PCB Assembly & Ordering Components

EEC-134B: Application Note:

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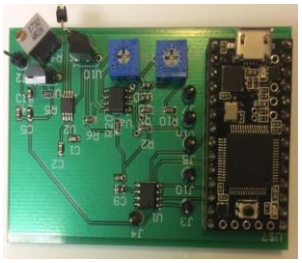
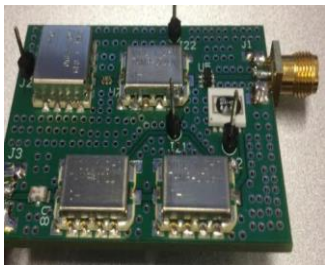




I. Introduction

Printed circuit boards (PCBs) are integral part of any major design in the field of electrical engineering. Often, we perhaps be able to get away with very low-level circuit designing using simple breadboards, however when we would want to implement ideas to any respectable communities we must put them together on a compacted printed circuit board. In this application note I will discuss how to solder various electrical components such as capacitors, resistors, operational amplifiers, VCO, mixers, attenuators and many others on printed circuit boards. This report will also discuss the protocols for testing each electrical elements part by part. Along with various testing protocols, I will discuss about the difficulties I came across throughout this incredible journey. I will also provide some helpful tips for the future participants to mitigate errors.

II. Components Ordering

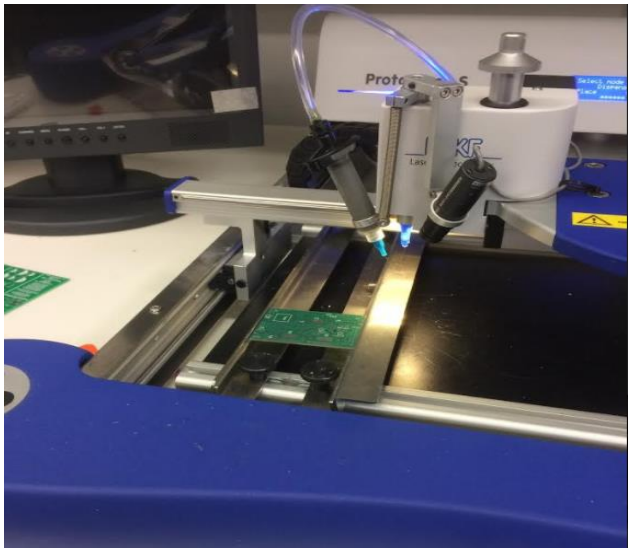
Before going to the lab and start the soldering process my team and I made sure we have all the components we need. If we don't have enough parts to solder, then it would be a waste of time for us to go the lab and putting solder paste on. When one of my teammates was busy ordering the PCBs to be fabricated, I made a list of all the components we will need. We had quite a bit of components to worry about, so I carefully looked at all the parts we have used on the PCB schematics and made a list of them. Not to mention that, all the part will be ordered through the university with an appropriate approval from the professor and respectable teaching assistants. We weren't allowed to just order one part at a time, rather we had to order all the components at once to fulfill the time requirements of the project. It is also essential to keep in mind that often we will make mistakes soldering the components on the PCB because mankind is born to make mistakes. So, to deal with those kind of situations, we have ordered multiple quantities of the same component. We have two different boards, one is the baseband board where all the regular low frequency components such as capacitors, resistors, operational amplifiers etc. will be soldered on. The second board will be called the RF (radio frequency) board. Where we have all the high frequency components like VCOs, Mixers, power amplifiers, attenuators, filters and two SMA connectors. So as per request we have ordered all the RF components through a private vendor of MiniCircuits. Where the baseband components were ordered mainly through Digikey and Mousers. Following I have a list of all the baseband components along with the quantity for future reference.

Component	Part Number	Quantity
3dB attenuator	(1284-1588-1-ND)	3
Reference Voltage	595-LT1009ILP	3
LPF	MAX7410EUA+-ND	3
Voltage Regulator	595-LM317LCLP	3
Antennas		2
DAC	MCP4921-E/P-ND	3
Op amp	595-TL972ID	
Resistors		
220 ohm	(311-220GRCT-ND)	10
2K Pot	(987-1065-ND)	10
3.6K ohm	(311-3.60KHRCT-ND)	10
10K ohm	(311-10KGRCT-ND)	10
20K pot	(3362P-203LF-ND)	5
Capacitors		
0.1uF	(478-1129-1-ND)	10
1uF	(587-1251-1-ND)	10
20pF	(311-1424-1-ND)	5

III. Component Arrival

It took about two weeks for all the components to arrive. This shows the importance of planning ahead and planning accordingly. After anxiously waiting for the component to arrive now, they are finally here, and we are ready to pick them up from the TAs and label them accordingly. It is very important to label all the components before going down to the electronics lab, where the soldering station is located. So, to make my life easier, I took out a sharpie and label all the relevant components, so they are easily visible when soldering.

