

Project 2

CSE 321 – REALTIME AND EMBEDDED SYSTEMS – FALL 21

NICK MINOR

PURPOSE: THE PROGRAM IS FOR A BARE-METAL AND USER-PROGRAMMABLE COUNT-DOWN ALARM SYSTEM. THERE IS FUNCTIONALITY FOR THE USER TO INPUT THE TIME DURATION OF THE TIMER AS WELL AS STARTING AND STOPPING THE TIMER. THE TIME REMAINING ON THE TIMER AND THE COMPLETION OF THE TIMER IS COMMUNICATED TO THE USER VIA AN LCD SCREEN AND LEDS.

Introduction

The program is for a bare-metal and user-programmable count-down alarm system. There is functionality for the user to input the time duration of the timer as well as starting and stopping the timer. The time remaining on the timer and the completion of the timer is communicated to the user via an LCD screen and LEDs.

Getting started:

1. Set up an empty project in Mbed Studio with MbedOS inside the project folder.
2. Place the file "CSE321_project2_naminor_main.cpp" into the project as the only file with a main function.
3. Select "NUCLEO-L4R5ZI" as the Target and connect the Nucleo to the computer using the micro-USB cable.
4. Connect the matrix keypad, LCD, LEDs to the Nucleo and breadboard.
5. Build the project and run to start the program.

Specifications

- Time is represented as m:ss (valid times between 0:00 and 9:59).
- User uses a prompt to enter the time.
- An LED will light up every time a value is entered.
- LCD will display "Time Remaining:" followed by how much time is left on the timer.
- System runs forever.
- Bounce is to be addressed and mitigated.
- Must use at least one interrupt and configured ISR.
- Bitwise masking used to control registers not used in an interrupt or the LCD display.

Features

A user can interact with the system by:

- Pressing A
 - Start or resume the timer when an input time is specified
- Pressing B
 - Pause the timer
- Pressing D
 - Input a time
- Pressing 0-9
 - Enter the desired input time

The LCD screen will display the time remaining on the timer.

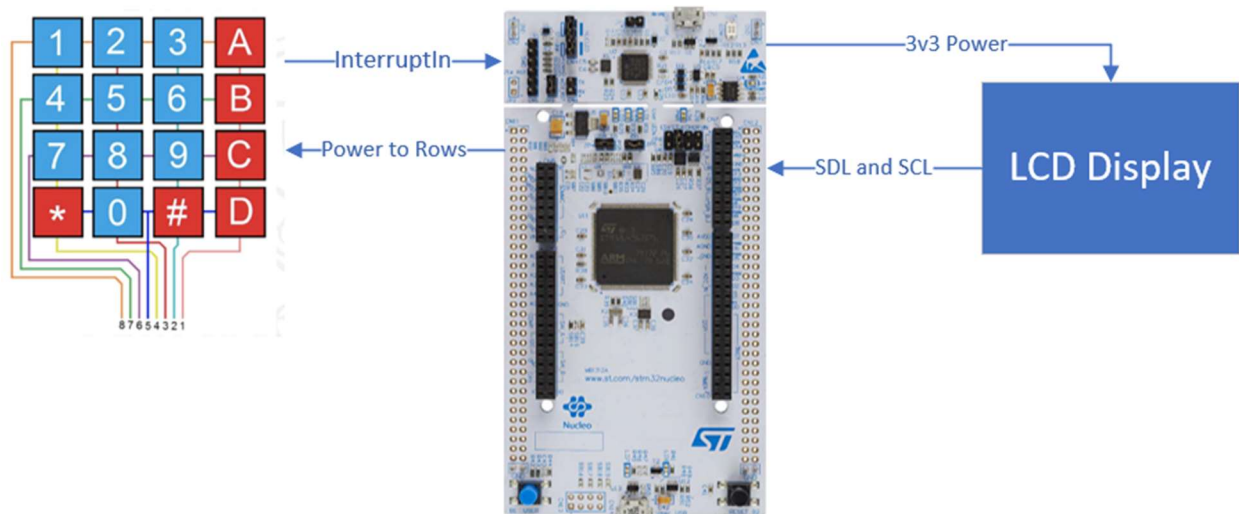
When the time has elapsed, the LCD screen will display "Time's Up", and two LEDs will light up.

