MTU
Micro Technology Unlimited

6502 PERIPHERALS AND SOFTWARE

CATALOG B6   FALL, 1980

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MICRO TECHNOLOGY UNLIMITED

Micro Technology Unlimited (MTU) was founded to bring high technology products and technical information to the market in easy to use form. Our present step towards this goal involves the design and sale of products based around the 6502 microprocessor. The price and performance of this processor are excellent while its advanced technical features allow us to build sophisticated products at very competitive prices. Our accessories in combination with any of the several excellent 6502 based systems on the market give computing/teaching power heretofor unavailable to those on restricted budgets. The principals of the company are Howard (Hal) A. Chamberlin and David B. Cox. These men have been cooperating in a synergistic manner for over a decade and have designed microcomputer based systems ever since the first microprocessor was introduced in 1972. The products offered in this catalog were developed with the above goal in mind. In addition to the advanced design concepts, thorough testing, and high performance of hardware and software products, we pride ourselves in detailed, accurate documentation. Our hardware products manuals include an extensive theory of operation section with timing diagrams and complete, easy to read schematics and parts list.

MANUALS — ADDITIONAL INFORMATION

For the technical information beyond the product description sheets in this catalog we suggest purchase of the manual for the product in question. Its price will be credited toward purchase of the associated product hardware. Manuals include schematics, parts list and layout, principles of operation, troubleshooting guide, specifications and a diagnostic program listing. If the manual does not answer a specific question or if you feel that your question is unlikely to be answered by the manual, please contact us. Our Manuals have been classed — BEST IN THE INDUSTRY.

WARRANTY

All products of MTU are warranted for 6 months from date of shipment from the factory to be free from defective parts and workmanship. Any other damages including but not limited to: misuse, misconnection to the system, abuse, fire, flood, other acts of God are not covered by this warranty. Units under warranty requiring repairs are to be returned to the factory postpaid. These will be returned postpaid within 2 weeks from the date of receipt. No statements other than these printed specifications are made or implied. Liability of MTU is limited to repair or replacement of faulty unit(s) and does not extend beyond the purchase price of the unit(s).

Out of warranty repairs are available on the same schedule as listed above. Minimum charge for factory repairs is **$20.00** plus parts.

BARE BOARDS

We wil sell our bare boards to individuals who call and discuss with us the expected use of the product. We offer bare boards as a service for those who cannot afford the assembled and tested units and are capable of performing their own purchasing, assembly, and debug. Please note that bare boards are intended only for experienced persons with adequate test equipment. Although the technical documentation is excellent, it is not in the form of kitbuilding instructions. In all cases the availability of a triggered sweep oscilloscope is necessary to bring up a bare board. If after receipt of a bare board you feel that it is beyond your skill level, it may be returned (postpaid) for full credit toward purchase of the assembled and tested version.

DELIVERY

All products are normally available off-the-shelf for one week delivery. Occasionally we may be out of stock on a particular item in which case notification will be sent if delivery is expected to exceed 30 days.

DISCLAIMER STATEMENT

Price changes noted in this catalog become effective March 1, 1981. All prices, specifications, and availability are subject to change without notice.

WARNING DO NOT PLUG OR UNPLUG **ANY** COMPUTER BOARDS WITH POWER ON. ALWAYS MAKE SURE THAT BOARDS ARE PLUGGED IN SECURELY PRIOR TO TURNING ON THE POWER TO THE SYSTEM. FAILURE TO DO SO WILL USUALLY BLOW CIRCUITS ON THE BOARD.

THE MTU SYSTEM PHILOSOPHY

As will be apparent while scanning through this catalog, the business of Micro Technology Unlimited is to provide a broad line of accessories for the most popular computers based on the 6502 microprocessor. The astute reader however should also notice that we can provide everything necessary to make an AIM-65, KIM-1, or SYM-1 into a uniquely powerful system in its own right. Although we do not currently sell the computer board itself, we do manufacture and sell everything necessary to make that board into a complete system.

One may ask then, "What is MTU's design and system philosophy?". The list below should provide some insight into this.

1. KIM BUS compatibility. For design purposes the KIM bus is defined as the signals and pin assignments found on the expansion connector of KIM, SYM, and AIM computer boards. It is also defined to operate at a 1MHz cycle rate with uniform timing from cycle to cycle. Because of noise considerations we feel that bus buffers should be on the accessory boards, not the motherboard, and we design that way.

2. Low power consumption. This is a prime consideration that is realized by the extensive use of low power schottky logic and dynamic RAM IC's for memory functions. Our boards typically use less than ¼ the power of competitor's products. Low power operation not only means a smaller power supply, but also considerably less heat buildup in the system to affect reliability.

3. On-board regulation. All of our KIM bus accessory boards require only two unregulated voltages; +7 to +12 volts for the logic and +14 to +20 for memory IC's. Negative or high positive voltages, if required by the circuitry, are generated on-board. Local regulation significantly reduces system noise and insures accurate operating voltages for the circuitry. The low power consumption minimizes heat dissipation in the regulators as well.

4. Sensible packaging. While we do not provide dress covers for the system, we are sensitive to packaging considerations. All bus interface boards will fit into our K-1005 series of motherboard/card files giving a sturdy and compact if not beautiful system.

5. Software products are written using structured programming discipline. This not only simplifies the design and development task, it also eases understanding and modification by our customers.

We also excel in the areas of production, quality control, and product test. Most production is done by our own people in our own plant. That which is done outside is restricted to the initial assembly of the product with final assembly being done in-house. Engineering is directly involved in the initial production of new products and individually tests each unit in the first run. Succeeding production testing is often automated using the same computers our products support. For example, all boards containing memory devices are actually run in a system error-free (not just clocked on a burn-in rack) for 24 hours before being shipped.

TRADEMARKS

Many trademarked product names are used throughout this catalog. They are: KIM-1, PET, and CBM are trademarks of Commodore Business Machines; SYM-1 is a trademark of Synertek Inc.; AIM-65 is a trademark of Rockwell International; Programmer's Toolkit is a trademark of Palo Alto IC's; DataTrack 8 is a trademark of Qume Inc. APPLE II is a trademark of APPLE Computer Company.

POSTAL AIR MAIL SHIPPING CHARGE COMPUTATION SHEET
AS OF NOVEMBER 1, 1980. ALL PRICES IN U.S. DOLLARS

Country	K-1000-5	All K-1002	Book All K-1005	K-1007 K-1008	K-1012 K-1013 K-1008-6 K-1032	K-1020	Software Or Single Manual	Bare Board & Manual
Australia	22.53	8.01	17.69	9.62	10.83	7.91	3.83	7.91
Belgium	13.51	3.97	8.23	5.89	7.81	4.63	3.06	5.29
Canada	5.01	2.75	3.68	3.35	4.23	2.75	3.06	2.75
Denmark	14.14	3.76	8.38	5.80	7.84	4.48	3.06	5.20
England	Distributor: IJJ DESIGNS LTD. 37 London Road, Marlborough Wilts SN8 2AA tel: 0672-53153; answer serv tel: 0272-292966							
Finland	15.22	3.86	8.90	6.04	8.22	4.65	3.06	5.44
France	14.08	4.54	8.80	6.46	8.38	5.20	3.06	5.86
Italy	16.07	4.32	9.36	6.50	8.68	5.11	3.06	6.56
Japan	15.39	3.89	8.99	6.09	8.29	4.69	3.06	5.49
Netherlands	Distributor: ELECTRONIKA/COMPU 2000 B.V. Chrysantenstraat 4-6 1031 HT Amsterdam tel: 020-360904 telex: 15271E							
Norway	14.14	3.76	8.38	5.80	7.84	4.46	3.06	5.20
Sweden	14.14	3.76	8.38	5.80	7.84	4.48	3.06	5.20
Switzerland	13.64	3.96	8.28	5.90	7.84	4.63	3.06	5.30
W. Germany	13.80	3.70	8.20	5.70	7.70	4.40	3.06	5.10
All Others	14.23	3.92	8.49	5.94	7.97	4.63	3.06	5.40

United States   Shipments will be via UPS, no charge, unless otherwise instructed. UPS blue will carry a charge of $2.00 and COD will carry a charge of $1.25.

NOTE:

1. FOR MULTIPLE ITEM SHIPMENTS, ADD THE SHIPPING CHARGES FOR EACH PRODUCT FOR THE TOTAL SHIPPING CHARGE TO PAY.
   EXAMPLE: THREE K-1008 TO SWITZERLAND WOULD BE 3 × $5.90 = $17.70
   ONE K-1000-5, ONE K-1005, ONE K-1008 SHIPPED TO ITALY WOULD BE
   $16.07 + $9.36 + $6.50 = $31.93

2. BE SURE TO GIVE FULL AND UNDERSTANDABLE SHIPPING ADDRESS AND **COUNTRY** IF OUTSIDE U.S.A.

3. WE PREFER THAT OUR ORDER FORM BE USED AND FILLED OUT TO INSURE THE PROPER INFORMATION.

NAME: _____

ADDRESS: _____

_____

Micro Technology Unlimited
2806 Hillsborough Street
P.O. Box 12106
Raleigh, N.C., USA 27605
(919)-833-1458

CITY: _____ STATE: _____ POSTAL CODE: _____

COUNTRY: _____ PHONE: _____ TELEX _____

QTY.	MTU PART NO.	DESCRIPTION OF PART	PRICE EACH

COLUMN TOTAL

INTERNATIONAL ORDERS MUST BE PREPAID AND MUST BE IN U.S. DOLLARS DRAWN ON A U.S. BANK OR PAID BY CHARGE CARD. (THIS APPLIES TO CANADIAN ORDERS ALSO).

WE ACCEPT VISA, MASTER CHARGE OR EUROCARD ON RETAIL AMERICAN AND INTERNATIONAL ORDERS. NO DEALER ORDER PAYMENTS ACCEPTED THIS WAY.

FOR ORDERS BELOW $10.00, INCLUDE $2.00 HANDLING CHARGE

SHIPPING

ORDER TOTAL

CARDHOLDER'S SIGNATURE: _____

CARD #:_____ EXPIRES: (Date)|_____
   Print Legibly or Not Valid

VISA _____   MASTERCARD _____   EUROCARD _____

IF DESIRED, PAYMENT CAN EASILY BE MADE BY WIRE TRANSFER:
   TO: MICRO TECHNOLOGY UNLIMITED: BANK ACCOUNT NUMBER 6265073329
   AT: RALEIGH, N.C. WACHOVIA BANK NUMBER 0531-07633
   THROUGH WACHOVIA INTERNATIONAL TRANSFER BANK: WINSTON-SALEM, N.C.
   BANK NUMBER 0531-00494

MTU APPLICATION NOTES

AN-2: $2.00, free if ordered with K-1008. Using the Visible Memory for Grey Scale and Color. Describes how two or more Visible Memory boards may be synchronized together and their outputs combined to provide a grey scale or color video display with full 320×200 resolution.

AN-3: $.50, free if ordered with K-1008. Operation of the Visible Memory on 50 Hz Power. Describes several ways to successfully operate the Visible Memory in areas where primary power is 50Hz.

AN-4: $.50, free if ordered with K-1012. Additional Notes on the K-1012 PROM/IO Board. Describes how to program and use the new 5 volt EPROMS (2508, 2516, 2732, and Intel 2716 on the K-1012.

AN-5: $.50, free if ordered with K-1008. Addressing the Visible Memory on Odd 4K Boundaries. Modifications to the Visible memory for addressing at 1000, 3000, etc. for use on the AIM-65.

AN-6: $.50, free if ordered with K-1008, K-1012, K-1013, K-1020, or K-1032. Addressing Considerations in AIM-65 Systems. Discusses the many options available in assigning addresses in an expanded AIM-65 system. Also describes a method for freeing up half of block A000 for expanded I/O.

AN-7: $.50, free if ordered with any K-1013 product. Describes exactly how to properly jumper the Qume DataTrak 8 double-sided 8" floppy disk drive for successful operation with the K-1013 Disk Controller and CODOS Disk Operating System.

AUTHORIZED DEALER LIST

CALIFORNIA

Channel Data Systems
5960 Mandarin Avenue
Goleta Ca 93017
Andy Anderson
(805) 964-6695

Lantor, Inc.
8055 Manchester Avenue
Playa Del Rey, Ca 90291
Mary Tant
(213) 821-0642

Sym-Physis
Sym-1 Users' Group
PO Box 315
Chico Ca 95927
Jean or Lux Luxenburg
(916) 895-8751

MINNISOTA

Excert Incorporated
Educational Computer Div.
PO Box 8600
White Bear Lake Mn 55110
Dave Colglazier
(612) 426-4114

MONTANA

The Computer Store
1216 16th St West
Suite 33
Billings Mt 59102
Delray Johnson
(406) 245-0092

NEW YORK

American Peripherals
3 Bangor Street
Lindenhurst NY 11757
Jack Woelfel
(516) 226-5849

Computer House, Inc.
721 Atlantic Avenue
Rochester NY 14609
Bill Berch
(716) 654-9238

The Computer Emporium
57 North Street
Middletown NY 10940
Robert Honders
(914) 343-4880

UTAH

Hi-Fi Shop
2236 Washington Blvd.
Ogden Ut 84401
Brent Richardson
(801) 621-5244

AUSTRALIA

Energy Controls
PO Box 31
73 Eric Street
Goodna Qld 4300
Australia
Ken Curry
228 2757

ENGLAND (Distributor)

IJJ Designs Ltd.
37 London Rd.
Marlborough Wilts Sn8 2AA
0272-54487

CANADA

Computer Shop
3515 18th Street SW
Calgary Alberta
Canada T2T 4T9
Austin Hook
(403) 243-4356

Micro Shack of W. Canada
333 Park Street
Regina Sask
Canada S4B 3N8
Dave Claypool
(306) 543-4079

Batteries Included
71 McCaul Street
Toronto Ontario
Canada M5T 2X1
Alan Krofchick
(416) 596-1405

Conti Electronics Lt.
5656 Fraser Street
Vancouver BC
Canada V5W 2Z4
Greg Harder
(604) 324-0505

NETHERLANDS (Distributor)
Electronika/Compu 2000 B.V.
Chrysantenstraat 4-6
1031 HT Amsterdam
020-360904
Telex: 15271E

SWEDEN

Firma Ake Sjodin
Bangatan 43A
S-7-2228 Vasteras
Sweden

PET INDEX

INTRODUCTION TO PET EXPANSION WITH MTU

MTU has tried to isolate the PET user from several types of present and future problems. First there is the problem of "old", "new", and most recently, 80 column PET's. Second is the problem of various manufacturers contending for the same address space. Third is the problem of where to physically put expansion boards without overheating the PET system.

The "old/new" is a two-fold problem of software compatability with the 1.0 "old" or 2.0 "new" ROMs and of mechanical compatability of the different PET memory Expansion Ports. MTU software products function on either 1.0 or 2.0 ROM's and sometimes both. In several cases, especially with new products, MTU has chosen not to make 1.0 ROM operation available since most users are upgrading to the 2.0 ROM's. If you have a gripe, call us and talk. Your request is your vote and enough votes can sway the "election".

MTU has taken an approach for the PET Memory Expansion Port mechanical problem that gives the greatest flexibility for the end user. We have small connector boards which mate with the two PET systems. The K-1007-2 board mates with the "old" 2001 series PET edge finger connector and the K-1007-3 mates with the 16/32K PET and CBM series ribbon cable connectors. These boards offer a standardized single 60 wire ribbon cable connector for connection to MTU products. In both cases the PET Memory Expansion Port is or can be recreated for further expansion. This approach can obviously be continued on to the 80 column and future PET systems with only a new connector board needed for upward compatability (within electronic limits).

INTRODUCTION TO PET EXPANSION WITH MTU

The availability of address space on the PET is becoming and will continue to grow as a problem for the user. The MTU K-1008-6 Integrated Visible Memory Board was designed to help solve this problem. This board offers bank switching of various resources allowing up to 5 ROM's, two 4K RAM blocks, and an external expansion bus to all reside at the same (or different) addresses. Thus for example the user who wishes to have the MTU graphics, Commodore WORD PRO ROM, and the Programmers ToolKit all on a 32K PET can do so! The addition of the K-1032 series of memory expansion boards adds yet another level of memory bank switching thus allowing the advanced PET machine language user to address and control considerably more than the 44K of addresses that a "stock" PET can handle.

For customers who only wish to enhance the graphics capabilities of the PET and address up to 5 ROM chips, the K-1008-6 Integrated Visible Memory in conjunction with a connector board (K-1007-2 or K-1007-3) and a K-1005-5 mounting bracket will fit entirely inside the PET cabinet. For large system expansion (1 or more MTU bus interface boards) or expansion without the Integrated Visible Memory, we have chosen to go outside the PET covers. This approach allows up to 4 of our standard bus expansion boards, including our K-1013 Floppy Disk Controller, to be mounted in a card file that sits beside the PET.

See the individual product descriptions for details about each of the products mentioned above as well as many more.

PACKAGE GROUP ORDER NUMBERS

These package groups are designed to make the most often ordered MTU "package" functions easier to order. The equivalent items may be purchased separately if desired. Your local dealer will be stocking the packages below.

K-1002-40 SIMPLE 4 MUSIC PACKAGE - $79.00
This package includes the K-1002-2 board and the K-1002-3C 4 voice music software package. It requires a minimum 8K PET and will run with either 1.0 or 2.0 ROM versions.

K-1002-41 INSTRUMENT MUSIC PACKAGE - $108.00
This package includes the K-1002-2 board and the K-1002-6C Instrument Music Software package. It requires at least an 8K PET but it is recommended to use 16K or 32K to obtain the full potential of the sound generation. It runs with either 1.0 or 2.0 ROM versions. For 1.0 operation, user must supply a machine language monitor which resides in high memory.

K-1008-40 2001 PET GRAPHIC PACKAGE - $395.00, $434.00 as of March 1, 1981
This package gives all necessary MTU items to upgrade an 8K RAM 2001 PET with 320 by 200 graphics, mount the graphic board inside the PET covers, and have a graphic software driver package. The package contains the K-1008-6 hardware, K-1007-2 connector board, K-1008-3C software, and K-1005-6 internal mounting bracket.

K-1008-41 16/32K PET ADVANCED GRAPHIC PACKAGE - $438.00, $483.00 as of March 1, 1981
This package gives all necessary MTU items to upgrade a 16/32K or CBM PET with 320 by 200 graphics, mount the graphic board inside the PET covers, and have the Keyword Graphic Software package. This package contains the K-1008-6 hardware, K-1007-3 connector board, K-1008-8C Keyword Graphic Software, and K-1005-5 internal mounting bracket.

K-1008-42 2001 PET ADVANCED GRAPHIC PACKAGE - $419.00, $458.00 as of March 1, 1981
This package gives all necessary MTU items to upgrade a 16K RAM (or larger) 2001 PET with 320 by 200 graphics, mount the graphic board inside the PET covers, and have the Keyword Graphic Software package. This package contains the K-1008-6 hardware, K-1007-2 connector board, K-1008-10C Keyword Graphic Software, and K-1005-6 internal mounting bracket.

MUSIC FOR THE PET

K-1002-2 HARDWARE MUSIC BOARD: $59.00

This board is a fully integrated digital audio system. An 8 bit digital-to-analog converter combined with a quality 6-pole low-pass filter and half-watt audio amplifier with volume control means that only a speaker is needed for rich, 4-part harmony with either of our music programs listed below. The CB2 sound used by many PET games is also fed through the amplifier. The board itself is approximately 5" wide by 3" deep and plugs on to the user and cassette ports at the rear of the PET. All signals are fed through to a second set of edge fingers to allow the continued use of cassettes and other user port accessories. Don't confuse the K-1002-2 with cheap imitations, it was designed by the originators of digital music for the PET! (see page 30)
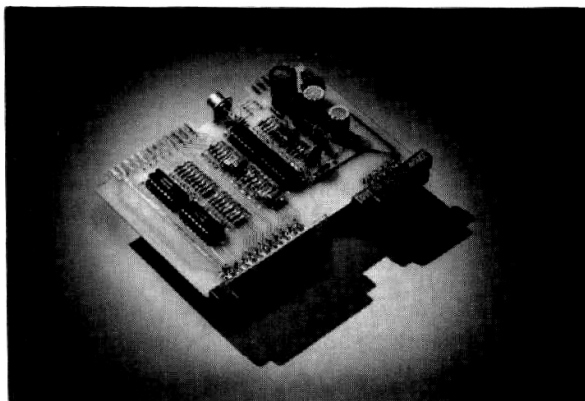
K-1002-3C SIMPLE 4 VOICE MUSIC SOFTWARE: $20.00

This program generates 4 musical voices simultaneously and is designed to run on all Commodore PET and CBM computers. It allows the user to compose and/or play back songs with up to 4 part harmony. Each part may have a different tone color (waveform) and a six octave (C_0 to C_6) range is possible. The waveforms are actually computed from harmonic specifications coded in the music itself. Nearly any organ voice is possible, not just the kazoo-like square wave sound of other "synthesizer boards" or the PET's CB2 port. Music is coded as a series of 5 byte "events" where 4 of the bytes specify the pitch for each of the 4 voices and the fifth byte specifies the duration. A very powerful feature of the system is a separate SEQUENCING TABLE which is used to control dynamic tempo, create or change waveforms, change voice assignments, perform repeats, etc., all without modifying the music coding itself. Some experience with the PET's Machine Language Monitor is necessary to code songs. (see page 31)

K-1002-6C INSTRUMENT MUSIC SOFTWARE: $49.00

This is by far the most powerful and flexible real-time 4 voice digital music synthesis program ever implemented on a microcomputer. Fundamentally this program is similar to the K-1002-3 music program described above except that the ability to specify an independent amplitude envelope for EACH HARMONIC of the tones has been added. Thus the harmonic structure of the tones ACTUALLY VARIES during individual notes in much the same way that conventional musical instrument sounds do. When coded instrument specifications are based on published analyses of common musical instruments, the resulting sounds will indeed closely resemble the analyzed instrument. The greatest power however comes from the ability to define original instrument sounds, and with the flexibility offered, quite a variety is possible. The manual supplied with the program contains an extensive discussion of sound synthesis principles and a library of over 20 different instrument specifications. The PET cassette contains the music program and three example songs, one for 8K, one for 16K and one for 32K machines. (see page 32)

K-1002-6DEMO AUDIO CASSETTE -$5.00

This is a narrated stereo cassette demonstrating the capabilities of the K-1002-6 Instrument Synthesis Music Software.

