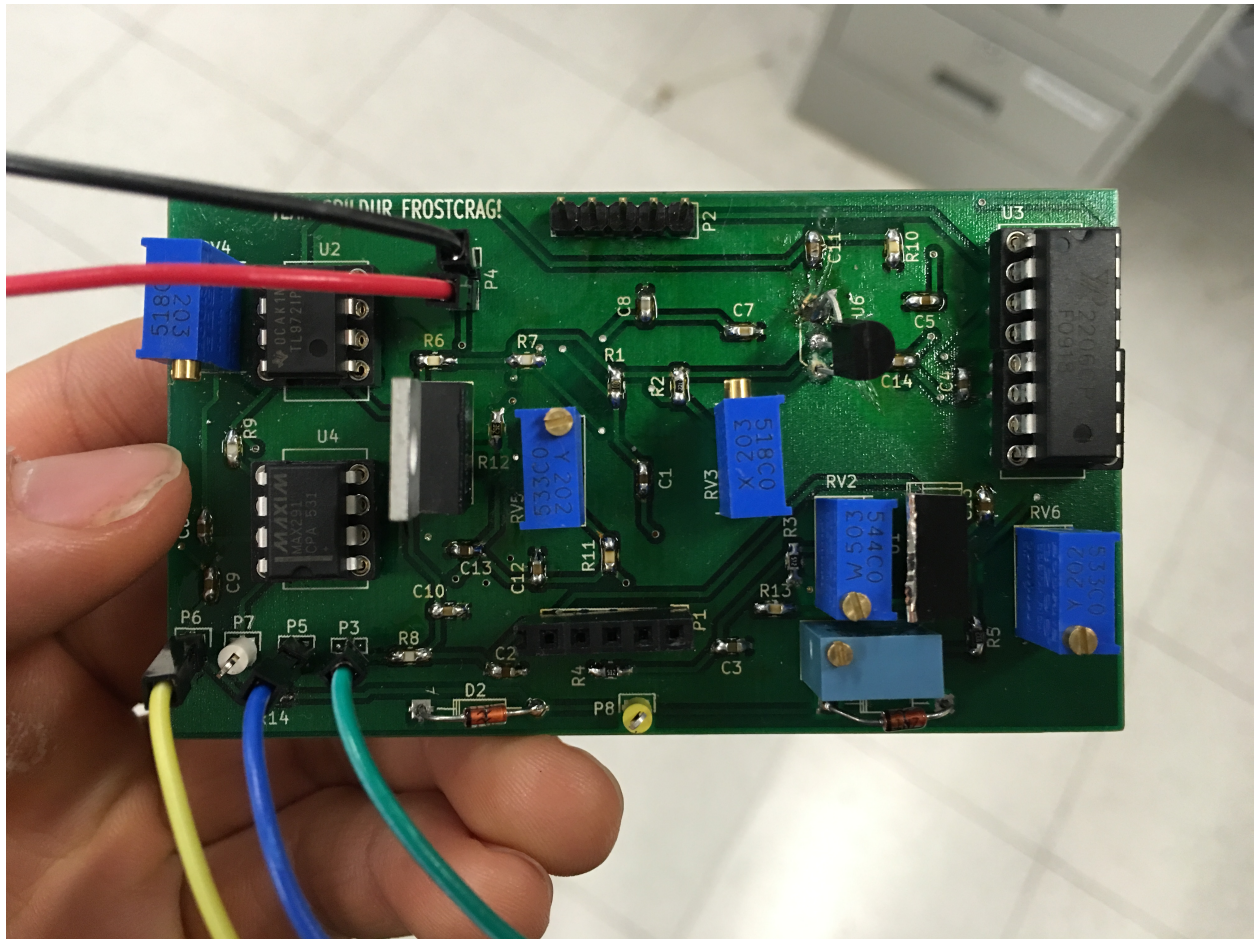


# Soldering Application

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## I. Introduction

Soldering, using fusible metal alloy as an adhesive, played a key role in constructing the quarter two RF radars. It is imperative that soldering is done correctly, otherwise, one erroneous connection can make the difference between a working and non-working system, potentially causing time consuming troubleshooting and frustration. The components previously prototyped on a bread board in quarter one, are now compacted into different shaped integrated circuits and passive components that lie in the realms of millimeters; with each different shaped component, there are several techniques and tools that can ensure a proper connection.

