MICROWAVE OVEN

Project Documentation

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Abstract

"Microwave Oven" is the project which implemented on PIC controller, it has different modes of cooking such as Micro, Grill, Convection and Start modes. As per the user requirement the user can choose whichever mode of cooking he wants to use.

Our objective to implement all the modes and functionality of a Microwave oven on the PIC16F877A board using and test it on simulating on the Picsim lab software. The code is written in Embedded C
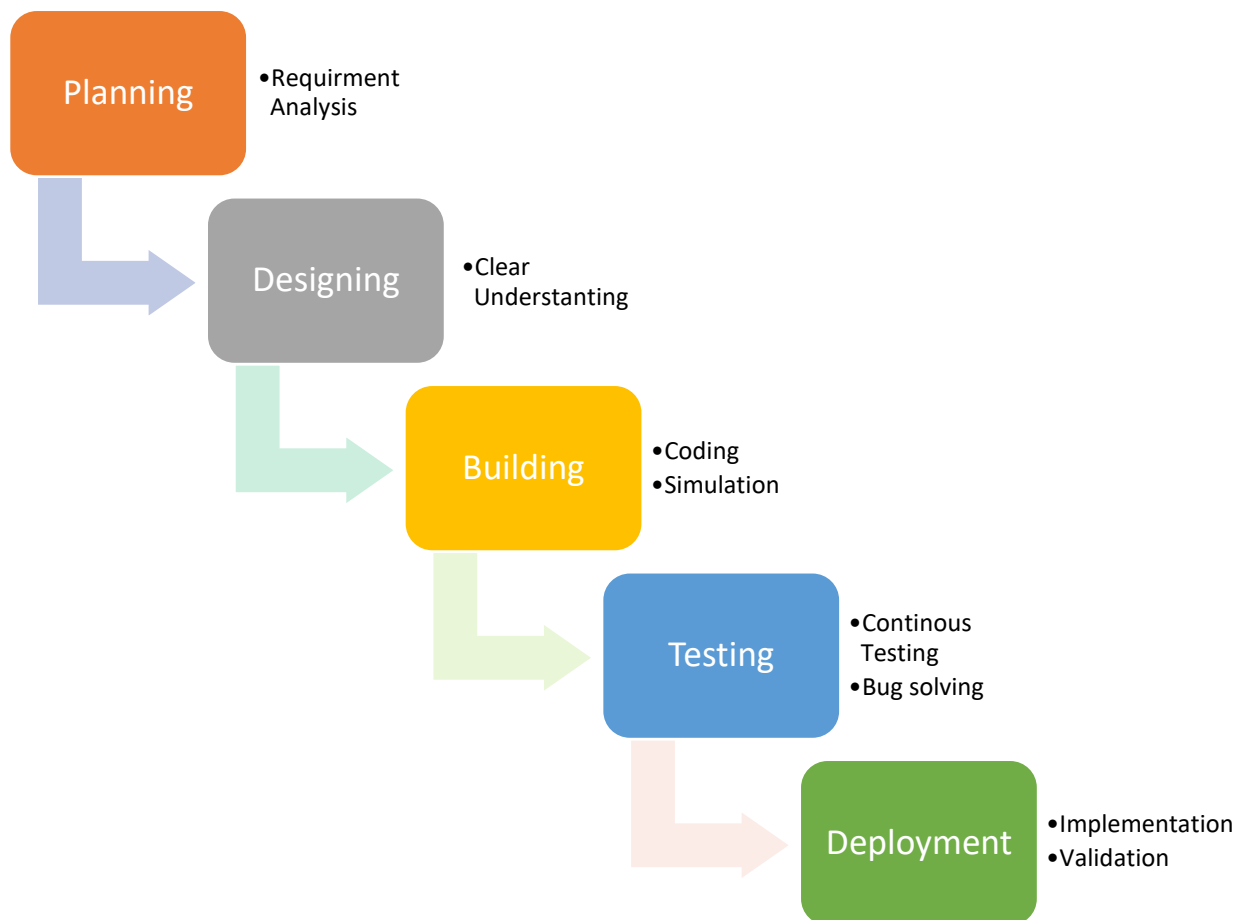
- **Key Features:**
    - Four different cooking modes
    - Count down Timer for each mode
    - Temperature can set manually
    - Generic code
    - Easy to implement
    - Real Time Status Display

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Project Development Phases

The project is developed considering the Software Development Life Cycle (SDLC) phases and divided into five phases of development. Below chart explains brief about these phases,

| Planning | •Requirment Analysis |

| Designing | •Clear Understanting |

| Building | •Coding •Simulation |

| Testing | •Continous Testing •Bug solving |

| Deployment | •Implementation •Validation |

Embedded Systems

Embedded system:

"Any combination of Hardware and Software which is intended to do a Specific Task can be called as an Embedded System".

