be prevented in audio processing. ■

Visit to an OEM Supplier

A Look at Shugart's New Fixed Disk Drive

Chris Morgan, Senior Editor



Photo 1: One of the high speed conveyors at Shugart Associates' Sunnyvale CA plant. Metal arms swing out to capture plastic bins of parts. 600 to 800 floppy disk drives and 300 to 400 minifloppy drives are turned out every day at the plant.

OEM can be a confusing term for people new to the personal computing field. It means "Original Equipment Manufacturer"—that is, a company which uses parts and equipment of *other* manufacturers in order to produce end user equipment for sale to the public.

Recently I had the opportunity to visit an OEM supplier whose name is well-known to the personal computing field: Shugart Associates. Shugart manufactures the floppy and minifloppy disk drives that go into equipment sold by North Star, Apple, PolyMorphics, Smoke Signal Broadcasting, Radio Shack, and many more. They also supply companies that manufacture large computer systems. All told, they claim to manufacture over three quarters of the floppy disk drives on the market, and two thirds of the minifloppies.

Upon entering their brand new 150,000 square foot facilities in Sunnyvale CA, I immediately noticed that the flow of production parts was controlled by an impressive array of high speed conveyor belts (see photo 1). Their workforce of over 700 people turns out 600 to 800 standard floppy drives and 300 to 400 minifloppy drives every day.

The most interesting feature of the tour, however, was getting a glimpse of the new Shugart SA4000 fixed disk drive—a unit that may have a major impact on the personal computer market a year or so from now. The SA4000 (see photos 2 and 3) is available in 14.5 and 29 megabyte (unformatted) capacities with an optional 144 K bytes of additional head-per-track storage. Winchester heads (named after IBM's "Winchester" disk technology) are used in the 35 pound (16 kg) unit, which is designed to fit in a 19 inch (48 cm) rack. But price is the most significant feature: the 14.5 megabyte

Photo 2: Prototype of the SA4000 fixed disk.



unit is \$2550, and the 29 megabyte unit is \$3500, both quantity one; prices for quantity 100 are \$1450 and \$2000, respectively.

The same voltage requirements are used for both the SA4000 drives and the Shugart standard size IBM compatible floppy drives, so the same power supply can be used for both types of drives in a system. In addition, the SA4600 intelligent controller (or equivalent) can be used to control up to four floppy disk drives and four SA4000 fixed disk drives with the same controller board. The new fixed disk drive has an interface similar to that of the standard Shugart SA800 and SA850 floppy drives, but it employs a higher transfer rate. The drive includes a data separator and encoder providing normalized NRZ read and write data.

Data on each disk surface is read by two read and write heads, each of which accesses 202 tracks. The drive is available in two basic configurations: one disk with four read

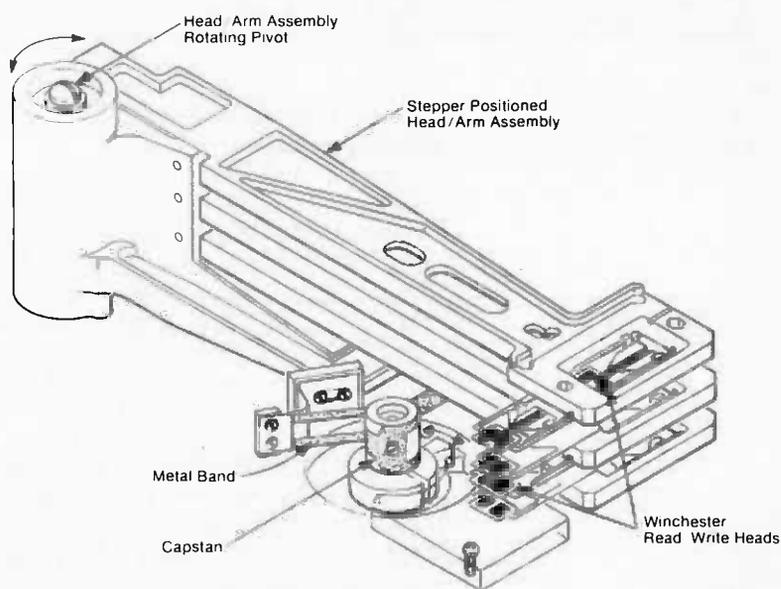


Figure 1: The Shugart SA4000 fixed disk head actuator assembly. A novel coiled-metal band driven by a stepper motor is used to position the head assembly. Graphics courtesy Shugart Associates.

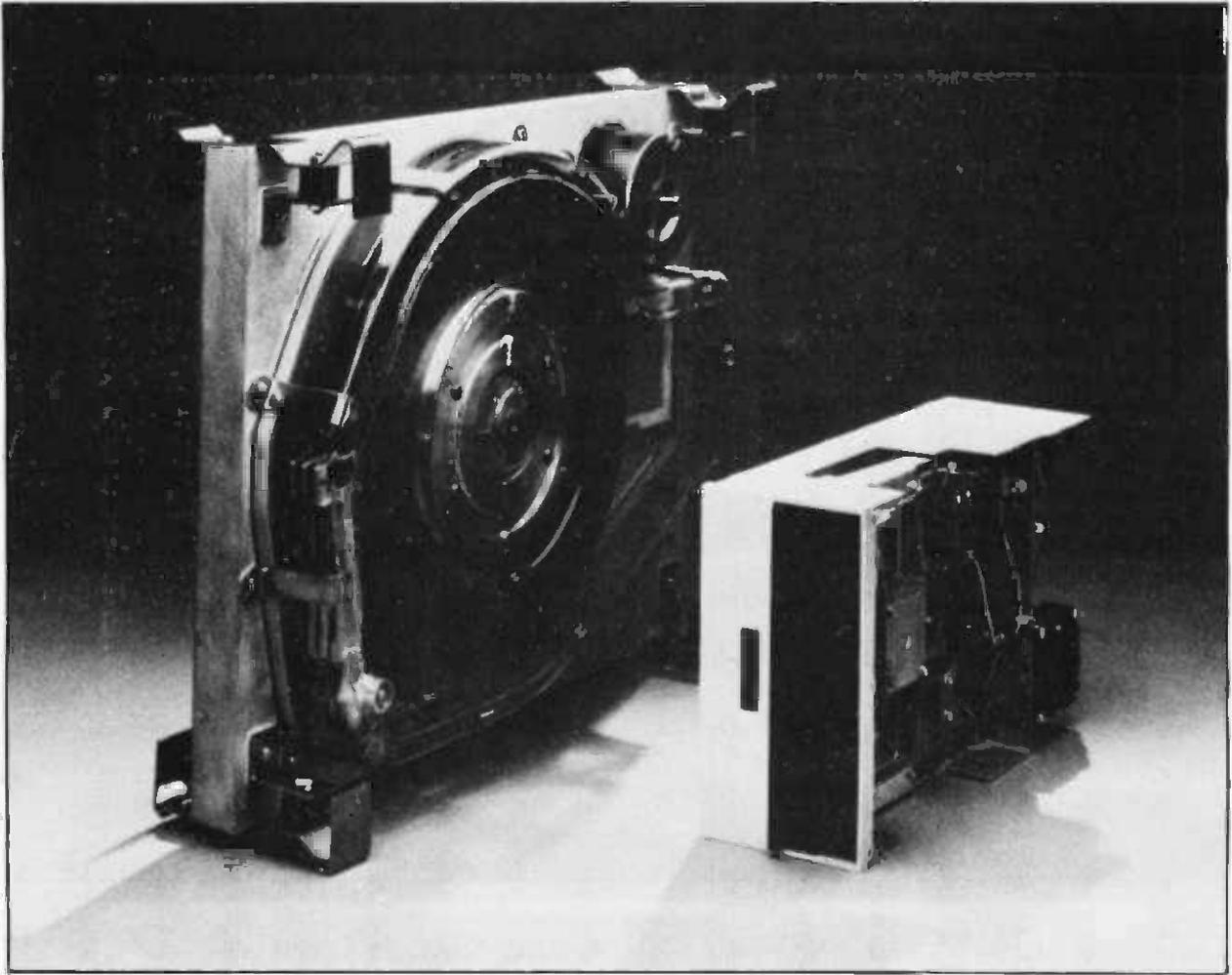


Photo 3: Shugart SA4000 fixed disk drive (left) next to standard SA800 floppy disk drive.

and write heads, or two disks with eight read and write heads.

A separate read and write head mounted to the base casting reads a prerecorded track which provides the master clock for the drive as well as the clock for write clock generation. The optional fixed heads are mounted on an assembly which is mounted directly on the base casting. Delivery is currently four months from receipt of order from Shugart Associates, 415 Oakmead Pky, Sunnyvale CA 94086, (408) 733-0100.

Since the SA4000 disk is permanent, users will need some form of off line storage to keep back-up copies of vital files in practical systems: a double density full size floppy disk drive seems to be the most logical choice.

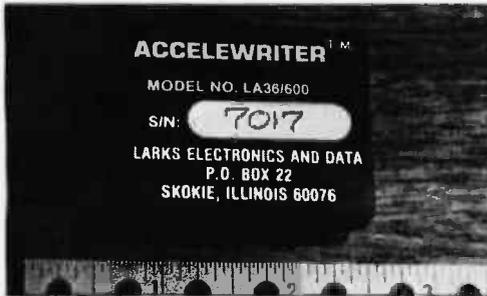
We should soon see the era of the 14.5 megabyte mass storage system *built into* a high end personal computer which sits on

top of a desk. The typical box might include:

- SA4000 disk main filing system
- SA800 removable media filing system (optional)
- 16 K bytes read only memory systems software
- 48 K bytes volatile program store
- Any third generation processor (9900, Z8000, 8086, 6809, etc)
- Video display (graphics plus full ASCII text capability)
- Keyboard
- Machine independent PASCAL systems software

Externally, this would look fairly conventional, but buried inside might be the SA4000 as a permanent on line nonvolatile memory resource. ■

Adapter Doubles DECwriter Speed

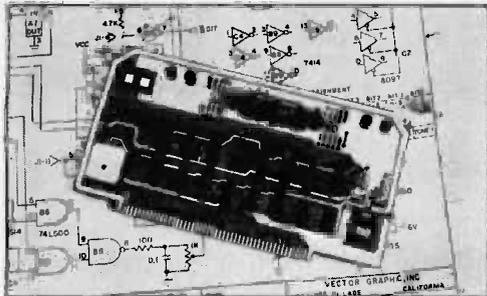


A new adapter, the Acceewriter, adapts any LA36 DECwriter to operate at 600 bps, converting the standard 110, 150 or 300 bps DECwriter to

220, 300 or 600 bps. The Acceewriter changes the internal timing of the DECwriter and causes it to print at 60 characters per second. Installation involves removal of two integrated circuits from the logic board of the DECwriter. These are replaced with low profile IC sockets. The Acceewriter is then installed in the board in place of the two original ICs, and the logic board is reinstalled in the DECwriter. The DECwriter can be reconverted to its original electronic configuration by unplugging the adapter and installing ICs of the original types in the sockets. Price is \$95 from Larks Electronics and Data, POB 22, Skokie IL 60077. ■

Circle 641 on inquiry card.

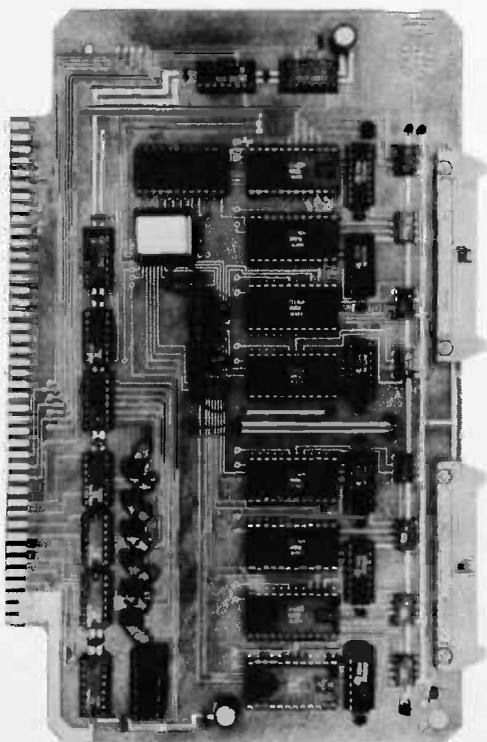
Analog Interface Board



A multifunction analog interface board, offered as a kit or fully assembled, has been introduced by Vector

Graphic Inc, 790 Hampshire Rd, A and B, Westlake Village CA 91361. According to the firm, board design permits interfacing with potentiometers, joysticks, or voltage sources. An 8 bit digital port with latch strobe can be used as a keyboard input port. Tone pulse generators can also be used to produce sounds for games or keyboard audio feedback. Additional features include four analog to digital inputs, MWRITE logic, and a power on jump feature for computers lacking front panel. Price is \$75 in kit form, \$115 assembled. ■

Circle 642 on inquiry card.



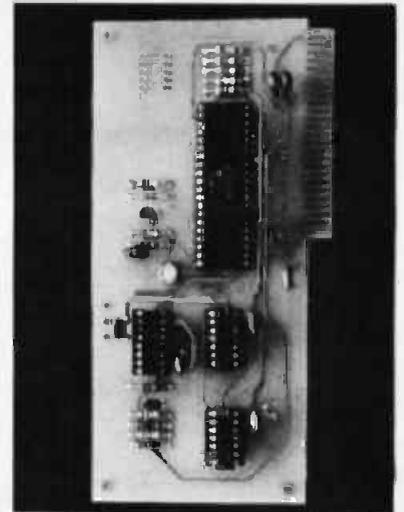
New Interface Module from Creative Micro Systems

The 9650 is an asynchronous serial interface module specifically designed for compatibility with the Motorola 6800 processor bus. It is pin and outline compatible with the Motorola EXORciser and Micromodules and with the MED6800D2 Evaluation Kit. It features full address decoding and fully buffered data, address and control lines. This module utilizes eight MC6850 Asynchronous Communications Interface Adapters with full RS-232C signal conditioning. An on board bit rate generator simultaneously provides 14 standard rates that can be individually strapped to each ACIA.

The 9650 occupies 16 consecutive memory addresses. The lowest eight of these access the eight control and status registers and the next eight access the transmit and receive data registers. This map arrangement allows optimum use of indexed addressing in IO intensive systems and permits the use of a very tight interrupt polling loop.

The standard configuration of the 9650 is fully populated to eight channels. The price is \$395 in single

Serial IO for the Apple II



Electronic Systems has announced a serial IO board for the Apple II computer. The board comes with software for input and output to and from a Teletype or other serial device via an RS-232 interface.

Features include switch selectable parity, selectable number of stop bits, and jumper selectable address. Data rates can be as high as 30,000 bps.

The board is available assembled and tested for \$62. The complete kit is \$42, and the board only is \$15. Contact Electronic Systems, POB 9641, San Jose CA 95157, (408) 374-5984. ■

Circle 644 on inquiry card.

Altair (S-100) Bus Interface Board for PET 100

HUH Electronic Music Productions, POB 259, Fairfax CA 93930, has announced the PET 100, a PET to Altair (S-100) bus interface board for the Commodore PET computer. The Altair (S-100) sized card plugs into the mainframe of your choice and a cable connects it to the PET, which then enables you to use any of the peripheral and memory cards available for the Altair (S-100) bus. The PET 100 emulates the true Altair (S-100) bus including direct memory address, read and write wait states, IO address mirroring, multiplexed status lines, and much more. The PET 100 is available in kit or assembled form for \$199.95 or \$279.95, respectively. ■

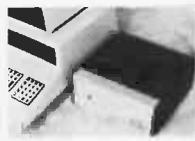
Circle 645 on inquiry card.

quantities. A partially populated 4 channel version is also available at a lower price.

The 9650 is one of a family of M6800 support modules. All cards of the family are 6.05 by 9.75 inches (15.4 by 24.8 cm) and utilize a 43 pin dual readout edge connector with 0.15625 inch (0.4 cm) pin spacing. Additional information is available from Creative Micro Systems, 6773 Westminster Av, Westminster CA 92683, (714) 892-2859. ■

Circle 643 on inquiry card.

*** 15359 BYTES FREE ***



INTERNATIONAL
TECHNICAL
SYSTEMS

Proudly announces the

PEM-8K

8K OF ADDITIONAL MEMORY FOR YOUR PET®

- COMPLETELY ASSEMBLED AND TESTED
- BUILT-IN HEAVY DUTY POWER SUPPLY
- ATTRACTIVE ENCLOSURE
- COMPATIBLE WITH 4K OR 8K PET®
- NO MODIFICATIONS REQUIRED

Introductory BONUS SOFTWARE PACKAGE: 10K
of Financial, Mathematical and Algebraic Programs

Shipped postpaid — Price: \$279.
(Virginia Residents Add 4% Sales Tax)

INTERNATIONAL
TECHNICAL
SYSTEMS

P.O. Box 264
WOODBIDGE,
VIRGINIA 22194

Circle 186 on inquiry card.

**CONVERT ANY TV
TO A HIGH QUALITY MONITOR**



- Hot Chassis or Transformer sets
- 64-80 characters per line
- By-passing tuner & I.F.
- Normal viewing unaffected
- Safe—Easy installation

ACVM Hi-Resolution \$24.95 ppd
RFVM Ch2-6 Modulator \$9.95 ppd

VAMP INC. Box 29315
Los Angeles, Calif. 90029

Calif. Residents add 6% Sales Tax

Circle 378 on inquiry card.

SURPLUS ELECTRONICS

ASCII



ASCII

IBM SELECTRIC
BASED I/O TERMINAL
WITH ASCII CONVERSION
INSTALLED \$695.00

- Tape Drives • Cable
- Cassette Drives • Wire
- Power Supplies 12V15A, 12V25A, 5V35A Others, • Displays
- Cabinets • XFMRs • Heat Sinks
- Printers • Components

Many other items
Write for free catalog
WORLDWIDE ELECT. INC.
10 FLAGSTONE DRIVE
HUDSON, N.H. 03051

Phone orders accepted using VISA
or MC, Toll Free 1-800-258-1036
In N.H. 603-885-3705

Circle 395 on inquiry card.

**PROGRAMMING
CONTEST!**

— WIN —

- 1st PRIZE— FLOPPY DISK SYSTEM OR \$1000 CASH
- 2nd PRIZE— FLOATING POINT BOARD OR \$400 CASH
- 3rd PRIZE— AUDIO INTERFACE OR \$200 CASH

T	M	A	Y
W	I	N	S
I	N	S	E
N	Y	E	S

OF COURSE YOU HAVE THE SEARCHING AND SORTING SKILLS
ACQUIRED BY EVERY HACK PROGRAMMER SINCE ENIAC! BUT
DO YOU HAVE A CUNNING AND CLEVERNESS THAT RANKS YOU
WITH CIA CALIBRE CODE CRACKERS? PUT YOUR PERSONAL
COMPUTER TO WORK AROUND THE CLOCK SOLVING OUR
ARDUOUS WORD PUZZLE IN AN ATTEMPT TO:
*** EXPAND YOUR SYSTEM BY WINNING PRIZES ***

For entry form and official rules send
a self-addressed stamped envelope to:
MICRO-PUZZLES Dept A 7858 Cantaloupe Ave.
Van Nuys, California 91402

Circle 213 on inquiry card.

**SCOPII 4 MEGABYTE
TAPE RECORDER!**

QUAD 5 CHANNEL 1/4" TAPE
TRANSPORT, ONE FURNISHED
LOGIC FOR AUTO SELECT, REWIND, E.O.T,
LOW LEVEL, & LAST CARTRIDGE-POWER
REQ'D 12V 5AMPS DC-STD RACK PANEL 12 1/8"
HIGH 19" WIDE 20" DEEP W/T 85LBS. FREIGHT COL.
USED-GOOD COND-LIMITED QTY. DATA BOOK \$10.00
\$269.00

.025 SQUARE PIN PUSH-ON TERMINALS,
FOR JUMPERS-PATCH-POWER-PLUG REPAIR, ETC.,
HARD TO FIND! 10/\$30.50 100/\$44.50
PC LEAD CAPACITORS 20/\$1.00
70PF N1500 100VOLT 5% DISC } 6 PAX
120PF 100VOLT 5% DISC } \$5.00
.01MFD 200VOLT TUBULAR CERAMIC
.005MFD 500VOLT DISC
.005MFD 100VOLT DISC
.006MFD 100VOLT SQ. DIPPED POLY
.01MFD 50VOLT 5% POLY TUBULAR, LONG LEADS,
10/\$1.00 100/\$7.50

BI-PIN BASE T-1 3/4 12V40MA
INCANDESCENT 10/\$1.00 100/\$9.00
CORE MATRIX STRIPPED FROM COMPUT
ERS-8 PLANES-NO DRIVERS-NO DATA-
AS IS-NO RETURN. 256+BYTES \$19.95, 1K BYTES
\$27.95, 4K+ BYTES \$39.95. 2 ONLY 1620 ASSY
GOOD COND EACH \$125.00
CARD GUIDE & FRAME-15PR-5 1/2H 5 1/4W 12 1/2L; OR
15 SOCKETS ELCO NO.7008-035-163-002 ON RAILS,
YOU STRIP-CHOICE \$9.95 EACH. OTHER SURPLUS-
SEND \$1.00 FOR LIST OR CALL 817-625-2916, MC,
BAC, VISA ACCEPTED. \$10.00 MINIMUM ORDER
J&E ELECTRONICS SALES
P O BOX 4504, FT. WORTH, TEX, 76106

Circle 191 on inquiry card.

P.E.T. Food

Creative Software offers a wide range of
programs on cassette tapes for 8K PETs:

- HOUSEHOLD FINANCE Parts I and II.....\$15.00
- SPACE WAR - Adapted for the PET.....\$10.00
- HOUSEHOLD UTILITY PACKAGE #1.....\$10.00
- GAMEPAC #1 - Five games for the PET.....\$12.00

Add \$1.00 per program packing and shipping.

Introducing a LOW PRICED Joystick!

Plugs right into the PET with no modifications
or assembly. Comes with two programs.

JOYSTICK - With MAZE and SKETCHPAD...\$35.00

STAR WARS SHOOTOUT For the joystick...\$10.00

Add \$2.50 packing and shipping for JOYSTICK.

Write for more information and a complete list
of currently available programs.

Creative Software

P.O. Box 4030 Mountain View, CA 94040

MASTERCHARGE AND VISA ACCEPTED
California residents add 6% sales tax

Circle 79 on inquiry card.

Datapoint CRT Terminals



Fully-Assembled — Guaranteed

#3360 **\$649.50**

- Add \$15 packing
 - Guaranteed
 - Add \$45.50 for scrolling mod. or do it yourself
 - Shipment FOB, no waiting
- NOW—Power your KIM-1 or other small processor
from these terminals. Up to 2 Amps at 5, 14, 25 volts
Model 3360 speeds from 300-4800 Baud, numeric
keypad, cursor controls, Edit, Block-Transmit, search
modes. ASCII Keyboard with codeable options.
Green phosphor, 24 82 Ch. lines, addressable cursor,
RS-232 serial interface, other speeds available
Manual \$10. Cable kit \$39.95. Datashare/IBM com-
patible version \$1,100. • Model 3000 \$675
M-33 KSR Teletypes \$595. ASR 33 \$735.
Call us for service on CRTs, micros, main-frames.
Leasing, quantity discounts available.

TELECOMMUNICATIONS SERVICES CO.
Box 4117, Alexandria, Va. 22303
703-683-4019 / TLX 89-623 T26

Circle 372 on inquiry card.

**S-100 Kits
at Discount Prices**

- 11 slot mother board with sockets
and active terminator \$80**
- 16 K EPROM board for 2708's \$48**
- 8 K static ram \$125**

There's much more, including
complete systems; send for our
flyer.

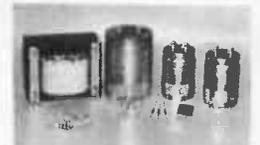
PCE ELECTRONICS

4782 DEWEY DRIVE
FAIR OAKS, CA. 95628

- Master Charge
- Visa
- Phone orders
- (916) 966-7033
- Add 5% for shipping,
access refunded.
- Calif. residents add
6% sales tax.
- No C.O.D.

Circle 296 on inquiry card.

**KIT INCORPORATES
ELECTROSTATIC SHIELD**



- 8 V at 20 amps & 16 V at ± 2 A with
fan cooling.
- Transformer secondary isolated by
electrostatic shield which helps to
reduce random logic problems.
- "Computer 20 K" kit priced at only
\$74.95 plus \$6.00 handling & shipping.
- "Computer 20" transformer available
for only \$29.95 plus \$3.50 handling
& shipping.
(Handling & shipping slightly higher
outside continental US)
- Club & OEM discounts available

Send check or money order to:

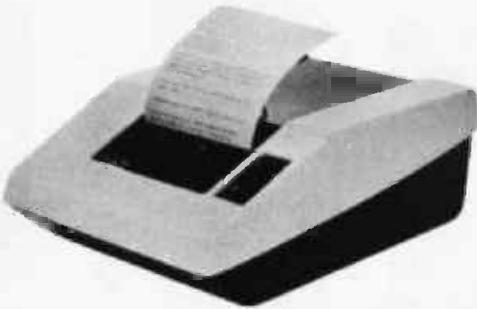
MIJOBE CORPORATION
P. O. Box 775
Claremont, CA 91711

Circle 241 on inquiry card.

What's New?

PERIPHERALS

Axiom Announces EX-801 MicroPrinter



An intelligent electrosensitive line printer, the model EX-801 Micro-Printer, has been announced by Axiom Corp, 5932 San Fernando Rd, Glendale CA 91202, for \$655. The EX-801, designed around an Intel 8048 processor, operates at up to 160 characters per second and offers users the choice of three character sizes to provide 80, 40 or 20 columns on the 5 inch (12.5 cm) wide electrosensitive paper. It is designed for video display hardcopy, data logging, program listing and record keeping. Standard features include RS-232C 20 mA serial input as well as parallel ASCII; 256 character multiline asynchronous input buffer as standard, optionally expandable to 2 K characters, making it possible to take a page dump from a video display terminal in approximately one second; 96 character ASCII standard, optionally expandable to 256 characters with user programmable fonts; software selection of "reverse" printing in which light characters are formed on a dark background; and optional 2 K bytes of user programmable read only memory. ■

Circle 593 on inquiry card.

Soft Touch Bill Paying Home Dial



The Soft Touch Tone Dial for "bank by phone" is designed for use by customers of banks and thrift institutions. The unit is a tone dial that screws on the mouthpiece of a regular rotary dial telephone and immediately converts it into a push button telephone. It has all the letters (a thru z) on the buttons as well as an asterisk (*) and number symbol (#) for commands. Upon dialing to the bank computer, the consumer taps in his account number, secret code, merchant code and amount to pay bills. Soft Touch is both a tone dial and microphone in a standard 1 cubic inch telephone mouthpiece. The tone frequencies are crystal controlled. The keyboard is .05 inches thin, made with eight layers of special conductors. For additional information contact the Telephone Computer Company Inc, 1838 W Bayshore, Suite 4, Palo Alto CA 94303. ■

Circle 594 on inquiry card.

Floppy Disk System for RS-232 Communication Devices



The Comm-Stor II is a communications floppy disk system which uses IBM 3740 compatible diskettes and interfaces with all RS-232 communications devices. Comm-Stor II is micro-processor-based enabling the user to store and retrieve files by file source. The system gives the user increased file storage capacity and maximum usage of the diskette regardless of the mix of file sizes; provides the capability of merging and creating new files composed of existing files; provides buffering at the terminal or modem port which allows commands and data to be stacked, minimizing the hand-shaking and system delays and provides protection from data overruns; and allows the user to specify selected files as "protected" (unalterable) while retaining the ability to create or alter other files. Since it uses a very simple serial interface and IBM 3740 compatibility this type of mass storage system should prove quite useful in a number of personal computer situations. A single drive system lists for less than \$3000 and a dual system for less than \$4000. For more information contact Sykes Datatronics Inc, 375 Orchard St, Rochester NY 14606. ■

Circle 595 on inquiry card.

LOGIC PROBE

Dual-Level LED Detectors Show HI-LO Status

\$27.95

Shipped prepaid with check or money order.

Model 3200A

SPECIFICATIONS

Input Frequency: <10MHz.
Input Impedance: <150KΩ.
Min. Pulse Width: 300NS. (TTL).
TTL/DTL Logic 1, 2.2V ± 0.2V.
Threshold: Logic 0, 0.6V ± 0.2V.
CMOS Logic 1, 70% of V_{DD} ± 0.5V.
Threshold: Logic 0, 30% of V_{DD} ± 0.5V.

Quantity Prices Available

ALCO ELECTRONIC PRODUCTS, INC.
1551 Osgood St., No. Andover, Ma. 01845
Tel: (617) 685-4371 TWX: 710 342-0552

Circle 6 on inquiry card.

CANADIANS

Announcing

HAMILTON LOGIC SYSTEMS

Specializing in logic devices, microprocessors, memories, TTL, Cmos, etc.

Send for your catalogue

Box 7

STONEY CREEK

ONTARIO L8G 3X7

Circle 146 on inquiry card.

BIT BASEMENT BARGAINS

SOROC IQ120 [assbled] . \$869.95
LEAR ADM-3A [assbled] . \$859.95
LEAR ADM-1A [assbled] . \$1199.95
16K RAM BOARD [assbled] . \$495.00
250nS 180 day warranty
CENTRONICS 779 [assbled] . \$1139.95
MICROPOLIS 1042 Mod I . \$779.00

BIT BASEMENT

P.O. Box 1719
Santa Monica, CA 90406

(213) 395-8801

all items shipped FOB factory

Circle 26 on inquiry card.



SCOPE DATA
INCORPORATED
A SUBSIDIARY OF SCOPE INC., RESTON, VA.

PRINTERS FOR SALE

- A LIMITED QUANTITY OF USED ELECTROSENSITIVE NON-IMPACT PRINTERS ARE AVAILABLE FROM THE MANUFACTURER
- AS IS WARRANTED TO WORK OR WILL RECONDITION TO LIKE NEW
- 300/1200 BAUD, 240 CPS, 80 COL BUFFERED, SERIAL OR PARALLEL
- RECEIVE ONLY AND KEYBOARD SEND/RECEIVE FOR CRT HARD COPY OR PRINTER TERMINALS
- THESE PRINTERS OPERATE WITH RADIO SHACK, TRS-80, HEATHKIT, IMSAI, LEAR SIEGLER, ADDS, HAZELTINE & OTHER SYSTEMS
- PRICES START AT \$395.00 EACH - CALL OR WRITE

WALT PLYTER, SCOPE DATA, INC.
3728 SILVER STAR RD.
ORLANDO, FL 32808
(305) 298-0500

Circle 314 on inquiry card.

INDUSTRIAL QUALITY
MICROPROCESSOR CARD KITS
All +5V only, std 4.5 x 6.5, 22/44 edge conn.

- 4 K RAM \$79.95 ● 2 K PROM \$ 79.95
- Motherboard \$39.95 ● 4 K PROM \$129.95
- Card Cage \$20.00 ● Digital I/O \$ 59.95
- Keyboard/Display \$89.95 ● Cassette Interface \$ 37.95
- Available tested and in OEM qts.
- KIM Interface Adapter \$24.95
- KIM Computer Enclosure \$80.00
- BARE BOARDS, ENCLOSURES, FIRMWARE, ETC. SEND \$3.70 FOR TECHNICAL MANUAL (INFORMATION ON ALL ABOVE).

PAL COMPUTERS USING 6502 SYSTEM!
● Pal Computer with CRK (24K) \$1395.00
● Component Boards Available Separately
● Video Board (also works with KIM) \$ 299.95
● RAM Board (8K) (also works with KIM) \$ 179.95
● 6 SLOT KIM Mother Board \$ 79.95
● ORDER OUR PAL TECHNICAL MANUAL (\$7.25 Postpaid) which fully describes the KIM Bus and individual Boards.



Electronic Communications Co. ● VISA
P. O. Box 365, Chino, CA 91710 ● MasterCard
or Visit Retail Store: ● Calif Residents Add
13552 Central Avenue ● 6% Sales Tax

Circle 317 on inquiry card.

DISKETTES

VERBATIM for Your DRIVE

MINI Soft Sector 10 Sector \$3.90 Ea. in boxes of 10
16 Sector

STANDARD \$4.10 Ea. in boxes of 10
Soft or Hard Sector

CP/M 1.4 Disk & Horizon \$145

PLASTIC BOX for Standard \$3
10 Diskettes

HAZELTINE CRT 1500 with cable \$1000

Complete 1+2+3 Computer System: Hazeltine 1500, Horizon-2, Centronic 779 \$5145

Visa, Master Charge, Cash, C.O.D.

MANCHESTER EQUIPMENT CO., Inc.
30 Midland Ave. • Hicksville, N.Y. 11801
Call Collect: (516) 433-0613

Circle 204 on inquiry card.

AN S-100 BUS COMPATIBLE COMPUTER FOR UNDER \$150?

Single board, S-100 compatible 8080-based computer designed at the University of Iowa to use the Intel cosmetic reject kit.

Features are:

- Memory: four 1702 EPROM's or three 1702's and two 2111's
- Power-on jump and independently selectable board address
- Uses TMS5501 multi-function I/O controller: Parallel in, parallel out USART
- Five interval timers
- Handles vectored interrupts
- TTY or RS232 interface on board
- Fully S-100 compatible
- Socket for front panel connection (IMSAI front panel connector pin compatible)
- Ideal CPU replacement for IMSAI's and Altairs. Will run with just applied unregulated voltages as a single board computer.
- Bare board, schematics, limited documentation \$35
- Schematics, limited documentation (includes simple monitor for single board operation) \$3

UPMEM

1291 Center St. N.E.
Cedar Rapids, Iowa 52402

Circle 376 on inquiry card.

