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ADVANCED OPERATION OF THE INSTRUCTION SET (octubre de 2021)

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Summary - For this laboratory practice we are trying to implement firmware in an 8-bit Microchip microcontroller in order to experiment with the input / output pins, to know the peripherals and settings of the instruction set. Different exercises are carried out such as: operating a 16x2 LCD screen from the microcontroller, capturing data from a 4x4 matrix keyboard in a microcontroller, using the microcontroller's ADC converter to capture analog signals, implementing a strobe display. With the assistance of a microcontroller in order to explore the potential of microcontrollers as embedded systems.

Index of Terms -ADC-strobe- Microcontroller, PIC16f887, Input and output ports, Instruction set, Delays, LCD, PCLATH, TIMERS, INTERRUPTIONS.

I. INTRODUCTION

The laboratory practice of the microcontrollers subject is carried out, which consists of a series of exercises that aim to reinforce all the topics addressed in class.

As the handling of the set of instructions to enable and disable the input and output ports, deactivate internal resistors, perform mathematical and logical operations and store them in memory, creating delays of different times from the microcontroller's clock frequency. All this applied to projects such as handling an LCD screen, using buttons, displaying data on a 7 segment display, handling keyboards, converting analog to digital signals and strobe display.

II. LABORATORY SUMMARY

A. Assembly of the hardware necessary for the laboratory activity.

For the development of the practice, a circuit must be built that includes the microcontroller connected to: a 16X2 LCD, a 4x4 matrix keyboard and three 7-segment displays connected through 10 pins only (for a strobe display, 7 data pins and 3 for multiplexing). You must have at least two pins enabled as analog inputs.

B. 16X2 LCD operation.

It is required to build a system that sends a message through the 16X2 LCD, which will be the student's names through a public type display. Display these names for an indefinite period of time, in addition the static "UPTC" message should be permanently displayed on the second row of the LCD.

C. 4x4 matrix keyboard control and strobe display.

Use a matrix keyboard to capture 3 “XXX” values and when pressing a button you must send them to the LCD and the three 7-segment displays through strobe display, you must include a button on the matrix keyboard that resets these values to “000”.

D. Analog digital converter.

Read an analog signal through the microcontroller ADC converter, use a matrix keyboard to switch between at least two channels of the microcontroller converter, display the captured analog decimal value on the LCD.

III. METHODOLOGY

For the development of the guide, first the necessary circuit was implemented to comply with everything required in the laboratory in the proteus simulator, see figure 1. In order to verify the correct operation, before its respective implementation in the protoboard.

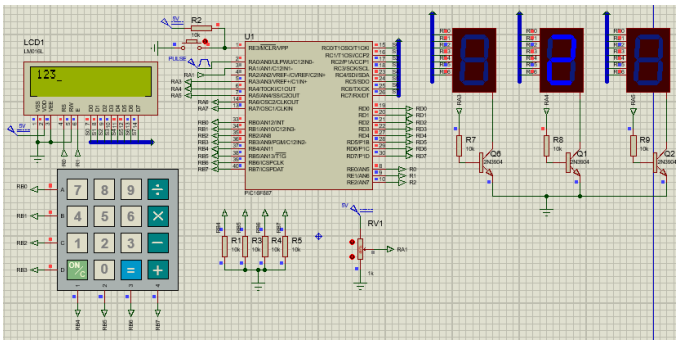

Fig. 3.Implementation of the circuit of figure 1 in proteus.

In the center is the pic16f887 microcontroller. On the left is the 16x2 LCD screen connected to the microcontroller via the data bus and the 4x4 keyboard, below there are 4 resistors for the keyboard pulldown connection. On the right there are 3 7-segment displays that have the same data bus, and the power pin is multiplexed to achieve the stereoscopic display effect. The potentiometer that is located in the lower center is to vary

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the voltage in a range of 0 to 5v that is used for the ADC converter part.

A. Assembly of the hardware necessary for the laboratory activity.

To assemble the circuit, the same one as in figure 1 was implemented, a double breadboard was required due to the large number of components.

