VAPOR SOLDERING DEVICE

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Vapor soldering system

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***Abstract*:**

A system is provided for vapor phase soldering of components and PCB, system controls increasing speed and cooling speed temperature of the components and PCB lands that are to be soldered together

Vapor phase soldering (VPS) uses the latent heat of liquid vaporization to provide heat for soldering. This latent heat is released as the vapor of the inert liquid condenses on components and PCB lands. The peak soldering temperature is the boiling temperature of the inert liquid at atmospheric pressure.

1. Introduction

1.1 What is Soldering

Soldering is a process of joining metallic surfaces with solder, without the melting of the base materials. The two metallic parts are joined by a molten Filler metal.

1.2 Vapor soldering

Vapor phase soldering (VPS), also known as condensation soldering, has gone through changes in popularity. It was the process of choice in the early 1980s[1]

VPS uses the latent heat of liquid vaporization to provide heat for soldering. This latent heat is released as the vapor of the inert liquid condenses on component leads and PCB lands. In VPS, the liquid produces a dense, saturated vapor that displaces air and moisture. The temperature of the saturated vapor zone is the same as the boiling point of the vapor phase liquid. This fluid does not have any environmental concerns. The peak soldering temperature is the boiling temperature of the inert liquid at atmospheric pressure.

VPS does heats uniformly, and no part on the board (irrespective of its geometry) exceeds the fluid-boiling temperature. The process is suitable for soldering odd-shaped parts, flexible circuits, pins, and connectors, as well as for reflowing tin/lead and lead-free surface mount package leads.

1.3 Research problem

Vapor Phase soldering was banned of lead and other potentially hazardous substances with the introduction of RoHS. The industry was forced to change over to new solder alloys, a lot of articles researched about lead-free soldering. Some important characteristic different between tin-lead and lead-free are:

-Tin-lead Paste melting point temperatures lower than lead-free Paste Component peak temperatures.

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-The wetting force of lead-free solder is not as strong as for the tin-lead solder

So graph profile soldering lead-free higher graph profile soldering tin-lead, and process have some different. [2]

Higher reflow temperature will stress components and the PCBA more. Logistics of lead-free and lead components was discussed. It is very likely that defect levels will increase. All defect types that occur today should be expected but there might be a modification to their frequency. Tomb stoning, misalignment, opens, shorts and voiding have increased.

2. Requirements of device

A solder reflow process follows an optimized temperature profile to prevent the board from experiencing high thermal stresses while it is undergoing reflow. A typical reflow temperature profile would consist of the following steps:

- Preheat, which consists of gradually ramping up the temperature to the preheat zone temperature at which the solvents will be evaporated from the solder paste;
- Flux Activation, which consists of bringing the dehydrated solder paste to a temperature at which it is chemically activated, allowing it to react with and remove surface oxides and contaminants;
- Actual Reflow, which consists of ramping up the temperature to the point at which the solder alloy content of the solder paste melts, causing the solder to sufficiently wet the interconnection surfaces of both the SMD's and the board and form the required solder fillet between the two; the peak reflow temperature should be significantly higher than the solder alloy's melting point to ensure good wetting, but not so high that damage to the components is caused; and
- Cold down, which consists of ramping down the temperature at optimum speed (fast enough to form small grains that lead to higher fatigue resistance, but slow enough to prevent thermo-mechanical damage to the components) until the solder becomes solid again, forming good metallurgical bonds between the components and the board.

The reflow temperatures required by Pb-free board assemblies are higher than those required by non-Pb-free boards, mainly because Pb-free solders generally have higher melting temperatures than Pb-Sn solders. As such, the optimization of the reflow profile is more critical in Pb-free assemblies with regard to preventing the occurrence of package cracking in the surface mount components on the board.