COMPUTER PROFESSIONALS



Opportunities available worldwide. Experience in Scientific or Business environments can lead to exciting projects in varied locations.

SUN STATES: State-of-the-Art Design and Development. 15-30K

HAWAII: Digital Switching Systems. 30-33K

GERMANY/JAPAN: Software Field Engineer. Base salary 17-18K + Bonus + Per Diem.

NEW ENGLAND: Scientific & Business Applications; Minis-Micros; Strong Assembler. 16-28K

Call us collect (603) 889-0112 or send resume.

PREFERRED POSITIONS, INC.
142 Main Street
Nashua, N.H. 03060

Circle 302 on inquiry card.

MICRO-VERTER

A SPECIAL COLOR MODULATOR FOR APPLE II USERS!!
UHF Version. Operates above channel 14. Eliminates worms!

Operates above the switching harmonics of the computer, thereby yielding a cleaner, worm-free picture. Tunable over a minimum of 4 channels. Interfaces directly with the Apple II as well as most other micros. Comes with video cable and RF output stub coupler. Two-toned cow type decorator cabinet. Size: 5.6cm x 8.5cm x 11.5cm. Power: +5V. Current approx. 1 ma. Self-powered with 4 pencil batteries. Operating life in excess of 1000 hours or near shelf-life of batteries. Excellent stability. Precise frequency adjustment. No assembly required except for installation of batteries, not supplied. MODEL MVX-500.

AVAILABLE FROM YOUR LOCAL COMPUTER DEALER or direct from ATV RESEARCH. COST including shipping anywhere in USA and Canada — \$35.00.

"PIXIE-PLEXER" An IC type video-to-RF modulator includes FM sound sub-carrier, color subcarrier and separate R-Y and B-Y inputs. Designed around the LM-1889 chip. A designer's dream with full data sheets. Model PXP-4500. Kit form. \$24.50 postpaid.

"PIXIE-VERTER" The original computer video-to-RF interface module. Kit form: SB-50. Model PXP-2A

PHONE OR WRITE TODAY. DIAL 402-987-3771.

13-B Broadway **ATV Research** Dakota City, Nebr. 68731

Circle 21 on inquiry card.



IT'S A GREAT BIG COMPUTER WORLD
But You Only Need
THE COMPUTER CORNER

- SOL — A New Dawn is Here!
- COMMODORE PET & KIM
- NORTHSTAR HORIZON
- IMSAI VDP-80
- Memories & I/O Boards

- Computer Book Service
- Magnetic Tapes & Disks
- Full Line of Magazines
- Brain Games & Puzzles
- Workshops & Club Information

Visit **THE COMPUTER CORNER** for all your computer needs. Stop in and browse — you'll like our personal service.

THE COMPUTER CORNER
White Plains Mall — Upper Level
200 Hamilton Avenue
White Plains, New York 10601

Tel: (914) WHY - DATA
Ample Parking
10-6 Daily & Saturday
10-9 Thursday

Circle 65 on inquiry card.

WE SHIP FROM STOCK

TELETYPE MODEL 43 TTL \$985
RS232 \$1085

TECHNICO 9900 SS 16 BIT COMPUTER 16 bit microP, 32 bit I/O, hardware mult and divide, buffered bus, 20 ma loop, RS232C, 8 interrupts, fully socketed. Expands up to 64 KB memory. Languages: assembler, BASIC, SUPER BASIC, (COBOL, FORTRAN IV soon available).

Super Starter Kit: \$299
Assembled: \$399

EX*150 ELECTRONICS PROJECTS KIT Build 150 working electronics projects including basic computer circuits, lie detector, transistor radio. Perfect for all ages to learn electronics fundamentals. A COMPLETE KIT! Nothing else required. \$69

ATTASHE 200 EXPERIMENT INTEGRATED CIRCUIT KIT. \$87

Ti 57 PROGRAMMABLE CALCULATOR. \$50
To order: Check, money order, major credit cards. \$4 shipping (except teletype). NYC residents add 8% tax.

OWENS ASSOCIATES, DEPT. B
147 NORWOOD AVENUE
STATEN ISLAND, N.Y. 10304

Day, evening, weekend calls welcome
(212) 448-6283 or (212) 448-6298

THE COMPUTER HARDWARE STORE INC.

Dealers for:
APPLE II, IMSAI
VECTOR GRAPHIC
KIM-I, OAE
CYBERNEX, JIM PAK

With
ALPHA-1 CASSETTE SYSTEM

16 Bits
ALPHA MICRO
TECHNICO STARTER SYSTEM

Catalog Available

818 FRANKLIN ST., ALEX., VA.
703-548-8085

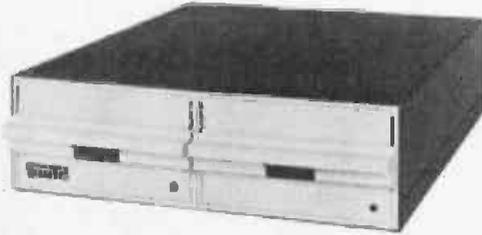
9 WEST CARY ST., RICHMOND, VA.
804-780-0348

Circle 71 on inquiry card.

What's New?

PERIPHERALS

8 Inch Floppy Disk System for SwTPC 6800



The Southwest Technical Products Corp DMAF1 is a dual drive, single density, double sided 8 inch floppy disk system. The hardware consists of an SS-50 bus (SwTPC 6800) compatible direct memory access (DMA) controller capable of handling up to four drives,

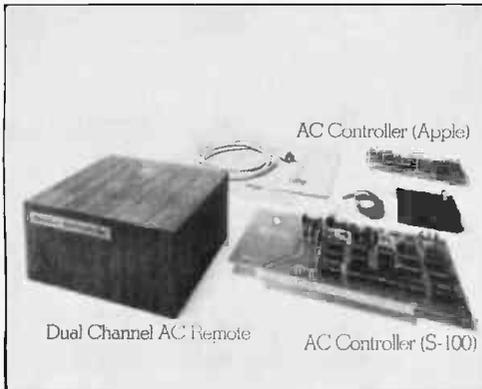
two CalComp 143M double density disk drives, aluminum chassis, regulated power supply, drive motor control board, cooling fan, diskette and interfacing cables. The unit is 5.4 by 17.1 by 20.5 inches (13.7 by 43.5 by 52 cm).

An 8 K BASIC interpreter with disk file capability and string functions is included with the system. Each diskette holds approximately 600,000 bytes of data. With two drives there is over one megabyte of data on line.

The system is available assembled or in kit form (the drives are fully assembled). The unit sells for \$2095 assembled, or \$2000 as a kit, plus postage. Contact Southwest Technical Products Corp, 219 W Rhapsody, San Antonio TX 78216. ■

Circle 585 on inquiry card.

AC Wiring Controller

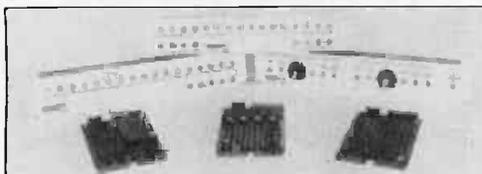


A new system designed to control AC devices remotely from any Altair (S-100) bus or Apple II computer over existing 110 VAC wiring has been announced by Mountain Hardware, POB 1133, Ben Lomond CA 95005. The new unit,

called Introl, provides on and off control and status checks at any AC outlet. The system impresses a 50 KHz control signal onto the ordinary AC wiring. It then decodes the signal at any outlet to switch AC devices on and off. In the home, such devices could include lights, TVs, stereos, solenoid valves, sprinklers, burglar alarms, etc. With the addition of input sensors the computer system can automatically control such variables as temperature, humidity and soil moisture. Programs are written in BASIC or assembler language. Software sub-routines come with the equipment. Complete documentation is also provided. For Altair (S-100) bus computers, a 100,000 day calendar and clock board is offered as an option. Price of the AC controller is \$149 in kit form or \$189 assembled and tested. Dual channel AC remote units are \$99 each in kit form or \$149 assembled and tested. The calendar and clock board is \$179 in kit form or \$219 assembled and tested. ■

Circle 586 on inquiry card.

LSI-11/2 Compatible Data Acquisition Code

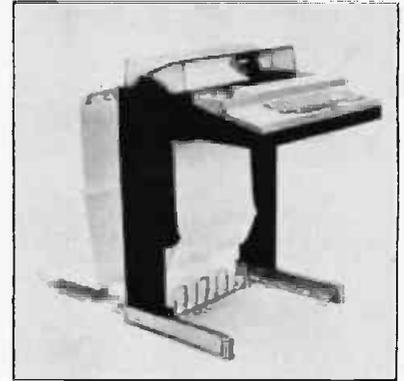


Three types of data acquisition cards that are compatible with the new LSI-11/2 computer as well as the older LSI-11 are now available from Andromeda Systems, 14701 Arminta St, Panorama City CA 91402. The three cards consist of: the ADC11, a 16 channel 12 bit analog to digital con-

verter; the DAC11, a 4 channel 12 bit digital to analog converter; and the PRTC11, a programmable real time clock with 13 internally generated rates, five operational modes, and two external inputs. These products are all functional supersets of the similar DEC products (AAV11, ADV11-A KVV11-A) but are in the dual width (rather than quad width) format. Also available is the CB11 series of compatible connector boxes which facilitate external connection to the above products. Prices are \$850 for the ADC11; \$700 for the DAC11 (four channels, deduct \$75 for each deleted channel); and \$600 for the PRTC11. All connector boxes are \$150 each; cables are extra. ■

Circle 587 on inquiry card.

New Teleprinter Offers Many Options



The TC480 teleprinter is available in receive only, keyboard send and receive or automatic send and receive configurations. It prints 128 ASCII characters in a 7 by 9 dot matrix at speeds up to 30 characters per second. Up to 132 characters per line can be printed and up to 64 characters to be printed can be stored in the teleprinter's internal memory. An adjustable sprocket feed handles paper from 3 to 15 inches wide. Horizontal and vertical tabbing can optionally be controlled by programs resident in read only memory or by a program loaded into programmable memory. Other options include a numeric keypad, pin and front feeds, a paper tape reader or reader and punch, a 2 drive cassette unit, a minifloppy disk drive and 8 K bytes of additional memory. A logic level serial interface is standard with a variety of options including RS232 and 20 mA current loop interfaces. In quantities of five or more, the TC480's price ranges from \$1625 (receive only) to \$1750 (keyboard send and receive), from Ollivetti Corp of America, 500 Park Av, New York NY 10022, (212) 371-5500. ■

Circle 588 on inquiry card.

Serial Data Translator

A serial data translator, Model ST-1, which performs code translations on a serial data stream has been announced by Sigma Data Systems, 715 Torrey Ct, Palo Alto CA 94303. The device is said to be a self-contained module, including power supply, and communicates via two RS-232 ports at up to 19.2 bps. Standard translations include the ASCII, EBCDIC and Baudot codes. Translation of terminal control codes (such as cursor control) have been implemented. Other translations are available or may be user programmed. The unit contains an Intel 8035 processor and up to 1 K of programmable read only memory. The device allows the user to change peripherals without having to modify software written for peripherals using different codes. It should be compatible with any host computer due to its serial RS-232 interface. ■

Circle 589 on inquiry card.

S & R Electronics, Inc.
4020 Hempstead Turnpike
Bethpage, New York 11714
Phone: (516) 731-8200

- ◆ Finest commercial quality S-100 Bus Memory Boards by Industrial Micro Systems. Fully static.
- ◆ Fully socketed, assembled, tested and burned in.
- ◆ 6 month warranty on parts and labor.
- ◆ All address & data lines fully buffered.

8k-450 Nanosec. ----- \$194.60
8k-250 Nanosec. ----- \$214.80
16k-450 Nanosec. ----- \$434.60
16k-250 Nanosec. ----- \$479.80

BankAmericard and Master Charge accepted.
Personal checks will delay shipment until cleared. Complete systems configured to your needs. NY state residents please add sales tax.
Call or Write.

Circle 313 on inquiry card.

datec
couplers
connect: always

The Datec 30 Originate Only and the Datec 32 Originate/Answer acoustic couplers provide reliable Bell System 403/413 compatible Duplex or Half-Duplex, 300 bps data communication over conventional telephones.

Datec acoustic couplers are the only couplers on the market with **CRYSTAL CONTROL** for both the receiver and the transmitter.

The Datec 30 and Datec 32 acoustic couplers control, time and time again.

datec inc

P. O. Box 839
Chapel Hill, North Carolina 27514
phone: (919) 967-5605

Circle 83 on inquiry card.



THE ULTIMATE IN:

OPTICAL TAPE READERS

Precision machined tape guide
Interface directly to a PDA or VANT
Tri-state buffer output
All handshake logic-TTL compatible
Pull thru tape. Reads 9 to 5000 cps
Interface thru a 14 pin IC plug (PROVIDED)

TTR-1 ASSEMBLED & TESTED \$42.50*

TTR-1 PLUG-IN HANDSHAKE ADAPTER \$7.50*

* IN SOME RESIDENTS ADD IN SALES TAX

TO ORDER, SEND CHECK OR M.O. TO:

MICROCOMP P.O. BOX 1221
FOND DU LAC, WI 54935

WE SPECIALIZE IN MICROCOMPUTER SYSTEMS FOR
HOBBY-BUSINESS-EDUCATION
WE ARE EXCLUSIVE OSI DEALERS...

... WE DO A BETTER JOB.
KITS-FULL SYSTEMS-PERIPHERALS-FLOPPY DISKS-ACCESSORIES-
DIGITAL CLOCK KITS-VIDEO TERMINALS-BOOKS-MAGAZINES-
SEND FOR FREE CATALOG TODAY!!!

Circle 309 on inquiry card.

Z-80 DISASSEMBLER
ZILOG MNEMONICS

North Star or CP/M
Disc, Others upon
request; \$5 extra

\$30.00 Immed. del.



Microlithics, Inc.
Bits, Bytes & Micros
2918 N. Mac Arthur Blvd.
Oklahoma City, OK 73127
(405) 947-5646

Circle 209 on inquiry card.

USR-310
ORIGINATE
ACOUSTIC
COUPLER



Operates With
Any Standard Telephone

\$139

Also Available

Direct ¹ Connect Style	Telco ² OAA Style
\$324	\$185
\$299	\$160

USR-330 Originate/Auto Answer Modem
USR-320 Auto-Answer Only Modem

(1 FCC Certified Package Connection to phone lines via standard extension phone jack.)
(2 Connection to phone lines via CBS-1001F DAA which can be leased from phone company for approx. \$5.00/mo plus installation fee.)

INTERFACES:

- USR-310 — RS232C only
- USR-320 and USR-330 — RS232C and 20mA
(Specify with order. If both interfaces are required, add \$10 to unit price.)

ALL UNITS FEATURE:

- 0-300 Baud Data Rate
- Stand Alone Unit
- Half/Full Duplex
- 90 Day Warranty
- Fully Assembled and Tested
- Optional Annual Maintenance Coverage

Prices include shipping and handling in continental U.S. Illinois Residents add 5% sales tax.

U.S. ROBOTICS, INC.

Box 5502 / Chicago, Illinois 60680 / (312) 528-9045

Circle 377 on inquiry card.

Disc/3
DISC/3 COMPANY
COMPLETE MICRO
BUSINESS SYSTEMS

SOROC IQ 120 Assembled	\$ 899.95
LEAR SIEGLER ADM-3A kit	\$ 749.95
INS 8K Memory Board	\$ 175.00
IMSAI 8080 kit	\$ 599.95
CENTRONICS Business Printer (132 columns)	\$1145.00



DISC/3 COMPANY
1840 LINCOLN BLVD.
SANTA MONICA, CALIF. 90404
(213) 451-8911

Circle 105 on inquiry card.

SHORT CASSETTES



PET-SIZED CASSETTES

DATA TAPE cassettes use high energy tape selected for reliable operation with all popular home and hobby computers. Send \$1 for sample C-10, prices and information.

Dealer inquiries invited

MICROSETTE CO.

777 Palomar Ave., Sunnyvale, CA 94086

Circle 214 on inquiry card.

RADIO SHACK AND
COMMODORE USERS

Low Cost Software on Compatible
Cassette Tapes for your TRS-80
and PET Computers.

- Games
- Investment/Small Business
- Educational/Scientific
- Kitchen Programs

INTRODUCTORY GRAPHIC GAME
SPECIAL—Star Trek (8K), Football
(8K), Lunar Lander, Wumpus, Bio-
rhythms and Acey Ducey on 2 Cas-
sette Tapes. A \$25 value for \$20.00.

SEND FOR FREE CATALOG

Software royalty plans also available.



APPARAT, INCORPORATED

P.O. Box 10324
Denver, CO 80210

Circle 11 on inquiry card.

DIABLO
TERMINALS!

LIMITED OFFER
HYTYPE I TERMINAL
\$1595.00

30 character per second
Daisy wheel printer
RS-232 serial interface

Also:

HyType II
NEC Spinwriter
Qume
Sanders 12/7

Complete line of
microcomputer products

MICRO MART

MICROCOMPUTERS, PERIPHERALS AND SOFTWARE
1015 Navarro San Antonio, TX 78205 512/222-1427

Circle 211 on inquiry card.

What's New?

Easy to Install Add-on Memory for PDP-11



The ARM-1100P, an add-on parity memory for the PDP-11, uses only one backplane slot and requires just one Unibus load, facilitating installation on any PDP-11 computer employing a Unibus structure. Each unit is supplied complete with wired card rack, power supply, interface, parity control, cooling fans and interconnecting cables. Provision is made on the rear of the chassis to connect to another chassis or to terminate the bus. An on line and off line switch removes the memory from the bus for diagnostic purposes. The core memory, which has an access time of 375 ns and a full cycle time of 700 ns provides from 32 K to 128 K of memory in 32 K increments, starting at any 8 K boundary. The ARM-1100P is priced at \$4950 for 32 K 18 bit words to \$12,750 for 128 K, from Ampex Corp, 200 N Nash St, El Segundo CA 90245, (213) 640-0150. ■

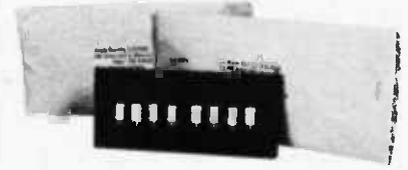
Circle 591 on inquiry card.

Point of Sale and Inventory Control

An interactive computer program which allows a microcomputer using the 8080 or Z-80 processors to be used as a Point of Sale and Inventory Control system has been released by The Data Group Inc, 5947 East 82nd St, Indianapolis IN 46250. According to the firm, POSIS can be used by a person with absolutely no prior computer experience. The program is said to converse with the user in "plain English" and to lead him through each transaction. Error handling capabilities are claimed to insure that human mistakes will be caught by the computer without destruction of vital information. POSIS stores information up to 9000 individual inventory items and is said to be able to generate a variety of management reports based on a business's inventory transactions. Additional features include: ID and password security checks at key points in the program and a complete audit trail summarizing every transaction. Minimum hardware requirements are: an 8080 or Z-80 system with 48 K bytes of user memory, a video terminal, and a Micropolis Corp dual drive disk. POSIS and its detailed instruction manual may be purchased at a cost of \$750. ■

Circle 592 on inquiry card.

Apple Seeds...



We recently purchased an additional 32 K bytes of memory for our Apple, filling up the available sockets to a full 48 K bytes of memory. Here is a picture we took of what you (or your local computer store) will get, photographed prior to insertion of the memory into an Apple II: two packages with eight of the 16 K dynamic memory chips per package. Note that with computers like the Apple which employ the large memory integrated circuit technology, there is no need for plug in memory boards when expansion is desired up to the limit of sockets built into the computer. An important consideration in purchasing such a computer, then, is how much memory can be plugged in before a new cabinet and printed circuit boards are required.

For more information on additional memory for Apple, contact Apple Computer Inc, 20863 Stevens Creek Blvd, Bldg B3-C, Cupertino CA 95014. ■

Circle 590 on inquiry card.

ATWOOD ENTERPRISES

KITS

\$ 79.95 4K RAM Available assembled and tested \$89.95.

\$129.95 4K PROM Bipolar 512 x 8 Proms 93448/6341.

\$149.95 8K EPROM Needs only 4K space 2716.

\$ 59.95 DIGITAL I/O 8 parallel ports plus 16 interrupts.

\$ 99.95 ANALOG IN 32 inputs, 8 bits, 100 microseconds.

\$ 49.95 PROM PROGRAMMING Burns 4. Can copy to 3.

\$129.95 SERIAL I/O 7 serial ports, fully software controlled. To 500 baud.

DID YOU KNOW ... DIGITAL I/O

8 parallel ports.

8 bits each (64 total).

Each line fully programmable.

Any line input or output.

16 interrupt lines.

80 I/O lines total.

2 - 50 pin I/O connectors.

\$59.95

MOTHER BOARD

8 SLOT 44 PIN BUS
50 Pin Edge Connector

Mother Board \$20.00 ea
Connectors 2.50 ea
Card guides for above \$10.00 per set.

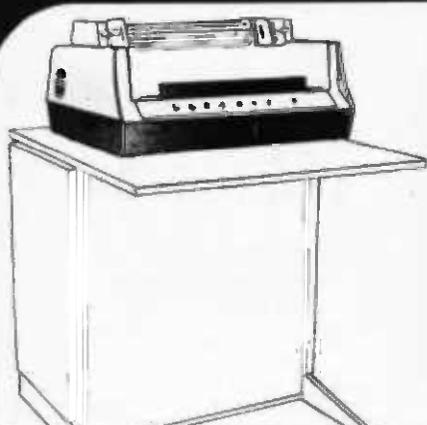
MAKE CHECK OR MONEY ORDER PAYABLE TO:

Kathryn Atwood Enterprises
P.O. Box 5203, Orange, CA 92667

Discounts available at OEM quantities. For orders less than \$25 total, add \$1.25 for shipping. California residents add 6% sales tax. Estimated shipping time 2 days ARO with money order. For checks allow 7 days for check to clear.

California Industrial

Post Office Box 3097 B • Torrance, California 90503



DIABLO HARDCOPY PRINTER

These Diablo model 1200 printers were originally manufactured for Control Data Corporation. The unit features a ninety-six character upper and lower case daisy wheel capable of printing thirty characters per second. Impact printer assures word processing quality on multiple copy forms. Adjustable tractor feed accepts paper width up to fifteen inches on a 132 character carriage.

All printers were removed from service in operating condition. Printer only \$795.00. Floor stand, power supply and Control Data interface package \$100.00 additional. Shipped from Los Angeles freight collect.

TELETYPE MODEL 43

New from Teletype, the Model 43 is capable of printing 132 ASCII characters per line. Send and receive data at 10 or 30 char. per second. Keyboard generates all 128 ASCII code combinations. RS-232 interface, same as the popular Model 33. Data sheet sent upon request. Manufacturer suggested price \$1377.00.

IMMEDIATE DELIVERY \$1219

TTL model with NOVATION brand Acoustic Modem. \$1419



HEXADECIMAL KEYBOARD

Maxi-Switch hexadecimal keyboards are designed for microcomputer systems that require 4-bit output in standard hex-codes.

\$34.95

Each assembly consists of 16 hermetically sealed reed switches and TTL "one shot" debounce circuitry.

Reliable low friction acetal resin plungers are credited for the smooth operation and long life of this premium keyboard.

Requires single +5 volt supply.



CONNECTORS

your choice
DB25P male plug & hood
or
DB25S female
\$395

Qty. fe. male hd.
10 3.45 2.45 1.15
25 3.15 2.25 1.05
100 2.85 1.90 .95
500 2.25 1.60 .85
1K 1.97 1.37 .73

Edge Connectors

100 PIN
IMSAI/ALTAIR

S-100 • GOLD PLATED • .125" CENTERS
Altair 140 row, soldertail, ... \$5.98 3/\$16.50
IMSAI 250 row, soldertail, ... \$4.98 3/\$11.95
3 Level Wire Wrap 250 row, ... \$4.98 3/\$13.00
SPECIALS

WW same as above without ears \$3.50 3/\$10
72 (dual 36) WW "156" centers, ... \$2.50 3/\$6



UNIVAC
KEYBOARD

The famous Univac 1110 Hollerith keyboard assembly is now available from California Industrial for only \$24.88. The ideal computer input device for accountants and mathematicians. The numeric keys are placed on the lower three rows to resemble a ten key adding machine. This format allows one handed numeric data entry. Original cost was \$385. Used but guaranteed in excellent condition. Complete with documentation.

Quiet Buss™ S-100 MOTHER

The Quiet Buss from California Industrial is quality engineered. No short cuts have been taken to produce this mother board. Active termination circuitry prevents noise and crosstalk. Manufactured from extra heavy FR-4 epoxy glass. Features 2 ounce double thickness copper traces.

1829.95
SLOT

IMSAI edge connectors 3 for \$1195

FROM ATARI COLOR TELEVISION R.F. MODULATOR

The Atari R.F. Modulator allows computer data to be displayed directly upon your existing television system. This unit converts the signal from the Apple II and other video sources into television frequencies. Operates from single 5 volt supply. Complete with metal case, making R.F. connector and 15 feet of coax cable. Schematics and instructions included.

\$1395

\$498
10 for \$45.

Scotch®

DISKETTES
8 inch 32 (IBM)
8 inch 5 sector
Mini 10 sector
Mini 16 sector

\$550

Certified Digital CASSETTES
Won't drop a BIT!

CALIFORNIA INDUSTRIAL is an Authorized Dealer of Scotch Brand Data Products

JOYSTICK \$4.50

3 for \$10.00

This joystick features 1600 100K potentiometers, that vary resistance proportional to the angle of the stick. Perfect for television games, quad stereo and radio controlled aircraft.

2708

450ns
\$9.95

8K UV Erasable MEMORY

Potter & Brumfield REED RELAY

5 volt coil, pulls 3.5v.

\$1.19

10 100 1k
SPST .37 .75 .85

S-100 PROTOTYPE BOARD

GP100-Maximum design versatility along with standard address decoding and buffering for S100 systems. Room for 32 uncommitted 16 pin IC's, 5 bus buffer & decoding chips, 1 DIP address select switch, a 5 volt regulator and more.

\$19.98

21L02

LOW POWER
450 NS

\$1.19

Lowest Price Anywhere

Our low power static RAMs are factory prime. Purchased, on contract, directly from one of California's leading semiconductor manufacturers. Access time guaranteed faster than 450ns. Minimum purchase 32 pieces. Sorry, credit cards not accepted on 21L02's.

MEMORY

7496	73	4033	1.99		
7499	3.99	4035	1.69		
74100	1.15	4040	1.99		
74107	3.39	4041	1.48	1702A	4.95
74108	4.99	4042	1.48	82C23	2.95
74110	1.79	4043	1.48	2102	1.59
74116	1.99	4044	1.49	82C123	2.95
74120	1.79	4046	1.49	2102	1.59
74121	3.39	4047	2.49	2102-1	1.89
74122	3.39	4049	1.79	2102	1.19
74123	6.59	4050	1.79		
74125	5.99	4051	1.99		
74126	5.99				
74128	4.99				
74132	9.99	80B0A	14.95	5314	2.95
74136	8.99	9800	24.95	5316	4.95
74141	9.99	280	99.95	5375	3.95
74145	9.99				
74147	2.49				
74148	1.99				
74150	1.19				
74151	9.99				
74153	8.99				
74154	9.99				
74155	9.99				
74156	1.29				
74157	9.99				
74159	2.99				
74160	1.19				
74161	9.99				
74162	1.49				
74163	9.99				
74166	1.19				
74167	4.99				
74170	2.49				
74173	1.49				
74174	1.19				
74175	9.99				
74176	9.99				
74179	9.99				
74180	2.5				
74181	9.99				
74182	2.5				
74183	9.99				
74184	1.19				
74185	4.99				
74186	2.5				
74187	2.5				
74188	3.40				
74189	2.79				
74190	4.99				
74191	9.99				
74192	9.99				
74193	4.99				
74194	9.99				
74195	7.9				

Digital Cassette Drive

COMPUTER CONTROLLED

\$795.00

This precision I/O assembly features remote software controlled search capabilities. Two independent capstan drive motors allow the computer to control direction and speed of the transport.

The assembly consists of a Raymond cassette transport, chassis, motherboard and three edge cards: read/write, capstan drive & control card.

Current replacement valued at over \$700.00. Schematics and complete documentation included. USED, but in excellent condition.

Thumbwheel switch

10 position
BCD
\$1.30 ea.

CAPACITORS

ELECTROLYTICS

ea.	10	50
80,000/10v.	3.95	349 2.95
4500/50v.	\$1.99	135 1.19
1000/15v	\$55	49 45

axial

MINIATURE SWITCHES

your choice

10	50	100	1k
\$1.98	\$8.88	\$1.73	\$6.66

SPDT Miniature Toggles

7101 C&K ON-NONE-ON
7107 J&T ON-OFF(moment. ON)
7108 C&K ON-(moment. ON)
Rocker 1BT 3P-4 Pos.
Rotary 3P-6 Pos.
Push B (N.O.) 5.39ea. 4/\$1

7400	7442	59	301H	39	350N	99
7401	7443	79	301CN	39	351CN	1.55
7402	7444	69	302H	1.29	370H	1.29
7403	7445	99	304H	1.29	370CN	1.39
7404	7446	99	304H	1.29	373H	3.19
7405	7447	99	307H	49	377H	3.99
7406	7448	99	307H	49	380N	1.39
7407	7449	99	307CN	39	381N	1.29
7408	7450	25	307CN	39	382N	1.79
7409	7451	25	308H	99	382N	1.79
7410	7452	25	308CN	1.09	NE555V	1.29
7411	7453	25	309	96	NE565H	1.49
7412	7454	25	310H	1.19	NE565H	1.49
7413	7455	25	310CN	1.19	NE565V	1.29
7414	7456	35	311H	99	703CN	4.35
7415	7457	49	312H	1.99	709H	1.39
7416	7458	49	312H	1.29	709N	39
7417	7459	359	318H	1.49	710N	79
7418	7460	79	320A-5	1.29	711H	39
7419	7461	79	320A-5	1.29	723H	55
7420	7462	79	320A-5	1.29	723H	1.45
7421	7463	99	320A-5	1.29	725H	3.49
7422	7464	99	320A-5	1.29	733H	1.45
7423	7465	99	320A-5	1.29	733H	1.45
7424	7466	49	320A-5	1.29	733H	1.45
7425	7467	49	320A-5	1.29	733H	1.45
7426	7468	340	320A-5	1.29	733H	1.45
7427	7469	340	320A-5	1.29	733H	1.45
7428	7470	279	320A-5	1.29	733H	1.45
7429	7471	99	320A-5	1.29	733H	1.45
7430	7472	99	320A-5	1.29	733H	1.45
7431	7473	99	320A-5	1.29	733H	1.45
7432	7474	99	320A-5	1.29	733H	1.45
7433	7475	49	320A-5	1.29	733H	1.45
7434	7476	49	320A-5	1.29	733H	1.45
7435	7477	49	320A-5	1.29	733H	1.45
7436	7478	49	320A-5	1.29	733H	1.45
7437	7479	49	320A-5	1.29	733H	1.45
7438	7480	49	320A-5	1.29	733H	1.45
7439	7481	49	320A-5	1.29	733H	1.45
7440	7482	49	320A-5	1.29	733H	1.45

Power Adapter

6 vdc, 140mA \$1.39
7 vdc, 1.4 A. 5.50
9 vdc, 15mA. 1.19
10 vAc, 300mA. 1.95

RELAYS

SPDT MINIATURE

10	25	100
\$1.19 ea.	\$1.15	\$1.04 .89

Coil 12 Volt dc.
7 P.C. Contacts
P.C. Board Mount

Transistors

ea.	10	50	100
2N2222A	.20	.18	.16 .15
2N3055	.69	.65	.59 .55
MJ3055	.79	.75	.69 .65
2N3772	1.59	1.49	1.39 1.29
2N3904	.15	.11	.09 .07
2N3906	.15	.11	.09 .07

Diodes

10	25	100
1N4002 100v.	.08	.06 .05
1N4005 600v.	.10	.08 .07
1N4148 signal.	.07	.05 .04

Jumbo red LED's ea. 10 25 100
\$15.13.11.09

CMOS

4001	25	25
4002	25	25
4003	19	25
4004	25	25
4005	19	25
4006	25	25
4007	25	25
4008	19	25
4009	69	318H
4010	69	318CN
4011	69	318CN
4012	49	320A-5
4013	49	320A-5
4014	49	320A-5
4015	39	320A-5
4016	69	318H
4017	69	318CN
4018	169	318CN
4019	149	318CN
4020	139	318CN
4021	149	318CN
4022	129	318CN
4023	25	25
4024	19	25
4025	25	25
4026	89	318H
4027	89	318CN
4028	89	318CN
4029	89	318CN
4030	69	318H
4031	69	318CN

SPECIAL

GENERAL INSTRUMENT ASCII Keyboard Encoder
AY 5-3600 Prime but house marked only \$4.95

50 CONDUCTOR RIBBON WIRE

69

Transistors

ea. 10 50 100

2N2222A .20 .18 .16 .15
2N3055 .69 .65 .59 .55
MJ3055 .79 .75 .69 .65
2N3772 1.59 1.49 1.39 1.29
2N3904 .15 .11 .09 .07
2N3906 .15 .11 .09 .07

Diodes

10 25 100

1N4002 100v. .08 .06 .05
1N4005 600v. .10 .08 .07
1N4148 signal .07 .05 .04

Jumbo red LED's ea. 10 25 100
\$15.13.11.09

Power Adapter

6 vdc, 140mA \$1.39
7 vdc, 1.4 A. 5.50
9 vdc, 15mA. 1.19
10 vAc, 300mA. 1.95

RELAYS

SPDT MINIATURE

10	25	100
\$1.19 ea.	\$1.15	\$1.04 .89

Coil 12 Volt dc.
7 P.C. Contacts
P.C. Board Mount

Transistors

ea. 10 50 100

2N2222A .20 .18 .16 .15
2N3055 .69 .65 .59 .55
MJ3055 .79 .75 .69 .65
2N3772 1.59 1.49 1.39 1.29
2N3904 .15 .11 .09 .07
2N3906 .15 .11 .09 .07

Diodes

10 25 100

1N4002 100v. .08 .06 .05
1N4005 600v. .10 .08 .07
1N4148 signal .07 .05 .04

Jumbo red LED's ea. 10 25 100
\$15.13.11.09

9 foot

Heavy duty grounded power cord and mating chassis connectors.