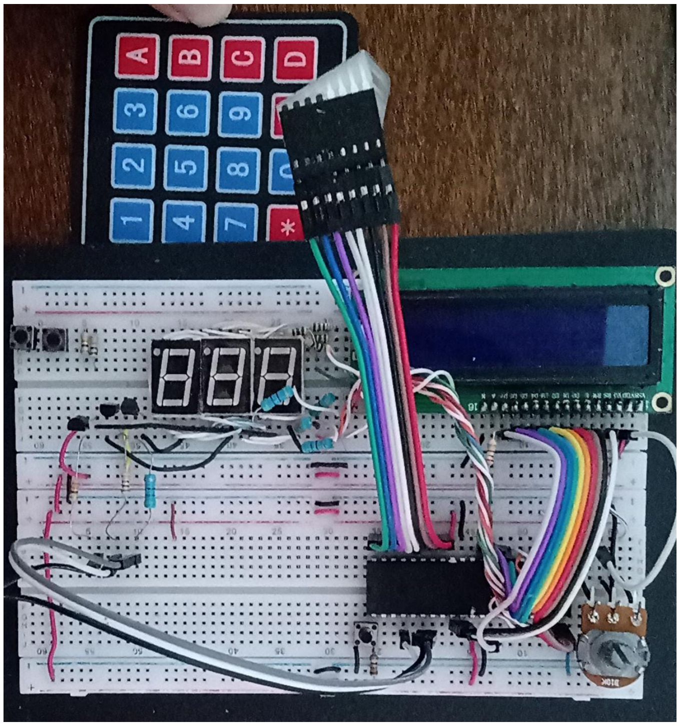

Fig. 2.Physical implementation of the circuit in figure 1.

B. 16X2 LCD operation.

Scrolling a message from right to left, the algorithm can very easily scroll up to 255 characters.

The table has a size of 59 characters, where 32 are to give the effect of which message disappears and reappears, the other characters contain the information of my name (JUAN CAMILO SERRANO CORREA), so that it was possible to give the effect of the type display public; The sliding window method was used, which consists first of displaying the first 16/59 characters on the LCD screen, after any time, in this case 20 ms, then the window is slid, that is, the following are loaded 16 data that would be data from 1 to 17, then from 2 to 18 and so on indefinitely. Figure 3 shows an example of the aforementioned.

0	1	2	3	4	5	6	7	8	9	10	11	12
0	1	2	3	4	5	6	7	8	9	10	11	12
0	1	2	3	4	5	6	7	8	9	10	11	12
0	1	2	3	4	5	6	7	8	9	10	11	12
0	1	2	3	4	5	6	7	8	9	10	11	12
0	1	2	3	4	5	6	7	8	9	10	11	12
0	1	2	3	4	5	6	7	8	9	10	11	12
0	1	2	3	4	5	6	7	8	9	10	11	12
0	1	2	3	4	5	6	7	8	9	10	11	12
0	1	2	3	4	5	6	7	8	9	10	11	12
0	1	2	3	4	5	6	7	8	9	10	11	12
0	1	2	3	4	5	6	7	8	9	10	11	12
0	1	2	3	4	5	6	7	8	9	10	11	12
0	1	2	3	4	5	6	7	8	9	10	11	12

Fig. 3.Sliding window method.

For the part of displaying the UPTC message, there is nothing to explain.

C. 4x4 matrix keyboard control and strobe display.

For matrix keyboard programming, it is essential that these pins be read through interruptions, otherwise their operation would be inefficient and would consume more processing resources, as well as making it difficult to complement their use with another application. The number of buttons on the keyboard is 16, but it is impractical to use 16 pins of the microcontroller for this task, so the operation consists in that the moment a key is pressed, the next machine cycle is done. The call to the interrupt function, which performs a scan for each row of the keyboard, checking which pin was pressed and knowing the port that called the interruption, the two coordinates of the button are pressed, in this way only 8 pins of the microcontroller are required.

For stereoscopic viewing, the same data bus is connected to all displays, a sweep is performed on the cathode pin so that only one display lights up at the same time.

When the first key is pressed it is stored in a variable, if it is pressed a second time this value is stored in another variable and finally when a key is pressed for the third time it is stored in another variable. Each of the three variables contains the data for each of the three displays respectively.

Additionally, two buttons on the keyboard are dedicated to clearing the 3 variables and showing the data on the display, this is done with the commands that the LCD has.

