EE344 : Milestone 1

Reflow Oven for Soldering SMD Components

Faculty : Prof. Joseph John & Prof. Gaurav Kasbekar

RA Mentor : Sayali, TA Mentor : Radheshyam

January 24, 2023

Amruta Mahendra Parulekar, 20d070009

Sameep Chattopadhyay, 20d070067

Anmol Saraf, 200070007

Contents

Abstract

A printed circuit board (PCB) is an electronic assembly used to create electrical connections between components. A surface-mount device (SMD) is an electronic device for which the components are mounted or placed directly onto the surface of the PCB. Reflow soldering is the process in which a solder paste is used to temporarily attach the SMD components to their contact pads, after which the entire assembly is subjected to controlled heat. The goal of the reflow process is for the solder paste to reach the desired temperature at which the particular solder alloy undergoes a phase change to a liquid or molten state, creating permanent solder joints.The aim of this project is to design and implement a reflow oven, which is a machine used for reflow soldering of SMD components to PCBs. It should be able to follow custom reflow profiles recommended by different manufacturers.The product designed by us would be much more economical than the commercially available products in the market. The package will have a 10cm × 10cm work station, where a PCB board can be placed for soldering SMD components.

1 Aim of the project

1. To design and implement a reflow oven, which is a machine used for reflow soldering of surface mount device (SMD) components to printed circuit boards (PCBs).

2. To design the PCB that will host the circuitry of the device, including power supply, a temperature sensor, switches, a micro-controller, indicators, a liquid crystal display (LCD) device, a cooling fan, a solid state relay (SSR) device, etc.

3. To program the micro-controller to turn off the heating element and indicators and to turn on the cooling fan when the hot plate has reached certain temperatures, after taking input from a temperature sensor.

4. To design the external packaging using computer aided design (CAD) and to use 3D printing techniques to build the completed package, which will have a 10cm × 10cm workstation, where a PCB board can be placed for soldering SMD components.

5. To make a product that would be much more economical than the commercially available products in the market. It should be able to follow custom reflow profiles recommended by different manufacturers.

2 Working of The Product

1. The product will have a uniformly heated hot plate, on which PCBs can be placed for soldering.

2. It will take 230V ac power supply and split it into two supplies, one of which will be converted to 5V dc supply using a buck converter. The other supply line will give power supply to the heating element of the hot plate, through an SSR.

3. The temperature of the hot plate will be conveyed to a micro-controller through a temperature sensor.

4. When the temperature of the hot plate reaches around 60-70 degrees Celcius, cooling fans will be turned on by the micro-controller.

5. When the temperature of the hot plate reaches around 250 degrees Celcius, which is near the melting point of the solder material used for SMD components, the micro-controller will turn off the supply to the heating element using the SSR.

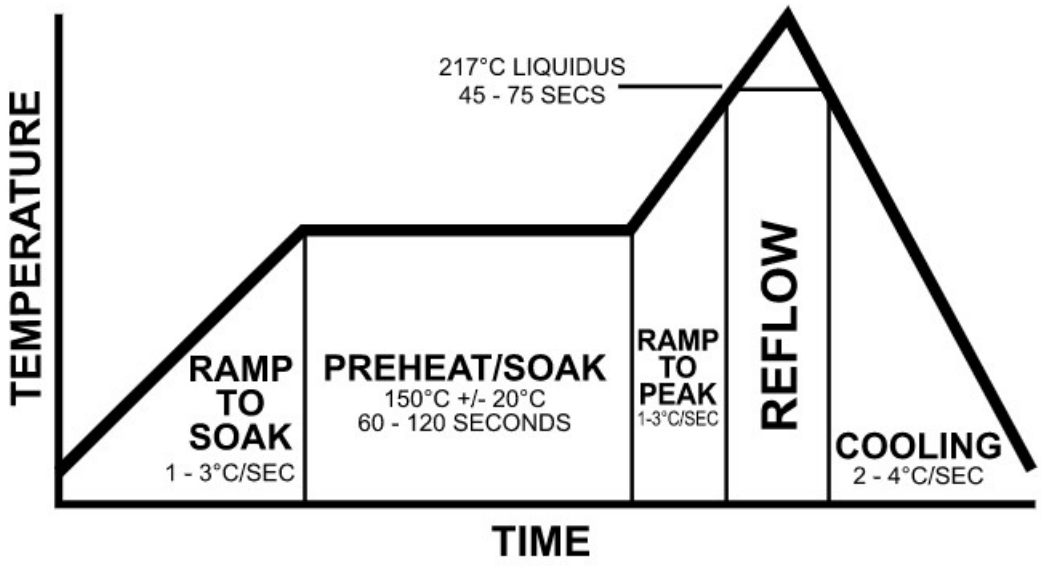
6. Now, the solder alloy will undergo a phase change to a liquid or molten state, creating permanent solder joints.