\$149

RELAYS

SPDT MINIATURE

10	25	100
\$1.19 ea.	\$1.15	\$1.04 .89

Coil 12 Volt dc.
7 P.C. Contacts
P.C. Board Mount

Transistors

ea. 10 50 100

2N2222A .20 .18 .16 .15
2N3055 .69 .65 .59 .55
MJ3055 .79 .75 .69 .65
2N3772 1.59 1.49 1.39 1.29
2N3904 .15 .11 .09 .07
2N3906 .15 .11 .09 .07

Diodes

10 25 100

1N4002 100v. .08 .06 .05
1N4005 600v. .10 .08 .07
1N4148 signal .07 .05 .04

Jumbo red LED's ea. 10 25 100
\$15.13.11.09

Wire Wrap Center

Wire wrap low profile

pin	ea.	25	50
8	37	36	35
14	38	37	36
24	99	93	85
40	169	155	139

17- 16 15
18 17 16
19 18 17
36 35 34
58 57 56

IC SOCKETS

50ft. \$98

500 1,000 11,000
\$9. \$15. \$105.

DISCOUNT

Wire wrap low profile

pin	ea
-----	----

Stand Alone ASCII Keyboard Specification



\$138⁰⁰
**ASSEMBLED
 AND TESTED**

Plus \$3.00 handling charge.
 California residents
 add 6 1/2% sales tax.

- ☆ 4 SIMULTANEOUS OUTPUTS AVAILABLE: THE ONLY ONE ON THE MARKET
 1. SERIAL TTL LEVEL
 2. BUFFERED 8 BIT (TRI-STATE LATCH) PARALLEL OUTPUT WITH VALID DATA SYNC PULSE AND LEVEL
 3. 20 MA OPTO-ISOLATED CURRENT LOOP, POLARITY INDEPENDENT
 4. EIA RS232C
- ☆ SINGLE +5 VOLT 300 MA (NOMINAL) POWER SUPPLY (REQUIRED)
- ☆ INDUSTRY STANDARD 2 KEY ROLLOVER ENCODER
- ☆ ANSI-COMPATIBLE KEY SET; FOR SLIM-LINE "HIDE-AWAY" PACKAGING

- ☆ SEGMENTED SPACE BAR ALLOWS FAST MULTIPLE-SPACING WITHOUT REPEAT KEY
- ☆ REPEAT KEY REPEATS AT CHARACTER RATE
- ☆ USER SELECTABLE UPPER CASE ONLY (KSR/ASR/33 REPLACEMENT) OR UPPER/LOWER CASE
- ☆ FACTORY SET AT 110 BAUD BUT EASILY ADJUSTED BY USER TO ANY BAUD RATE FROM 110 TO 9600 BAUD
- ☆ FLEXIBLE PARITY
- ☆ LED INDICATOR FOR SHIFT-LOCK KEY ELIMINATES CASE UNCERTAINTY
- ☆ 24 PIN DUAL-INLINE CONNECTOR
- ☆ LOW PROFILE CASE (OPTIONAL) \$40.00

COMPONENT SALES INC.
 778-A BRANNAN, SAN FRANCISCO, CA 94103
(415) 861-1345

Orders accepted by phone or mail. 
 MASTERCHARGE ☆ VISA ☆ COD ☆ CHECK ☆ MONEY ORDER

Electrolabs

PO Box 6721 Stanford

CA. 94305
 415-321-5601

Educational Grade VIDEOTAPE Special: 1/2"x2400' 20 boxes/\$125.00

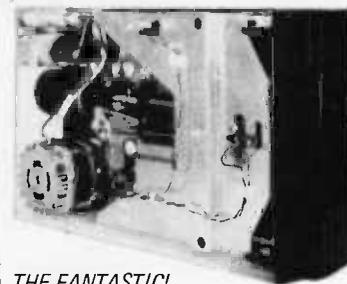
The "Pro" fully encoded ASCII Keyboard by Cherry. Auto REPEAT feature, 5 special function keys. 300mA/5V. (Shown as mounted in 'The Case', Below) \$119.00, 3/99.00, 10+/89.00

USED SYLVANIA *The Dumb Terminal for Smart People*

12" MONITORS
 80X24 with full 128 char. ASCII UC+LC font with all control characters displayed. 300-19,200 baud RS232. 2nd font addressable from keyboard in you-program-it 2708 for APL, Graphics sets, etc. Plug in monitor I/O connector, 110VAC and you are ready. INCLUDES: 'The Case', Cherry Kbd. A used monitor, ESAT 200A, all options except vector addressable cursor and modem. Bulletproof design and construction. Normally \$675.00 What you always wanted your ADM3 to be:
SYSTEM"A" \$649.00 10/\$599.00

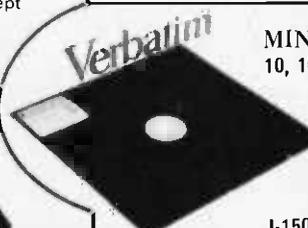


"The Case" Beautiful and sturdy anodized aluminum case in deep black designed to contain the ESAT 200A, and with a bezel cut out for the Cherry 'Pro' keyboard. (installed as shown above) Choose deep brown, light yellow, or crimson to accent or color code your installation. The only choice for hard-use institutional and educational applications. **\$69.00, 10/ 59.00**



THE FANTASTIC!
 MEMOREX FIVE-FIFTY

* Hard and Soft Sectoring
 * Single and Dual Density
 * Double side configuration as a retrofit at any time.
 * 110/220V, 50/60Hz
 * Pin for pin compatible with Shugart 800,801,850,851 (50 pin edge connector)
\$536, 2/499, 5/475, 10/449
 25/425, 100/405
 Double Sided Retrofit \$200



MINIDISKETTES (5.25") 1-9 10-24 25+
 10, 16 or Soft Sector \$4.79 4.65 4.45

STANDARD (8") DISKETTES
 Hard or Soft Sector \$5.99 5.33 4.79

CASSETTES
 R-300 Certified Phillips Type \$5.25 4.99 4.35
 I-150 Certified for audio decks \$4.60 4.30 3.90
 ('Kansas City' & SWTP formats)

SURPLUS Muffin type fans \$7.95, Lambda Power Supplies 5V/70A-\$145.00, 35A-\$89.00, 16A-49.00, 12V/7.3A-\$69.00

OUR CATALOGUE Contains IC's, T.I. Sockets (1cent/pin) Advice and much more. It is free.

Shipping and Handling: Surface: \$0.40/lb. Air: \$0.75/lb., 1.00 minimum
 Cal. Tax: 6.5% Insurance: \$0.50 per \$100.00

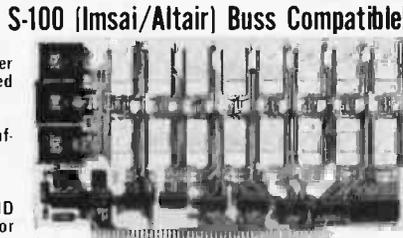
New!

16K E-PROM CARD

IMAGINE HAVING 16K OF SOFTWARE ON LINE AT ALL TIME!

KIT FEATURES:

1. Double sided PC board with solder mask and silk screen and gold plated contact fingers.
 2. Selectable wait states.
 3. All address lines & data lines buffered!
 4. All sockets included.
 5. On card regulators.
- KIT INCLUDES ALL PARTS AND SOCKETS (except 2708's). Add \$25. for assembled and tested.



PRICE CUT!

\$57.50 kit

SPECIAL OFFER:

WAS \$69.95

Our 2708's (450NS) are \$12.95 when purchased with above kit.

Fully Static!

8K LOW POWER RAM KIT - \$149.00

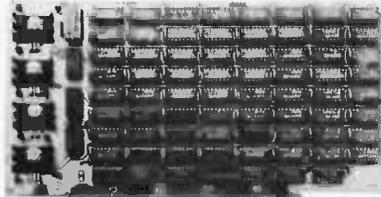
S-100 (Imsai/Altair) Buss Compatible!

2 KITS FOR \$279

KIT FEATURES:

1. Doubled sided PC Board with solder mask and silk screen layout. Gold plated contact fingers.
2. All sockets included.
3. Fully buffered on all address and data lines.
4. Phantom is jumper selectable to pin 67.
5. FOUR 7805 regulators are provided on card.

ADD \$20 FOR 250NS



USES 21L02 RAM'S!

Fully Assembled & Burned In \$179.00

Blank PC Board w/ Documentation \$29.95

Low Profile Socket Set . . . 13.50

Support IC's (TTL & Regulators) \$9.75

Bypass CAP's (Disc & Tantalums) \$4.50

MOTOROLA QUAD OP - AMP MC 3401. PIN FOR PIN SUB. FOR POPULAR LM 3900.

3 FOR \$1

ALARM CLOCK CHIP N.S. MM5375AA. Six Digits. With full Data. New!

\$1.95 each

FULL WAVE BRIDGE

4 AMP. 200 PIV.

69¢ 10 FOR \$5.75

NOT ASSOCIATED WITH DIGITAL RESEARCH OF CALIFORNIA, THE SUPPLIERS OF CPM SOFTWARE.

MOTOROLA 7805R VOLTAGE REGULATOR Same as standard 7805 except 750 MA output. TO-220. 5VDC output. 44c each or 10 for \$3.95

450 NS!

2708 EPROMS

Now full speed! Prime new units from a major U.S. Mfg. 450 N.S. Access time. 1K x 8. Equiv. to 4-1702 A's in one package.

\$15.75 ea.

4 FOR \$50⁰⁰

COMPUTER MFG. MAKES \$500,000.00 GOOF!

MOTOROLA

4K RAM CHIPS — 99¢ EACH

22 PIN DIP

A major U.S. computer mfg. installed thousands of these 4K Motorola RAM's on the wrong boards and had to remove them. All parts were then tested, and met FULL SPECS! If you don't mind a little solder on the leads, then this is the best memory buy in the world. Arranged as 4096 x 1 Bits. 470 NS. The Motorola 6605 is one of the easiest dynamic RAM's to use since it DOES NOT require multiplexed addresses as do most other 4K's such as the 4096 or 4027. A complete memory board design using the 6605 is outlined in the Motorola M6800 Applications Manual starting on page 4-70.

99¢ EACH (WITH DATA SHEET)

LOOK!

MCM6605

FOR \$6.95 YOU GET AS MUCH STORAGE AS IN 32 - 2102's!

8 FOR \$6.95 4096 BYTES OF RAM!

FULLY GUARANTEED!

SURPLUS BUY OF THE DECADE!!!

4K STATIC RAM'S 2114. The new industry standard. Arranged as 1K x4. Equivalent to 4-21 L02's in 1 package! 18 pin DIP. 2 chips give 1Kx8. 2/\$24. 8/\$85.

OPCOA LED READOUT SLA-1. Common Anode. .33 inch character size. The original high efficiency LED display. 75c ea.

4 FOR \$2.50

Z-80 PROGRAMMING MANUAL

By Mostek, The major Z-80 second source. The most detailed explanation ever on the working of the Z-80 CPU CHIPS. At least one full page on each of the 158 Z-80 instructions. A MUST reference manual for any user of the Z-80. 300 pages. Just off the press. \$12.95

2102 RAM BLOWOUT!

Fully static. Standard Power. The most popular RAM for microprocessors. We made a huge surplus buy, but there will be NO MORE WHEN THESE ARE GONE!

Part #21FO2-4 450 N.S. FAST!

8 FOR \$6⁹⁵ 32 FOR \$25

HEAVY DUTY! Full Wave Bridge 25AMP 50PIV

\$1.25

GE 10 AMP Triac SC146D. House no. To-220 case. Rated 10 amps 400PIV. 75c ea. 3/\$2.

Tantalum Capacitors 1 MFD. .35V. By Kemet. Axial Lead. Best Value! 10/\$1.

New! REAL TIME Computer Clock Chip

N.S. MM5313. Features BOTH 7 segment and BCD outputs. 28 Pin DIP. \$4.95 with Data

LS SERIES TTL

74LS00 — 33c	74LS74 — 49c
74LS02 — 35c	74LS90 — 69c
74LS04 — 35c	74LS138 — 89c
74LS08 — 35c	74LS154 — 1.49
74LS10 — 33c	74LS175 — 1.10
74LS20 — 33c	74LS367 — 75c
74LS73 — 49c	74LS368 — 85c

Digital Research Corporation

(OF TEXAS)

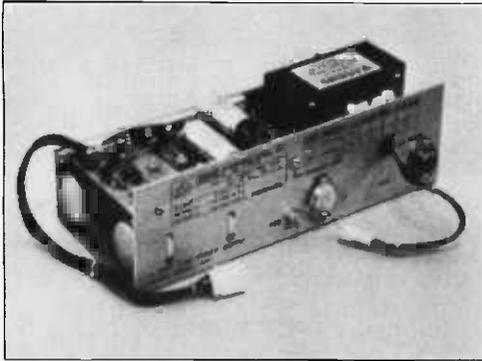
P. O. BOX 401247 • GARLAND, TEXAS 75040 • (214) 271-2461

TERMS: Orders under \$15. add 75c. No COD's. We accept VISA, MasterCard and American Express Cards. Money Back Guarantee on all items! Texas Residents add 5% Sales Tax. WE PAY POSTAGE!

What's New?

MASS STORAGE

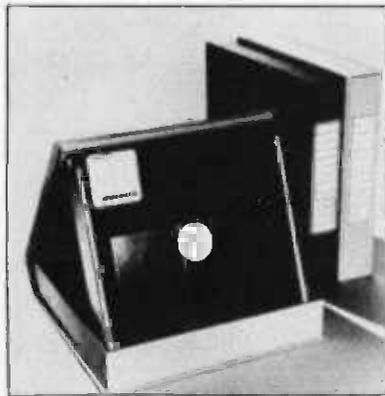
AED 101 Floppy Disk Power Supply



A power supply for floppy disk subsystems has been developed by Advanced Electronics Design Inc, POB 61779, Sunnyvale CA 94088. The AED 101 Triple Output supplies +5 VDC at 12 A, -12 VDC at 0.7 A, and +24 VDC at 3.5 A. It contains features such as switching regulation of +5 V, foldback limiting, current limiting and short circuit protection. The AED 101 is compact and is said to be available immediately. The cost is \$137.50 in large production quantities (\$.90 per watt). ■

Circle 637 on inquiry card.

Organized Protection for Diskettes



The KAS-ETTE/10 Library Case has been announced by the Alpha Supply Company, 18350 Blackhawk St, Northridge CA 91326. These library cases are designed to handle diskettes while in use, permanently store diskettes or safely ship several diskettes in one library case. When open and in use, a plastic insert aids in locating the desired diskettes. Color coded labels applied to the spine of the library case permit users to organize a permanent library. The units are available in blue or beige. Write to the manufacturer for further information and complete price list. ■

Circle 640 on inquiry card.

Fast, High Capacity Mass Storage



General Micro-Systems' new tape drive subsystem is a fast, inexpensive, high capacity mass storage device for microcomputers. The SYS 1 records biphasic Manchester code at 1600 bits per inch on ANSI specified data cassettes with a transfer rate of 2000 characters per second at ten inches per second.

The tape record is variable length,

which gives efficiency of storage space on tape, unlike the 128 or 256 byte fixed length records, where all bytes must be recorded, whether used or not. A 10 byte record may be followed by a 32 K byte record. The user program may dynamically load the next record, operating as a batch data processing system, with an unlimited amount of data. Over 700 K bytes may be recorded on one side of a cassette, using large records. Rewind time is less than 30 seconds at over 120 inches per second. Search can be accomplished at over 120 inches per second by counting the interblock gaps, getting to any record in an average time of less than 15 seconds.

One to four drives may be connected to the computer through the interface board. No power is taken from the computer bus, except what is necessary to run the simple synchronous serial interface board.

The unit is offered assembled, tested and guaranteed. The single drive is \$595, the dual drive is \$969, and the Altair (S-100) interface board is \$168. Contact Bob Smith, General Micro-Systems, 12369 W Alabama Pl, Lakewood CO 80228. ■

Circle 647 on inquiry card.

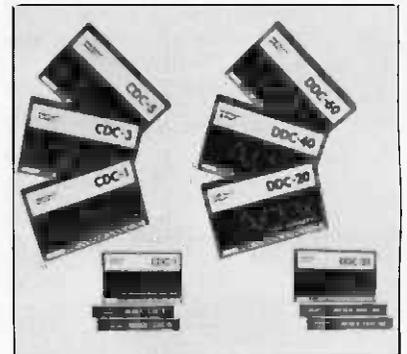
Minifloppy System Offers Versatility



The DataMate minifloppy disk system is a data storage and editing unit for connection between any RS-232 asynchronous ASCII coded printer or display terminal and its modem. Features include 560 addressable records of up to 128 characters each, selective data transfer rates of up to 9600 bps, editing capabilities, search modes, and manual and remote controls. The price is \$1750 from Western Telematic Inc, 2435 S Anne St, Santa Ana CA 92704. ■

Circle 638 on inquiry card.

Data Cassettes Specially Tailored to Small Systems Use



The introduction of a full line of data cassettes and cassette tape data acquisition systems specifically designed for use in personal computers and various small business computers has been announced by the AVDEX Corp. For users who prefer to load different programs on separate cassettes, the cassettes are available in one minute, three minute and five minute lengths and are custom loaded with extra short leaders so that the leader at no time comes in contact with the recording head. This makes possible instant start operation and eliminates any lost data as a result of failure to allow the leader to run through. In addition to short loads, a group of three cassettes in the C-20, C-40 and C-60 configuration is also available. Retail prices are: CDC-1, \$4.95; CDC-3, \$5.65; CDC-5, \$6.35; DDC-20, \$4.50; DDC-40, \$5.00; and DDC-60, \$5.50 from AVDEX Corp, 2280 Grand Av, Baldwin NY 11510. ■

Circle 639 on inquiry card.

ELECTRONIC SYSTEMS

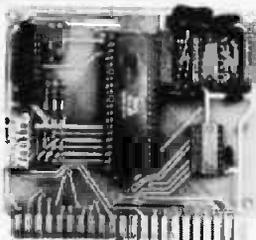
P.O. Box 9641 San Jose, CA 95157 (408) 374-5984

FOR CATALOG INCLUDING PARTS LISTS AND SCHEMATICS,
SEND A SELF ADDRESSED ENVELOPE WITH 24¢ POSTAGE.

RS-232/TTY * INTERFACE **NEW**

Part no. 600

- Converts RS-232 to 20mA current loop, and 20mA current loop to RS-232
- Two separate circuits
- Requires +12 and -12 volts
- Board only \$4.50, with parts \$7.00

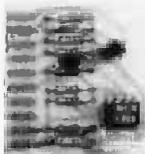


UART & BAUD RATE GENERATOR *

Part no. 101

- Converts serial to parallel and parallel to serial
- Low cost on board baud rate generator
- Baud rates: 110, 150, 300, 600, 1200, and 2400
- Low power drain +5 volts and -12 volts required
- TTL compatible
- All characters contain a start bit, 5 to 8 data bits, 1 or 2 stop bits, and either odd or even parity.
- All connections go to a 44 pin gold plated edge connector
- Board only \$12.00; with parts \$35.00

RS-232/TTL INTERFACE *



Part no. 232

- Converts TTL to RS-232, and converts RS-232 to TTL
- Two separate circuits
- Requires -12 and +12 volts
- All connections go to a 10 pin gold plated edge connector
- Board only \$4.50; with parts \$7.00

DC POWER SUPPLY *



Part no. 6085

- Board supplies a regulated +5 volts at 3 amps., +12, -12, and -5 volts at 1 amp.
- Power required is 8 volts AC at 3 amps., and 24 volts AC C.T. at 1.5 amps.
- Board only \$12.50; with parts \$42.50 excluding transformers

Part no. 111

TAPE INTERFACE *

- Play and record Kansas City Standard tapes
- Converts a low cost tape recorder to a digital recorder
- Works up to 1200 baud
- Digital in and out are TTL-serial
- Output of board connects to mic. in of recorder
- Earphone of recorder connects to input on board
- Requires +5 volts, low power drain
- Board \$7.60; with parts \$27.50
- No coils

Part no. 107

RF MODULATOR *

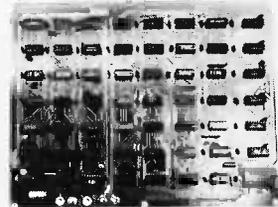
- Converts video to AM modulated RF, Channels 2 or 3
- Power required is 12 volts AC C.T., or +5 volts DC
- Board \$7.60; with parts \$13.50

Apple II Serial I/O Interface *

Part No. 2

- Baud rates up to 30,000
 - Plugs into Apple Peripheral connector
 - Low-current drain
 - RS-232 Input and Output
- SOFTWARE
- Input and Output routine from monitor or BASIC to teletype or other serial printer.
 - Program for using an Apple II for a video or an intelligent terminal. Board only - \$15.00; with parts - \$42.00; assembled and tested - \$62.00.

TELEVISION TYPEWRITER



Part no. 106

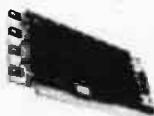
- Stand alone TVT
- 32 char/line, 16 lines, modifications for 64 char/line included
- Parallel ASCII (TTL) input
- Video output
- 1K on board memory
- Output for computer controlled cursor
- Auto scroll
- Non-destructive cursor
- Cursor inputs: up, down, left, right, home, EOL, EOS
- Scroll up, down
- Requires +5 volts at 1.5 amps, and -12 volts at 30 mA
- All 7400, TTL chips
- Char. gen. 2513
- Upper case only
- Board only \$39.00; with parts \$145.00

MODEM *

Part no. 109

- Type 103
- Full or half duplex
- Works up to 300 baud
- Originate or Answer
- No coils, only low cost components
- TTL input and output-serial
- Connect 8 ohm speaker and crystal mic. directly to board
- Uses XR FSK demodulator
- Requires +5 volts
- Board \$7.60; with parts \$27.50

8K STATIC RAM



Part no. 300

- 8K Altair bus memory
- Uses 2102 Static memory chips
- Memory protect
- Gold contacts
- Wait states
- On board regulator
- S-100 bus compatible
- Vector input option
- TRI state buffered
- Board only \$22.50; with parts \$160.00

TIDMA *

Part no. 112

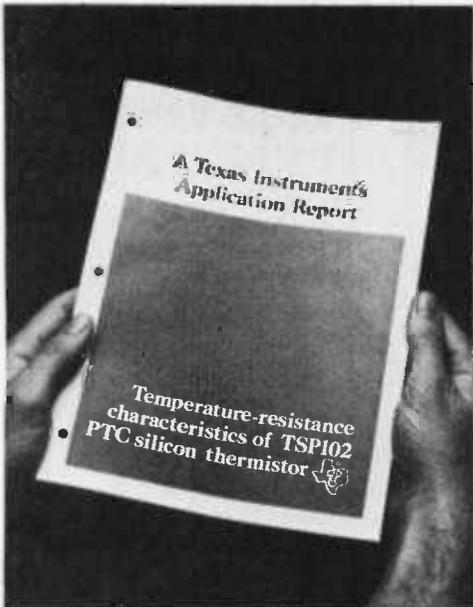
- Tape Interface Direct Memory Access
- Record and play programs without bootstrap loader (no prom) has FSK encoder/decoder for direct connections to low cost recorder at 1200 baud rate, and direct connections for inputs and outputs to a digital recorder at any baud rate.
- S-100 bus compatible
- Board only \$35.00; with parts \$110.00

To Order:



Mention part number and description. For parts kits add "A" to part number. Shipping paid for orders accompanied by check, money order, or Master Charge, BankAmericard, or VISA number, expiration date and signature. Shipping charges added to C.O.D. orders. California residents add 6.5% for tax. Parts kits include sockets for all ICs, components, and circuit board. Documentation is included with all products. Dealer inquiries invited. 24 Hour Order Line: (408) 374-5984.* Designed by John Bell.

Temperature Resistance Applications Report



Bulletin CA-195 from Texas Instruments, POB 5012, Dallas TX 75222, explains the temperature-resistance characteristics of the TSP102 PTC silicon thermistor. The 22-page applications report is titled *Temperature-Resistance Characteristics of the TSP102 Positive-Temperature-Coefficient Silicon Thermistor* and can be obtained by writing to the company. ■

Circle 654 on inquiry card.

Manual on Relocatable Assembler for 2650

A manual describing the Signetics 2650 Relocatable Assembler can be purchased for \$4 from Signetics. The assembler is a two pass program that builds a symbol table, issues error messages, produces a program listing, and outputs a computer readable object (load) module. The program includes conditional assembly, symbolic and relative addressing, forward references, free format source code, self-defining constants, complex expression evaluation, relocatability, and pseudo operations. The assembler is capable of generating data in several number based systems, including ASCII character code.

The manual covers such subjects as a summary of 2650 instruction mnemonics, ASCII code and character set, conversion of previous cross assembler source programs and 2650 assembler grammar.

Contact Signetics, MOS Microprocessor Marketing, POB 9052, 811 E Arques Av, Sunnyvale CA 94086, (408) 739-7700. ■

Circle 655 on inquiry card.

Computer Aided Education Materials

ENTELEK is currently offering a large list of directories, reports, conference proceedings, and periodicals on the subject of computer-based education. Among the nearly 30 titles offered are *Index to Computer Based Learning - 1976*, *Research Guidelines For Computer-Assisted Instruction*, *The LOGO Language - Learning Mathematics Through Programming*, *Proceedings of the Fall 1976 EDUCOM Conference*, and the 1978 edition of *Computer Based Education Abstracts* compiled by ENTELEK. The *ENTELEK CBE Abstracts* contain selected reports summarized in abstracts up to 250 words in length and brought together under headings that include "CAI in Reading," "CAI in Science," "Computer Aided Counselling," "Minicomputers," "Networks," "Decision Rules," "Simulation," etc. A complete list of titles and prices is available from ENTELEK, Dept T, POB 810, Newburyport MA 01950. ■

Circle 656 on inquiry card.

Electric Counter Selection Guide

A new six page, four color selection guide from Hewlett-Packard summarizes specifications and characteristics of 15 counters in HP's electronic counter line. Included are models from simple, low cost, frequency counters to sophisticated high speed universal and microwave counters. Described are two new microprocessor controlled models: Model 5342A Microwave Counter for automatic measurements to 18 GHz, and the Model 5370A Universal Time Interval Counter with a resolution of ± 20 picoseconds. The selection guide *Electronic Counters* is available free of charge from Hewlett-Packard, 1501 Page Mill Rd, Palo Alto CA 94304. ■

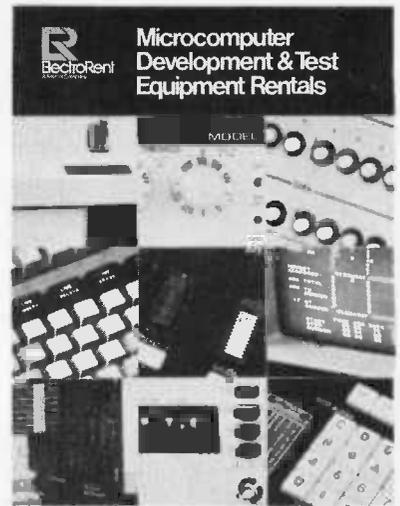
Circle 658 on inquiry card.

Free Computer Guides

To keep you up to date on new computer products, stores, etc, the following guides are available free of charge: *A Shopping Guide to Computer Stores*, *A Guide to Computing Magazines and Books*, *A Guide to Computer Clubs and User Groups*, *A Guide to the Home Computer*. Each guide is approximately 50 pages long. To get a copy of any guide simply write to Microcomputer Resource Center, 5150 Anton Dr, Room 212, Madison WI 53719. It would be appreciated by the Center if you would send \$.35 in stamps for 1st class postage for each guide requested (18¢ for 3rd class). ■

Circle 657 on inquiry card.

Electro Rent Microcomputer Development and Test Equipment Rental Catalog



This 8 page catalog features nearly 200 pieces of the latest microcomputer and minicomputer development and test equipment available for rental. Equipment manufacturers include Intel, Tektronix, Biomation, Prolog, Digital Equipment, Beehive, Hewlett-Packard, ICOM, Remex and Texas Instruments. For further information contact Electro Rent, 4131 Vanowen Pl, Burbank CA 91505. ■

Circle 573 on inquiry card.

New "Breadboarding and Test Equipment" Catalog

A new, full-color 12 page catalog is available describing Continental Specialties Corporation's entire line of electronic prototyping development and testing hardware. The contents include quick test sockets, experimenter sockets, and Proto Board breadboards, Design Mate test instruments, Proto Clip IC test clips and clip-on IC Logic Monitors. *Breadboarding & Test Equipment* is available from Continental Specialties Corporation, 70 Fulton Ter, New Haven CT 06509. ■

Circle 572 on inquiry card.

Industrial Control Microcomputers Brochure

A new 8 page brochure describes Wyle's line of microcomputers, digital logic modules, and software. The line includes parallel and serial digital IO, analog IO, communications modules and a wide variety of other units including over 200 digital logic modules. Also available are modules to allow the Wyle hardware to couple directly to existing 4-20 and 10-50 mA current loops. To obtain a copy of this brochure contact Wyle Laboratories Computer Products, 3200 Magruder Blvd, Hampton VA 23666. ■

Circle 571 on inquiry card.

**NEW
ANNOUNCING**

The EW-2001 A "Smart" VIDEO BOARD KIT At A "Dumb" Price!

A VIDEO BOARD + A MEMORY BOARD + AN I/O BOARD - ALL IN ONE!

- STATE OF THE ART TECHNOLOGY USING DEDICATED MICROPROCESSOR I.C.
- NUMBER OF I.C.s REDUCED BY 50% FOR HIGHER RELIABILITY ■ MASTER PIECE OF ENGINEERING ■ FULLY SOFTWARE CONTROLLED

\$199.95

Priced at ONLY Basic Software Included

SPECIAL FEATURES:

- S-100 bus compatible
- Parallel keyboard port
- On board 4K screen memory (optional)* relocatable to main computer memory
- Text editing capabilities (software optional)
- Scrolling: up and down through video memory
- Blinking characters
- Reversed video
- Provision for on board ROM
- Provision for onboard scratch pad RAM (256 x 8)
- CRT and video controls fully programmable (European TV)

- Programmable no. of scan lines
 - Underline blinking cursor
 - Cursor controls: up, down, left, right, home, carriage return
 - Composite video
- *Min. 2K required for operation of this board.

DISPLAY FEATURES:

- 128 displayable ASCII characters (upper and lower case alphanumeric, controls)
- 64 or 32 characters per line (jumper selectable)
- 32 or 16 lines (jumper selectable)
- Screen capacity 2048 or 512
- Character generation: 7 x 11 dot matrix

OPTIONS:

- Sockets \$10.00
- 2K Static Memory (with Sockets) \$45.00
- 4K Static Memory (with Sockets) \$90.00
- Complete unit, assembled and tested with 4K Memory \$335.00
- Basic software on ROM . . . \$20.00
- Text editor on ROM \$75.00

**DEALER
INQUIRIES WELCOMED**

APPLE II I/O BOARD KIT

Plugs into slot of APPLE II MOTHER BOARD

FEATURES:

- 1 8-Bit Parallel Output Port (Expandable to 3 Ports)
- 1 Input Port
- 15mA Output Current Sink or Source
- TTL or CMOS Compatible
- Addressable anywhere in memory output area
- Can be used for peripheral equipment such as printers, floppy discs, cassettes, paper tapes, etc.

KIT INCLUDES:

P.C. Board, I.C.'s Sockets and Assembly Manual.

PRICE:

- 1 Input and 1 Output Port **\$49**
- 1 Input and 3 Output Ports **\$64**

**DEALER
INQUIRIES INVITED**

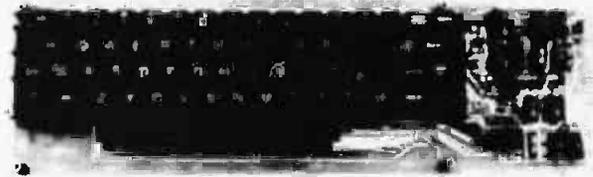
INSTRUCTION MANUAL AND SOFTWARE LISTINGS AVAILABLE FOR:

- PR-40 SWTPC Printer \$10.00
- Converted Selectric \$10.00

SHIPPING: Keyboard and Video Board: \$3.50; I/O Board: \$1.00
California residents add 6% sales tax

ELECTRONICS WAREHOUSE Inc.
1603 AVIATION BLVD.
REDONDO BEACH, CA. 90278
TEL. (213) 376-8005
WRITE FOR FREE CATALOG
You are invited to visit our store at the above address

ASCII 3rd GENERATION *ONLY KEYBOARD KIT \$68.00



- TTL Logic Circuits
- Power: +5V 275mA
- Upper and Lower Case
- Full ASCII Set (Alpha Numeric, Symbols, Control)
- 7 or 8 Bits Parallel Data
- Optional Serial Output
- Selectable Positive or Negative Strobe, and Strobe Pulse Width
- 'N' Key Roll-Over
- Fully Debounced
- Carriage Return Key
- Repeat Function Key
- Shift Lock, 2 Shift Keys
- 4 User Defineable Keys
- P.C. Board Size: 17-3/16" x 5"

OPTIONS:

- Metal Enclosure Painted IBM Blue and White) \$25.00
- 18 Pin Edge Con. \$2.00
- I.C. Sockets \$4.00
- Serial Output (Shift Register) \$2.00
- Upper Case Lock Switch for Capital Letters and Numbers \$2.00

KIT INCLUDES: Keyboard, P.C. Board, all required components & assembly manual.

