A simple system for displaying alphanumeric characters on an oscilloscope using an AIM-65 microcomputer

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A simple system for displaying alphanumeric characters on an oscilloscope screen is described. It may be useful for those applications in which only a few characters should be shown, but within small time limitations. The system, using an AIM-65 microcomputer, is capable of exposure durations below 100 microsec/character. Possibilities of speeding up the system and designing characters are indicated.

The interface and program described below offer a very simple and inexpensive way to display alphanumeric characters on an oscilloscope screen. If a Rockwell AIM-65 microcomputer is used, as proposed in this paper, it takes about 90 microsec to write one character (5 by 7 dot matrix) on the CRT screen, which is fast enough for many applications in which only a small number of characters must be shown.

The principle of operation (elaborated in Barnig, 1977) is a combination of a line-scanning design, in which the beam scans all possible display points of the screen (as used in video monitors), and a character-scanning mode, in which only the used display points are scanned (as used in vector displays). In our application, the beam (switched off at this time) is directed to the position where the desired character should appear and then, like the beam in a video display, rotated 90 deg. It scans all possible display points for any alphanumeric character (the 5 by 7 matrix) and is switched on at appropriate positions (see Figure 1).

DESCRIPTION OF THE SYSTEM

Hardware

The greatest advantage of this system is simplicity. If an AIM-65 microcomputer is used, one can profit by using the Monitor-ROM for character generation and the 6522 VIA as a shift register (Mayer-Lindenberg, 1979). Furthermore, the AIM can be employed for experimental control, data acquisition, and evaluation, using BASIC or FORTH.

The interface between the AIM and the oscilloscope (shown in Figure 2) generates the needed ramp-formed voltage to deflect the CRT beam in the Y direction, whenever the 6522 VIA is loaded (CSA low), and then reads out serially. It may be necessary to connect an amplifier between CB2 and the Z input of the oscilloscope if the input is not TTL compatible.

The whole arrangement (hardware and software) is designed to display one row of, for example, 16 charac-

Figure 1. Principle of operation for displaying the number 4.

Figure 2. Hardware interface between the AIM-65 and the oscilloscope.

ters, a variable value sufficient for our research. If the user wishes to display characters on several vertical positions, he/she must add the appropriate voltages to the Y input using, for example, a simple D/A converter supplied by the PB1-PB7 outputs of the 6522 VIA of the AIM.

Software

The program (listed in Table 1) starts at Position \$0200 (\$ indicates hexadecimal notation), but it may be shifted to any other area of the memory without modification. Before starting the program, the user must initiate the 6522 VIA,

\$A002 : \$01 (PB0 = output)

\$A00B : \$18 (shift register control),

Table 1
Disassembled Machine Code for the AIM-65

Hex Address	Instruction	Comment
0200	A0 LDY #00	Character counter = zero
0202	A9 LDA #FE	
0204	2D AND A000	
0207	8D STA A000	PB0 = low (trigger)
020A	B1 LDA (DC),Y	
020C	29 AND #3F	
020E	AA TAX	
020F	BD LDA F2E1,X	The first column is loaded
0212	0A ASL .A	
0213	8D STA A00A	
0216	EA NOP	NOPs important for timing
0217	EA NOP	
0218	EA NOP	
0219	EA NOP	
021A	BD LDA F321,X	The second column
021D	0A ASL .A	
021E	8D STA A00A	
0221	EA NOP	
0222	EA NOP	
0223	EA NOP	
0224	EA NOP	
0225	BD LDA F361,X	
0228	0A ASL .A	
0229	8D STA A00A	
022C	EA NOP	
022D	EA NOP	
022E	EA NOP	
022F	EA NOP	
0230	BD LDA F3A1,X	
0233	0A ASL .A	
0234	8D STA A00A	
0237	EA NOP	
0238	EA NOP	
0239	EA NOP	
023A	EA NOP	
023B	BD LDA F3E1,X	
023E	0A ASL .A	
023F	8D STA A00A	
0242	EA NOP	
0243	EA NOP	
0244	EA NOP	
0245	EA NOP	
0246	A9 LDA #01	
0248	EA NOP	
0249	EA NOP	
024A	0D ORA A000	
024D	8D STA A000	PB0 = high
0250	C8 INY	
0251	C0 CPY #10	Number of characters
0253	30 BMI 020A	All characters written?
0255	60 RTS	

and set a pointer, which marks the position in RAM where the first character to be displayed is located. The pointer address is \$00DC (LSB) and \$00DD (HSB).

If, for example, \$00DC is loaded with \$89 and

\$00DD with \$FF, the access of the processor is directed to Memory Location \$FF89, where the first character of the string "ROCKWELL AIM 65" is stored in the Monitor-ROM; thus, this string is displayed.

The writing of a 16-element character string (three blanks included, one at the beginning) takes less than 2 msec (16×90 microsec + the time needed for shifting between the characters). The advantage of this pointer technique is obvious: One can hold several strings in readiness and switch between them by altering only two memory locations. The characters that should be displayed must be stored in their ASCII form (e.g., 65, or \$41, for A). If a BASIC interpreter is available, an easy way to get this form is typing ASC('A').

The program is written as a subroutine (it ends with an RTS); so one jumps to it by executing JSR or, coming from BASIC, the appropriate statements described in the *AIM-65 BASIC Language Reference Manual* (Rockwell International, 1979). If periodical interrupts are used to jump to the display program, the processor registers must be saved beforehand, because they are altered by execution of the program. The number of characters to be displayed is stored in \$0252, so it can be changed easily.

CONCLUDING REMARKS

If an external clock and a shift register are used, the system can be speeded up to 40 microsec/character; this is the fastest value attainable by the AIM. One can make use of all characters available to the AIM printer, but beyond this, original characters can be created. For this purpose, a character generator must be written. Each character takes 5 bytes of the RAM if a 5 by 7 dot matrix is chosen. The *AIM-65 Monitor Program Listing* (Rockwell International, 1978) provides useful hints.

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