7. When the heating element is turned off, a buzzer will ring and a red Light emitting diode (LED) will be turned on. When the heating is on, a green LED will be turned on.

8. An LCD device will display the temperature, mode, time, etc of the hot plate, and toggle switches will allow manual control of the device.

9. Adequate insulation will also be provided in addition to the fan so that the device circuitry does not get damaged by heat.

10. Care will be taken to ensure that our oven also follows the above temperature vs time graph, which the soldering process follows, so that the solder material gets enough time to cool down and solidify properly.



3 Design

3.1 Components

1. A **uniformly heated hot plate** on which a PCB can be placed for soldering.
2. A **solid state relay device** for controlling the power supply.
3. Two **cooling fans** to prevent the heat of the hot plate from reaching the rest of the circuitry of the reflow oven and to dissipate it safely.
4. A **temperature sensor** to sense the temperature of the hot plate and convey it to the microcontroller.
5. A **micro-controller** that will take input from the temperature sensor and accordingly turn on the cooling fans and turn off the hot plate power supply at the required temperatures.

6. A **buck converter** to convert the 230V ac supply to 5V dc supply.
7. A **metal plate** to distribute the heat so that the fans can dissipate it.
8. **Outer packaging** which will be designed using Computer-aided design (CAD) and then 3D printed.
9. An **LCD screen** to display the hot plate temperature, mode, time, etc.
10. **Toggle switches** for manual control of the device.
11. **LED lights and buzzer** to indicate when the cutoff temperature has been crossed, and when the heating has been turned on or off.
12. A **mica sheets/cotton heat insulation pad** to reduce the amount of heat that is transferred from the hot plate to the heat dissipation mechanism and for safety purposes.
13. An additional **heat sink** for fast cooling purposes.