NOTE: If you have this 63 Key Teletype Keyboard you can buy the Kit without it for only \$44.95.

cybercom BOARDS

- MB-1** MK-8 Computer RAM (not S-100), 4KX8, uses 2102 type RAMs, PCBD only\$22.00
- MB-3** 1702A EROM Board, 4KX8, S-100 switchable address and wait cycles, kit less PROMS.....\$58.00
- MB-4** Basic 4KX8 ram, uses 2102 type rams S-100 buss. PC board\$25.95
- MB-6A** Basic 8KX8 ram uses 2102 type rams. S-100 buss. PCBD\$25.95
- MB-7** 16KX8, Static RAM uses μ P410 Protection, fully buffered. KIT.....\$375.00
- MB-8** 2708 EROM board, S-100, 8KX8 or 16KX8 kit without PROMS\$65.00
- MB-9** 4KX8 RAM/PROM Board uses 2112 RAMS or 82S129 PROM kit without RAMs or PROMs\$72.00
- 10-2 S-100 8 bit parallel I/O port, $\frac{1}{2}$ of boards is for kludging. Kit\$46.00 PCBD.....\$25.95
- 10-4 Two serial I/O ports with full handshaking 20/60 ma current loop: Two parallel I/O ports. Kit\$130. PCBD\$29.95
- VB-1B** 64 x 16 video board, upper lower case Greek, composite and parallel video with software, S-100. Kit\$125.00 PCBD\$25.95
- Allair Compatible Mother Board, 11 x 11 $\frac{1}{2}$ x $\frac{1}{8}$ ". Board only\$40.00. With 15 connectors\$90.00
- Extended Board full size. Board only\$ 9.00
- With connector\$13.00
- SP-1** Synthesizer Board S-100
- New Low Price.....Kit\$135.95

82S23	\$1.50	PRIME DEVICES	
82S123	1.50		
82S114	2.95	8080A	\$12.00
82S115	5.50	8212	3.75
82S126	1.95	8214	6.30
82S129	1.95	8216	3.95
82S130	3.00	8224	5.00
82S131	3.00	8228	6.95
82S136	3.95	8251	9.95
82S141	3.95	8255	9.95
MMI6330	1.50		

WMC inc. WAMECO INC.

- MEM-1** 8KX8 fully buffered, S-100 uses 2102 type rams. PCBD\$25.95
- Mother Board** 12 slot, terminated, S-100, board only\$30.95
- CPU-1** 8080A Processor board S-100 with 8 level vector interrupt PCBD\$25.95
- RTC-1** Realtime clock board. Two independent interrupts. Software programmable. PCBD\$23.95
- EPM-1** 1702A 4K Eprom card PCBD\$25.95
- 10% discount on 10 or more of WAMECO PCBD in any combination.
- 2102AL-2 Prime 250 NSEC\$1.60
- 2102AL-4 Prime 450 NSEC\$1.25
- 2708 Intel Prime (.5USEC)\$15.00
- 2708 Prime (National)\$10.00
- 1702A-6 AMD Prime\$3.50
- 1702A Intel Nct Prime (2US)\$1.50
- TMS-6011 Prime\$6.95
- 2501B\$1.50 1488N\$1.50
- 2502B1.50 1489N1.25
- 25041.50 40442.25
- 2507V1.50 80383.90
- 2510A1.50 53205.95
- 2517V1.50 55541.90
- 2518B1.50 55552.50
- 2519B1.50 55562.50
- 25211.50 50551.25
- 25221.50 53124.00
- 25251.50 MH00251.50
- 25271.50 MH00261.75
- 2532V1.50 MH00281.90
- 25292.75
- 2533V1.95

MIKOS PARTS ASSORTMENTS

All piece parts for assembly of Wameco and SSM PCBD's. All Factory Marketed Parts. Order PCBDs right.

- Mikos #1** Parts for MEM-1 PCBD with prime 2102AL-4 450 nsec rams. Less PCBD\$103.00
- Mikos #2** Parts for CPU-1 PCBD with prime 8080A 8212's and 8214. Less PCBD\$60.00
- Mikos #3** Parts for MEM-1 PCBD with prime 2102AL-2 250 nsec rams. Less PCBD\$113.00
- Mikos #4** Parts for QM-1A with super low loss gold plated connectors. Less PCBD.\$52.00
- Mikos #5** Parts for RTC-1. Less PCBD\$40.00
- Mikos #6** Parts for VB-1B less molex connectors and PCBD.\$62.00

82S06	\$1.00	8T26	\$2.00
82S07	1.00	8T28	2.00
82S50	1.00	8T34	2.50
82S62	1.00	8T37	2.50
82S90	1.00	8T38	2.50
82S91	1.00	8T74	1.50
8T01	2.50	8T80	2.50
8T09	1.25	8T90	2.50
8T10	2.50	8T95	2.30
8T13	2.50	8T96	2.45
8T14	2.50	8T97	1.50
8T20	2.50	8T98	2.00
8T23	3.00	8T110	2.00
8T24	2.50	567	1.50

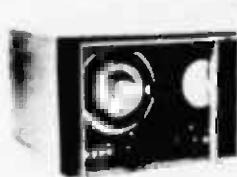
MIKOS

419 Portofino Drive
San Carlos, California 94070

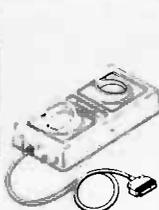
Please send for IC, Xistor
and Computer parts list.

Check or money order only. If you are not a regular customer and your order is large please send either a cashier's check or a postal money order, otherwise there will be a delay of two weeks for the check to clear. All items post paid in the U.S. Calif. residents add 6% tax. Money back 30 day guarantee. We cannot accept returned IC's that have been soldered to. Prices subject to change without notice. \$10 minimum order. \$1.00 service charge on orders less than \$10.

COMMERCIAL GRADE EQUIPMENT - HOBBYIST PRICES!!



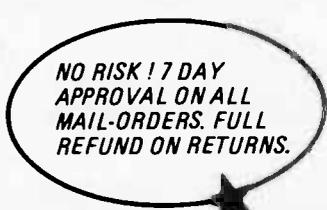
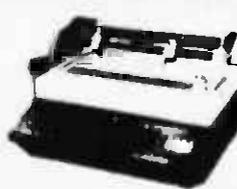
TAPE DRIVES



MODEMS AND PHONE COUPLERS



SELECTRIC TERMINALS



- **AMPEX MODEL TMX TAPE DRIVES** with built-in NRZ1 formatter. 800 BPI, 9 track, 12 IPS, 8" reel includes 8 bit CPU controller diagram and 8080 interface instructions. Ideal for microcomputerist who wants back-up mass storage and access to IBM-type systems via standardized $\frac{1}{2}$ " maq tape...\$750
- **AMCOMP SERIES 2700 TAPE DRIVES:** current model, vacuum column control; like new:
 - (2) MODEL 2749 - 45 ips, 800 BPI, 7-Track, 10" reel.....\$1500
 - (3) MODEL 2769 - 125 ips, 800/1600 BPI, 9-Track, 10" reel...\$3000
- **TAPE DRIVE FORMATTERS** "Pertec Standard Interface":
 - (3) AMCOMP SERIES 2900 NRZ1/Phase Encoded, 25-125 ips...\$1500
 - (1) PICO MODEL 1011, NRZ1, 800 BPI FORMATTER / CONTROLLER for PDP-11.....\$2000
- **MODEMS, Full-Duplex, Auto Answer circuitry, by VADIC CORP.**
 - BELL 103 Type (300 Baud) Circuit Card only.....\$75
 - BELL 103 Circuit Card, Power Supply, Case, Connectors\$125
 - BELL 202 Type (1200 Baud) with Reverse Channel Transmission from \$125
 - **DB-25 MALE CONNECTOR + 2 wire cable to Phone Jack.**\$4
 - **PAPER TAPE READER (ADDMASTER 601-1):** 150 cps, LED sensors read 5-8 level tapes, bi-directional stepper motor, includes TTL serial interface plus 8080 parallel interface instructions. Requires +5V & 24V.....\$90
 - **DATATEST PROGRAMMABLE AUTOMATIC CIRCUIT CARD ANALYZER MODEL 4000A.**\$2000
 - **DATATEST PROGRAMMABLE AUTOMATIC CIRCUIT CARD ANALYZER MODEL 4700.**\$6000
 - **DIABLO SYSTEMS Spare Circuit Cards for HyType Printer, Series 20 + 40**
 - Disk Drives; complete but defective or below current revision level.\$20
 - **ASCII ENCODED KEYBOARD** from HyType Terminal, never used\$60
 - **TELEPHONE ACOUSTIC COUPLER.**\$30

- **SELECTRIC I/O TERMINALS** (by GTE/INFORMATION SYSTEMS). Includes 8080 interface plus software ASCII translation and I/O driver routines 15" carriage, interchangeable type spheres & carbon/fabric ribbons. Built-in modem optional.
 - MODEL 5541 (IBM Correspondence Code, 2741-type terminal).....\$895
 - MODEL 5550 (Corres. Code w/350 char. line buffer memory + built-in cassette drive for data storage/off-line printing/word processing).....\$1495
 - MODEL 5560 (ASCII Code, with cassette tape drive).....\$1495
- **IBM SELECTRIC TYPEWRITER** with magnets, switches & magnet driver PCB (from GTE/IS Terminal) plus instructions for 8080 printer/driver interface. Typewriter mechanism complete, cleaned & adjusted.....\$325
 - Aluminum Case & Power Supply (+24V, \pm 12V, +5V @ 5V).....\$75
- **CONVERT IBM OFFICE SELECTRIC to I/O Typewriter:** solenoids, switches, wire harness, magnet driver PCB plus instructions + 8080 Interface Diaq. \$150
- **IBM PIN-FEED PLATENS** for 15" SELECTRICS (13 1/8 pin-to-pin) new \$50
- **IBM SELECTRIC APL TYPE SPHERES** (Specify EBCDIC or Correspondence Code). new.....\$15
- **FORMS TRACTORS, Moore Variable-width "Form-A-Liner".**new \$50 for 15" Carriage IBM SELECTRICS.....used \$30
- **DIGITAL CASSETTE DRIVE** (from GTE/IS Terminal) 2400 baud, FWD/REWIND/STOP circuitry, plus tape head, but no read/writes electronics.\$25
- **INTERDATA 8-BIT MINICOMPUTER (Model One),** includes full front panel, 4K core memory (16K addressable), plug-in teletype port; optional serial I/O + Tape Drive Controller PCB's software.....\$300
- **RIBBON CABLE 50 Strand X 4' long terminated with 3M edge connector** (.10" spacing) + paddle card\$3
- **AC LINE FILTER 10AMP RFI (110/230V) with Line Relay + Fuses** new \$50

Call or write for details, quantity discounts, order forms. All orders shipped from stock - no back orders, no substitutions. All equipment is shipped insured FOB Palo Alto within 7 days after check clears or COD order is received. M/C & VISA cards accepted.

PACIFIC OFFICE SYSTEMS, INC.
2600 EL CAMINO REAL, SUITE 502
PALO ALTO, CALIF. 94306
Tel: (415) 321 3866

90 day warranty against defects in material or workmanship on all used equipment. Full documentation included PLUS interface instructions where indicated. Availability subject to prior sale. Prices may change without notice.

DIODES/ZENERS				SOCKETS/BRIDGES				TRANSISTORS, LEADS, etc.			
1N914	100v	10mA	.05	8-pin pcb	.25	ww	.45	2N2222A	NPN	(2N2222 Plastic .10)	.15
1N4005	600v	1A	.08	14-pin pcb	.25	ww	.40	2N2907A	PNP		.15
1N4007	1000v	1A	.15	16-pin pcb	.25	ww	.40	2N3906	PNP	(Plastic)	.10
1N4148	75v	10mA	.05	18-pin pcb	.25	ww	.75	2N3904	NPN	(Plastic)	.10
1N753A	6.2v	z	.25	22-pin pcb	.45	ww	1.25	2N3054	NPN		.35
1N758A	10v	z	.25	24-pin pcb	.35	ww	1.10	2N3055	NPN	15A 60v	.50
1N759A	12v	z	.25	28-pin pcb	.35	ww	1.45	T1P125	PNP	Darlington	.35
1N4733	5.1v	z	.25	40-pin pcb	.50	ww	1.25	LED Green, Red, Clear, Yellow			.15
1N5243	13v	z	.25	Molex pins .01	10-3 Sockets		.45	D.L.747	7 seg 5/8" High com-anode		1.95
1N5244B	14v	z	.25	2 Amp Bridge	200-prv		1.20	XAN72	7 seg com-anode (Red)		1.25
1N5245B	15v	z	.25	25 Amp Bridge	200-prv		1.95	MAN71	7 seg com-anode (Red)		1.25
								MAN3610	7 seg com-anode (Orange)		1.25
								MAN82A	7 seg com-anode (Yellow)		1.25
								MAN74A	7 seg com-cathode (Red)		1.50
								FND359	7 seg com-cathode (Red)		1.25

C MOS			T T L			LINEARS, REGULATORS, etc.					
4000	.15	7400	.15	7473	.25	74176	1.25	74H72	.45	74S133	.40
4001	.15	7401	.15	7474	.30	74180	.75	74H101	.75	74S140	.55
4002	.20	7402	.20	7475	.35	74181	2.25	74H103	.75	74S151	.30
4004	3.95	7403	.20	7476	.40	74182	.95	74H106	.95	74S153	.35
4006	.95	7404	.15	7480	.55	74190	1.75			74S157	.75
4007	.35	7405	.25	7481	.75	74191	1.05	74L00	.25	74S158	.30
4008	.95	7406	.35	7483	.95	74192	.75	74L02	.25	74S194	1.05
4009	.45	7407	.55	7485	.75	74193	.85	74L03	.30	74S257 (8123)	1.05
4010	.45	7408	.25	7486	.25	74194	1.25	74L04	.30		
4011	.20	7409	.15	7489	1.35	74195	.95	74L10	.30	74LS00	.25
4012	.20	7410	.10	7490	.55	74196	1.25	74L20	.35	74LS01	.35
4013	.40	7411	.25	7491	.95	74197	1.25	74L30	.45	74LS02	.35
4014	.95	7412	.30	7492	.95	74198	2.35	74L47	1.95	74LS04	.30
4015	.90	7413	.35	7493	.35	74221	1.00	74L51	.45	74LS05	.45
4016	.35	7414	1.10	7494	.75	74367	.85	74L55	.65	74LS08	.25
4017	1.10	7416	.25	7495	.60			74L72	.45	74LS09	.35
4018	1.10	7417	.40	7496	.80	75108A	.35	74L73	.40	74LS10	.35
4019	.50	7420	.15	74100	1.15	75110	.35	74L74	.45	74LS11	.35
4020	.85	7426	.30	74107	.35	75491	.50	74L75	.55	74LS20	.25
4021	1.00	7427	.45	74121	.35	75492	.50	74L93	.55	74LS21	.25
4022	.85	7430	.15	74122	.55			74L123	.85	74LS22	.25
4023	.25	7432	.30	74123	.55	74H00	.15			74LS32	.40
4024	.75	7437	.30	74125	.45	74H01	.25	74S00	.35	74LS37	.35
4025	.30	7438	.35	74126	.35	74H04	.20	74S02	.35	74LS40	.45
4026	1.95	7440	.25	74132	1.35	74H05	.20	74S03	.30	74LS42	1.10
4027	.50	7441	1.15	74141	.90	74H08	.35	74S04	.30	74LS51	.50
4028	.95	7442	.45	74150	.85	74H10	.35	74S05	.35	74LS74	.65
4030	.35	7443	.65	74151	.65	74H11	.35	74S08	.35	74LS86	.65
4033	1.50	7444	.45	74153	.75	74H15	.45	74S10	.35	74LS90	.95
4034	2.45	7445	.65	74154	.95	74H20	.30	74S11	.35	74LS93	.95
4035	1.25	7446	.95	74156	.95	74H21	.25	74S20	.35	74LS107	.85
4040	1.35	7447	.95	74157	.65	74H22	.40	74S40	.20	74LS123	1.00
4041	.69	7448	.65	74161	.85	74H30	.20	74S50	.20	74LS151	.95
4042	.95	7450	.25	74163	.85	74H40	.25	74S51	.25	74LS153	1.20
4043	.95	7451	.25	74164	.60	74H50	.25	74S64	.20	74LS157	.85
4044	.95	7453	.20	74165	1.50	74H51	.25	74S74	.35	74LS164	1.90
4046	1.75	7454	.25	74166	1.35	74H52	.15	74S112	.60	74LS367	.75
4049	.45	7460	.40	74175	.80	74H53J	.25	74S114	.65	74LS368	.75
4050	.45	7470	.45			74H55	.20			74C04	.25
4066	.95	7472	.40							74C151	2.25
4069	.40										
4071	.35										
4081	.70										
4082	.45										
MC14409	14.50										
MC14419	4.85										

9000 SERIES		
9301	.85	95H03 1.10
9309	.35	9601 .45
9322	.75	9602 .45

MICRO'S, RAMS, CPU'S, ETC.	
74S188	3.00
1702A	4.50
MM5314	3.00
MM5316	3.50
2102-1	1.45
2102L-1	1.75
TR1602B	4.50
TMS 4044-45N L	14.50
8080AD	12.00
8T13	1.50
8T23	1.50
8T24	2.00
8T97	1.00
2107B-4, A	4.00
2708	11.50

MCT2	.95	LM320T5	1.65	LM340K15	1.25	LM723	.50
8038	3.95	LM320T12	1.65	LM340K18	1.25	LM725N	2.50
LM201	.75	LM320T15	1.65	LM340K24	.95	LM739	1.50
LM301	.45	LM324N	.95	78L05	.75	LM741 (8-14)	.25
LM308 (Mini)	.95	LM339	.95	78L12	.75	LM747	1.10
LM309H	.65	7805 (340T5)	.95	78L15	.75	LM1307	1.25
LM309K (340K-5)	.85	LM340T12	1.00	78M05	.75	LM1458	.95
LM310	1.15	LM340T15	1.00	LM373	2.95	LM3900	.50
LM311D (Mini)	.75	LM340T18	1.00	LM380 (8-14 PIN)	.95	LM75451	.65
LM318 (Mini)	.95	LM340T24	.95	LM709 (8, 14 PIN)	.25	NE555	.50
LM320K5(7905)	1.65	LM340K12	1.65	LM711	.45	NE556	.95
LM320K12	1.65					NE565	.95
						NE566	1.75
						NE567	1.35

INTEGRATED CIRCUITS UNLIMITED

7889 Clairemont Mesa Boulevard, San Diego, California 92111
(714) 278-4394 (Calif. Res.)

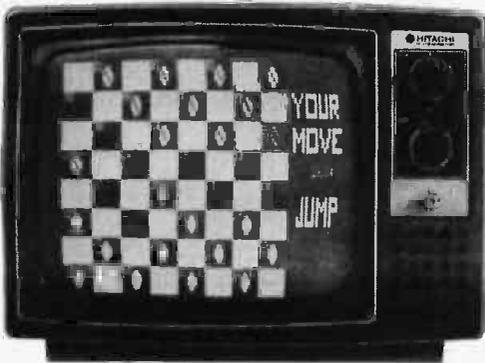
All orders shipped prepaid	No minimum
Open accounts invited	COD orders accepted

Discounts available at OEM Quantities California Residents add 6% Sales Tax
All IC's Prime/Guaranteed. All orders shipped same day received.

24 Hour Toll Free Phone 1-800-854-2211 **American Express / BankAmericard / Visa / MasterCard**

SPECIAL DISCOUNTS	
Total Order	Deduct
\$35 - \$99	5%
\$100 - \$300	10%
\$301 - \$1000	15%
\$1000 - Up	20%

Video Checkers on Cassette for PolyMorphic Video Interface



Compu-Quote has developed several games on cassettes, recorded in the Tarbell format and programmed in MITS BASIC.

Contained on one cassette is Video Checkers, which produces checkerboard graphics on a video display when used with the PolyMorphic Video Interface and 64 character option. The game plays under MITS BASIC (3.1). Two versions

of the program on one 60 minute cassette play a challenging game which conforms to international rules. The first version requires a total of 16 K of memory, inclusive of 8 K BASIC. The second version is more graphic and requires an additional 4 K.

The checkerboard is pictorially displayed on the video monitor. As the player and computer each take turns, the checkers blink and move to indicate their passage. Kinged pieces are identified on the display and messages appear at the right of the board relating to each move. In accordance with international rules of the game, the program will not accept illegal moves and warns of their entry.

Included with Video Checkers is a 9 page instruction book. The author of Video Checkers has invited purchasers of the cassette to add enhancements to the program. Therefore an entire program listing is included. Video Checkers and manual will be ordered for \$10 from Compu-Quote, 6914 Berquist Av, Canoga Park CA 91307. ■

Circle 648 on inquiry card.

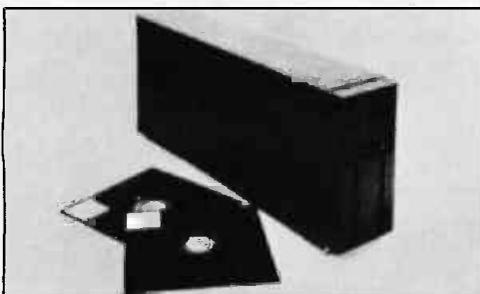
Low Cost Business Software Package

This new, low cost general business software package for microcomputers includes general ledger, accounts receivable, accounts payable, finished goods inventory control and payroll. The Grimes Business Information System (GBIS) is specifically designed for small businesses. In a typical application the GBIS can store up to 400 customer listings, 50 vendors, 400 line items of inventory, 25 employee records and 60 general ledger accounts on a single minifloppy diskette. Requiring only 24 K of memory, the GBIS is a system

in which receivables decrease book inventory, payables increase book inventory, and general ledger accounts are updated automatically. GBIS is written in North Star BASIC, although other disk BASIC languages can be used for the listings. There are 51 programs with 120 pages of documentation. A GBIS Users Group has been formed entitling purchasers to updates as they become available. The cost is \$200 (include \$2.50 to cover postage and handling). The package can be obtained from The Computer Mart, 633 W Katella Av, Orange CA 92667. ■

Circle 649 on inquiry card.

INFO 2000 Disk Systems Fully Software Supported for 8080 and Z-80



INFO 2000 Disk Systems owners may now utilize expanded software for both 8080 and Z-80 microcomputers. Previously, the INFO 2000 Corporation offered Z-80 based software only for their disk systems, but have increased the disk operating software capability using Digital Research CP/M.

Among the software packages which operate under CP/M are two full versions of disk BASIC, including Microsoft Extended Disk BASIC (4.41), priced at \$350. Also available is a Structured Systems Group QSORT at \$95. This is a high speed, general purpose sort package. A name and address maintenance system, called NAD, includes mailing labels, and is priced at \$79. The manufacturer states that all software is currently available for immediate delivery for use in INFO 2000 Disk Systems.

Still available for Z-80 systems is the complete TDL software package including 12 K BASIC, macro assembler, Z-TEL text editor and word processor. INFO 2000 has expanded this software to operate under CP/M and Zapelle operating systems. The entire software package is priced at \$215.

All INFO 2000 software is designed to operate on INFO 2000 Disk Systems

Z-80 and 8080 Business Programs

Structured Systems Group announces a series of business programs designed to run on the 8080 or Z-80 processors with the CP/M operating system. All software comes fully documented. The following products are being offered:

General Ledger (GL) is a comprehensive system designed for professional accountants and small businesses. Any number of custom charts of accounts may be set up to handle single or multiple departments. The system verifies data interactively. Report formats and headings may be customized. Documentation is included, and no prior computer knowledge is required. Written in CBASIC, the GL system costs \$995.

The Name and Address (NAD) system maintains files and allows selection on all fields for printing labels, reports, or new files. NAD is documented and written in CBASIC. The price is \$79.

QSORT is a fast full disk sort and merge program featuring automatic operation, multiple sort keys, and complete backup. In 8080 code, the price is \$95.

CBASIC is a comprehensive, commercially oriented compiler and interpreter including full disk access, a PRINT USING feature, 14 digits of precision, and an 85 page manual. The price is \$99.95.

For more information, contact Structured Systems Group, 5615 Kales Av, Oakland CA 94618, (415) 547-1567. ■

Circle 650 on inquiry card.

New Natural Language Operating System

NLOS is a phase oriented natural language operating system. Information in the form of sentences entered into the system is broken down into phrases which are classified both grammatically and by the type of information they convey. This is made possible by a dictionary of phrases maintained by the system in programmable memory. Hardware requirements include any 8080 or Z-80 processor, audio cassette tape interface, a serial IO board and a minimum of 12 K of programmable memory. NLOS/1 comes with a fully documented set of assembly language source listings with commentary on possible ways to use NLOS/1. The price for NLOS is \$200; it can be obtained from Cybermate, RD #3, POB 192A Nazareth PA 18064. ■

Circle 651 on inquiry card.

which employ the PerSci 277 dual diskette drive with intelligent controller. The disk system is available for all Altair (S-100) microcomputers using Z-80 or 8080 processors, for Digital Group Z-80 and 8080 systems and for the Heathkit H8. Contact INFO 2000 Corp, 20630 S Leapwood Av, Carson CA 90746, (213) 532-1702. ■

Circle 652 on inquiry card.

SOCKET JUMPERS

Mates with two rows of .025" sq. dia. posts on patterns of .100" centers and shielded receptacles. Probe access holes in back. Choice of 6" or 18" length.

Part No.	No. of Contacts	Length	Price
924003-18R	26	18"	\$ 5.38 ea.
924003-06R	26	6"	4.78 ea.
924005-18R	40	18"	8.27 ea.
924005-06R	40	6"	7.33 ea.
924006-18R	50	18"	10.31 ea.
924006-06R	50	6"	9.15 ea.

JUMPER HEADERS

Solder to PC boards for instant plug-in access via socket-conductor jumpers. .025" sq. posts. Choice of straight or right angle.

Part No.	No. of Posts	Angle	Price
923863-R	26	straight	\$1.28 ea.
923873-R	26	right angle	1.52 ea.
923865-R	40	straight	1.94 ea.
923875-R	40	right angle	2.30 ea.
923866-R	50	straight	2.36 ea.
923876-R	50	right angle	2.82 ea.

INTRA-CONNECTOR

Provides both straight and right angle functions. Mates with standard .10" x .10" dual row connectors (i.e. 3m, Ainsley, etc.). Permits quick testing of inaccessible lines.

Part No.: 922576-26 No. of contacts: 26 Price \$6.90 ea.

INTRA-SWITCH

Permits instant line-by-line switching for diagnostic or QA testing. Switches actuated with pencil or probe tip. Mates with standard .10" x .10" dual-row connectors. Low profile design. Switch buttons recessed to eliminate accidental switching.

Part No.: IS-26 No. of contacts: 26 Price \$13.80 ea.

CRYSTALS

THESE FREQUENCIES ONLY

PART NO.	FREQUENCY	CASE	PRICE
CY1A	1.000MHz	HC33	5.95
CY1.84	1.8432MHz	HC33	5.95
CY2A	2.000MHz	HC33	5.95
CY2.01	2.010MHz	HC33	1.95
CY2.50	2.500MHz	HC33	4.95
CY3.27	3.2768MHz	HC33	4.95
CY3.57	3.579545MHz	HC33	4.95
CY3A	4.000MHz	HC18	4.95
CY4.91	4.916MHz	HC18	4.95
CY7A	5.000MHz	HC18	4.95
CY5.18	5.185MHz	HC18	4.95
CY6.14	6.144MHz	HC18	4.95
CY6.40	6.400MHz	HC18	4.95
CY6.55	6.5536MHz	HC18	4.95
CY12A	10.000MHz	HC18	4.95
CY14A	14.31818MHz	HC18	4.95
CY19A	18.000MHz	HC18	4.95
CY18.43	18.432MHz	HC18	4.95
CY22A	20.000MHz	HC18	4.95
CY30A	32.000MHz	HC18	4.95

SWITCHES

Part No.	Mounting holes	Function	Price
JMT121	SPDT	on-off-on	\$1.95 \$1.43
JMT123	SPDT	on-none-on	1.65 1.21
JMT221	DPDT	on-off-on	2.55 1.87
JMT223	DPDT	on-none-on	2.15 1.58
MPC121	SPDT	on-off-on	\$2.05 \$1.53
MPC123	SPDT	on-none-on	1.75 1.31
MPC221	DPDT	on-off-on	2.65 1.97
MPC223	DPDT	on-none-on	2.25 1.68
PB123	SPDT	maintained momentary	1.95 1.47
PB126	SPDT	momentary	1.95 1.47
MS102	DPST	momentary open	.35 .30
MS103	SPST	momentary closed	.35 .30
206-4	8 pin dip	4 switch	1.75 1.65
206-7	14 pin dip	7 switch	1.95 1.85
206-8	16 pin dip	8 switch	2.25 2.15

1/16 VECTOR BOARD

Part No.	Material	Size	Price
64P44 062XXXP	PHENOLIC	4.50 x 6.50	1.72 1.54
64P44 062WWE	EPoxy GLASS	4.50 x 6.50	3.89 3.32
64P44 062WE	EPoxy GLASS	4.50 x 6.50	2.07 1.86
64P44 062WE	EPoxy GLASS	4.50 x 8.50	2.56 2.31
64P44 062WE	EPoxy GLASS	4.50 x 17.00	5.04 4.53
169P84 082WE	EPoxy GLASS	8.50 x 17.00	9.23 8.26
169P84 082WEC1	EPoxy GLASS	4.50 x 17.00	6.80 6.12

ELLY WRAP

Model P180 includes 2-100' spools #28 AWG wire wrap wire.

Supplies insulated wire from spool to wrap-posts without pre-wiring and pre-cutting using "daisy chain" method.

Model P180 \$24.50

REPLACEMENT WRAP BIT for P180 \$12.95 each

Replacement wire-wrap wire for P180 #28 AWG (pkg. of 3) \$2.75 each

W28-2-A green W28-2-B red W28-2-C clear W28-2-D blue

INSTRUMENT/CLOCK CASE

Injection molded unit. Complete with red bezel. 4 1/2" x 4" x 1-9/16"

\$3.49

MICROPROCESSOR COMPONENTS

Part No.	Description	Price
CDP 1802	CPU	\$19.95
P8085	CPU	29.95
8080A	CPU	10.95
8212	8-Bit Input/Output	4.95
8214	Priority Interrupt Control	7.95
8216	Bi-Directional Bus Driver	4.95
224	Clock Generator/Driver	5.95
228	System Controller/Bus Driver	5.95

USER MANUALS

Part No.	Description	Price
1802M	CDP1802 Manual	\$ 7.50
780M	280 Manual	7.50
2650M	2650 Manual	5.00

SHIFT REGISTERS

Part No.	Description	Price
MM500H	Dual 25 Bit Dynamic	50
MM503H	Dual 50 Bit Dynamic	50
MM504H	Dual 100 Bit Static	50
MM506H	Dual 100 Bit Static	50
MM507H	Dual 100 Bit Static	50
MM510H	Dual 64 Bit Accumulator	50
MM5013N	1024 Bit Accumulator Dynamic	2.95
MM5016H	500/512 Bit Dynamic	89
MM5017N	Dual 500/512 Bit Dynamic	2.95
2504T	1024 Dynamic	3.95
2518	Hex 32 Bit Static	4.95
2519	Hex 40 Bit Static	2.95
2522	Dual 132 Bit Static	2.95
2524	512 Dynamic	.99
2525	1024 Dynamic	2.95
2527	Dual 256 Bit Static	2.95
2528	Dual 250 Static	4.95
2529	Dual 240 Bit Static	2.95
2532	Quad 80 Bit Static	4.95
2533	1024 Static	2.95
3341	Fit	1.95
74LS670	4 X 4 Register	6.95

RAM'S

Part No.	Description	Price
1101	256 X 1 Static	\$ 1.49
1103	1024 X 1 Dynamic	7.50
2101	256 X 4 Static	5.95
2102	1024 X 1 Static	1.75
2107/5280	4096 X 1 Dynamic	4.95
2111	256 X 4 Static	6.95
2114	4K X 1 Static 450ns	9.95
2114L	4K X 1 Static 450ns Low Power	10.95
2114-3	4K X 1 Static 300ns	10.95
2114-3	Static 300ns Low Power	11.95
2114-3	16 X 4 Static	1.75
8101	256 X 4 Static	5.95
8111	256 X 4 Static	6.95
2111	16 X 4 Static	3.49
21102	1024 X 1 Static	1.95
74200	256 X 1 Static	6.95
83421	256 X 1 Static	2.95
MMK262	8K X 1 DYNAMIC 16 PIN	5.95
MMK416 (UPD416)	16K DYNAMIC 16 PIN	29.95
TMS4044-45NL	4K STATIC	14.95

ROM'S

Part No.	Description	Price
2513(2140)	Character Generator (upper case)	\$ 9.95
2513(3021)	Character Generator (lower case)	9.95
2516	Character Generator	10.95
MM2309N	2048 Bit Read Only Memory	1.95

UART'S

Part No.	Description	Price
AY-5-1013	30K BAUD	\$ 5.95

SPECIAL REQUESTED ITEMS

Category	Part No.	Description	Price	
TELEPHONE	KEYBOARD CHIPS	ICM7045	\$24.95	
	AY-5-1010	\$14.95	ICM7205	19.95
	AY-5-8200	14.95	ICM7207	7.50
	AY-5-8500	14.95	ICM7208	19.95
KEYBOARD CHIPS	AY-5-2376	14.95	ICM7209	6.95
	HDD185	7.95	TV NAME CHIP SET	
MEMORIES	MCM6571	\$13.50	MCM6574	13.50
	MCM6575	13.50	MCM6575	13.50
MISCELLANEOUS	LD110/111	\$25.00/set	MC4016(74416)	7.50
	MC3061P	11.95	MC1408L	4.95
	DS0020CH	3.75	MC1408L	5.75
	DS0020CH	3.75	4N33	3.95

PARATRONICS Logic Analyzer Kit Model 100A

\$229.00/kit

- Analyzes any type of digital system
- Checks data rates in excess of 8 million words per second
- Trouble shoot TTL, CMOS, OTL, RTL, Schottky and MOS families.
- Displays 16 logic states up to 8 digits wide
- See ones and zeros displayed on your CRT, octal or hexadecimal format
- Tests circuits under actual operating conditions
- Easy to assemble — comes with step-by-step construction manual which includes 80 pages on logic analyzer operation.