## K-1003-1D 2040 INSTRUMENT MUSIC SONG PACK 1 - $20.00 (Available Nov. 15)

This is a set of over 25 coded songs on 2040 disk. It requires a K-1002-6C, K-1002-2, and a 32K PET with the Commodore 2040 disk system. (See Page 47)

## K-1003-2D CODOS INSTRUMENT MUSIC SONG PACK 1 - $20.00 (Available Nov. 15)

Same as K-1003-1D except on MTU CODOS diskette (requires MTU K-1013-4D disk system).

K-1005-P ASSEMBLED PET EXPANSION CARD FILE: $75.00, K-1005M $10.00

The K-1005-P card file was designed to answer the need for system expansion of the PET beyond that allowed internally, and remain consistent with the MTU tradition to allow the end user (i.e. the computer owner) to have maximum flexibility to use MTU products with other competitive products. This card file structure is what MTU has adopted as a new standard and will continue to support as the system approach for the 6502 processor, as the S-100 structure is for the Z-80 processor. All MTU products will work in this card file, allowing PET owners to have the same expansion that we offer to the AIM, SYM and KIM users. The PET user must have either the K-1007-1 or K-1008-6 to interface to this system. (see page 33)
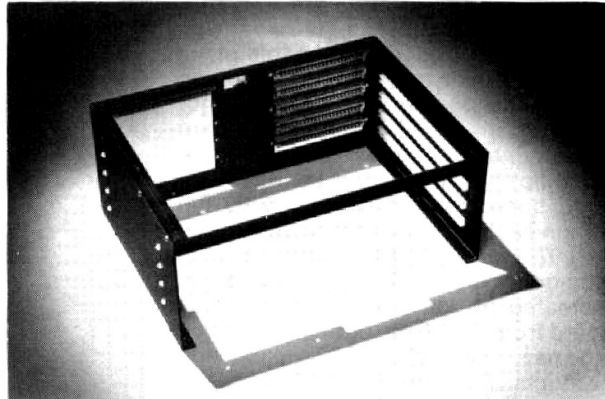
MOUNTING BRACKETS FOR K-1008-6 INSIDE PET
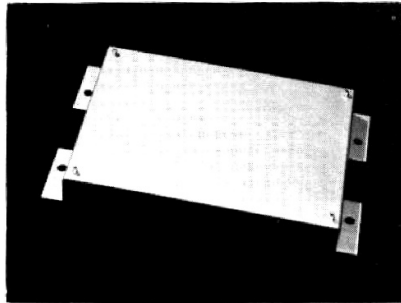
K-1005-5 MOUNTING BRACKET: $10.00

This bracket is used to mount a K-1008-6 Integrated Visible Memory Board to the inside bottom of the PET top cover on the 16/32K PET and CBM computers.
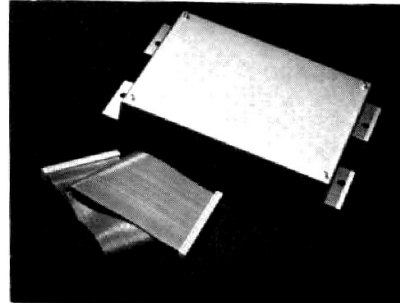
K-1005-6 MOUNTING BRACKET: $15.00

This bracket (same as K-1005-5) and longer ribbon cable is used to mount a K-1008-6 Integrated Visible Memory Board inside the 2001 PET computer. If upgrade is made to the 16/32K PET systems, this set can be used with no modifications.

K-1007-1 PET TO MTU INTERFACE BOARD: $78.00, K-1007M $10.00

The K-1007-1 interface coverts the PET memory expansion port into a bus compatible with the 6502 industry standard KIM BUS supported by our K-1005 card file system. This board comes with a 12" ribbon cable to bring the signals out to the card file. It can be used in place of the K-1008-6 Integrated Visible Memory Board if MTU expansion is desired that is totally compatible with the KIM BUS. For instance, if you have a PET and an AIM-65, you may wish to use the K-1008 Visible Memory for graphics instead of the K-1008-6 since the K-1008 can be used also by the AIM-65. Use of this product requires a K-1005-P and a K-1007-2 or K-1007-3. (see page 34)
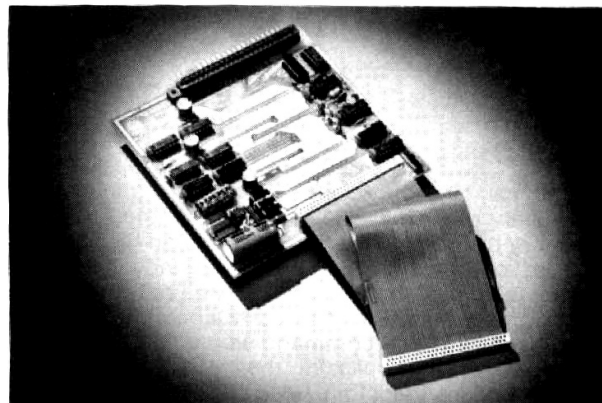
K-1007-2 2001 PET CONNECTOR BOARD: $35.00

This board plugs on to the 2001 PET series edge finger memory expansion port, parallel to and in the same plane as the PET main logic board. In addition it connects to the PET CRT monitor cable, to the PET main logic board video connector, 3 wires to solder or clip (clips not supplied) to the PET main logic board for power, and a 60 pin ribbon cable connector to mate with the K-1007-1 or K-1008-6 cable. The PET memory expansion edge fingers are recreated on the opposite side of the board from the 80 pin connector, allowing use with other PET expansion products. The board is 2 ½" wide and protrudes from the PET covers at the memory expansion port. (see page 34)
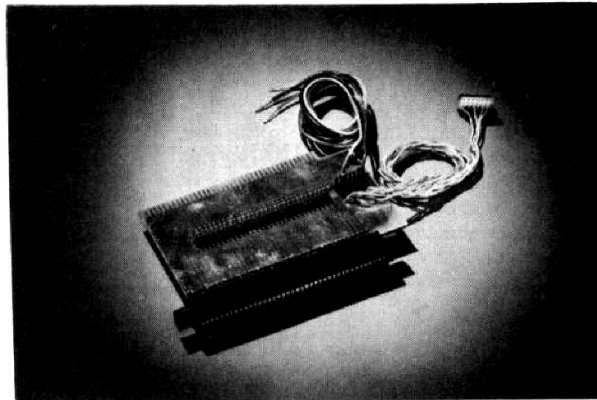
K-1007-3 16/32K PET CONNECTOR BOARD: $65.00

This board plugs on to the 16/32K or CBM PET series memory expansion port which consists of two 50 pin ribbon cable connectors mounted 0.200 inch apart in the same horizontal line inside the PET covers. The board has 2 connectors which mate with the PET memory expansion port connectors, a socket to accept the PET CRT monitor cable plug, a cable with plug to mate with the PET main logic board video connector, and a 60 wire ribbon cable connector to mate with the K-1007-1 or K-1008-6 cable. In addition, open holes (signals prewired in PC) are provided on the board to mount two 50 pin ribbon cable connector "straight head-
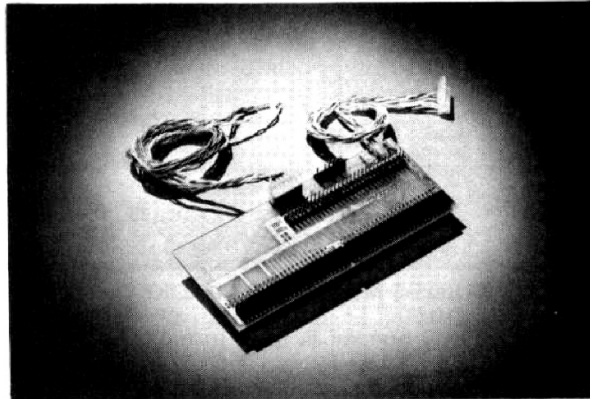

ers" which recreate the PET memory expansion port. These connectors mount 0.500 inch apart (not 0.200 inch as in the PET) allowing use with other PET expansion products. This board plugs in perpendicular to the PET main logic board and is completely enclosed in the PET case. (see page 34)

PET GRAPHIC PRODUCTS

K-1008-3C PET GRAPHIC SOFTWARE: $25.00

This package of machine language graphics subroutines allows the PET BASIC programmer to rapidly plot points, lines, and characters on the Visible Memory display with a minimum of memory usage. All functions operate on the variables X1%, Y1%, X2%, and Y2% which define two pairs of coordinates. The SYS command is used to call the graphics subroutines into action. For example, to plot the best straight line between two points, X1%, Y1% would be set to the coordinates of one endpoint, X2%, Y2% would be set to the other endpoint, and a GOSUB 105 which in turn issues the SYS command would be executed. Characters are plotted by specifying their coordinates and then passing their ASCII code to a subroutine. This software only requires 2K of memory and is ideal for use on 8K PET's with either the K-1008-6 or the K-1007-1/1008-P graphic expansion systems. (see page 37)

10

K-1008-8C 16/32K PET KEYWORD GRAPHIC SOFTWARE: $49.00

This package offers an easier to use interface between the graphing routines and PET BASIC 2.0, and contains many more features than the K-1008-3C package described above. With the Keyword Graphic Software loaded and enabled, over 45 new COMMANDS are added to PET BASIC. Thus a line may be plotted with a simple command such as: LINE 25,85,305,167 and text with a command such as: CHAR "MARKET TREND". In addition, scaling and offsetting of coordinate values and clipping of offscreen data is supported. Up to 4 independent "windows" are maintained by the package with easy switching from window to window. The most significant new feature is "shape tables" similar to that on the Apple II computer but with the addition of relative vectors and subshape subroutining as well. This package requires 7.5K of memory which means that at least 16K of memory must be present to run, in addition to the K-1008-6 or K-1007-1/1008-P graphic systems. (see page 39)

K-1008-10C 2001 PET KEYWORD GRAPHIC SOFTWARE: $49.00

This is the same package as the K-1008-8 but modified and assembled to run on version 1.0 "old" PET ROM's (see page 39)

PET HIGH RESOLUTION GRAPHICS HARDWARE

K-1008-6 INTEGRATED VISIBLE MEMORY $320.00, (as of March 1, 1981 $359.00)
K-1008-6M $10.00

This board allows the PET user to add full control over a 320 by 200 dot matrix on the display, and additionally solve several user expansion problems. There are 4 types of video images available under software control; PET, Graphic, both simultaneous, or a blank display. The 8K byte of on-board video RAM can be used by the PET system when the graphics are not being used. The user can have up to 5 ROM's installed on the board, with software selection of which ROM is presently active, permitting operation of ROM's with the same address! A set of KIM-BUS edge fingers allows external bus expansion to all other MTU products and bank switch control of this bus from software. The board is designed to fit **INSIDE** the PET cabinet for maximum protection and portability, or mount into an MTU K-1005-P card file for further system expansion. Connection from the board to the PET is through a 12" ribbon cable which mates with either a K-1007-2 or a K-1007-3 connector board. Use of the K-1008-8, or K-1008-10 Keyword Graphic Software package is recommended. (see page 36)
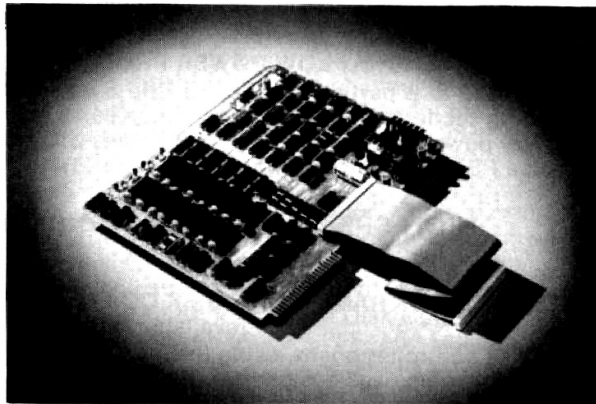
K-1008-P PET VISIBLE MEMORY BOARD: $243.00, K-1008M $10.00

Like the K-1008-6, this board is an 8K memory add-on which includes circuitry to simultaneously display the memory contents as 320 by 200 dots on the PET display. The display image shows no snow or other visible interference nor are there any wait states or CPU time required to refresh the display. When not being used as a graphic board, the 8K byte of on board RAM is usable by the processor. This board requires use of the K-1007-1 PET interface and K-1005-P card file, and it may also be used with KIM, AIM, and SYM processors. The only difference from the standard K-1008 product is that three wires are added to the board edge fingers from ICs generating the video signals. (see page 35)
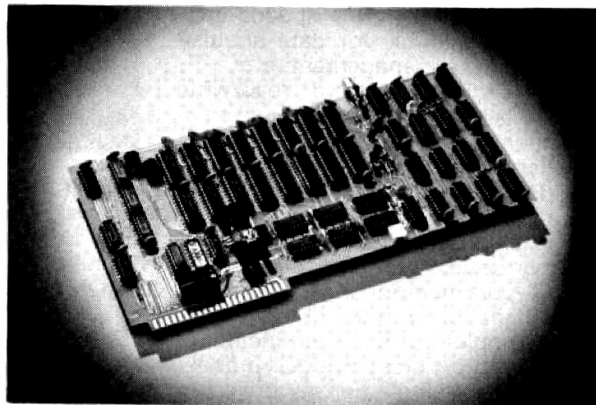
11

K-1012 PROM-I/O SYSTEM BOARD: $295.00, K-1012M $10.00

This system oriented expansion board offers 4 basic expansion functions, allowing the system designer to construct powerful, yet easy to use turn-key systems. These four functions are: low power EPROM storage, four 8 bit parallel I/O ports, a UART controlled RS-232 serial communications port and, a PROM programmer. The 12 PROM sockets are designed for 2708 or 2716 EPROMs and are switched **off** when not addressed, giving super low power operation. The I/O ports (two 6520s) have full handshaking and interrupt capability. The UART controlled full RS-232 serial communications port allows quick system expansion or turning it into a remote intelligent terminal. This board may be connected directly to any KIM BUS system with no modification and no external interface circuitry required. The board is supplied with a complete user manual. Use of this board with any PET system requires either a K-1007-1 or K-1008-6 board, a K-1007-2 or -3 connector board and a K-1005-P card file. (see page 41)
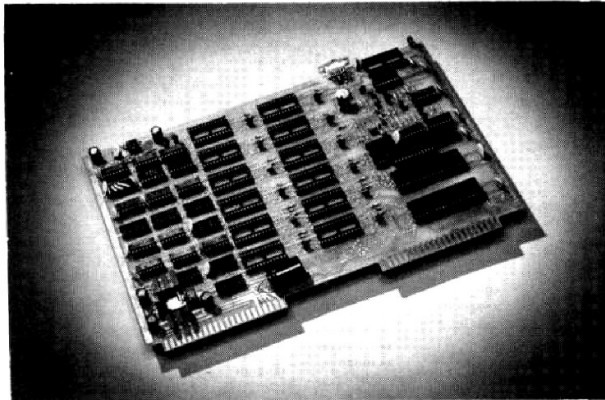
K-1012-1 LOW POWER PROM BOARD: $165.00, K-1012M $10.00

This board is a partial assembly of the System Expansion Board with only the PROM and addressing sections assembled. Its creation came about from market requests for a board to allow super low power firmware operation. It comes with the same manual as the K-1012, and requires the same PET interface hardware. (see page 41)

HIGH SPEED PET FLOPPY DISK CONTROLLER PACKAGE

K-1013-4D PET 16K RAM FLOPPY DISK CONTROLLER WITH CODOS: $595.00, K-1013M $10.00
(available November 15, 1980)

This disk controller board, using the NEC uPD765 chip, was designed from the ground up for maximum speed and reliability in data transfer operations. Disk data transfers are done via direct memory access to on-board memory without program intervention. Using our CODOS disk operating system, a 32K byte program can be located and loaded in less than 3 seconds, with a sustained data transfer rate of 19.6 KByte/sec. This allows speeds previously unattainable for data acquisition, data base management, etc.

The 16K of on-board read/write memory is split into two 8K blocks, independently addressable on any 4K boundary. One block is available for the user. The other 8K block can be write protected (under software control) and is normally used to hold the disk operating system software and disk data buffers.

The hardware allows operation with standard or mini-floppy drives, single or double density, single or double sided, up to 4 drives with simultaneous seek. In addition, it contains 16K of on-board 2-port memory, initial program load ROM for turn-key systems, and complete MTU/KIM BUS compatibility in the MTU tradition.

The complete disk system including CODOS is designed to function with 8" double density, single or double sided Shugart model SA800 or SA850 8" or equivalent floppy disk drives. Use of mini-floppy or single density drives are not presently supported by MTU. The controller is sold with a diskette containing CODOS, the K-1013M hardware manual and K-1013-4M CODOS manual. No drives or cables are supplied in this package. (For cables and drives, see page 42)
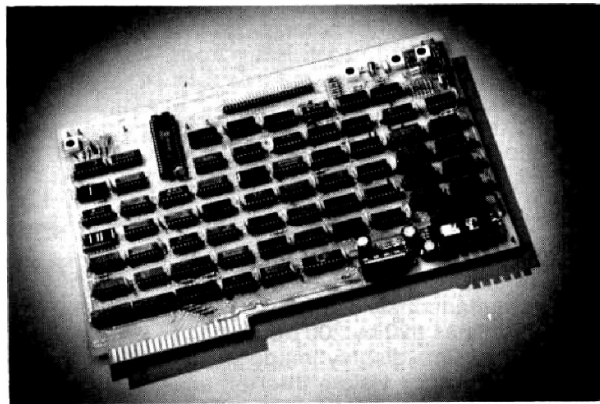
PET CODOS DISK OPERATING SOFTWARE

PET CODOS DISK OPERATING SYSTEM SOFTWARE (included with K-1013-4D package), **K-1013-4M** $25.00

Now all of the powerful CODOS features available to KIM, SYM, and AIM users are also available to PET users. In addition, several new features related to PET BASIC have been added. The user may interact with CODOS either through its built-in monitor or through the PET's BASIC operating system. When operating through BASIC, all CODOS commands are preceded by a left bracket "[" character and all of these have optional single character abbreviations. The commands available through BASIC 2.0 (which may be executed immediatelv or embedded in a program) are as follows:

BASIC COMMANDS AVAILABLE IN INITIAL RELEASE 1.1

LOAD	Load a BASIC program	APPEND	Append to BASIC program in memory
SAVE	Save a BASIC program on disk	INPUT	Input from channel ("batch" input)
CODOS	Execute **any** CODOS command	PRINT	Print to channel ("spooled" output)

ADDITIONAL COMMANDS AVAILABLE IN RELEASE 2.0 (PRELIMINARY)*

LIST	List program to channel	PUT	Output byte to channel
ENTER	Input program from channel	GET	Input byte from channel
BLKWRT	Write array or multiple variables as a record	POSN	Position channel to any byte in file
		GETPOSN	Determine present file position
BLKRD	Read array or multiple variables as a record	RUN	Chain execution to another program

These commands can be used to implement byte-addressable, random-access, or indexed-sequential files, plus BASIC-controlled "virtual memory". English error messages are issued automatically as they occur. CODOS is many times faster than Commodore's disk, even the new 8050 model, and offers larger capacities (up to 1 Megabyte files on a single 8 inch double-sided disk). PET CODOS uses 12K bytes of the 16K memory on the K-1013 Disk Controller board, at $5000-7FFF, optimized for 16K PETs. For Optional Address $9000-AFFF, add $10.00.

*Note: Release 2.0 available Dec. 31, 1980; retro-shipped free to owners of release 1.1.

CUSTOM PROTOTYPING BOARD MOUNTS IN CARD FILE

K—1020 PROTOTYPE BOARD: $42.00

This board allows construction of custom circuits and comes assembled with on-board +5 and +12 Volt regulators, bypass and input filter capacitors. It mounts in a K-1005-P Card File. Both bus Expansion and Application edge fingers are provided with gold plating and pads for connection. The board hole pattern allows 8, 14, 16, 18, 20, 22, 24, 28, 40, 64 pin IC's to be used, with a maximum capacity of seventy-five 14 and 16 pin chips. A heavy ground plane covers most of the board bottom for noise suppression while +5V and +12V planes intermesh on the top side. The board is constructed of standard glass epoxy material with all holes plated through. A documentation manual is provided containing example schematics for bus interface and address decoding. (see page 45)
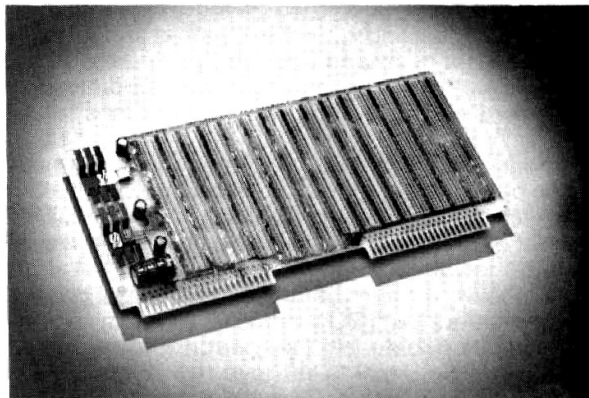
BANK SWITCHABLE RAM ROM I/O BOARDS

K-1032-1 THE BANKER 32K RAM ROM I/O Board: $395.00 introductory special, $450.00 as of 3/1/81, **K-1032-1M** $10.00, (available November 15, 1980.)

