8085 A look at the software required to control an eight channel analog signal monitor.

C. TITUS, P. RONY, D. LARSEN, and J. TITUS*

IN A PREVIOUS COLUMN, WE DESCRIBED the needs of the 8085 control system and the use of the I/O ports and programmable timer to form an eight channel analog monitor. The necessary initialization of the I/O ports was also discussed. Now we will discuss the software that is necessary for proper operation of the system. It is assumed that the control process is very simple, perhaps just sensing only upper and lower limits of the analog signals.

The programmable timer within the 8155 generates an interrupt every 10 ms.

```
RST75,   PUSHPSW   /SAVE REG A & FLAGS
         MVIA      /CLEAR INTERRUPT FLAG
         020
         SIM
         MVIA      /RE-ENABLE INTERRUPTS
         013
         SIM
         LDA       /GET # OF LOOPS REMAINING
         SEC
         0
         DCRA      /DECREMENT IT BY ONE
         STA       /SAVE IT
         SEC
         0
         JNZ       /IF NOT ZERO, DO ANOTHER LOOP
         NOTYET    /THROUGH THE INTERRUPT
         0
         MVIA      /YES, IT'S ZERO, SO RESET THE SECOND
         144       /COUNTER TO 100 (10 MSEC LOOPS)
         STA       /STORE IT
         SEC
         0
         LDA       /GET THE TIME
         BCDTIM
         0
         STC       /SET THE CARRY FLAG
         CMC       /COMPLEMENT IT TO CLEAR IT
         ADI       /ADD 239 = DECIMAL 99
         143
         DAA       /DECIMAL ADJUST IT FOR A SUBTRACTION OF ONE
         STA       /OF ONE, AND THEN STORE IT
         BCDTIM
         0
         JNZ       /IF THE RESULT IS NOT ZERO, LOOP THROUGH
         NOTYET    /AGAIN
         0

         /ADC SERVICE ROUTINE
         IN        /INPUT THE BCD DATA FROM THE SWITCHES
         201
         STA       /UPDATE THE BCD TIME
         BCDTIM
         0
ADC,     NOP       /THE ADC SERVICE STEPS GO HERE
         NOP
         NOP
         NOP       /ETC.
NOTYET,  POPPSW    /RESTORE REG A & FLAGS
         RET       /RETURN TO MAIN PROGRAM
```

FIG. 1

Since the basic unit of time in this system is a 1-second interval, 100 1-second interrupts must be counted before any action can occur. When the 1-second point has been reached, the program must check to see if it must perform some other action, or continue timing for another 1-second interval. A read/write memory location, SEC, is set aside that will be used to count the 100, 10-ms interrupts. Another location will be required to contain the number of seconds that must be delayed between sampling. Since the thumbwheel-switch data will be entered in binary-coded decimal (BCD) format, you have to decide whether it will be processed in binary or BCD format. We have chosen to process it in BCD format to eliminate a BCD-to-binary code conversion process.

A typical timer control subroutine is shown in Fig. 1. Note that there are steps in this subroutine that clear the RST 7.5 flag and then re-evaluate the RST 7.5 interrupt mask. The information stored in location SEC and BCDTIM has also been used.

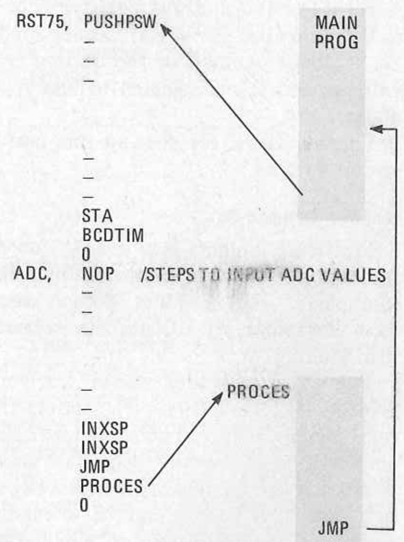

FIG. 2

In our example, it can take up to about 200 μs to proceed through the steps shown, leaving 9800 μs for the remaining program steps. If a slow A/D converter is used to acquire the eight samples, much of the 9800-μs period would be gone, leaving little time in the interrupt-service subroutine before the next 10-ms interrupt occurs. If this happens, the interrupt-service subroutine is interrupted and the computer becomes interrupt-bound. Most A/D converters can perform conversions quickly so this will not be considered further.

We suggest that you acquire the analog data in the subroutine and then proceed to a data or control-processing section of the program that is *outside* of the interrupt-service subroutine. The control or processing of the program will be interrupted briefly every 10 ms, but it will have up to 1 second to process the old data. It has been assumed that the processing takes less than 1 second. The software example in Fig. 2 shows how the control processing software has been removed from the interrupt-service subroutine. There are other equally valid solutions to this problem. Remember, however, that when you do not intend to use a return address on the stack, you must increment the stack pointer twice to avoid loading the stack with useless information.

This application does not use the serial-in (SID) or serial-out (SOD) connections on the 8085. These connections could be used as a single line-control input and a single line-control output, respectively. They can also be used to serialize ASCII characters for output or to parallel the serial bit stream to reconstruct parallel data bytes. Thus, a software UART could be constructed very easily. **R-E**

*This article is reprinted courtesy American Laboratories. Dr. Rony, Department of Chemical Engineering, and Mr. Larsen, Department of Chemistry, are with the Virginia Polytechnic Institute & State University. Both Mr. J. Titus and Dr. C. Titus are with Tychon, Inc.

NOM CARD FOR 1802

continued from page 48

$\overline{EF}_2$, $\overline{EF}_3$, $\overline{EF}_4$). The flip-flop is reset when the status/output register is read.

The only portion of the interface we have not discussed is the clock—a simple 400-kHz RC oscillator operating between +5 volts and −4 volts, and the hold/reset circuits. The reset circuit is a TTL-to-MOS voltage converter since the reset, hold and oscillator pins are non-TTL inputs. The reset must be held low for at least eight oscillator periods as part of its power-on sequence (8 oscillator periods equals 20 μs). Thus, when the system is powered-up as part of the initialization routine, the reset is set for a minimum of 20 μs, during which time the input-ready flip-flop is clocked three times. The first two times it is set, write an 80_{HEX} to the input port to clear the flip-flop; this is necessary because the hold is set each time the output ready occurs. When the third signal occurs, the NOM interface is ready for its first instruction. If it is not needed at this time, store a 40_{HEX} in the input port. The hold circuit is formed by a TTL-to-MOS voltage converter driven by a 2-input OR gate.

continued next month

ANNUAL INDEX JANUARY—DECEMBER 1978

To present the maximum number of articles to our readers, we have not published the Annual Index as part of this issue. A 4-page brochure containing this index is available for those who need one. To get your free copy, send a *stamped self-addressed envelope (legal size)* to:

Radio-Electronics
Annual Index
45 East 17th Street
New York, NY 10003

Any requests postmarked on or before February 28 are free. After that date there is a 25¢ fee. Questions and comments about anything other than the Index that are included with your request cannot be handled. Send them separately to our Editorial Offices.