We need to build a device for a fairly simple psychological experiment. The purpose of the experiment is to determine whether people respond more quickly to a positive or negative occurrence. That is, whether an LED goes on unexpectedly or it goes off unexpectedly.

The prevailing theory is that a positive event is more quickly noticed. We aim to prove or disprove that theory.

Using the multiplexed seven-segment display and timing routines (modified a little) from the previous labs, design (the software for) and build a unit which will have the following specifications:

- It will have one SPST switch, SW1, connected to some input. (Which one is up to you, but I'd suggest one from port A, because you'll be using port B for the display and RB15 for the LED. The circuit is shown with the switch connected to RA0.)
- It will have an LED (connected to port B pin 15).
- The seven-segment displays will be connected as in the previous lab.
- Operation of the circuit is as follows:

  1 On reset, the display should be off.

  2 The application should wait for SW1 to be pressed.

  3 When SW1 is pressed, the display should go off (if on).

  4 The application should then wait a random amount of time (see below), then turn the LED on.

  5 When SW1 is pressed again, the software should measure the time that the LED was on. The software should then wait another random time (see below) and then the LED should go off. The software should then wait for the SW1 to be pressed again and measure the interval between the LED going off and the switch activation.

  6 Our goal is to measure the difference between the reaction times and to display the difference. This difference should be less than .09 seconds plus or minus (if it's greater, that would indicate something very interesting.) Here's how you will display the results: Using the 7-segment display you can display, for example, '0' - '9' by simply turning on only the low-order digit. To display "-1" -

"-9" is easy: turn on only the g segment of the high-order digit. To indicate a value larger than .09, display segments b, c, and g on the high-order digit and g on the low order digit (it will look like '+'), and make it blink, on for half a second, off for half a second. To indicate a negative result off the scale, display a blinking "-" "-". (The purpose of this methodology is so that a relatively untrained operator – such as a psychology grad student – can do the experiment.)

7 The application should then wait for SW1 to be released (if it has remained pressed for a long time).

8 Repeat from step 2.

The random time should be a value, in milliseconds, uniformly distributed in the range 1000 to 9999. To generate this, use the following code:

```
t = random(); // where random returns a pseudorandom number from 0 to 65535
t = t % 9000; // gives a number from 0 to 8999
t += 1000;    // now t is a number from 1000 to 9999.
```

Notice that this requires a clock that measures the time interval in hundredths of a second, (accurate to the nearest .01 seconds). You will need to know that the minimum human reaction time (about .2 second) is roughly 5 times that of the maximum switch bounce (roughly 40 milliseconds.) The conditions on the valid measurements mean that you don't have to worry (much) about switch bounce.

It may be that the user may press SW1 and keep it pressed until the LED goes on (at least one second, and probably several seconds).

You can (and should) use the pseudo-random number generator and multiplexed display routines from earlier labs.

To get credit for this laboratory, demonstrate your working model for the TA.

Optional: If you want, you may make the lab more challenging by making the measurement an iterative one and displaying an average rather than one sample. The number of iterations should be at least 10, but not so many that the subject will drop out due to boredom. The display can be the same (or, if you like, you can ask for a 3-digit display – I have some I could lend you). Due to statistics, the average is likely to be more stable and less likely to be out of range.

After you complete this lab you can retire the 7-segment LED modules. They won't be used in any more labs.