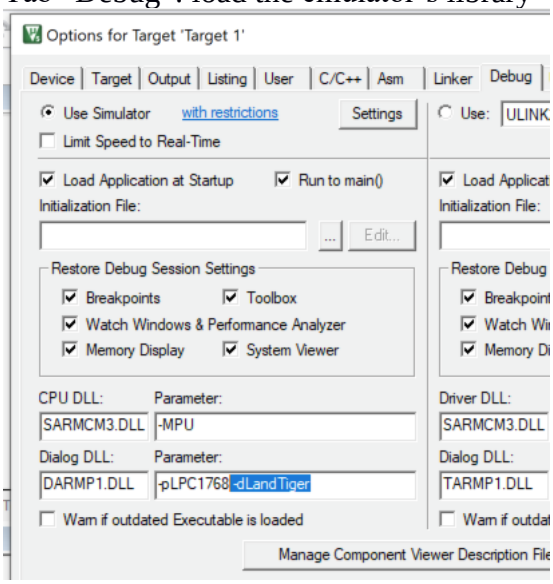
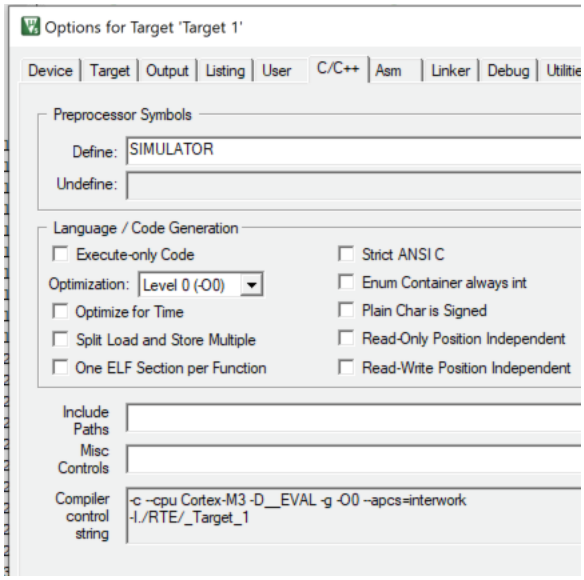
Architetture dei Sistemi di Elaborazione 02GOLOV Laboratory 9	Delivery date: Tuesday 22/12 Expected delivery of lab_09.zip must include: - zipped project folder of the exercise 1 - this lab track completed and converted to pdf format.

Solve the following problems by starting from the *sample_BUTTON_LED* project (open the file project from the uVision menu). Test the problems using the *LandTiger* emulator.
Remember to check if the emulator is enabled in the menu "Options for Target" after installing the emulator.

