MICROCONTROLLER EXERCISE 7.2

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1. Schematic

The schematic contains: PIC 16F887 Microcontroller, LM35 thermo sensor, 16x2 LCD. The PIC uses reference voltage of 1.5V (explanation in part 2).

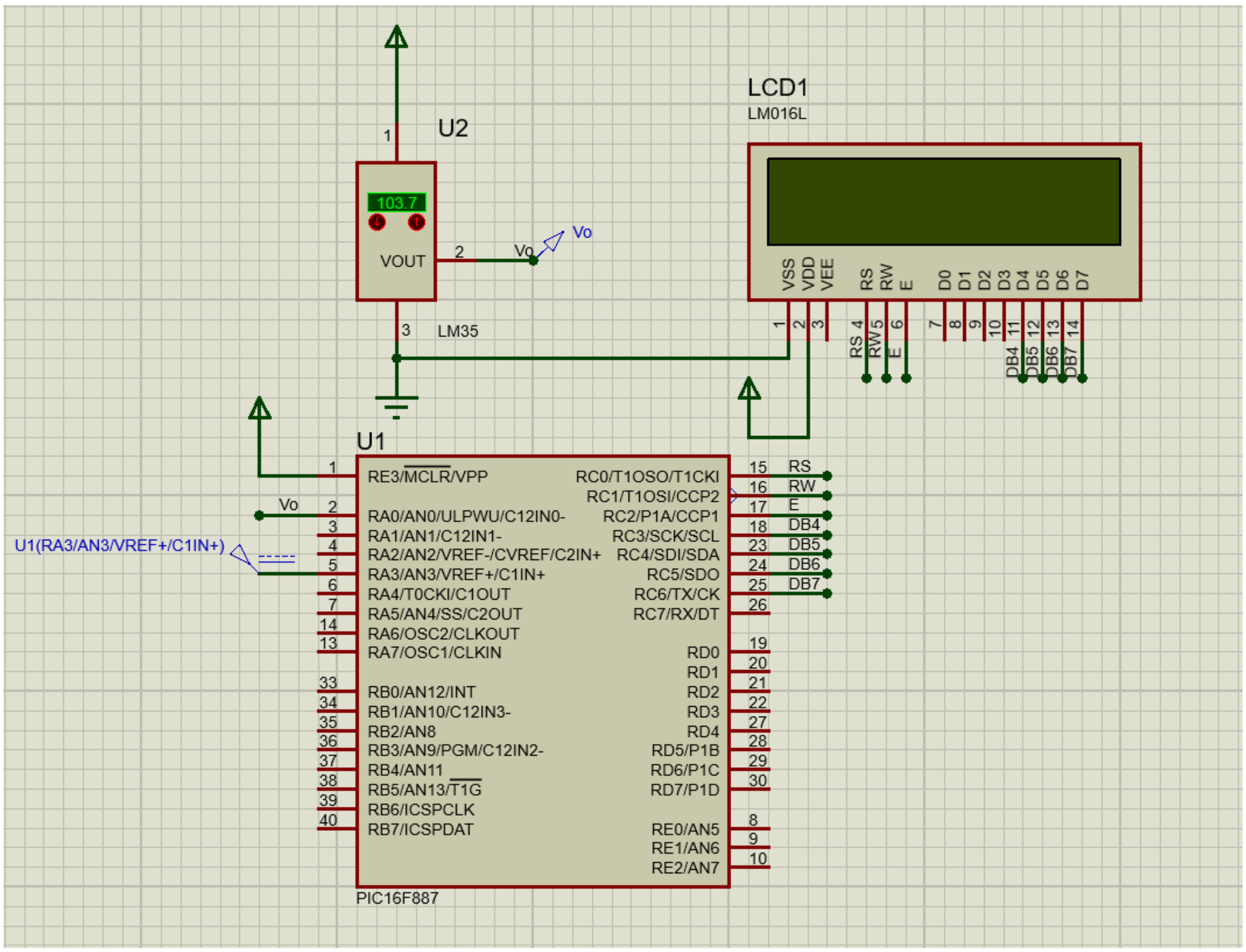

Fig: Exercise 7.2 Schematic view

2. Functionality

1.5V reference voltage using:

Ideally, the output voltage of the LM35 sensor is expressed by: $V_{out} = \frac{\text{Temperature}}{100}$ [V]

And the ADC value can be read from the PIC is known as: $ADC = \frac{1024}{V_{ref}}.V_{out}$

If the increment of the temperature is 0.1 degree Celsius, the voltage increment will be 0.001 Volts and so the ADC increment will be expressed by:

$$\Delta ADC = \frac{1024}{V_{ref}}.0.001$$

Or we may prove the increment of ADC value through linear function:

$$ADC_2 = \frac{1024}{V_{ref}}.V_2 = \frac{1024}{V_{ref}}.(V_1 + 0.001)$$

$$ADC_1 = \frac{1024}{V_{ref}}.V_1$$

By subtraction, we calculate the difference:

$$\Delta ADC = ADC_2 - ADC_1 = \frac{1024}{V_{ref}}.\ 0.001$$

Ideally, setting the maximum value of temperature corresponding to the full scale ADC, which is 150^{o}C – 1024 relation, we must use 1.5V reference voltage. In addition, using this value of reference only causes temperature error of 0.1 degree Celsius due to the step/difference of ADC is closely 0.6827 which means 1 step of temperature (increment of 0.1) may cause the ADC increment neglectable but 2 or more steps count (we are considering ideal calculations).

Example:

1. Consider temperature of 30 degrees Celsius, after 10 minutes it changed to 30,1. Let's calculate the ADC value read from PIC microcontroller:

Ideal calculation:

$ADC_1 = \frac{1024}{V_{ref}}.V_1 = \frac{1024}{1.5}.0.3$ = 204.8 (consider 204)

$ADC_2 = \frac{1024}{V_{ref}}.V_2 = \frac{1024}{1.5}.0.301$ = 205.4 (consider 205)

We see the output ADC is even better than we expected the error of 0.1 degree Celsius.

2. Consider temperature of 75 degrees Celsius, after 10 minutes it changed to 75,1. Let's calculate the ADC value read from PIC microcontroller:

Ideal calculation:

$ADC_1 = \frac{1024}{V_{ref}}.V_1 = \frac{1024}{1.5}.75$ = 512

$ADC_2 = \frac{1024}{V_{ref}}.V_2 = \frac{1024}{1.5}.0.751$ = 512.68 (consider 512)

We see now, the output ADC remains the value of 512, so the error of temperature is 0.1 degree Celsius.