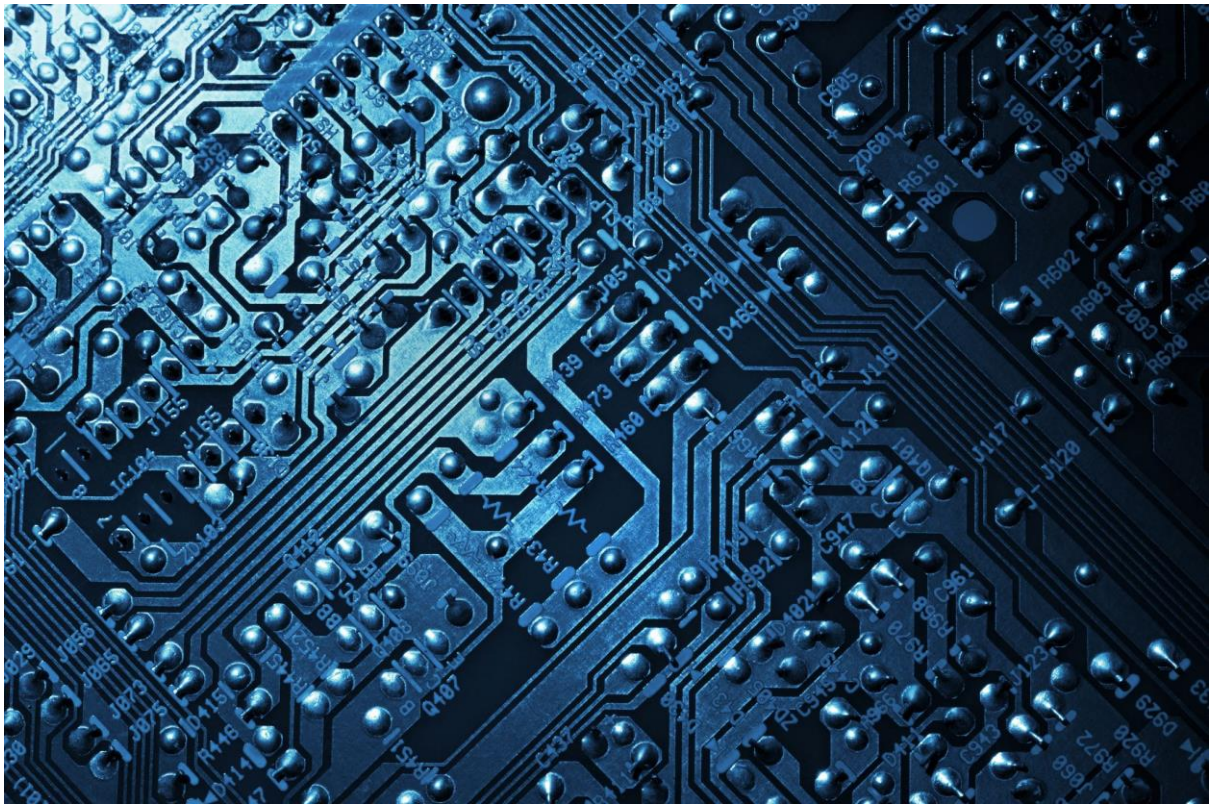
CSE211
Introduction to Embedded Systems



TEAM 17

Mechatronics and Automation Program

Mokhtar Khaled Salah El Din	19P8294
Omar Tarek Ibrahim Salah	19P8492
Dina Essam Sayed	19P6501
Mohamed Salah Ibrahim	19P6357
Omar Mahrous Eltoutongy	19P1060
Morcous Osama Kamal	19P6167

Name	Contribution
Mokhtar Khaled Salah El Din	GPIO, and GPIO interrupts driver
Omar Tarek Ibrahim Salah	GPTM driver
Dina Essam Sayed	Calculator and Stopwatch
Mohamed Salah Ibrahim	Calculator and Stopwatch
Omar Mahrous Eltoutongy	LCD module
Morcous Osama Kamal	Timer Mode

Table of Contents

1. Introduction

It is required to make an embedded application which has three modes, calculator mode, stopwatch mode, and a timer mode. The calculator mode has four operations, addition, subtraction, division, and multiplication. The stopwatch has three push buttons, one to start counting, one to pause, and one to reset. Finally, in timer mode, timer starts ticking with a certain time, and when the timer timeouts, buzzer starts working. The desired time is written on the keypad and the timer starts ticking when 'D' is pressed.

