NOAA Technical Memorandum NWS EDL-15

A MICROPROCESSOR-CONTROLLED MANUAL ENTRY DISPLAY

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Silver Spring, Md.
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Weather Bureau Technical Notes

TN 41 EDL 1 Infrared Cloud Cover Detector. Ferdinand H. Zegel, May 1966. (PB-173-427)

ESSA Technical Memoranda

WBTM EDL 2 Notes on Wind Measurement. Herman H. Crouser, August 1967. (PB-175-774)

WBTM EDL 3 A Wind Vector Component Accumulator. Herman H. Crouser, December 1967. (PB-177-143)

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NOAA Technical Memoranda

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NWS EDL 13 Design and Operation of a Digital Video Integrator Processor (DVIP). Kenneth H. Shreeve, May 1974. (COM-74-11430)

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NATIONAL OCEANIC AND
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MANAGEMENT SUMMARY

This paper describes the 256-character Manual Entry Display (MED) designed for National Weather Service Meteorological Offices (WSMO). MED will display AMOS along with observer comments, entered via a keyboard. Displayed data are formatted electronically for transmission over Service A teletype lines. A microprocessor controls the display and functions that, previously, would have required hardware logic. The microprocessor chip has reduced system hardware complexity by a factor of 2 or approximately 100 integrated circuits. Software stored in programmable read-only memories (PROMs) can be easily reprogrammed for system expansion or changes. MED was developed into a fully operational and documented engineering model in less than 5 months. The projected cost for MED is around $2500.

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1. BACKGROUND

Available displays were surveyed in order to meet the display requirements of approximately 250 alphanumeric characters. The Burroughs self-scan display was chosen because it had by far the lowest price, and was packaged in a very convenient mechanical form. LED displays are roughly four times as expensive, and are unsuited for displaying 250 characters. On the other hand a CRT display is an overkill, being more suited for displays on the order of 1000 or more characters. A microprocessor-controlled system was used to reduce hardware and increase system flexibility. Since a requirement for a RAMOS MED will be forthcoming, all hardware and software was designed to be easilty converted to a RAMOS MED.

2. MED SPECIFICATIONS

a. The MED will be baudot coded to transmit into the FAA Service A teletype circuit.

b. AMOS data displayed will be updated at 1-minute intervals. Visual observations and final remarks will be inserted via the keyboard and must be operator validated for transmission. Validation will end following transmission. AMOS data will be transmitted regardless of validation.

c. The MED will be interrogated by a contact closure for transmission over the Service A lines.

d. The display will consist of 8 lines with 32 characters per line. The characters are formed by a 5 x 7 dot matrix 0.26" high and 0.18" wide.

e. The first 3 and last 3 lines of the display will be for observer comments. Lines 4 and 5 will be for AMOS data and will not be addressed from the keyboard.

f. Keyboard characters will consist of letters and baudot upper case arrangement "D" except that cloud symbols will be omitted.

g. Four cursor position buttons will be provided on the keyboard. The cursor will show where the next letter is to be typed.

h. At power up the entire display will be cleared. The AMOS will be polled immediately after a clear.

i. When the carriage return button is depressed the cursor will move to the beginning of the next line and clear the line.

j. A buzzer will warn that the end of a line is near.

k. Lines 4 and 5 will be cleared just prior to each AMOS interrogation and the updated message will be displayed as it is read.

l. The AMOS message will be broken at a space between lines 4 and 5.

m. Carriage return and line feed will be automatically inserted in the output message.

n. The output message will be compacted so that no more than one space will be transmitted between blocks of comments or data.

3. SYSTEM DESCRIPTION

The MED has four major functions. The first is the generation of the timing for the self-scan display and the housekeeping routines of system start-up and interrupt recognition. The second is to interrogate AMOS on 1-minute intervals and receive and display this data on lines 4 and 5. The third is to display observer comments entered via the keyboard. The fourth is to transmit the displayed data, with or without comments, to the Service A telephone lines. A block diagram of the hardware involved in the MED is shown in figure 1. A system level software flow chart is presented in figure 2 and should be referred to in the following discussion of the MED function.