(Model 100A Manual - \$4.95)

PARATRONICS TRIGGER EXPANDER - Model 10

Adds 16 additional bits. Provides digital delay and qualification of input clock and 24-bit trigger word. — Connects direct to Model 100A for integrated unit.

Model 10 Kit - \$229.00
Baseplate — \$9.95
Model 10 Manual — \$4.95

3 1/2-Digit Portable DMM

Model 2800 \$99.95

- Overload Protected
- 3 high LED Display
- Battery or AC operation
- Auto Zeroing
- 1muV, 0.1 ohm resolution
- Overrange reading
- 10 meg input impedance
- DC Accuracy 1% typical
- Range: DC Voltage - 0-1000V; AC Voltage - 0-1000V; Freq Response 50-100 Hz; DC/AC Current: 0-100mA; Resistance 0-10 meg ohm
- Size: 6 1/2" x 4 1/2" x 5 3/8"

Accessories:
AC Adapter BC-28 \$9.00
Rechargeable Batteries BP-26 20.00
Carrying Case LC-28 7.50

ACCESSORIES FOR MAX 100:
Mobile Charger/Eliminator use power from car battery Model 100 - CIA \$3.95
Charger/Eliminator use 10 V AC Model 100 - CAI \$9.95

KEYBOARDS

63-Key Unencoded \$29.95/each

Hexadecimal Encoder \$10.95/each

This is a 63-key, terminal keyboard newly manufactured by a large computer manufacturer. It is unencoded with SPST keys, unattached to any kind of PC board. A very solid molded plastic 13 x 4" base suits most applications. IN STOCK

\$5.00 Minimum Order - U.S. Funds Only
California Residents - Add 6% Sales Tax

Spec Sheets - 25¢
1978A Catalog Available - Send 35¢ stamp

Jameco ELECTRONICS

MAIL ORDER ELECTRONICS - WORLDWIDE
1021 HOWARD AVENUE, SAN CARLOS, CA 94070
Advertised Prices Good Thru June

PHONE ORDERS WELCOME
(415) 592-8097

The Incredible "Pennywhistle 103" Kit Only

\$129.95

The Pennywhistle 103 is capable of recording data to and from audio tape without critical speed requirements for the recorder and it is able to communicate directly with another modem and terminal for telephone "hamming" and communications for the deaf. In addition, it is free of critical adjustments and is built with non-precision, readily available parts.

QAM Transmission Method... Frequency-Shift Keying, full-duplex (half-duplex selectable).

Maximum Data Rate... 300 Baud.

QAM Format... Synchronous Serial (return to mark level required between each character).

Receive Channel Frequencies... 2025 Hz for space; 2225 Hz for mark.

Transmit Channel Frequencies... Switch selectable: Low (normal) - 1070 space, 1270 mark; High - 025 space, 2225 mark.

Receive Sensitivity... 46 dbm accurately coupled, 15 dbm nominal. Adjustable from -6 dbm to -20 dbm.

Receive Frequency Tolerance... Frequency reference automatically adjusts to allow for operation between 1800 Hz and 2400 Hz.

Digital Gate Interface... EA RS-232C or 20 mA current loop (receiver is optoisolated and non-polar).

Power Requirements... 120 VAC, single phase, 10 Watts

Physical... All components mount on a single 5" by 9" printed circuit board. All components included in package.

Requires a VOM, Audio Oscillator, Frequency Counter and/or Oscilloscope to align.

the 3rd Hand

\$9.95 each

Leaves two hands free for working

Clamps on edge of bench, table or work bench

Position board on angle or flat position for soldering or clipping

Sturdy, aluminum construction for hobbyist, manufacturer or school rooms

DIGITAL STOPWATCH

- Bright 6 Digit LED Display
- Times to 59 minutes 59.99 seconds
- Crystal Controlled Time Base
- Three Stopwatches in One
- Times Single Event - Split & Taylor
- Size 5 1/2" x 2 1/2" x .90" (4 1/2 ounces)
- Uses 3 P-Cell Cells

Kit - \$39.95
Assembled - \$49.95
Heavy Duty Carry Case \$5.95

Stop Watch Chip Only (7205) \$19.95

3 1/2 DIGIT DPM KIT

Model KB500 DPM Kit \$49.00
Model KB503 5V Power Kit \$17.50

- New Bipolar Unit
- Auto Zeroing
- .5" LED
- Auto Polarity
- Low Power
- Single IC Unit

JE700 CLOCK

The JE700 is a low cost digital clock, but is a very high quality unit. The unit features a simulated walnut case with dimensions of 6 1/2" x 2 1/2" x 1 1/2" utilizes a MAM72 high brightness readout, and the MM5134 clock chip

115 VAC KIT ONLY \$16.95

JE803 PROBE

The Logic Probe is a unit which is for the most part indispensable in trouble shooting logic families. TTL, DTL, RTL, CMOS. It allows the power to be tested directly at the output under test, drawing a scant 10 mA max. It uses a MAM3 readout to indicate any of the following states by these symbols: H (LOW), P (PULSE), L (HIGH), X (UNKNOWN), Z (ZENER), S (SIGNAL), T (TEST), F (FAULT), E (ERROR), C (CLOCK), D (DATA), I (INITIAL), R (RESET), W (WAIT), B (BATTERY), G (GROUND), V (VOLTAGE), A (ANALOG), M (MEMORY), N (NOT), O (OFF), U (UNKNOWN), Y (YIELD), Q (QUALITY), K (KEEP), J (JUMP), L (LIMIT), P (PULSE), R (RESET), S (SET), T (TEST), V (VOLTAGE), W (WAIT), X (UNKNOWN), Y (YIELD), Z (ZENER).

\$9.95 Per Kit
printed circuit board

TPL 5V 1A Supply

This is a standard TTL power supply using the well known LM7805 regulator. It provides a solid 1 AMP current at 5 volts. We try to make things easy for you by providing everything you need in one package including the hardware for only

JE225 \$9.95 Per Kit

PROTO BOARDS

PROTO BOARD 6 \$15.95 (6" long X 4" wide)

Part No.	Size	Price
PB100	4.5" x 6"	\$ 19.95
PB101	5.8" x 4.5"	29.95
PB102	7" x 4.5"	39.95
PB103	9" x 6"	59.95
PB104	9.5" x 8"	79.95
PB203	9.75 x 6 1/2 x 2 3/4	80.00
PB203A	9.75 x 6 1/2 x 2 3/4	129.95 (includes power supply)

PROTO CLIPS

Part No.	Price
14 PIN	\$4.50
16 PIN	4.75
24 PIN	8.50
40 PIN	13.75

7400 TTL

SN7400N	16		
SN7401N	16	SN7427N	29
SN7402N	16	SN7473N	35
SN7403N	16	SN7415N	95
SN7404N	18	SN7475N	49
SN7405N	20	SN7476N	89
SN7406N	29	SN7477N	5.00
SN7407N	29	SN7478N	1.25
SN7408N	20	SN7479N	99
SN7409N	20	SN7483N	59
SN7410N	18	SN7485N	79
SN7411N	25	SN7486N	35
SN7412N	25	SN7487N	1.75
SN7413N	40	SN7489N	45
SN7414N	20	SN7491N	59
SN7415N	25	SN7492N	43
SN7417N	25	SN7493N	43
SN7418N	20	SN7494N	65
SN7419N	20	SN7495A	65
SN7420N	29	SN7496N	65
SN7421N	29	SN7497N	3.00
SN7422N	39	SN74100N	89
SN7423N	29	SN74101N	35
SN7424N	29	SN74102N	35
SN7425N	29	SN74103N	35
SN7426N	29	SN74104N	35
SN7427N	29	SN74105N	35
SN7428N	29	SN74106N	35
SN7429N	39	SN74107N	35
SN7430N	20	SN74108N	35
SN7431N	25	SN74109N	35
SN7432N	25	SN74110N	35
SN7433N	25	SN74111N	35
SN7434N	25	SN74112N	35
SN7435N	25	SN74113N	35
SN7436N	25	SN74114N	35
SN7437N	25	SN74115N	35
SN7438N	25	SN74116N	35
SN7439N	25	SN74117N	35
SN7440N	20	SN74118N	35
SN7441N	89	SN74119N	35
SN7442N	49	SN74120N	35
SN7443N	25	SN74121N	35
SN7444N	75	SN74122N	35
SN7445N	75	SN74123N	35
SN7446N	69	SN74124N	35
SN7447N	59	SN74125N	35
SN7448N	79	SN74126N	35
SN7449N	20	SN74127N	35
SN7450N	20	SN74128N	35
SN7451N	20	SN74129N	35
SN7452N	20	SN74130N	35
SN7453N	20	SN74131N	35
SN7454N	20	SN74132N	35
SN7455A	29	SN74133N	35
SN7456N	29	SN74134N	35
SN7457N	65	SN74135N	35

BUGBOOK

Continuing Education Series

BUGBOOK I and II by Peter R. Ray, David G. Larnan, WB9HJ **\$17.00 per set**
Sells as set these two books outline over 90 experiments designed to teach the reader all he will need to know about TTL logic chips to use them in conjunction with microprocessor systems. You'll learn about the basic concepts of digital electronics including gates, flip-flops, latches, buses, decoders, multiplexers, demultiplexers, LED displays, RAM's, ROM's, and much, much more.

BUGBOOK III by Peter R. Ray, David G. Larnan, WB9HJ **\$6.00**
This volume will introduce you to the fabulous UART chip — that all important interface between data terminals, etc. and your microprocessor. It also covers current loops, and the RS-232C interface standard. Particularly recommended for any RTTY enthusiast.

THE 555 TIMER APPLICATIONS SOURCEBOOK WITH EXPERIMENTS by Howard M. Berlin WB8H **\$6.95**
This book shows you what the 555 timer is and how to use it. Included are over 100 various design techniques, equations and graphs to create "ready-to-go" timers, generators, power supplies, measurement and control circuits, party games, circuits for the home and auto, photography, music, and Amateur Radio.

INSTRUCTOR'S MANUAL by David G. Larnan, Peter R. Ray, Jonathan A. Thib **\$3.00**
Necessary guide to application of experimental and laboratory experiments, suggestions for further reading, philosophy of authors approach to digital electronics. A must for self-teaching individuals.

OP AMP MANUAL by Howard M. Berlin WB8H **\$9.00**
Necessary guide to application of operational amplifiers. Over 25 experiments on all phases of Op Amps.

DEBUG **\$8.00**
8000 interpretive debugger. A program for entering, debugging and starting assembly language programs.

COMPLETE MANUAL FOR DIGITAL CLOCKS by John Wells and John Brooks **\$3.95**
Familiarizes technician or hobbyist with basic theories behind digital clocks. Includes trouble shooting guides, basic characteristics of clocks, soldering techniques, clock component data sheets and construction tips.

WIRE-WRAP KIT — WK-2-W

WRAP • STRIP • UNWRAP

- Tool for 30 AWG Wire
- Roll of 50 Ft. White or Blue 30 AWG Wire
- 50 pcs. each 1", 2", 3" & 4" lengths — pre-stripped wire.

\$12.95

WIRE WRAP TOOL WSU-30

WRAP • STRIP • UNWRAP • \$6.95

WIRE WRAP WIRE — 30 AWG

25 ft. min. \$1.25 50 ft. \$1.95 100 ft. \$2.95 1000 ft. \$15.00

SPECIFY COLOR — White • Yellow • Red • Green • Blue • Black

WIRE DISPENSER — WD-30

- 50 ft. roll 30 AWG KYNAR wire wrap wire **\$3.95 ea.**
- Cuts wire to desired length
- Strips 1" of insulation **Spools — Blue-Yellow-White-Red**

REPLACEMENT DISPENSER SPOOLS FOR WD 30

Specify blue, yellow, white or red **\$1.99/spool**

DISCRETE LEDS

XC209	Red	5/81	XC111	Red	5/81
XC209	Green	4/81	XC111	Green	4/81
XC209	Orange	4/81	XC111	Yellow	4/81
XC209	Yellow	4/81	XC111	Orange	4/81

125' dia. 190' dia.

XC222	Red	5/81	XC526	Red	5/81
XC222	Green	4/81	XC526	Green	4/81
XC222	Yellow	4/81	XC526	Yellow	4/81
XC222	Orange	4/81	XC526	Orange	4/81
SSL-22	RT	4/81	XC526	Clear	4/81

165' dia. 200' dia. 208' dia.

INFRARED LED
1/4" x 1/4" x 1/16"
Flat **\$5.00/lot**

EXAR

XR-L555 \$1.50

Micro-power version of the popular 555 Timer and directly interchangeable. Dissipates 1/15th the power and operates down to 2.7 volts. Perfect for battery operation and CMOS circuitry.

XR2242CP \$1.50

Precision timing circuit for generating time pulses for microprocessors. Operates for 1 year by using two. Reduces cost of time delay circuits. Basic 555 Timer with built-in 8-bit Counter.

XR2206KA-\$14.95

XR205	\$ 6.40	XR1489	1.39	XR255	\$ 3.20
XR210	4.40	XR1800	3.20	XR257	2.99
XR215	4.40	XR2206	4.40	XR3403	1.25
XR320	1.55	XR2207	3.25	XR4136	1.25
XR355	3.99	XR2208	5.20	XR4151	2.85
XR567CP	1.95	XR2209	1.75	XR4202	1.45
XR667CT	1.25	XR2211	5.25	XR4202	3.60
XR1310P	1.30	XR2240	3.45	XR4558	7.75
XR1488N	3.85	XR2254	4.25	XR4739	1.15
XR1488	1.39			XR4741	1.4*

XR2206KB-\$19.95

XR205	\$ 6.40	XR1489	1.39	XR255	\$ 3.20
XR210	4.40	XR1800	3.20	XR257	2.99
XR215	4.40	XR2206	4.40	XR3403	1.25
XR320	1.55	XR2207	3.25	XR4136	1.25
XR355	3.99	XR2208	5.20	XR4151	2.85
XR567CP	1.95	XR2209	1.75	XR4202	1.45
XR667CT	1.25	XR2211	5.25	XR4202	3.60
XR1310P	1.30	XR2240	3.45	XR4558	7.75
XR1488N	3.85	XR2254	4.25	XR4739	1.15
XR1488	1.39			XR4741	1.4*

ZENERS — DIODES — RECTIFIERS

TYPE	VOLTS V	400m	PRICE/TYP	VOLTS V	PRICE W	
1N751A	5.1	400m	4/100	1N4005	600 PIV 1 AMP	10/1.00
1N752	5.6	400m	4/100	1N4007	1000 PIV 1 AMP	10/1.00
1N753	6.2	400m	4/100	1N4350	50 PIV	20/0m 81.00
1N754	6.8	400m	4/100	1N4448	75	10m 15/1.00
1N589	5.8	400m	4/100	1N4478	6.8	1W 12/1.00
1N589B	5.8	400m	4/100	1N4478	7.5	25m 20/1.00
1N5232	5.6	500m	28	1N4734	5.6	1W 28
1N5234	6.2	500m	28	1N4735	6.2	1W 28
1N5235	6.8	500m	28	1N4736	6.8	1W 28
1N5236	7.5	500m	28	1N4738	8.2	1W 28
1N456	25	400m	6/100	1N4744	15	1W 28
1N458	150	7m	6/100	1N4744	15	1W 28
1N4654	100V	10m	4/100	1N4654	50 PIV	35 AMP 1.60
1N4601	50 PIV	1 AMP	12/100	1N1184	100 PIV	35 AMP 1.70
1N4602	100 PIV	1 AMP	12/100	1N1185	150 PIV	35 AMP 1.70
1N4603	200 PIV	1 AMP	12/100	1N1186	200 PIV	35 AMP 1.80
1N4604	400 PIV	1 AMP	12/100	1N1188	400 PIV	35 AMP 3.00

SCR AND FW BRIDGE RECTIFIERS

C360	15A @ 60V	SCR2(N1849)	\$1.95
C38M	35A @ 400V	SCR	1.95
2N2282	1.6A @ 300V	SCR	1.95
MDA 980-1	12A @ 50V	FW BRIDGE REC.	1.95
MDA 980-3	12A @ 200V	FW BRIDGE REC.	1.95

TRANSISTORS

C1691	50	2N3055	89	2N3904	4/1.00
MPS405	5/1.00	MJE3055	1.00	2N3906	4/1.00
MPS406	5/1.00	2N3932	5/1.00	2N4013	3/1.00
1T597	6/1.00	2N3938	5/1.00	2N4123	6/1.00
1T598	6/1.00	2N3939	5/1.00	2N4123	6/1.00
1T599	6/1.00	2N3947	3/1.00	2N4403	4/1.00
1T5135	5/1.00	2N3958	6/1.00	2N4403	4/1.00
40409	1.75	2N3959	4/1.00	2N4400	4/1.00
40410	1.75	MPS3838A	5/1.00	2N4401	4/1.00
40411	1.75	MPS3702	5/1.00	2N4402	4/1.00
40412	1.75	2N3704	5/1.00	2N4403	4/1.00
2N2219A	3/1.00	MPS3704	5/1.00	2N4409	5/1.00
2N2221A	4/1.00	2N3705	5/1.00	2N4006	4/1.00
2N2222A	5/1.00	MPS3705	5/1.00	2N5087	4/1.00
2N2262	3/1.00	2N3706	5/1.00	2N5088	4/1.00
2N2369A	4/1.00	MPS3706	5/1.00	2N5089	4/1.00
MPS2369	5/1.00	2N3707	5/1.00	2N5129	5/1.00
2N2484	4/1.00	2N3711	5/1.00	2N5134	5/1.00
2N2905	4/1.00	2N3722A	4/1.00	2N5138	5/1.00
2N2906	5/1.00	2N3725A	4/1.00	2N5139	5/1.00
2N2925	5/1.00	2N3727	2.25	2N5210	5/1.00
MJE2955	1.25	2N3823	1.00	2N5449	3/1.00
2N3053	2/1.00	2N3903	4/1.00	2N5951	3/1.00

DISCRETE LEDS

XC209	Red	5/81	XC111	Red	5/81
XC209	Green	4/81	XC111	Green	4/81
XC209	Orange	4/81	XC111	Yellow	4/81
XC209	Yellow	4/81	XC111	Orange	4/81

125' dia. 190' dia.

XC222	Red	5/81	XC526	Red	5/81
XC222	Green	4/81	XC526	Green	4/81
XC222	Yellow	4/81	XC526	Yellow	4/81
XC222	Orange	4/81	XC526	Orange	4/81
SSL-22	RT	4/81	XC526	Clear	4/81

165' dia. 200' dia. 208' dia.

INFRARED LED
1/4" x 1/4" x 1/16"
Flat **\$5.00/lot**

DISCRETE LEDS

XC209	Red	5/81	XC111	Red	5/81
XC209	Green	4/81	XC111	Green	4/81
XC209	Orange	4/81	XC111	Yellow	4/81
XC209	Yellow	4/81	XC111	Orange	4/81

125' dia. 190' dia.

XC222	Red	5/81	XC526	Red	5/81
XC222	Green	4/81	XC526	Green	4/81
XC222	Yellow	4/81	XC526	Yellow	4/81
XC222	Orange	4/81	XC526	Orange	4/81
SSL-22	RT	4/81	XC526	Clear	4/81

165' dia. 200' dia. 208' dia.

INFRARED LED
1/4" x 1/4" x 1/16"
Flat **\$5.00/lot**

DISCRETE LEDS

XC209	Red	5/81	XC111	Red	5/81
XC209	Green	4/81	XC111	Green	4/81
XC209	Orange	4/81	XC111	Yellow	4/81
XC209	Yellow	4/81	XC111	Orange	4/81

125' dia. 190' dia.

XC222	Red	5/81	XC526	Red	5/81
XC222	Green	4/81	XC526	Green	4/81
XC222	Yellow	4/81	XC526	Yellow	4/81
XC222	Orange	4/81	XC526	Orange	4/81
SSL-22	RT	4/81	XC526	Clear	4/81

165' dia. 200' dia. 208' dia.

INFRARED LED
1/4" x 1/4" x 1/16"
Flat **\$5.00/lot**

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

1.0	1-9	10-49	50-100	1-9	10-49	50-100
0.01	0.05	0.04	0.03	0.01uF	0.05	0.04
0.02	0.12	0.10	0.07	0.047uF	0.05	0.05
0.047	0.12	0.10	0.07	0.047uF	0.05	0.05
0.100	0.05	0.04	0.03	0.022uF	0.06	0.04
0.220	0.05	0.04	0.03	0.047uF	0.06	0.04
0.470	0.05	0.04	0.03	0.1uF	0.09	0.075

100 VOLT MYLAR FILM CAPACITORS

0.01	0.12	0.10	0.07	0.022uF	1.1	1.1
0.02	0.12	0.10	0.07	0.047uF	2.1	1.7
0.047	0.12	0.10	0.07	0.1uF	2.7	2.3
0.1	0.12	0.10	0.07	0.22uF	3.3	2.7

50%+20% DIPPED TANTALUM (SOLDO) CAPACITORS

1/35V	28	23	17	1.5/25V	30	26	21
1/15/35V	28	23	17	2.2/25V	31	27	22
2.2/35V	28	23	17	3.3/25V	31	27	22
3.3/35V	28	23	17	4.7/25V	31	27	22
4.7/35V	28	23	17	6.8/25V	31	27	22
6.8/35V	28	23	17	10/25V	40	35	29
10/35V	28	23	17	15/25V	50	45	40

MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS

47/50V	15	13	10	47/25V	15	13	10
1.0/50V	16	14	11	47/50V	16	14	11
3.3/50V	14	12	9	1.0/15V	15	13	10
10/50V	1						

Floppy Disk Based Z-80 Microcomputer System

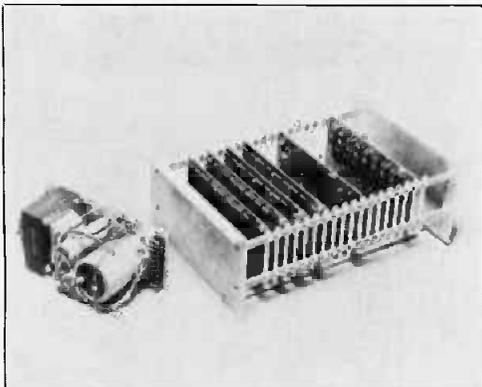


The AID-80F is a complete disk based computer from MOSTEK that provides for hardware and software development and debug. The heart of the AID-80F is the SDB-80 which combines the Z-80 processor with 16 K bytes of on board programmable memory. The

RAM-80 memory and IO expansion board includes 16 K bytes of programmable memory and four 8 bit IO ports. The FLP-80 flexible disk drive controller board interfaces the SDB-80 with up to four drives with soft sector format. An optional board, the AIM-80, allows real time in-circuit emulation with extensive debug, trace and diagnostic capabilities. Software programs and features include: monitor, text editor, assembler, relocating linking loader, debugger and a peripheral interchange program that takes completely unformatted soft sector diskettes, formats them to IBM 370, and records the system software. The program also copies files from disk to disk, disk to peripheral, or from any peripheral to any other peripheral. The AID-80F is priced at \$5995; each board is also available separately. Contact MOSTEK Corp, 1215 W Crosby Rd, Carrollton TX 75006. ■

Circle 578 on inquiry card.

Vector 1 Computer Now in Rack Mount Kit



Vector Graphic Inc has announced availability of its Vector 1 computer in a new rack mount kit. The complete kit comprises a card cage, assembled and tested 18 slot mother board with 18 connectors, card guides and locking buttons for 18 cards. The mother board is fully shielded to reduce noise on the bus. The price is \$225. A companion power supply kit, designed for rack mounting, also is available. The 18 A 8 V, 2.5±16 V custom supply provides power for a full 18 boards. Transformer has primary taps for 110 V, 120 V and 130 V. Price for the supply kit, including mounting bracket, fuse and all hardware, is \$90. Further information may be obtained from Vector Graphic Inc, 790 Hampshire Rd, Westlake Village CA 91361. ■

Circle 579 on inquiry card.

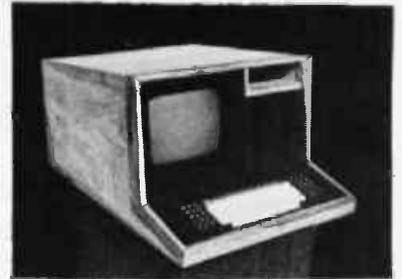
Bytemaster from Digital Group



The Digital Group's first completely integrated computer package, the Bytemaster, features either 18 K or 32 K of programmable memory, but will support up to 64 K memory if desired. The Bytemaster is fully wired to support various external peripherals with provisions for expansion. User options include a printer, monitor, and additional digital cassette minifloppy, or standard floppy disk drives plugged into any of the four available IO ports. The unit comes in a metal cabinet mounted on a heavy duty metal yoke and is priced at \$3245 for the top of the line Master 4 Model (minifloppy, 32 K of programmable memory, fully assembled). Details are available from The Digital Group Inc, POB 6528, Denver CO 80206. ■

Circle 580 on inquiry card.

Intel 8085 with PASCAL



The 85/P, a programmer's workbench from Northwest Microcomputer Systems Inc, is a complete system which includes:

- 8085 processor with 54 K bytes of static programmable memory.
- One megabyte of storage in two double density Shugart floppy disk drives.
- 24 by 80 high resolution display.
- Two serial ports for printer and second terminal or modem.
- A choice of solid oak or walnut cabinet.

The system provides a 700 lines per minute PASCAL compiler and interpreter, random and sequential files, a screen oriented editor, interactive source linked debugger, plus documentation and a 90 day warranty.

The 85/P costs \$7495. Delivery is quoted at 30 to 60 days, with Northwest Microcomputer Systems paying for delivery on any order shipped later than 60 days. A variety of options are available, including a complete turnkey screen oriented accounts receivable package. The system also supports CP/M, FORTRAN, BASIC and 8080 compatible software. Contact Northwest Microcomputer Systems Inc, 121 E 11th, Eugene OR 97401. ■

Circle 581 on inquiry card.

Small Business Computer Systems

A complete small business accounting system, Micro Executive, has been announced by Microcomputer Business Systems Inc, 1776 E Jefferson St, Rockville MD 20852. The system is said to include accounts receivable, accounts payable, merchandise inventory, fixed assets inventory, payroll, financial reporting, and general ledger. The company has announced a computer system called Micro Executive II which consists of an 8080 processor, 64 K bytes of user memory, two full-size Shugart Associates floppy disk drives (Models 801 or 851 for either a total of 630,000 bytes or 1.2 million bytes of secondary storage). The system also comes with a Lear Seigler 80 by 24 video display terminal and a 30 cps printing terminal. Optional terminals, printers, and hard disk drives are available. ■

Circle 582 on inquiry card.

S-100 32K STATIC MEMORY BOARD

features:

1. FULLY STATIC - usable with all DMA devices.
2. BUFFERED - with noise suppressed control inputs.
3. MODULAR - populated in 1k increments.
4. RELIABLE - single source +5V regulator
5. PROM COMPATIBLE - monitors available on request.

AVAILABLE EITHER IN COMPLETE KITS OR ALREADY ASSEMBLED UNITS WHICH HAVE BEEN FULLY TESTED AND BURNED IN.

BARE BOARD \$38⁰⁰

	KIT	ASSEMBLED
8K	\$270 ⁰⁰	\$296 ⁰⁰
16K	\$440 ⁰⁰	\$465 ⁰⁰
24K	\$580 ⁰⁰	\$612 ⁰⁰
32K	\$695 ⁰⁰	\$740 ⁰⁰

PRICES QUOTED ARE FOR 300ns MEMORIES
KITS AND ASSEMBLED UNITS INCLUDE DOCUMENTATION

DEC® LSI-11 16K MEMORY BOARD

- Q-BUS—FULLY STATIC
- MODULAR
- ADDRESSABLE TO 128K WORDS
- MAPPABLE IN 4K INCREMENTS
- BUFFERED AND NOISE SUPPRESSED
- PROM COMPATIBLE

ASSEMBLED, TESTED & BURNED IN **\$119900** COMPLETE KIT **\$110900**

LARGEST & FASTEST STATIC MEMORY AVAILABLE

S-100 EXPANDABLE MOTHER BOARD

- 8-SLOT EXPANDABLE BACKPLANE—in line male and female connectors enable backplanes to be plugged together, or the female may be used in place of an extender board.

QUIET—ground plane decouples all signal lines.

RELIABLE—SAE 8100 phenolic body, gold contact connectors.

COMPLETE KIT **\$6600** ASSEMBLED **\$8900**

UNIVERSAL "U DESIGN" WIRE WRAP BOARDS

ALL BOARDS ARE G-10 GLASS EPOXY. HAVE V_{CC} AND GROUND PLANES. PLATED THROUGH HOLES, & GOLD PLATED EDGE CONNECTORS

No. 1 "BEST ON THE MARKET" MICRO CPU CARD WITH S-100 BUS. 3 ON BOARD REGULATORS. FITS ALL STANDARD I.C. SOCKET CONFIGURATIONS. 1700+ HOLES. SIZE 5"x10"

\$2395

No. 2 UNIVERSAL BOARD FITS 86 PIN SOCKET WITH 0.10" CONTACT SPACING. MADE BY LEADING COMPUTER MANUFACTURER AS "IN HOUSE" BOARD. 1600+ HOLES. SIZE 4-7/8"x7-5/8"

\$795

S-100 EXTENDER BOARD

with connector

A MUST for trouble-shooting your Computer boards **\$1795**

BUILD YOUR OWN LOGIC PROBE

24 TO-92, SMALL SIGNAL DARLINGTONS AND 24 LEDs—ALL FUNCTIONAL **only \$495**

MAXI SWITCH KEYBOARDS

UNENCODED-MOUNTED ON G-10 GLASS EPOXY BOARDS-A BLACK METAL FRAME KEEPS KEY SWITCHES SECURELY IN PLACE.

No. 1

- 53 key main keyboard
- 10 auxiliary & cursor control keys
- 11 key numeric pad
- Bank of 5 auxiliary power and control, rocker arm switches—one of them lights up.

\$3995

WIRE WRAP SOCKET CONNECTOR FOR NO. 1 KEYBOARD **\$295**

No. 2

- 53 key keyboard
- 1 auxiliary power/control DPDT rocker arm switch

\$2995

BEIGE METAL FRAME MOUNT FOR NO. 2 KEYBOARD **\$995**

SOCKET CONNECTOR FOR NO. 2 KEYBOARD **\$295**

OUR NEW ASCII KEYBOARD

HAS ON BOARD UV PROM, A MAIN KEYBOARD SECTION OF 58 KEYS, A HEX PAD OF 15 KEYS AND 16 MORE PERIPHERAL KEYS. 89 KEYS TOTAL & ASCII ENCODED for only **\$9995**

EDGE VIEW METER

CHARGE DISCHARGE SCALE READS -20.0-40 MOVEMENT +60.-120mA 0.135 OHMS **\$249**

POWER SUPPLY PARTS

DIODES

IN4001	50V at 1A	6c
IN4003	200V at 1A	8c
IN4007	1000V at 1A	12c
IN250	60V at 20A	95c
IN3909	50V at 30A	\$1.25

BRIDGES

FAST RECOVERY AVALANCHE BRIDGE		
IN4436/T	200V at 10A	\$4.25
FULL WAVE "MINI BRIDGE" WITH TAB TERMINALS		
PR-10F	100V at 12A	\$3.75

5% ZENERS

IN4733A	5.1V	1w	39c
IN4739A	9.1V	1w	39c
IN4744A	15V	1w	39c

VOLTAGE REGULATORS

uA723-VARIABLE 2V to 3.7V			38c	69c
78105-5V at 100mA	TO-92		3/98c	
340T-6 6V at 1 AMP	TO-220		2/98c	

PASS TRANSISTORS

MJE3055	10A PLASTIC	89c
2N3055	10A TO-3	95c
2N5301	30A TO-3	\$1.95

PROTECT YOURSELF. INSTALL AN ELECTRONIC CROWBAR CIRCUIT IN YOUR POWER SUPPLY.

