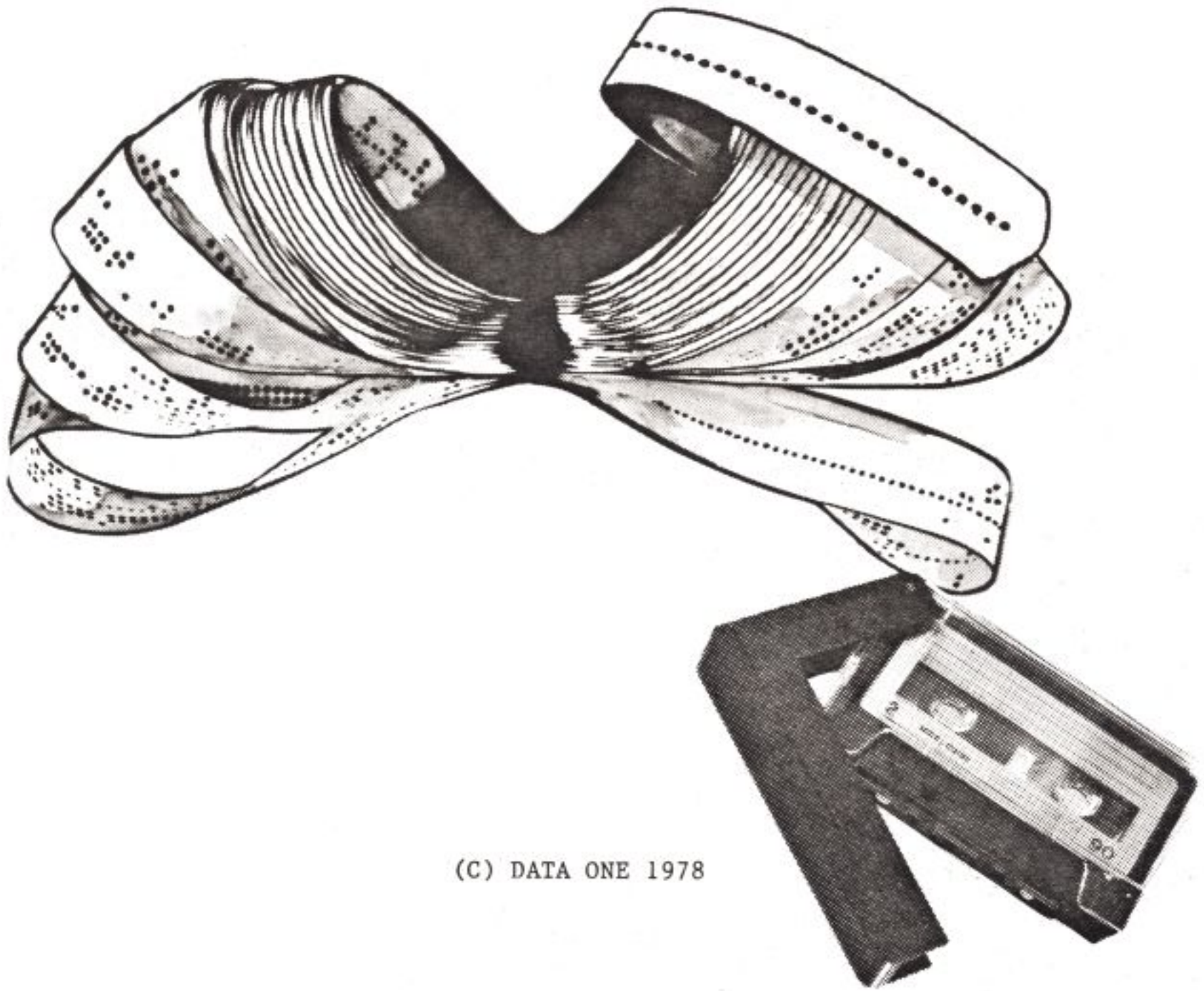


DATA1-K RESIDENT
ASSEMBLER/EDITOR
FOR THE
MOS TECHNOLOGY 6502



(C) DATA ONE 1978

**JOHNSON
COMPUTER**

P. O. BOX 523 MEDINA, OHIO 44256

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LOADING THE DATA1-K ASSEMBLER/EDITOR FROM CASSETTE
(See Instructions for Storing DATA1-K and Key Memory Locations p. 7 & 11)

The following procedure may be used to load the DATA1-K Assembler/Editor into a KIM-1 from cassette tape.

(1) Verify that the version of the Assembler/Editor that you have is compatible with the memory configuration of your KIM-1. The version number printed on the cassette indicates the memory address where the Assembler/Editor will load. For example, the V2000- version loads into memory at hex 2000 through 31FF and, as supplied, uses hex 3200 through 5FFF as workspace. To use this version, you must have memory located in this area (the location of the workspace can be changed - see Key Memory Locations - but the location of the Assembler/Editor program cannot).