3.1 Self-Scan Timing

The self-scan display as purchased from Burroughs consists of only the drivers to turn on the matrix display. Each character on the display is formed by turning on the dots, on a 5-horizontal-by-7-vertical matrix, required to form a character. The self-scan display must be refreshed vertically much like a TV set is refreshed horizontally. Every vertical row of dots (7 dots by 8 lines, or 56 dots) is pulsed on for approximately 40 microseconds. The dot pattern for the next row of dots is then loaded in the display buffer during a 14-microsecond interval; then the following row is pulsed for 40 microseconds. The entire display is refreshed every 12 milliseconds, at a refresh rate of 80 Hz. This is far above the noticeable flicker rate of the eye. The timing for the self-scan display is generated on the Display Timing and Memory Board (DT&M). The Random Access Memories (RAM) on the DT&M board contain the display characters and the Read-Only Memories (ROM) on the same board have the 5 x 7 dot pattern codes for the characters stored in the RAM memory. The DT&M board also contains the tri-state buffers for reading and writing into the RAM. The timing diagrams for the DT&M board can be found in figures 3 and 4.

3.2 Start-Up

When power is applied to the MED or the reset button is pushed, circuitry on the Microprocessor Card (purchased from ProLog Corporation) generates an interrupt to the CPU chip that forces the CPU to the beginning of the stored program. This program immediately initializes all input latches and also initializes the Universal Asynchronous Receiver/Transmitter chip (UART). The routine then clears the entire display by writing spaces. Next AMOS is interrogated and a fresh AMOS message is written on the display. Upon completion of the AMOS message the Input Routine is entered where the microprocessor is continuously looking for interrupts.

3.3 AMOS Interrogate and Display

A 1-minute oscillator located on the I/O Interface Board (IOIB) interrupts the microprocessor which then sends the microprocessor to the AMOS Initiate Routine. This routine clears out the AMOS data presently in lines 4 and 5 of the display and prepares for the first character to be transmitted by AMOS. This is done by locating the AMOS cursor at the beginning of line 4. The microprocessor then sends an interrogate pulse to AMOS. When the first baudot character has been received from AMOS, via the Universal Asynchronous Receiver/Transmitter chip (UART) on the IOIB, the microprocessor is interrupted by the UART and goes into the AMOS Input Routine. This routine checks if the data is a letter or figure shift, and sets a flip-flop if necessary. The microprocessor then writes the character in RAM so it can be displayed. The routine also checks to see if the message is nearing the end of line 4, and if it is, starts the next block of data on line 5 when a space is detected. This is done so all blocks of data will be together on the display.

3.4 Keyboard Input

The keyboard is interfaced to the display via an input port on the IOIB to the microprocessor. The microprocessor checks which key has been depressed and performs the appropriate function. The most obvious function to be performed is to write a character into RAM so that it can be displayed. Another function is cursor movement, the cursor being a diamond-shaped character that indicates where the next character is to be displayed. This cursor can be moved in any one of four directions (up, down, left, or right) by four keyboard keys. Important: if the cursor should be moved over a character on the display the character will not be destroyed in RAM unless a new character is typed over it. The circuitry that allows this to happen is located on the Display Timing and Memory Board. The Return button on the keyboard will cause the cursor to move to the start of the next line as well as clearing all the data on that line by writing in spaces. The Data Call button will initiate a new AMOS message on lines 4 and 5 of the display. The Validate button will set the validate flip-flop on IOIB which tells the microprocessor to send the entire display message when a transmit signal is received. If the validate button has not been pushed, only the AMOS message will be transmitted. When a character is written into RAM or whenever the cursor is moved, an important check is performed by the microprocessor; that is, the microprocessor will never let anything be displayed in lines 4 or 5 via the keyboard. Lines 4 and 5 are strictly reserved for the AMOS message. The microprocessor also generates a signal that activates a short buzz when the end of a line is near, like the bell on a typewriter.

3.5 Transmit Displayed Data

The transmit mode is initiated by a relay closure in the Stunt Box. This relay closure triggers a one-shot, setting a latch. Both the relay and one-shot are located on the IOIB. The latch input interrupts the microprocessor which immediately checks the validate flip-flop to see if the entire display or only the AMOS message is to be transmitted. The first character to be transmitted is then loaded into the UART chip and transmitted in baudot via the Service A lines. When the first character has been transmitted the UART chip interrupts the microprocessor and the second character makes a variety of checks during this transmit routine. The first check is to see if the character to be transmitted has changed from a letter to a figure. If a change has occurred a letter or figure shift must be transmitted prior to the character. Another check performed is to see if a carriage return or line feed must be transmitted to the Service A lines. This is done by looking for a space or slash after 65 characters have been transmitted. Still another function in this routine is compacting the displayed message. This eliminates all but one of the spaces between blocks of data, reducing the length of the message. Even if a new AMOS message is being written on the display, the transmitter will follow this message and deliver a complete message to the Service A lines. The keyboard and AMOS initiate are locked out via a software mask and hardware mask during the transmitting of data.