Profile feature	PB-free Assembly
Average ram up rate	$3C^0$/ second max
Preheat Temperature Mn (t_{smin}) Temperature Mmax (t_{smax})	 150^0C 200^0C

Time (Tmin to tmax)	60-180 second
Time maintained aboard Temperature (lt) Time (lt)	 $220^{o}C$ 60-150 second
Time Peak temperature (tp)	20-40 second
Ram-Down rate	$6^{0}C$/ second max
Time from $6^{0}C$ to peak	8 minute max

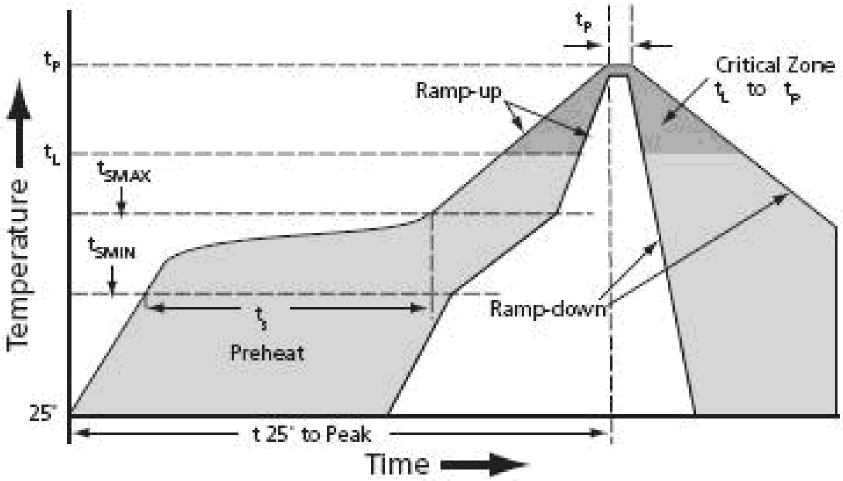


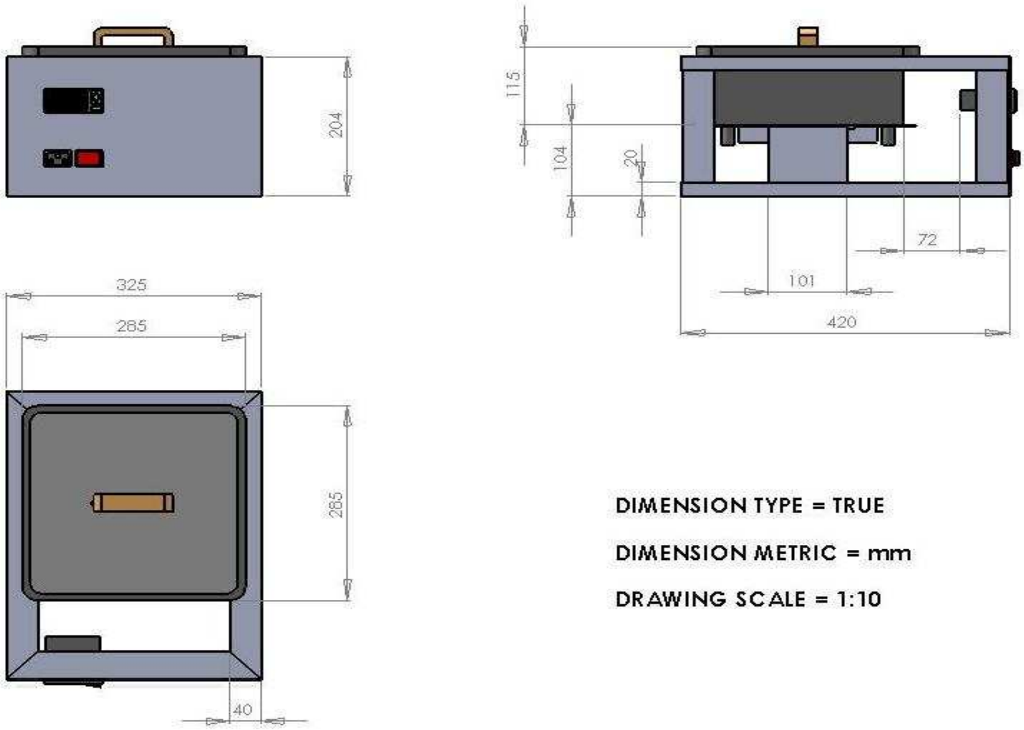
Fig:1 Lead free reflow profile

CHAPTER THREE

3. Automated soldering device with resistance heater

3.1 Structure

The major parts of this oven are the Soldering Tank, Main frame, Electric Heater, Temperature Sensor, Temperature Indicator, Cooling Device, and Controller. This Project II is concentrated to design and to manufacture the underpants consisting of these parts above except the cooling device.