This is the 32K Memory Board with a difference. Not only does it have 32K of low-power dynamic RAMs individually addressable in 4K blocks, it also has 4 ROM sockets for up to 16K of ROM, and 4 parallel I/O ports implemented with 6522 VIA's. It even has a EPROM programmer for 5 volt 2716 or 2732 EPROM's. The most significant feature is **TWO** kinds of bankswitching right on-board which allows one to expand a PET well beyond its normal 32K limit. The RAM and the ROM are divided into 4 blocks each (8 total) and an Enable Register determines which blocks respond, thus allowing two or more blocks to be at the SAME address. Jumpers select which blocks are enabled by Reset. The Banker also recognizes 18 address bits which make it usable in future 18 bit address bus 6502 based systems. Note that standard PET BASIC does not automatically perform bank switching although a BASIC program can by issuing POKE's. (see page 46)

K-1032-2 THE BANKER 16K RAM BOARD: $295.00, K-1032-1M $10.00
(available November 15, 1980)

This is the same as the K-1032-1 Banker memory described above but with only 16K RAM installed and none of the ROM or I/O circuitry. It replaces our earlier K-1016 16K RAM. (see page 46)

AIM-65 INDEX

PRODUCTION DESCRIPTION   PAGE NUMBER

DISCUSSION OF BUS BUFFERING

The KIM BUS systems come with "unbuffered" signals on their Expansion connector. This means that the 6502 processor chip itself is the driver for the address and data lines. The clock and Write Enable control lines are driven by TTL gates. Large bus-oriented systems, such as S-100 systems, typically have powerful bus buffers on their processor board which are designed to drive dozens of peripheral boards. The peripheral boards in turn also have buffers to minimize loading of the large system bus. The large number of buffers and their strong, fast-rising outputs are responsible for some of the power consumption and most of the noise seen in S-100 systems.

Most competing motherboards for 6502 single-board computers duplicate this philosophy by providing buffers for the processor on the motherboard itself. While this is indeed necessary for very large systems, it is **NOT** necessary when only a few expansion boards are to be added **AND** the boards are designed with low-power Schottky logic connecting to the bus. The 6502 processor is specified to be and is fully capable of driving 5 low-power Schottky inputs and 25 MOS inputs such as memory and I/O chips or disabled tri-state driver outputs. One of these low-power Schottky inputs and as many as 18 of the MOS inputs are present on the processor board itself leaving 4 low-power shottky inputs and 7 disabled tri-state outputs for expansion. Thus there is enough drive capability left over for at least four exapansion boards provided that each presents a maximum of one low-power Schottky input and one tri-state output to either the address or the data bus.

DISCUSSION OF BUS BUFFERING cont'd

We feel that the advantages offered by our unbuffered motherboard far outweigh the single disadvantage of being limited to 4 expansion boards. In particular our motherboard is much smaller, less expensive, and more power conservative than others on the market. The small size allows it to be installed into a simple and compact card file that completely protects the expansion boards from "stray elbow" type accidents that can easily wipe out the entire system when the expansion boards are left exposed on the table. The simplicity of the unbuffered bus (simply 5 edge connectors wired together) also eases trouble-shooting of blown systems because the motherboard need not be suspected as the trouble source. Finally extensive groundplane shielding, the exceptionally short bus itself, and lack of powerful bus buffers contributes to a low system noise level; much lower than most buffered bus systems.

In order to determine how much operating margin can be expected with an unbuffered 6502 bus system, MTU built an AIM-65 system using three of our K-1005 motherboard/card files wired together. We were able to plug 12 of our 16K memory boards into the bus and the system still worked admirably. A check of address and data bus signals with an oscilloscope revealed somewhat leisurely rise and fall times but solid zero and one logic levels with plenty of timing margin remaining. Clearly there is adequate margin when the rated maximum of four expansion boards is used. (It is interesting to note that a single MTU K-1000-5 power supply powered the AIM, its printer, and all 12 of these boards without excessive strain.)

PACKAGE GROUP NUMBERS

K-1002-20 SIMPLE 4 VOICE MUSIC PACKAGE: $69.00
This package includes all the MTU products necessary to create music on a basic AIM-65 (with 4K RAM). This includes the K-1002 hardware and the K-1002-5C software.

K-1002-21 INSTRUMENT SYNTHESIS MUSIC PACKAGE: $98.00
This package includes all the MTU products necessary to create instrument music on an AIM-65. This includes the K-1002 hardware and the K-1002-8C instrument software. A prerequisite for using this package is that the AIM must have expanded memory such as the K-2200-1 package.

K-1008-20 AIM GRAPHIC PACKAGE: $290.00
This package gives all necessary MTU items to upgrade an AIM-65 with 320 by 200 graphics, a graphic software driver package and a Text/Graphic print software driver package. The package contains the K-1008 hardware, K-1008-5C and K-1009-1C software.

K-1008-21 AIM KEYWORD GRAPHIC PACKAGE: $314.00
This package gives all necessary MTU items to upgrade an AIM-65 with 320 by 200 graphics, an advanced graphic software driver package and a Text/Graphic print software driver package. This package contains the K-1008 hardware, the K-1008-9C Keyword Graphic Software and the K-1009-IC AIM Text/Print Software. A prerequisite is that the AIM have expanded memory such as the MTU AIM 16K Memory Expansion Package K-2200-1 below.

K-2200-1 AIM 16K MEMORY EXPANSION PACKAGE: $448.00
This package gives the AIM-65 owner a power supply, 4+1 expansion board card file and an additional 16K RAM memory. The package consists of the K-1000-5 power supply, K-1005-A Card File and the K-1032-2 16K RAM board.

MUSIC FOR THE AIM—65

K-1002 MUSIC HARDWARE BOARD: $49.00

This board is a fully integrated digital audio system. An 8 bit digital-to-analog converter combined with a quality 6-pole low-pass filter and half-watt audio amplifier with volume control means that only a speaker is needed for rich, 4-part harmony with either of our music programs listed below. The board itself is approximately 5.5" wide by 3" deep and plugs into a 44 pin edge socket (not supplied) that may be mounted in a K-1005 card file. Only +5 Volts is needed for power and any 8 bit parallel output port is suitable as the data source. Don't confuse the K-1002 with cheap imitations, it is designed and built by MTU, the originators of digital music for microcomputers! (see page 30)
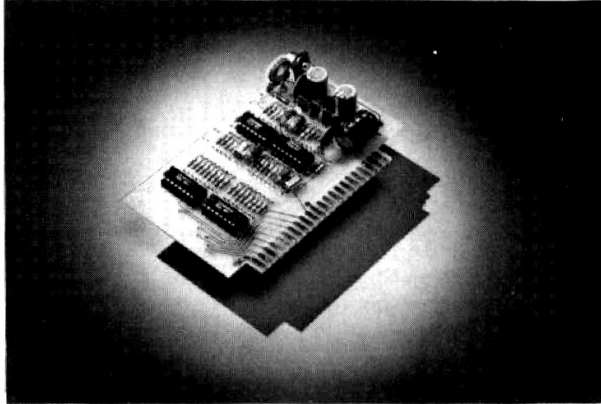
K-1002-5C AIM FOUR VOICE MUSIC SOFTWARE: $20.00

This package is a collection of several programs designed to utilize the K-1002 music board as fully as possible with as little as 4K of memory. The Simplified Music Interpreter plays 4 simultaneous tones each of which may have a different, arbitrary waveform. It is based on Hal Chamberlin's 9/77 Byte magazine article with enhancements. The Advanced Music Interpreter uses a more compact method of storing songs in memory and also provides for the redefinition of tempo, voices, etc. during the performance. The NOTRAN Compiler generates coded song data in memory from an ASCII encoded score read from an AIM text file in memory or on tape. The Fourier Series program allows one to prepare custom waveform tables for either music interpreter from harmonic specifications. The memory locations assigned to the various programs allows many of them to be in memory simultaneously. Despite the low price and modest memory requirement, this package generates true organ quality tones, not the kazoo-like square waves of other software systems or "synthesizer" boards. (see page 31)

K-1002-8C AIM INSTRUMENT SYNTHESIS MUSIC SOFTWARE: $49.00

This is by far the most powerful and flexible real-time 4 voice digital music synthesis program ever implemented on a microcomputer. Fundamentally this program is similar to the K-1002-5C music software described above except that the ability to specify an independent amplitude envelope for **EACH HARMONIC** of the tones has been added. Thus the harmonic structure of the tones **ACTUALLY VARIES** during individual notes in much the same way that conventional musical instrument sounds do. When coded instrument specifications are based on published analyses of common musical instruments, the resulting sounds will indeed closely resemble the analyzed instrument. The greatest power however comes from the ability to define original instrument sounds, and with the flexibility offered, quite a variety is possible. The manual supplied with the program contains an extensive discussion of sound synthesis principles and a library of over 20 different instrument specifications. The AIM cassette contains the music program and three example songs, one for 8K, one for 16K and one for 32K machines. (see page 32)

K-1002-6DEMO INSTRUMENT MUSIC CASSETTE: $5.00

This is a narrated stereo cassette demonstrating the capabilities of the K-1002-8C Instrument Music Software.

K-1003-2D CODOS MUSIC SONG PACK 1: $20.00 (available Nov. 15, 1980)

This is a set of over 25 coded songs on CODOS disk. Most of the songs use the instrument synthesis technique. It requires a K-1002, K-1002-8C and a 32K AIM with K-1013-3D disk system. (see page 47)

AIM-65 GRAPHIC AND PRINTING PRODUCTS

K-1008 VISIBLE MEMORY BOARD: $240.00, K-1008M $10.00

This board is a unique concept in microcomputer memory systems. It is an 8K memory add-on to the AIM-65 which includes that circuitry to simultaneously display the memory contents as 320 by 200 dots on a CRT monitor. The board is designed for the AIM BUS and is merely connected in parallel with the expansion connector (some lines not connected). With this board, the processor runs at full speed with no wait states, and no software overhead or CPU time is required to refresh the display. There is no snow or other visible interference on the screen when the display memory is being accessed by the processor, or any other time. (see page 35)
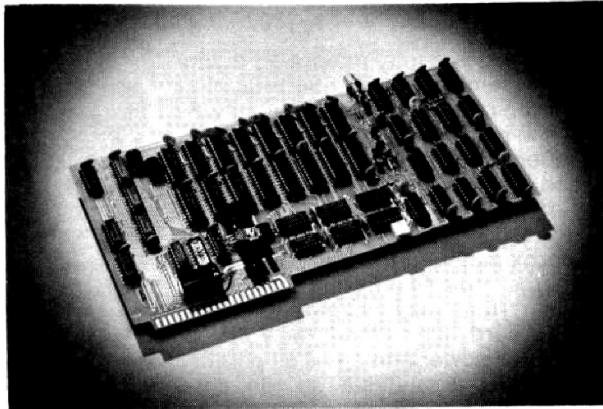
K-1008-5C AIM GRAPHICS/TEXT SOFTWARE $25.00

This is a package of several support programs for the Visible Memory for both machine language and BASIC programmers. The machine language subroutine library provides for plotting of points and lines given point coordinates or line endpoints as pairs of 16 bit integers. In addition, there are two text display routines for 22 or 18 lines of 53 characters each. An interface between AIM BASIC and the graphics routines is also provided so that the Visible Memory becomes BASIC's console with 53 character lines. Point and line plotting functions are called from BASIC programs by establishing values for X1%, Y1%, X2%, and Y2% variables and using the USR call facility. Text may be plotted by setting the cursor position with POKE's and then using normal PRINT statements. The console display functions are also usable by the AIM monitor and the AIM text editor. Links are provided for the K-1009-1C graphic print software which allows a printout of the Visible Memory screen contents at any time under BASIC control. The entire package is less than 2.5K and comes assembled for 4K and 20K AIM systems. (see page 37)

K-1008-9C AIM KEYWORD GRAPHIC/TEXT SOFTWARE: $49.00 (available Nov. 30, 1980)

The K-1008-9C graphics software is optimized for versatility and ease of use by the BASIC programmer. When loaded into memory and enabled, over **40 COMMANDS** are added to AIM BASIC and the Visible Memory becomes a 22 line, 53 character console, which makes it much easier to write and edit AIM BASIC programs. A line may be plotted with a simple command such as: LINE 25, 85, 305, 167 and text with a command such as: CHAR "MARKET TREND". In addition, scaling and offsetting of coordinate values and clipping of offscreen data is supported. Up to 4 independent "windows" are maintained by the package with easy switching from window to window. The most significant new feature is "shape tables" similar to that on the Apple II computer but with the addition of relative vectors and subshape subroutining as well. There are even commands to cause a printout of the Visible Memory screen if the user has purchased the K-1009-1C Print Package. This software requires 7K and comes assembled for use with a 20K AIM. (see page 39)

K-1009-1C AIM GRAPHIC PRINT SOFTWARE: $25.00, $35.00 as of March 1, 1981

This package consists of a Visible Memory screen print routine and a sideways text print routine. The screen print routine prints the 320 x 200 Visible Memory dot array DOT-FOR-DOT meaning that any kind of graphic image can be printed. The **QUICK PRINT** routine gives the entire image on one strip and the **QUALITY PRINT** routine gives it on two strips for proper proportioning. The **TEXT PRINT** routine can print the contents of the AIM text buffer (maintained by the AIM editor) SIDEWAYS in groups of 10 lines with line lengths up to 127 characters. (see page 40)

18
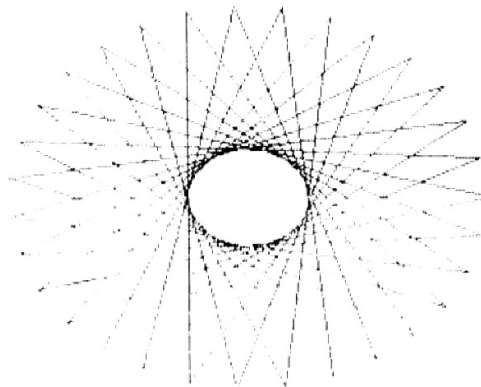
AIM-65 EXPANSION PRODUCTS

K-1000-5 AIM POWER SUPPLY $65.00

This power supply is designed specifically for the AIM-65 system. It is designed for table top operation and comes fully enclosed with a line cord, fused primary circuit and a terminal strip for connection to the DC power. The power outputs are: regulated +5 Volts at 3 Amps maximum (no other loads) 2 Amps with all other voltages loaded, regulated +24 Volts at 2.5 Amp maximum 0.5 Amp continuous draw, unregulated +8 Volts nominal up to 0.75 Amp, unregulated +16 Volts nominal up to 0.25 Amp. This supply will drive the AIM-65 and any three (typically four) of our bus expansion products. (see page 30)
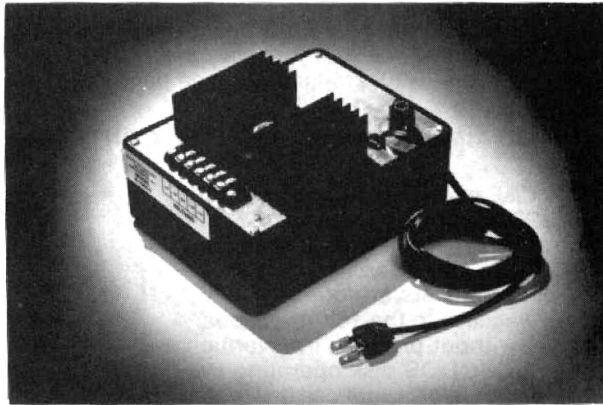
K-1005-A AIM ASSEMBLED CARD FILE: $85.00, K-1005M $5.00

The K-1005-A Card File was designed to answer the need for system expansion of an AIM-65. The structure mounts the AIM above the frame with 5 expansion slots below it, 4 serviced by the backplane and the bottom slot with no connectors. Brackets extend the basic frame to mount the AIM keyboard at the 11.5 degree typewriter angle, in front of the display. A Bus Expansion Motherboard is supplied with gold plated connectors and a barrier terminal strip for power connections. This card file structure and expansion bus is what MTU has adopted as **THE STANDARD** and will continue to support as the system approach for the 6502 processor as the S-100 structure is for the Z-80. All

MTU bus expansion products will work in this card file, allowing an AIM-65 to be upgraded to a truly powerful system. An application motherboard is optionally available. (See page 33)

K-1012 PROM-I/O SYSTEM BOARD: $295.00, K-1012M $10.00

This system oriented expansion board offers 4 basic expansion functions, allowing the system designer to construct powerful, yet easy to use turn-key systems. These four functions are low power EPROM storage, four 8 bit parallel I/O ports, a UART controlled RS-232 serial communications port, and a PROM programmer. The 12 PROM sockets are designed for 2708 or 2716 EPROMs and are switched **OFF** when not addressed, giving super-low power operation. The I/O ports have full handshaking and interrupt capability. The UART controlled full

RS-232 serial communications port allows quick system expansion or turning it into a remote intelligent terminal. This board may be connected directly to the AIM BUS with no modification or external interface circuitry required. The board is supplied with the K-1012M complete user manual. (see page 41)
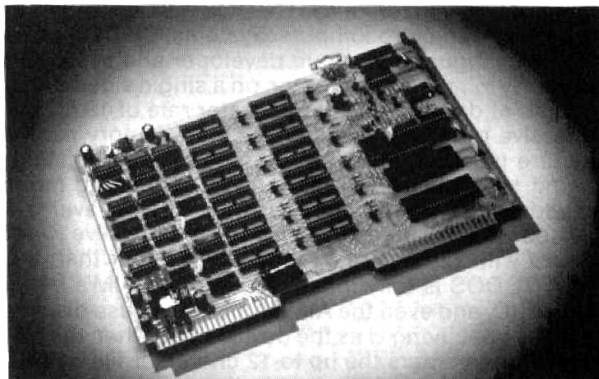
AIM-65 EXPANSION PRODUCTS

K-1012-1 LOW POWER PROM ONLY BOARD $165.00, K-1012M $10.00

This version of the board has only the PROM and addressing sections assembled. Its creation came about from market requests for a board to allow super low power firmware operation. It comes with the K-1012M manual. (see page 41)

K-1013-3D AIM 16K RAM FLOPPY DISK CONTROLLER WITH CODOS $595.00, K-1013M $10.00

This disk controller board, using the NEC uPD765 chip, was designed from the ground up for maximum speed and reliability in data transfer operations. Disk data transfers are done via direct memory access to the 16K of on-board memory without program intervention. Using our CODOS disk operating system, a 24K byte program can be located and loaded in 3 seconds, with a sustained data transfer rate of 19.6 KByte/sec. This allows speeds previously unattainable for date acquisition, data base management, etc.

The 16K of on-board read/write memory is split into two 8K blocks, independently addressable on any 4K boundary. One block is available for the user. The other 8K block can be write protected (under software control) and is normally used to hold the disk operating system software and disk data buffers.

The hardware allows operation with standard or mini-floppy drives, single or double density, single or double sided, and up to 4 drives with simultaneous seek. In addition, it contains 16K of on-board 2-port memory, initial program load ROM for turn-key systems, and complete MTU/KIM BUS compatibility in the MTU tradition. To use this product on the AIM-65 requires a power supply, K-1005-K Card File, 8" Floppy Disk drive, and disk cables.

The complete disk system including the AIM CODOS operating software is designed to function with 8" double density, single or double sided Shugart model SA800 or SA850 8" or equivalent floppy disk drives. Use of mini-floppy or single density drives are not presently supported by MTU. The controller is sold with a diskette containing our AIM CODOS, the K-1013-1M hardware manual and K-1013-3M CODOS manual. No drives or cables are supplied in this package. (see page 41)
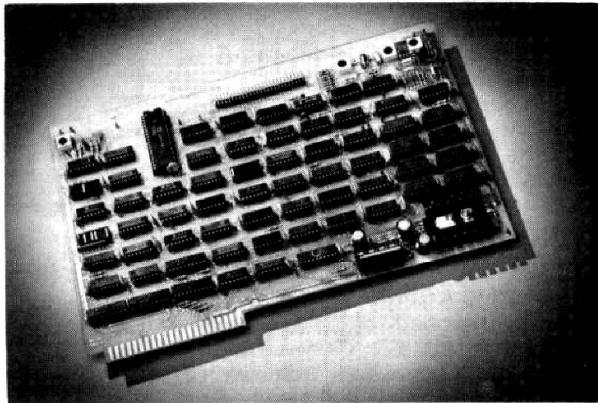
AIM CODOS DISK OPERATING SYSTEM (supplied with K-1013-3D only) K-1013-3M $25.00

The AIM-65 version of the CODOS disk operating system provides features not available even on much larger microcomputer systems. CODOS provides an ideal environment for the assembly or BASIC language program developer and system implementer. Twelve character named files and nearly ½ megabyte storage on a single sided 8-inch diskette makes the manipulation of large amounts of data simple. Fast transfer rate of 19.6K bytes per second average makes the loading of massive programs or data files into memory nearly instantaneous. The channel-oriented I/O structure means that user programs need not distinguish between devices and files when performing sequential I/O. The built-in debugging monitor completely replaces the AIM monitor and adds many new functions as well. There is even a Visible Memory text/graphics driver routine provided free of charge to allow the inexpensive K-1008 Visible Memory to be used as a display terminal with 22 lines of 53 characters rather than the single line 20 character AIM display.