Examples:

- o Microwave Oven
- o Washing Machine
- o TV
- o Cameras
- o Refrigerator, etc.

Categories of embedded system:

- Stand-alone
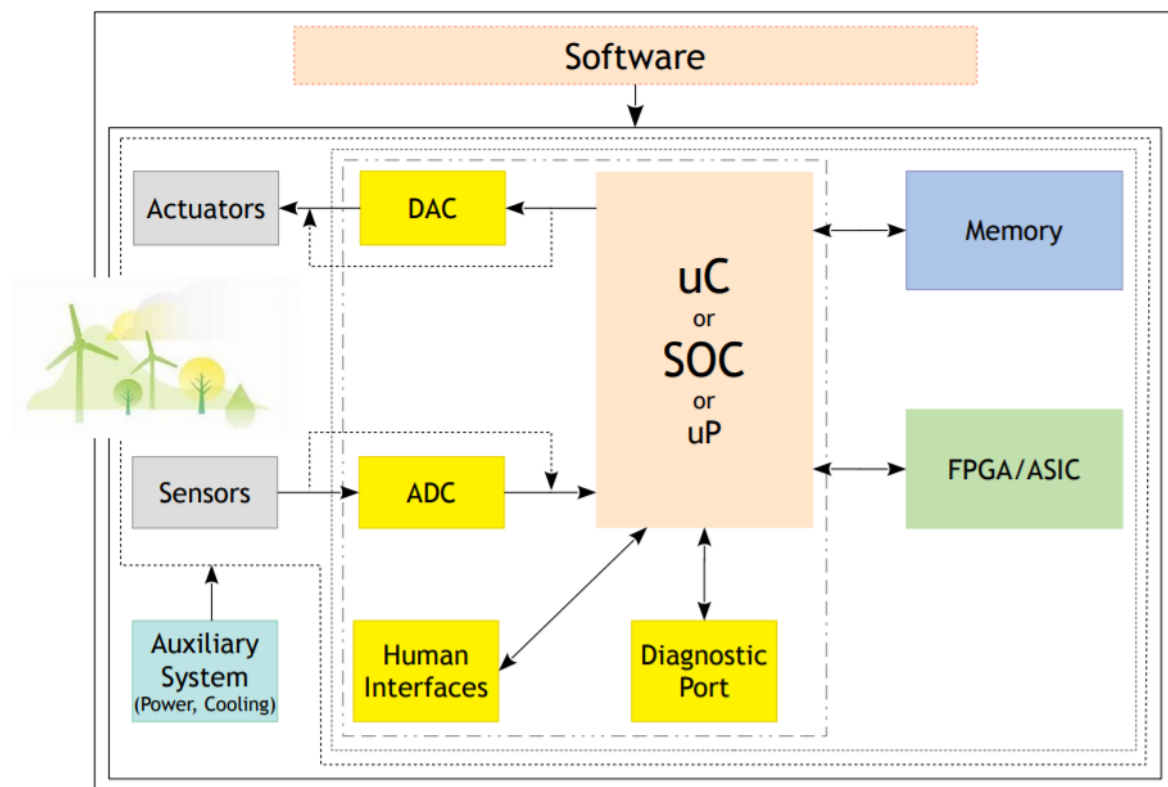- Real Time
- Networked
- Mobile

Requirements of Embedded system:

- ○ Reliability
- ○ Cost-effectiveness
- ○ Low Power Consumption
- ○ Efficient Usage of Processing Power
- o Efficient Usage of Memory

Challenges:

- ○ Efficient Inputs/Outputs
- ○ Embedding an OS
- ○ Code Optimization
- o Testing and debugging

Components of embedded system:

Microcontrollers

In Microwave Oven project PIC16F877A controller is used based on that some important terms can be given as,

➢ **Host:**
A system which is used to develop the target.
Here, Desktop, PIC16F877A