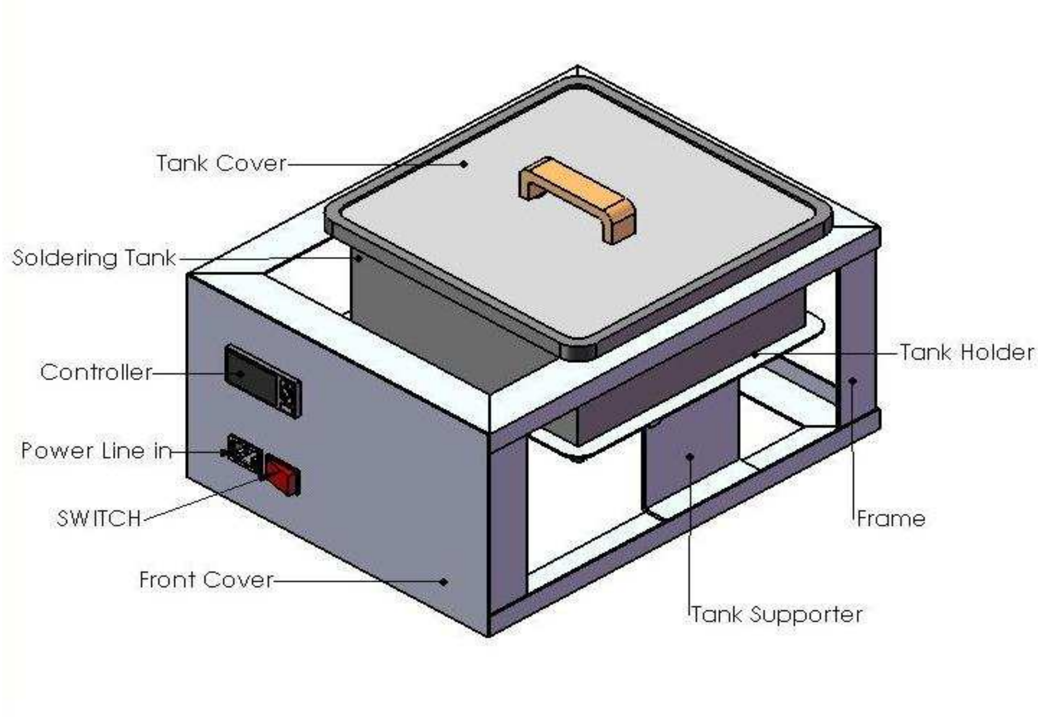


Fig:2 Structure of automated device with resistance heater

3.2 Running and results