3.6 Microprocessor Programming

The software for the MED display was developed using a ProLog Corporation Development System. This system uses a teletype interface along with a software package, provided by ProLog, to allow development of a program in random access memory (RAM). This program can be easily edited and executed via teletype commands. The software was written in machine language with the instruction codes given in hexadecimal, where two hex numbers represent one 8-bit instruction word.

The following describes the microprocessor instructions. Any register can be loaded with the contents of any other register or memory and can be loaded immediate. Memory can be loaded immediate or with data from any register. All registers with the exception of the A Register can be incremented or decremented. The arithmetic instructions can add or subtract with any register, memory, or immediate data from Register A, either with or without carry. Any register, memory, or immediate data can be ANDed, ORed, XORed or compared with Register A. Registers can also be rotated right or left either through or around the carry. Decisions can be made on any of the four status flags either with a straight jump or jump to subroutine. Decisions can also be made on either the true or false condition. Input and output are handled by individual I/O instructions.

After the software is operational in RAM memory, the program is dumped out on paper tape. The tape is then used to program programmable read-only memories (PROMs) using a programmer manufactured by ProLog. If a change in the program is required the PROMs can be erased with ultraviolet light and reprogrammed. Once the PROM has been programmed, it serves as the permanent memory for the microprocessor.

4. TEST

The MED has been breadboarded and the software has been developed using this breadboard. Paper tapes of the completed software have been made and used to program PROMs. These PROMS are erasable by ultraviolet light and can be utilized in the final system by covering the PROM window with tape, giving a nonerasable memory. Two Engineering Models are now being built to be evaluated at Sterling. The engineering models will have printed circuit cards completely documented, and a complete set of mechanical drawings. All the software has been flow charted and the detailed code has also been documented.

5. CONCLUSIONS

The development of the MED has proven that NWS display and preprocessed data acquisition requirements can be solved quickly in-house using current technology. This task required less than 5 months and 1 man-year. During this time two engineering models with complete documentation were delivered.