CROWBAR SCR C220D 400V at 10A **\$1.75**

BUILD YOUR OWN PAPER TAPE READER

1/10" CENTER STACKABLE

PHOTO TRANSISTORS
10/\$960

TTL COMPATIBLE REED RELAY

400 OHMS **\$149** **7/\$975**

4K STATIC RAMS

2114	650ns	600mw	\$6.25
TMS-4045-4	450ns	300mw	\$10.95
HM-47214	300ns	200mw	\$11.95

MINIATURE

16 BUTTON PADS

4x4 MATRIX ENCODED **\$195**

I.C. SOCKETS LOW PROFILE-SOLDERTAIL

for that professional touch CARBIDE DRILL BITS for P.C. BOARD WORK
ASSORTMENT OF SIZES FROM NO. 55 TO NO. 70
5 MIX/\$749 10 MIX/\$1249 100 MIX/\$9900

GOLD WIRE WRAP SOCKET STRIPS

MAKE UNIVERSAL END AND SIDE STACKABLE WIRE WRAP BOARDS

7 PIN STRIP
TOP VIEW

SIDE VIEW

- 12 PIN 48c
- 14 PIN 48c
- 2 LEVEL 48c
- 3 LEVEL 56c

	GOLD INLAID	TIN
8 PIN	10/\$1.59	10/\$1.35
14 PIN	10/\$1.89	10/\$1.49
16 PIN	10/\$1.99	10/\$1.59
22 PIN	5/\$1.69	5/\$1.49
24 PIN	5/\$1.89	5/\$1.59
28 PIN	5/\$1.99	5/\$1.69
40 PIN	4/\$1.99	4/\$1.69

OPTO DEVICES

PHOTO TRANSISTORS
SIMILAR TO FPT 100
4/98c

ULTRA HIGH SPEED
EXTREMELY SENSITIVE LIGHT-ACTIVATED SCR

Triggerable by flashlight at several hundred yards
\$295

PHOTO DARLINGTONS
MOTOROLA
4/98c

PHOTO DETECTOR
0.5ns RISE TIME
\$375

INFRA RED DETECTOR

ULTRA LOW LEVEL
PIV 7V
1 on 1ma **\$495**

SOLAR CELLS

2x2cm 130ma
\$159 ea. 10/\$990

HEWLETT-PACKARD JUMBO-RED HIGH EFFICIENCY

LED

ON BOARD STATUS INDICATOR **6/\$100**

HIGH INTENSITY RED

LED LAMP
EXTREME WIDE ANGLE VIEWING
3/98c 10/\$245

GOLD EDGE CARD CONNECTORS

No. 1 SAC185/2-2 SINGLE ROW, 18 PIN CONNECTOR WITH 0.156" CONTACT SPACING. **99c**

No. 2 SAC225/2-2 SINGLE ROW, 22 PIN CONNECTOR WITH 0.156" CONTACT SPACING. **99c**

No. 3 2VH31/ICB6 31 SOLDER LUG CONNECTOR WITH 0.125" CONTACT SPACING. **99c**

WIRE WRAP POST
2 LEVEL
10 99c
100 \$7.40
1000 \$64.00
3 LEVEL
10 \$1.25
100 \$8.60
1000 \$72.00

HI-REL GOLD WIRE WRAP SOCKET PIN
10/\$1.25
100/\$9.00
1000/\$79.00
LIST PRICE 29c

OP AMPS
SINGLE
709 10c
741 12c
DUAL
MC1458 39c
QUAD
LM3900 49c

DIODES
IN91 15c
IN270 12c
IN914 15c
IN3600 15c
IN4148 10c

TRANSISTORS
2N2222 12c
2N3904 12c
2N3906 12c
2N3053 49c

D/A CONVERTER
SIGNETICS
NE5008
\$995

SUB MINIATURE CRYSTAL FILTER
455 KHZ WITH DATA
\$295

LEDS
YELLOW, GREEN, OR AMBER (SPECIFY COLOR)
3/88c

HIGH VOLTAGE DIODES
EPOXY 1500V at 1 AMP 10/\$1.99
EG250 2500V at 350mA 95c
HY60EL 6KV at 25mA \$1.95
SUBMINIATURE 20KV at 100mA \$2.95

NO BACK ORDERS FREE DELIVERY BY UPS ON U.S. ORDERS ONLY!
YOUR PARTS OR IMMEDIATE REFUND OR BY SURFACE MAIL, IF SPECIFIED - CALIF. RES. ADD 6% SALES TAX
MONEY BACK GUARANTEE (MOS AND LED DEVICES EXCLUDED) \$20 MINIMUM
FOR UNDER 8 HOUR PROCESSING SEND MONEY ORDER, CERTIFIED OR CASHIERS CHECK.
SORRY! WE CANNOT ACCEPT PURCHASE ORDERS, COD'S, PHONE ORDERS OR CREDIT CARDS.

F. Reichert Sales
1110 E. GARVEY AVE.
W. COVINA, CA. 91790

3-1/2 DIGIT L.C.D.'s LIQUID CRYSTAL DISPLAY

No. 1 0.4" CHARACTER WITH CONNECTOR **\$695**

No. 2 THIS MINIATURE L.C.D. IS IDEAL FOR POCKET SIZED INSTRUMENTS **\$395**

FOREIGN ORDERS

CANADA PUERTO RICO, U.S. POSSESSIONS ADD U.S. \$3.50. ALL OTHER ADD U.S. \$7.00
IMMEDIATE SHIPPING ON CHASE MANHATTAN, FIRST CITIZENS, CASHIERS CHECKS & CANADIAN POSTAL MONEY ORDERS

LOS ANGELES
(213) 967 4611

LMN ELECTRONICS
1042 E. GARVEY AVE. W. COVINA, CA. (VINCENT & SAN BERD. FWY)
TUE TO SAT 10:8-CLOSED SUN & MON

DROP INTO ONE OF OUR LOCATIONS

PORTLAND (503) 646-4044

WIZARD OF PARTS
8225 SW CIRCUIS OR BEAVERTON, ORE (KOLL BUS. CNTR/WASHINGTON SQUARE)

DENVER

(303) 573-5214

ELECTRONIC LOLLIPOP
5643 N. BROADWAY, DENVER, CO (I-25 & 58th AVE.)

What's New?

A Talking Clock



The TCE-124 Talking Clock, with a distinctive male voice, automatically logs the time of day in English, German or Arabic. The vocabulary of the talking clock is produced electronically by a custom speech synthesis processor. When used with either voice or device activated recorders, the TCE-124 inserts a distinct verbal announcement immediately following each recorded message. Each message is indexed with its own time reference. Although developed to be used with Omnicon recorders, the Talking Clock can be used in other applications where continuous or on demand time announcements are required. Features include: 12 or 24 hour format; visual LED display; monitor speaker; 1 W, 8 ohm audio output; "universal" IO control circuits; compact size. For further information contact Omnicon Electronics, POB 623, Putnam CT 06260. ■

Circle 574 on inquiry card.

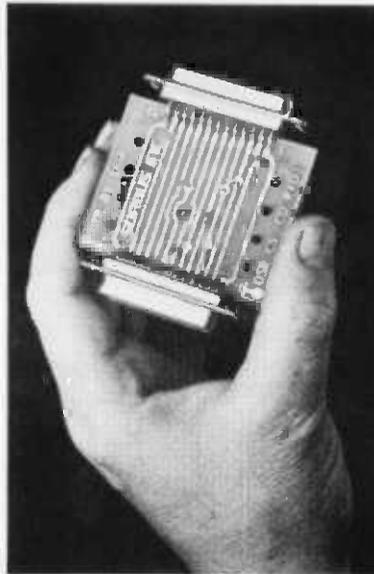
Prevent Memory Glitches



The Velostat conductive floor mat can eliminate electrostatic discharge, one cause of computer equipment problems. The mat has been designed to drain static away from computer operators by providing a positive path to ground. The manufacturer recommends that users wear leather soled shoes. Velostat mats are supplied with a 15 foot (37.5 cm) ground cord, snap fasteners, and 1 megohm resistors. Two sizes are available: 24 by 32 inches (61 x 81 cm) at \$28.80, and 4 by 8 feet (1.2 x 2.4 meters) at \$98.40. Available from Alpha Supply Company, 18350 Blackhawk St, Northridge CA 91326. ■

Circle 575 on inquiry card.

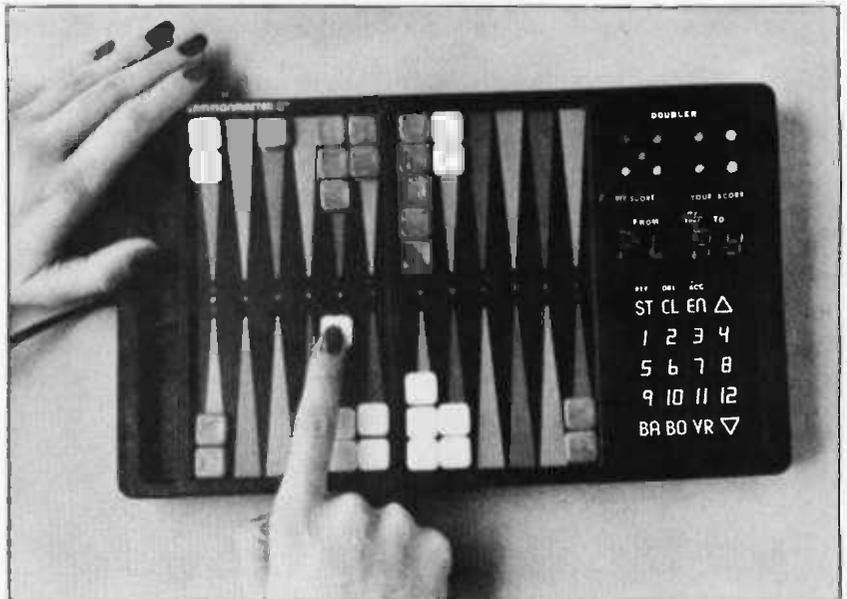
Modem Monitor with LED Display



This compact signal display device can be placed in line between data sets and data communication terminals to isolate failures. The unit, called the Traffic Light, monitors without disrupting communications activity. Plugged in line, the monitor uses light emitting diodes (LEDs) to provide constant status display of seven key signals on the EIA RS-232 25 pin Business Machine Interface. The signals monitored include: transmitted data, received data, request to send, clear to send, data set ready, carrier detect, and data terminal ready. The monitor also has a spare LED circuit that can be used to show the status of any other signal. It provides test points for oscilloscopes, meters, and logic probes to the seven displayed signals, the spare circuit signal, and logic ground. All LED displays and test points are grouped logically: signals originating in the data set (modem) are grouped on one side of the circuit board; signals originating in the Business Machine and the spare circuit are grouped on the opposite side of the board. The unit is covered by a one year warranty on both parts and labor and is priced at \$89. It can be obtained from Sorbus Inc, 150 Allendale Rd, King of Prussia PA 19406. ■

Circle 576 on inquiry card.

Backgammon, the King of Games, for Your Computer



Gammonmaster II, the latest entry in the computerized games market, pits your skill and ingenuity against the computer at backgammon. Gammonmaster II is a self-contained, portable backgammon game programmed to recognize and defend itself against all the strategies of the game: running, blocking, blot hitting contest, back and semiback games, bearing off strategies and combinations of these basic techniques. Electronic rolling of the dice ensures randomness of play. The computer displays each of its moves

electronically while recording your moves. You chart the game with regular pieces; the location of every man on the board can be verified at the touch of a button. The optional doubling cube feature allows the tournament backgammon player to compete against the computer at multiple point games. The opponent may double the computer, or the computer may double its opponent. Gammonmaster II is available from Tryom Inc, 23945 Mercantile Rd, Cleveland OH 44122 for \$199.50. ■

Circle 577 on inquiry card.

COMPUTER PERIPHERAL & PARTS WORKSHOP

POLY PAKS INTRODUCES THE FIRST MAGAZINE RETAIL STORE FOR THE ELECTRONIC MAIL-ORDER HOBBYIST!

"RED" LED READOUTS!

as low as **20¢ each**

Cat. No.	Size	Description	Sale
651890	.127"	MAN-3**	5 for \$1.00
651903	.13	MAN-4**	2 for \$1.19
651273	.27	MAN-1*	\$1.00
653093	.33	MAN-72 equal*	\$1.19
653161	.33	MAN-74 equal*	\$1.19
653512	.35	FND359**	\$1.00
652949	.5	FND500**	\$1.50
652950	.5	FND507**	\$1.50
653483	.5	727-Dual**	\$2.50
652485	.5	727-Dual**	\$2.50
652256	.5	747**	\$1.95

*Common Anode **Common Cathode

HEXADECIMAL MICROPROCESSOR AND CONTROL KEYBOARD KIT! \$34.95

Address microprocessors, control computer operated equipment, 2 key rollover. Has 20 keys, 16 encoded, 3 external to be assigned by user. Output 4 bit binary. Also an EXCLUSIVE FEATURE... 4 LEDs display the binary output. TTL CMOS compatible, requires +5, 12VDC. Complete kit! Nothing else to buy! With instructions.

• 4 bit binary/hexadecimal output plus strobe!
• New! Improved design! Saves you time!
• Keyboard pre-assembled onto PC board!

Cat. No. 655009 Hexadecimal Kit \$34.95
Cat. No. 655110 Hexadecimal Wired \$39.95



POLY PAKS SPECIAL

BUY \$15 WORTH Take **10% DISCOUNT**

BUY \$100 WORTH Take **25% DISCOUNT**

FROM THIS AD ONLY

DISCRETE LED'S 6 for \$1.19

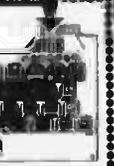
Order in multiples of 6 of each type!

Cat. No.	Description	Similar to
652135	Jumbo Red	WV0563
651944	Jumbo Yellow	XC556Y
652138	Jumbo Green	XC556G
652785	Medium Red	XC22
652788	Medium Green	XC22G
652137	Micro Red	XC209
651948	Micro Yellow	XC209Y
652140	Micro Green	XC290G

\$69.95 KEYBOARD & ENCODER KIT

Cat. No. 655001 Kit \$69.95
Cat. No. 655002 Wired \$79.95

Outputs standard 7 bit ASCII; interfaces with most data systems. • Uses MOS Encoder ROM!
Keyboard pre-assembled onto PC board. 2 key rollover. Electronic. • 7 LED Test Feature!
Shift lock and carriage return. 4 modes: Normal, control, shift, shift control. Additional functions can be assigned by user. • • 64 key keyboard!
12VDC, 200 mA. Negative or positive logic, jumper selectable. • Encodes 128 ASCII Characters!
Exclusive test feature... 7 LEDs display the ASCII code. • Interfaces with ALTAIR, IMSAI, and more!
Complete kit, nothing else to buy! Size: 13" x 5 1/2" x 1 1/4", 3 lbs.



MICROPROCESSORS! MEMORIES! SUPPORT!

Order by Cat. No. 653459 and type

Type	Description	Sale
81C6800L	8 bit CPU	\$24.95
8080A	8 bit CPU, 2 usec	14.95
Z80A	8 bit CPU	34.95
8008	CPU	9.95
1101	256 x 1 stat. RAM	1.29
1103	1K Dyn RAM	1.59
1702A	256 x 8 EPROM	5.95
2102-11	1K x 1 Lo-power RAM	1.69
2111	256 x 4 Stat. RAM	1.95
2708	8K EPROM	19.95
MK4116	16K Dyn RAM	32.00
MK4200P11	4K x 1 Dyn RAM, 350nsec	3.95
MMS202	2K EPROM	6.95
MMS203	2K EPROM	8.95
MMS260	1K Dyn RAM	.99
MMS262	2K x 1 Dyn RAM	.99
8212	8 bit I/O port	1.50
8216	BI-direct bus driver	3.95
8224	Clock Gen	4.95
8228	System cont.	9.95
8251	Communication Int.	11.50
8255	Periph inter.	11.95

COMPUTER GRADE CAPACITORS

Mfd	WVDC	Sale
8,000	50	\$2.75
13,000	40	2.25
14,000	75	2.75
15,000	12	1.50
22,000	75	3.95
24,000	30	2.50
655112 and value!		3.95

Low Power ICs

Order by Cat. No. 653667 & Type No.

Type	Sale	Type	Sale
74LS00	\$3.32	74LS132	1.19
74LS02	.32	74LS138	1.24
74LS04	.35	74LS139	1.24
74LS08	.32	74LS151	1.25
74LS10	.32	74LS153	1.25
74LS11	.32	74LS155	1.25
74LS13	.64	74LS160	1.47
74LS20	.32	74LS161	1.47
74LS21	.32	74LS162	1.47
74LS22	.32	74LS163	1.47
74LS27	.64	74LS168	1.68
74LS30	.32	74LS169	1.68
74LS32	.39	74LS173	1.68
74LS37	.45	74LS174	1.05
74LS38	.64	74LS177	1.35
74LS42	1.19	74LS191	1.75
74LS47	.99	74LS192	1.75
74LS74	.89	74LS193	1.35
74LS90	.89	74LS195	1.25
74LS92	.89	74LS197	1.25
74LS93	.89	74LS267	1.35
74LS109	.58	74LS266	.54
74LS112	.58	74LS266	.56
74LS113	.58	74LS368	.69
74LS114	.49	74LS390	2.95

C-MOS

Order by Cat. No. 652320 & Type No.

Type	Sale	Type	Sale
CD4000	\$2.29	CD4022	1.19
CD4001	.29	CD4023	.29
CD4002	.29	CD4024	.79
CD4006	1.19	CD4025	.34
CD4007	.29	CD4027	.69
CD4008	.79	CD4028	.69
CD4012	.29	CD4029	1.19
CD4010	.59	CD4030	.49
CD4011	.29	CD4033	1.60
CD4012	.29	CD4035	.99
CD4013	.69	CD4040	1.19
CD4015	1.19	CD4041	1.25
CD4016	.49	CD4042	.88
CD4017	1.19	CD4043	1.75
CD4018	1.19	CD4049	.49
CD4019	.49	CD4066	.79
CD4020	.99	CD4071	.29
CD4021	1.29		

BRIDGE RECTIFIERS!

PIV	2 AMP	6 AMP	10 AMP	25 AMP
50	\$.59	\$1.05	\$1.45	\$2.73
100	.65	.99	1.15	1.25
200	.69	1.19	1.29	1.95
400	.99	1.40	1.79	2.95
600	.99	1.95	1.95	3.95
800	1.19	1.95	2.25	4.95
1000	1.25	2.25	2.50	5.50

Order by Cat. No. Amperage and Voltage

POLY PAKS "CHIPS" AWAY IC AND CRYSTAL PRICES!

Order by Cat. No. 654048 and Type No!

Type	Description	Sale
ICM7205	Stopwatch	\$14.95
AY38500-1	6 TV Games	9.95
CMMS330	4 1/2 Digit DVM	4.95
8038C	Volt Control Osc.	4.95
OKR2376-139	BCD Encoder Rom	6.95
OKR2376-5T	ASCII Encoder Rom	14.95
11C190DC	650MHz Prescaler	14.95
95H90DC	350MHz Prescaler	8.88
CMC14410	Touch Tone Chip	9.95
CMK2002P	Char Gen. (aim 2513)	3.95
07207A/7208	Freq Counter pair	24.95
11CMT1007	3 1/2 Digit DVM/DMM	12.50
CMMS316	Alarm Clock	2.95
CMMS369	60 Hz Timebase IC	1.95
03.579MHz	Timebase Xtal	1.95
01.00MHz	Touchtone Xtal	5.95
03.2768MHz	Stopwatch Xtal	4.95

SILICON POWER STUD RECTIFIERS!

Order by Cat. No. Amperage and voltage.

PIV	12 AMP	50 AMP	250 AMP
50	\$2.29	\$.75	\$4.95
100	.36	1.10	6.50
200	.45	1.35	7.50
400	.61	1.75	8.50
600	.79	2.25	10.50
800	.90	2.75	11.50

TTL'S

Type	Sale	Type	Sale
SN7400	\$0.14	SN7472	.26
SN7401	.14	SN7473	.31
SN7402	.17	SN7474	.31
SN7403	.14	SN7475	.39
SN7404	.17	SN7476	.39
SN7405	.14	SN7483	.69
SN7406	.18	SN7485	.98
SN7407	.24	SN7486	.44
SN7408	.18	SN7490	.69
SN7410	.14	SN7492	.45
SN7411	.19	SN7493	.45
SN7412	.19	SN7494	.45
SN7413	.19	SN7495	.45
SN7414	.61	SN74107	.31
SN7415	.24	SN74123	.49
SN7416	.24	SN74124	.39
SN7417	.24	SN74128	.83
SN7418	.24	SN74145	.89
SN7419	.24	SN74151	.63
SN7420	.26	SN74153	.63
SN7421	.26	SN74154	.98
SN7422	.26	SN74157	.64
SN7423	.24	SN74161	.27
SN7424	.24	SN74162	.95
SN7425	.24	SN74164	.44
SN7426	.24	SN74174	.44
SN7427	.24	SN74175	.88
SN7428	.24	SN74181	1.95
SN7429	.24	SN74190	1.15
SN7430	.24	SN74191	1.15
SN7431	.24	SN74192	.83
SN7432	.24	SN74193	.83
SN7433	.24	SN74195	.75
SN7434	.24	SN74251	1.39

SPECTRA-TWIST RIBBON CABLE

Twisted pairs of brightly colored cable! 24AWG

Cat. No. 653680 48 cond. 2 ft. \$1.98
Cat. No. 654081 32 cond. 2 ft. \$1.98

RIBBON CABLE AT THIN PRICES

Ultra-flat! 28 AWG!
Single color! Indexed!
Order by Cat. No. 653939 and conductors

Conds	Length	Sale
20	8 ft.	\$1.98
26	6 ft.	\$1.98
34	5 ft.	\$1.98
49	4 ft.	\$1.98
50	3 ft.	\$1.98

HANDY COMPUTER MULTIMETER

1000 ohms per volt
1% precision, movements diode protected against burnout. Measures DC volts 0-15-150-1000; AC volts 0-15-150-1000; DC current 0-150mA; resistance X1000. Sensitivity 1000 ohms/volt AC-DC. Uses penlite cell, not included. Size 2 3/4 x 3 1/2. Cat. No. 653921

IC SOCKETS

as low as **17¢ ea.**

Low profile, solder tail.

652123	8 pin mid/lo p. \$17
651308	14 pin dip \$19
651309	16 pin dip \$22
653378	18 pin dip \$25

DIP SWITCHES

Cat. No.	Switches	Sale
653668	2	\$7.77
653669	4	8.99
653021	4	.99
653670	5	1.19
653671	6	1.29
652677	7	1.79

SOLAR ENERGY DISCS

All Cells .5V! As low as **\$3.95**
High efficiency! As low as \$3.95
Gang for higher voltages and amps!

Cat. No.	Size	Mils	Sale
655046	2"	500ma	\$3.95
653862	3"	1000ma	8.88
653788	3 1/2"	1200ma	12.50
655057	4"	1500ma	15.95

LINEARS

Type	Sale	Type	Sale
LM301H, V	\$2.25	LM379N	4.95
LM307H, V, N	.25	LM380N	1.19
LM309H, V	.79	LM381N	1.19
LM309K, V	1.19	LM381V	1.19
LM311H, V	.79	LM555N	.69
LM320T-5V	1.19	LM565N	.65
LM320K-12V	1.19	LM703H	3.95
LM320K-15V	1.19	LM709N, N	.22
LM320K-15V	1.19	LM710N	.29
LM320K-15V	1.19	LM723N	.42
LM320K-15V	1.19	LM741, V, N	.29
LM320K-15V	1.19	LM747H, N	.59
LM320K-15V	1.19	LM1458V	.69
LM320K-15V	1.19	LM1800N	1.49
LM322N	1.19	LM3900N	3.5
LM324N	.99	LM75491	.69
LM324N	1.09	LM75492	.75
LM327N	1.50	PA265	1.50

ECCO 10-POSITION BCD THUMBWHEEL SWITCH

1-2-4-8 BCD encoding!
Positions labeled 0-7, F, L, 3 for (F coded for 8, L coded for 9). Write numerals on a black background. Ecco 800 series. 1 1/4 x 1 1/4 x 1/2". Cat. No. 653846 **\$1.49**

GIANT SALE! MICRO-MINI TOGGLE SWITCHES

Cat. No.	Contacts	Sale
653936	SPST	\$1.19
654036	SPDT	1.29
655085	SPDT	1.39
654037	DPDT	1.45

3A, 125VAC contacts or better!
Complete with mounting hardware!
Center off

SPECTROL "SKINNY-TRIMS"

3/8" square, screwdriver shaft. 2 for \$1.00

Ohms	Quantity	Sale
10K	25	\$1.00
50K	25	1.00
100K	25	1.00
200K	25	1.00
500K	25	1.00
1K	25	1.00
2K	25	1.00

MOTHERBOARD EDGE CONNECTOR

106 pins (63 each side). Use

DUAL TRACE 15 MEGAHERTZ

\$395⁰⁰

PORTABLE MINISCOPE



**MADE
IN THE
U.S.A.!**

**BATTERY
OPERATED!**

FEATURES

- Dual Trace- 2 channel: separate, chopped or alternate modes.
- 15 megahertz bandwidth.
- External and internal trigger.
- Time Base - 0.1 microseconds to 0.5 Sec/div - 21 settings.
- Battery or line operation.
- Automatic and line sync modes.
- Power consumption less than 15W.
- Vertical Gain - 0.01 to 50 volts/div - 12 settings.
- Weight is only 3 pounds.

From the originator of the Digital Voltmeter, Non-Linear Systems comes the MS-215 Miniscope. It is a fine electronic instrument with a great deal of measuring capability and excellent accuracy. Its design is modern, utilizing the latest in low-powered integrated circuits, and it is packaged into the smallest practical size. The instrument fits into many briefcases and tool boxes with room to spare.

Operating characteristics have been chosen so that the MS-215 will make all of the measurements needed in servicing most electronic equipment. It is field-portable so its use is not restricted to the bench.

SPECIFICATIONS:

Vertical Mode: CH1, CH2, CH1 & CH2 (Chopped) & CH1 & CH2 (Alt.)
The Following Specifications apply to each channel

Y Axis Vertical Input: 10mV/div to 50V in 12 Calibrated ranges, as follows:
x1-10mV/div to 10V/div in four ranges, each continuously variable.
x2-20mV/div to 20mV/div in four ranges, each continuously variable.
x5-50mV/div to 50mV/div in four ranges, each continuously variable.
Accuracy is 3%

Input Impedance: 1M ohm shunted by 50 pF.

Bandwidth: DC/DC to 15 Mhz ±6 db (DC to 8 Mhz ±3 db). AC, same as DC down to 3Hz.

Rise Time: Approximately 23 nS @ 1 division deflection.

Input Voltage: 250 maximum (DC and Peak AC).

Horizontal Mode: Internal Time Base or External Horizontal, switch selectable. In the XY mode, vertical input is through CH1 and horizontal input is through CH2

Bandwidth: DC to 200 KHz (±3 db).

Coupling: AC, DC or ground, switch selectable. Low frequency point on AC is 3 Hz.

Input Impedance: 1Meg ohm shunted by 50 pF.

Deflection Factor: 10mV/div to 50V/div in 12 calibrated ranges. The ranges can be calibrated with the CH2 gain control

Input Voltage: 250V maximum (DC and Peak AC)

Time Base: 0.1 uS/div to 0.5 Sec/div in 21' calibrated ranges, as follows:
x1, uS-0.1 uS/div to 100 uS/div. x2, uS-0.2uS/div to 200 uS/div.
x5, uS-0.5uS/div to 500 uS/div. x1, mS-0.1 mS/div to 100 mS/div.
x2, mS-0.2mS/div to 200 mS/div. x5, mS-0.5mS/div to 500 mS/div.
all in four ranges, each continuously variable. (Range increments ar .1, 1, 10, 100.) With vernier in full clockwise position, calibrated time measurements are possible. Accuracy is 3%.

Triggering Internal: Sweep triggered from internal trigger source (In the dual trace modes, the internal trigger source is CH1).

Automatic: Trigger source is internal calibrator frequency. To be used if there is no other trigger source available to synchronize the sweep.

Line: Trigger is derived from line frequency when using the battery charger.

External: Controls function as for internal triggering (1 Megohm input impedance).

Slope: Selects sync to positive- or negative- going waveform.

Coupling: AC

Sensitivity: Less than 1 div for internal trigger and less than 1 volt for external trigger.

Level: Trigger Level control permits continuous adjustment of trigger point in all modes except Auto.

Internal Calibrator: A square-wave signal of 1 volt p-p ±5% is provided. Frequency is approximately 1KHz.

Display Graticule: 4x5 div, each division is 0.25 inch. Viewing area 1.1"Hx1.35"W

CRT: Bluish-white phosphor, medium persistence. CRT uses low power filament for low battery drain. Instant on!

Power On-Board Batteries: Three sealed, rechargeable lead acid "D" Cells

Operating Time: Typically 4 hours.

Charging Time Scope Operating: Will run indefinitely but not reach full charge.

Non-operating: Sixteen hours.

Battery charger: 115 vac (220 vac on request), 50-400Hz, less than 15 watts.

Dimensions: 3.1"Hx6.4"Wx8.0"D.

Weight: Three pounds.

Environment Operating Temperature: 0° to 40°C

Shock and Vibration: Designed to withstand normal shock and vibration encountered in commercial shipping and handling.

Accessories Furnished: Tilt stand, battery charger, 2 input cables, and 3 miniature banana plugs.

Optional: Leather carrying case and probes

Warranty: One year parts and labor. Made in the U.S.A.

MS-215 with Rechargeable Batteries and Charger \$395.00

Leather Carrying Case

The leather case has 2 separate compartments. One to hold the scope, the other to hold the charger, probe, shoulder strap, etc. The case can be worn on the belt, or over the neck.

The snaps used on the case are "one way", thus accidental striking of the case against an object will not undo the snaps or let it be pulled off your belt.

41-140 \$30.00

Probes

10 to 1 probe with 10 megohm input.

Probe uses spring hook tip for sure connection. Compensation network is located at the connector rather than at the probe, so as to keep size and weight to a minimum.

41-141 \$24.50

Deluxe Combination Probe

Switchable 10to1/1to1 probe with an assortment of probe tips to suit any situation.

41-3495 \$34.95

\$40.00 OFF

On Any Accesories Purchased with MS-215 MINISCOPE, Just Send or Mention the COUPON and Byte Magazine

MS-15 Single Trace version of MS-215

\$289⁰⁰

PRIORITY ONE ELECTRONICS

10031 A Woodley Ave. Sepulveda CA. 91343

Terms VISA, MC, BAC, check, Money Order, C.O.D., U.S. Funds Only. CA residents add 6% sales tax. Minimum order \$10.00. Orders less than \$75.00 include 10% shipping and handling, excess refunded. Just in case please include your phone no. "Sorry, no over the counter sales" Good thru July 15, 1978



Send for our latest brochure

phone orders welcome (213) 893-8202

OEM and institutional inquiries invited

NLS MS-15 MINISCOPE \$289.00

MS-15 MINISCOPE \$289.00 MS-15 MINISCOPE

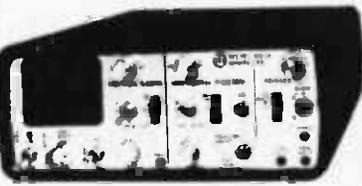
NLS MS-15 MINISCOPE \$289.00 NLS MS-15 MINISCOPE \$289.00

SC-5 With Rechargeable Batteries & Charger Unit \$89

FM-7 With Rechargeable Batteries & Charger Unit \$195

Features include: • By using the new NLS SC-5 Prescaler, the range of the FM-7 Frequency Meter, which is 10 KHz to 80 MHz, may be extended to 512 MHz (the upper VHF & UHF frequency bands). • The FM-7 utilizes an LED readout, providing 7-digit resolution. • The FM-7 can be calibrated to an accuracy of 0.00001%. • The SC-5 is accurate to one part per million. • Each unit has 30 microamps sensitivity, is battery powered and has a charger unit included. • Dimensions of each are 1 9/16" H x 2 7/8" W x 3 1/8" D. • The units may be ordered separately or as a Frequency Duo. • Parts & Labor guaranteed 1 year. • Full stand option \$3.50. • Leather case \$16.00.

MS-15 MINISCOPE \$289
With Rechargeable Batteries & Charger Unit



• 15 megahertz bandwidth.
• External and internal trigger.
• Time base — .1 microsec. to 0.5 Sec/div 21 settings ±3%.
• Battery or line operation.
• Automatic & line sync modes.
• Power consumption < 15 watts.
• Vertical Gain — .01 to 50 V/div - 12 settings ±3%.
• Viewing area 1 1/4" x 1.25".
• Case size 2 7/8" H x 6 1/4" W x 7 5/8" D, 3 pounds.
• Parts & Labor guaranteed 1 year.
• 10 to 1, 10 meg probe.
• Leather carrying case \$24.50 \$30.00

NEW VOLKSMETERS!
With LCD Display—
Excellent Readability in Direct Sunlight!

NEW

100% LM-300
Full three digits \$99.50*

0.5% LM-350
3 1/2 digits \$125.00*

FEATURES

- Measures DC volts, AC volts, ohms and current
- Automatic polarity, decimal and overload indication
- No zero adjustment and no full scale ohms adjust
- Large LCD display for easy reading without interpolation
- Size 1 9/16" H x 2 7/8" W x 4 1/8" D
- Parts and labor guaranteed for one year

SPECIAL!!

Batteries & Charger \$1.00 with the purchase of Meter and the mention of this magazine \$1.50

3 1/2" NiCad-Batts. & Charger \$1.95

Standard AA-size batteries provide up to 20 hours of operation. Rechargeable NiCad batteries and charger unit available as optional equipment. Batteries not included.