➢ **Target:**
A system which is being developed for specific application.
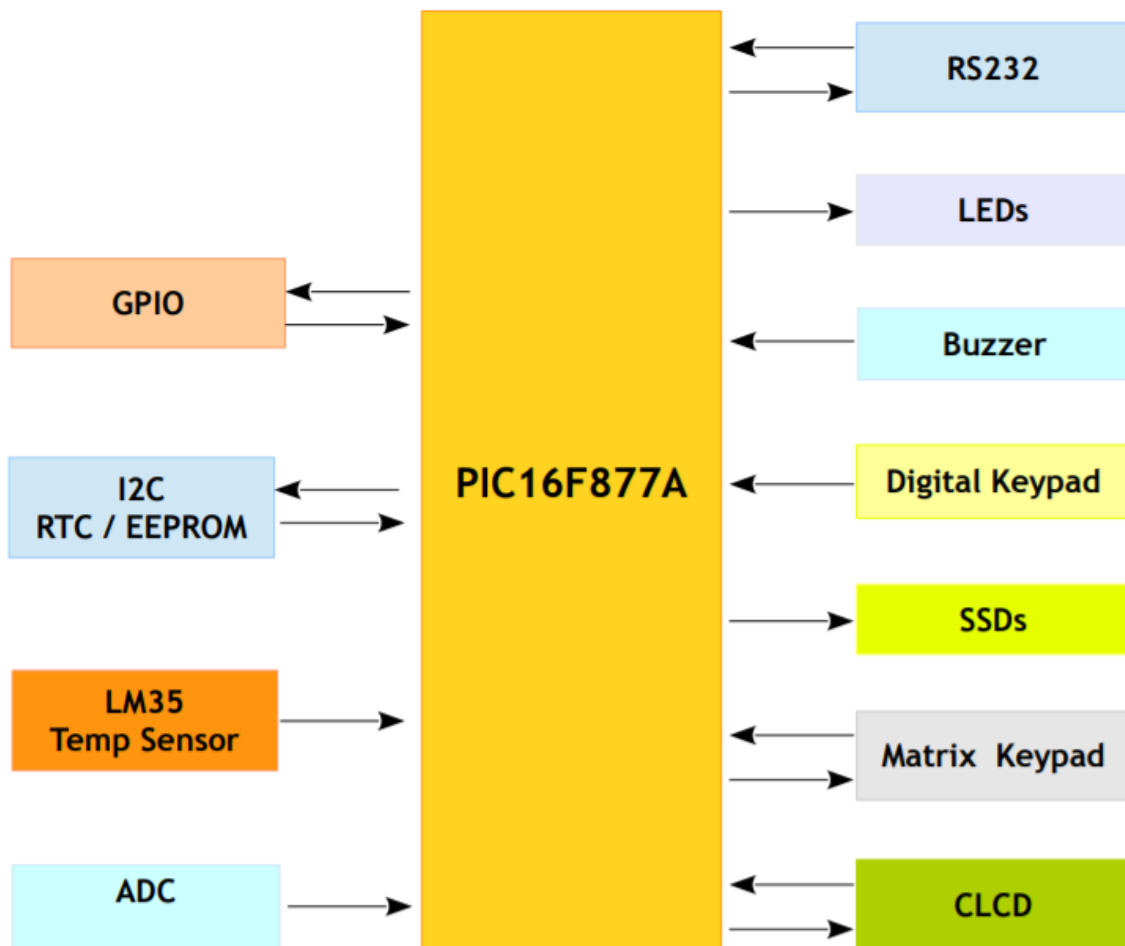Here, Microwave Oven

➢ **Cross Compiler:**
An application used to generate code for another architecture being in another architecture
Here, MPLAB xIDE

Components

- ➢ PIC16F877A
- ➢ CLCD
- ➢ BUZZER
- ➢ MATRIX KEYPAD
- ➢ SOFTWARES:
  - o MPLAB xIDE
  - o PICSimLab

PICSimLab Architecture

PIC16F877A:

- ➢ Operating Frequency: 20 MHz
- ➢ Power on reset
- ➢ Flash Program Memory: 8K
- ➢ Data Memory (bytes): 368
- ➢ EEPROM Data Memory (bytes): 256
- ➢ 15 Hardware & Software Interrupts
- ➢ 5 I/O Ports: A, B, C, D, E
- ➢ Timers: 3
- ➢ 2 Capture/Compare/PWM modules
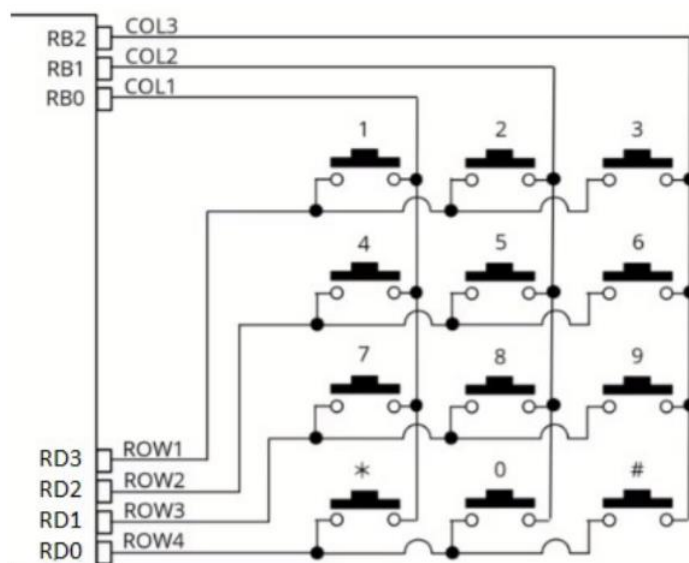- ➢ USART and PSP for serial & parallel communication