Applications

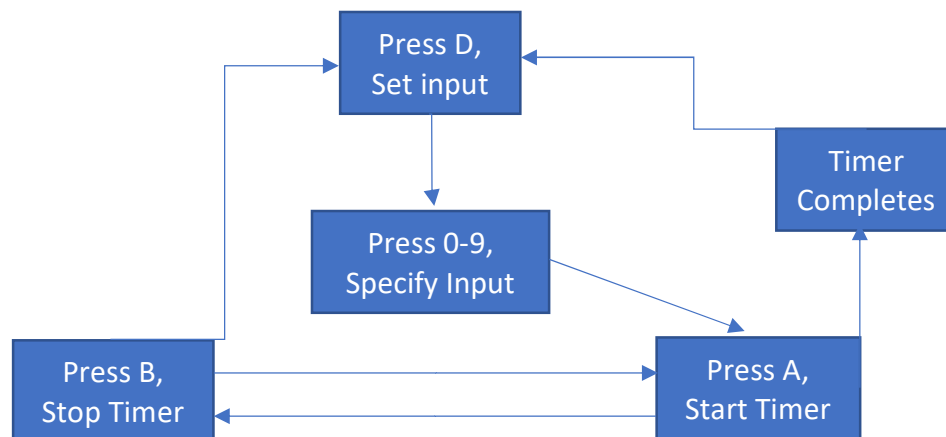
Possible applications for this system are anything that can utilize a countdown alarm. The system can be used inside things such as:

- Alarm clocks
- Microwaves
- Ovens
- Pomodoro timers

Block Diagram



Functionality Diagram



Bill of Materials

- Nucleo L4R5ZI
- LCD
- LEDs
- Matrix Keypad
- Solderless Breadboard
- Jumper wires
- USB-A to micro-USB-B cable
- Computer to run Mbed Studio (Windows, Mac or Linux versions available at <https://os.mbed.com/studio/>)

Schematic

Connect Power -> Breadboard -> Matrix Keypad rows ()
PB4 row1, PA4 row2, PB3 row3, PB5 row4

Matrix Keypad columns -> Breadboard -> InterruptIn (PC11 through PC8)

|
-> LED (long) -> resistor -> ground

LCD -> SDA (PB_9)

|
-> SCL (PB_8)

|
-> 3v3 power

|
-> ground

LEDs:

PB2 -> LED (long) -> resistor -> ground

PB6 -> LED (long) -> resistor -> ground

Test plan

Configure Matrix Keypad

- Create Interrupt Service Routines for each column of the keypad.
- Assign each column to a pin and create InterruptIn objects for each column.
- Have ISR be triggered on a rising edge for any keypress.
- Light up LEDs depending on the key that was pressed.

Configure LCD Screen

- Place 1802.h and 1802.c in project folder. Include 1802.h in main file.
- Create CSE321_LCD object with the number of columns and rows on the display, dots, SDA pin and SCL pin.
- Initialize LCD.
- Configure LCD to output messages and work with a timer.

Set up interaction between LCD and Matrix Keypad

- Pressing:
 - A: Start the timer
 - B: Stop the timer
 - D: Input the timer duration
 - 0-9: Specify time m:ss

Results

The test plan was ultimately successful as the desired outputs were achieved met specifications were met. The keypad properly receives input from a user and sends the information to the Nucleo. The Nucleo then parses this information and sends the appropriate outputs to the LCD screen and LEDs.

Recommendations for Improvement

- Create functionality for the timer to also count up from 0:00 to 9:59, allowing the user to enter a time that they would like to be counted to. The system should tell the user once this time is reached on the LCD screen and by lighting up LEDs.
- Implement more messages on the LCD screen so that the user better understand what is occurring and when they may make certain commands.