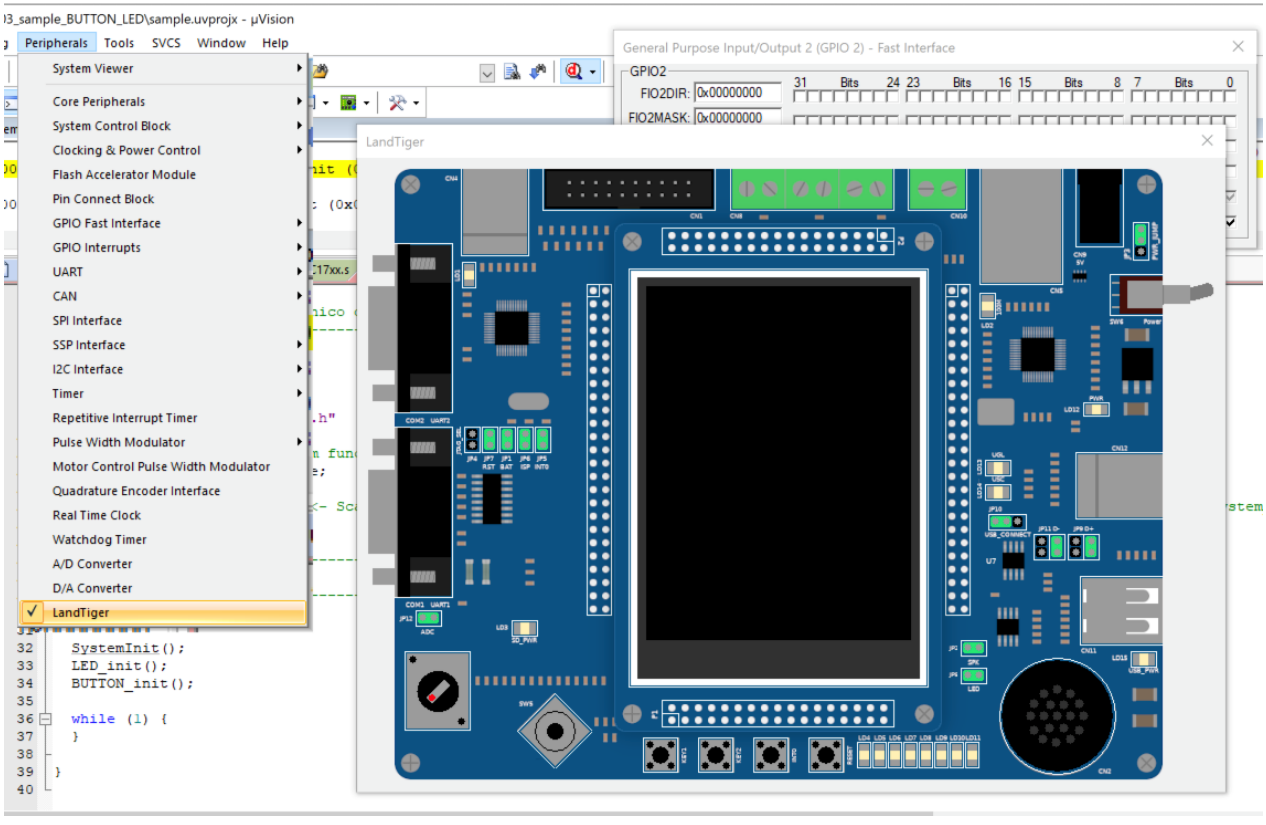
Tab "Debug": load the emulator's library



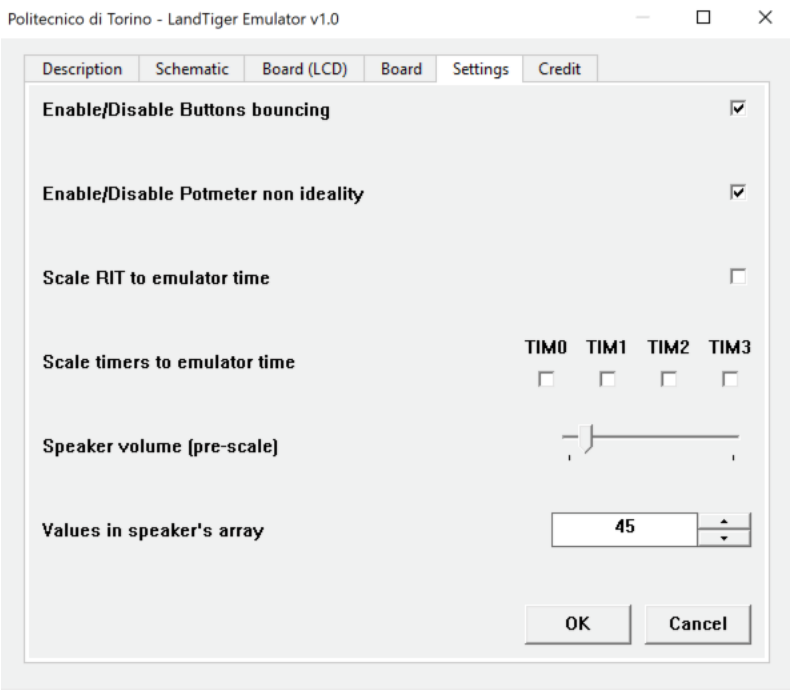
Tab "C/C++": define SIMULATOR



Once you run the debug, if the emulator is correctly installed and added to the debug option, you shall find *LandTiger* under the Peripherals menu.