AIM CODOS is fully integrated into the AIM's I/O structure. The AIM Editor, AIM Assembler, AIM BASIC, and even the AIM monitor may use disk files in place of cassette tape or memory files simply by specifying U as the device code when the "IN=" or "OUT=" prompt is printed by the AIM. The user then enters the up to 12 character file name and CODOS takes over from there. At this time BASIC support is limited to the program save and load functions built into the AIM BASIC ROM. The Supervisor Call facility provided by CODOS makes it possible for AIM assembly language programs to be transportable to other CODOS equipped 6502 systems. The CODOS Supervisor Calls provide for all device and file I/O as well as providing 16 bit arithmetic and number conversion functions needed by assembly language programs. Standard CODOS is available at 8000-9FFF. For optional address 6000-7FFF add $10.00. (See page 42)

AIM-65 EXPANSION PRODUCTS

K-1020 PROTOTYPE BOARD: $42.00

This board allows construction of custom circuits and comes assembled with on-board +5 and +12 Volt regulators, and bypass and input filter capacitors. It mounts in a K-1005-A Card File. Both bus Expansion and Application edge fingers are provided with gold plating and pads for connection. The board hole pattern allows 8, 14, 16, 18, 20, 22, 24, 28, 40, 64 pin IC's to be used, with a maximum capacity of seventy-five 14 and 16 pin chips. A heavy ground plane covers most of the board bottom for noise suppression while +5V and +12V planes intermesh on the top side. The board is constructed of standard glass epoxy material with all holes plated through. A documentation manual is provided containing example schematics for bus interface, address decoding, and form pages for your documentation. (see page 45)
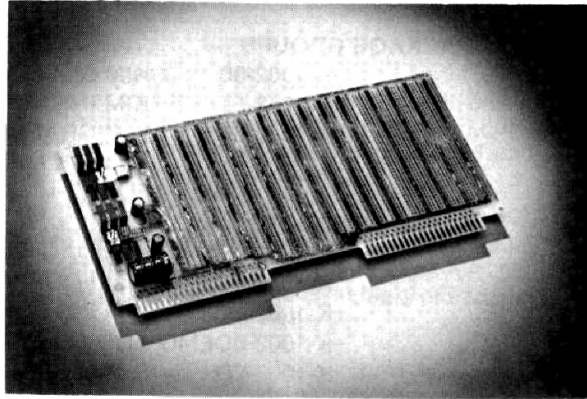
K-1032-1 THE BANKER 32K RAM ROM I/O BOARD: $395.00 introductory special, $450 as of March 1, 1981, Available Nov. 15, 1980, K-1032-1M $10.00

This is the 32K Memory Board with a difference. Not only does it have 32K of low-power dynamic RAM individually addressable in 4K blocks, it also has 4 ROM sockets for up to 16K of ROM, and 4 parallel I/O ports implemented with 6522 VIA's. It even has a EPROM programmer for 5 volt 2716 or 2732 EPROM's. The most significant feature though is **TWO** kinds of bankswitching right on-board which allows one to expand an AIM well beyond its normal 40K limit. The RAM and the ROM are divided into 4 blocks each (8 total) and an Enable Register determines which blocks respond thus allowing two or more blocks to be at the SAME address. Jumpers select which blocks are enabled by Reset. The Banker also recognizes 18 address bits which make it usable in future 18 bit address bus 6502 based systems. (See page 46)

K-1032 THE BANKER 16K RAM BOARD: $295.00 (available Nov. 15, 1980)

This is the same as the K-1032-1 Banker memory described above but with only 16K RAM installed and none of the ROM or I/O circuitry. It replaces our earlier K-1016 16K RAM board. (see page 46)

KIM-1 INDEX

INTRODUCTION TO KIM-1 EXPANSION WITH MTU

The KIM-1 is one of the cleanest 6502 processor boards to interface to and work with. As the KIM comes, it is little more than a 1 MHz 6502 processor board with some I/O capability. To turn it into a truly powerful system equal or superior to a PET or APPLE, the user needs additional functions such as a keyboard, display, and mass storage. This is where MTU can help. We offer a series of expansion products which allows the user to buy a little now, a little later, with each purchase upgrading the flexibility of the KIM system. All MTU bus expansion products will run on the KIM-1 **AND** will be usable on future systems which can be constructed with MTU products—upward compatability, not programmed obsolesence. The basic MTU/KIM BUS is what MTU supports now and will continue to support with the TRIMEG processor board for higher speeds and compatability with MTU current products. We have started our company supporting the KIM-1 and see no reason to drop support with so many customers in the field who are now ready to **GROW** their board into a system.

The basic approach that MTU takes is a series of bus expansion boards which, along with the KIM-1, mount into a 5 position Card File. The mechanical expansion approach is solid and offers the user protection for his investment. The following pages show and describe the Card File and boards (and software drivers) which can be purchased separately in the expansion plans. We understand that many users and institutions have budgetary limits that can be added to over time, but are not unlimited at any single purchase. For instance, if you want the best Floppy Disk system available for a 6502 system, but cannot afford an initial $1500 range investment, buy the K-1013-2D Disk Controller and use it as a 16K RAM board until you can purchase the Disk Drives and cables. Our products are all designed with this type of multi-use in mind.

PACKAGE GROUPS

K-1002-30 KIM SIMPLE 4 VOICE MUSIC PACKAGE: $69.00
This package includes all the MTU products necessary to create music on a basic KIM-1. This includes the K-1002 hardware and the K-1002-1C software.

K-1002-31 KIM INSTRUMENT MUSIC PACKAGE: $98.00
This package includes all the MTU products necessary to create instrument music on a KIM-1. This includes the K-1002 hardware and the K-1002-7C instrument software. A prerequisite for using this package is that the KIM must have expanded memory such as the K-2300-1 package.

K-1008-30 KIM GRAPHIC PACKAGE: $267.00
This package gives all necessary MTU items to upgrade a KIM-1 with 320 by 200 graphics, and have a graphic and keyboard software driver package. The package contains the K-1008 hardware, and K-1008-7C software. A prerequisite to run is that the KIM needs memory expansion such as the K-2300-1 16K MEMORY EXPANSION PACKAGE. (see below)

K-2300-1 KIM 16K MEMORY EXPANSION PACKAGE: $373.00
This package gives the KIM-1 owner a 5 position expansion card file and an additional 16K RAM memory. The package consists of the K-1005-K 5 position Card File and a K-1032-2 THE BANKER 16K MEMORY BOARD.

MUSIC FOR THE KIM-1

K-1002 MUSIC HARDWARE BOARD: $49.00

This board is a fully integrated digital audio system. An 8 bit digital-to-analog converter combined with a quality 6-pole low-pass filter and half-watt audio amplifier with volume control means that only a speaker is needed for rich, 4-part harmony with either of our music programs listed below. The board itself is approximately 5.5" wide by 3" deep and plugs into a 44 pin edge socket (not supplied) that may be mounted in a K-1005-K card file. Only +5 Volts is needed for power and any 8 bit parallel output port is suitable as the data source. Don't confuse the K-1002 with cheap imitations, it is designed and built by MTU, the originators of digital music for microcomputers! (see page 30)
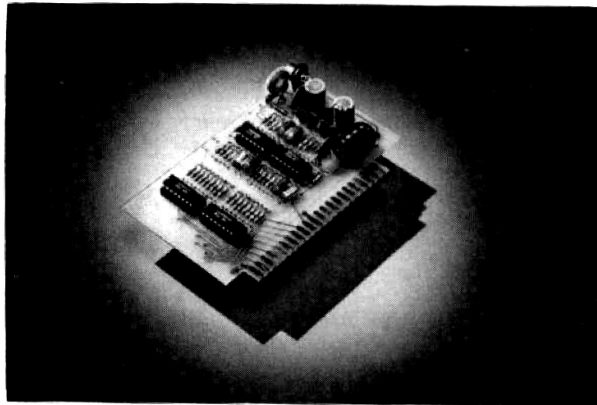
K-1002-1C KIM-1 SIMPLE 4 VOICE MUSIC SOFTWARE: $20.00

This package is a collection of several programs designed to utilize the K-1002 music board as fully as possible with as little as 1K of memory. The Simplified Music Interpreter plays 4 simultaneous tones each of which may have a different, arbitrary waveform. It is based on Hal Chamberlin's 9/77 Byte magazine article with a few enhancements. The Advanced Music Interpreter uses a more compact method of storing songs in memory and also provides for the redefinition of tempo, voices, etc. during the performance. The NOTRAN Compiler generates coded song data in memory from an ASCII encoded score read from an I/O device. The Fourier Series program allows the preparation of custom waveform tables for either music interpreter from harmonic specifications. Despite the low price and modest memory requirement, this package generates true organ quality tones, not the kazoo-like square waves of other software systems or "synthesizer" boards. The only hardware required to use this software is a KIM-1, K-1002, and power supply (4K RAM will enhance the flexibility). (see page 31)

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MUSIC FOR THE KIM-1

K-1002-7C KIM-1 INSTRUMENT SYNTHESIS MUSIC SOFTWARE: $49.00

This is by far the most powerful and flexible real-time 4 voice digital music synthesis program ever implemented on a microcomputer. Fundamentally this program is similar to the K-1002-1C music software described above except that the ability to specify an independent amplitude envelope for **EACH HARMONIC** of the tones has been added. Thus the harmonic structure of the tones **ACTUALLY VARIES** during individual notes in much the same way that conventional musical instrument sounds do. When coded instrument specifications are based on published analyses of common musical instruments, the resulting sounds will indeed closely resemble the analyzed instrument. The greatest power however comes from the ability to define original instrument sounds, and with the flexibility offered, quite a variety is possible. The manual supplied with the program contains an extensive discussion of sound synthesis principles and a library of over 20 different instrument specifications. The KIM cassette contains the music program and three example songs, one for 8K, one for 16K and one for 32K machines. (see page 32)

K-1002-6DEMO INSTRUMENT MUSIC DEMONSTRATION AUDIO CASSETTE: $5.00

This is a narrated stereo cassette demonstrating the capabilities of the K-1002-7C Music Software.

K-1003-2D CODOS INSTRUMENT MUSIC SONG PACK 1: $20.00 (available Nov. 15, 1980)

This is a set of over 25 coded songs stored on a CODOS disk. All songs are instrument synthesis types. It requires a K-1002-7C, K-1002, speaker and a 32K KIM with K-1013-2D disk system. (see page 47)

KIM-1 GRAPHIC PRODUCTS

K-1008 VISIBLE MEMORY BOARD: $240.00, K-1008M $10.00

This board is a unique concept in microcomputer memory systems. It is an 8K memory add-on to the KIM-1 which includes the circuitry to simultaneously display the memory contents as 320 by 200 dots on a CRT monitor. The board is designed for the KIM BUS and is merely connected in parallel with the expansion connector (some lines not connected). Signals necessary to expand the KIM-1 memory are provided. With this board, the processor runs at full speed with no wait states and no software overhead or CPU time is required to refresh the display. There is no snow or other visible interference on the screen when the display memory is being accessed by the processor, or any other time. (see page 35)
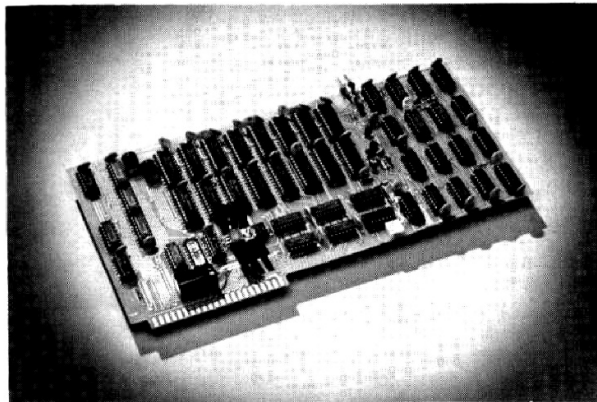
K-1008-7C KIM-1 BASIC GRAPHICS/TEXT SOFTWARE: $27.00

This is a package of several support programs for the Visible Memory for both machine language and BASIC programmers. The machine language subroutine library provides for plotting of points and lines given point coordinates or line endpoints as pairs of 16 bit integers. Also, there are two text display routines for 22 or 18 lines of 53 characters each. An interface between Microsoft BASIC for the KIM and the graphics routines is also provided so that the Visible Memory becomes the console when operating in BASIC and to allow plotting from BASIC programs. Additionally, there are 2 keyboard driver routines, one for an ASCII encoded keyboard and the second for a MATRIX encoded keyboard. (see page 38)

KIM-1 CARD FILE EXPANSION

K-1005-K ASSEMBLED CARD FILE: $75.00, K-1005M $5.00

The K-1005-K Card File was designed to answer the need for system expansion of a KIM-1. The structure mounts the KIM in the top of 5 slots, giving 4 expansion slots below the processor. A Bus Expansion Motherboard is supplied with gold plated connectors and a barrier terminal strip for power connections. This card file structure and expansion bus is what MTU has adopted as **THE STANDARD** and will continue to support as the system approach for the 6502 processor as the S-100 structure is for the Z-80. All MTU bus expansion products will work in this card file, allowing a KIM-1 to be upgraded to a truly powerful system. An application motherboard is optionally available. (see page 33)
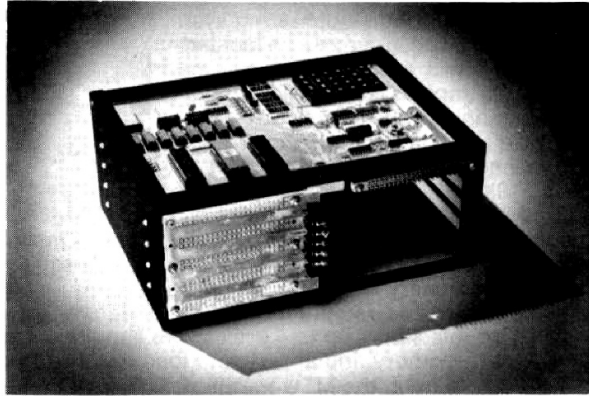
KIM-1 EXPANSION PRODUCTS

K-1012 SYSTEM EXPANSION BOARD: $295.00, K-1012M $10.00

This system oriented expansion board offers 4 basic expansion functions, allowing the system designer to construct powerful, yet easy to use turn-key systems. These four functions are low-power EPROM storage, four 8 bit parallel I/O ports, a UART controlled RS-232 serial communications port, and a PROM programmer. The 12 PROM sockets are designed ror 2708 or 2716 EPROMs and are switched **off** when not addressed, giving super low power operation. The I/O ports have full handshaking and interrupt capability. The UART controlled full RS-232 serial communications port allows quick system expansion or turning it into a remote intelligent terminal. This board may be connected directly to the KIM BUS with no modification or external interface circuitry required. The board is supplied with a complete user manual. (see page 41)
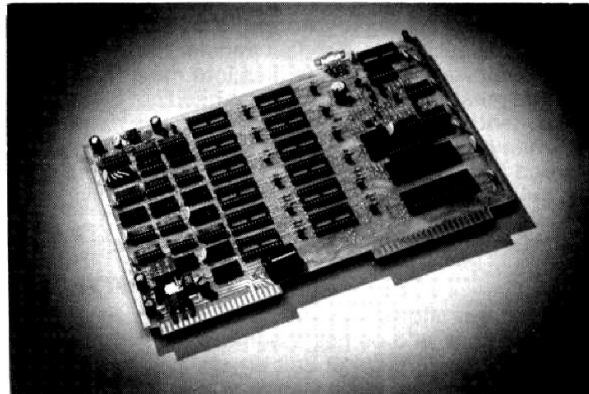
K-1012-1 LOW POWER PROM ONLY BOARD: $165.00, K-1012M $10.00

This version of the board has only the PROM and addressing sections assembled. Its creation came about from market requests for a board to allow super low power firmware operation. It comes with the K-1012M manual. (see Page 41)

KIM-1 FLOPPY DISK CONTROLLER
K-1013-2D DISK CONTROLLER WITH 16K RAM & CODOS: $595.00, K-1013M $10.00

This disk controller board, using the NEC uPD765 chip, was designed from the ground up for maximum speed and reliability in data transfer operations. Disk data transfers are done via direct memory access to the 16K of on-board memory without program intervention. Using our CODOS disk operating system, a 24K byte program can be located and loaded in 3 seconds, with a sustained data transfer rate of 19.6 KByte/sec. This allows speeds previously unattainable for data acquisition, data base management, etc.

The 16K of on-board read/write memory is split into two 8K blocks, independently addressable on any 4K boundary. One block is available for the user. The other 8K block can be write protected (under software control) and is normally used to hold the disk operating system software and disk data buffers.

The hardware allows operation with standard or mini-floppy drives, single or double density, single or double sided, up to 4 drives with simultaneous seek. In addition, it contains 16K of on-board 2-port memory, initial program load ROM for turn-key systems, and complete MTU/KIM BUS compatibility in the MTU tradition. To use this product on the KIM-1 requires a power supply, K-1005-K Card File, 8" Floppy Disk drive, and disk cables.

The complete disk system including CODOS operating software is designed to function with 8" double density, single or double sided Shugart model SA800 or SA850 8" or equivalent floppy disk drives. Use of mini-floppy or single density drives are not presently supported by MTU. The controller is sold with a diskette containing our CODOS, and the K-1013-1M hardware and K-1013-2M software user manuals. No drives or cables are supplied in this package. (see page 41)

KIM-1 CODOS DISK OPERATING SYSTEM: (with K-1013-2D package) K-1013-2M: $25.00

The KIM-1 version of the CODOS disk operating system provides features not available even on much larger microcomputer systems. CODOS provides an ideal environment on the KIM-1 for the machine language program developer and system implementer. Twelve character named files and nearly ½ megabyte storage on a single 8-inch diskette makes the manipulation of large amounts of data simple. The fast transfer rate of 19.6K bytes per second average makes the loading of massive programs or data files into memory nearly instantaneous. The channel-oriented I/O structure means that user programs need not distinguish between devices and files when performing sequential I/O. The built-in debugging monitor completely replaces the KIM monitor and adds many new functions as well. There is even a Visible Memory text/graphics driver routine provided free of charge to allow an inexpensive K-1008 Visible Memory to be used as a display terminal. A system customization routine is provided to link up with the user's keyboard routine when CODOS is first installed. Standard CODOS is available, at C000-DFFF for continued use of the KIM's keypad. For optional address E000-FFFF for turn-key systems, add $10.00. (see page 42)

K-1020 PROTOTYPE BOARD: $42.00

This board allows construction of custom circuits and comes assembled with on-board +5 and +12 Volt regulators, and bypass and input filter capacitors. It mounts in a K-1005-K Card File. Both bus Expansion and Application edge fingers are provided with gold plating and pads for connection. The board hole pattern allows 8, 14, 16, 18, 20, 22, 24, 28, 40, and 64 pin IC's to be used, with a maximum capacity of seventy-five 14 and 16 pin chips. A heavy ground plane covers most of the board bottom for noise suppression while +5V and +12V planes intermesh on the top side. The board is constructed of standard glass epoxy material with all holes plated through. A manual is provided containing examp schematics for bus interface, address decoding, and blank documentation forms.
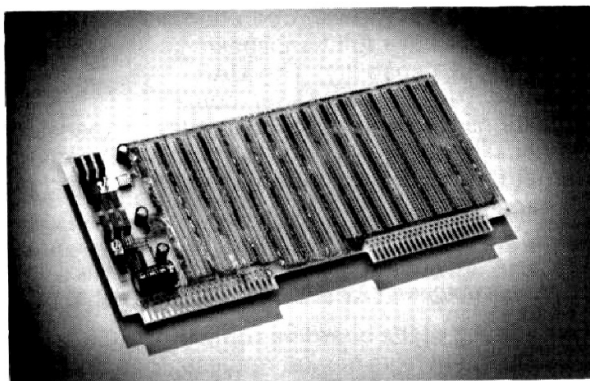
KIM-1 BANK SWITCHABLE RAM ROM and I/O EXPANSION

K-1032-1 THE BANKER 32K RAM ROM I/O BOARD: $395.00 introductory special,
$450.00 as of March 1, 1981, Available Nov. 15, 1980, **K-1032-1M** $10.00

This is the 32K Memory Board with a difference. Not only does it have 32K of low-power dynamic RAM individually addressable in 4K blocks, it also has 4 ROM sockets for up to 16K of ROM, and 4 parallel I/O ports implemented with 6522 VIA's. It even has a EPROM programmer for 5 volt 2716 or 2732 EPROM's. The most significant feature is **TWO** kinds of bankswitching right on-board which allows one to expand a KIM well beyond its normal 56K limit. The RAM and the ROM are divided into 4 blocks each (8 total) and an Enable Register determines which blocks respond, thus allowing two or more blocks to be at the SAME address. Jumpers select which blocks are enabled by Reset. The Banker also recognizes 18 address bits which make it usable in future 18 bit address bus 6502 based systems. (see page 46).

K-1032-2 THE BANKER 16K MEMORY BOARD: $295.00 **K-1032-1M** $10.00
(Available Nov. 15, 1980)

This is the same as the K-1032-1 Banker memory described above but with only 16K of RAM installed and none of the ROM or I/O circuitry. It includes the K-1032-1M manual, and replaces the previous MTU K-1016 16K RAM board. (see page 46)

SYM-1 INDEX

All bus expansion products (K-1008, K-1012, K-1013, K-1020, K-1032) that are described for the KIM-1 are also operational to the same level on the SYM-1. Software not specifically designated for the SYM-1 will require some modification to operate on the SYM-1. For software functioning on the SYM-1, contact LUX ASSOCIATES. (see dealer page)

K-2400-1 SYM 16K MEMORY EXPANSION PACKAGE $370.00

This package offers the SYM-1 user a 5 position Expansion Card File (K-1005-S) and a bank switchable 16K RAM board (K-1032-2). The package then allows the user to expand with an additional 3 boards (including the MTU K-1013-5D Disk Controller with CODOS).

