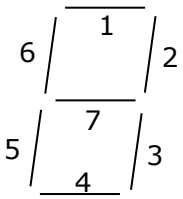
Department of Mechanical, Materials and Manufacturing Engineering

The University of Nottingham

Computer Engineering and Mechatronics MMME3085

Exercise Sheet 4: State Tables and Finite State Machine

1. So-called "seven segment" displays are popular for visual output of numeric data in control panels etc. (as well as forming the basis of many digital displays e.g., some calculators, fuel pumps etc.). They work by having seven light-emitting diode (LED) or liquid crystal display (LCD) elements arranged as follows:



The seven segments are then selectively activated as follows:

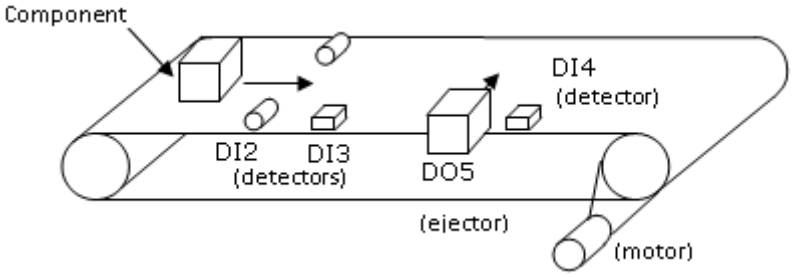
a) Write a state table which describes these ten states of the display.

b) Write a simple program which reads a numerical value in the range 0–99 from Port K of the Arduino Mega and outputs the states for the seven-segment displays to Ports A and C. Assume that each segment is connected to bits 1–7 of each port leaving bit 0 spare.

Hint: use integer division (just the / sign used with integer operands) to get the "tens" digit and the modulo symbol % to obtain the "units" digit.

Bonus: Extend this to 9-segment displays to show more characters.

2. Consider a simple model of a conveyor belt with automatic inspection facilities. It consists of an inspection station which has two optical detectors (DI2 and DI3), and an ejection station (DO5) which has a third detector (DI4) and immediately adjacent to it a deflector which ejects faulty components from the conveyor.



   a) Draw a timing diagram to illustrate the following process, then write a state transition diagram which represents the various stages of solving the problem:

      - If a component passes which is too long, both of the first two detectors (DI2 and DI3) are activated at the same time.
      - If the component is the correct length, both these detectors are activated but not at the same time. It will then proceed to the end of the belt and fall off the end without further event.
      - If the component is too long, however, when it passes the third detector, the ejector will extend to push the component off the belt, then retract again.

   It is probably best to consider each state in turn so that no unexpected situations occur and catch you out! Now modify or rewrite your diagrams so that the function is reversed: the "short" box is rejected while the "long" box is retained.

   Assume that you have available digital inputs corresponding to pins 2, 3 and 4 and a digital output corresponding to pin 5.