To measure temperature, we used 5 thermometers type K, and labview software

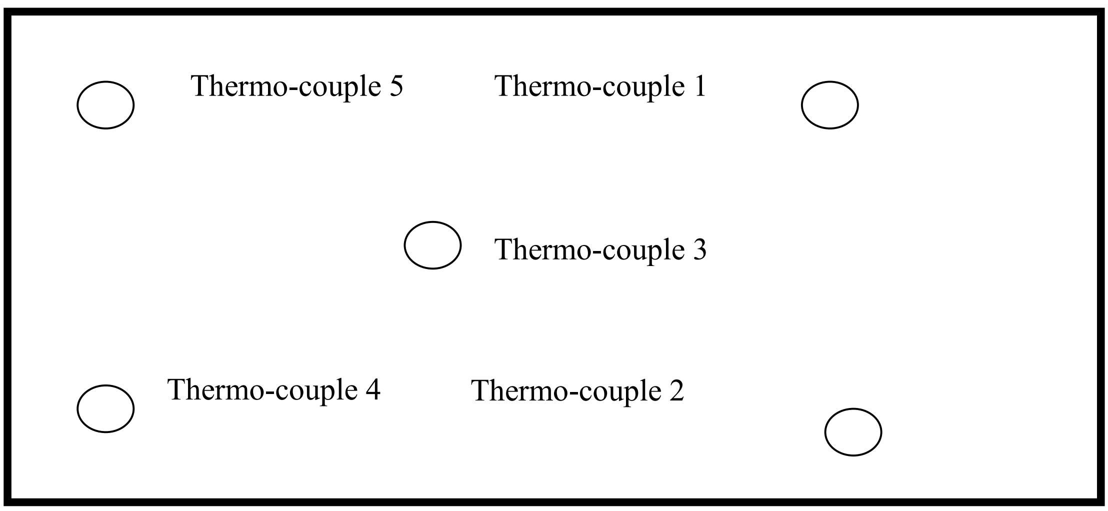
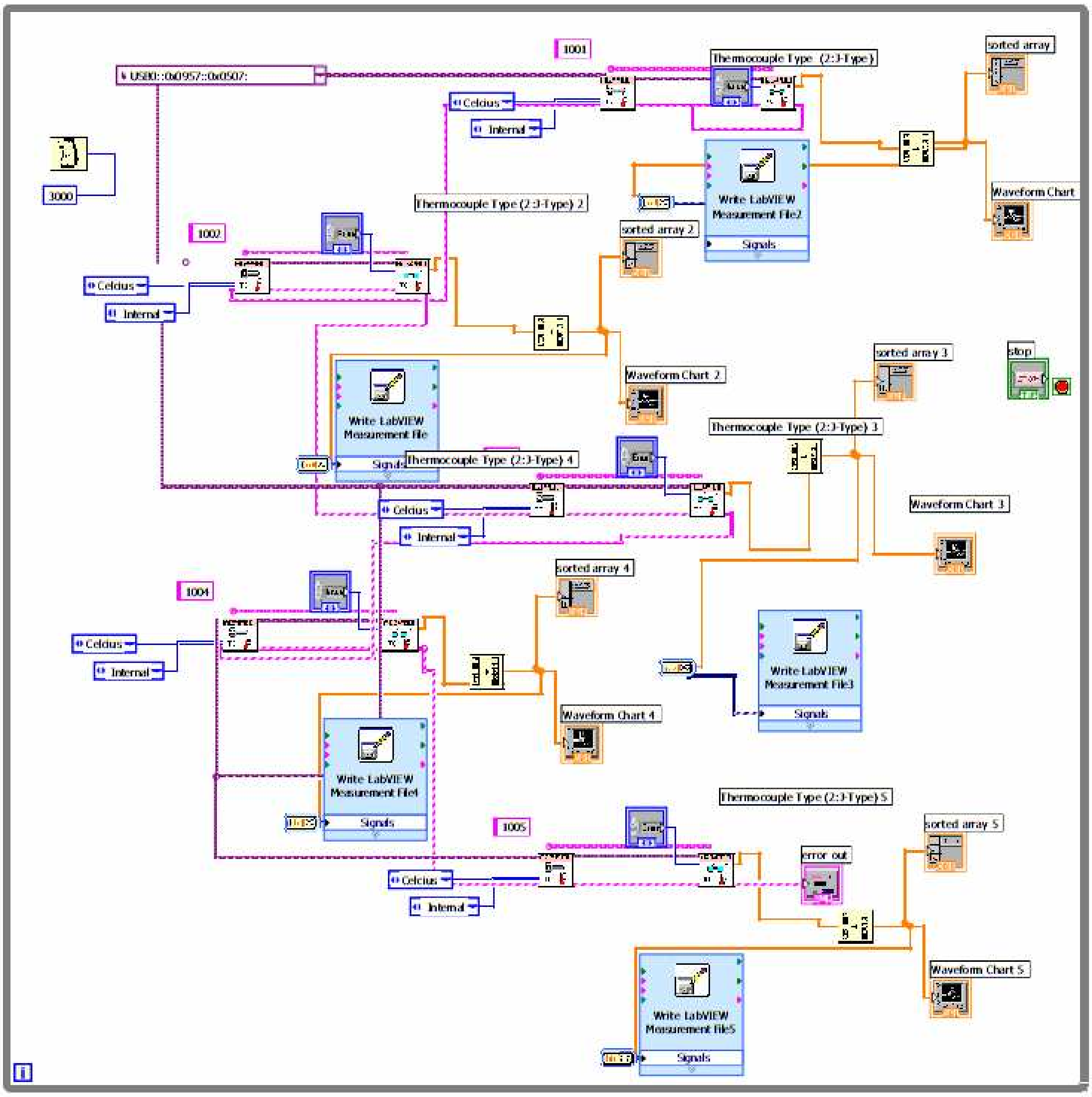