D. Digital Analog Converter

For the conversion of analog signals, in the absence of a signal generator, a potentiometer is used for an analog channel and a button for the second analog channel, which simulates being the analog signals that the microcontroller is going to convert

to digital.

IV. Flowcharts

The flowcharts only present the most important logic of the program, omitting parts such as: pin configuration, delays, display table, LCD RE and WE commands etc.

When it is required to explain code for a function, it is represented by another flowchart.

Flowchart 1 from point 1 begins by sending the LCD initialization and printing the uptc message in row 1.

In the next box, place the cursor in row 0, load data to some variables and iteratively start calling the MY-NAME function

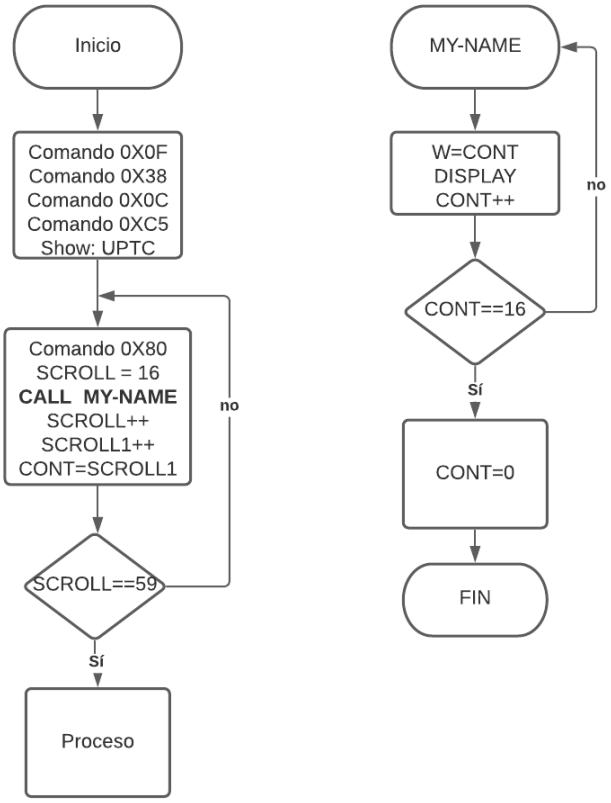

Diagram 1. Flow diagram point 1.

For point two, the first part corresponds to the function called by interruption of port B, it consists of the operation of the 4x4 keyboard that first determines which of the 4 ports produced the silk interruption then tests one by one which of the following 4 ports is in high, in order to determine which key was pressed. Finally, it loads the value to be shown on the LCD to W and temporarily the value to be shown on the displays. See diagram 2.1.

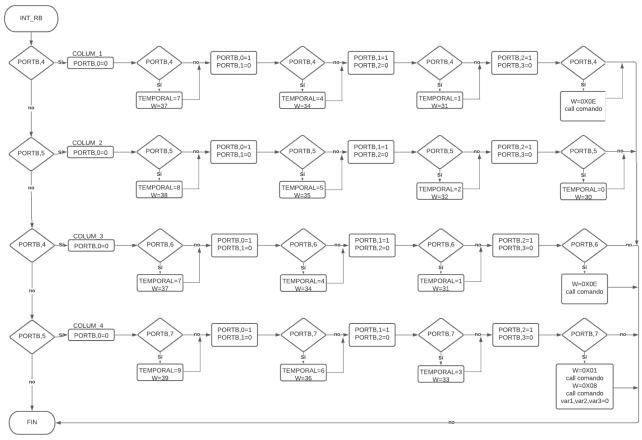

Diagram 2.1. Flow diagram point 2.

The second part, see diagram 2.2. It is for stereoscopic viewing. As it is only required to show 3 pressed keys, these are assigned to each display in order, when a key has already been assigned to the first display then it cannot receive any more values and thus with the other two displays, when the 3 displays are assigned a value can no longer be received, until the "=" key is pressed so that the variables are cleared and the process can be restarted again.

