

computer corner

8085 How to use the 8085 with an A/D converter to monitor eight analog channels.

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THIS MONTH'S COLUMN WILL SHOW HOW to interface an 8085 microcomputer with an A/D converter so that eight analog channels can be monitored with the time period between measurements programmed by the user. It is assumed that all eight channels are monitored quickly with a long period between these quick samplings. The system's computer, the 8085, must have the following input/output (I/O) devices:

1. A fast 10-bit analog-to-digital (A/D) converter with an eight-channel multiplexer.
2. A set of thumbwheel switches to select the time period (1 second to 99 seconds).
3. A set of eight control on-off outputs that can be used to control the process being monitored.

The block diagram of Fig. 1 shows how we assigned I/O ports and bits to various I/O devices. One 8155 read/write memory and one 8355 read-only memory (ROM) device are used. Note that the six I/O lines of Port C on the 8155 have not been used. These I/O lines can be used for later expansion.

The 8355's I/O ports were chosen to control the A/D converter system because a combination of inputs and outputs was needed. The 8355's I/O ports can be assigned input or output functions on a bit-by-bit basis. The 8155 was used for the switch inputs and the control outputs since these were already prearranged in groups of eight lines each.

The bits of the I/O ports must first be assigned input or output functions. The eight bits at Port A are all input bits, while those at Port B are a combination of input and output bits. Thus, the following control words must be sent to the 8355's two port-control registers:

Port A Control = 00000000₂
 0 = Input Bit
 Port B Control = 11111000₂
 1 = Output Bit

*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 Dr. C. Titus and Mr. J. Titus are with Tychon, Inc.

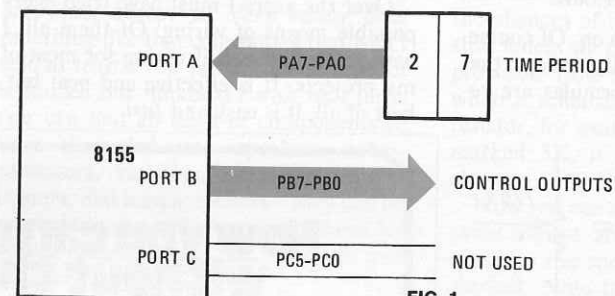
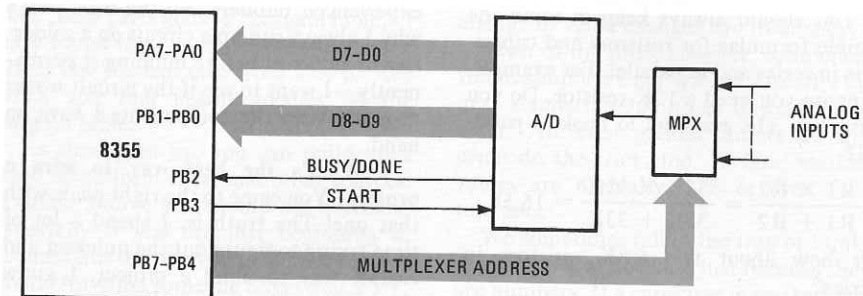


FIG. 1

```

START  MVIA  /LOAD REG A WITH PORT A CONTROL WORD
        000
        OUT  /OUTPUT IT TO THE 8355 CHIP
        002
        MVIA /LOAD REG A WITH PORT B CONTROL WORD
        370
        OUT  /OUTPUT IT TO THE 8355 CHIP
        003
        NOP  /PROGRAM CONTINUES HERE
    
```

FIG. 2

```

/CONVERSION START PORTION OF THE PROGRAM
LDA     /GET THE STATUS WORD, BIT PB3 = START
STATUS
0
ORI     /SET THE START BIT TO A ONE
010
OUT     /OUTPUT IT
001
ANI     /CLEAR THE START BIT
367
OUT     /OUTPUT IT
001
NOP     /CONTINUE HERE

/MULTIPLEXER UPDATE, SWITCH TO THE NEXT CHANNEL
LDA     /GET THE STATUS WORD, BITS PB7 - PB4
STATUS
0
ADI     /ADD ONE TO MULTIPLEXER ADDRESS
020
OUT     /OUTPUT IT TO THE MULTIPLEXER
001
STA     /STORE THE NEW STATUS WORD BACK IN
STATUS /ITS MEMORY LOCATION
0
NOP     /CONTINUE HERE
    
```