Fig:3 Thermo-couple position

Program labview



We had run with 100ml liquid and cooling by 150ml liquid. The first time cooling with 100ml liquid, the second time cooling with 50ml liquid

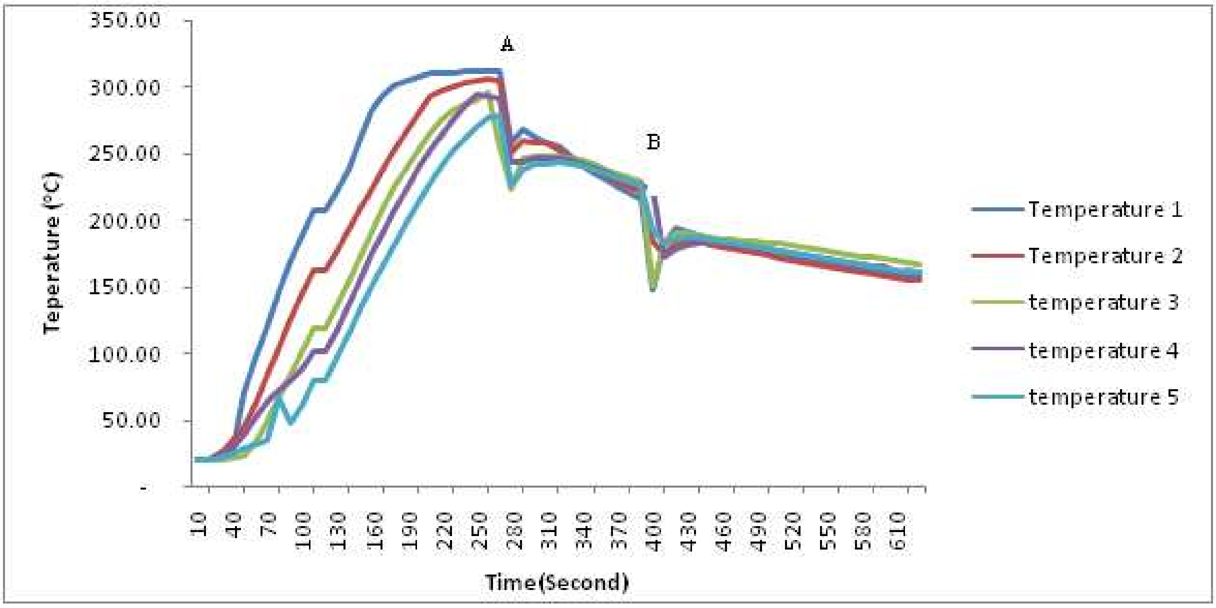


Fig: 4 Temperature graph. A is the first time cooling, B is the second time cooling

3.3 Conclusions

As a result I came to the following conclusion:

Soldering device with resistance heater increase quickly temperature liquid to the peak temperature. Easy to built device. But this device is difficult to control increase temperature. Because the heater continues heating when power disconnect.(temperature at the heater higher than the liquid so energy continues transform to liquid). Electronic energy is not transfer immediately to thermo energy. And difficult to codling down because volume of cooling liquid is limited but the energy of hot liquid, cover and heater is so much.