CLCD:

- ➢ Most commonly used display ASCII characters
- ➢ Some customization in symbols possible
- ➢ Communication Modes
    - ○ 8 Bit Mode
    - ○ 4 Bit Mode
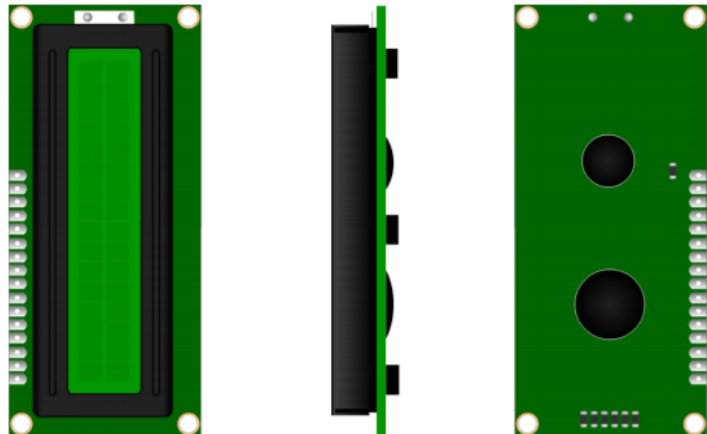
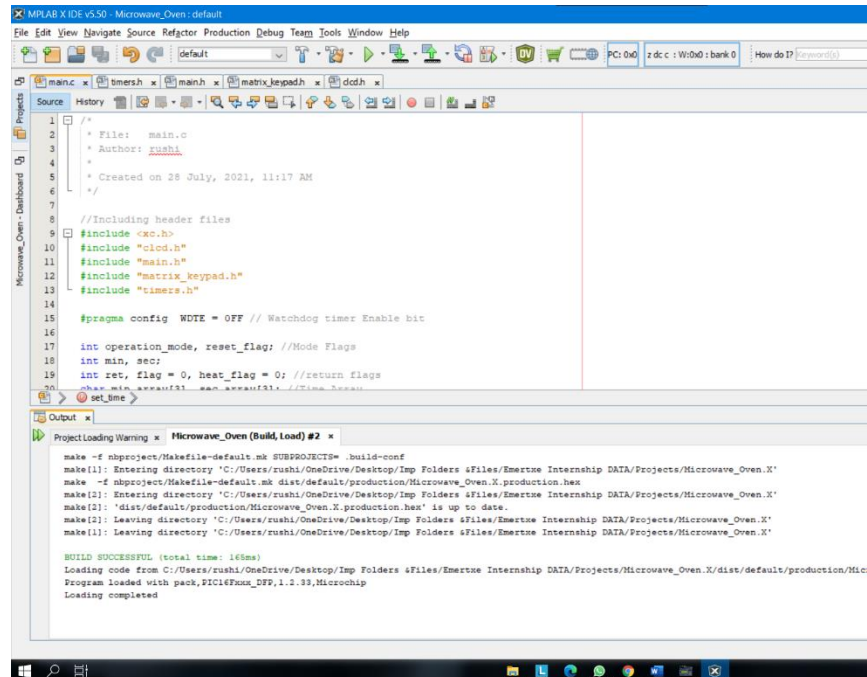| 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Vdd	Vdd	Vo	RS	R/W	E	D0	D1	D2	D3	D4	D5	D6	D7	A	K

Matrix Keypad:

- ➢ 4 rows x 3 columns
- ➢ 12 Tactile Switches used
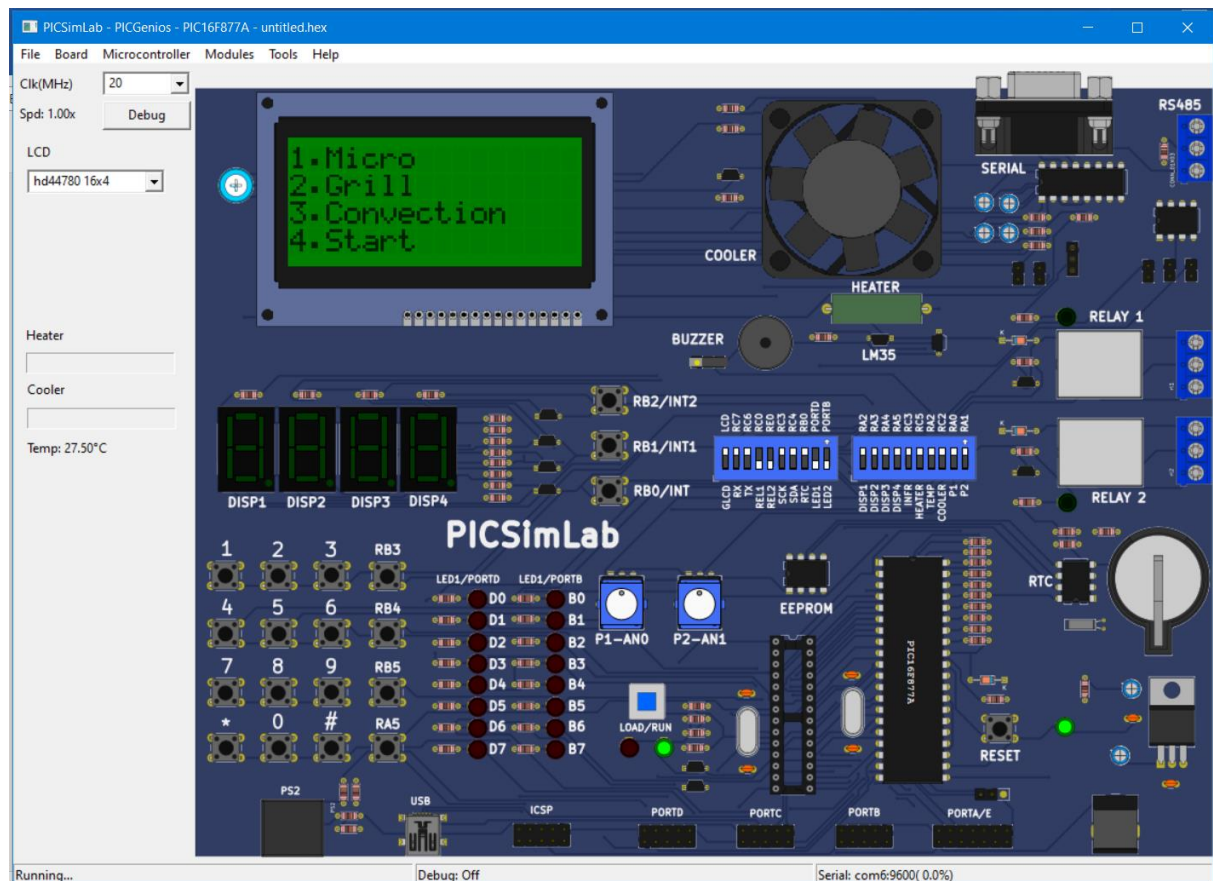- ➢ Columns -> Port B
- ➢ Rows -> Port D

MPLAB xIDE

Next picture shows the MPLAB xIDE interface where the system code is written. It supports the XC8 compiler to compile codes and generate hex files for PIC controllers by compiling C code.

PICSim LAB

The picture shows the Picsim lab window where the Microwave Oven project is simulated by loading hex file into PIC16F877A.
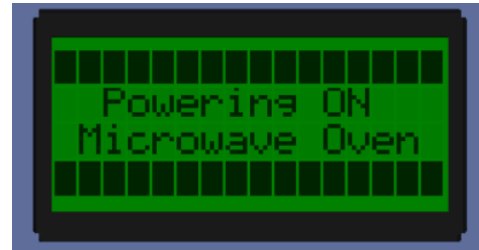
Microwave Oven

The whole project is categorized on the various modes and based on the CLCD Display output, will explain according to those modes only,
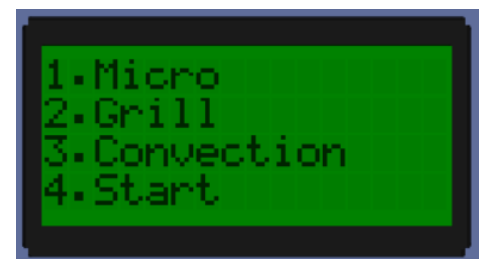
Power On Screen