LEDU MG 10A
List \$72.00



Perfectly balanced, fluorescent lighting with precision magnifier lens. For proff. techn. & hobbyist. Has die cast protective shade, inst. stand & 2 diopter lenses 42 inch \$44.95

SPECIAL \$44.95

• 15 megahertz bandwidth.
• External and internal trigger.
• Time base — .1 microsec. to 0.5 Sec/div 21 settings ±3%.
• Battery or line operation.
• Automatic & line sync modes.
• Power consumption < 15 watts.
• Vertical Gain — .01 to 50 V/div - 12 settings ±3%.
• Viewing area 1 1/4" x 1.25".
• Case size 2 7/8" H x 6 1/4" W x 7 5/8" D, 3 pounds.
• Parts & Labor guaranteed 1 year.
• 10 to 1, 10 meg probe.
• Leather carrying case \$24.50 \$30.00

• **MS-215 Dual Trace Version of MS-15 \$395.00**

PROBE 1¢ with the purchase of SCOPE and the MENTION of this MAGAZINE

8803 MOTHER BOARD FOR \$100 BUS MICRO-COMPUTERS

• Includes 12 16-pin sockets for 4 5 = 12 12 buses and integrated matching buffers.
• Working side shown. Component side has copper glass with white markings for component locations.
• 12 16-pin pins board with 2 multi-copper solder plates and 038 diameter holes for ICs.
• Solder mask with solder windows on etched circuit to avoid accidental short circuits.
• Mounts 11 receptacles with 100 contacts (12 rows) on 172 letters with 250 row spacing. (See part number 8801) or mounts 10 receptacles plus microconnections to smaller mother boards for expansion.
• Includes etched circuit and instructions for option of active side up or floating terminations.
• Large boards: 7 1/2" x 9 1/2" (16 AMP) ± 1/16" or 10 1/2" x 10 1/2" (20 AMP). Current capacity per lead: \$10 275-watt 100°C.
• For Vector case enclosures.
• For Vector 8800 microcomputer as expansion board.

Price: \$29.50

Vector Plugboards

8800V Universal Microcomputer/processor plugboard, use with S-100 bus. Complete with heat sink & hardware. 5 3/4" x 10" x 1 1/16" \$19.95

3682-2 9.6" x 4.5" \$10.97

3682-2 6.5" x 4.5" \$9.81

Hi-Density Dual-in-Line Plugboard for Wire Wrap with Power & Grd. Bus Epoxy Glass 1/16" 44 pin con. spaced 156

Same as 8800V except plain, less power buses & heat sink.

1-4 5-9 10-24 \$13.45 \$17.95 \$15.96

3677 9.6" x 4.5" \$10.90

3677-2 6.5" x 4.5" \$9.74

3662 6.5" x 4.5" \$7.65

3662-2 9.6" x 4.5" \$11.45

Gen. Purpose D.I.P. Boards with Bus Pattern for Solder or Wire Wrap. Epoxy Glass 1/16" 44 pin con. spaced 156

3662-2 9.6" x 4.5" \$11.45

P pattern plugboards for IC's Epoxy Glass 1/16" 44 pin con. spaced 156

R644 P.C. recepticle 22/44 con. 156 pins pierced solder eyelets tails gold \$2.95

R644-3 P.C. recepticle 22/44 con. 156 pins Wire Wrap tails gold \$4.49

Bus P.C. Edge Connectors

R681 DIP solder tails on 140 spaced rows for ALTAIR mother boards. Frts 042 dia holes, gold \$7.35

R681-1 025" sq. 3 wrap lengths posts (62 long) on 250 spaced rows, gold \$5.00

R681-2 025" sq. 1 wrap length posts (22 long) on 250 spaced rows for wiring or DIP solder for IMSAI mother boards, gold \$5.85

R681-3 pierced solder eyelet tails gold \$3.35

1/16" Vector BOARD
.042 dia holes on 0.1 spacing for IC's

Phenolic

PART NO.	SIZE	PRICE
64P44-062XXP	4.5 x 6.5"	\$ 1.49
169P44-062XXP	4.5 x 17"	\$ 3.51

Epoxy Glass

PART NO.	SIZE	PRICE
64P44-062	4.5 x 6.5"	\$ 1.70
84P44-062	4.5 x 8.5"	\$ 2.10
169P44-062	4.5 x 17"	\$ 4.30
169P84-062	8.5 x 17"	\$ 6.39

ELITE WIRE
Wraps insulated wire on .025" square posts
FOUR TIMES FASTER

P180 with two 100' spools of 28 GA wire \$24.50

P180-4T includes charger, wire \$75.00

NO PRE-STRIPPING*
NO PRE-CUTTING*
SPOOLED WIRE*

*The spooled wire passes through the tool past a sliding edge next to the wire post. A narrow longitudinal cut is made in the insulation where it presses the square post through the wire. The cut is made by the sharp edge of the wire post.

SLIT-N-WRAP WIRE
NO 28 GAGE INSULATED WIRE, 100' SPOOLS

Only clean cuts. Available and easy to use. Manual or power operation.

12" Package \$13.95

1/2" Package \$10.95

2708 8K 450 ns

EPROM
FACTORY PRIME
\$10.00 EA.
25 + Call For Price

14 & 16 PIN
3 LEVEL
WIRE WRAP
SOCKETS

14-T3 100 for \$30.00

16-T3 100 for \$30.00

50 of ea. for \$32.00

ACE - All- for fast, solderless, Circuit plug-in circuit building and testing Evaluator

Just plug in any components with leads to .032" dia. Interconnect with solid wire up to 20 ga. Assembled models tool

ACE Model No.	To Points	RF Capacity	No. of Solder Pads	Board Size (inches)	Price (each)
200-R (4x1)	728	8 (16 x 1)	2	4.9/16 x 5.9/16	\$18.95
208 (4x2)	832	8 (16 x 1)	8	4.9/16 x 5.9/16	\$8.95
281-4 (4x4)	1032	12 (14 x 1)	2	16 x 7	\$4.95
212 (4x2)	1328	12 (14 x 1)	8	4.9/16 x 7	\$4.95
218 (4x2)	1760	18 (14 x 1)	10	6.1/2 x 7.1/8	\$8.95
222 (4x2)	2212	27 (14 x 1)	78	4 x 8 x 1.9/16	\$8.95
238 (4x2)	3848	36 (14 x 1)	36	10.1/4 x 9.1/4	\$9.95

SALE

LIQUID CRYSTAL DIGITAL CLOCK-CALENDAR

• For Auto, Home, Office
• Small in size (2x2 1/2")
• Push button for seconds release for date
• Clocks mount anywhere with either 3M double-sided tape or VELCRO, included
• 2 MODELS AVAILABLE
• LCD 101, portable model runs on self-contained batteries for better than a year
• LCD 102, runs on 12 Volt system and is back-lighted
• LCD 101 or LCD 102 your choice

\$34.95 ea.

Clear desk stand for \$2.00

3 LEVEL GOLD WIRE WRAP SOCKETS

	1-24	25-49	50-99
8 pin	47	42	37
10 pin	45	41	37
14 pin	39	38	37
16 pin	43	42	40
18 pin	75	68	62
20 pin	84	77	71
22 pin	100	97	95
24 pin	100	94	94
28 pin	103	98	94
36 pin	159	145	130
40 pin	149	139	129

MICRO-KLIP for .042 dia. holes (all boards on this page)

T42-1 pkg 100 \$ 1.50

T42-1 pkg 1000 \$11.00

P-149 hand installing tool \$ 2.03

8" LED ALARM CLOCK

12 hr LED Alarm Clock uses 3 1/2 digit 8 LED Display with AM/PM indicators and colons. Direct drive. PIN to PIN interface with ST998A IC. Just add switches, AC Supply Alarm Display and I.C. only

\$7.95 or 2/\$15.00

Price Breakthrough! \$17.95

MA1003
CAR CLOCK

Bright Green Fluorescent Display Crystal Time Base Assembled, just add switches and 12 VDC

SPECIAL
14CS2 100 for \$14.95
16CS2 100 for \$16.95
14 pin CS2 100 for \$21.95
16 pin CS2 8 for \$21.95

These low cost DIP sockets will accept both standard width plugs and chips. For use with chips, the sockets offer a low profile height of only .125" above the board. These sockets are and stackable.

Vector WRAP POST for .042 dia. holes (all boards on this page)

T-44 pkg 100 \$ 2.28

T-44 D-4 1000 \$14.00

A-13 hand installing tool \$ 2.80

PRIORITY ONE ELECTRONICS

1003! A Woodley Ave. Sepulveda CA. 91343

Terms: VISA, MC, BAC check, Money Order, C.O.D. U.S. Funds Only. LA residents add 6% sales tax. Minimum order \$10.00. Orders less than \$75.00 include 10% shipping and handling, excess refunded. Just in case please include your phone no. "Sorry, no over the counter sales" Good thru July 15, 1978

phone orders welcome (213) 893-8202

OEM and Institutional inquiries invited

24 PIN DIP PLUGS WITH COVERS

3 / \$1.00
40 / \$10.00

NLS MS-15 MINISCOPE \$289.00 NLS MS-15 MINISCOPE \$289.00

★ YOUR BEST BUY IN WIRE WRAP SUPPLIES ★

PRECUT WIRE

WHY BUY WIRE ON ROLLS?

PRECUT & STRIPPED WIRE IS:

- Fast - No more cutting & stripping by hand
- Reliable - Good, clean, uniform strip
- Economical - Cheaper than using bulk wire

Precut Wire

100 pcs of 3" at \$2 : 3/4"/ft. 50 ft roll at \$1 99 - 44"/ft.
100 pcs of 6" at 1 06 : 26"/ft. 100 ft roll at 2 95 : 36"/ft.
Wire Kit 1 at \$6 95 : 2 1/36"/ft.

Bulk Wire

• 30 Kynar stripped 1" on each end. Lengths are overall
Colors: Red, Blue, Green, Yellow, Black, Orange, White
Wire packaged in plastic bags. Add 25¢/length for tubes

	100	500	1000	5000
2 1/2 in	78	240	430/K	3 89/K
3 in	82	260	471/K	4 22/K
3 1/2 in	86	280	512/K	4 55/K
4 in	90	300	552/K	4 88/K
4 1/2 in	94	321	593/K	5 21/K
5 in	98	342	634/K	5 52/K
5 1/2 in	102	365	675/K	5 86/K
6 in	106	385	716/K	6 19/K
6 1/2 in	115	405	757/K	6 52/K
7 in	120	425	798/K	6 85/K
7 1/2 in	125	445	839/K	7 18/K
8 in	129	465	880/K	7 53/K
8 1/2 in	132	485	921/K	7 84/K
9 in	136	505	962/K	8 17/K
9 1/2 in	140	525	1003/K	8 50/K
10 in	145	551	1044/K	8 83/K
Addl. inches	10	41	82/K	66/K

WIRE KITS

# 1	\$6.95	# 2	\$19.95
250 3" 100 4 1/2"		250 2 1/2" 250 4 1/2"	250 6"
250 3 1/2" 100 5"		500 3" 250 5" 100 6 1/2"	
100 4" 100 6"		500 3 1/2" 100 5 1/2" 100 7"	
		500 4" 1 250 ft. Roll Bulk	

Choose One Color or Assortment

WIRE WRAP SOCKETS

	1-9	10-24	25-99	100-249	250-999	1K-5K
8 pin	41	38	35	31	29	27
14 pin	42	39	36	32	29	27
16 pin	46	43	39	35	32	30
18 pin	63	58	54	47	44	41
20 pin	84	78	71	63	59	54
22 pin	130	120	110	95	90	84
24 pin	91	84	78	68	64	59
28 pin	125	115	108	95	89	82
40 pin	165	155	142	125	115	109

Gold 3-level Closed Entry Sockets
End & Side Stackable All prices include gold
Tin sockets and 2-level sockets available

INTERCONNECT CABLES

Ribbon cable connectors for connecting boards to
front panels, or board to board

SINGLE ENDED			DOUBLE ENDED		
14 pin	16 pin	24 pin	14 pin	16 pin	24 pin
6"	1.24	1.34	2.05	2.24	2.45
12"	1.33	1.44	2.24	2.33	2.55
24"	1.52	1.65	2.63	2.52	2.76
48"	1.91	2.06	3.40	2.91	3.17

WIRE WRAP TOOLS



\$34.95

With Free Wire Kit 1
(\$6.95 Value)
HOBBY WRAP
Model BW 630

- Batteries & Charger \$11.00
- WSU 30 Hand Wrap-Unwrap Strip Tool 5.95
- WSU 30M, for Modified Wrap 6.95
- BT 30 Extra Bit 2.95

WIRE WRAP BOARDS

			1-4	5-9	10-24	WW Connector
H-PCB-1	4x4 1/2	44	Buses on both sides	4.75	4.50	4.00 3.00
3682	4x6	44	Blank	6.25	5.85	5.50 3.00
3682	4x10	44	Buses on one side	10.50	10.00	9.50 3.00
3682-2	4x6	44	Buses on one side	9.50	9.00	8.25 3.00
4066-4	4x6	72	Buses on both sides	13.50	13.00	12.50 4.00
3719-1	4x6	72	Blank	9.00	8.50	8.00 4.00
3719-4	4x10	72	Blank	11.00	10.50	10.00 4.00
4350	7x9 1/2	80	Buses on both sides	17.50	16.50	16.00 7.00
8800V	10x5.3	100	Buses on both sides	19.50	17.95	16.95 5.00
169P64	8 1/2 x 17		Blank	6.25	5.75	5.25

SOCKET SALE!

	1-9	10-49	50 up
14 pin Gold WW	.34	.32	.30
16 pin Gold WW	.36	.35	.33
24 pin Gold WW	.75	.70	.68

Prices good through
6/1/78
when purchased with
Wire Kit #1 or #2

PAGE DIGITAL ELECTRONICS

Ordering Information:

- Orders under \$25 and COD's, add \$2
- All others, shipped Ppd in U.S. via UPS
- For Blue Label (Air) or 1st Class, add \$1
- We accept Visa & Mastercard
- Most orders shipped same day

135 E. Chestnut Street 4A
Monrovia, California 91016
Phone (213) 357-5005

Dealer Inquiries Invited

P.O. Box 4430X Santa Clara, CA 95054

For will call only: (408) 988-1640
2996 Scott Blvd.



Same day shipment. First line parts only. Factory tested. Guaranteed money back. Quality IC's and other components at factory prices.

INTEGRATED CIRCUITS

MICROPROCESSOR	2708	14.85	2104A-4	4.95
8800	2107B	2.90	2107B	4.70
8080A with data	2111-1	2.90	2111-1	4.95
780	2112-2	7.90	2112-2	7.90
8212	2114	13.45	2114	13.45
8214	MK1116	27.50	MK1116	27.50
8216	2513B	8.75	2513B	8.75
8224	21L02-1	1.49	21L02-1	1.49
8228	MM5282	.40	MM5282	.40
8251	14-18 28 43	MM5280	3.00	
8253	16-20 36 58	MM5280	9.95	
8255	18-27 40 61	MM5330	5.94	
CDP1802CD	22-35	PD4110-3	4.00	
CDP1802D	3 level wire wrap gold.	PD4110-4	5.00	
CDP1861	14 pin .35 18 pin .39	P5101	13.95	
6820	2 level 14 pin ww .25	4200A	12.95	
6850		8225	2.90	
6502		91L02A	1.75	
PROM		H00165-5	6.95	
1702A	44 pin edge	MM57100	9.50	
N82S23	100 pin edge	GIAY38500-1	13.95	
N82S123	100 pin edge WW 5.25	MCM6571A	9.95	
N82S126		9368	3.50	
N82S128		MOS/MEMORY RAM		
N82S129		2101-1	3.95	
N82S131		2102-1	1.28	
N82S136		2102A-4	1.60	
N82S137		21F02	1.85	
		INTERFACE		
		AM197	1.69	
		8728	2.75	
		8797	1.69	
		CRYSTALS		
		1 MHz	4.50 2.0100 MHz 1.95	
		2 MHz	4.50 2.087152 MHz 4.50	
		4 MHz	4.25 2.4576 MHz 4.50	
		5 MHz	4.25 3.2768 MHz 4.50	
		10 MHz	4.25 5.0688 MHz 4.50	
		18 MHz	3.90 5.185 MHz 4.50	
		20 MHz	3.90 5.7143 MHz 4.50	
		32 MHz	3.90 6.5536 MHz 4.50	
		32768 Hz	4.00 14.31818 MHz 4.25	
		1.8432 MHz	4.50 18.432 MHz 4.50	
		3.5795 MHz	1.20 22.1184 MHz 4.50	
		60 Hz Crystal Time Base Kit	\$ 4.40	
		30 MHz Frequency Counter Kit	\$47.75	
		Prescaler Kit to 350 MHz	\$19.95	
		COMPUTER BOARD KITS		
		8K RAM Board Kit	\$134.95	
		4K EPROM Kit	114.95	
		I/O Board Kit	44.50	
		Extender Board w/connector	12.50	
		Video Interface board kit	125.00	
		16K EPROM board kit w/ PROMS	74.50	
		16K Static RAM board kit	39.00	
		North Star Floppy Disk Kit	\$65.00	
		Additional Drive Kit	415.00	
		Paratronix 100A Logic Analyzer Kit	\$199.00	
		Model 10 Trigger Expander Kit	\$229.00	
		Model 150 Bus Grabber Kit	\$369.00	

New Cosmac Super "ELF"

RCA CMOS expandable to 64K micro-computer w/HEX keypad input and video output for graphics. Just turn on and start loading your program using the resident monitor on ROM. Pushbutton selection of all four CPU modes. LED indicators of current CPU mode and four CPU states. Single step op. for program debug. Built in pwr. supply, 256 Bytes of RAM, audio amp. & spkr. Detailed assy. man. w/PC board & all parts fully socketed. Comp. Kit \$106.95. High address display option 9.95; Low address display option 9.95; Custom hardwood cab.; drilled front panel 19.75; Nicad Battery Backup Kit

w/all parts 4.95; Fully wired & tested in cabinet 151.70; 1802 software club. 10-12 pg. monthly publication 12.00 per yr.

4K Elf Expansion Board Kit with Cassette I/F \$79.95

Available on board options: 1K super ROM monitor \$19.95. Parallel I/O port \$7.95. RS232 I/F \$3.50. TTY 20 ma I/F \$1.95. S-100 Memory I/F \$4.50

Tiny Basic for ANY 1802 System \$10.00

Kansas City Standard Cassette On ROM Monitor \$38.00
Super Elf owners take 30% off.
Object code listing or paper tape \$5.50 with manual

Auto Clock Kit \$15.95

DC clock with 4-50" displays. Uses National MA-1012 module with alarm option. Includes light dimmer, crystal timebase PC boards. Fully regulated, comp. instrs. Add \$3.95 for beautiful dark gray case. Best value anywhere.

'78 IC Update Master Manual \$30.00

1978 IC Update Master Manual \$30.00
Complete IC data selector 2175 pg. Master reference guide. Over 42,000 cross references. Free update service through 1978. Domestic postage \$3.50. Foreign \$6.00. Final 1977 Master closeout \$15.00

Video Modulator Kit \$8.95

Convert your TV set into a high quality monitor without affecting normal usage. Complete kit with full instructions.

RCA CosmacVIP Kit \$275.00

Video computer with games and graphics.

Sinclair 3 1/2 Digit Multimeter \$69.95

Batt. oper. 1mV and .1nA resolution. Resistance to 20 meg. 1% accuracy. Small, portable, completely assem. in case. 1 yr. guarantee.

TERMS: \$5.00 min. order U.S. Funds. Calif residents add 6% tax. BankAmericard and Master Charge accepted. Shipping charges will be added on charge cards. FREE: Send for your copy of our NEW 1978 QUEST CATALOG. Include 24¢ stamp.



S.D. COMPUTER PRODUCTS

AN EMPIRE IND. CO

P.O. BOX 28810B DALLAS, TEXAS 75228

EXPANDABLE EPROM BOARD

16K OR 32K EPROM \$49.95 W/OUT EPROM
Allows You to Use Either 2708's For 16K of Eprom or 2716's for 32K of Eprom.

KIT FEATURES:

- All Address Lines & Data Buffered
- Quality Plated through P.C. Board Including Solder Mask and Silk Screen
- Selectable Unit States
- On Board Regulation Provided
- All Sockets Provided W/Board

WE CAN SUPPLY 450As 2708's AT \$11.95 WHEN PURCHASED WITH BOARD.

EXPANDORAM THE ULTIMATE RAM BOARD 32K FOR \$475.00



32K MODEL	
8K	\$151.00
16K	259.00
24K	367.00
32K	475.00

64K MODEL	
16K	\$281.00
32K	519.00
48K	757.00
64K	995.00

THE 32K VERSION USES THE MOSTER MK4115 RAM AND HAS 8K BOUNDARIES AND PROTECTION & UTILIZES DIP SWITCHES. P. C. BOARD COMES WITH SOCKETS FOR 32K OPERATION

BUY A S100 COMPATIBLE RAM BOARD AND UPGRADE THE SAME BOARD TO A MAXIMUM OF 65K MEMORY IN STEPS OF EITHER 8K OR 16K AT YOUR OPTION BY MERELY PURCHASING MORE RAM CHIPS FROM S.D. COMPUTER PRODUCTS.

THE 64K VERSION USES THE MOSTER MK4116 RAM AND HAS 16K BOUNDARIES AND PROTECTION & UTILIZES DIP SWITCHES. P. C. BOARD COMES WITH SOCKETS FOR 64K OPERATION

- LOOK AT THE FEATURES WE HAVE BUILT INTO THE EXPANDORAMI**
- MEMORY ACCESS TIME IS 375 ns
 - MEMORY CYCLE TIME IS 500 ns
 - POWER REQUIREMENTS ARE:
 - 8 VDC 400 MA DC
 - 18 VDC 400 MA DC
 - 18 VDC 30 MA DC
 - ON BOARD INVISIBLE REFRESH
 - NO WAIT STATES REQUIRED
 - NO CYCLE STEALING NEEDED
 - ON BOARD REGULATION
 - CONTROL DATA & ADDRESS INPUTS UTILIZE LOW POWER SCHOTTKY DEVICES
 - DESIGNED TO WORK WITH Z-80, 8080, 8085, CPU's

ADD \$50.00 TO ABOVE PRICES FOR FULLY ASSEMBLED AND TESTED BOARDS

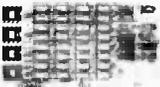
Low Cost Cassette Interface Kit \$19.95



Features: Play and record K.C. Standard 2400/1200 Hz tapes, 500 Baud, TTL I/O Compatible, Phase Lock Loop. Both 22 Pin Connector and 8 Pin Molex Connector. Comes partially assembled. Oscillator and phase lock loop pre-tuned to K.C. Standard. Selector switch sends cassette data or auxiliary input data to microprocessor. LED indicates logic 1 level.

4K LOW POWER RAM KIT The Whole Works - \$79.95

Full Buffered on board regulated reduced power consumption utilizing low power 21L02-1 500ns RAMS - Sockets provided for all IC's. Quality plated through PC board.



*Add \$10.00 for 250ns RAM operation.

8K LOW POWER RAM \$159.95

FULLY ASSEMBLED AND TESTED. NOT A KIT. 1msai - Altair - S-100 Bus compatible, uses low power static 21L02-500ns fully buffered on board regulated, quality plated through PC board, including solder mask & pos. dip switches for address select.

*Add \$30.00 for 250ns RAM operation



Z-80 CPU BOARD KIT Complete Kit \$139.

CHECK THE ADVANCED FEATURES OF OUR Z-80 CPU BOARD: Expanded set of 158 instructions, 8080A software capability, operation from a single 5VDC power supply; always stops on an M1 state, true sync generated on card (a real plus feature!), dynamic refresh and NMI available, either 2MHZ or 4MHZ operation, quality double sided plated through PC board; parts plus sockets provided for all IC's. *Add \$10. extra for Z-80A chip which allows 4MHZ operation.



NEW FROM S.D. "VERSAFLOPPY"™ KIT THE VERSATILE FLOPPY DISK CONTROLLER ONLY \$149.00

FEATURES: IBM 3740 Soft Sektored Compatible, S-100 BUS Compatible for Z-80 or 8080. Controls up to 4 Drives (single or double sided). Directly controls the following drives:
1. Shugart SA400/450 Mini Floppy
2. Shugart SA800/850 Standard Floppy.
3. PERSCI 70 and 277.
4. MFE 700/750.
5. COC 9404/9406.
34 Pin Connector for Mini Floppy. 50 Pin Connector for Standard Floppy. Operates with modified CP/M operating system and C-Basic Compiler. The new "Versafloppy" from S.D. Computer Products provides complete control for many of the available Floppy Disk Drives. Both Mini and Full Size. FD1771B-1 Single Density Controller Chip. Listings for Control Software are included in price.
FD 1771B-1 CHIP ALONE \$39.95

Z80 STARTER KIT LEARN COMPUTERS FROM THE START! SIMPLE, STEP BY STEP LEARNING. CONSTRUCTION, PROGRAMMING, OPERATION, MEMORIES, INTERFACING, COMPUTING, AND CONTROLLING WITH AUDIO CASSETTE INTERFACE CAPABILITIES.

Complete Kit includes: Key board and Display; Z80 Central Processing Unit; Instructions; Operation Manual; Learning Guides.
Features: Powerful Z80 CPU with 158 instructions * 1024 Bytes (Expandable to 2048 Bytes ON BOARD) of RAM * 2 Bi-Directional Input/Output Ports with Handshaking * Kansas City Standard Audio Cassette Interface for Program Storage * Hexadecimal Keyboard and Display * Wirewrap area for custom circuitry * S-100 Connector on board for Memory and I/O Expansion * 2716/2758 PROM Programmer * "Z-BUG" Monitor ROM (Including: Memory, Port and Register Examine and Change Commands; Breakpoints; Single Step Capability; Audio Tape Load and Dump; Execute user program Commands.)
Many more unique features. The best computer educational kit on the market... the complete computer and educational package for only \$199.00. (Available June 1978).

INTRODUCING THE SBC-100 (The Z-80 Based, S-100 Single Board Computer) \$349.00

FEATURES:

- No Front Panel Needed
- Z-80 CPU (2 or 4 MHZ)
- 1K RAM
- 4 ROM/PROM Sockets for 4K/8K of Memory
- SYNCHRONOUS/ASYNCHRONOUS Serial I/O with RS-232 and Current Loop Interface and Software
- Programmable Baud Rate
- Parallel Input Port
- Parallel Output Port
- 4 Channel Timer/Counter
- 4 Vectored Interrupts

O. E. M. SPECIAL

ASK ABOUT SPECIAL O.E.M. DISCOUNTS ON THE S.D. "COMPATIBLE SET"
SBC-100 — SINGLE BOARD COMPUTER \$349.00
VERSAFLOPPY™ — FLOPPY DISK CONTROLLER \$149.00
EXPANDORAM — 32K RAM \$475.00
EACH KIT IF PURCHASED SEPARATELY TOTAL \$973.00
ORDER ALL 3 KITS TOGETHER FOR \$899.00
This Powerful Threesome Operates Together to Form A Complete Computer for Your System.

Z-80 Programming Manual

IN DEPTH DETAIL OF
THE Z-80 CPU
MICRO-COMPUTER

S. D. SALES SPECIAL \$9.95

RAMS

21L02-500NS	8/11 50
21L02-250NS	8/15 95
2114-4K	14 95
1101A-256	8/54 00
1103-1K	35
MK 4115-8K	15 45
74S200-256	3 95

CPU's

Z-80 includes manual	29 95
Z-80A includes manual	34 95
8080A CPU 8 BIT	11 95
8008 CPU 8 BIT	6 95

PROMS

1702A-1K-1.5us	3.95 or 10/35.
2708-8K-450ns	14.95
5204-4K	7.95
82S129-1K	2.50
2780B 8K signetics 650ns	9.95

COUNTER CHIPS

MK50397 6 Digit elapsed timer	8.95
MK50250 Alarm clock	4.99
MK50380 Alarm chip	2.95
MK50395 6 digit up/dn. count.	12.95
MK5002 4 digit counter	8.95
MK5021-Cal. chip sq. root	2.50

S.D. NOW HAS SOFTWARE FOR IT'S CUSTOMERS

CP/M™ DISK OPERATING SYSTEM . . . \$99.95

CP/M is a powerful disk operating system which has become an industry standard. It is compatible with several disk based FORTRAN and BASICS. This package includes a CP/M diskette (mini or full size) adapted for S.D.'s SBC-100/VERSAFLOPPY EXPANDORAM board set. Complete documentation is included. CP/M is a registered trademark of Digital Research Corp., Pacific Grove, CA.

Z-80™ DISK BASED ASSEMBLER . . . \$69.95

Runs on ANY CP/M based disk system. Assembles the official Zilog-Mostek Mnemonics. Contains extensive set of pseudo-ops. Available on mini or full size diskette.

VERSAFLOPPY™ CONTROL FIRMWARE . . . \$24.95

Provides control for VERSAFLOPPY and boots up CP/M. This runs on Z-80, 8080 or 8085 based computers. Available in 2708 or 2758 prom.

SD MONITOR . . . \$49.95

Powerful monitor for SBC-100 single board computers. Includes all VERSAFLOPPY control firmware. Comes in 2716 prom. Available in 4-6 weeks.

VERSAFLOPPY DIAGNOSTIC PROGRAM . . . \$24.95

Provides routines which are helpful in checking out a disk based system Available in 2708 or 2758 prom.

MICROPROCESSOR CHIPS

8212-1/D port	3.50
8214-P.I.C.	12.95
8216-Non Invert Bus	4.95
8224-Clock Gen.	4.95
8226-Invert Bus	3.95
PID for Z-80	14.95
CTC for Z-80	14.95
8228 Sys. Controller	8.20
8251 Prog. comm. interface	10.95
8255 prog. prep. interface	13.50
8820 Dual Line Recr	1.75
8830 Dual Line Dr.	1.75
2513 Char. Gen.	7.50
8838 Quad Bus. Recvr.	2.00
74LS138N-1/8 decoder	.99
8T97-Hex Tri-State Buffer	1.25
1488/1489 RS232	1.50
TR 1602B Uart	3.95
TR 1863 Uart	8.50
FD 1771B-1	39.95

CMOS

4001	19	4029	99
4002	19	4042	69
4011	19	4047	1.50
4013	32	4049	35
4016	32	4059	23
4017	95	4071	19
4020	97	4076	97
4022	97	1451B	1.10
4024	75	1452B	85
4027	39	14529	85

SUPER FLOPPY SPECIAL

S. D. SALES' VERSAFLOPPY S-100 CONTROLLER BOARD PLUS SHUGART SA 400 FLOPPY DISK DRIVE INCLUDING CABLE FOR ONLY

\$449.00

CALL IN YOUR BANKAMERICARD (VISA) OR MASTER CHARGE ORDER IN ON OUR CONTINENTAL TOLL FREE WATTS LINE:

1-800-527-3460

Texas Residents Call Collect:
214/271-0022

DEALER INQUIRIES INVITED!



(All prices subject to change without prior notice.)

NO COD'S. TEXAS RESIDENTS ADD 5% SALES TAX. ADD 5% OF ORDER FOR POSTAGE & HANDLING. ORDERS UNDER \$10. ADD 75c HANDLING. FOREIGN ORDERS - U. S. FUNDS ONLY!

Unclassified Ads

FOR SALE: Cromemco Bytesaver with MITS 8 K BASIC + 8 PROMS \$300. With 1 PROM \$150. MITS disk boot loader \$30. Multi boot loader \$20. IMSAI 4 K static \$80. MITS 4 K dynamic \$80. Ken Roberts, 10560 Main, #515, Fairfax VA 22030. (703) 591-6008 or (703) 378-7266.

WANTED: For Microdata 1600 processor (Reality) magnetic tape controller and disk controller and core memory boards. Jack Hardman, 140 Forest Av, Glen Ridge NJ 07028, (201) 429-8880.

FOR SALE: COSMAC microprocessor CDP1802 and 2 2101 programmable memory chips. Get started for \$20. CPU used less than 1 hour. Programmable memory new. I also have 10 new 2101s. \$2.50 each or all ten for \$20. Jeff Duntemann, 6424 N Albany Av, Chicago IL 60645, (312) 764-5069.

FOR SALE: SwTPC 6800 16 K system with AC30 cassette interface, fully socketed, first-class working condition, with documentation, \$700, delivered within 200 miles. Processor Technology VDM-1 video board, \$125 shipped prepaid. Robert Boyd, Woodlawn Av, Kennebunkport ME 04046.

FOR SALE OR SWAP: Altair 8800 kit micro-computer. Prefer ham gear. Write or call after 7 PM. Manley Nichols, Box 344, Henning MN 56551, (218) 583-2124.

FOR SALE: Viatron System 21. It has two tape storage units, a video monitor, a keyboard, two IO ports, etc. It also includes three tapes, two instruction manuals, and a technical manual (which includes all circuits). Asking \$600. P Gabrail, 209 Highland Av, Syracuse NY 13203.

FOR SALE: 200 CPM Burroughs B122 card reader, fair condition \$150. You provide transportation. P Carlson, 103 Drood Ln, Pittsburgh PA 15237. (412) 367-4632.

WANTED: Any information that you may have pertaining to hardware and software of personal computing systems, programming language and interfaces. Any and all contributions gratefully acknowledged by correspondence. Am presently assigned overseas and have no access to such material. David E Feher, Box 22, US Naval Communications Station, Fleet Post Office, New York NY 09571.