## II. Safety Concerns

Before soldering, it is **HIGHLY** recommended to put on goggles. While soldering, bits of solder may fly out and if you're looking closely at the board, which tends to happen while soldering the smaller passive components, melted bits of solder, upon contact, can cause permanent damage to the eyes. Also, there may be cases where a peer may accidentally bump into you, causing the solder tip to jerk towards your face. Although these cases may seem very situational, you may prevent these permanent consequences with simple eyewear.

The soldering iron is typically 600 to 750 degrees Fahrenheit, so please be aware of where you are each whenever you grab the iron as well as your surroundings. Quickly turning while holding the iron, may come into brief contact with a peer who the user isn't aware of, however this brief contact is more than enough to cause serious burns. Also when soldering a wire you may find it quickly heats up, so it is advised to hold the wires with tweezers or clamps to avoid burns.

It is also advised to work with constant ventilation: near a window, or have a fan running that may direct the solder fumes away from the solderer. The most common types of solder is a lead-tin alloy with a rosin core, which cause fumes that is known to cause occupational asthma and dermatitis. If ventilation isn't possible, you may want to consider investing in a face mask.

Finally, as mentioned above, the most common type of solder is has strong concentration of lead which is a known neurotoxin. Lead can pose significant chronic health effects with digestive problems, memory, and reproductive problems [1]. Although lead is harmless upon direct skin contact, problems arise when dust from lead remains on the solderer's hands which can be ingested when eating, smoking, biting nails, etc, so it is highly suggested to wash your hands after each soldering session.

## III. Different methods

There are three main methods that were utilized for constructing our radar: Hot Iron, Hot plate, and Hot Air. Hot Iron is analogous to a heated pen, which can melt solder at precise locations, and clean up existing connections. Hot plate uses, as the name implies, a hot plate where a printed circuit board (PCB) may sit on top on, and conduct enough heat to melt solder on the surface. Finally, Hot air is essentially a blow dryer, that typically operates in the range of 275 -

400 degrees Fahrenheit, and is primarily for specific connections and aligning existing connections.



Figure 1. Hot Iron, Hot Plate, Hot Air.

#### IV. Hot Iron

Hot iron was the primary method in constructing our PCBs. Because the Hot Iron is only heating a specific part of the PCB and the Iron can be simply lifted off the PCB if damage is a concern, I found it to be the safest method of construction. Hot Iron works well with smaller components such as resistors and capacitors, but it cannot be used for IC components that have a grounded pad. If there are different tips available, typically the more finer the tip, you will have better accuracy and control of applied the solder. Before soldering, I would clean the iron of any excess solder by heating it up, and scraping it with steel wool. Also if the iron looks dull, I would apply some solder onto the tip, and clean it until it looks shiny. If the iron looks dull, it may transfer heat slower, so cleaning it after each use is advised.

To begin, I will go over soldering potentiometers, pin headers, and other pin based PCB components. Before soldering, have the components in place into the PCB positioned as you intend them to stay in. Have the hot iron in your dominant hand, and the solder wire in the other. Soldering from the bottom side of the vi, first place the soldering iron onto the vi, and then apply solder to the tip of the iron, where it's in contact with the vi. After applying solder, remove the iron first, and keep the component in place for a second or so to let the solder harden. Once

one pin is in place, it is unlikely that the rest will move from place, so you may quickly solder the other pins without being concerned with holding the rest of the pins in place.

Moving on, I will discuss how to solder resistors and capacitors. Put the tip of the iron in contact with the copper pad, then quickly dab the solder wire at the tip. Due to the nature of the solder, it will reposition itself on the copper, so you do not need to be concerned with solder positioned outside the footprint. Once you have successfully applied solder onto one side of a interconnect, grab your passive components with a sharp tipped tweezers. Make sure to level you passive component as flat as possible with the PCB to ensure a strong connection and to prevent tombing. Once you have leveled your passive component, heat the solder previously applied, then slide the passive component into place. **Remove the iron first then the tweezers.** Hold the component in place with tweezers, and after a second or so, the solder should be hardened and the component should be in place. To finish the connection, apply solder onto the other side of the component.

**\*Note, you do not need a large amount of solder for a sufficient connection; very little solder is needed for a proper connection.** An indication of an appropriate amount of solder is to look for a “heel” shape connection, but for those who are unsure, a small ball of solder connection is more than enough. The capacitor on the left has two small balls of solder for its connection while the resistor, the left side in particular, has a “heel” shape connection.