K-1005-S ASSEMBLED CARD FILE: $75.00, K-1005M $5.00

The K-1005-S Card File was designed to answer the need for system expansion of a SYM-1. The structure mounts the SYM in the top of 5 slots, giving 4 expansion slots below the processor. A Bus Expansion Motherboard is supplied with gold plated connectors and a barrier terminal strip for power connections. This card file structure and expansion bus is what MTU has adopted as *The Standard* and will continue to support as the system approach for the 6502 processor as the S-100 structure is for the Z-80. All MTU bus expansion products will work in this card file, allowing a SYM-1 to be upgraded to a truly powerful system. An application motherboard is optionally available. (see page 33)

K-1013-5D SYM-1 16K RAM FLOPPY DISK CONTROLLER WITH CODOS: $595.00, K-1013M $10.00

This disk controller board, using the NEC uPD765 chip, was designed from the ground up for maximum speed and reliability in data transfer operations. Disk data transfers are done via direct memory access to the 16K of on-board memory without program intervention. Using our CODOS disk operating system, a 24K byte program can be located and loaded in 3 seconds, with a sustained data transfer rate of 19.6 KByte/sec. This allows speeds previously unattainable for data acquisition, data base management, etc.

The 16K of on-board read/write memory is split into two 8K blocks, independently addressable on any 4K boundary. One block is available for the user. The other 8K block can be write protected (under software control) and is normally used to hold the disk operating system software and disk data buffers.

The hardware allows operation with standard or mini-floppy drives, single or double density, single or double sided, up to 4 drives with simultaneous seek. In addition, it contains 16K of on-board 2-port memory, initial program load ROM for turn-key systems, and MTU/KIM BUS compatibility in the MTU tradition. To use this product on the SYM-1 requires a power supply, K-1005-S Card File 8" Floppy Disk drive, and disk cables.

The complete disk system including CODOS operating software is designed to function with 8" double density, single or double sided Shugart model SA800 or SA850 8" or equivalent floppy disk drives. Use of mini-floppy or single density drives are not presently supported by MTU. The controller is sold with a diskette containing our CODOS, and the K-1013M hardware and K-1013-5M software user manuals. No drives or cables are suplied in this package. (see page 41)

SYM-1 CODOS DISK OPERATING SYSTEM: (with K-1013-5D package) K-1013-5M $25

The SYM-1 version of the CODOS disk operating system provides features not available even on much larger microcomputer systems. CODOS provides an ideal environment on the SYM-1 for the machine language program developer and system implementer. Twelve character named files and nearly ½ megabyte storage on a single 8-inch diskette makes the manipulation of large amounts of data simple. The fast transfer rate of 19.6K bytes per second average makes the loading of massive programs or data files into memory nearly instantaneous. The channel-oriented I/O structure means that user programs need not distinguish between devices and files when performing sequential I/O. The built-in debugging monitor completely replaces the SYM monitor and adds many new functions as well. There is even a Visible Memory text/graphics driver routine provided free of charge to allow an inexpensive K-1008 Visible Memory to be used as a display terminal. A system customization routine is provided to link up with the user's keyboard routine when CODOS is first installed. Standard CODOS is available, at 6000-7FFF for continued use of all of the SYM's ROM sockets. For optional address C000-DFFF for systems without the BASIC ROM, add $10.00. (see page 42)

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MUSIC FOR THE APPLE II COMPUTER

K-1002-4 APPLEDAC HARDWARE MUSIC BOARD: $89.00

This board is a fully integrated digital audio system. An 8 bit digital-to-analog converter combined with a quality 6-pole low-pass filter and half-watt audio amplifier with volume control means that only a speaker is needed for rich, 4-part harmony with the Instrument Synthesis music software listed below. The board itself is standard Apple II size and can plug into either slot 0, 2, or 4. The volume control handle is accessible through the Apple's rear slots and a 3 foot audio cable is included. Don't confuse the K-1002-4 with cheap imitations, it is designed and built by MTU, the originators of digital music for microcomputers! (see page 30)
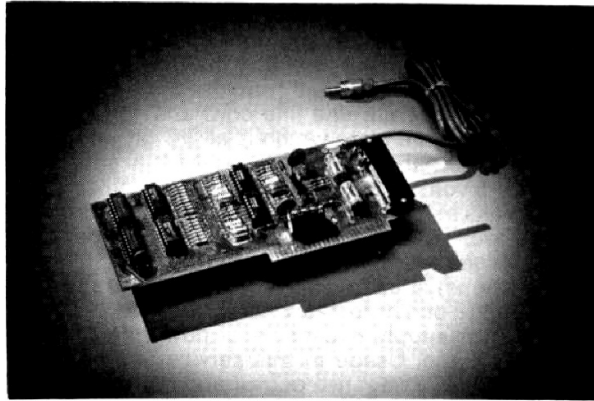
K-1002-9D APPLE II INSTRUMENT MUSIC SOFTWARE: $49.00 (available Nov. 15, 1980)

This is by far the most powerful and flexible real-time 4 voice digital music synthesis program ever implemented on a microcomputer. Fundamentally this program is similar to our earlier 4 voice music programs for the KIM, AIM, and PET except that the ability to specify an independent amplitude envelope for **EACH HARMONIC** of the tones has been added. Thus the harmonic structure of the tones **ACTUALLY VARIES** during individual notes in much the same way that conventional musical instrument sounds do. When coded instrument specifications are based on actual analyses of common musical instruments, the resulting sounds will indeed closely resemble the analyzed instrument. The greatest power however comes from the ability to define original instrument sounds, and with the flexibility offered, quite a variety is possible. The manual supplied with the program contains an extensive discussion of sound synthesis principles and a library of over 20 different instrument specifications. The Apple II diskette contains the music program and three example songs, and requires a 48K system. (see page 32)

K-1003-3D APPLE II DISK SONG PACK 1: $20.00 (available Nov. 15, 1980)

The above song pack 1 is stored on an APPLE II diskette for use with an APPLE II system containing at least one disk, the K-1002-9C software and the K-1002-4 board. Most songs require a 48K RAM system. (see page 47)

K-1000-5 TABLE-TOP ENCLOSED POWER SUPPLY

This power supply offers the user the following advantages:
- AC line cord already provided for ready to use operation
- Fused primary circuit for safety and protection
- Barrier terminal strip for DC voltage connections
- Totally enclosed electrical components to prevent shock hazard
- Attractive design and package to help "show off" your project
- Internal current limit and thermal shutdown on hybrid voltage regulators

This power supply is totally enclosed in a black bakelite box, 5 5/16" wide by 6 13/16" long by 2 13/16" high overall. The line cord and voltage output terminal strip are mounted to the top brushed aluminum plate which is at DC ground potential. The regulated outputs (except +24V) have both internal current limit and thermal shutdown for failsafe operation. The regulated voltages are: +5 volts at 3 Amps Maximum (no other loads) or 2 Amps with all other voltages loaded, and +24 volts at 2.5 Amp max, .5 Amp continuous draw (to power AIM-65 printer). The unregulated voltages are: +8.0 volts nominal, +7.5 to +12 depending on load (sufficient for external "5 Volt chip" voltage regulators), at up to .75 Amps., +16 volts nominal (+14 to +20 volts depending on load variations) at up to .25 Amps. All units are tested at full current specifications over an input voltage range of 110 to 125 volts 60Hz AC.

This power supply is capable of powering 8 inch floppy disk drives which do not require a negative voltage. Usage in this service is more economical than buying a floppy disk power supply that has a negative output and more power than needed.

K-1000-5 POWER SUPPLY: $65.00

K-1002, -2, -4, DIGITAL TO ANALOG MUSIC HARDWARE BOARD

The K-1002 music boards are **COMPLETE AUDIO OUTPUT** systems for microcomputers. They connect to any parallel I/O port for data and require 5 volts only to operate. With 1 MHz 6502 based systems, up to four quality musical tones may be generated simultaneously. This system and technique is capable of audio quality that far surpasses other software or hardware based microcomputer music systems anywhere near the same price range. Tones are generated using a sampling technique with waveform tables stored in memory. A wide variety of tone colors may be generated by changing waveform tables, and even dynamic waveform changes and amplitude envelopes are possible by rapidly switching among a number of tables. Although software is the key to this level of performance, a microcomputer with 8K of memory available is sufficient to realize virtually the full potential of the technique.

In operation, a string of 8 bit bytes is sent to the 8 bit digital-to-analog converter section on the board at a rate of 8KHz or greater. The converted output voltage is fed to a sharp cutoff low-pass filter to remove switching spikes and alias distortion thus generating a smooth waveform. The filtered output is then routed to a low power high-fidelity amplifier capable of driving any 4, 8, or 16 ohm speaker.

The power requirement is regulated +5 volts @ 30MA quiescent, 300MA peak driving an 8 ohm speaker. The Digital-to-Analog section is 8 bits guaranteed monotonic with straight binary input code, 0 to +5 volts output, 5K source impedance, and uses the 5 volt power supply as a reference after heavy filtering. The lowpass filter section has 6 poles with a 0.5dB Chebyshev response, 3.5kHz cutoff frequency and unity gain. The amplifier section has a 20Hz to 20KHz response +3dB, can drive a load impedance of 4 ohms or more with a power output of 250MW at 8 ohms. The amplifier includes an onboard volume control. A manual is supplied and contains a complete hardware schematic, parts list, and layout.

K-1002 MTUDAC: $49.00

This board is designed to plug into a 22/44 position 0.156 spacing edge finger connector (not supplied). Thus, it can be mounted in a K-1005 series card file. This board is the minimum cost approach to the K-1002 series boards.

K-1002-2 PETDAC: $59.00

This board has the same electronics as the K-1002, but additionally has 2 edge connectors to mate with the PET I/O and second cassette ports. Both ports pass through the board and are recreated by edge fingers on the opposite side of the board.

K-1002-4 APPLEDAC: $89.00

This board is complete with data latches and may be plugged directly into slot 0, 2, or 4 of any Apple II computer. The volume control is a slide pot accessible through the slots on the rear of the Apple II. A 3 foot audio cable with male RCA plug is included.

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K-1002-1, 3, 5 SIMPLE FOUR—VOICE MUSIC SOFTWARE

The following software packages are based on the original DAC method of producing multi-part music described in an article by Hal Chamberlin in the 9/77 issue of *Byte*. The musical tones produced have a limitless variety of different waveforms but the rectangular envelopes tend to give an organ-like timbre. The primary advantages of these packages are simplicity of use and memory requirements as small as 1K.

K-1002-1C FOUR VOICE MUSIC SOFTWARE FOR KIM-1: $20.00

This package is a collection of several programs designed to enhance the educational and musical value of the KIM-1 processor and the K-1002 music board.

The SIMPLIFIED MUSIC INTERPRETER allows the user to code and play song tables. It is essentially the same as the one described in the *Byte* Magazine article. Musical "subroutine" (refrains) capability has been added with nesting to over 10 levels depending on stack allocation. This program runs in the basic KIM-1 memory.

The NOTRAN MUSIC COMPILER accepts an ASCII string from the teletype serial port (or other device with user supplied I/O routines) and produces interpretive code in memory for the advanced music interpreter. The compiler requires 2.5K of memory plus storage for interpretive song data.

The ADVANCED MUSIC INTERPRETER allows a more compact and flexible song table than the simplified interpreter while retaining 4 voice capability. Each musical event requires as little as 1 byte rather than the constant 5 bytes needed by the simplified interpreter. Provisions for separate waveforms for each voice, variations in tempo, changes in timbre, and "musical subroutines" are included. The interpreter resides in 1K memory with an additional 4K recommended for song and waveform storage. It accepts song table code generated by the NOTRAN COMPILER or by hand.

The FOURIER SERIES PROGRAM accepts a table of up to 16 harmonic amplitudes and phases generated by the user. It computes a 256 point waveform table usable with either the simplified music interpreter or the advanced interpreter. This allows new waveform tables (i.e. timbres) to be generated by the user. This program runs in the basic KIM-1 memory.

The software package comes supplied on KIM-1 readable cassette stored in KIM and HYPER-TAPE format and includes a user manual. It requires a KIM-1, K-1000 power supply, cassette recorder (for loading only), speaker and K-1002 MTUDAC board to run. For the ADVANCED INTERPRETER and NOTRAN COMPILER it is recommended that 4K bytes of RAM be available.

K-1002-3C FOUR VOICE MUSIC SOFTWARE FOR ALL PETS: $20.00

This software program generates 4 voices simultaneously and is designed to run on all Commodore PET computers. It is a completely rewritten version of the K-1002-1 KIM-1 music software package. It allows the user to compose and/or playback songs with up to four part harmony. Each part may have a different tone color (waveform) and a six octave (C_0 to C_6) range is possible. Many of the run-time features of the NOTRAN music compiler interpreter have been incorporated while maintaining compatibility with the original 5 byte per event song table format as proposed by Hal Chamberlin in *Byte* magazine. A very powerful feature of the system utilizes a separate SEQUENCING TABLE which is used to control dynamic tempo, create or change waveforms, change voice assignments and the number of active voices, perform repeats, and call refrains. A Fourier series routine allows new waveform tables to be computed on the fly during natural pauses in the music as short as a fraction of a second. The software is supplied on PET cassette with several encoded songs. The user's manual gives complete instructions for coding song and sequencing tables and includes coding form masters. The music interpreter will function in 8K bytes. This software package was written by Dr. Frank Covitz, an active PET user and close associate of MTU.

K-1002-5C FOUR VOICE MUSIC SOFTWARE FOR AIM-65: $20.00

This is essentially the same as the K-1002-1C version for the KIM-1 except it has been reassembled and made compatable with the AIM-65. Memory allocation is such that the Simplified Music Interpreter and the Fourier Series program may be in memory at the same time making experimentation with different timbres easier. The NOTRAN compiler uses calls to the AIM I/O system so that NOTRAN source code in memory or on cassette can be compiled. The AIM editor may be used to prepare the NOTRAN source code. The package along with a demonstration song for each interpreter comes supplied on AIM-65 cassette with user manual.

K-1002-1ART ARTICLE REPRINT: $2.00

16 page reprint of Hal Chamberlin's September 1977 article in *Byte* which describes the synthesis techniques used in the simple 4 voice music software packages.

K-1002-6, 7, 8, 9 INSTRUMENT SYNTHESIS SOFTWARE

This is by far the most powerful and flexible real-time software music synthesis program ever implemented on a microcomputer. It is released as a "black box software synthesizer" for those familiar with music synthesis principles and hexadecimal coding. This package operates on the principles described in the April 1980 issue of *Byte* magazine as an article titled "Advanced Real-Time Music Synthesis Techniques Using a Digital-to-Analog Converter." However, many major improvements have been made to turn the concept into a usable product.

Fundamentally this system is similar to the MTU 4-voice software synthesis system. What has been added is the ability to specify an amplitude envelope for **EACH** harmonic in the tones used. Thus the overall amplitude and harmonic structure of the tone may vary during the duration of individual notes. This action closely mimics that of conventional musical instruments. When coded instrument specifications are based on published analyses of common musical instruments, the resulting sounds from this system still indeed closely resemble the analyzed instrument. To date, good simulations of banjo, acoustic guitar, tuba, clarinet, cello, and even bell-like tones have been obtained. The greatest power however comes from the ability to define original instrument sounds, and with the flexibility offered, quite a variety is possible.

In the instrument coding, harmonic amplitude envelopes are specified as piecewise linear approximations to the desired smooth curves. Any number of line segments may be used to define the envelope of a harmonic and different harmonics may be defined by a different number of line segments. By using segments of unity length, direct input of sampled analysis data is also possible. All of the routines needed to compute waveforms from instrument data are part of the music playing program and thus are always available. Another feature of the system is stereo capability using two K-1002 series DAC's. During performance, instruments may be assigned to either channel or changed at will.

The synthesis technique utilized by this system involves sequences of waveform tables where each waveform in the sequence differs slightly from its neighbor. When the differences are small and the sequence is rapid, there is no audible stepping between waveforms. Memory usage, however, is fairly high in order to hold all of the waveforms. For instruments of moderate complexity, 4K bytes is sufficient for a single instrument waveform set although both simpler and more complex ones are possible. Thus 16K is the minimum recommended amount of memory and 32K is desirable.

Songs are coded into two separate lists of bytes in memory called the Sequence String and the Note String. The Sequence String contains commands to compute instrument waveforms, set the tempo, assign the voices to left or right stereo channels, reallocate waveform memory, set the number of voices between 1 and 4 (to save memory in the Note String), set individual pitch offsets for each voice (allows on the spot transposition from one key to another), and play segments of the Note String. The Note String contains the actual note coding and consists of N+1 bytes per musical "event" where N is the number of voices. Each pitch byte has two extra bits which specify one of three possible attacks for the note or a sustain from the previous event. This allows proper articulation of complex, multi-part musical passages. Both of these strings of bytes may be coded by hand using a monitor or may be "assembled" by an assembler using .BYTE statements. The advantage of the latter is easier editing of the score and the ability to comment the score. A "macro assembler" is particularly effective and can be nearly as convenient as a specialized music editor and much more flexible. Also see the BOOK and article reprint listing on page 46.

K-1002-6C PET INSTRUMENT SYNTHESIS MUSIC SOFTWARE: $49.00

This program is supplied on PET cassette and is approximately 2.5K bytes long. Three sample songs and listings of a variety of instrument definitions are also supplied. The Interpreter is at $0400-0DF6 and song data starts at $0E00.

K-1002-7C KIM INSTRUMENT SYNTHESIS MUSIC SOFTWARE: $49.00

This program is the same as -6C above but supplied on KIM cassette with the interpreter at $2000-$29C4 and song data starts at $2A00.

K-1002-8C AIM INSTRUMENT SYNTHESIS MUSIC SOFTWARE: $49.00

This program is the same as -6C above but supplied on AIM cassette with the interpreter at $0200-$022D and $0400-0DC4 and song data starts at $0E00.

K-1002-9D APPLE II INSTRUMENT SYNTHESIS MUSIC SOFTWARE: $49.00

This program is the same as -6C above but supplied on APPLE II disk with the interpreter at $0800-$11D6 and song data starts at $1200.

K-1002-6DEMO AUDIO DEMONSTRATION CASSETTE: $5.00

Narrated stereo demonstration cassette with recordings of several songs using a variety of instrument definitions. This can be played with any audio cassette recorder, no computer needed.

K-1002-6ART ARTICLE REPRINT: $2.00

22 page reprint of Hal Chamberlin's April, 1980 article in *Byte* magazine which describes the synthesis techniques used in the MTU instrument synthesis software packages.

K-1005 CARD FILES AND MOTHERBOARDS

The K-1005 card file system was designed to answer the need for a compact quality mechanical support and electrical connection system for the KIM BUS family of microcomputers. The system consists of a card file frame, custom processor board mounting brackets, and two types of connector backplanes. This structure is that which MTU has adopted and will continue to support as **THE STANDARD** approach for the 6502 processor, just as the S-100 structure is for the Z-80.

The card file **BASIC FRAME** is "U" shaped and is constructed of black anodized aluminum with insulating plastic card guides for mechanical support of the cards. It holds up to five boards inside the frame. The bottom of the "U" has cutouts at the "Expansion" and "Application" positions of KIM, SYM and AIM processor boards. This allows mounting individual connectors or the K-1005 series of motherboards with connectors. The top and bottom edges of the frame are bent in ½ inch and contain holes for mounting to adjacent surfaces. The frame mechanical dimensions are: 11.25 inches wide, 4.75 inches high, and 8.5 inches deep (less motherboards). The frame is designed for cards 11.0" wide and any depth up to 8.5". The basic MTU card depths are 5" and 7.5". All direct bus interface cards listed in this catalog fit these dimensions.

The **K-1005-2K BRACKET** mounts the KIM-1 or SYM-1 processor in the top slot of the card file to allow access to the keyboard. Users may have some difficulty accessing all the connectors on the SYM-1 when mounted in the frame, but it is possible. The **K-1005-2A BRACKET SET** extends the card file depth to mount the AIM-65 on top of the card file frame by plugging into a motherboard (mandatory) and screw mounting to the two bracket set at the back. The AIM keyboard is mounted by the brackets at an 11.5 degree angle (standard typewriter keyboard angle) and is positioned in front of the AIM display, opposite the motherboard side. There are 5 slots in the AIM card file, with 4 serviced by the motherboard.

The **BUS MOTHERBOARD** is a double sided, plated through hole, glass epoxy printed circuit board. It is assembled with five connectors which are parallel wired or it can be purchased for custom uses and modification. The signals are bus connected on the "inside" with the outside covered with ground plane copper to shunt noise. The topmost connector plugs on to the processor EXPANSION CONNECTOR fingers. This connector does not have lines running to all the pins (left out are: 2, 3, 16, 17, 18, 19, 20, X) because MTU boards use some of these pins for power and expanded 18 bit address bus, while the different processors use them for different functions not pertaining to bus operation. There is no buffering on the motherboard, thus, it draws no power. The short bus and proper attention to shielding and grounding allows the full 4 low power Schottky load capability of the processor-bus to be realized. A five screw terminal strip on the motherboard provides power connections to the processor (GND, +5 and +12 volts regulated) and expansion boards (+7.5 and +16 volts unregulated). The board size is 3.8" high by 5.1" wide by 1.0" deep. The connectors are 0.156 inch contact spacing, 44 pin double sided, gold contact surfaces

For a system to be flexible for most any desired task, it is necessary to allow customization. This coupled with the need to bring signals outside the computer "box" was the driving force for the development of the **APPLICATION MOTHERBOARD.** It provides a one piece mounting for up to 5 application edge connectors and four standard 24 pin dip sockets for interfacing. The assembled board uses printed circuit tab connectors and sockets for solder wiring of custom connections. By using the bare board, User supplied Wire Wrap connectors may be installed if preferred. The printed wiring is solid ground plane only, no wire interconnects between connector pins. Thus, 5 expansion boards can mate with the motherboard to interchange signals and 96 signals can be brought to the outside world through 24 pin ribbon cables. The edge of the board extends beyond the edge of the card file to allow room for the I/O cables to plug into the I/O sockets. The standard 24 pin DIP socket was chosen because of the easy availability of mating ribbon cables with 24 pin plugs.