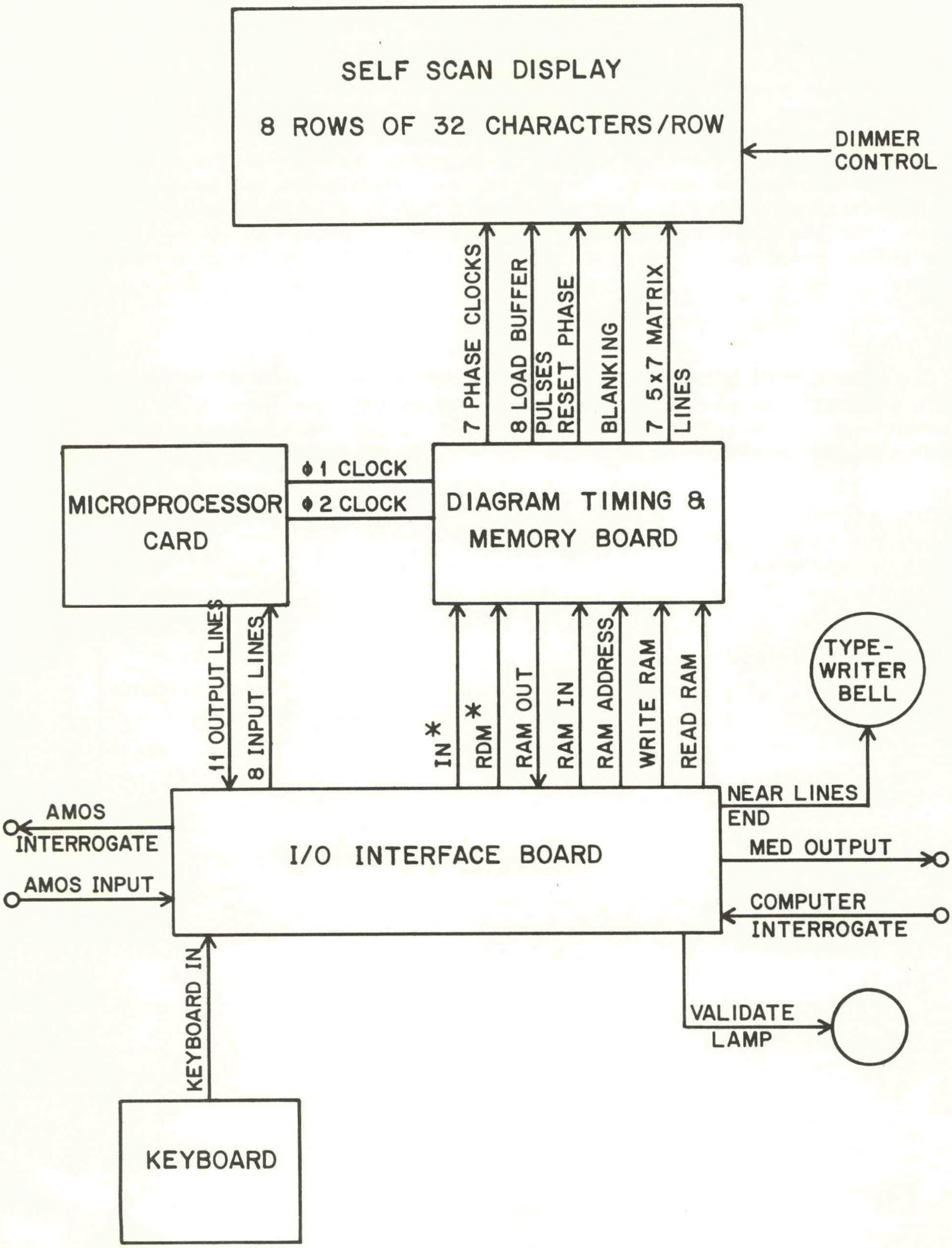

Figure 1.--MED Block Diagram.

