laSalle ENG
Universitat Ramon Llull

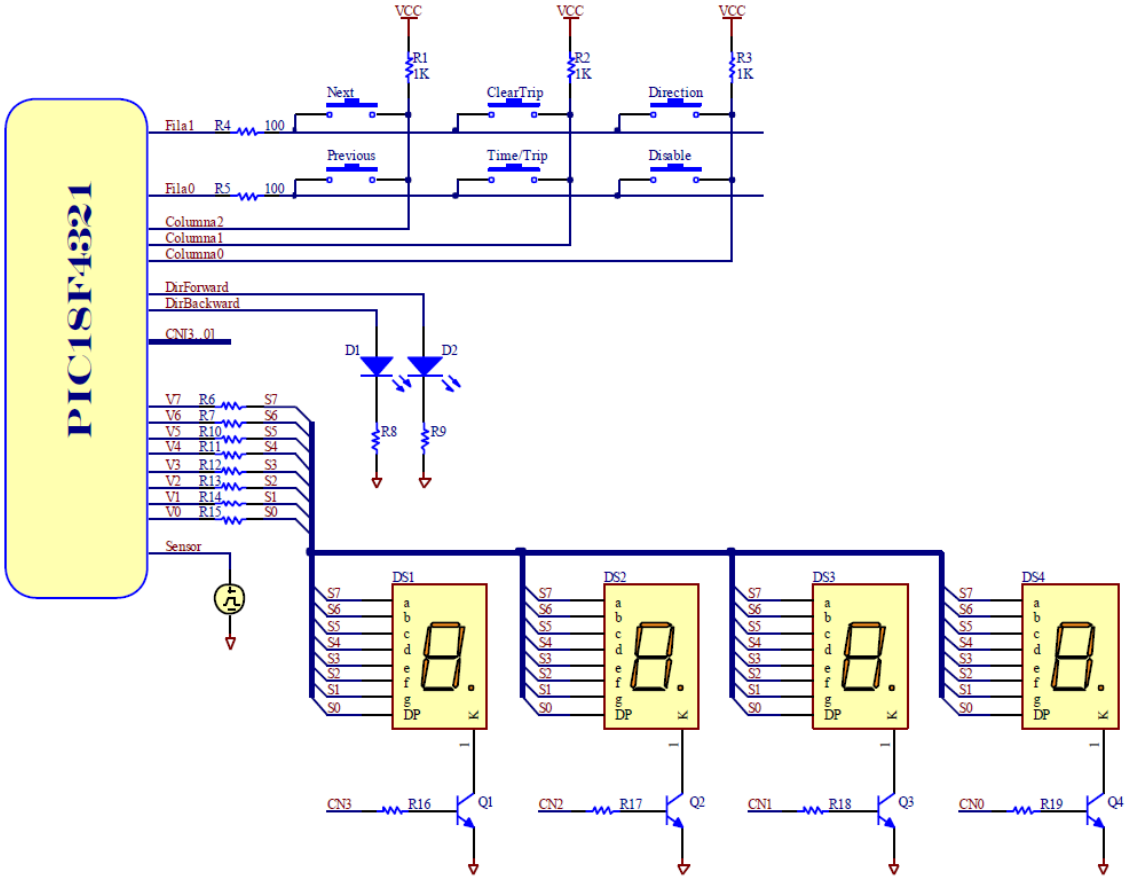
June Exam. 2nd Semester

Subject: Digital Systems and Microprocessors
Date: 07/06/2012

Surname: _____ Name: _____ Login _____ Year: **2011/12**

Problem #2: The TERRATRIP 1h 45 minutes, 7 points

The *terratrip* is a precision instrument used to measure the distance that a vehicle has run. This gadget is typically used in orientation races. Those devices can measure different distances (channels) simultaneously; for example, the channel 0 could be used to measure the total distance traveled during a race while the channel 1 could be used to measure the distance travelled during an specific part of the race only. Bellow, a functional schematic is proposed:



Inputs and Outputs:

- Row[1..0]: The outputs used to scan the matrix keyboard.
- Column[2..0]: The inputs used to scan the matrix keyboard. These inputs can have up to 25ms of bounces.
- DirForward: Output used to indicate that the *terratrip* is incrementing the current channel distance. When activated, this pin outputs a pulse train of 50ms of period and 50% of duty cycle.
- DirBackward: Output used to indicate that the terratrip is decrementing the current channel distance. When activated, this pin outputs a pulse train of 50ms of period and 50% of duty cycle.
- CN[3..0]: Outputs used to control each of the 7-segments display. Each display must be turned on during 125ms.
- V[7..0]: Data outputs connected to the 7-segments displays.
- Sensor: Input connected to the wheel sensor. A rising edge on this input means that the vehicle has advanced 80cm. Take into account that we do not know the amount of time that this signal is set to 1.

Working specifications:

This *terratip* needs to be able to measure the distance of the 16 channels. When the *terratrip* is turned on, it must have the following default configuration:

- Run distance: 0 meters.
- Elapsed time: 0 minutes.
- Direction: forward.
- Activated channel: no.
- Show time: no.

Consequently, the displays will all have to show 0 and the LED DirForward will have to be on.

Afterwards, the system will wait until the copilot introduces new orders using the matrix keyboard:

- Next: The 7 segments must show the information (time and distance) of the next channel, if the actual channel is the sixteenth, the 7 segments must show the information of the first channel. The LEDs status must also be updated according to the current channel configuration.
- Previous: The 7 segments must show the information (time and distance) of the previous channel, if the actual channel is the sixteenth, the 7 segments must show the information of the first channel. The LEDs status must also be updated according to the current channel configuration.
- ClearTrip: The actual channel run distance and time must be reset (cleared) .
- Time/Trip: This button controls the information that the displays show. If the run distance is being showed on the displays, the system must display the time in minutes that the current channel has been active (elapsed time) instead. If the time is being showed on the displays, the system must display the run distance instead.
- Direction: If the direction is forwards, it must be changed to backwards. On the other hand, if the direction is backwards, it must be changed to forward. Moreover, the LEDs DirForward and DirBackward must be turned on and off accordingly by using a pulse train.
- Disable: This button allows to enable/disable each channel. If the channel is active, it must be deactivated (ignoring the pulses that the sensor gives) and both LEDs DirForward and DirBackward must be turned on by using its corresponding pulse train.

Moreover, every 15 seconds the information from each of the 16 channels (run distance, run time, direction and active channel) must be stored at the PIC EEPROM memory.
You can consider that the run distance will never be greater than 9999 meters and that the time will not get over 9999 seconds.

To do:

1. Justify the interrupts you are going to use, and if they are going to have priority.
2. Port assignation.
3. Design of the cooperative software:
    a. ADTs diagram.
    b. State machines.
4. Justify which would be the maximum number of channels that the *terratrip* could compute without changing the hardware or the microcontroller.
5. Implementation of the cooperative software in ANSI C or *assembler*. Only cooperative solutions will be accepted.