K-1005 FRAME: $25.00
K-1005-2K BRACKET: $15.00
K-1005-2A AIM-65 BRACKET: $25.00
K-1005-3 BUS MOTHERBOARD: $40 or **K-1005-3B (BARE PC board) $12.50**
K-1005-4 APPLICATION MOTHERBOARD: $29 or **K-1005-4B** (bare PC board) $8.00
K-1005-K KIM ASSEMBLED CARD FILE: $75.00 (K-1005, K-1005-2K, K-1005-3)
K-1005-S SYM ASSEMBLED CARD FILE: $75.00 (K-1005, K-1005-2K, K-1005-3)
K-1005-P PET ASSEMBLED CARD FILE: $75.00 (K-1005, K-1005-2K, K-1005-3)
K-1005-A AIM ASSEMBLED CARD FILE: $85.00 (K-1005, K-1005-2A, K-1005-3)

K-1007 SERIES PET TO MTU BUS INTERFACES

The K-1007 series of interfaces are designed to allow all MTU bus interface products to work with all present Commodore PET computers. The series presently contains 3 boards explained below. SEE ALSO K-1008-6 PET GRAPHIC INTERFACE which performs the K-1007-1 function.

K-1007-1 PET TO MTU INTERFACE BOARD: $78.00 K-1007-1M $10.00

The K-1007-1 converts the PET memory expansion port into a buffered bus that is in turn compatible with the 6502 industry standard KIM BUS serviced by the MTU K-1005 card file system. It can be used in place of the K-1008-6 PET Graphic Interface Board if MTU expansion is desired that is totally compatible with the KIM BUS. For instance, if you have a PET and an AIM-65, you may wish to use the K-1008 Visible Memory for graphics instead of the K-1008-6 since the K-1008 can be used also by the AIM-65. Then you would need the K-1007 series interface for the PET (the K-1008-6 includes interface circuitry onboard).

The K-1007-1 is a 6" by 6" printed circuit board with a 12" ribbon cable and contains all the electronic interface components: power supply, sync processor circuitry, video switcher between PET and the K-1008-P Visible Memory, and address combination logic to re-encode the upper 4 address bits into KIM BUS standard form. The board has connector **HOLES** to mount a single 22/24 position .156 spacing connector to accept any single MTU expansion bus board. The connector mounts the expansion board perpendicular to the K-1007-1 board. A set of gold plated edge fingers are provided which can be used to mate with the K-1005-P card file for up to 4 board expansion (which can be powered by the power supply on the K-1007-1 through the PET). The single connection to the board is by the 12" long 60 wire ribbon cable supplied which is pluggable on both ends. This cable mates with either the K-1007-2 or K-1007-3 connector board, depending on what type of PET you have. This allows the basic K-1007-1 board to work with either old, new, or possibly future PETS.

The board utilizes PET low voltage AC to provide +8 and +16 volts unregulated to the expansion boards. The video sync processor controls include horizontal position, vertical position, and height to center the Visible Memory image on the PET screen. The video switch selects PET video after reset or if memory location BFFE is accessed, and selects the Visible Memory image if location BFFF is accessed. PET addresses from 2000 through 7FFF and 9000 through AFFF are encoded into a contiguous range from 2000 through 9FFF. PET addresses from B000 through BFFF are translated to F000 through FFFF. The board comes with the K-1007M manual containing installation instructions, principles of operation, connector pinouts and schematic diagrams for the K-1007-1, -2, and -3 boards.

K-1007-2 PET-2001 CONNECTOR BOARD: $35.00

This board has an 80 pin PC edge connector which plugs onto the PET memory expansion **EDGE FINGERS** (distinguishing mechanical feature of the OLD PET). The board mounts parallel to and in the same plane as the PET main logic board. In addition it has a connector to accept the PET CRT monitor cable (6 wires), a 6 wire cable with plug to mate with the PET main logic board video connector, 3 wires to solder or clip (clips not supplied) to the PET main logic board for power, and a 60 pin ribbon cable connector to mate with the K-1007-1 or K-1008-6 cable. The PET memory expansion edge fingers are recreated on the opposite side of the board from the 80 pin connector. The board is 2 ½" wide and protrudes from the PET case.

K-1007-3 16/32K PET CONNECTOR BOARD: $59.00, $65.00 as of March 1, 1981

This board mates with the "new" 16/32K and CBM PETs (this version of PET has the two 50 pin ribbon cable connectors mounted 0.200 inch apart in the same horizontal line for the memory expansion port). The board has 2 connectors which mate with the PET memory expansion port connectors, a connector (6 pins) to accept the PET CRT monitor cable plug (6 wires), a cable with plug to mate with the PET main logic board video connector, 3 wires to solder or clip (clips not supplied) to the PET main logic board for power, and a 60 wire ribbon cable connector to mate with the K-1007-1 or K-1008-6 cable. In addition, open holes (signals prewired in PC) are provided on the board to mount two 50 pin ribbon cable connector "straight headers" which recreate the PET memory expansion port. These connectors are mounted 0.500 inch apart (not 0.200 inch as in the PET) so they may accept individual ribbon cables for mounting to competitors PET expansion products. This board plugs in perpendicular to the PET main logic board and is completely enclosed in the PET case.

K-1008 VISIBLE MEMORY BOARD

This board is an 8K memory add-on to All KIM BUS systems which includes the circuitry to simultaneously display the memory contents as 64,000 dots on a TV monitor. Unlike many other add-on boards, this one is designed specifically for the KIM-BUS, to be connected in parallel with the expansion connector (some pins are not bussed). There are no wait states, and no software overhead or CPU time required to refresh the display as logic on-board automatically refreshes it. There is no snow or other visible interference on the screen when the display memory is being accessed by the processor (or any other time).

Addressing of the memory for display purposes is easily accomplished. Each row of dots is composed of 40 bytes (40X8=320 dots), with the topmost row and leftmost byte being the home position on the display. The second dot row starts with the 41st byte through the 80th byte, and so on for a total of 200 dot lines. Problems experienced with dynamic memory in other systems are absent in this board due to the superior bus control architecture of the 6502 processor and MTU advanced circuit design. The circuitry that generates the display pattern also refreshes the memory automatically as it scans. The display scanning frequencies are derived from the 1MHz 6502 clock and are: Horizontal—15,625 Hz, Vertical—60.1 Hz. The user supplied CRT display requires a video bandwidth of 4 MHz. The video output is 1.25Vp-p composite video into 75 ohms, sync negative with non-interlace operation. The only adjustment on the board is the dot sync potentiometer which comes prealigned on assembled units.

The memory starting address can be jumper selected at any 8K boundary with the 8K memory block contiguous from the selected address. An extra jumper selectively disables the top or bottom half of the display thus allowing 4K to be used for program storage without showing up as a random pattern on the screen. The "Decode Enable" and "K7" signals needed for the KIM-1 to expand beyond 4K memory are generated by the board and need simply be connected to the proper pins of the KIM application connector. These signals are not used on the SYM, AIM, or MTU processors. Up to four Visible Memory boards may be connected directly to an unbuffered KIM-bus (12 have been connected).

K-1008 Visible Memory Board: $240.00 K-1008M $10.00

The board comes with the K-1008M manual containing complete hardware schematics, principles of operation, timing diagram, programming instructions, and troubleshooting guide. All integrated circuits are socketed on the board. The dimensions are 5" high by 11" wide exclusive of the gold plated edge fingers. The power requirements are: unregulated +7.5V @ .25 amp, and +16V @ .25 amp (-5V for the memory chips is generated on board). ALSO SEE: Application notes AN-2 and AN-3.

K-1008-P PET VISIBLE MEMORY: $243.00

This version of the Visible Memory for the PET computer series is the same as the standard K-1008 with the addition of three wires for separate video, horizontal and vertical sync signals used by the K-1007-1 PET Interface board. It comes supplied with the K-1008M manual.

K-1008-6 INTEGRATED VISIBLE MEMORY FOR PET

This board is the newest member of our series of high resolution graphics products for PET and CBM computers. It offers the PET user full control over a 320 by 200 dot matrix on the display. Additionally, the K-1008-6 can be used as an 8K RAM board (when the graphics are not in use). Several valuable new features are: 4 types of video images, 5 bank switchable ROM sockets, a bank switchable KIM-BUS for external bus expansion, and light pen registers (optional). The board is designed to fit INSIDE the PET cabinet for maximum protection and portability or mount into an MTU K-1005-P card file for further system expansion and performance enhancements. Connection from the board to the PET is through a 12" ribbon cable which mates with an MTU connector board model K-1007-2 for the old style PETs or a K-1007-3 for the new style PET or CBM, thus allowing operation with either style of PET.

The 4 video image types allow software selection of screen blank, PET video, Visible Memory video, or BOTH videos to appear on the screen at any time. The 5 ROM sockets permit holding ROM based software such as Commodore's word processor, the MacroTea, Programmer's Toolkit, and others ALL AT THE SAME TIME under software selection of which one(s) will answer to the bus addresses. The light pen register option latches the X and Y screen position when triggered by an external logic signal. Finally, the board generates the KIM expansion bus at its edge fingers for simple interfacing to all MTU KIM/SYM/AIM bus interface boards including our K-1013 disk controller. When using the KIM expansion bus capability, the board should be plugged into a K-1005-P card file which then gives the user 4 additional bus expansion positions for external expansion. The on-board power supply, which is driven by AC and unregulated DC from the PET's transformer, has sufficient power to drive several MTU standard bus interface boards.

K-1008-6 INTEGRATED VISIBLE MEMORY FOR PET cont'd

MTU has taken a unique approach to solving the address space saturation problem that occurs when expanding PET's that already have 32K of memory or where the user wishes to use ROM software that reside at the same addresses. The multiple board functions are actually divided into eight "devices" which are Visible Memory upper 4K, Visible Memory lower 4K, each of 5 ROM sockets, and the external KIM bus. Each of these devices may be independently addressed on 4K boundaries by means of jumpers. A separate software controlled Enable Register determines which "devices" are active at a particular time. By enabling devices only when needed, it is possible to have more than one assigned to the *same* 4K block. This is particularly beneficial when using the ROM sockets because ROM's from different sources that must reside in the same address block can be in the system simultaneously. There is even a jumper selectable default enable configuration that restores the system to a "standard" configuration after power up or reset activation.

The board dimensions are 11" wide by 8.5" deep by 1" thick exclusive of edge fingers (and mounting bracket). The RAM memory chips used are the 22 pin 4K dynamic type. The ROM sockets are designed to accept the 4K byte masked ROM types as used in the newer PET's which is a 2332 pinout. The light pen input is an active-low schmidt trigger with a 27K ohm pullup resistor to +5.

K-1008-6 INTEGRATED VISIBLE MEMORY FOR PET: $320.00, $359.00 as of March 1, 1981,
K-1008-6M $10

This product includes the assembled and tested board, a 12" 60 wire ribbon cable, the K-1008-6M user's manual containing use instructions, technical description, schematic, and a diagnostic program listing. Not included are the mounting brackets for internal mounting, PET connector board (K-1007-2, or -3) or light pen option circuits or pen.

K-1008-3, -5, -7 GRAPHICS/TEXT SOFTWARE

This software package for the K-1008 Visible Memory is designed to provide the user with a library of utility graphic and text display oriented subroutines written in assembly language. By incorporating calls to these routines, the assembly language user can create and manipulate text and graphic images whose complexity is limited only by the 320 by 200 display matrix size. Most routines operate on X and Y coordinate arguments. In addition to the subroutine library, two assembly language demonstration programs are provided.

GRAPHIC FUNCTIONS: Point plotting functions available in the package are Set Pixel, Clear Pixel, Flip Pixel, Write accumulator contents to Pixel, and Load Pixel contents to accumulator. The Pixel location is specified by double-precision X and Y coordinates stored in Page 0 locations.

Line drawing functions available are draw line from X1:Y1 to X2:Y2 by turning the points on (white lines), by turning them off (black lines) or by flipping their previous state (exclusive-or function). The flip function will leave the state of the display unchanged (upon completion) if the same image is drawn twice. This allows the user to "move" an image through the display and leave the background unchanged. The total graphic routines require 500 bytes of memory.

TEXT FUNCTIONS: The DCHAR routine is a software character generator. The character images have been carefully chosen for maximum legibility. The main character matrix is 5X7 and with descenders on the lower case characters the effective matrix is 5X9. The character code is full ASCII. When called, DCHAR writes the indicated image with its upper left corner at the X1:Y1 coordinate.

The DTEXT routine accepts ASCII characters and formats them into text. It interprets ASCII control codes Carriage Return, Line Feed, Backspace, DC1-DC4 (cursor movement), and SI/SO (baseline shift for sub/superscript). Text entry starts at the X1:Y1 coordinate which is updated following each call. An underline cursor is provided at the current location. The format is a 5X9 character matrix in a 6X11 field providing 18 lines of 53 characters. The sub/superscript operation is allowed on the full character set. The ability to set margins (top, bottom, left, right) allows windowing to be done with text scrolling occurring only in the window, not in the outside area. Including the DCHAR subroutine, DTEXT with all features requires 2500 bytes of storage.

The SDTXT routine is a simplified version of DTEXT requiring only 1200 bytes with lower case, and 1000 bytes without. It interprets the ASCII control codes for Carriage Return, Line Feed, Backspace, Forms Feed, and provides the underline cursor at the current location. SDTXT uses line number and character column as its method of addressing instead of X1:Y1 coordinates. The font is a 5X7 matrix of upper case in a 6X9 field providing 22 lines of 53 characters. The lower case alpha characters are smaller versions of their upper case counterparts.

DEMONSTRATION PROGRAMS: Two machine language demonstrations are provided. LIFE Implements the game of Life in the full 320 by 200 matrix. An initial colony is provided or the processor keyboard may be used to set the initial colony pattern and control evolution of the generations. SWIRL produces an infinite variety of patterns under the control of two parameters. It uses a simple difference equation algorithm.

K-1008-3, -5, -7, GRAPHICS/TEXT SOFTWARE cont'd

BASIC INTERFACE: Positioning on the display is done in terms of X and Y coordinates. X can vary from 0 to 319 and Y can vary from 0 to 199. Position 0,0 is at the bottom left position of the screen. Four graphic variables called X1%, Y1%, X2%, and Y2% are set up at the beginning of the program using a BASIC statement. A point may then be plotted anywhere on the screen by assigning the desired coordinates to X1% and Y1% and then executing the statement "Z=USR(1)". A line may be plotted from X1%, Y1% to X2%, Y2% merely by assigning coordinates and executing "Z=USR(2)". Other plotting functions available as USR commands are erase point, erase line, clear screen, and read the state of a point.

Text printed by BASIC PRINT statements may be placed wherever desired for axis labelling, etc. Text cursor control functions available with USR statements allow set and clear functions to be performed. Pokes into the cursor position bytes may be used for direct cursor positioning. Text can be displayed as full upper and lower case (using small caps for lower case—SDTXT) in a 5X7 matrix and gives a screen capacity of 22 lines of 53 characters each. All coordinates and cursor locations are verified and corrected if necessary thus giving fail-safe entry and execution of commands. Plotting and character generation speed is such that less than 10% of the execution time of a typical program is spent creating the display.

K-1008-3C PET GRAPHICS/TEXT SOFTWARE WITH BASIC INTERFACE: $25.00

This software package includes the GRAPHIC and TEXT assembly language routines as described on the previous page and a different BASIC interface routine for PET. The BASIC interface uses GOSUB statements callable from PET BASIC preceeded by variable quantities input. For instance, to plot a line, the user would enter the following statements in the program:

```
GM%=1      :REM 0=FLIP, 1=ON, 2=OFF
X1=A       :REM where A, B is the coordinates of the beginning endpoint
Y1=B
X2=C       :REM and C, D is the coordinates of the ending endpoint
Y2=D
GOSUB   106
```

The TEXT DISPLAY routine displays upper case in a 5X7 matrix and gives a screen capacity of 22 lines of 53 characters each. Failsafe operation from invalid X and Y values can be accomplished by the user either through BASIC checking or modification of the assembly language program (both given in the manual). Plotting and character generation speed is such that less than 20% of the execution time of a typical program is spent creating the display.

Using the package requires an 8K PET or larger, the appropriate PET connector board (K-1007-2, or K-1007-3) and a K-1008-P VISIBLE MEMORY with K-1007-1 PET interface. The package may also be used with a K-1008-6 PET Integrated Visible Memory with slight modifications to the software, instructions are included in the manual. The graphics routines require only 1K bytes of memory. The text routines, if used, require an additional 1K. A relocation program is supplied to load the machine language routines for different PET memory sizes and for "OLD" or "NEW" PET ROMs. The primary use for this package is with 4K or 8K PET's or where the graphics software overhead must be minimized. The package is supplied on cassette in PET format as assembled object code with a user manual describing use of the functions.

K-1008-5C AIM-65 GRAPHICS/TEXT SOFTWARE: $25.00 (ALSO SEE K-1008-5CS PAGE 38)

This software package is a combination of the TEXT/GRAPHICS and BASIC INTERFACE packages described on the previous page, configured for the AIM-65. The BASIC interface contains the graphic routines embedded and comes assembled for a minimum 4K AIM (BASO4) and for a 4K AIM expanded with 16K (MTU K-1032-2) to a total of 20K (BAS20). The BASIC interface requires 2.5K of RAM and requires the AIM BASIC ROMs to function. Hooks have been provided for easy addition of the MTU GRAPHICS/TEXT PRINT package (K-1009-1C) to allow printing of the graphic and/or text images formed.

With use of this package, all text output from BASIC and from the AIM monitor appears on the Visible Memory screen (using the DTEXT routine) **instead** of the AIM 20 character display. In addition, the package includes the full GRAPHICS, DTEXT and SDTXT subroutines separately assembled for use by assembly language programmers. The programs require 1.2K byte for SDTXT, 2K byte for DTEXT, and .6K byte for the GRAPHIC package. The SWIRL and LIFE demonstration programs provided are self-contained and may be run on a 2K AIM.

The package is supplied on cassette in AIM-65 readable object code form with a user's manual containing full explanation of the commands and critical address locations of the subroutines. To use the package requires an AIM-65 with 4K, K-1000-5 power supply, K-1008 Visible Memory board, and a K-1005-A card file. Also the AIM BASIC ROMs if the BASIC interface is used.

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K-1008-5CS AIM-65 GRAPHIC/TEXT SOFTWARE SOURCE CODE IN ASSEMBLABLE FORM
$40.00

This product is the K-1008-5 source code on cassette, stored in a format acceptable to the AIM-65 ROM assembler. This allows an assembly language programmer to easily incorporate the software into application programs. The package includes the code for SDTXT, DTEXT, and the graphics routines. The BASIC interface and demonstration programs are not available on the cassette. Additionally, the full commented source listings are supplied (a total of 107 program pages). A 20K AIM is necessary to assemble or edit the source. To run the package requires the same hardware as the K-1008-5C software and additionally the AIM assembler ROM. Purchase of this product requires signing an individual use license agreement prior to receiving the package. prior to receiving the package.

K-1008-7C KIM-1 GRAPHIC/TEXT SOFTWARE: $27.00

This package is the GRAPHIC/TEXT subroutines and BASIC INTERFACE subroutines described on earlier pages assembled for the KIM-1 single board computer. It is a combination of previous MTU products K-1008-1C (GRAPHIC/TEXT ROUTINES) and K-1008-2C (PATCHES TO MICROSOFT BASIC Johnson Computer early version).

In addition to the display handling routines, two keyboard routines are provided. These are greatly enhanced routines that allow full user control of program execution and text printing. They also allow effective use of upper **AND LOWER** case characters with BASIC. One keyboard routine allows the use of an inexpensive unencoded keyboard (construction article reprint included) while the other supports an ASCII encoded upper and lower case keyboard. The routines use the Visible Memory both for textual communication with BASIC (22 lines by 53 characters) and as a graphics display device.

The GRAPHICS/TEXT portion of the package requires the following hardware to run: a KIM-1, K-1008 Visible Memory board, K-1000 power supply, a CRT composite video monitor, and a K-1005-K card file. In addition, if the BASIC INTERFACE routines are used, a keyboard and a K-1032-2 16K or K-1032-1 32K memory board will be necessary. Required software other than this package is the Microsoft 9 Digit BASIC assembled at location 2000 AND NOT EXTENDING BEYOND LOCATION 4260. This is available from Johnson Computer (Box 523, Medina, OH 44256) and was sold as their early version of KIM-1 BASIC. Later versions of their BASIC will not run with this package due to additional memory requirements on Johnson's part.

The SWIRL and LIFE demonstration programs reside in the standard KIM-1 1K byte RAM and assume that the Visible Memory resides at location 2000 (may be easily changed). Included with the BASIC INTERFACE routine is an instructive BASIC demonstration program as an example of how to use the package with BASIC.