2. Special Functions

2.1. Concurrent modes

In this project, we also concentrated to make the modes work concurrently not sequentially. The user can use the calculator mode while the stopwatch and the timer are counting. When the timer timeouts, buzzer is triggered even if the user is not in the timer menu.

2.2. Stopwatch and Timer Status

At the top right of the LCD, there is "SN TN" which means **s**topwatch **n**ot working, **t**imer **n**ot working. If the stopwatch works alone, this string becomes "SW TN" which means **s**topwatch **w**orking, **t**imer **n**ot working. If the timer works alone, the string becomes "SN TW" which means **s**topwatch **n**ot working, **t**imer **w**orking. If both timer and stopwatch are working, the string becomes "SW TW" which means **s**topwatch **w**orking, **t**imer **w**orking. So, when the user is at the main menu or using the calculator, he will know if he forgot to turn off the stopwatch for example.

2.3. Stopwatch overflow

The LCD display minutes and seconds with format "MM:SS". The stopwatch can count up to 99 minutes, 59 seconds. If the stopwatch is still counting after that time, the time on the screen is frozen and blue LED is turned on indicating that stopwatch reached its maximum. If the user pressed the pause button or the reset button, the blue LED is turned off.

2.4. Stopwatch can be accessed anywhere

By pressing the start, pause, or reset button, the stopwatch is started, paused, or reset anywhere while the program is running. When the user goes to the stopwatch menu, stopwatch time is displayed on the screen.

3. Embedded concepts used in this project

a) General Purpose Input Output (GPIO) (for LCD, keypad, buzzer, and LED)
b) General Purpose Timer Module (GPTM) (for stopwatch and timer)
c) External Interrupts (for stopwatch push buttons)
d) Systic Timer (for generating delay for the LCD)

4. Timer Configurations

We used Timer0 and Timer1 in TIVAC. Both does not have pre-scaling, both counting up, both reload values are adjusted to generate interrupts after 1 second.

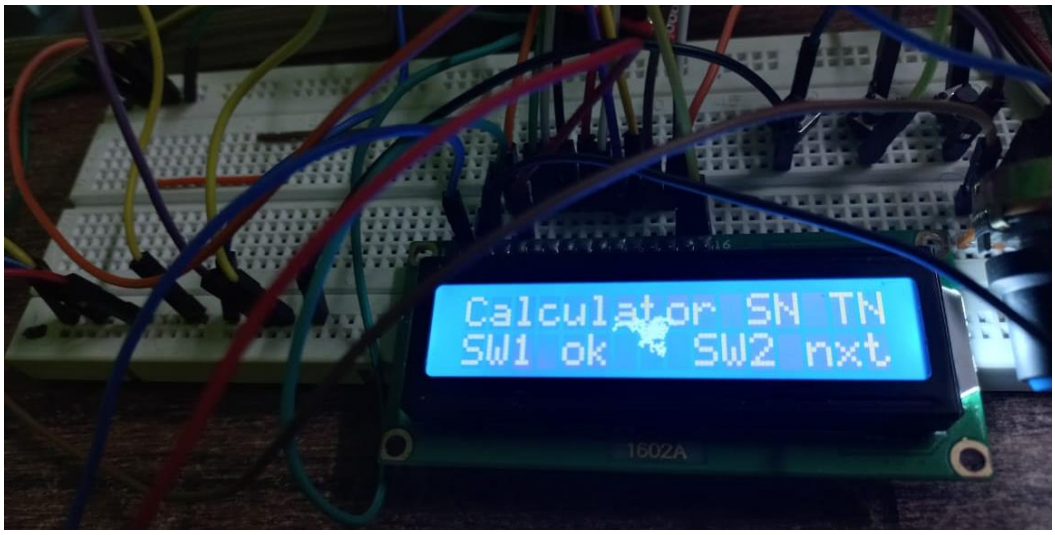
5. External Interrupts Configurations

Each push button for the stopwatch is connected to a separate PORT in TIVAC. All push buttons work with the help of the internal pull up of the microcontroller. All push buttons raise interrupts at falling edge.

