CodeMash 2022 Alien Spaceship Badge

The CodeMash 2022 Spaceship Badge is great little souvenir and conversation starter that also serves as an easy introduction to surface mount soldering and the endless possibilities of the 555 timer.

It consists of 2 main components: a battery-powered spaceship badge and an add-on alien. They are connected via SAO V1.69BIS standard 6-pin connectors, so other SAO boards will work with the badge as well.

Surface Mount Soldering

If you haven't done much surface mount soldering before, the surface mount devices (SMDs) may seem pretty small compared to their through-hole counterparts. The resistors are all of package type **1206**, meaning that they are 0.12 x 0.06 inches in size (3.0 x 1.5 mm) – which is relatively large for SMDs. You'll find that with the right technique and a little patience, you'll be getting good results very quickly.

A good technique for getting started is to:

1. Melt a bit of solder onto one of the device pads. Don't use a big glob – just enough to cover the pad is sufficient.
2. Place the device on the pads, paying attention to any orientation markings
3. Hold the device in place using tweezers, a toothpick, or a small clip. Don't use your finger!
4. Re-melt the solder you placed on the pad to secure the device to the board.
5. Solder the other device leads to their pads.
6. Inspect your work to make sure that you didn't miss any pads, the device is relatively straight, and there are no solder cross-bridges between device leads or pads.

Dealing with Solder Cross-bridges

When solder ends up connecting two or more leads that should NOT be connected:

- Take a clean soldering iron (use brass sponge to ensure no solder on the tip) and comb the solder away from the device leads.
- Apply a bit of solder flux on stubborn cross-bridges and re-heat/re-comb leads.
- For stubborn cases, use a solder sucker or solder wick to remove excess solder.

Cross-bridges often happen when you're using too much solder, so use as little solder as possible while still achieving a good physical connection between the pad and the device.

Safety

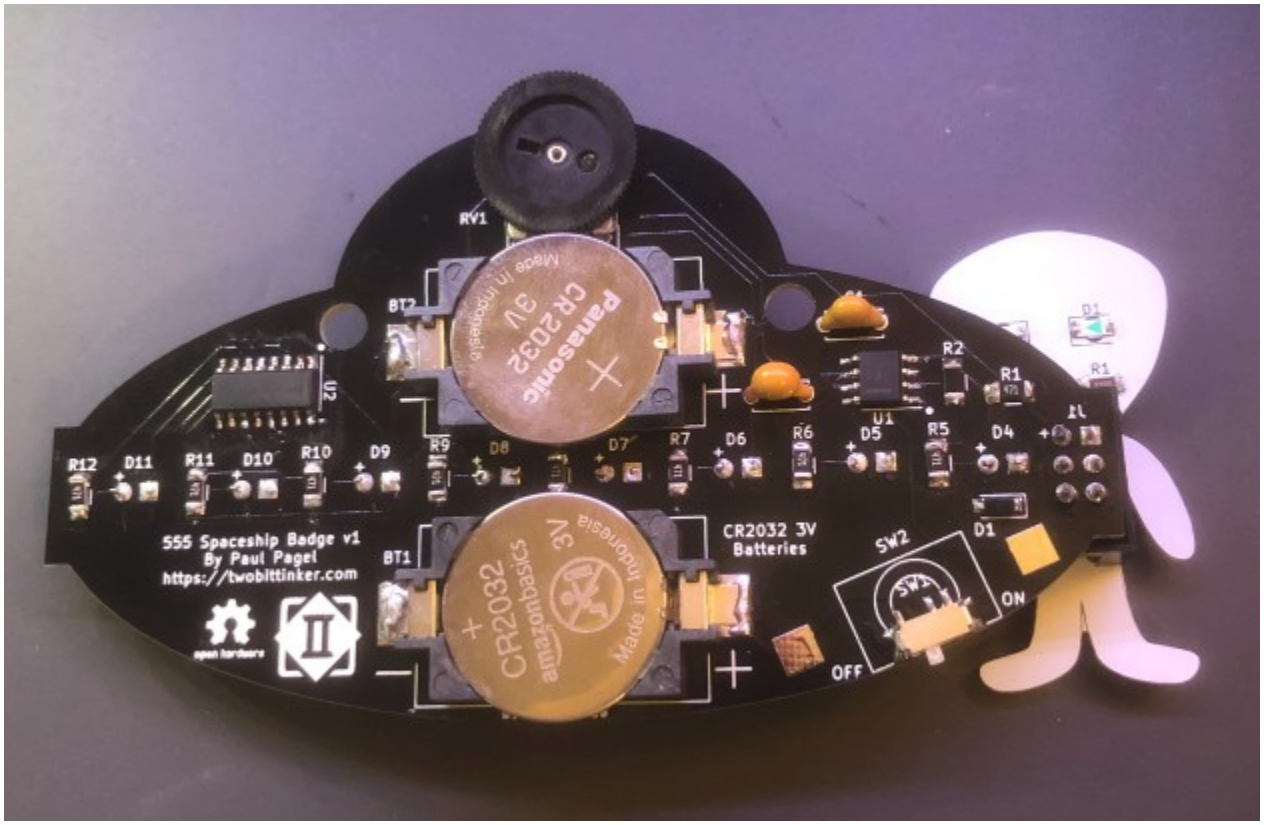
- All standard through-hole soldering safety rules apply.
- Don't use fingers when picking up or holding devices in place. Use tweezers.
- Be careful when using tweezers. Tweezers used with electronics tend to be a lot sharper than cosmetic tweezers.
- If you're not sure if something is safe, ASK!

