Embedded systems: lab 1

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2025-2026

1 Introduction

The goal of this first lab session is to build a first electronic circuit containing a microcontroller in order to program it. This session will roughly last 3:30 hours. Please, register in the following form, and, before attending the lab please follow the instructions of Section 2. The active participation to this session is necessary to take the exam.

2 Homework

In order to program the MCU during the lab (PIC16F1789, Microchip), every student must download and install the required programming environment. To do so, go to this wep page and download the software according to your system, then go to this web page to find installation instructions.

Once this has been done, it is time to test your installation. For that, download `blink.asm` and `Makefile`. Create a new directory and move `blink.asm` and `Makefile` there. Then, open `Makefile` and edit it according to your system. To do so, find the directory in which MPLAB is installed and replace paths so that they end with the same name as is the original `Makefile`.

Then, open a terminal (on Windows, use WSL or Ubuntu on Windows) in the directory where `blink.asm` and `Makefile` are located and type `make`. If no error is reported, you are ready for the lab!

3 Powering up the circuit

3.1 Material

For this part, you will need a breadboard, a voltage regulator (7805), two 1 μF electrolytic capacitors **Caution: Polarity**, a diode, a few black and red wires, a multimeter, and a benchtop DC voltage source.

3.2 Manipulation

On a breadboard, connect the components according to figure 1 (tip: to find out which pin is which on the 7805 regulator, check its datasheet[1]). Make sure that the shorter leg of each capacitor is connected to 0 V and that their longer leg is connected to a positive voltage. The aim of this circuit is to convert an input DC voltage of about 9 V (typically like a battery) into a steady DC voltage of 5 V, to power the microcontroller. The diode ensures that the polarity is respected, to protect the circuit. Capacitors act as small charge reservoirs: they deliver or absorb current when an abrupt voltage change occurs.

Once this wiring is done, it is time to power up the circuit. For this, you will use the DC voltage source. If you do not know how to use it, ask the assistant for a demo. Measure the output voltage with a multimeter (black lead in comm and red lead in V/Ω). What is the output? Turn off the power supply.

4 Adding the MCU

Now that there is a good power input, it is time to connect a microcontroller. Before adding anything to the circuit, make sure that the power supply is off. Plug the PIC16F1789 across the central line. Place a 100 nF capacitor across each V_{DD}/V_{ss} port pair (tip, to find out where these pins are located, check the datasheet). Again, these

[1] LM7805 is an alias for 7805

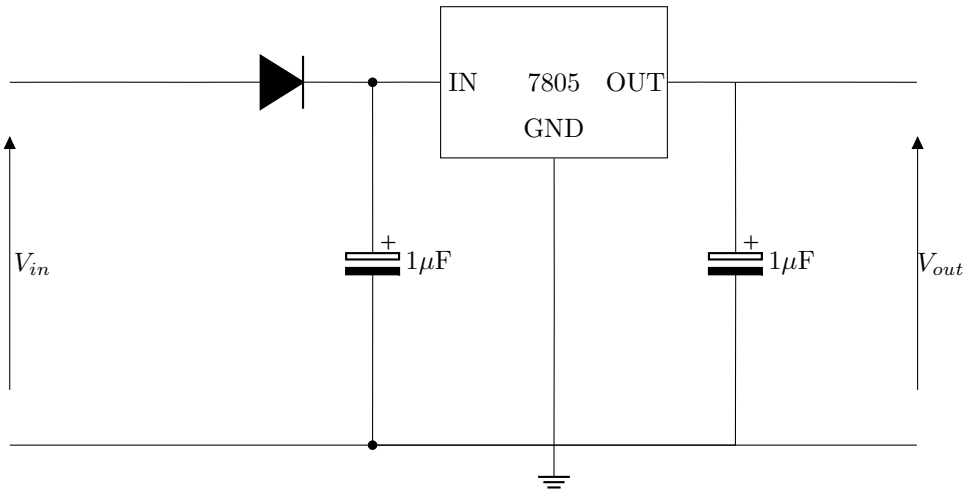

Figure 1: Power input stage

are decoupling capacitors, used to maintain a steady voltage. To maximise their beneficial effect, place them as close as possible to the MCU. Connect V_{DD} pins to +5 V and V_{SS} pins to ground.

Then, connect a 10 kΩ resistor between +5 V and the VPP/$\overline{\text{MCLR}}$/RE3 pin of the microcontroller. This allows to reset the microcontroller. When it is high, the MCU is in normal mode and whenever it goes low, the MCU experiences a reset.

Now, connect a resistor and an LED according to figure 2. The use of a resistor is mandatory as it controls the current flow across the LED (and hence from the MCU).

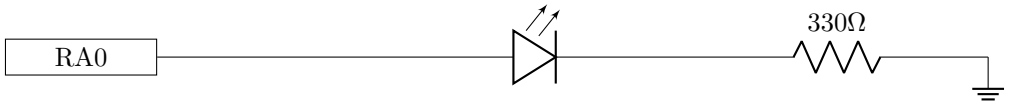

Figure 2: LED connection

Once this is done, power the cicuit. If everything went well, you should see the LED blink. This is because the MCU has been preprogrammed for this (for the purpose of this lab). Turn off the power supply before entering the next section.

5 Programming the MCU

Now, we will change the program running on the MCU (we will change the frequency at which the light blinks). For that, make sure that the power supply is off and then connect the PICKIT BASIC programmer to the board. There are five wires to connect:

- Master clear, to the VPP/$\overline{\text{MCLR}}$/RE3 pin of the MCU (before the resistor).
- V_{DD} to the +5 V line.
- GND to the ground.
- DATA to RB7/ICSPDAT PIN.
- CLK to RB6/ICSPCLK PIN.

To make things clearer respect the colour code on the programmer.

Once this is done, power on again the circuit and plug the USB terminal of the programmer to a computer where `blink.asm` has been succesfully compiled. On that computer, open `mplab_ipe`. Select PIC16F1789 as Device, PICKIT BASIC as tool, and `blink.hex` as HEX file (you will find it in the same directory as `blink.asm`) under Settings chose Release from Reset. Then, click on program. The result of the operation will be displayed in

the console of the application. If everything went well, it should say success and the LED should be blinking twice as fast as previously.

Congratulations! This is the end of this first session. Next time, we will write our first program, use inputs, timers, interrupt routines etc.