FIG. 3

```

/TIMER CONTROL PROGRAM FOR THE 8155 CHIP
MVIA   /PRESET THE 8 LSBs OF TIMER'S COUNT
020
OUT    /OUTPUT TO TIMER
204
MVIA   /OUTPUT THE 6 MSBS OF TIMER'S COUNT &
347   /THE 2 MODE CONTROL BITS, D6 & D7
OUT    /OUTPUT THEM TO THE TIMER
205
MVIA   /SET UP PORTS A & C FOR INPUT,
302   /PORT B FOR OUTPUT, AND START THE
OUT    /COUNTER
200
NOP    /CONTINUE HERE
    
```

FIG. 4

```

/RESTART 7.5 INTERRUPT SERVICE ENABLING STEPS
MVIA   /CLEAR ANY PREVIOUS RST7.5 INTERRUPTS
020
SIM    /SET INTERRUPT MASK
MVIA   /ENABLE RST7.5 INTERRUPTS
013
SIM    /SET INTERRUPT MASK
    
```

FIG. 5

The output of these control words is shown in Fig. 2.

When these control words are output to the control registers, the ports will be configured as required. It is wise to exercise some caution when you use Port B, since you want to control bit PB3 and bits PB7-PB4 independently. Therefore, when bit PB3 changes, bits PB7-PB4 must not be altered. Some careful thought must be applied to this problem so that the program does not start a conversion when all you want to do is

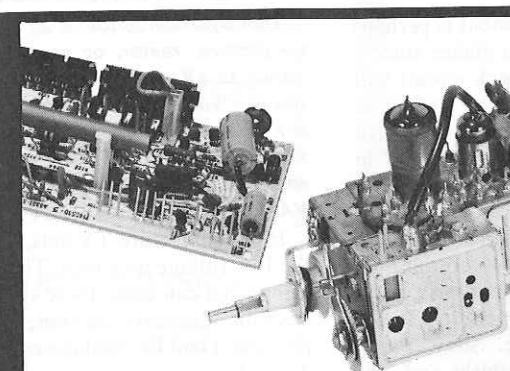
change the multiplexer's 4-bit address. A status word, stored in read/write memory, is used to tell the program the current status of the output lines. Individual bits can then be manipulated without affecting the other bits. Figure 3 shows two sections of the program, one indicating how the multiplexer is updated without affecting the converter, and the other showing how the converter is started without affecting the multiplexer. In fact, each routine can be treated as a subroutine.

The I/O ports on the 8155 are also easy to control. The bits at Port A are used as inputs and the bits at Port B are used as outputs; Port C is not used. Rather than using a software delay loop, we used the timer function in the 8155 to help time the 1-second period. Assume that the 8085 has a 1- μ s clock period. With a 14-bit counter this provides periods of up to 16.36 ms. In our example, we used a 10.00-ms time period, using a 14-bit binary count of 100111 00010000, which must be loaded into the counter. Since the timer will be used repeatedly, we used it in mode 3—automatic reload with a pulse at the end of each programmed period. Now it is necessary to initialize the 8155 to control Ports A and B plus the timer. The following sequence (see Fig. 4) initializes the system and starts the 10-ms clock period.

The timer's pulse output generates an interrupt ("RST 7.5") whenever a 10-ms period "times out." To activate the RST 7.5 interrupt (on the 8085) the RST 7.5 interrupt mask must be enabled using the instruction steps shown in Fig. 5.

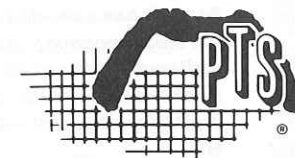
To initialize the I/O ports fully, only combine the steps from Figs. 2, 4 and 5. Remember also that you will have to establish a stack pointer before the interrupts can be used. In a future article, we will discuss the overall software integration necessary for this application. R-E

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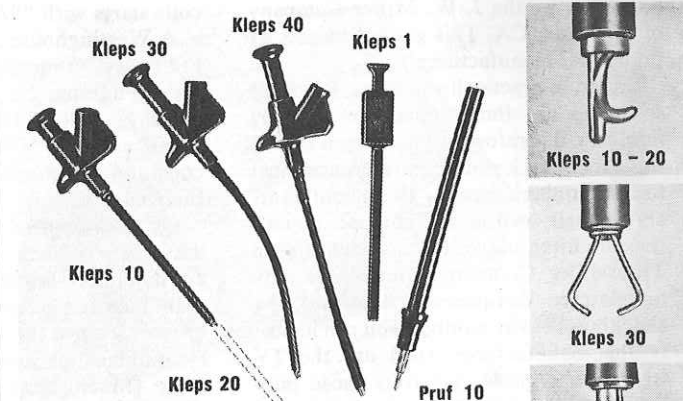
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