At the cooling liquid pours in the hot liquid(A,B). Because immediately cooling liquid mixes with hot liquid so mixture liquid temperature decreases quickly. But temperature of cover and heater are still higher liquid temperature so the liquid is little increases temperature.

4. Soldering device with peltier heater

4.1 Peltier

Peltier element is a thermoelectric element consists of semiconductor materials paired to accomplish heating or cooling processes as a result of peltier effect. If a voltage is placed on a Peltier element, one side is cooled and the opposite side simultaneously heats up. Simply by reversing the polarity of the supply voltage, the hot and cold sites of the Peltier element can be swapped.[4]

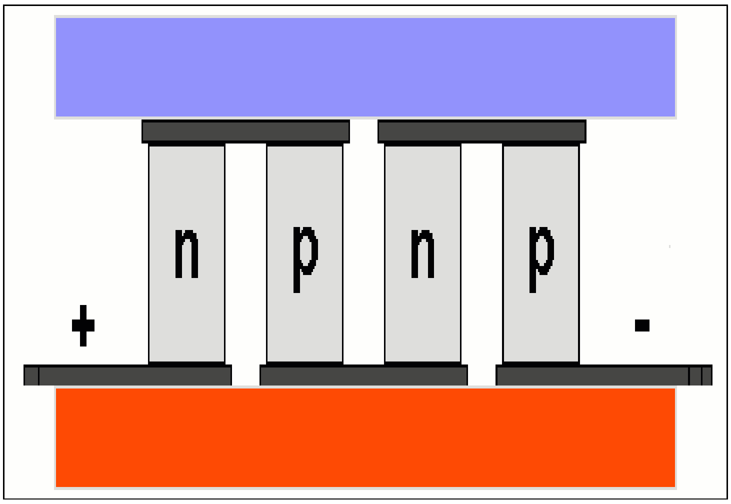


Figure 5 Semiconductor combination

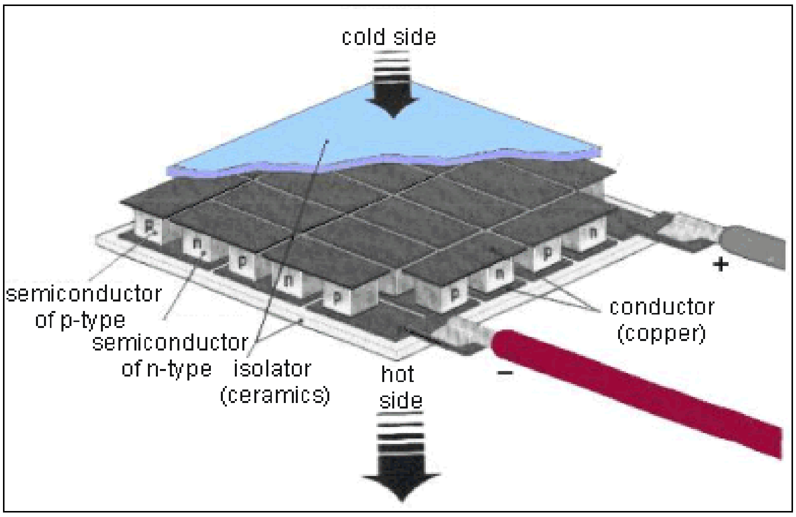


Figure 6 Peltier Effect

Peltier element can be used in single or cascade combination. The element is arranged properly to fit the needs. In this project, the element will be interconnected in series and parallel constructing a cascading layer of peltier element. Each element and combination in any layer need to be controlled precisely regarding the temperature curve.