When system is beginning power on the CLCD displays 'Powering ON Microwave Oven' & oven will start.
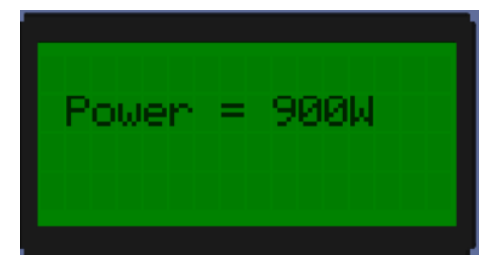
Cooking Mode Display

After turned on oven CLCD shows listed cooking modes user have to press respective key from matrix keyboard to choose the specific mode of cooking,

1.Micro mode, 2.Grill mode, 3.Convection mode, 4.Start Mode.

Micro Mode

If user presses '1' from matrix keyboard system will enter in micro mode of operation by increasing & displaying power to 900W after that CLCD screen displays the **Set Time Screen**.

Set Time Screen

In the set time screen user have to define for what specific time for cooking is to be done the Min:Sec are displayed as '00:00' user have to set from keypad. User can clear the time by pressing '*' or after setting time user have to press '#' to start oven to cooking.
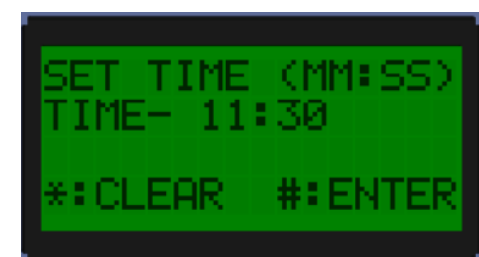
Time Display Screen

After pressing '#' system enters in Time Display screen where Timers come in picture, Timer2 and Fan get starts and timer starts down counting the time to zero '0'.
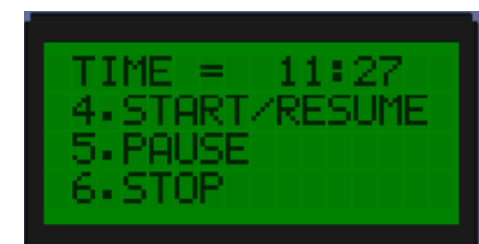
In Time Display if user presses '4', '5' or '6' then system will respond as follows,

PAUSE   If user presses key '5' it will stop Timer and Fan and hold system in that condition unlit any response from user

START/RESUME   If system is already paused by user, then by pressing key '4' system will resume starting Timer and Fan on. If not paused by pressing this key the timer will increment by 30 sec for each key press.

STOP   When user press key '6' the system will stop every operation and come back in the **cooking mode display**.

Done Cooking Screen

When timer down counting reaches to 0 the interrupt will be generated leads to turning on Buzzer and turning off timer and fan also displays 'Cooking Time Up' on CLCD.
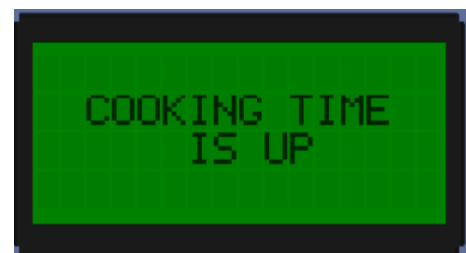
System stays in this for 3 sec and then will turn off buzzer and came back to **cooking mode display.**

Grill Mode

In the cooking mode display if user presses key '2' then system will enter in grill mode and shows **Set Time Screen** to enter time '00:00' for cooking. After that system function identical as in **Micro Mode**.
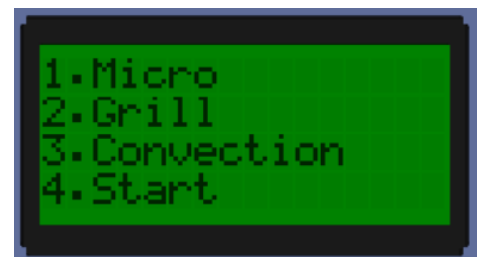
Convection Mode

System enters in Convection mode when user presses key '3'. In the convection mode system requires to set Temperature from user, user can enter Temp. between 0 ºC to 250 ºC. By pressing '*' will clear temp to 0 and by pressing '#' system will enter in **Preheating mode**.