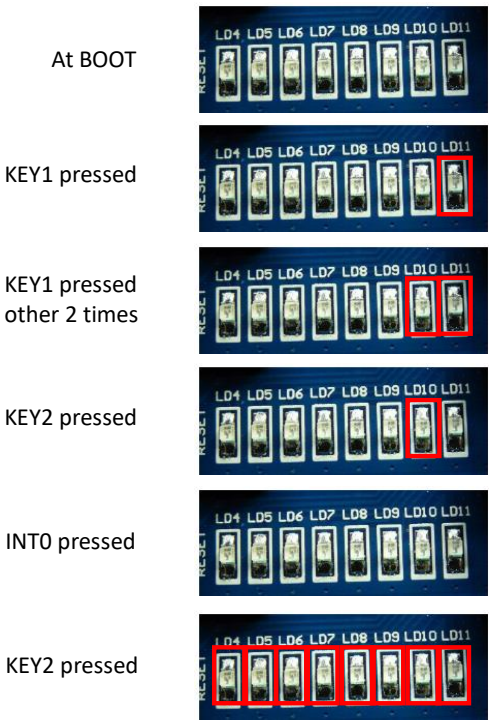
If you right-click on the board, you can access the configuration menu, where you can eventually change some default parameters (tab “Settings”).

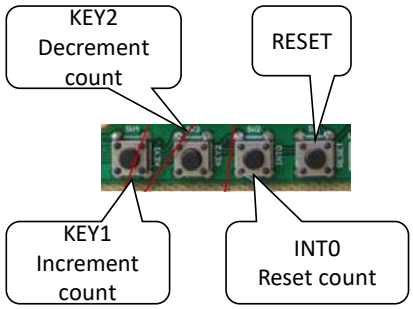


Exercise 1) Implement an 8-bit “signed counter” by using LANDTIGER board; the software permits to use buttons to update a counting value which could be either positive or negative, and the LEDs to show the current value. By first using emulation capabilities, please implement the following functionalities:

- increment a variable every time the button Key1 is pressed,
- decrement when Key2 is pressed (in case, go to negative number)
- reset the count when INT0 is pressed

LEDs are showing the current count in a binary, 2’s complement representation.





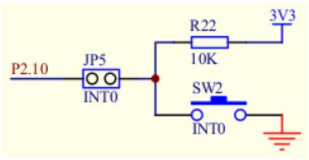
HINT: It could be useful to use a global variable in order to keep the information about turned ON LEDs. For example, using a variable called “`char led_value`”, already available in the project.

Q1: By adjusting the emulator settings, you can activate a non-ideal behaviour of the buttons called "bouncing". Do you notice any different behaviour on the emulator if you enable such a bouncing setting? Please comment.

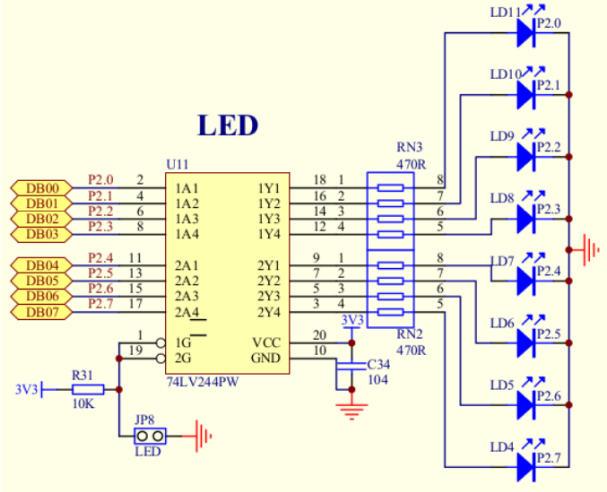
By enabling buttons bouncing, the counter is increased by more than one unit. This non ideal behaviour is due to how switches are physical made. When a switch is toggled, the contacts have to physically move from one position to another. As the components of the switch settle into their new position, they mechanically bounce, causing the underlying circuit to be opened and closed several times. In this scenario, when a switch is pressed, the corresponding interrupt handler is trigged multiple times.

Q2: What happens if you act on jumpers JP5 and JP8 with respect to the default configuration?

Key INT0 (SW2) is only connected to P2.10 when the jumper (JP5) is inserted. So, key INT0 may be disabled by removing the jumper (JP5).



The 8 data lines P2.0-P2.7 are directly connected to a 74LV244 driver (U11) followed by 8 red LEDs (LD4 ... LD11). To enable driver output, a low logic level must be provided to pin 1 and pin 19 of the driver. This low logic level is provided by a pull-up resistor (R31) and an inserted jumper (JP8) connected to ground. LEDs may be disabled by removing the jumper (JP8).



Using the emulator, check the schematic and fill the following table.

Component	Pull-up resistor name	Pull-up resistor size
LEDs	*R31*	*10 kΩ*
INT0	*R22*	*10 kΩ*
KEY1	*R25*	*10 kΩ*
KEY2	*R23*	*10 kΩ*