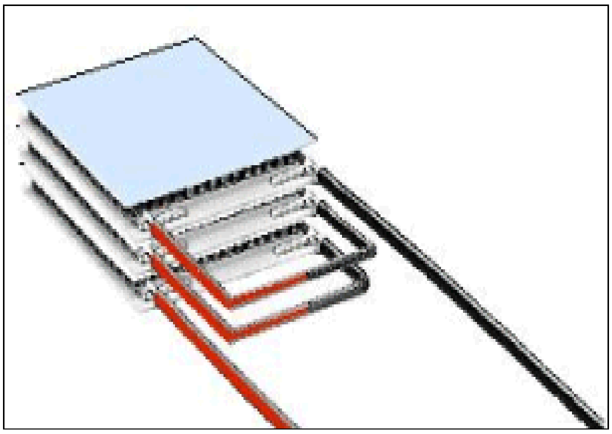


Fig 7 Series of peltier

4.2 Structure of soldering device with Peltier Heater

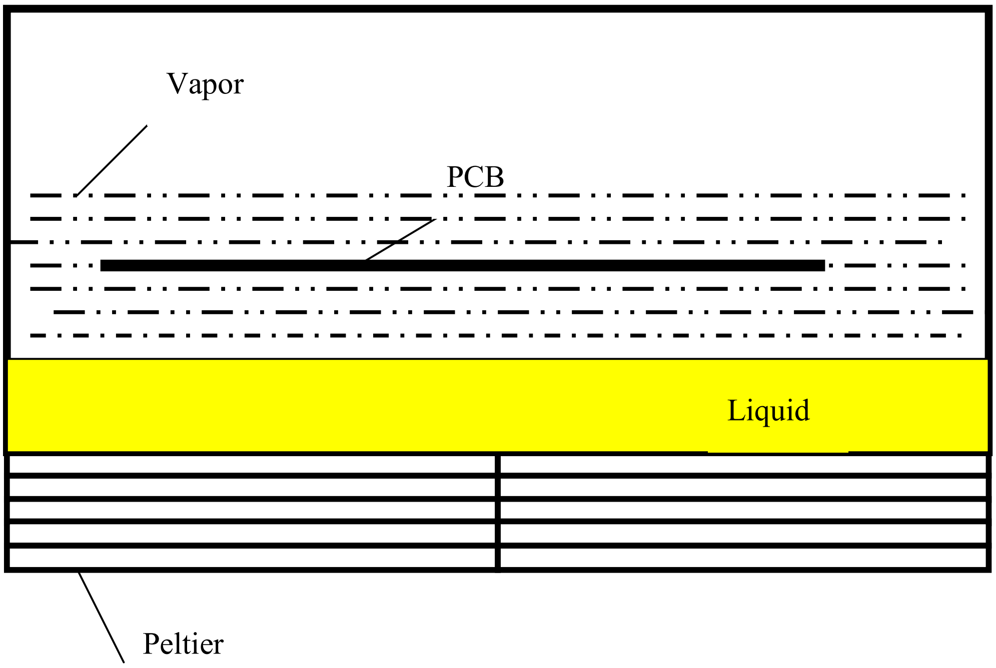


Fig: 8 Structure soldering device with peltier heater

This soldering device use HB TEC1-12710

Performance Specifications		
Hot Side Temperature (ºC)	25ºC	50ºC
Qmax (Watts)	85	96
Delta Tmax (ºC)	66	75
Imax (Amps)	10.5	10.5
Vmax (Volts)	15.2	17.4
Module Resistance (Ohms)	1.08	1.24

This device uses 5 layers peltier. Is we keep the temperature on the bottom layer equal environment so the average delta T on 1 layer is:

$(220-20)/5= 40^{o}C$

From the graph we control current for each layer increase from bottom to top.

5 Conclusion

As a result I came to the following conclusion:

Soldering device with peltier heater solve the problem of resistance heater. Increase quickly liquid temperature to the peak temperature. Easy to built device. Easy to control increase temperature. Electronic energy is transfer immediately to thermo energy. It is cooling without fan or codling liquid by reverse the current.

Literature

[1] Today's Vapor Phase Soldering An Optimized Reflow Technology for Lead Free Soldering Dipl.-Ing. Helmut Leicht; Andreas Thumm IBL-Lˆttechnik GmbH. Germany

[2] A Study of Lead-Free Solder Alloys By Karl Seelig

[3] Peltier basics .Anne-Elise Tobin Lamont Tang. Adam Taylor. March 9, 2007