Memory requirements are: for Microsoft BASIC locations 2000-4260, the BASIC INTERFACE routines locations 4261-49D7. For the TEXT/GRAPHIC subroutines: SDTXT 5B00-5FC0, DTEXT and all graphics routines 5500-5F75, keyboard routines locations 0200-03E1 for the unencoded keyboard and 0200-02BC for an ASCII encoded keyboard. Page zero locations E3-FF are used by the graphics and text routines. The package is supplied on cassette as assembled object code with the subroutines recorded in HYPERTAPE and in standard KIM-1 format. The documentation supplied is the full printed source code listing along with usage instructions.

KEYWORD GRAPHICS SOFTWARE

The Keyword Graphics Software is the newest MTU 6502 machine language graphics program. It extends the command repertoire of BASIC to include over 40 graphics commands for the Visible Memory. Besides being much easier to use and understand than previous software packages for the Visible Memory, it is much faster since manipulation of the 64,000 picture elements in the display is done at machine language speed.

For example, if a solid vector between the coordinates 35,21 and 117,73 is desired, the BASIC statement:

```
130 LINE 35,21,117,73
```

should be inserted into the user's program, or by omitting the line number 130, the vector would be drawn as soon as the command was typed in. A caption located at X=220 and Y=123 could be generated simply by coding:

```
710 MOVE 220,123
720 CHAR "MARKET INDEX"
```

In addition the package provides some powerful advanced functions not found in other graphics packages such as automatic coordinate transformation (both translation and scaling), solid or dotted lines, keeping track of up to 4 different **DISPLAY WINDOWS** and subimage definitions (shape table) which can be used to create special characters or other shapes used repetitively.

The package works by making a patch in the page zero area of BASIC which diverts all characters entered by the user or read from memory to the Keyword Graphics Software first. If a graphics command is recognized, it is executed and if not, the characters are passed on to BASIC for interpretation. The graphics commands added are listed below:

PETMEM[1]	RDGM	NOCHK	OFFSET	TEXCSR	RDDLOC
VISMEM[1]	CLEAR	WRPIX	SCALE	RDCSR	RDTLOC
PVMEM[1]	SCLEAR	RDPIX	CHAR	RDXY	CHINIT
NOMEM[1]	WCLEAR	LINE	AUTEXT	GRSHRT	CHDFC
NRMDSP	SCFLIP	MOVE	CHSCALE	VMPAGE	CHBLD
RVSDSP	SETWIN	DRAW	CHROT	GKILL	CSETUP
FLPDSP	WINDOW	DOTL	SCROLL	CHDLOC	CHRESET
GMODE	BNDCHK	XFFLG	GRACSR	CHTLOC	QKPRNT[2]
					QLPRNT[2]

NOTE 1: PET version only, K-1008-8, 10
2: AIM-65 version only, K-1008-9

In addition to drawing figures by using the above commands with BASIC, a "shape interpreter" routine is included in the package. The shape interpreter looks at coded "shape definitions" in memory and will draw the complete shape anywhere on the screen at machine language speed with only one BASIC statement. In fact, the standard set of ASCII characters supplied with the package are actually predefined shapes and are drawn by the shape interpreter. Two types of drawing instructions are recognized by the shape interpreter. **VECTORBYTE** instructions may, in a single byte, specify drawing (or move without drawing) of a line segment in any of 8 different directions with a length of 0 to 14 coordinate units. Relative Move/Draw instructions allow drawing lines in any direction up to 128 coordinate units long with 3 bytes per vector. A "subshape" facility even allows a shape definition to call upon another shape definition to form the repetitive portions of a shape. A shape scale factor even allows the shapes to be drawn larger or smaller (in powers of 2 increments) than the definitions specify. Five hundred bytes are available for user shape definitions inside the graphics package and more are available in the user's own memory.

K-1008-8C 16/32K PET KEYWORD GRAPHICS SOFTWARE: $49.00

This program is supplied on PET compatible cassette for 2.0 ROMs. Three versions are included, from 2200-3FFF, 4200-5FFF, and 6200-7FFF for 16K, 24K, and 32K PET's respectively. This package **is** compatible with Commodore's DOS support program and the Programmer's Toolkit.

K-1008-9C AIM-65 KEYWORD GRAPHICS SOFTWARE: $49.00

This program is supplied on AIM compatible cassette. It requires approximately 8K and is intended to occupy the upper 8K portion of a 20K AIM.

K-1008-10C 2001 PET KEYWORD GRAPHICS SOFTWARE: $49.00

This program is supplied on PET compatible cassette for 1.0 ROMs. Three versions are included, from 2200-3FFF, 4200-5FFF, and 6200-7FFF for 16K, 24K, and 32K PET's respectively.

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K-1009-1C AIM-65 TEXT/GRAPHICS PRINTOUT SOFTWARE

The most unique feature of the Rockwell AIM-65 microcomputer is its built-in printer. The most unique feature of the AIM-65 printer is that it is software controlled and therefore capable of any print format desired. With this breakthrough software package the AIM-65 user can now print high resolution graphics images and 60 characters (up to 127) per line of text with **NO** modification to the AIM or its printer.

The screen print routines will print an exact image of the Visible Memory graphics display screen as a 320 wide by 200 high dot matrix on the AIM-65 printer. The user need only load the page address number of the Visible Memory into the accumulator and then jump to the screen print program for a fast, accurate printout. The program operates either in a **QUICK PRINT** mode in which the entire 320 X 200 image is printed in one piece or in a **QUALITY PRINT** mode in which the image is printed as two strips of 320 X 100 which can be taped together for a complete, properly proportioned image. The K-1008-5C software package is recommended for creating the graphics image which may also contain text. Any contiguous 8K block of memory may be used to hold the image although we suggest a Visible Memory for previewing the image on a video monitor. The program requires 800 bytes of RAM and is supplied assembled in 4 different locations (0CD8-0FFF, 0456-0771, 4456-4771, and 0366-0681). To perform screen print requires an AIM-65 with a minimum of 2K byte of RAM, a K-1000-5 power supply, and a K-1008 or other 8K of contiguous memory to hold the image.

The **TEXT PRINT** routine prints the contents of the AIM-65 Text Editor text buffer as full 60 character lines. The text is printed sideways as strips of 10 lines with up to 127 characters per line (the AIM EDITOR only allows 60 to be manipulated). This makes program listings very easy to read and even allows word processing to be done on the AIM. The full 96 character ASCII font with lower case descenders is supported (the AIM Text Editor does not allow use of lower case characters). The program requires 1.5K bytes of RAM which includes the character generator images and is supplied assembled in two different locations (0200-07FB, and 0A04-0FFF). To perform text print requires only an AIM-65 with a minimum of 3K byte of RAM, and a K-1000-5 power supply.

K-1009-1C AIM-65 TEXT/GRAPHICS PRINTOUT SOFTWARE: $25.00, $35.00 as of March 1, 1981.

This software is supplied as a cassette tape, recorded in AIM-65 readable format containing the 4 screen print and 2 text print programs as binary memory dumps. In addition, a user's manual is supplied containing use instructions and theory of operation. This breakthrough software package is a tremendous enhancement to the AIM-65. The package is copyrighted and is considered proprietary. If you wish to use the package in systems intended for resale please contact MTU regarding license arrangements.

K-1012 PROM-I/O SYSTEM EXPANSION BOARD

This system oriented expansion board converts the KIM BUS processors into powerful yet easy to use turn-key systems. Functions included on the board are low power PROM storage, four 8 bit parallel I/O ports, a UART controlled serial communications port, and a PROM programmer. Each of the 12 PROM sockets may be individually jumpered for 2708 or 2716 (multi-voltage type) operation for any mix of the two types. Four 8 bit parallel input/output ports with full handshaking and interrupt capability as well as a UART controlled full RS-232 serial communications port allow quick systems expansion. This board may be connected directly to any KIM BUS system with no modification and no external interface circuitry required. Special signals required by the KIM-1 when memory is expanded beyond 4K (Decode Enable and K7) are generated on board.

Although standard and available 2708 and 2716 (multivoltage type) PROM's are utilized, the K-1012 continues the MTU tradition of low power consumption and operation from standard KIM-1 power supply voltages. Because the PROM's require -5 volts, it is supplied onboard by a high efficiency inverter circuit. A unique power down circuit for each PROM disconnects its power when not accessed for longer than one microsecond. Because only one PROM can be accessed at a time, the total power consumption for twelve PROMs is scarcely more than that for one.

Parallel input/output is expanded to an additional 32 lines through the use of two 6520 PIA circuits. Each of the 32 lines is individually programmable as input or output. In addition, 4 pairs of handshaking control lines are available for positive verification of data transfer to and from external devices or additional I/O functions. Also 4 independently maskable interrupts, each associated with 8 I/O lines and one pair of handshaking lines, are included. This interrupt capability is fully compatible with the KIM, SYM, and AIM monitors or may be disabled with jumpers.

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K-1012 PROM-I/O SYSTEM EXPANSION BOARD cont'd

Serial input/output is provided by a type 6850 Asynchronous Communications Interface Adapter. True RS-232 with proper positive and negative output voltages is the interface method with all of the important modem control signals provided. Full maskable interrupt operation for transmitted data, received data, and modem control is provided. Standard baud rates from 75 to 4800 may be selected by plugable jumpers or user supplied dipswitch. Simultaneous transmit and receive is easily programmed for use in communications networks.

A PROM programmer with jumpers for 2708 or 2716 (multi-voltage type) operation is provided as a standard feature. This socket in conjunction with two of the parallel ports (connections onboard) provides programming and verification functions. The parallel ports may be used for I/O when not actually programming a PROM. Again following MTU tradition, an on-board inverter supplies the +26 volts needed for PROM programming.

The power requirements (with all PROM sockets full) are unregulated +7.5 volts .35 amp, and +16 volts .25 amp typical (.35 amp peak during programming). Addressing of the board requires that 8K of PROM must be contiguous on an 8K address boundary, the remaining 4K may be scattered in a second 8K block. Either or both PROM blocks may also be disabled by a jumper change thus removing it from the address space if required. I/O requires 16 contiguous addresses in the next to last page or last page of any 4K block. Sockets are provided for all address jumpers. The board is supplied with a manual containing detailed principles of operation, complete schematic, parts list, layout and loopback diagnostic and PROM programmer program listings. PROM's are not included. Also see APPLICATION NOTE AN-4 for use of the new 5 volt EPROM's with this board.

K-1012 PROM-I/O SYSTEM BOARD: $295.00 K-1012M $10.00

The full assembly of the board described above.

K-1012-1 LOW POWER PROM ONLY BOARD: $165.00

This version of the board has only the PROM and addressing sections assembled. Its creation came about from market requests for a board to allow super low power firmware (PROMs or ROMs) operation. It comes with the K-1012M manual.

K-1013 16K RAM FLOPPY DISK CONTROLLER HARDWARE BOARD

This floppy disk controller board has all of the features that should exist for a disk controller including standard or mini-floppy operation, single or double density, single or double sided, up to 4 drives with simultaneous seek, 16K of on-board memory, initial program load ROM for 8" drive turn-key systems, and of course complete KIM-BUS compatibility in the MTU tradition. The board does not allow simultaneous use of 8" and 5 ¼" drives due to frequency differences. The controller is sold with a diskette containing CODOS, our powerful Disk Operating System.

The K-1013 Disk Controller was designed from the ground up for speed and reliability in data transfer operations. The design is based around the NEC UPD765 disk controller chip. Disk data transfers are done via direct memory access to the on-board memory without program intervention. The board allows simultaneous head seek capability which greatly speeds up disk intensive software (CODOS 1.0 does not presently use this function). Using the disk operating system, software (CODOS 1.0 does not presently use this function). Using the disk operating system, a 24K program can be located and loaded in 3 seconds. The board uses a phase locked loop data separator which allows double density recording without loss of data accuracy. With specialized programs, an average data transfer rate of over 40K bytes per second can be sustained for an indefinite period by swapping diskettes in two standard 8 inch disk drives.

The eight 4116 dynamic RAM memory chips gives 16K of on-board read/write memory which is split into two 8K blocks, independently addressable on any 4K boundary. One block is available for user program storage, data, etc. The other 8K block can be write protected (under software control) and is normally used to hold the disk operating system software and disk data buffers. Only 7.75K is actually RAM; the remainder is shadowed by the 256 byte IPL ROM and I/O addresses for the controller chip. Memory refresh and direct memory access cycles are totally transparent to the 6502 microprocessor and **DO NOT** cause wait states.

The board is designed with a 50 pin ribbon cable header which is pin/wire compatible with the Shugart model SA800 or SA850 8" floppy disk drives. Others including all 5 ¼" drives require cabling change and possibly slight K-1013 modifications. Timing changes for the lower data frequency needed by the 5 ¼" drives are made to the K-1013 by jumper options.

Power requirements are +8 volts unregulated 600MA and +16 volts unregulated 125MA. The board physical dimensions are 7½" high by 11" wide exclusive of edge fingers which fits the MTU K-1005 series of card files. A maximum of 1 LS TTL load is presented to the bus on all address and data bus lines. The board is designed to operate with a PHASE 2 clock frequency of 1.0mHz, crystal controlled as provided by all KIM, SYM, AIM, and PET computers.

Each disk controller package includes the assembled and tested board, a hardware manual containing installation instructions, principles of operation, schematic, and a diskette (8") with a disk diagnostic program and CODOS. Not included in the K-1013 packages are disk drives, disk drive power supply, or a cable from the controller to the disk (Uses 50 pin ribbon cable with normal ribbon cable connector on one end and 50 pin edge connector on the other end).

K-1014-1 CABLE ONE DISK DRIVE CABLE SET: $59.00

The signal cable is a flat cable assembly with a K-1013 compatible connector on one end and one Shugart compatible disk drive connector on the other end. Total length is 5 feet. The AC and DC power cables are 2 feet long. Each power cable has a Shugart compatible connector on one end and is stripped and tinned on the other end.

K-1014-2 CABLE TWO DISK DRIVE CABLE SET: $89.00

The signal cable is a flat cable assembly with a K-1013 compatible connector on one end and two Shugart compatible disk drive connectors on the other end, separated by 8". Total length is 5 feet. The 2 AC and DC power cables are 2 feet long. Each power cable has a Shugart compatible connector on one end and is stripped and tinned on the other end.

K-1014-3FDISK DOUBLE SIDED FLOPPY DISK DRIVE $719.00

This is the QUME DATATRACK 8 floppy disk drive. It supplies 1 MEGABYTE of formatted storage when used with a K-1013 controller. A K-1000-5 power supply will power this drive. MTU tests these drives to insure their operability. WARNING: During shipping, any floppy disk drive can be "bounced around" to the point that it may require realignment to function properly.

K-1000-5 POWER SUPPLY FOR ONE K-1014-3FDISK DISK DRIVE: $65.00

This power supply is capable of powering one QUME DATATRACK 8 floppy disk drive. (See page 30)

K-1013 CODOS CHANNEL ORIENTED DISK OPERATING SYSTEM
(Formerly APEX-65)

CODOS (Channel-Oriented Disk Operating System) provides 6502-based computer system with the performance, flexibility, and reliability which has long been sought after by microcomputer users. It is a tool which vastly simplifies the use of a computer by managing the operational details of disks, memory, and input/output devices while presenting a simple and uniform interface to the user. Unlike other systems which are patched or "adapted" to their hardware environment, CODOS was engineered from the ground up for integration with the MTU K-1013 Floppy Disk Controller board. The on-board bootstrap ROM effortlessly loads CODOS into the "System" 8K block of memory on the controller board. The hardware write-protect on the K-1013 insures that user programs cannot "crash" the system by inadvertently writing into System memory. This arrangement combines the startup ease and security of a ROM-based system with the flexibility of a RAM-based system, insuring painless future system upgrades.

CODOS provides true device-independent Input-Output over logical "channels". A program can output to a printer, CRT, or disk file with equal ease, since there is no distinction between files and devices from the program's point of view. Channels can be assigned by a monitor command so that programs can access different devices or files without modification. Transfers can be made to any file or device using single characters or variable length records of from 1 to 65,534 bytes. Application programs do not need buffers, "File Control Blocks", tables, or other artifaces to perform disk I/O, thus making disk operations totally transparent.

CODOS supports true random access files. Any record can be read from any position in the file in one disk access. A file is simply an arbitrarily large array of bytes which can be read or written at any position. Files may be freely appended at any time so the maximum file length does not need to be specified in advance. To illustrate system performance, an MTU test program for CODOS writes 2000 records of 80 characters each on a file. A second file specifies a list of 25 RANDOM record numbers which are read back from the new 160,000 byte data file and are written to a third file. The entire test executes in 17 seconds on a standard 1MHz 6502 with two single-sided disk drives. Other disk systems can take as long as several minutes to perform these functions.

Files are named with up to 12 characters plus an optional single character file "extension", such as "ACCOUNTS-REC.B". File size is limited only by the amount of remaining space on the disk, with up to 247 files on each disk. Files can be individually write-protected in software by a monitor command.

K-1013 CODOS CHANNEL ORIENTED DISK OPERATING SYSTEM
(Formerly APEX-65) cont'd

A Monitor program is included in the CODOS system with 28 built-in commands. In order to conserve memory space while providing the functionality of a large system, most of these commands execute as overlays, loaded automatically by the system as needed. The time required for this loading operation is normally imperceptible to the user. User-defined commands may be easily added which are executed by typing the name of the command. Typically, CODOS can search the directory, locate, load, and begin execution of a 24K byte program in three seconds. Over 50 different English error messages are provided, such as "SPECIFIED FILE WAS NOT FOUND". Commands can be read from disk files or other devices to give a Batch capability. A special "STARTUP" file of Commands is read automatically by the Monitor when CODOS is "booted" up, facilitating automatic loading of device drivers, turnkey application programs, etc.

Program interfacing to CODOS is simplified through the use of address-independent SuperVisor Call (SVC) instructions. The SVC consists of a 6502 BRK instruction followed by a one byte code indicating which system function is to be performed. The SVC processor does not interfere with interrupts. In fact, since CODOS does not use any interrupts or critically-timed loops, programs are free to fully utilize interrupts, even during disk accesses! This, plus the speed, reliability, and capacity of the CODOS/K-1013 system, makes data acquisition application ideal.

Every CODOS system must include a "Console" device, which normally consists of a keyboard and CRT, Teletype, or similar terminal. Users may need to provide a simple driver routine for the Console; a sample driver routine is included. Additional devices (e.g., printer) can be added permanently to the system by specifying the address of the device-driver and the desired name of the device. A complete driver package is included on the CODOS distribution disk which enables a K-1008 Visible Memory board to be the Console output device, displaying 22 lines of 53 characters.

Most important of all, there is the reliability, commitment to continuing support, and detailed documentation that has always been an MTU hallmark.

DISKS SUPPORTED: 8 inch Shugart-compatible, 1 or 2 sided, 1-4 drives (1-2 drives for Release 1.0).

DATA RECORDING TECHNIQUE: MFM Double density.

SECTORING: IBM compatible soft sectors, 77 tracks of 26 sectors, 256 bytes per sector.

INTERLEAVING: CODOS disks are formatted with alternating and staggered sector numbers thus allowing an average of 10 sectors of data to be transferred in a disk revolution.

FORMATTED CAPACITY: 512K bytes per side, double density.

MAXIMUM FILE SIZE: 512K bytes on single-sided, 1M bytes on double-sided diskette.

NUMBER OF FILES: 247 per disk.

FILE NAMES: 2 to 12 characters plus optional 1-character extension denoting file type.

NUMBER OF I-O CHANNELS: 10. Up to 6 may be simultaneously-active disk files. All channels are bi-directional.

SYSTEM DISK OVERHEAD: Track 12 used for the directory. Track 0 (and 8 sectors of track 13 on single-sided disks) hold the operating system image. Operating system does not have to be present on any disk except in drive 0.

RELIABILITY ENHANCEMENTS: ROM boot loader. Hardware memory write-protect for operating system and tables. All critical directory information redundantly recorded. Multiple automatic retry after read-write errors. Software write protect on individual files. File backup utility program. FORMAT Utility tests, reports, and bypasses defective sectors on disk.

MEMORY REQUIREMENTS: 8K of the 16K RAM on the K-1013; 45 bytes of zero-page for scratch, 2 global bytes of zero-page. SVC processor uses additional 400 bytes of memory when in use. Some additional memory will be needed for user driver subroutines supporting custom I-O devices.

MONITOR: Accepts 28 built-in commands (see list), with free format input. Parameters are specified by position, with numerous defaults. Command verbs may be abbreviated. Numeric arguments for commands may be hexadecimal or decimal, or mixed expressions using addition, subtraction, multiplication, division, and remainder.

SUPERVISOR CALLS

0 Exit to CODOS Monitor	12 Querry location of default I-O line buffers
1 Exit to monitor with message	13 Execute CODOS monitor command
2 Output inline text message over channel	14 Querry channel assignment
3 Input byte from channel	15 Read record from channel
4 Output byte to channel	16 Write record to channel
5 Input line from channel	17 Change file position to Beginning-of-Data
6 Output line to channel	18 Change file position to End-of-File
7 Output string to channel	19 Specify file position
8 Convert ASCII hex to value	20 Querry file position
9 Convert ASCII decimal to value	21 Assign channel to file or device
10 Convert value to ASCII hex	22 Free channel
11 Convert value to ASCII decimal	(More to be added in future releases)

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ASSIGN	Display or alter I-O channel assignments	GO	Begin execution of program
BEGINOF	Change file position to Beginning-of-Data	LOCK	Enable file write-protect
		NEXT	Resume exec. of prog.
COPY	Copy memory block	OPEN	Open disk for use
CLOSE	Terminate operations on a specified disk	PROTECT	Enable memory write-protect
DATE	Set the date	REG	Display or change CPU registers
DELETE	Delete a disk file		
DISK	Display the number of files and amount of unused space remaining on each disk drive	RENAME	Change the name of a file
		SAVE	Save memory image as a disk file
DRIVE	Specify default drive number	SET	Set memory location(s) to specified value(s)
DUMP	Display contents of memory in hex & ASCII		
		SVC	Enable/disable Supervisor Calls
ENDOF	Change file position to End-of-File		
FILES	Display names of files on disk	TYPE	Display, print, or append text file
FILL	Fill memory block with a constant		
FREE	Release channel if assigned	UNLOCK	Disable file write-protect
GET	Load program or memory image(s) from file	UNPROTECT	Disable memory write-protect
GETLOC	Display file load-addresses and entry point	VMT	Set up and use Visible Memory as the console

K-1013-2D KIM-1 16K RAM FLOPPY DISK CONTROLLER WITH CODOS: $595.00 K-1013-2M
$25.00 (Optional Address E000-FFFF Add $10.00)

This package contains the K-1013 floppy disk controller with on-board 16K RAM memory, the K-1013M hardware and K-1013-2M KIM CODOS manuals, and the CODOS disk operating system on diskette at $C000-DFFF. This version requires a terminal device of any kind (user must supply appropriate device drivers; sample driver included). Alternatively, a Visible Memory may be used as the console output display (VMT driver included with CODOS) and the user need only supply an ASCII keyboard and driver. The Monitor is extended to include a **KIM** command which exits CODOS to the KIM Monitor.