3.2 Block Diagrams

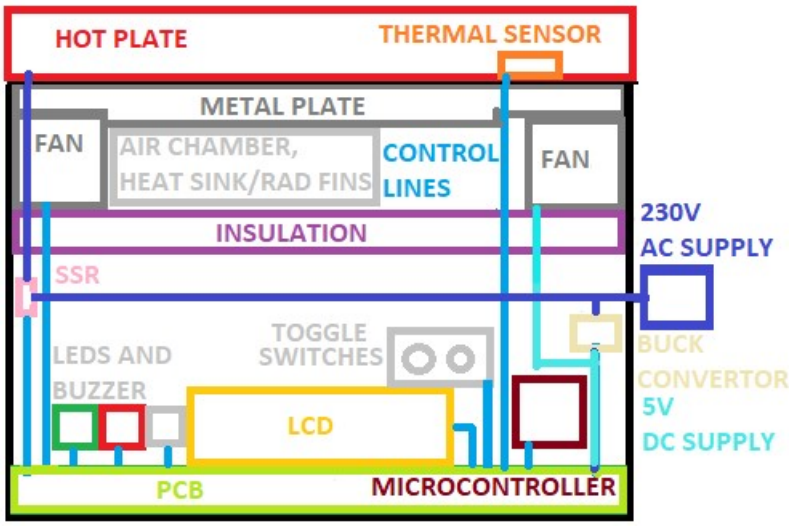


Figure 1: Layout diagram of all the components

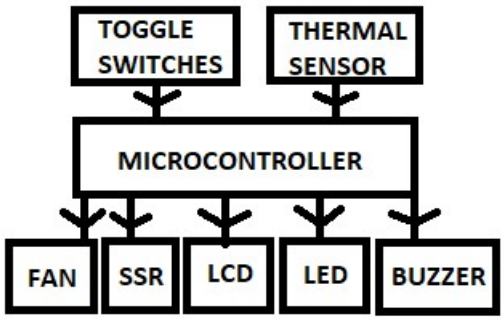


Figure 2: Block diagram of control signals

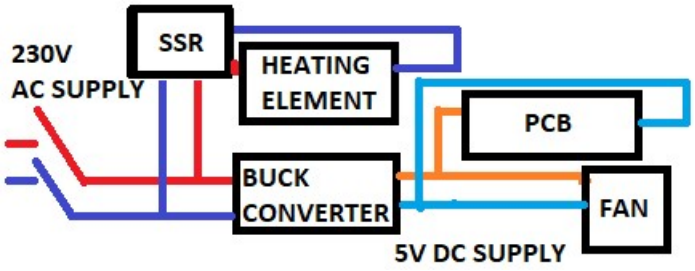


Figure 3: Block diagram of power supply

4 Work distribution

Task	To be executed by:
Micro-controller coding	Anmol and Sameep
PCB design	Amruta and Sameep
CAD design of the packaging and assembly	Amruta and Anmol
Overall circuit design	Sameep
Documentation	Amruta and Anmol

5 Timeline

Time duration	Work to be done
26th Jan - 1st Feb	Design review and update, purchasing and testing of components
2nd Feb - 8th Feb	Design of circuit schematics and testing it on a breadboard
9th Feb - 15th Feb	Completion of breadboard testing and starting PCB Design
16th Feb - 22nd Feb	– **Mid-semester exam week** –
23rd Feb - 1st Mar	Continue PCB design and review and start with CAD design of oven
2nd Mar - 8th Mar	Start microcontroller coding and continue with PCB and CAD designing
9th Mar - 15th Mar	Complete CAD and PCB designing, testing and reviewing
16th Mar - 22nd Mar	3D Printing of CAD model and PCB and complete microcontroller coding
23rd Mar - 29th Mar	Assembling all the components and testing of the circuit
30th Mar - 6th Apr	Continue and testing and finalization of the project
7th Apr - 13th Apr	– **Final Demo and Report** –

6 Similarities and differences with the other groups

Two other groups are going to be working on the same project.

Similarities: All three groups will be building a device where a heating plate is controlled by a microcontroller, based on inputs from a thermal sensor. All devices will have cooling systems.

Differences:

- Use of device: Our group aims to make a device that can be used for both soldering and desoldering. For this we will have modes, where the

heating and cooling will be adjusted according to the process.

- Cooling system: We also have an elaborate cooling system, consisting of an air chamber which has a metal plate above it to evenly distribute heat. The chamber will have radiator fins and two fans to efficiently cool the system in a controlled manner. The microcontroller will control the fans.

- Components: We will be using an aluminium PTC heating element, a thermistor for temperature sensing, cooling fans and radiator fins for cooling, and an ATMEGA128A microcontroller. The first group will be using a thermoelectric peltier cooler, nichrome wire for heating and ESP32 microcontroller. The second group will be using nichrome wire for heating, Pt100 thermal sensor and TivaC microcontroller.

7 Bill of Materials

Part Name	**Quant.**	**Unit Price**	**Link**
Cooling Fan - 5VDC 0.136 A	2	₹299	Link
Thermocouple Temperature Sensor	2	₹337	Link
PT100 Temperature Sensor	1	₹1131	Link
LCD Display 16x2 i2c interface, green backlight	1	₹529	Link
SK 81 Heat Sink	1	₹921	Link
ATMEGA128A - AU Microcontroller	1	₹1200	Link
AC-DC Converter, 80 264VAC, Output 5V, 1A	1	₹787.15	Link
Mica Sheets for insulation from heat	4	₹299	Link
Metal Sheet	4	₹380	Link
Buzzer for audio indication	1	₹28	**WEL**
RED LED - 3mm Diffused	5	₹5	**WEL**
DIP Switch to turn on/off the work station	1	₹14	**WEL**
Nichrome Wire	1	₹258	Link
AC-DC Converter, 80-265VAC, Output 12V, 0.42A	1	₹926	Link
MCP 3008-ADC	1	₹255	Link

8 Conclusion

A total of ₹5,000 will be spent on the materials for the oven. Commercially accessible items for the same purpose, however, are on an industrial scale for factories and plants and cost around ₹3,00,000. In contrast, products for single PCBs are much smaller(20mm x 20mm) and cost around ₹30,000. So, following the proposed approach for the reflow solder oven offers a usable soldering station of size 100mm x 100mm, and is very economical compared to already existing competitors.