(2) Turn the KIM system on and place the KIM in the keyboard mode by opening the switch or jumper between application connector pins 21 and V.

(3) Set the memory locations below for the NMI vector, BRK vector and Status:

Address	Data	
17FA	00	NMI vector (to KIM monitor)
17FB	1C	
17FE	00	BRK vector (to KIM monitor)
17FF	1C	
00F1	00	Status (non-decimal mode)

(4) Load the cassette as described in the KIM-1 USER MANUAL, section 4.2, page 48. The complete Assembler/Editor program is the only data block on the supplied cassette and its ID number is 01. Loading time is 1.5 minutes.

(5) Insure the KIM display relights showing 0000 xx indicating successful load.

(6) Place the KIM in TTY mode by closing the switch or jumper between the application connector pins 21 and V.

(7) Press the RS key on the KIM keyboard to reset the KIM, then type a RUBOUT or DELETE on the terminal. The KIM will then type the following:

KIM
0000 xx

(8) Type starting address of the Assembler/Editor, then a space. For example:

2000(space)

The KIM will then type:

2000 4C

(9) Type a G. This will initiate the Editor which will first ask if you want to clear the workspace:

CLEAR?

(10) Type YES (or just Y) and proceed with Editor/Assembler operation as outlined in the User Instructions.

LOADING THE DATA1-K ASSEMBLER/EDITOR FROM PAPER TAPE
(See Instructions for Storing DATA1-K and Key Memory Locations p. 7 & 11)

The following procedure may be used to load the DATA1-K Assembler/Editor into a KIM-1 from paper tape:

(1) Verify that the version of the Assembler/Editor that you have is compatible with the memory configuration of your KIM-1. The version number printed on the tape leader indicates the memory address where the Assembler/Editor will load. For example, the V2000- version loads into memory at hex 2000 through 31FF and, as supplied, uses hex 3200 through 5FFF as workspace. To use this version, you must have memory located in this area (The location of the workspace can be changed - see Key Memory Locations - but the location of the Assembler/Editor program cannot).

(2) Turn the KIM system on and place the KIM in TTY mode by closing the switch or jumper between application connector pins 21 and V.

(3) Set the following memory locations for the NMI vector, BRK vector and status:

ADDRESS	DATA	
17FA	00	NMI vector (to KIM monitor)
17FB	1C	
17FE	00	BRK vector (to KIM monitor)
17FF	1C	
00F1	00	Status (non-decimal mode)

(4) Load the paper tape as described in the KIM-1 USER MANUAL. Loading time is twenty minutes for paper tape.

(5) Type the starting address of the Assembler/Editor, then a space. For example:

2000(space)
2000 4C

The KIM will then type:

(6) Type a G. This will initiate the Editor which will first ask if you want to clear the workspace:

CLEAR?

(7) Type YES (or just Y) and proceed with the Editor/Assembler operation as outlined in the user instruction summary.

NOTE: Any number of line specifications separated by commas can be entered on the same line after a DELETE or PRINT command.

Example: P 30, 100-160, 260-

MEMORY (Decimal Memory Address): Sets the last available memory address for the source file workspace. Standard versions of the Editor generally have the workspace begin at hex 3200 and end at hex 5FFF (decimal 24575). If 8K of memory were added, starting at hex 6000, the end of the workspace would move up to hex 7FFF and, thus, would be specified by typing M32767.

Examples: MEMORY 32767
MEM 24575
M49151

The following table of addresses can be used for reference when specifying memory size:

Hexidecimal	Decimal	Hexidecimal	Decimal
0FFF	4095	8FFF	36863
1FFF	8191	9FFF	40959
2FFF	12287	AFFF	45055
3FFF	16383	BFFF	49151
4FFF	20479	CFFF	53247
5FFF	24575	DFFF	57343
6FFF	28671	EFFF	61439
7FFF	32767	FFFF	65535

EXIT: Transfers control to the KIM monitor at hex 1C4F. If exit to a different location is required, enter the address of that location (low, high) into hex 3174 and hex 3175 to so modify the EXIT command.

Example: EXIT
E

Each Editor command is terminated by entering a carriage return. Any number of commands may be entered on the same line before the terminating carriage return is entered. (Comma separators are not needed between commands, but are needed between multiple line specifications.) Only the first letter of a command specifies the command to be performed; any other contiguous letters are ignored. Thus, CLEAR is equivalent to C.

Any uninterpretable command results in a printed message and a pointer to the specific part of the command not interpretable. When such an error has occurred, any correct commands that appeared on the line previous to the erroneous command are completed. Any after the error are ignored.

