Workshop Notes
Surface Mount Techniques for Hobbyists
Waverley Amateur Radio Society
3 December 2022
Version: 1.1

Preparation and Supplies

The Waverley club will supply materials for the workshop including printed circuit boards (PCBs) and components so there is no absolute requirement for participants to bring equipment to the workshop. However you will get much more out of the experience and be more likely to complete all the tasks if you prepare in advance.

The components are extremely small so you will be well advised to bring along some magnifying lenses or headsets such as the Jaycar QM3511 ($30) or equivalent. If you have a hand magnifying lens (with or without inbuilt lighting) bring it.

Tools for manipulating tiny components will be almost essential. The Jaycar tweezer set TM1760 ($20) is an example. If you use supplementary lighting to do fine work and have a preferred desk lamp arrangement – bring it along – with a long mains lead.

Some folks already have ideas or experience regarding surface mounting and may wish to bring along a soldering iron with a fine tip or a "re-work station" with hot air gun or other tools or techniques to demonstrate to the group. A couple of re-work stations will be available to share.

The "default technique" to be used – if all else fails – is reflow soldering using solder paste and reflow ovens. These will be supplied by the club so using your own soldering equipment is optional.

If you have a multi-meter bring it along for testing the components and boards once they are assembled. A small number of meters will be available for sharing if you need one.

Boards and Components

The workshop will involve assembly of two different PCBs (Figs. 11 and 12). One board (Prax) is not a functional circuit but simply a number of different styles of mounting pads to practise adding (and subtracting) components of several sizes and shapes.

The component packages include resistors in several sizes from R1206 to R0402. These numbers refer to dimensions in hundredths of an inch so the width of a R0402 package is 0.02 inches or about 0.5mm. These resistors are hard to see let alone work. There are pads for SOT-23 which is a pretty conventional "small outline transistor" (SOT) package, an SOIC8 which is for a "small outline integrated circuit" (SOIC) with 8 pins and an SOT-1061 which is a transistor package with no pins at all – just some pads underneath the component. The SOT-1061 may prove extremely difficult to work with a soldering iron and may require the reflow technique.

The second board (LedFLash) is a functional circuit so you will be able to test whether your construction actually works. It is possible that some folks will not finish two boards in the available time of the workshop but we expect that everybody will learn something (even by trial and error) and we will all have fun.

Lab One – PCB Prax

Start by fastening a R1206 resistor to the board. This will be the easiest.

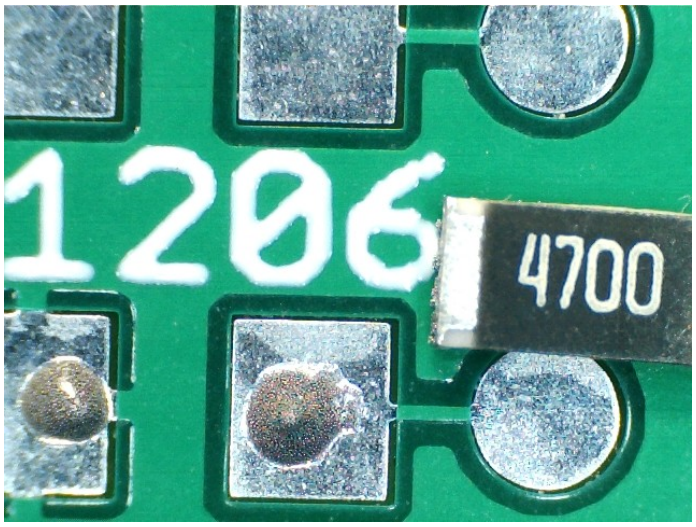

Fig. 1 R1206 Pad, Paste and Component

Method 1 – soldering iron
Put a dab of solder paste on each pad of a R1206 item on the PCB (see Fig. 1). Place the component carefully on the pad over the paste without smearing the paste around on the board. With one hand press a tiny screwdriver, probe or tweezer tip down on the component to keep it from shifting. With your second hand tin the soldering iron to assist in heat transfer and touch the iron to one end of the resistor and its pad. With your third hand you may wish to add some more solder to the exercise. With your fourth hand you may want to steady the board so it doesn't slide around on the table. Don't worry about the quality of the solder joint; at this stage it is just mechanical. Once the first joint is cool you can solder the opposite end of the resistor without everything moving around. Then when that joint cools you can go back and improve the first joint in case of a "cold joint".

Method 2 – reflow oven
Put a dab of solder paste on each pad of a R1206 item on the PCB (see Fig. 1). Place the component carefully on the pad over the paste. Only tiny "nudges" of adjustment are possible lest the paste is smeared around to form a short circuit. If you make a mistake don't try to fiddle a repair. Remove the entire component and clean all the paste off the component and the board using a tissue. Check cleanliness with a magnifying lens and then start again.