Parts

Detailed bill of materials (BOM) list with vendor links is available in the Github repo.

Reference(s)	**Value**
Custom Spaceship PCB	
BT1, BT2	2032_Battery_Holder
C1	10nF ceramic capacitor
C2	1uF ceramic capacitor
D1	1N4728 diode, SOD-123
D4, D5, D6, D7, D8, D9, D10, D11	3mm LED (any colors)
J1	6-pin Badge_Connector
R1, R5, R6, R7, R8, R9, R10, R11, R12	470R resistor, 1206 size
R2	10K resistor, 1206 size
RV1	B100K thumbwheel potentiometer
SW1	SW_SPDT slide switch*
SW2	Mini latching pushbutton switch*
U1	NE555D timer, SOIC-8
U2	CD4017 counter, SOIC-16
Alien PCB	
D1, D2	LED (any color), 1206 size
R1, R2	220R resistor, 1206 size
J1	6-pin SAO Connector

* Only 1 switch should be used. Which one depends on availability and your personal preference.

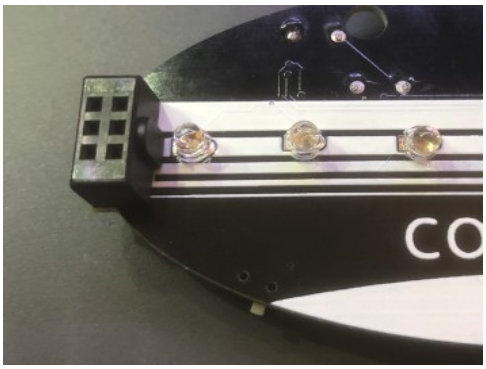


Detailed Assembly Instructions

The Spaceship Badge

1. Identify the 470R resistors. These should be marked with “471” on their top side.
2. Solder resistors to R1, R5 – R12.
3. Solder 10K resistor to R2. These may be marked “103” or “1002”.
4. Solder the 3V3 Zener diode to D1.
   - Diodes are polarized, so orientation is critical.
   - There should be a bar on one side of the top of the diode.
   - The bar should be placed on the side of the footprint closest to the edge of the badge.
   - Magnification and a small light source will make this easier to verify.
5. Identify the CD4017 binary counter device and place on the U2 footprint.
6. Make sure the bar on the package is on the same side as the line on the badge footprint and solder in place.
7. Identify the 555 timer device and place on the U1 footprint.
8. Again, make sure the bar on the package is on the same side as the line on the badge footprint and solder in place.
9. Take the thumb wheel potentiometer and place in RV1.
10. Flip the badge over and solder the pins for RV1 from the front of the badge, being careful not to scorch the board.
11. For the power switch, there are 2 different options. SW1 is a small slide switch. SW2 is a larger latching push-button. Either will work fine, but only 1 should be soldered to the board.
12. Find the 10nF ceramic capacitor C1. It should be marked with “103” on one side.