If user enters temperature more than 250 ºC and presses '#' to enter the system will generate an error showing 'Invalid Temp.' on screen and turning on buzzer for 2 sec and will again come back to set temperature.

Pre-heating Mode

When '#' keypress occurs and temp is below 250 ℃, system will accept the entered temperature and starts preheating to that temperature it will require 180 sec to heat, therefore the timer will also be displayed on that screen down counting.
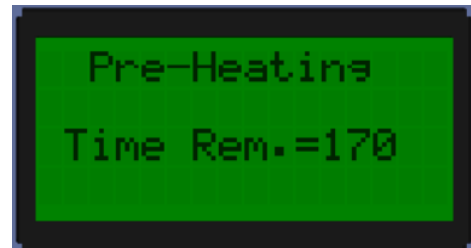
After Pre-Heating is done the system will go on **Set Time Screen** and oven will do same operation as Micro mode after time is set.

Start Mode

The start mode will be executed by pressing key '4' when system is in **cooking mode display**. In the start mode **time display screen** will appear on CLCD and automatic timer will set to 30 sec and will operate same as **Micro Mode.**
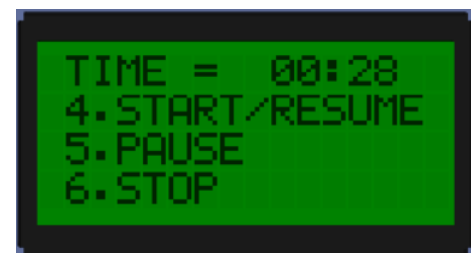
Door Open State

Whenever the system is operating in **Time Display** and user presses key 'RB3' that will open the door of microwave oven and will interrupt the ongoing process and makes timer pause and fan stop and turning on buzzer. This screen will be shown untill the door is closed after closing the all previous process will continue.
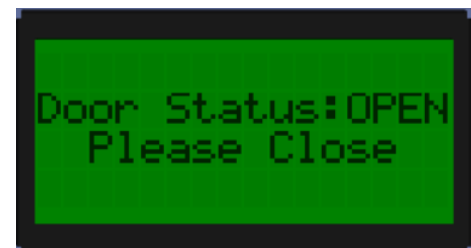
Code Overview

Code is written in a very generic way so that whenever there is a chance for improvent or adding any feature to system that can be easily added.

Header Files were all Macros & function prototype are defined

In clcd.h file all Macros and function prototyes are written related to CLCD

In main.h fileall Macros & function prototype are defined used in main.c

In matrix_keypad.h file were all Macros & function prototype are defined of keypad

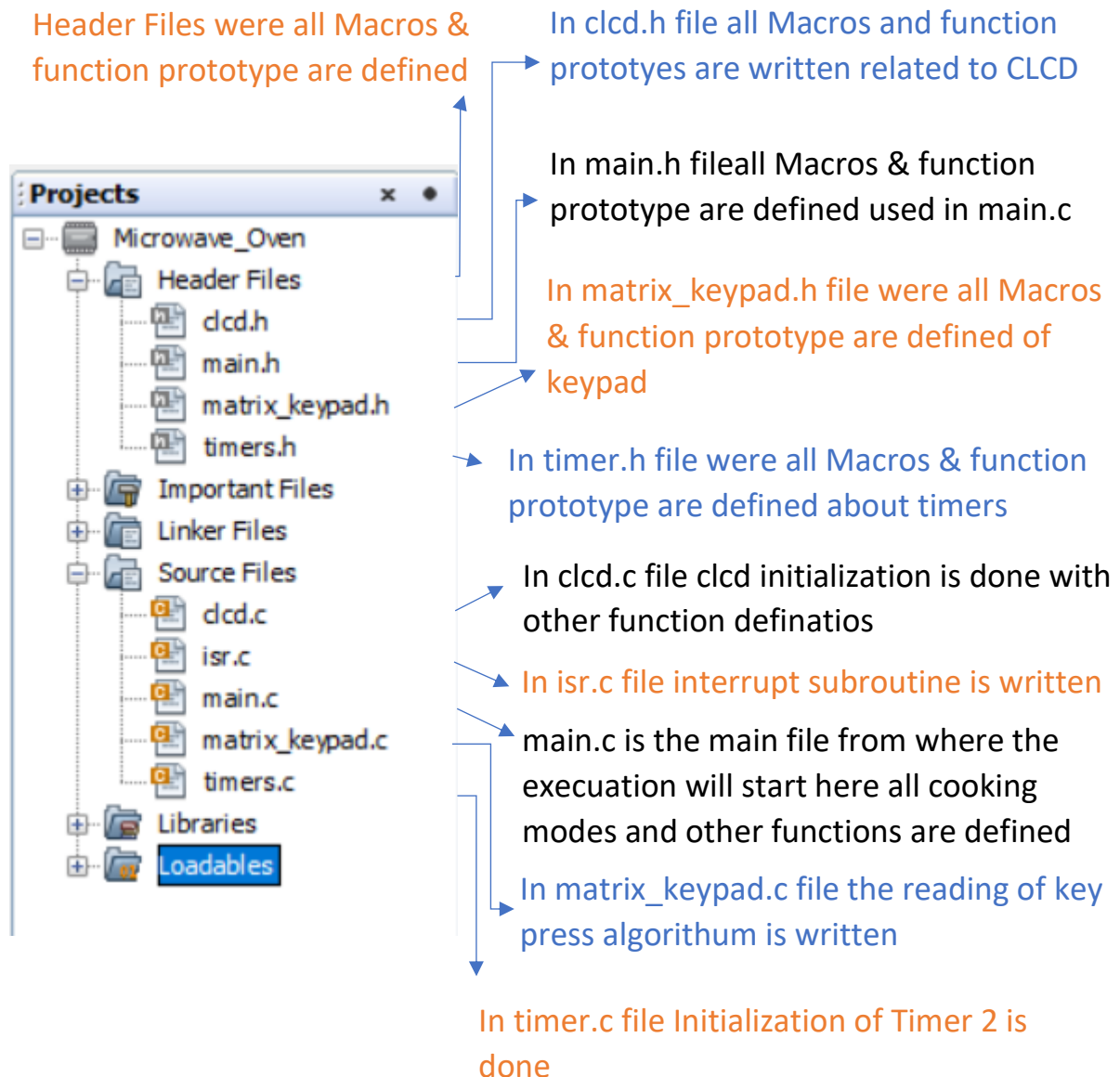In timer.h file were all Macros & function prototype are defined about timers

