**THE FOLLOWING IS AN EXAMPLE FROM A POD V PCB.**  
  
Braking IO Rev A Bring Up Procedure

11/6/2019

**Purpose**

This document is designed to list the steps required to bring up the Rev A Braking IO PCBs.

**Initial Inspection and Continuity Checks**

1. Check packaging for any visible damage from shipping.
2. Open package and verify 5 bare PCBs arrived
3. Inspect the board for any visual defects, including poor soldermask, damaged pads, etc.
4. Check power rails
   1. On each IC, verify VCC and GND are present on the appropriate pad
   2. Verify power rails are not shorted together
   3. Verify power rails are not shorted to GND
      1. V-BUS
      2. V-POS7V
      3. V-POS5V
      4. V-POS3V3
5. Check for undrilled vias and through holes
6. Check for any shorted pads or traces

**Solder Paste**

1. Ensure you have a fresh, refrigerated tube of solder paste
2. If desired, laser cut a sheet of mylar
3. Apply solder paste to each pad
   1. Avoid applying too much solder paste
   2. Avoid applying too little solder paste

**Organizing Components**

1. Organizing components beforehand can be a huge timesaver when doing assembly by hand. I recommend splitting your components into groups (resistors, capacitors, ICs, etc and arrange them in alpha-numeric order.
   1. This set of components was a self-contained digikey order, so if should be easier to find what you need.
2. Print off a copy of a BOM (and Schematics if desired)
3. Make sure you check the schematic for DNP components, If a component is DNP, that means DO NOT POPULATE! This could be done for a number of reasons like configuration options, addressing, or flexibility.

**Place SMD Components**

1. It is recommended to place the power supply components first and verify the supplies are functional before placing the rest of your components. Remember, boards are cheap, components are expensive.
2. Reflow components using an oven (preferred) or a hot air tool, reflow your components
   1. Inspect the board after to make sure all solder joints were reflowed
   2. Inspect the board after to make sure there are no shorts
   3. If necessary, populate a 24V header so you can power on the initial supplies
3. Performing continuity checks, especially on your power rails and when everything is as expected, power on the board and verify all of the power rails are coming up appropriately
   1. Be sure to set the power supply to 24V and 500mA current limit
4. Fill in the table after powering on the board

|  |  |  |
| --- | --- | --- |
| **Rail** | **Expected** | **Actual** |
| V-BUS | 24V (Power supply) |  |
| V-POS7V | 7V +/- 2% |  |
| V-POS5V | 5V +/- 2% |  |
| V-POS24V | 24V +/- 1% |  |
| V-POS3V3 (After Nucleo populated) | 3.3V +/- 2% |  |

1. After power supplies are placed and verified, place the rest of the SMD components
   1. Note, only place one of the solenoid driver circuits and verify that circuit is working before placing the rest of the ICs
2. Reflow components, as before
3. Inspect and touch up any open circuits or shorts

**Place Through Hole Components**

1. Almost there! Solder your through hole components to the board
2. Perform one last continuity check on the power rails

**Power on the Board!**

1. Set a current limit on the supply.
2. Connect the board to power
3. Be prepared to power off the supply in the event of a short circuit (indicated by either hitting the current limit or magic smoke coming off of the board)

**Verify Sub-Circuits**

Some circuits can be tested more easily than others. Below is a recommended test procedure

Tests that can be performed without software support:

1. Voltage telemetry on all rails (Measure the output of the Op-Amp and verify it corresponds to the actual measurement)

|  |  |  |
| --- | --- | --- |
| Rail | Expected Range | Measured Value |
| V-BUS | 1.82V-2.54V |  |
| V-POS7V | 4.1V-4.2V |  |
| V-POS5V | 3.9V-4.0V |  |
| V-POS24V | No Telem |  |

1. Current Telemetry on all rails (Measure on the output of the INA240x)

|  |  |  |
| --- | --- | --- |
| **Rail** | **Expected Range** | **Measured Value** |
| V-BUS | 4.0V Max |  |
| V-POS7V | 4.0V Max |  |
| V-POS5V | 4.0V Max |  |
| V-POS24V | No Telem |  |

1. Verify Pressure Sensor Circuit
   1. This is a lower priority circuit to test, as it’s a direct copy from Pod IV
   2. Connect a pressure sensor to P12 and verify the output is appropriate.
   3. Bonus: Connect to a pressurized system

|  |  |  |  |
| --- | --- | --- | --- |
| **Sensor Number** | **Sensor Type** | **Expected Vout** | **Measured Vout** |
|  |  |  |  |
|  |  |  |  |

1. Verify Temperature circuit
   1. Similar to the pressure sensor circuit, verify the output voltage is appropriate for the thermistor.
   2. Verify the voltage changes with temperature

|  |  |  |  |
| --- | --- | --- | --- |
| **Expected Vout @ Room Temp** | **Measured Vout @ Room Temp** | **Expected Vout @ 40C** | **Measured Vout @ 40C** |
|  |  |  |  |
|  |  |  |  |

1. Verify Retroreflective Circuit
   1. Connect a retroreflective sensor to the header
   2. Flash a retro tape and confirm:
      1. LED output changes
      2. Voltage changes on the negative edge

|  |  |
| --- | --- |
| Retro Number | Pass? |
| 1 |  |
| 2 |  |

1. Verify Solenoid Driver Circuit
   1. Connect a solenoid to the solenoid header
   2. Drive the solenoid EN signal (Either manually, or via controls if they are ready)
   3. Ensure that the solenoid is driven
   4. Measure how power consumption

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Solenoid Number | Actuates? | Unactuates? | Nominal Power Consumption | Max Power Consumption |
| 1 |  |  |  |  |
| 2 |  |  |  |  |
| 3 |  |  |  |  |
| 4 |  |  |  |  |
| 5 |  |  |  |  |
| 6 |  |  |  |  |
| 7 |  |  |  |  |
| 8 |  |  |  |  |

1. Verify Watchdog Circuit
   1. Watchdog design must be completed first
2. Verify I2C Devices
   1. Relies heavily on controls
   2. I2C Scan can be implemented through MBED OS
3. Verify UART Circuit

Note: The STM32L432KC has a quick and dirty compiler called MBED OS that you can write quick programs to test hardware functionality of the microcontroller. Production code won’t necessarily use this, but verifying hardware is important. Remember, the goal of the document is to have the firmware engineers not able to blame all of the troubles on hardware issues! If you can verify with MBED, you can likely say “sounds like a firmware issue”

**Debugging**

Some general tips on circuit debugging:

1. Thou shall check voltages
   1. Seriously, 95% of issues for projects like this are either an unplugged power supply, disabled power supply
2. Thou shall understand what circuit you are trying to test
   1. Is it really borked? Or do I just not understand what’s actually going on? Re-read your datasheet, pull up the schematic
3. Thou shall check continuity
   1. Go around all of the pins for your IC and verify they are connected properly. In my experience, it could be a bad lead, bad solder connection, or even a misspelled net name on your schematic. Don’t fret, you can always bluewire low current connections you might be missing!
   2. Also make sure you have placed all of the components. Last year we were plagued by missing 0-ohm resistors or other configurations
4. Thou shall check voltages
   1. See 1

**Congrats**

**If you’ve made it this far, you should have a completed, functional, non-buggy PCB!**