If you are assembling several components you may place them all on the board at this stage. At the start it will be easiest to reflow the board with a very small number of components to avoid accidentally shifting component 1 while placing component 2. The reflow process can be repeated several times although some components are less tolerant than others about repeated heating. When

the board and components are ready put the board in one of the reflow ovens supplied by the club for this workshop, hit “Start” and relax.

Once the component is soldered to the board check the resistance between the test pads connected to the component traces.

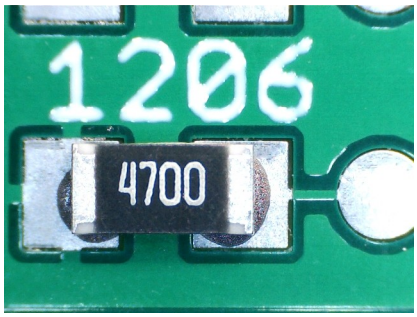

Fig. 2 R1206 Placed and Ready for Reflow

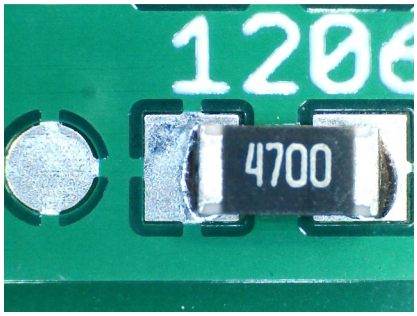

Fig. 3 R1206 After Reflow

Now move on the the other resistor pads in decreasing size and increasing difficulty, finishing with the R0402 (Figs 4-7).

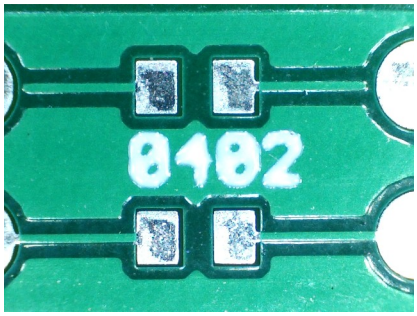

Fig. 4 R0402 pads before assembly

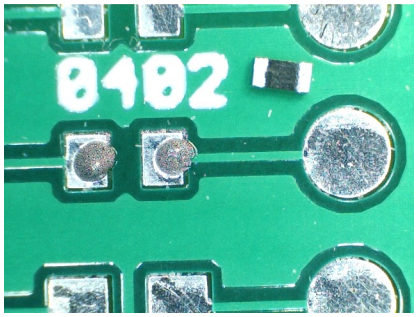

Fig. 5 R0402 Pad, Solder Paste and component

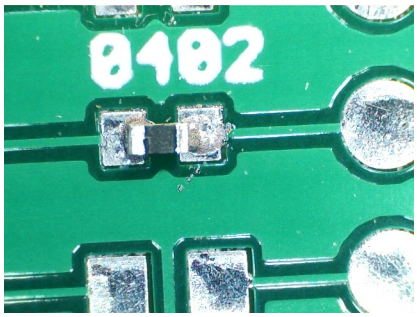

Fig. 6 R0402 – component placed ready for reflow

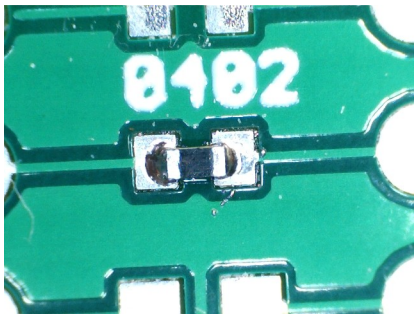

Fig. 7 R0402 after reflow

Now solder on the SOT-23 component. Then the SOIC8. Check for short circuits between adjacent pins.

Lastly add the SOT-1061 transistor (Figs. 8-9). This is not very tricky using the reflow oven but it may be a major challenge with a soldering iron. We will see how the participants manage. Check the base-emitter and base-collector junctions with an ohmmeter/diode tester.