IV. Soldering station



Now, that all the components have arrived along with the printed circuit boards all we have to do is put the components on the board. How hard could that be right? Not so fast, soldering is actually not the easiest job in the world, especially, when the footprints are surface mounted SMD. some of the footprints on our boards were so small that we had to use a microscope to view them. There are multiple ways to solder components onto printed circuit boards. Mainly we used three techniques to properly solder our components onto the boards. It really depends on what you are soldering on the board and use the soldering techniques accordingly. The first technique I used was the conventional soldering gun which everyone knows about. This specific technique is very helpful when you are soldering the through hole components. Components like resisters, or somewhat bigger through hole integrated circuit or those pin headers. During the performance, you have to be careful not to solder pins together or bun yourself or the people around you, because that does happen. It is essential to follow the lab safety protocols. The easiest way to solder components using heat gun is that you place the heated gun on the pad and once it heats the pad up you place the solder iron on it. As soon as solder melts you take the gun away and let it cool down for a few seconds.

For the second technique I used a vacuum tube, solder paste and a heating microwave. This technique is perfect for those smaller components like the package of 0603 footprints. This technique could be little tricky because you could easily put too much more or too little solder and both of them are bad. You never want to put too much which may potentially short the pads whereas if you put too little that might make the signal weaker. Rushing the process during this technique will only be worse so make sure you have enough time and patients when you put solder on the pads. It is important to cover the whole pad with solder past because during the heating process it will shrink down to the respected pad and pin. So, if the hole pad isn't cover with solder paste that might not have enough paste during the shrinking process. Also, you never want to put too much paste on the pad frankly, that will spill over to the neighboring pads which essentially called a short. It called short because to unwanted pads are connected together when they are supposed to be separate. It is highly recommended that you work on area at a time to mitigate errors. If you jump around too much, might miss a pad which will cause you to have a discontinues circuit. Since, the components you are working with are very small it is advised you use the magnifying glass or in our case we had used the closed-up camera. When all the soldering paste is placed on each pad I used the help of the vacuum tube to place the components on the pads. I had to be very careful during this process because it is very easy to misplace the pins to the pads. Once the components are placed on the pad then I use the microwave to heat the solder up and make a

connection from the pads to pins. After it the temperature reaches to about 500-600 degrees the solder paste starts to boil up and then it cools down for 2.5 minutes. Once the process is done the paste turns to metallic, which is an indication of success.

The 3rd and final technique I used was a hot air gun. This technique is used to solder those large RF components such as VCOs, power amplifiers, mixers, attenuator. This process is quite the same as the second technique. In this process I used solder paste and made sure I covered the pads with the paste. Then once I am one I used the hot air gun which essentially, blows hot air out of a hollow pipe. You can adjust the temperature of the air. You place the hot air gun directly over the component. The idea is to heat up the board as well as the pad, once its heated the paste starts to boil. As soon as the boiling is noticed you should stop and it will turn to metallic color. It is highly recommended that you work one component at a time when working with a hot air gun. Because to establish a good connection you must put all the heat and energy towards on component at a time to make sure all the pins are connected to the respected pads. otherwise there will be a discontinuity in the circuit which may not working properly.

Once the soldering job is complete, you must look at the continuity of the circuits. I used a microscope to carefully investigate each of the pins to make sure that they are all connected properly. Second was to use a digital multimeter to see the continuity. This method is more accurate and it quite helpful and highly recommended before doing any kind of testing. Once everything verified, now we can go ahead and start the testing process of the PCB. If the output isn't what it supposed to be you must check the circuit part by part. Which is why the test points are very essential in that sense. The test pins are highly recommended on each output and input. Also, be sure to put a test pin for a ground reference.

V. Helpful Tips

It is quite important to become good at PCB design in quarter I. Everyone makes mistake and we all learn from our past mistakes. So, quarter I should be a test run where you make mistakes and learn from it and try to mitigate those mistakes in quarter II. Quarter II is very essential for the project and this is where you must have a successful working system to win the competition, get good grades and essentially a good engineer. PCB design is not a one-day job rather it needs practice to be good at. Also, planning ahead can help significantly in this particular project. Because if something goes wrong you have time to come back and make another run. This project for us went on until the very final week where everyone was busy studying for other finals as well get this system to work properly. So, having little time on should help reach to goal faster, easier and it is the most efficient way to do it.

VI. Conclusion

In conclusion, throughout this magnificent journey, I have learned quite a bit. Most importantly, I have learned how to design and solder PCBs efficiently. Working on PCBs take time and patient is the key in this process. Rushing this process will only be worse for the project. Learning these various forms of design techniques made me a better engineer.