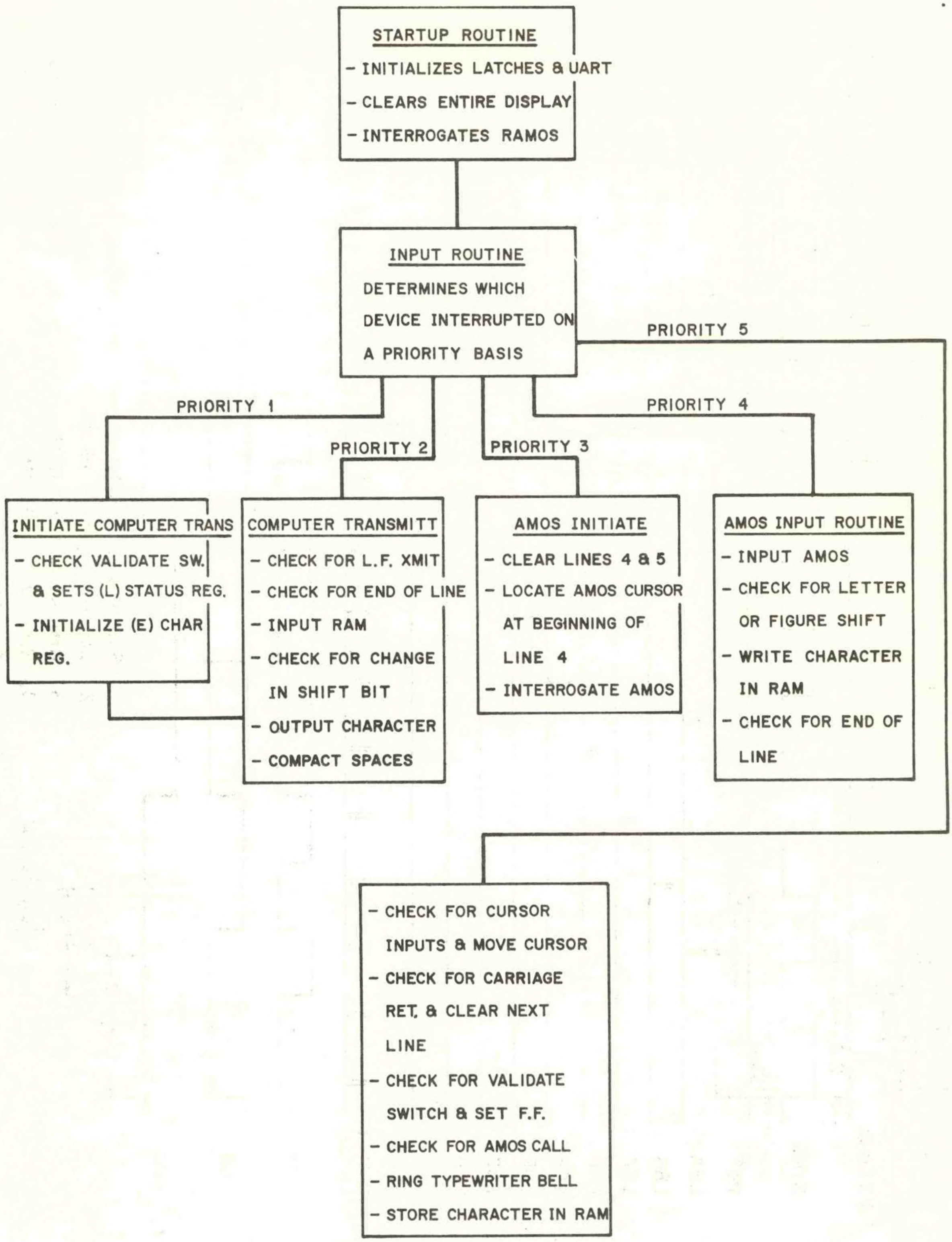

Figure 2.--MED Software.

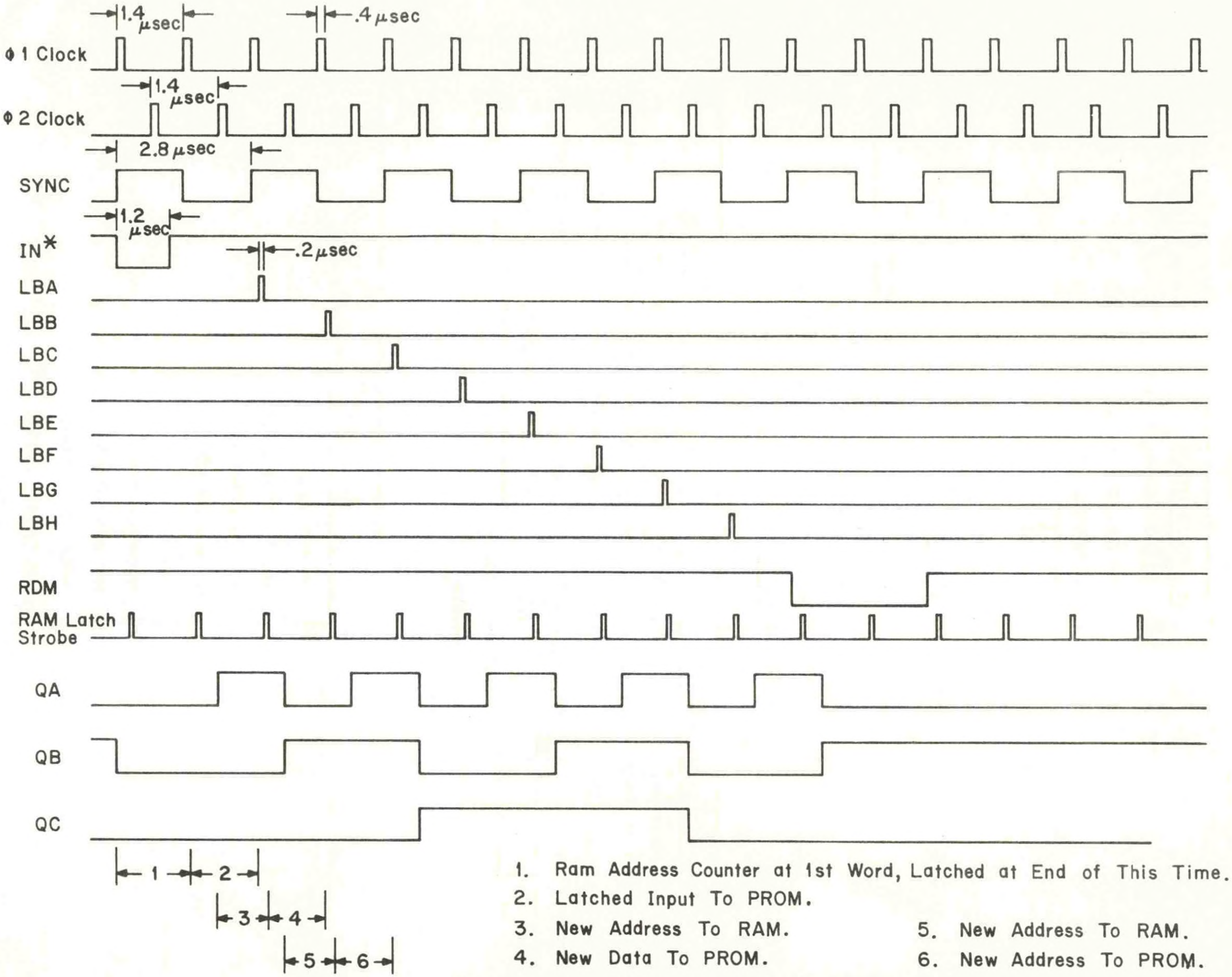

Figure 3.--MED Timing Diagram 1.