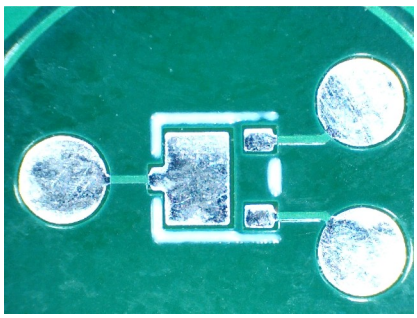

Fig. 8 – SOT-1061 Pad before assembly

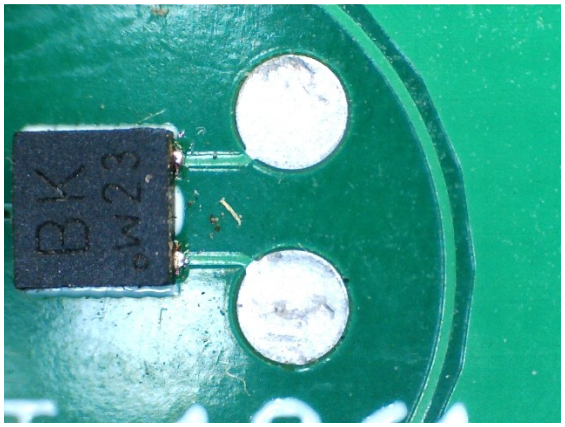

Fig. 9 SOT-1061 – BC56 transistor in place after reflow

Advanced Techniques (optional)

Advanced particpants may want to try removing one of the R0402 resistors and replacing it. This is best done by shielding the adjacent components with polyimide (Kapton) tape (Jaycar NM2892) and then heating the component to be removed with a hot air gun and lifting it off with tweezers or a vacuum tool. Then the board pad must be meticulously cleaned with solder braid and added flux to ensure the replacement fits correctly.

Advanced particpants may also try mounting “metal electrode – leadless face” (MELF) components on the MELF0204 pad. These components are usually high-end precision (and expensive) items with a cylindrical profile which adds to the challenge because the packages tend to roll around on the table. Some wags claim that MELF stands for “mostly end up lying on the floor”.

Lab Two – PCB LedFlash

This board produces light flashing such as could be used for strings of Christmas lights with individual “twinkling” patterns. The circuit is shown at Fig. 10 and is conventional except that it is intended to drive “high power” LEDs as well as normal 20 ma. LEDs. For this reason it has an output buffer transistor (using the SOT-1061 package). If you are assembling a board using conventional 20 ma LEDs then R4 will be 1Kohm, if you are using high power LEDs then R4 = 12 ohms.

To provide “random” patterns of twinkle the plan is for each participant to use different values of R2 and R3 which are in parallel. The resulting net resistance should lie in the range from 100K to 1 Megohm. Choose a value and work out the components for the board – selections available include 100K, 150K, 220K, 330K, 470K, 560K, 1M, 1.5M and 2M.

Best plan would be to assemble resistor R1 and transistor Q1 first, reflow them and test them on the board independently. These would be the most difficult and the ones most likely to need rework. Then add R4, integrated circuit U1 (pin 1 is adjacent to the C2 pad) and capacitor C1 and test. Then add R2 (and R3 if used), R5 and C2.

For testing, it will be easiest to try out the circuit before mounting the LEDs checking with a voltmeter or oscilloscope. If a short length of bus wire is soldered to the power pads a 12V supply can be clipped on with alligator clips. The voltage at pin 3 of the U1 device should be jumping between +12volts and 0 volts every few seconds.

Now add the LEDs. This is a hybrid board using through-hole mounted LEDs to allow for the high power so the LEDs will be mounted last using conventional through hole soldering. The shorter lead of an LED is the cathode and should go toward the flat side of the silk screen outline.