When entering commands or source lines, corrections can be made to a line anytime before the final carriage return is entered. An up-arrow character may be used to delete all characters so far entered on the line and a back-arrow character may be used to successively delete previously entered single characters, one back-arrow for each character to be deleted. The ASCII values of these characters are 5E hex and 5F hex or 94 dec. and 95 dec., respectively, and may correspond to other key symbols on your particular terminal.

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Punching and Loading Source Tapes:

To punch a tape of a source file created with the Editor when an ASR Teletype is used as a terminal device:

- (1) Enter P (for PRINT)
- (2) Turn the punch on
- (3) Enter a carriage return

The source file will be printed and simultaneously a paper tape copy punched. It is recommended that a source file be resequenced before punching it on tape.

To load a previously punched source tape when an ASR Teletype is used as the terminal device:

- (1) Enter C (for CLEAR) and return the carriage
- (2) Enter Y (for YES) in response to the question CLEAR? and return the carriage
- (3) Type a LINE FEED key to turn echo suppression on (or any other control key other than CARRIAGE RETURN)
- (4) Place the source tape in the reader with the first punched frame over the read head and turn the reader to START

The tape will be loaded into the Editor source file. When the tape has been read to completion or to the desired point, turn the reader off and type a RUBOUT to terminate echo suppression.

Statistics:

PROGRAM SIZE: DATA1-K Assembler plus 2.5K bytes (total of 4.5K bytes) and source file space.

SOURCE FILE SIZE REQUIREMENTS PER LINE: 2 bytes for the line number plus 1 byte for each text character plus 1 byte for the carriage return. All repeated characters, such as a sequence of spaces, occupy only 2 bytes; 1 for the character and 1 for a repeat count.

RESIDENT ASSEMBLER FOR KIM-1 MODEL DATA1-K
User Instructions

The DATA1-K Assembler provides complete assembly language programming capability for the KIM-1. This assembler is compatible with the MOS TECHNOLOGY Cross Assembler assembly language, however, the DATA1-K assembler provides more detailed diagnostic error messages to pinpoint the location of any assembly errors. The MOS TECHNOLOGY Cross Assembler Reference Manual contains a description of the assembly language.

Assembly Commands:

ASSEM: (or just A) Assembles the text in the resident source file and produces a full assembly listing including object code, the assembly language source code and error messages for any detected assembly errors.

SYMBOLS: (or just S) Assembles the text in the resident source file as with the ASSEM command, above, but without clearing the symbol table from the previous assembly. A previous ASSEM must have been done before a SYMBOLS assembly or a CMD ERR message will be printed. Also, since the symbol table is positioned at the high end of the workspace, the memory size should not be changed between one assembly and a subsequent one which is to use the symbols from the earlier assembly.

Assembly Options:

Assembly options are specified by entering one of the following digits after the ASSEM or SYMBOLS command:

- 0 - same as A above
- 1 - output lines containing assembly errors and error messages only
- 2 - output only the object (machine) code from the assembly. If the punch is on, a loadable object tape will be created.
- 3 - place the object code into memory, offset by the user specified offset address

Example: ASSEM 3 - Or simply A3

Offset Command:

OFFSET (Decimal Address Offset): Specifies the address offset to be added to the program counter value to arrive at the memory address where resulting object code will be placed into memory during an option 3 assembly. Since the addition is performed modulo 65536, a negative offset can be invoked by entering 65536 minus the offset. For example, to assemble a program of origin hex 2000 so that the object code is placed into memory at hex 1000, a minus 4K offset is required. This would be specified by typing OFFSET 61440 because $65536 - 4096 = 61440$.

Resident Assembler for KIM-1 Model DATA1-K cont'd.

Examples: OFFSET 61440
OFF 0
05000

Statistics:

PROGRAM SIZE: DATA1-K editor plus 2K bytes (total of 4.5K bytes) plus space for the symbol table.

SYMBOL TABLE SIZE REQUIREMENTS: 6 bytes per symbol.

INSTRUCTIONS FOR STORING DATA1-K IN PROM

This version of DATA1-K, as furnished, runs in RAM beginning at 2000 Hex and loading up to 31FF. Workspace is set to begin at 3200 and ends at 5FFF. You may change this according to your available RAM. For addresses to change, see below.

For PROM, it may be desirable to change workspace to begin at 4002. 4000 and 4001 must be RAM locations used to store the last used address within the workspace.

Example: You want to place DATA1-K in PROM. The PROM will be addressed beginning at 2000 and the board will go through 3FFF. The DATA1-K will take 2000-31FF. Your RAM area will begin at 4000 and end at 4FFF. Enter the following:

Beginning of workspace	31C9	02 40
End of workspace	31CB	FF 4F

Then, put DATA1-K into PROM beginning at 2000.

ASSEMBLER/EDITOR USER NOTES

The need for the XON, XOFF feature on the TTY, or a reader control relay driven by the microprocessor software (the Intel approach), is not necessary. A print suppression technique and start bit verification, prior to entering the KIM input routine, GETCH, are used instead, for tape loading.