13. Flip the board to the back and insert the capacitor from the back and solder on the front.
14. Find the 1uF ceramic capacitor C2. It should be marked with “105” on one side.
15. Flip the board to the back and insert the capacitor from the back and solder on the front.
16. Take the battery holders BT1 and BT2 and place them on the board so that the little circle with a small + on the corner of each case is right next to the large + symbol on the board.
    - The polarity symbols on the holders can be hard to see.
    - The + side can also be identified by the two small pins sticking up that will make contact with the side of the battery (vs. the longer pins on the other side which make contact with the bottom of the battery.
    - Solder the battery holder leads to the board pads. Be a bit more generous with the solder on these as they will be subject to mechanical stress when changing batteries.
    - Do NOT put the batteries in yet.
17. Notice the footprints for D4 – D11. The anode through-hole for each one is marked with a small + which is always on the left.
18. Flip the board over and insert the 3mm LEDs from the front, making sure that the longer lead on the LED goes through the hole for the anode (which will be on the right when viewing the badge from the front). Solder the LEDs in place.



19. Take the 6-pin badge connector and place in the holes on the front left of the badge. If the connector has a key, the key should be on the right side of the connector, close to an LED. Flip over and solder on the back. It helps to use something to keep the board level as you do this.
20. Place the batteries into the battery holders, + side up. It works best to insert the battery edge closes to the holder + (right) side first, then snap the battery into place by the negative (left) pad next.
21. Use the power switch to turn on the badge. Use the thumb wheel to adjust the LED cycle rate.
22. If everything works, turn off the badge and proceed with the alien assembly. If it doesn’t work, don’t despair – just see the troubleshooting section below.

The Alien Add-On

1. Take the 220R resistors R1 and R2 (marked 2200) and solder to the board.
2. Take the LEDs D1 and D2 for the eyes and place them so that the top of the LED is in the eye hole and the bottom of the LED is facing up.
    - The back of the LED will have an arrow (usually green) that points toward the cathode (negative end of the device).
    - Position the LEDs so that the arrows point towards each other: [>] [<]
3. Take the SAO connector and place it so that it fits over the connector on the badge.

4. Place the alien so that the 6 holes in its chest fit over the connector pins.
5. Solder the connector pins to the front side of the alien.
    - Be careful not to scorch the button connections as these will be visible.
    - Wait a few seconds for the metal and plastic to cool before putting any stress on the connectors to avoid pulling pins out.
6. Turn the badge on and verify both eyes light up.

Troubleshooting

If the board does work when you power it on, turn the power off and follow these steps one at a time. Retest after every step where you changed or fixed something on the board to see if the board works. Turn the board back off before proceeding to the next step.

- Make sure the battery is seated properly and making contact with the positive and negative battery holder contacts.
- Examine all solder connections and make sure you didn't miss any.
- Re-melt any solder connections that look cracked or irregular.
- Check for any cross-bridges and remove them.
- Verify device orientation for polarized components:
    - D1: line to right side
    - U1: line on bottom edge
    - U2: line on right edge
    - BT1, BT2 – plus symbol
    - Alien D1, D2: arrows point to middle [>] [<]
- Try different CR2032 batteries.
- Take a multimeter and with the badge power on, check:
    - Battery holder leads
    - Battery ground to power pin on switch (right-most pin)
    - (-) D1 (+) : should measure at least +2V
    - Top 2 pins on connector should measure ~3.3V