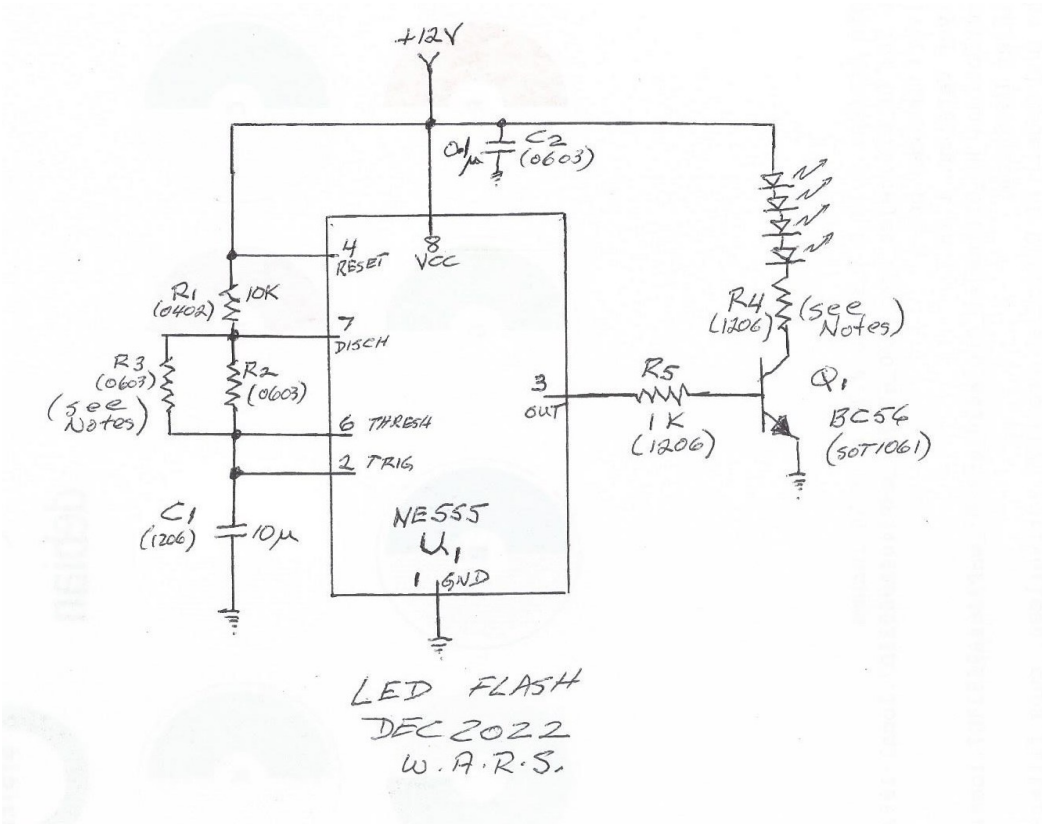

Fig 10 – Schematic LedFlash board – W.A.R.S. Dec 2022

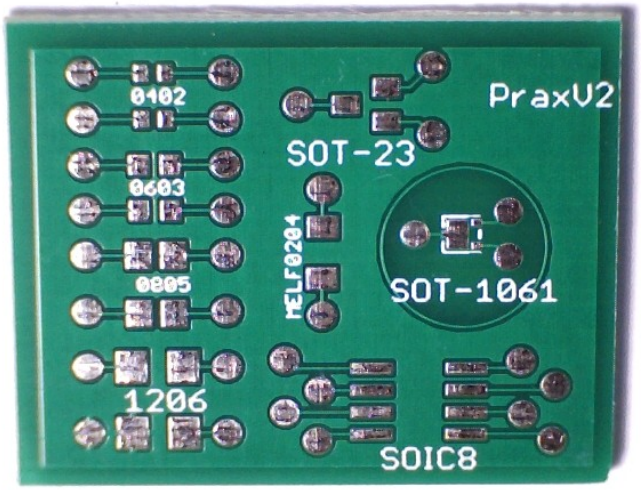

Fig. 11 – Initial State Practise Board PraxV2

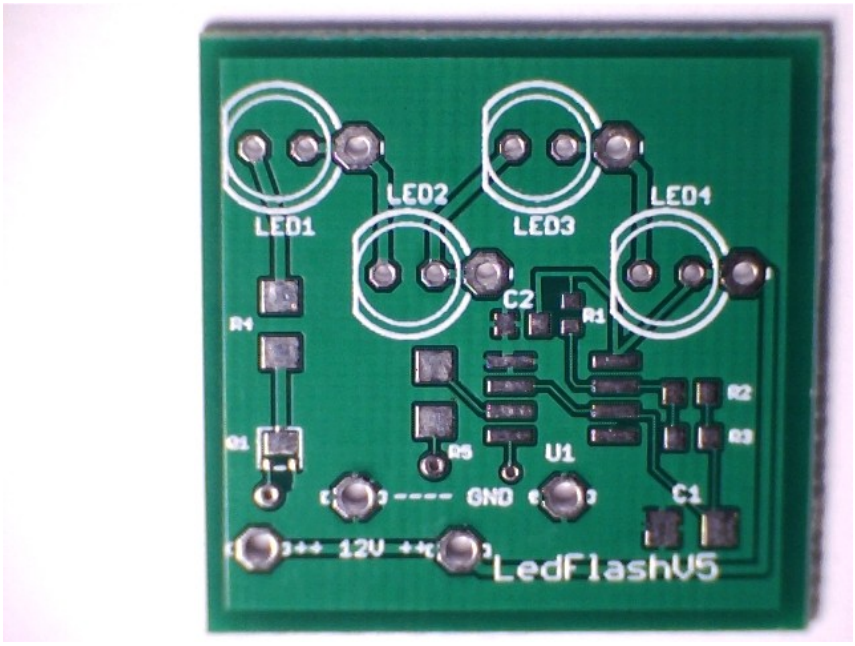

Fig. 12 – Initial State LedFlash Board – LedFlashV5