Both the Editor and the Assembler run under page control, which prints a pre-defined number of lines per page then slews over the margin between pages. The number of printed lines per page can be changed to any desired number by changing memory location 31E0 hex. The total number of lines per page is usually 66 decimal but may also be changed, it is in location 214C hex. Prior to entering the Editor from the KIM monitor, preset the paper with the perforation three lines above the print head. Paging will be maintained automatically thereafter. After reading a source paper tape, the page control must be reset by re-entering the Assembler/Editor from the Monitor.

A colon (:) prompting character is output whenever the Editor is ready for user input.

The complete Assembler/Editor is pure procedure - no self modifying code or data storage is intermixed with the program code. Consequently, the entire 4.50K can be placed into ROM or protected RAM, if so desired. Naturally, the ability to change Assembler parameters is lost if it is placed into ROM.

The margin bell is rung if the length of an input line exceeds the allotted 56 characters. Excess characters are ignored.

The WORD and DBYTE directives can be used to generate CAN code strings of one, two, or three characters. For example:

```
CODE
0874   .DBYTE "AND, "BIT, "X
0DFC
9600
```

CAN code will store three characters per 16 bits from the set A-Z, 0-9, :, ., and \$, where A=0, Z=26, :=36, .=38, \$=39 (all decimal) and the 16 bit word is:

$$= (\text{1st char}) \times 1600 + (\text{2nd char}) \times 40 + (\text{3rd char})$$

Page zero temporary storage is re-established on each entry into the Assembler/Editor (which uses all of page zero). Thus, user programs which use page zero can be run and tested while the Assembler/Editor is resident without affecting subsequent use of the Assembler/Editor. This facilitates switching back and forth between editing, assembly and debugging in seconds instead of minutes or hours with conventional systems. Also, the current end of the source file in the workspace is saved in the first two bytes of the workspace (31FE, 31FF). This permits source files in the workspace to be written out to cassette (or floppy disc, etc.) to be read back later for another edit or assembly. To do this, write out from *31FE to the location contained in *31FE, *31FF. When this is later read back in and the Editor reentered, answer NO to the question CLEAR?, and proceed with editing or assembly of the source program.

*Addresses may be changed for DATA-K in PROM.

Four nuls are output by the Assembler/Editor after each line feed to provide for slow terminals. The number of nuls output can be changed by changing location hex 311A. Any number from 1 to 255 may be entered. For certain terminals, such as the T.I. Silent 700 series and, in particular, the 733, an additional delay may be required. If the timing nuls are needed after the carriage return rather than the line feed, change locations 3116 and 3124 from 0A to 0D.

The Editor includes a tab function to ease typing in source code. Two tab stops are provided, the first at column 8 (for opcodes) and the second at column 22 (for comments). The predefined tab stops can be changed by changing the contents of locations 30B0 and 30B4. Always put the leftmost tab location in 30B0 and the rightmost one in 30B4. If you want only one tab stop, put zero in location 30B4.

The tab character is 09 in ASCII*. This is a control-I on a Teletype or is sometimes labeled H TAB on other terminal keyboards. If you want to redefine the tab character, change locations 201E and 30D1 to the ASCII character code you want for the tab character. It must be a control code (ASCII 00-1F) and cannot be CR (0D), LF (0A) or NULL (00).

The MOS Technology assembly language permits reference to the high or low byte of a memory address in an immediate operand by preceeding the address label with a less-than sign (<) for the low byte or a greater-than sign (>) for the high byte.

The same effect can be had in the DATA1-K assembler by using the following approach:

```
Z = ADR/256*256
LDA #ADR - Z           Low byte reference
LDA #ADR/256           High byte reference
```

There is some patch area available within the main body of the assembler. This patch area can be used to advantage by those who patch the assembler for use with non-TTY terminals or 6502 systems other than the KIM-1. The available patch area is at 317D through 318F.

*ASCII is the American Standard Code for Information Interchange, used by nearly all (non-IBM) terminals including the Teletype.

DATA1-K ASSEMBLER
ERROR MESSAGES

Message #	Meaning
1	A, X, Y, S and P are reserved names
2	Accumulator mode not allowed
3	Address not valid
4	Forward reference in equate, ORG or reserve directive
5	Illegal operand type for this instruction
6	Illegal or missing opcode
7	Invalid expression
8	Invalid index
9	Label does not begin with an alphabetic character
10	Label greater than six characters
11	Label or opcode contains invalid character
12	Label previously defined
13	Out of bounds on indirect addressing
15	Ran off end of line
16	Relative branch out of range
18	Undefined symbol
19	Forward reference to page zero memory
20	Immediate operand greater than 255
25	Symbol table overflow