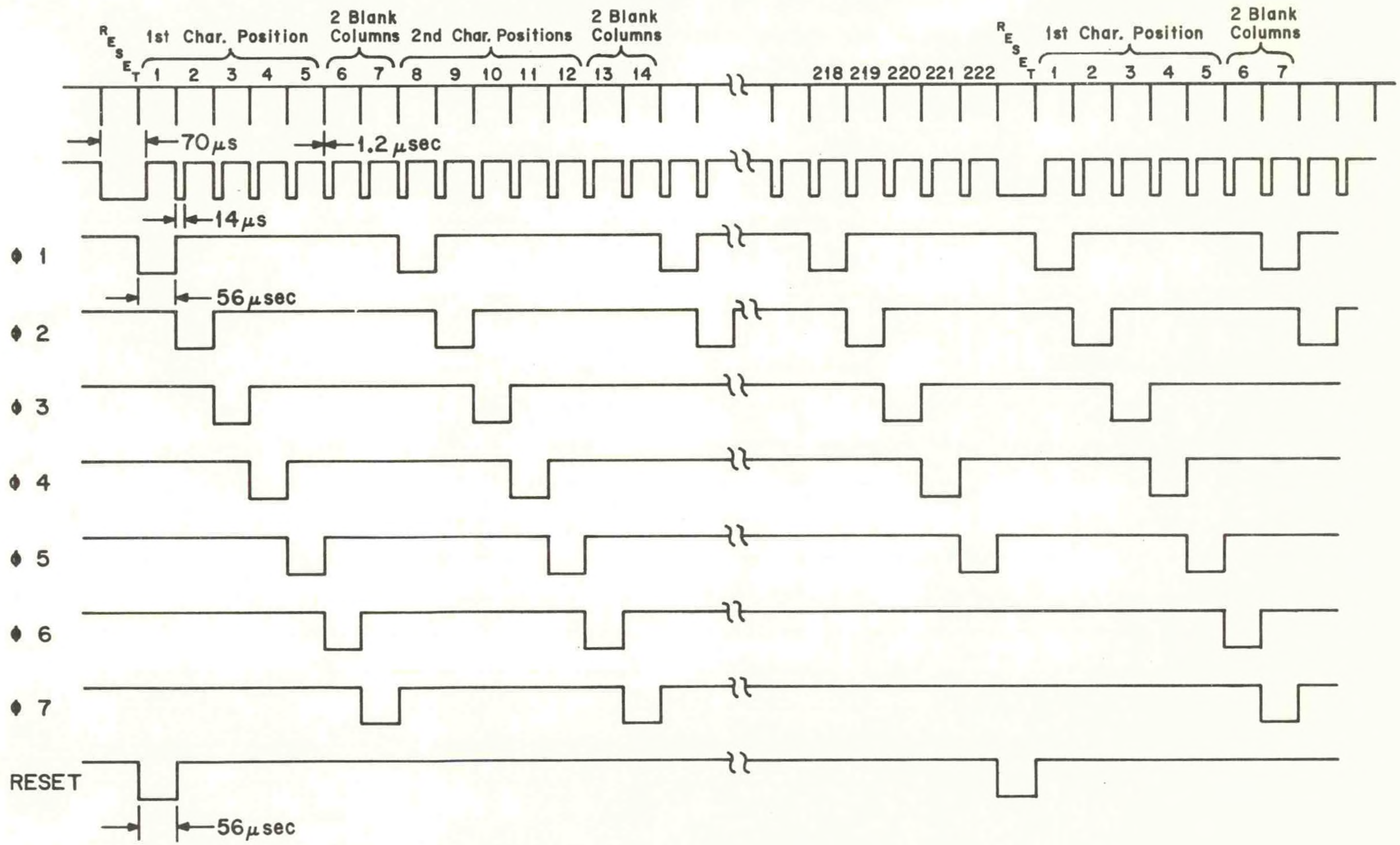

Figure 4.--MED Timing Diagram 2.

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