EE 337: Microprocessors Laboratory (Spring 2021)
Section: S2 (Third year UG)
Indian Institute of Technology Bombay

Lab 5: 20 points Date: Feb 17, 2021

Before attempting this lab, go through the video lectures and notes on interrupts, timers shared in the course Teams page and website.

1. [10 points] You will use the built-in hardware timers in 8051 to generate delays. This is in contrast to the software delay subfunctions you had used in the previous labs.

   - Write a subroutine that will use a 16-bit number as the count value to program the timer `T0` to generate a proportional delay.

     Recall that the 8051 timers count *up*. These generate an interrupt (if enabled to do so) when the count wraps around from `FFFFH` to `0000H`. If we want a timer to time-out after N cycles, it should be loaded with $-N$ (i.e., 2's complement of N).

     So the subroutine should subtract the 16-bit number from `0000H` and load the result as the initial count in `T0`. While debugging the program with single stepping, you could consider a count value of `1`, and load the timer register with `-1`, so that it overflows at the first increment itself. In actual use, a different count has to be stored.

   - Write a program that will use the above subroutine to blink the onboard LEDs such that these are ON for one second and OFF for one second continuously. Adjust the timer count and the number of times the delay subroutine is called to make the ON and OFF period as close to 1 second as possible.

2. [10 points] You will configure the timers to generate a periodic 4-Level pulse amplitude modulated (PAM) signal that takes integer values in the range `0-15`. Level 2 and Level 1 are stored as `4`MSB and `4`LSB, respectively, of the data in location `70H`. Level 4 and Level 3 are stored as `4`MSB and `4`LSB, respectively, of the data in location `71H`. The period of the PAM signal should be 4 s with each level occupying 1 s. The PAM levels have to be written out on the port pins `P3.3-P3.0`. These are also to be written on the LCD in the following format. First row of the LCD should display the level as "Level 1", "Level 2", "Level 3" or "Level 4". Second row should display the corresponding value as "Value: xxxx", where 'xxxx' is the binary representation.

TA Checkpoints

1. For question 1, ask the students to show the LEDs blinking and check that they use the Timer.

2. For question 2, place arbitrary 8-bit values in the memory locations `70H` and `71H`. Check that the levels and binary values are appropriately displayed on the LCD.