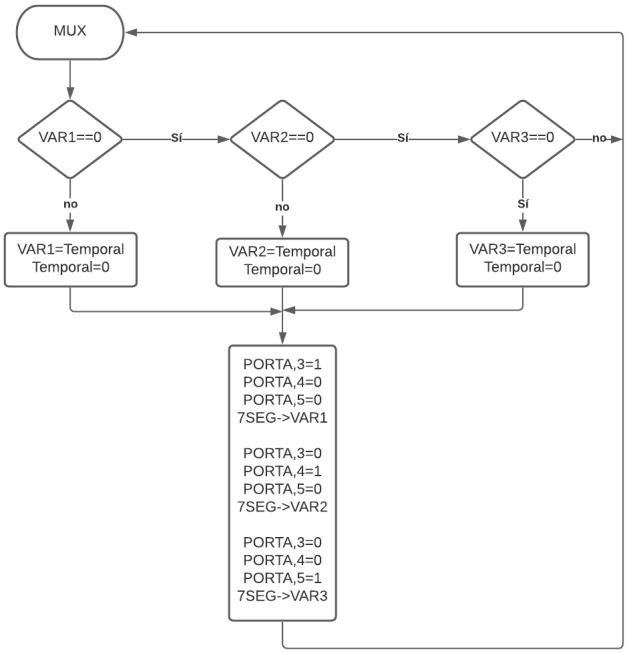

Diagram 2.2. Flow diagram point 2.

For the conversion of analog values, the selection of the port is done by means of the keyboard, where only the keys “0” and “1” are functional, these enable the channel AN0 and AN1 respectively. See diagram 3.

The keyboard flow diagram does not need to be exposed since its operation is very similar to diagram 2.1.

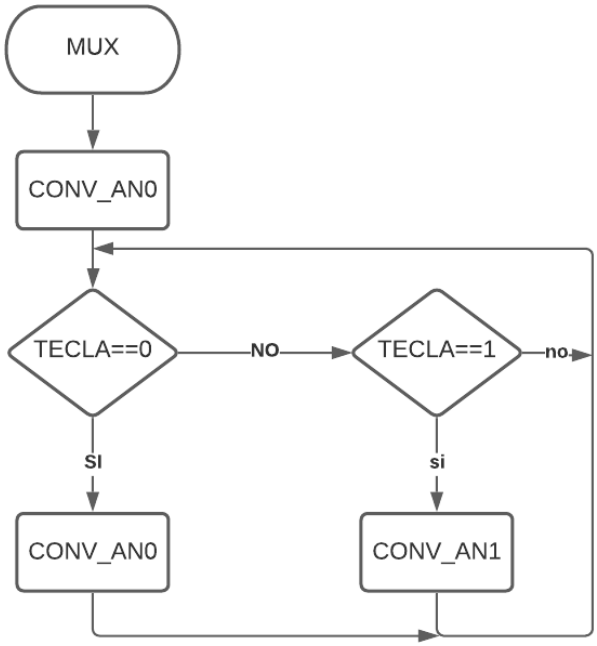

Diagram 3. Flow diagram point 3.

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V.ANALYSIS OF RESULTS

All the projects were previously simulated in proteus to corroborate the good performance. Then the implementation proceeded.

A. 16X2 LCD operation.

To operate the screen; both the static message and the public type message worked perfectly in simulation.

At the time of implementation, the static message worked well but it was not possible to display the public type message.

B. 4x4 matrix keyboard control and strobe display.

In the simulation it worked, but for now to carry out its respective implementation, it was necessary to adjust the memory bank where the code was executing and save the high bit of the PCLATH.

C. Conversor Análogo digital.

En simulación se consiguió cumplir con lo requerido, pero a la hora de realizar su respectiva implementación no se consiguió su correcto funcionamiento.

IX. CONCLUSION

Although assembly language occupies less memory, the development of some algorithms have an extra complexity, such as the manipulation of data with a higher quantity of bits than the microcontroller, in this case data of more than 255.

It is evident how unreliable the proteus simulator is for microcontrollers, since many errors that occurred in the implementation were not evident in the simulation.

Port B interrupts and timers provide a wide variety of projects that can be developed with ease.

It was not possible to implement the LCD command that performs the scrolling, as this scrolling is done on both rows, and it was only required to be done on a single line.

REFERENCES

[1] https://pdf1.alldatasheet.com/datasheet-pdf/view/197543/MICROCHIP/PIC16F887.html

[2] http://ww1.microchip.com/downloads/en/AppNotes/00556e.pdf

No fue necesario el uso de más bibliografía, toda la información requerida fue vista en clase.