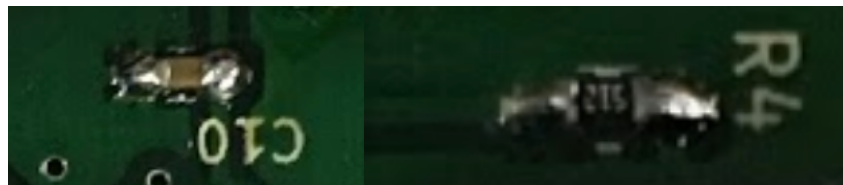


Figure 2. Different types of proper connections.

## V. Hot Plate

As shown in figure 1, the hot plate is a very simple device. Simply set the setting of by turning the knob, and the light shown on the front-left side of the device indicates whether or not the plate is active. The hot plate works well with soldering IC components, especially ones with a grounded connection underneath the component pad. With the hot plate, you will be using solder flux which is a gray paste in a syringe that has a lower melting point than traditional solder. **Be warned, if the PCB is left on the plate for too long, it can easily damage the board, so you must work quickly once it's in use.**

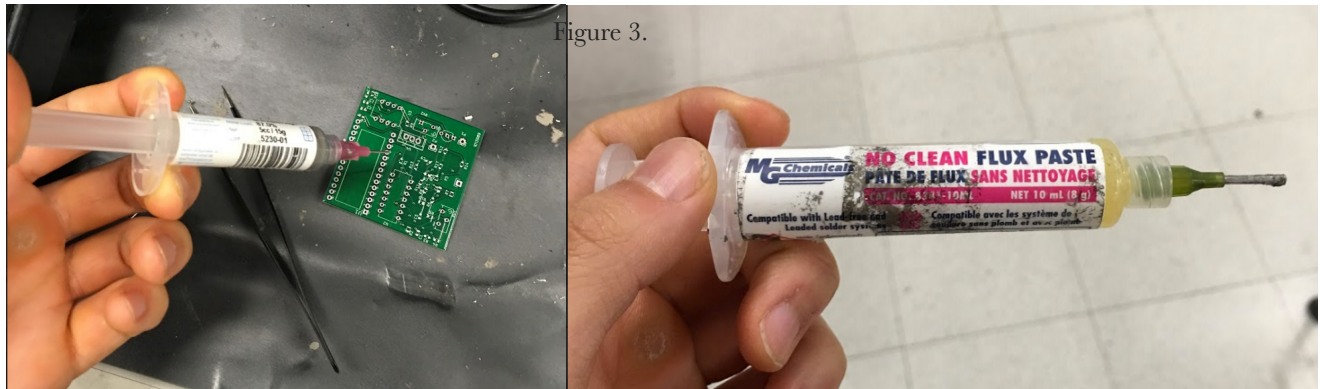


Figure 3.

To begin, apply a small amount of paste onto the all the connection sites you intend to use the hot plate for. It is better to set all your IC's in as few runs as possible because with each run, there is a higher risk of damaging the PCB with every trial. Set the hot plate onto low, or around 230F, and place the PCB onto the pad. The paste will quickly melt and look just like traditionally melted solder. Once the paste as melted, quickly place your components on top of the melted solder. To know if there is a good connection, tap the components to the side very lightly and the solder should snap the IC back into place. Once all the components are placed properly, carefully move the PCB off the plate. From my experience, solder paste solidifies much slower than rosen core solder, so be wary of components moved from place, and solidifying improperly. Also, do not try to move a hot plated pcb with your bare hands; it will be extremely hot. Also we wary with the amount of solder paste applied: if to much solder is applied, IC legs may become shorted with one another and establish connections that lead to failure.

## VI. Hot Air

Shown in figure, the hot air is also another simple device. Once lifted off it's stand, it will begin heating up, and once its placed back into the stand, it will automatically shut itself off. I typically operated the hot air at 270C, which is hot enough to melt both types of solders. Hot Air is a great tool to realign solder components, and could also be a tool to form connections as well. Before applying hot air onto the solder, I always make sure to apply drops of flux where i'm going to air to help with the conduction and to remove impurities at the solder connection site. Also, if you make solder connections on all the connection sites of your component, for an example both sides of a resistor, then you can rely on hot air to properly align them. In figure 4, the PCB is shown before applying hot air, and is evidently unpolished. However if there is solder at each connection footprint, the hot air will snap each component into place. This greatly speeds up the

soldering process because if there is a sufficient connection, you can simply hot air it later to refine it, instead of attempting to perfectly align every component when its initially soldered on.