3. Program flow

3.1. Explanation of the operation.

When the Program starts a menu which shows a text saying:



Where the SN and TN stands for Stopwatch not working, Timer not working

SW1 is the first switch on board which if pressed then we select the calculator mode

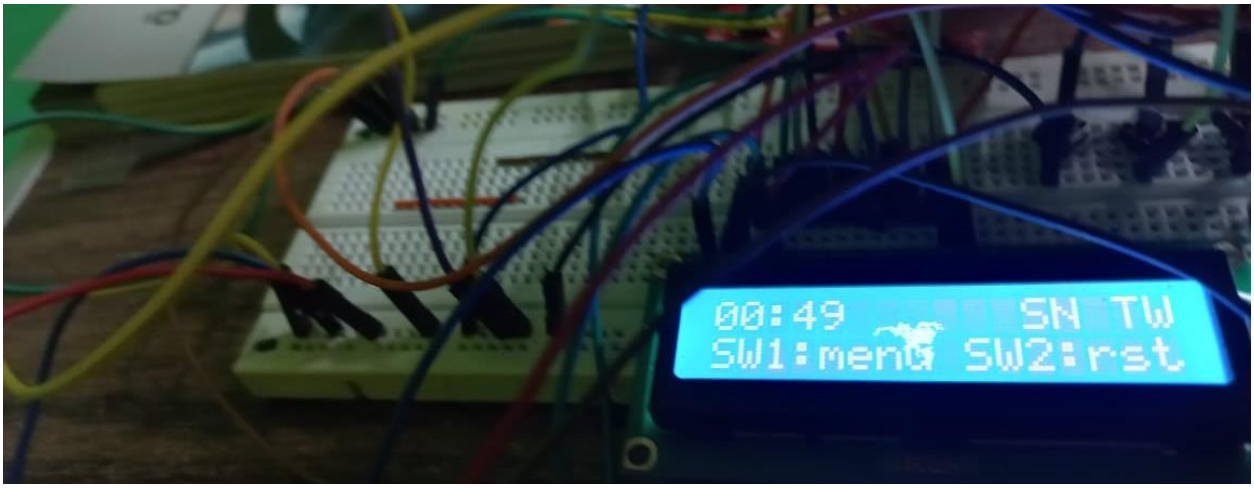
Here the calculator is performing operations whilst the stopwatch is working.

Return to main menu using Hash on keypad.

SW2 is the second switch at which if pressed then mode is switched from calculator to either timer or stopwatch.

If the stopwatch is working, then its status will be SW which refers to Stopwatch working.

Timer mode



If the timer is working, then its status will be TW which refers to timer working.