FOR SALE: Processor Tech Video Display Module VDM-1 for \$160, 2 K Read Only Memory 2 KRO for \$50. Still in kit form. Includes manuals and VDM software. Will sell both for \$200. Shipped by return mail to first money order. G Briggs, 6195 Deer Path, Manassas VA 22110.

IMSAI MEMORY: Four programmable memory 4 A assembled, tested, and burned in \$99.95 each. These use NEC 2102AL-4 Chips. They are 4 K X 8 static memory cards with write protect in 1 K blocks. Excellent in all respects, with documentation. Cashier's check or money order to Don Johnson, 3139 SW Altadena Terr, Portland OR 97201, (503) 246-3139.

Readers who have equipment, software or other items to buy, sell or swap should send in a clearly typed notice to that effect. To be considered for publication, an advertisement should be clearly noncommercial, typed double spaced on plain white paper, and include complete name and address information. These notices are free of charge and will be printed one time only on a space available basis. Insertions should be limited to 100 words or less. Notices can be accepted from individuals or bona fide computer users clubs only. We can engage in no correspondence on these and your confirmation of placement is appearance in an issue of BYTE.

Please note that it may take three or four months for an ad to appear in the magazine. ■

FOR SALE: KSR37 Tech manual and schematics for maintenance and installation, including opto-isolator mods, perf orig, \$25; HEATH LSI-11 manual set, including terminal and punch/reader in binders \$15; INTERFACE AGE end SCCS INTERFACE, vol 1, #1 to present, perfect, \$50; BYTE back issues, \$1.75 each; misc set of micro-computer mags, including ROM, PERSONAL COMPUTING, etc, the lot for \$10; POLY-MORPHICS VTI-64 video board assembled, \$75; STAT/MATH/PERT program listings in BASIC, \$5 each, send SSAE for list; D E Mann, 1201 N Roosevelt St, Arlington VA 22205.

WANTED: Original soft LEATHER (not plastic) case for HP-35 calculator. State price, condition, and whether snaps or velcro. John Ball, Oak Hill Rd, Harvard MA 01451.

FOR SALE: HP 9830A 32 K (OPT 001) memory (B) with following ROMs strings, matrix, ext IO, API, APII, plotter. 9871A Printer with form feed. 11203A BCD interface. Make offer. Robert Luke MD, Dept of Pathology, Maine Medical Center, Portland ME 04102, (207) 871-2843 days, (207) 883-9998 nights.

FOR SALE: Altair 680b with complete documentation, very little work left to get it up and running \$200. I pay shipping. William J Spencer, V-2 Div USS America (CV66), FPO New York NY 09501.

FOR SALE: 16 bits plus parity by 8096 words per board Texas Instruments memory labeled "1103 memory assembly number 226844-000 card number 226845-0001 and 8 K logic number 226846(L)", includes on board sense amps, clock sync etc \$100 per board, or all 3 boards (24 K x 16 bits) for \$250. Contact Robert Monaghan, Dept of Anthropology SMU, Dallas TX 75275.

FOR SALE: Complete Altair 8080a System II w/8 K programmable memory, 4 K static, 2SIO interface to COMTER II terminal and cassette tape recorder, VDM-1 kit, TV Dazzler kit, 4 slot expander board, 8 K BASIC tape papertape VDM driver and 5 K BASIC. All documentation included. \$2000 or best offer. Barry C Frank, 306 Oak Rd, Seaford DE 19973.

FOR SALE: Complete microcomputer system, new (purchased 12/77), fully assembled. Byte 8; Digicom Byteuser (prom); Cromemco D + 7A IO (7 channel analog interface); Dazzler (color TV interface); Byte MPU (processor); SD Sales 4 K programmable memory; all manuals. Our cost \$1300, best offer takes it. D G Linville, 4865 Pasadena Av, Sacto CA 95841, (916) 485-4050.

FOR SALE: DEC rack mount building block system. Contains two DEC 749 power supplies, one DEC 721 power supply, one positive current driver, one negative current driver, twelve plug in units as follows: 2 clocks, 2 inverters, 6 delays, one flip flop, one pulse generator. Comes complete with two mother boards capable of accepting 20 of the plug in units. Will sell the whole thing for \$125. Also have Micro Switch keyboard \$15; and one industrial power supply 5 V 25 A \$35. Write or call Ron Demcko, POB 243, Richfield Spgs NY 13439, (315) 858-1755.

PET SOFTWARE: Bring your PET alive with this interesting collection of games, personal finance, teaching, and demonstration programs written in BASIC especially for a 4 K PET. Includes black-jack, children's math, biorhythm, and 15 other programs. On cassette, ready to load and run. Accompanied by written program descriptions. All for \$15.95. Robert G Schmidt 14 Tinker Rd, Nashua NH 03060.

MOTOROLA 6800 USERS: I have a nifty trace program that prints out the results of each step: CC, B, A, X, plus the PC, opcode, and instruction of the next step. Program locates anywhere in memory. A beautiful debugging aid. Uses combined hardware/software trace and will trace through ROM. Works as is on any D2 kit interfaced to video or Teletype. Works on any MIKBUG or other system with NMI vector user available, with the addition of 2 ICS. Send \$3 and SASE for complete listing and instructions. Specify D2/MIKBUG/Other. Lynn Kurtz, 2104 Campo Alegre Rd, Tempe AZ 85281.

FOR SALE: Radio Shack TRS-80 with 16 K, level I and II BASIC. No monitor or recorder but all documentation and cables. Best cash offer. Mike Heck, 167 S Spring Mill Rd, Villanova PA 19085, (215) 525-0709.

WANTED: Memorex 3664 or IBM2311 disk drive. Please reply via air mail stating price and condition. Also, would like contact with anyone who owns a Memorex 40 minicomputer and for information exchange on its hardware or software. P R Williams, 15 Pinny Av, Lower Hutt NEW ZEALAND.

FOR SALE: IBM 1402 card reader/punch, manual included. Best offer over \$200 or trade for disk drive. You pay shipping. Steve Marsh, 5805 Boulder Creek, Austin TX 78724, (512) 926-5497.

FOR SALE: HAL-MCEM-8080 with keyboard, BASIC in ROM, 9 K programmable memory, 2708 programmer, dual cassette interface & power supply. Cost \$1200 will sell for \$695 used less than 4 hours. William C Dewberry, 314 Interbay Av, Pensacola FL 32507, (904) 456-6644.

FOR SALE: Control Data 160-A computer system, 8 K by 12 bits core memory, two multiple-device IO channels, 350 cps paper tape reader, TTY BRPE punch (110 cps), in desk-type cabinet, 110 VAC; also 161A IO typewriter interface with stand, 168-2 auxiliary arithmetic unit, two Model 601 magnetic tape drives, all documentation, software on magnetic tape and listed, spare cards, cables. \$995 for all. Roger C Buck, 1122 Post Dr, Rockford IL 61108, (815) 399-2507.

FOR SALE: E and L Instruments MMD-1 micro-computer with MMD-1/MI memory interface board. 1/2 K of memory on processor board, 2 K on interface board. Cassette (K-C format) Load/Dump PROM included. Fully tested and burned in. Only 8 months old. "Bugbooks" 1 thru 7 included. Good machine to learn on and expand. Cost me \$650; will sacrifice at \$485 or best offer. Serious inquiries may be sent to Garth L Bock, RR #1 Box 123, LeRoy IL 61752.

WANTED: Any information, especially schematic, for UNIVAC core unit, type 9001-03, part number 4029200-00, serial 2792-B. This core was probably used in a UNIVAC 1004 card processor system. W E Hefley, 157 Marian Ln, San Jose CA 95127.

FOR SALE: Quay Z-80 processor, factory assembled and tested, \$250. VDM-1 video display module, factory assembled by Processor Tech, \$200. SD Sales 4 K static memory for Altair (S-100), Z-80 compatible, \$50. Godbout-Morrow "Smart Cassette Interface" for three cassettes and RS232 and 20 mA, \$75. CCTV high resolution professional video monitor, \$100. SwTPC ASCII keyboard, fully encoded with interface and parity, in cabinet, \$50. SwTPC power supply suitable for Altair (S-100), 5 and 12 and -12 V, in cabinet, \$50. IMSAI 6 slot mother board, \$15. Or take all of the above with documentation for \$750. Eric Schneck, 426 E 85th St #5D, New York NY 10028, (212) 737-6458.

FOR SALE: One Tarbell cassette interface for \$85 and one DaJen cassette interface (CRI) for \$95. Both operate on popular Tarbell cassette bi-phase interface standard. DaJen board is completely software and hardware interchangeable with the Tarbell board but has switch selectable bps rates. Both fully assembled, socketed. Altair (S-100) compatible, and working perfectly. Dan S Parker, 1007 3rd Street #3, Davis CA 95616, (916) 758-2341 after 6:00 PM.

FOR SALE: Monroe #326 BETA "Scientist" programmable calculator with Model 392 digital tape unit. Tape drive fully controllable by program, permitting automatic read-in of program overlays plus automatic storage/retrieval of data. Features over 100 keyboard scientific functions, metric conversions, full edit and self-test capabilities, conditional jumps and nested subroutines, and large 12 digit display. Program size can extend to 27,000 keystrokes using the tape drive. Originally cost \$1300, asking \$650. In like-new condition with full documentation and fitted attaché carrying case with key lock. Gene Szymanski, 693 Rosedale Rd, Princeton NJ 08540, (609) 924-8856.

VISIBLE
OR
INFRA RED

USED FOR CHARACTER
RECOGNITION FOR
COMPUTERS WITH
EXTERNAL CIRCUITS

MAY BE USED IN
A VACUUM,
UNDER WATER,
HIGH ALTITUDE

IN MAGNETIC ENVIRONMENT
BECAUSE THERE IS NO
HIGH VOLTAGE OR
MAGNETIC DEFLECTION

MINATURE SOLID STATE

202 VIDEO CAMERA KIT

FEATURING A 100 x 100 BIT SELF SCANNING CHARGED COUPLED DEVICE

THIS UNIQUE UPDATED CAMERA KIT
FEATURES THE FAIRCHILD CCD 202C IMAGE SENSOR

ADVANTAGES

- IN THE FUTURE WE WILL SUPPLY A COMPUTER VIDEO INTERFACE CARD
- All clock voltages operate at 6V requiring no adjustments
- Higher video output signal
- We supply the power board, so only a 5V 1 Amp power source is needed
- The circuitry has been simplified for easier assembly
- Two level TTL output is supplied for interfacing

FEATURES

- Sensitive to infra red as well as visible light
- May be used for IR surveillance with an IR light source
- Excellent for standard surveillance work, because of light weight and small size
- All components mounted on parallel 3 3/4" x 6 1/2" single sided boards
- Total weight under 1 lb.



SURPLUS CENTRONICS PRINTERS

101 — \$1,150
306 — \$900

\$349.00 KIT

Add \$75.00 to assemble and test
Add \$2.00 Postage and Handling

We supply all semiconductors, boards, data sheets, diagrams, resistors and capacitors, and 8MM lens. Sorry we do not supply the case, batteries and 5V supply.

UNIVERSAL 4Kx8 MEMORY BOARD KIT \$79.95

32-21.02-1 fully buffered, 16 address lines, on board decoding for any 4 of 64 pages, standard 44 pin buss, may be used with F-8 & KIM

EXPANDABLE F8 CPU BOARD KIT \$99.00

featuring Fairbug PSU, 1K of static ram, RS 232 interface, documentation, 64 BYTE regis.er

4K BASIC FOR FAIRBUG F8 on paper tape \$25.00

C/MOS (DIODE CLAMPED)	QTY	PRICE
4001-16 4016-28 4027-37 4053-71		
4002-16 4017-78 4028-73 4056-125		
4005-95 4018-78 4029-73 4066-58		
4007-16 4019-37 4030-33 4071-24		
4008-37 4020-84 4031-57		
4010-37 4021-77 4042-58 4518-69		
4011-16 4022-86 4046-145 74C10-22		
4012-16 4023-16 4047-150 74C193 1.50		
4013-29 4024-66 4049-34		
4015-74 4025-16 4050-34		

PRINTED CIRCUIT BOARD

4 1/2" x 6 1/2" SINGLE SIDED EPOXY BOARD 1 1/6" (11x14) 5/\$2.60
7 WATT LD-65 LASER DIODE IR \$8.95

2N 3820 P FET	\$.45
2N 5457 N FET	\$.45
2N2646 UJT	4 \$ 1.00
ER 900 TRIGGER DIODES	4 \$ 1.00
2N 6028 PROG UJT	\$.65

MINIATURE MULTI-TURN TRIM POTS 100, 1K, 2K, 5K, 10K, 25K, 50K, 100K, 200K, 500K, 1Meg, 2Meg, \$.75 each 3/\$2.00

VERIPAX PC BOARD

This board is a 1/16" single sided paper epoxy board, 4 1/2" x 6 1/2" DRILLED and ETCHED which will hold up to 21 single 14 pin IC's or 8, 16, or LSI DIP IC's with busses for power supply connector. \$4.00

FP 100 PHOTO TRANS	\$.50
REO, YELLOW, GREEN or AMBER	
LARGE LED's 2"	6/\$1.00
TIL-118 OPTO-ISOLATOR	\$.75
MOLEX PINS	100/\$1.00
1000/\$8.00	
10 WATT ZENERS 3.9, 4.7, 5.6, 8.2, 18.22, 100, 150 or 200V	ea. \$.60
1 WATT ZENERS 4.7, 5.6, 10, 12, 15 18 or 22V	ea. \$.25
MC6860 MODEM CHIP	\$9.95
MCM 6571A 7 x 9 character gen	\$10.75

Silicon Power Rectifiers

1N4001-100	40¢
1N4002-100	40¢
1N4003-100	40¢
1N4004-100	40¢
1N4005-100	40¢
1N4006-100	40¢
1N4007-100	40¢
1N4008-100	40¢
1N4009-100	40¢
1N4010-100	40¢
1N4011-100	40¢
1N4012-100	40¢
1N4013-100	40¢
1N4014-100	40¢
1N4015-100	40¢
1N4016-100	40¢
1N4017-100	40¢
1N4018-100	40¢
1N4019-100	40¢
1N4020-100	40¢
1N4021-100	40¢
1N4022-100	40¢
1N4023-100	40¢
1N4024-100	40¢
1N4025-100	40¢
1N4026-100	40¢
1N4027-100	40¢
1N4028-100	40¢
1N4029-100	40¢
1N4030-100	40¢
1N4031-100	40¢
1N4032-100	40¢
1N4033-100	40¢
1N4034-100	40¢
1N4035-100	40¢
1N4036-100	40¢
1N4037-100	40¢
1N4038-100	40¢
1N4039-100	40¢
1N4040-100	40¢
1N4041-100	40¢
1N4042-100	40¢
1N4043-100	40¢
1N4044-100	40¢
1N4045-100	40¢
1N4046-100	40¢
1N4047-100	40¢
1N4048-100	40¢
1N4049-100	40¢
1N4050-100	40¢

SAD 1028-A RED/GRN/YEL/BLU/WH/BRN 8-Channel 8-Bit 8000Hz shift register \$18.95

15.50 30

MCA 81 OPTICAL LIMIT SWITCH \$1.50

309K	\$.95	340K-12 15	
723	\$.50	or 24V	\$.95
LM 376	\$.60	340T-5, 6, 8, 12	
320K-5, 12		15, 18 or 24V \$.95	
or 15V	\$1.00	78 MG	\$1.35
320T-5, 15		or 24V	\$.95
or 24V	\$.95	79 MG	\$1.35

TRANSISTOR SPECIALS

2N6233-NPN SWITCHING POWER	\$ 1.95
MRF-8004 a CB RF Transistor NPN	\$ 1.50
2N3772 NPN Si TO 3	\$ 1.00
2N1546 PNP GE TO-3	\$.75
2N4908 PNP Si TO 3	\$ 1.00
2N6056 NPN Si TO 3 Darlington	\$ 1.00
2N5086 PNP Si TO 92	\$.4
2N3137 NPN Si RF	\$.85
2N404 PNP GE TO 5	5 \$ 1.00
2N3919 NPN Si TO 3 RF	\$ 1.50
2N1420 NPN Si TO 54	3/\$ 1.00
2N3767 NPN Si TO 66	5 \$.70
2N2222 NPN Si TO 18	5 \$ 1.00
2N3055 NPN Si TO 3	\$.50
2N3904 NPN Si TO 92	5/\$ 1.00
2N3906 PNP Si TO 92	5 \$ 1.00
2N5296 PNP Si TO 220	\$.50
2N6109 PNP Si TO 220	\$.55
2N3638 PNP Si TO 5	5/\$ 1.00

TTL IC SERIES

7400-13	7445-65	74151-61
7401-13	7446-68	74153-61
7402-13	7447-68	74154-94
7403-13	7448-68	74155-58
7404-13	7449-68	74157-65
7405-13	7472-25	74161-55
7406-16	7473-28	74163-55
7407-20	7474-28	74164-95
7408-18	7475-28	74165-95
7409-18	7476-30	74170-168
7410-13	7480-31	74173-120
7411-16	7483-65	74174-95
7412-13	7485-87	74175-85
7413-36	7486-28	74176-75
7414-80	7489-42	74177-75
7415-22	7491-58	74180-85
7417-25	7492-43	74181-190
7420-13	7493-43	74190-100
7425-25	7494-87	74191-100
7426-22	7495-65	74192-79
7427-19	7496-65	74193-79
7430-13	74107-28	74194-80
7432-22	74121-29	7525B-150
7433-21	74122-38	74196-86
7436-21	74123-45	74279-55
7440-13	74125-40	74287-55
7441-70	74126-40	75491-50
7442-37	74150-84	75492-50

44 Pin Solder Tail .156" Connector \$1.95

MM 5387AA new clock chip which will directly drive LED's 1/24 hrs., 1 supply & alarm \$5.95

NO. 3 WIRE WRAP WIRE SINGLE STRAND 100' \$1.40

ALCO MINIATURE TOGGLE SWITCHES

MTA 106 SPOT	\$ 1.05
MTA 206 OPOT	\$ 1.70
MTA 206 P-DPDT CENTER OFF	\$ 1.85
MSD 206 P-DPDT CENTER OFF	\$ 1.85
LEVER SWITCH	\$ 1.85

Full Wave Bridges DIP SOCKETS

100	25A	8 PIN .22	24 PIN .40
300	3.00	14 PIN .28	48 PIN .50
600	1.30	16 PIN .25	20 PIN .60
	1.75	18 PIN .30	

SANER AND POWER AMPS

S 1010 6 10 WATTS	\$ 6.90
S 1020 G 20 WATTS	\$ 13.70
S 1050 G 50 WATTS	\$ 25.90

TANTULUM CAPACITORS

22UF 35V 5/\$1.00	6.8UF 35V 4/\$1.00
47UF 35V 5 \$1.00	10UF 10V \$.25
68UF 35V 5 \$1.00	22UF 25V \$.40
1UF 35V 6 \$1.00	15UF 35V 5/\$1.00
2.2 UF 20V 5 \$1.00	30UF 6V 5/\$1.00
3.3UF 35V 4 \$1.00	47UF 20V \$.35
4.7UF 15V 5/\$1.00	68 UF 15V \$.50

WALSBERG

74LS00-21	74LS126-47	LM 101-75
74LS02-21	74LS132-80	LM 301/748-29
74LS03-21	74LS138-38	LM307-30
74LS04-28	74LS138-70	LM 308-75
74LS05-28	74LS139-70	LM 311-75
74LS08-21	74LS151-70	LM 318-1.20
74LS09-28	74LS153-70	LM 319-85
74LS10-21	74LS155-70	LM 324-1.05
74LS11-21	74LS156-70	LM 339-1.10
74LS12-44	74LS157-72	LM 358-70
74LS15-25	74LS160-88	LM 370-1.15
74LS20-24	74LS161-85	LM 377-2.50
74LS21-26	74LS162-85	LM 380-95
74LS22-26	74LS163-85	LM 381-1.25
74LS26-32	74LS168-88	LM 382-1.25
74LS27-32	74LS169-88	LM 537-2.50
74LS30-26	74LS170-168	LM 553-2.50
74LS32-32	74LS173-110	LM 555-39
74LS33-32	74LS174-100	LM 556-85
74LS37-32	74LS175-80	NE540L-2.25
74LS40-28	74LS193-70	LM 319-85
74LS42-65	74LS191-95	555-95
74LS47-79	74LS192-95	566-1.25
74LS51-26	74LS193-95	567-1.30
74LS54-26	74LS195-95	703-90
74LS90-95	74LS196-95	709-25
74LS74-35	74LS197-95	710-35
74LS76-35	74LS221-25	741C or V
74LS83-130	74LS257-70	747-50
74LS86-55	74LS258-70	LM 1310-2.50
74LS92-55	74LS278-85	1456-95
74LS93-55	74LS285-85	1458-50
74LS109-38	74LS366-55	CA3046-75
74LS112-38	74LS367-55	3900-48
74LS113-48	74LS368-55	8038C-3.90
74LS114-38	74LS390-1.40	791-1.95
74LS125-47	MC14680-1.35	LF356H-1.20

TRIACS SCR'S

100V 1A	10A 35A	1.6A 6A 75A
200V 40 10 1.30 40 50 1.20		
300V 30 1.0 1.75 60 1.0 1.80		
400V 1.10 1.80 2.60 1.00 1.30 2.20		
500V 1.10 2.30 3.60 1.50 1.50		

Terms: FOB Cambridge, Mass. Send Check or Money Order. Include Postage, Minimum Order \$5.00, COD'S \$20.00

Send 25¢ for our catalog featuring Transistors and Rectifiers 145 Hampshire St., Cambridge, Mass.

SOLID STATE SALES
P.O. BOX 748
SOMERVILLE, MASS. 02143 TEL. (617) 547-7053

WE SHIP OVER 95% OF OUR ORDERS THE DAY WE RECEIVE THEM

Reader Service

To get further information on the products advertised in *BYTE*, fill out the reader service card with your name and address. Then circle the appropriate numbers for the advertisers you select from the list. Add a 13 cent stamp to the card, then drop it in the mail. Not only do you gain information, but our advertisers are encouraged to use the marketplace provided by *BYTE*. This helps us bring you a bigger *BYTE*.

Inquiry No.	Page No.	Inquiry No.	Page No.	Inquiry No.	Page No.
1	AAA Chicago Computer Center 111	160	Heath 34, CIV	297	PerCom Data 11
3	Administrative Systems Inc 118	170	Hobby World 177	298	PerSci 63
4	AJA Software 130	175	IMSAI CIII	299	Personal Computing '78 89
6	Alco Electronic Products 180	176	Information Unlimited 133	*	PolyMorphic Systems 21
10	Anderson Jacobson 69	177	Integral Data Systems 77	301	Poly Paks 201
11	Apparat 183	179	Integrand 137	302	Preferred Positions 181
15	Apple Computer 12, 13	180	Integrated Circuits Unlimited 193	303	Priority I 202, 203
*	Art-by-Computer 169	181	International Data Sciences 125	305	Processor Technology 8, 9, 10
20	Artec Electronics Inc 51	185	International Data Systems 54	306	Program Design 106
21	ATV Research 181	186	International Technical Systems 179	307	Quest Electronics 204
25	Atwood Enterprises 184	190	Ithaca Audio 133	*	Radio Shack 73
26	Bit Basement 180	191	J & E Electronics 179	311	Rothenberg Information Systems 123
35	BITS 59, 96, 97, 122, 141, 157	195	Jade 195	312	S-100 128
*	BYTE Back Issues 138	200	James Electronics 196, 197	313	S & R Electronics 183
39	California Industrial 185	201	Jim-Pak 49	310	Scelbi 36, 37
40	Canada Systems 131	202	LMN Electronics 199	322	Scelbi/BYTE Primer 65
45	Central Data 71	203	MACC 152	*	Scientific Research 39, 45
50	Centronics 53	204	Manchester Equipment 181	314	Scope Data 181
60	Component Sales 186	206	Magnemedia 135	315	SD Computer Products 205
65	Computer Corner 181	207	Maxi-Switch 61	316	Seattle Computer Products 104
66	Computer Data Directory 131	309	Micro Comp 183	317	Silver Spur 181
70	Computer Enterprises 139	208	Micro Computer Devices 55	318	Small Business Computer Magazine 98
71	Computer Hardware Store 181	209	Microolithics 183	319	Small Systems Services 128
75	Computerland 6, 7	211	Micro Mart 183	321	Ed Smith's Software Works 136
72	Computer Mart of MA 120	212	Micromation 15	320	Smoke Signal Broadcasting 75
73	Computer Mart of NJ 125	213	Micro-Puzzles 179	325	Software Exchange 35
73	Computer Mart of PA 125	214	Microsette Co 183	330	Software Records 107
77	Computer Products of America 148	216	Micro Systems Services 109	335	Solid State Music 23
78	Contemporary Marketing 92, 93	240	Microware 110	340	Solid State Sales 207
79	Creative Software 179	241	MIJOBE 179	350	Southwest Technical Products CII
80	Cromemco 1, 2	242	Mikos 192	351	Speech Technology 132
81	Dal Data 145	243	Minicomputer Accessories 105	352	Structured Systems Group 19
82	Databyte 100	250	Mini Micro Mart 102	353	subLOGIC 127
83	Datec 183	251	Mini Micro Mart 102	354	Summagraphics 103
90	Digital Group 29	265	mpi 134	356	Sybex 33
91	Digital Pathways 126	275	National Multiplex 87	355	Synchro Sound 94
95	Digital Research (CA) 83	280	Netronics Research 101	358	Synchro Sound 95
100	Digital Research (TX) 187	281	New England Electronics 126	357	Szerlip Enterprises 130
105	Disc 3 183	282	Newman Computer Exchange 134	360	Tarbell Electronics 43
110	Dynabyte 67	285	North Star Computer 17, 31	370	Technical Systems Consultants 41
115	Electrolabs 186	286	Northwest Microcomputing Systems 121	371	Technico 79
120	Electronic Control Technology 127	*	Ohio Scientific 24, 25, 26, 27	372	Telecommunications Services 179
125	Electronic Systems 189	287	OK Machine & Tool 5	373	TransNet 136
130	Electronics Warehouse 191	288	Oliver Advanced Engineering 132	374	TRS-80 Software Exchange 124
131	EMM/CMP 99	289	Osborne & Associates 85	376	uPMEM 181
140	Forethought Products 124	*	Owens Associates 181	377	US Robotics 183
145	Gallaher Research Inc 107	291	Pacific Digital 129	378	Vamp 179
146	Hamilton Logic Systems 180	292	Pacific Office Systems 192	379	Whales 157
155	DC Hayes Associates 81	293	Page Digital 204	395	Worldwide Electronics 179
156	Hazeltine 119	294	PAIA Electronics 137	400	Xitex 108
		296	PCE Electronics 179	405	Xybek 129

*Correspond directly with company.

BOMB— BYTE's Ongoing Monitor Box

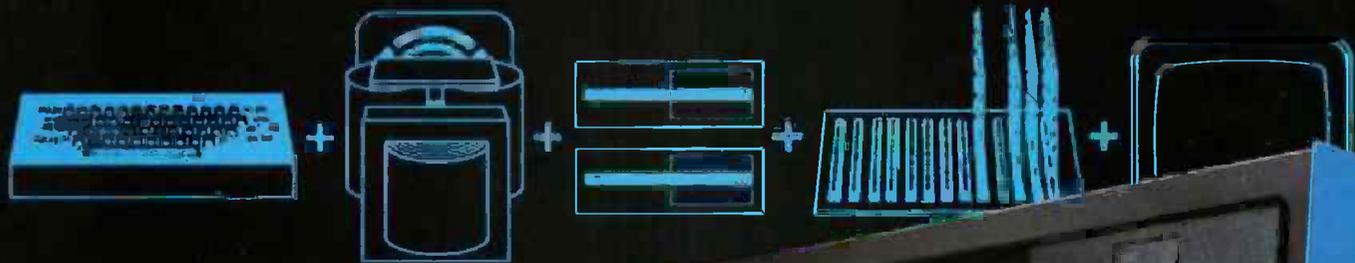
Article No.	ARTICLE	PAGE
1	Weinstein: A Programmable Character Generator	14
2	Thorson: A Programmable IC Tester	28
3	Tennant: Natural Language Processing and Small Systems	38
4	Georgiou: Give an Ear to Your Computer	56
5	Pearce: The HP-67 and HP-97	112
6	Norton: Notes on Teaching with Microcomputers	138
7	O'Haver: More Music for the 6502	140
8	Ciarcia: Talk to Me: Add a Voice to Your Computer	142
9	Hemsath-Seawright-Ghent-Garrard: Theatrical Lighting Graphics	153
10	Webster-Young: GRAPH: A System for Television Graphics	158
11	O'Haver: Audio Processing with a Microprocessor	166
12	Morgan: A Look at Shugart's New Fixed Disk Drive	174

EROM BOMBS

"Program Your Next EROM in BASIC" by Steve Ciarcia, page 84, was the winning article in the March BOMB, placing 1.7 standard deviations above the mean. Steve will receive a bonus of \$100. Second place was a tie between "User's Report: The PET 2001" by Dan Fylstra, page 114, and "The Intelligent Memory Block" by Kenneth Castleman, page 186, each placing 1.5 standard deviations above the mean. Both authors will receive \$50. To find out more about *BYTE*'s BOMB, see the card opposite. ■

Microcomputer System Solution.

Announcing the IMSAI VDP-40.



- Fully integrated video data processor in a single cabinet.
- Twin floppies, professional keyboard, S-100 expansion slots.
- 24 line by 80 char. CRT, insert/delete, programmable font, protected fields, inverse video.
- Handsome flip-top cabinet for easy access.
- Serial and parallel I/O ports included.
- FORTRAN IV, Extended and Commercial BASIC.
- IMDOS (enhanced CP/M®).
- ISAM.



You've decided you want a microcomputer system—but what to buy? The component system? A computer box here, a CRT box there, a keyboard box here, a floppy disk box there... Messy! The \$695 system? But... no disk; no way to add enough memory... and, if you could, it's not so cheap anymore, and you still wind up with an expensive box collection anyway. Messy!

The IMSAI VDP-40, a fully integrated Video Data Processing system that, in one handsome package, combines a professional keyboard, heavy-duty power supply, twin mini-floppies, multi-slotted motherboard and 9-inch CRT at a new low price.

System Expansion? The IMSAI VDP-40 was built for you. The extra slots in our

S-100 bus motherboard and heavy-duty power supply allow almost unlimited expansion. Need more RAM? Add up to ½ MByte with our Intelligent Memory Manager and 64K RAM boards. Need more disk storage? A controller option of the VDP-40 will allow you to expand to nearly 5 megabytes! Add a line printer, an IBM-compatible tape drive, a MODEM! IMSAI has them all, with the interfaces and software to make it work for you. The standard of excellence IMSAI places at your disposal at a price/performance no one else has put together allows you to achieve the full potential of your imagination.

Check us out. IMSAI has what you want and what you need. Visit your dealer or write us directly. Ask about the IMSAI VDP-40 and the entire IMSAI line.

Features and prices subject to change without notice.
*CP/M is a trademark of Digital Research Corporation.

IMSAI®

**The Standard of Excellence
in Microcomputer Systems**

IMSAI Manufacturing Corporation,
Dept. EWN, 14860 Wicks Boulevard,
San Leandro, CA 94577 (415) 483-2093

IMSAI EUROPE Europa Terrassen 8 Rue Jean Engling Dommeldange, Luxembourg 43-67-46 Telex: 1428

See us at the NCC Show, booth 2860

Price/Performance no one else has put together.

Circle 175 on inquiry card.

the world's most powerful microcomputer comes home



Computer hobbyists have always wanted the power and speed of professional machines. But they've had to settle for less. Professional machines were too expensive. Not anymore. Now there's the Heathkit H11.



Professional performance, kit price. The H11 uses Digital Equipment Corporation's 16-bit LSI-11 CPU. Exactly the same CPU found in the famous DEC PDP-11 - probably the most popular commercial and industrial computer in the world. So now a low-cost kit gives you the speed, power and throughput of the world's most popular professional computer.

Software and support. As an H11 owner, you have access to an incredible range of software - editor, relocatable assembler, linker, absolute loader, debug program, I/O executive program, dump routines, BASIC and FOCAL. And, by joining the DEC user's group (DECUS), you can have access to one of the largest software libraries in the world. And there's more to come. Much more.

Of course, the H11 executes the powerful PDP 11/40 instruction set which includes over 400 commands. And the fully assembled KD-11F CPU board includes 4K x 16 bits of memory. The backplane accepts up to six additional modules (memory, serial and parallel I/O, etc.)

Heath will soon introduce a dual floppy with a disk operating system to take

full advantage of the H11's power. And the H11 is fully compatible with all DEC LSI-11 accessories.

Heath documentation is second to none. You get illustrated step-by-step instructions on how to build the kit, thorough explanations of the software and comprehensive operating instructions. If you want to see for yourself, we'll send you the entire manual set (#HM-1100) for just \$25. And you can apply the cost to the price of the computer.

With the Heathkit H11, you can enjoy power, speed, versatility and potential no 8-bit machine can match. And the H11 costs little more than lesser computers - just \$1295.*

Don't settle for less than the best. A close look in the latest Heathkit catalog will convince you that the H11 is the best home computer you can buy.



DEC, DECUS, PDP and FOCAL are registered trademarks of Digital Equipment Corp.

* Mail order, FOB, Benton Harbor, Michigan. Retail price slightly higher.

Prices and specifications subject to change without notice.

HEATHKIT COMPUTERS

System Engineered for Personal Computing



Be sure to use coupon on page 34 of this magazine to order your FREE Heathkit Catalog!



Circle 160 on inquiry card.