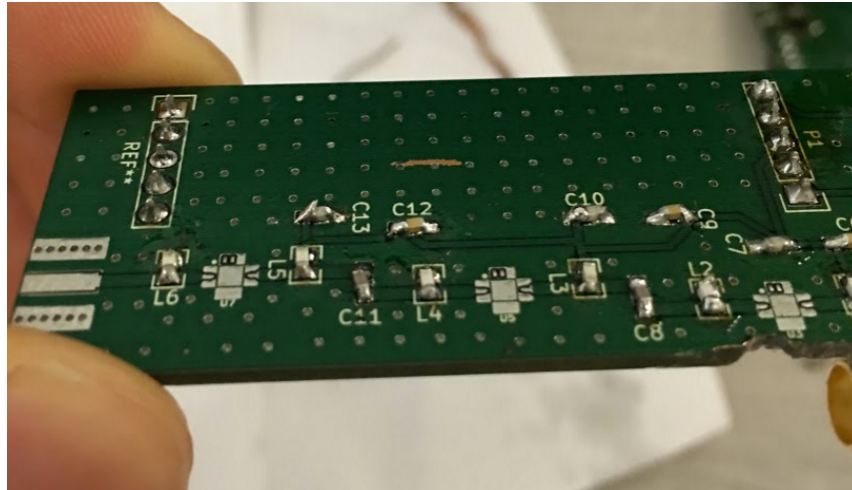


Figure 4. PCB before hot airing.

Mentioned before, you could also use the hot air to place components. Placing soldering paste on the PCB just like the hot plate, the hot air can be operated to melt the soldering paste, but doing minimal damage to the PCB. This was a alternative I utilized frequently over the hot plate, because it takes much more time for the hot air to damage the board, and also I may focus the heat in the specific location I'm soldering, minimizing interference with other solder components and damage to the PCB.

## VII. Final tips

If there was excess solder applied, I would use two main methods: scraping, and soldering wick. In cases where the component has several adjacent connections, like the VCO and LNA IC components, you could clean the iron, and gently hold the tip of the iron where the excess solder is, or scrap it away from the connection. **By bringing a cleaned solder iron to a connection, a bit of the melted solder will attach itself to the iron, which may be enough to clear a unwanted short.** If there is a great excess however, this method doesn't work, so you may turn to the soldering wick. To use the wick, place a strip on top of the area with an excess amount of solder. Then press down on the wick with the hot iron, and hold it in place until the wick stick absorbs the solder. Note that the wick does heat up, so you may want to hold the strip of wick in place with tweezers. In the case of removing through hole components, you may heat on side, while pulling the component out until all the solder in contact is melted. Heat transfer in solder goes relatively quick, but if it takes to long for the heat to travel to the other side of the pin, you could

also apply two soldering irons on each side, while a second person pulls on the component until it frees. Once you remove a pinhole component, there are times where excess solder remains in the vi, which may block any future components going in. To remove this solder, you could use the wick, or another tool called the soldering tube. It acts as a vacuum, and sucks in any melted solder. First you would heat one side of the vi, and then place the opening of the tube as flat as possible on the other. Once the solder melts, you release the spring in tube, the black button in figure 5, and it will suck the solder up.

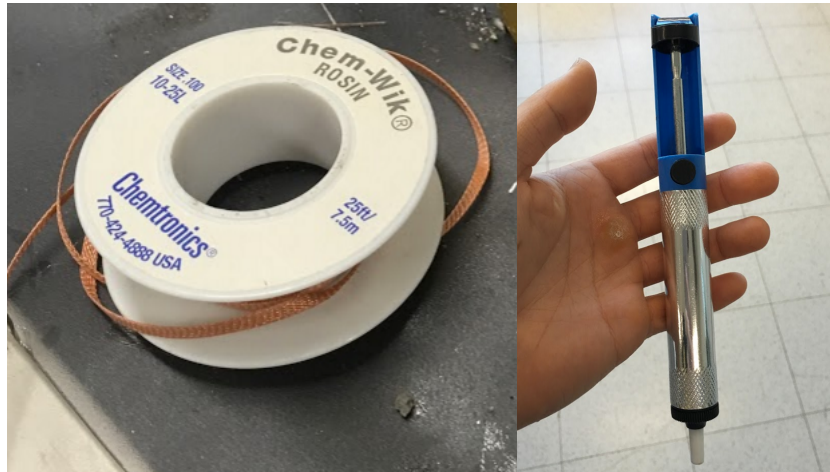


Figure 5. Soldering wick and Soldering Tube