In clcd.c file clcd initialization is done with other function definatios

In isr.c file interrupt subroutine is written

main.c is the main file from where the execution will start here all cooking modes and other functions are defined

In matrix_keypad.c file the reading of key press algorithum is written

In timer.c file Initialization of Timer 2 is done

Challenges/Bugs fixing

While testing and checking all processes are working correctly or not I got to know about some bugs were present in the system, and all bugs fixed by me by updating or adding some lines the in code.

1. Unwanted Cursor appared on CLCD Display:

This bug were occurred while entering time in the **Set Time Screen** when accepting the min value.

Solution: Previously I used 'if' statement where I must have use 'else if'
In main.c line no. 279
Function: set_time()

```
274          }
275          if(key_count < 2)
276          {
277              blink_pos = 0;
278          }
279          else if(key_count >= 2 && key_count < 4)
280          {
281              blink_pos = 1;
282          }
283      }
284
```

2. Blinking issue after pressing '*'

When using '*' in the **Set Time Screen** to clear min after clearing min and sec both sec should be linking which were not.

Solution: Added two lines in the code which solved the problem
main.c line no. 292 & 298
Function: set_time()

```
289          {
290              sec = 0;
291              key_count = 0;
292              blink_pos = 0;
293          }
294          else if(key_count > 2 && key_count < 5)
295          {
296              min = 0;
297              key_count = 2;
298              blink_pos = 1;
299          }
300      }
301
```

3. Open door waring not displayed in other modes even if RB3 is pressed

The door status function was executing in only micro mode

Solution: Whenever door is closed returned a value & assigned it to an variable and checked that variable in each mode**.**
main.c line no. 367
Function: door_status_check()

```
360              ;
361          }
362          clear_display();
363          TMR2ON = 1; //Timer 2 ON
364          BUZZER = OFF;
365          FAN = ON;
366      }
367      return CLOSED;
```

4. After pre-heating and setting time in convection mode operation start

When we set time in convection mode it should display Time Display screen and starts down counting.

Solution: Linked set temp and set time in convection mode to time display function.

Acknowledgment

I am thankful to Emertxe Information technologies who provided me this great opportunity to work under their guidance and do a hands-on implementation of "Microwave Oven" project.

I am also thankful to all my mentors and all other Emertxe associates and my fellow Interns who helped me to complete this project.

Here I learnt how embedded system works how to program a system various embedded platform, which added in my skillset. Also, a lot many fundamentals of embedded C programming, it also covers microcontroller like PIC16F877A and other peripheral like CLCD, FAN, Tactile Switches, matrix keypad, etc.

Thank You.