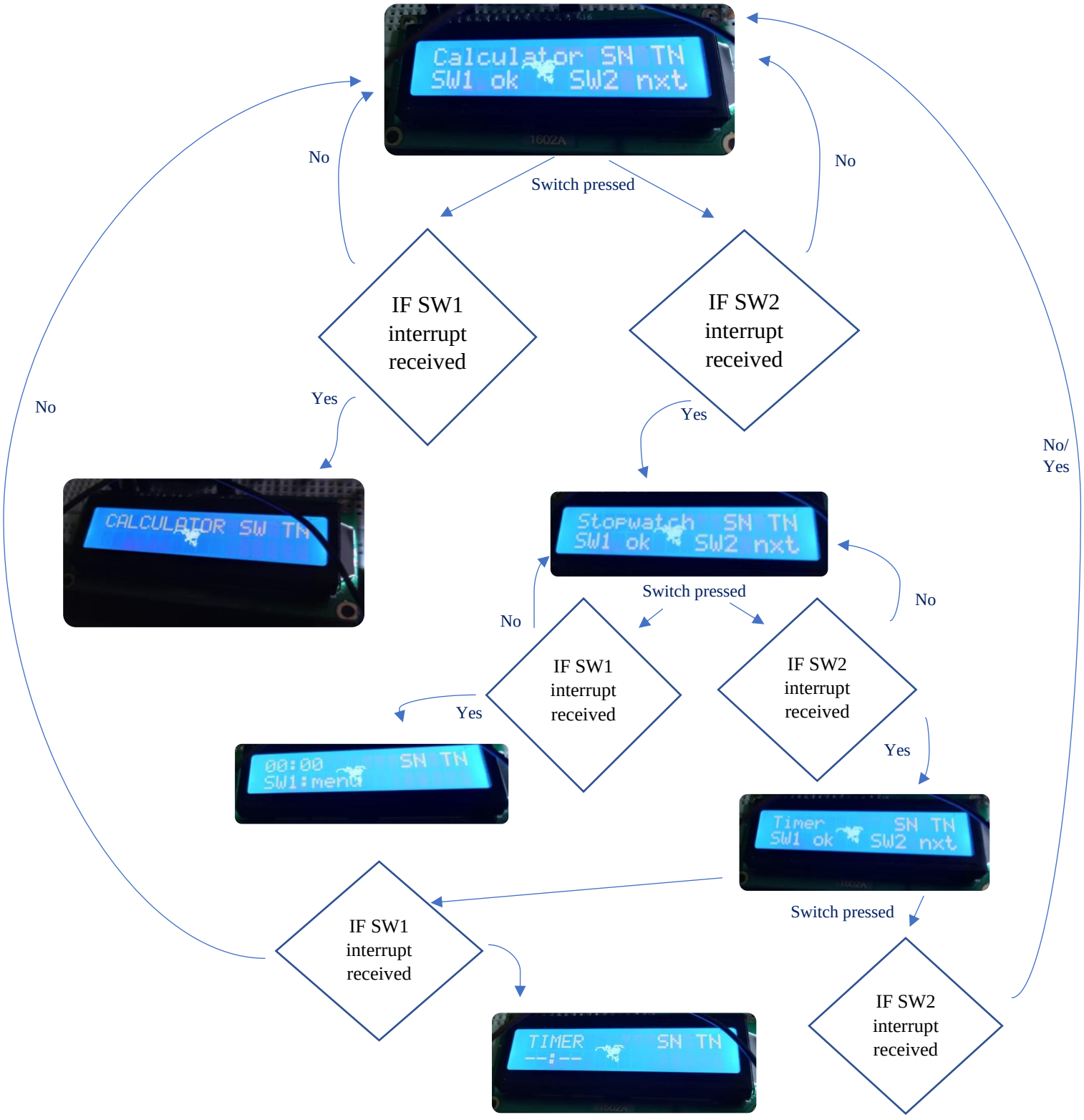
If we return to the calculator whilst having the timer or stop watch operating it'd be just fine as the calculator is unrelated to the operation of the timer nor the operation of the stop watch as they both operate with timers that are external and each operate with it's own timer.

Therefore when going from stopwatch to calculator it'll operate just fine and same goes for the timer.

Here the stopwatch is working as SW is written in the status as well as the calculator which is performing an addition operation.

3.2. Flow chart:

3.2.1. Main menu



User entered

Is user input invalid?

True

False

True

Did timer finish?

False

SW pressed

Is sw #?

Is sw is start?

Is sw is stop/pause ?

True

True

True

Did Stopwatch finish?

True

False

3.2.2. Special case:

In this case if timer or stop watch were already working and menu was selected:

Here SW is still working

Overflow

Blue LED Lights up indicating overflow

Here SW and timer are still working

Time out

Red LED Lights up Timer Time out

4. Link containing videos, images, and code

[CSE211 Embedded - Google Drive]