K-1013-3D AIM-65 16K RAM FLOPPY DISK CONTROLLER WITH CODOS: $595.00 K-1013-3M
$25.00 (Optional Address 6000-7FFF add $10.00)

This package contains the K-1013 floppy disk controller with on-board 16K RAM memory, the K-1013M hardware and K-1013-3M AIM CODOS manuals, and the CODOS disk operating system on diskette at $8000-$9FFF. Default terminal driver software for using the AIM keyboard and printer as the Console is supplied. Alternatively, a Visible Memory may be used as the console display (VMT driver included with CODOS). Additional features include **ESC** key which exits CODOS to AIM Monitor and **F3** key which exits AIM Monitor to CODOS Monitor. The user can load and save BASIC programs, edit, and assemble using disk files with the normal AIM ROMs and Monitor. If used, the VMT driver and Supervisor Call processors load into memory at $5000-$5FFF. The VMT driver assumes the Visible Memory at $6000.

K-1013-4D PET 2.0 16K RAM FLOPPY DISK CONTROLLER WITH CODOS: $595.00 K-1013-4M
$25.00 (available November 15, 1980) (Optional Address 9000-AFFF add $10.00)
(available November 15, 1980)

This package contains the K-1013 floppy disk controller with on-board 16K RAM memory, the K-1013M hardware and K-1013-4M PET CODOS manuals, and the CODOS disk operating system on diskette at $5000-$7FFF. This version comes supplied with default terminal driver operation for using the PET display and keyboard. The CODOS monitor includes several commands related to PET BASIC 2.0 that are not found in other versions of CODOS.

K-1013-5D SYM-1 16K RAM FLOPPY DISK CONTROLLER WITH CODOS: $595.00 K-1013-5M
$25.00 (Optional Address C000-DFFF Add $10.00)

This package contains the K-1013 floppy disk controller with on-board 16K RAM memory, the K-1013M hardware and K-1013-5M SYM CODOS manuals, and the CODOS disk operating system on diskette at $6000-$7FFF. This version requires a terminal device of any type interfaced through the normal SYM Monitor Input/output vectors. Alternatively, a Visible Memory may be used as the console display (VMT driver included with CODOS) and the user need only supply an ASCII keyboard and driver. The CODOS Monitor includes a **SYM** command to exit CODOS Monitor and enter SYM Monitor. The VMT driver and Supervisor Call processors if used load into memory at $5000-$5FFF. The VMT driver assumes Visible Memory at $C000. Also supplied on the diskette is an interface to RAE (Resident Assembler Editor) and the source for that interface. You can create and assemble source files larger than will fit into memory at one time.

K-1020 CUSTOM PROTOTYPING BOARD

As many of our customers have requested, we now offer a prototyping board for KIM BUS systems. It is assembled with on-board +5 Volt and +12 Volt regulators and mounts in the K-1005 card files. Both Expansion and Application edge fingers are provided with gold plating and pads for wire-wrap post or direct wiring. The board has power bussing on both sides, all holes are plated through and it is constructed of standard glass epoxy material. A universal hole pattern covers part of the board which allows 8, 14, 16, 18, 20, 22, 24, 28, 40 and even 64 pin IC's to be used. The maximum capacity is seventy-five 14 and 16 pin dips or up to sixteen 40 pin dips with space left for 14 smaller dips. A heavy ground plane occupies most of the bottom side of the board while separate power planes for +5V and +12V intermesh on the top side. Bypass and input filter capacitors for the regulators are provided. The board size is 5" high by 11" wide exclusive of the edge fingers. The on-board regulators supply +5 volts at 1.2 Amp and +12 volts at .250 Amp.

The manual for this product is designed to allow the user to fully document the circuit which has been built on this board for future reference. The manual is bound and includes: 5 strips of paper 2" wide for glueing custom schematics in (once they are in final form), Expansion and Application bus signal names that are used, assembly layout sheet for component location and identification, and parts list sheet. In addition, an example schematic of an interface circuit to the KIM BUS and a schematic of the on-board power supply are provided.

K-1020 PROTOTYPING BOARD: $42.00
The board comes assembled as described above and includes the documentation manual.

K-1032 THE BANKER 32K RAM ROM I/O BOARD

The Banker is MTU's short term answer to the need for large quantities of low cost memory and I/O and our long term answer to the growing problem of address space saturation in 8 bit microcomputer systems. The Banker is designed with **TWO** solutions to the limited address space problem. One involves an **ENABLE REGISTER** on the board which can turn resources on and off, allowing different parts of the board to be at the same physical address in the system without interference. The other solution is the extension of all address recognition logic to **18 ADDRESS BITS** making the Banker compatible with the 18 bit address bus 6502 based systems of the future. In addition it also has 4 ROM sockets which will accept 2K or 4K EPROMs or 4K masked ROMs for up to 16K of permanent storage. Four 8 bit I/O ports with 8 handshaking lines are included and there is even an on-board EPROM programmer for 5 volt EPROMS (2716 or 2732).

The RAM section of the Banker uses 16 type 4116 RAM chips to provide 32K bytes of read/write memory. Realizing however that many 6502 systems do not have 32K of clear addresses for such a large amount of memory, the addressing has been made very flexible. First the 32K RAM is broken into 4 completely INDEPENDENT 8K blocks with each block INDEPENDENTLY addressable on any 4K boundary. Second, each of these 8K blocks may be independently ENABLED and DISABLED with 4 bits in the ENABLE REGISTER. In fact the only RAM addressing restriction whatsoever is that all 32K must be in the same 64K "bank" when 18 bit Addressing is used. Any number or mixture of 4K blocks of RAM may also be permanently jumpered out of address space.

The ROM section of the Banker consists of 4 24-pin ROM sockets. These may be jumpered as a group for either 2K byte or 4K byte chips. When set for 4K chips, each socket may be individually set for EPROM (2732) or masked ROM (2332) operation. The address decoding logic is such that the power-down feature of the 2716 and 2732 EPROM chips is utilized to minimize power consumption. The ROM section address decoding is done in two steps and is completely independent of RAM or I/O address decoding. The first step selects a 16K (for 2K ROM's) or 32K (for 4K ROM's) block of addresses on a 16K or 32K boundary and decodes the block into 8 "select" signals. The second step involves jumpering between the select signals and the ROM sockets. In addition each ROM socket is associated with an ENABLE REGISTER bit allowing wiring to the same select signals if desired.

The I/O section of the Banker consists of two 6522 Versitile Interface Adapter chips wired to a separate 44 pin Application Connector on the board. These I/O chips are indeed versatile having two 8 bit bidirectional I/O ports with two handshaking lines each, two counter/timers, and an on-chip 8 bit shift register for serial I/O functions. The chips also have a very flexible interrupt capability and are even capable of recognizing pulses as short as 1 microsecond and counting them or signalling their presence through interrupts. The I/O address decoder is completely separate from the RAM and ROM decoders. The I/O section requires 48 contiguous addresses and may be jumpered for **ANY** block of 64 addresses on a 64 byte boundary.

The on-board EPROM programmer can program 5 volt 2716 or 2732 EPROMS. One of the 6522 I/O chips operates the programmer but is uncommited when programming is not being performed. The +25 Volts needed for programming is *GENERATED ON-BOARD*.

THE BANKER 32K RAM ROM I/O BOARD cont'd

The **ENABLE REGISTER** is used to implement bank switching on the Banker board. Four of its 8 bits are associated with the 4 RAM blocks and the other 4 are associated with the 4 ROM sockets. When a board resource is turned off with the enable register, that resource does not respond to addresses. If no on-board resource responds, then the Banker's buffers are not activated either thus allowing several Banker boards to share the same addresses. The possible combinations are endless. To insure orderly system start-up, a set of 8 jumpers determines the default contents of the **ENABLE REGISTER** after power-on or a system reset.

Each of THE Banker's address decoders (RAM, ROM, I/O) recognizes 18 address bits. Thus RAM, ROM, and I/O can be in **DIFFERENT 64K BLOCKS** in 18 bit address systems. Jumpers are included for ignoring the two extra address bits in conventional 16 address bit systems.

The Banker board is designed to connect directly (some pins not bussed) to the Expansion connector of the KIM, SYM, or AIM and to a PET with MTU/KIM BUS interface. It is fully buffered and presents only 1 low power Shottky load to the bus signals. The board size is 11" wide by 7.5 inches deep and is fully compatible with the K-1005 series of motherboards and card files. Plus 8 and +16 volt unregulated power is expected but regulated +5 and +12 may be used. Power consumption ranges from 450MA on +8V and 75MA on +16V with no ROM's and no RAM access, to 650MA on +8V and 175MA on +16V with 5 2716 EPROM's installed, 100% access in the RAM, and programming a 2716.

K-1032-1 The Banker 32K RAM ROM I/O Board: $395.00, $450.00 as of March 1, 1981, Available Nov. 15, 1980, **K-1032-1M** $10.00
This number is for the board described above including the K-1032-1M manual.

K-1032-2 The Banker 16K RAM BOARD: $295.00
The K-1032-2 is a partial assembly of the K-1032-1 with only half of the RAM and none of the ROM or I/O logic installed. The 16K of RAM is divided into two 8K blocks and may be enabled or disabled with 2 bits of the Enable Register. The board is supplied with the K-1032-1M Manual.

BOOK—MUSICAL APPLICATIONS OF MICROPROCESSORS
Available November 30, 1980

Nearly three years in writing and just released, this book is **THE** authority on all musical applications of microprocessors. It is written in clear, non-mathematical language for anyone with some computer or microprocessor background. The initial chapters begin by establishing a foundation in sound and music synthesis principles and then build upon it. Synthesis techniques involving microcomputers interfaced to standard analog synthesizers, synthesizer boards for use with microcomputers, hardware digital synthesis, and software digital synthesis are all covered in depth. Many program listings such as the fast Fourier transform in BASIC and numerous practical circuit diagrams suitable for construction projects are included. Over 500 figures fully illustrate the 653 pages of text which means that this is an in-depth look at the growing field of microcomputer music. Each copy ordered directly from MTU is individually autographed by the author and our Vice President of Research and Development, Hal Chamberlin.

SECTION I. BACKGROUND

1. Music Synthesis Principles
2. Sound Modification Methods
3. Voltage-Control Methods
4. Direct Computer Synthesis Methods
5. Microprocessors

SECTION II. COMPUTER CONTROLLED ANALOG SYNTHESIS

6. Basic Analog Modules
7. Digital-to-Analog and Analog-to-Digital Converters
8. Signal Routing
9. Organ Keyboard Interface
10. Other Input Methods
11. Control Sequence Display and Editing

SECTION III. DIGITAL SYNTHESIS AND SOUND MODIFICATION

12. Digital-to-Analog-to-Digital Conversion of Audio
13. Digital Tone Generation Techniques
14. Digital Filtering
15. Percussive Sound Generation
16. Source Signal Analysis
17. Digital Hardware
18. Music Synthesis Software

K-1002-BOOK MUSICAL APPLICATIONS OF MICROPROCESSORS: $25.00 (hardcover, 653 pages)
Individually autographed by the author, Hal Chamberlin.

K-1002-1ART ARTICLE REPRINT: $2.00
16 page reprint of Hal Chamberlin's September 1977 article in *BYTE* which describes the synthesis techniques used in the simple 4 voice music software packages.

K-1002-6ART ARTICLE REPRINT: $2.00
22 page reprint of Hal Chamberlin's April, 1980 article in *BYTE* which describes the synthesis techniques used in the Instrument Synthesis Software packages.

CODED MUSIC FOR THE INSTRUMENT SYNTHESIS MUSIC
Available Nov. 15, 1980

Due to popular demand and an extensive library of coded music, MTU is making available songs coded for our Instrument Synthesis Music System. Most songs will require a 32K system to run so it is recommended that only customers with 32K systems purchase coded music. Music is available **ONLY** on Commodore 2040, APPLE II, and MTU CODOS diskettes due to the large volume of data involved. All song data is memory position independent but is recorded on the disk to load into the area of memory defined by the standard version of the Instrument Synthesis Software for each system.

CONTENTS OF SONG PACK #1

SINFONIA #1	INVENTION #1	POLONAISE IN B-FLAT
SINFONIA #2	INVENTION #4	PRELUDE AND FUGUE #2
SINFONIA #3	INVENTION #8	NUTCRACKER MARCH
SINFONIA #4	INVENTION #14	LE TAMBOURIN
SINFONIA #10	PENNY LANE	LARA'S THEME
SINFONIA #11	JESU—JOY OF MAN'S DESIRING	DUELIN' BANJOS
SINFONIA #12	FUGHETTA	FALLING WATERS
SINFONIA #13	MARCH IN D	TOCCATA AND FUGUE IN D-MINOR
SINFONIA #14	THE ENTERTAINER	DANCE OF THE REED FLUTES
SINFONIA #15	MAPLE LEAF RAG	DANCE OF THE CANDY FAIRIES

HOW TO GET SONG PACK #2 FREE

We plan to issue a new song pack every time we issue a new catalog which is every 6 months. The material in Song Pack #1 was coded by Frank Covitz, his sons, Cliff Ashcraft, Hal Chamberlin, M.R. Ganis, and others. The material in Song Pack #2 will be submitted by customers. To encourage the submission of songs by customers, we are offering a free copy of Song Pack #2 to anyone who submits one or more coded songs that meet the requirements below:

1. The note coding must be at least 1K in length and have two or more voices playing at least 50% of the time. In other words, the song must be a substantial work.
2. The song code must not use any system dependent coding (avoid command codes ED and EF).
3. The total amount of memory used by the song and the instruments it creates must be less than 28.5K so that it will run on any of the 32K systems MTU supports.
4. Any original instrument definitions used should be documented using the format in the Instrument Synthesis manual for possible inclusion into the instrument library.
5. The song must be in machine readable form: either KIM, SYM, AIM or PET cassette, Commodore 2040 disk, CODOS disk, or Apple II disk (standard format).
6. The **CODING** of the song for the Instrument Synthesis System must be original with the submitter and free of any royalties or other encumberences. If the **SONG MELODY** is copyrighted by ASCAP, MTU will execute paying royalties to ASCAP.

K-1003-1D PET DISK SONG PACK 1: $20.00
The above song pack 1 is stored on a Commodore 2040 diskette for use with either 2001 or 16/32K PETs with Commodore disks and the MTU K-1002-6C software and K-1002-2 PETDAC board. Most songs require 32K RAM.

K-1003-2D CODOS Disk Song Pack 1: $20.00
The above song pack 1 is stored on an MTU CODOS diskette for use with any system containing a K-1013-XD disk system, the K-1002-7C (KIM-1) or K-1002-8C (AIM-65) software and the K-1002 board. Most songs require 32K RAM.

K-1003-3D APPLE II DISK SONG PACK 1: $20.00
The above song pack 1 is stored on an APPLE II diskette for use with an APPLE II system containing at least one disk, the K-1002-9C software and the K-1002-4 board. Most songs require a 48K RAM system.

PRODUCT	PRICE	PAGE	PRODUCT	PRICE	PAGE	PRODUCT	PRICE	PAGE
Descriptions of Use with PET			**Descriptions of Use with AIM**			**Descriptions of Use with KIM-1**		
K-1002-1ART	$2.00	31	K-1000-5	$65.00	19/30	K-1002	$49.00	23/30
K-1002-2	$59.00	8/30	K-1002	$49.00	17/30	K-1002-1C	$20.00	23/31
K-1002-3C	$20.00	8/31	K-1002-1ART	$2.00	31	K-1002-1ART	$2.00	31
K-1002-6ART	$2.00	46	K-1002-5C	$20.00	17/31	K-1002-6ART	$2.00	46
K-1002-6DEMO	$5.00	32	K-1002-6ART	$2.00	46	K-1002-6DEMO	$5.00	32
K-1002-6C	$49.00	8/32	K-1002-6DEMO	$5.00	32	K-1002-7C	$49.00	24/32
K-1002-40	$79.00	7	K-1002-8C	$49.00	17/32	K-1002-30	$69.00	23
K-1002-41	$108.00	7	K-1002-20	$69.00	16	K-1002-31	$98.00	23
K-1002-BOOK	$25.00	46	K-1002-21	$98.00	16	K-1002-BOOK	$25.00	46
K-1003-1D	$20.00	47	K-1002-BOOK	$25.00	46	K-1003-2D	$20.00	47
K-1003-2D	$20.00	47	K-1003-2D	$20.00	47	K-1005	$25.00	33
K-1005-P	$75.00	9/33	K-1005	$25.00	33	K-1005-K	$75.00	25/33
K-1005	$25.00	33	K-1005-A	$85.00	19/33	K-1005-2K	$15.00	33
K-1005-3	$40.00	33	K-1005-2A	$25.00	33	K-1005-3	$40.00	33
K-1005-3B	$12.50	33	K-1005-3	$40.00	33	K-1005-3B	$12.50	33
K-1005-4	$29.00	33	K-1005-3B	$12.50	33	K-1005-4	$29.00	33
K-1005-4B	$8.00	33	K-1005-4	$29.00	33	K-1005-4B	$8.00	33
K-1005-5	$10.00	9	K-1005-4B	$8.00	33	K-1008	$240.00	24/35
K-1005-6	$15.00	9	K-1008	$240.00	18/35	K-1008-7C	$27.00	24/38
K-1007-1	$78.00	9/34	K-1008-5C	$25.00	18/37	K-1008-30	$267.00	23
K-1007-1M	$10.00	9/34	K-1008-5CS	$40.00	38	K-1012	$295.00	25/41
K-1007-2	$35.00	10/34	K-1008-9C	$49.00	18/39	K-1012-1	$165.00	25/41
K-1007-3	*$59.00	10/34	K-1008-20	$290.00	16	K-1013-2D	$595.00	26/41
K-1008-P	$243.00	11/35	K-1008-21	$314.00	16	K-1013-2M	$25.00	26/42
K-1008-3C	$25.00	10/37	K-1009-1C	*$25.00	18/40	K-1013M	$10.00	26/41
K-1008-6	*$320.00	11/36	K-1012	$295.00	19/41	K-1014-1CABLE	$59.00	42
K-1008-6M	$10.00	11/36	K-1012-1	$165.00	20/41	K-1014-2CABLE	$89.00	42
K-1008-8C	$49.00	11/39	K-1013-3D	$595.00	20/41	K-1014-3FDISK	$719.00	42
K-1008-10C	$49.00	11/39	K-1013-3M	$25.00	20/42	K-1020	$42.00	26/45
K-1008-40	*$395.00	7	K-1013M	$10.00	20/41	K-1032-1	$395.00	27/46
K-1008-41	*$438.00	7	K-1014-1CABLE	$59.00	42	K-1032-2	$295.00	27/46
K-1008-42	*$419.00	7	K-1014-2CABLE	$89.00	42	K-2300-1	$373.00	23
K-1012	$295.00	12/41	K-1014-3FDISK	$719.00	42			
K-1012-1	$165.00	12/41	K-1020	$42.00	21/45			
K-1013-4D	$595.00	12/41	K-1032-1	$395.00	21/46			
K-1013-4M	$25.00	12/42	K-1032-2	$295.00	21/46			
K-1013M	$10.00	12/41	K-2200-1	$448.00	16	**APPLE II PRODUCTS**		
K-1014-1CABLE	$59.00	42						
K-1014-2CABLE	$89.00	42				K-1002-4	$89.00	29/30
K-1014-3FDISK	$719.00	42				K-1002-9D	$49.00	29/32
K-1020	$42.00	13/45				K-1003-3D	$20.00	47
K-1032-1	$395.00	14/46						
K-1032-2	$295.00	14/46	**Descriptions of Use With SYM-1**					
			K-1005-S	$75.00	28/33			
			K-1013-5D	$595.00	28/41			
			K-1013-5M	$25.00	28/42	**LITERATURE**		
MANUALS			K-1014-1CABLE	$59.00	42			
K-1005M	$5.00	33	K-1014-2CABLE	$89.00	42	K-1002-BOOK	$25.00	46
K-1007M	$10.00	34	K-1014-3FDISK	$719.00	42	K-1002-1ART	$2.00	46
K-1008M	$10.00	35				K-1002-6ART	$2.00	46
K-1008-6M	$10.00	36						
K-1012M	$10.00	41						
K-1013M	$10.00	44	*PRICE INCREASES MARCH 1, 1981					
K-1013-2M	$25.00	44						
K-1013-3M	$25.00	44						
K-1013-4M	$25.00	44						
K-1013-5M	$25.00	44						
K-1032-1M	$10.00	46						