FR4 Machine Shield

Troubleshooting Manual

Revision History

Revision A 4/5/17

Initial release. Many sections are not filled in at this point. An initial release is being made to get some users going sooner than later.

Revision B 4/17/17

Added troubleshooting information for X, Y and Z limit switches, detached motor solder pad and grinding caused by motor binding or other.

Added photo diagrams to of hall sensor to Photos and Diagrams section.

Table of Contents

Important Notes

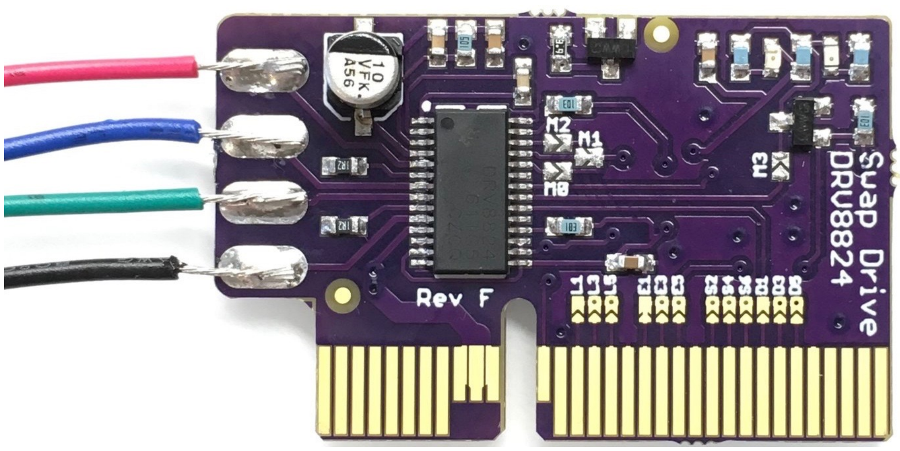
This section has not yet been filled in.

Detached Motor Solder Point

In the case of a detached motor solder point detaches during the soldering process users can use a special replacement swap drive that includes solder points for the motor wires. This drive can be purchased from the Pocket NC store or made using the open source files posted with the drive on the Pocket NC store.
http://www.pocketnc.com/fr4-machine-shield-1/xxpd1765fk6nxrwg4z660hh6wtgci7

When connecting wires to this drive, it should be noted that many orientations of the wires will result in function of the motor but may alter the direction of the motor from that of the desired direction. Each stepper motor used on the FR4 has two phases, these are marked with colored wires. Phase 1 consists of the red and blue wire and phase 2 consists of the green and black wire. While it does not matter if red or blue is soldered first for phase 1, it does matter if phase 1 is soldered to pin 1 and 2 vs pin 3 & 4. Changing the order of the phases will change the initial direction of a stepper motor. To reverse the direction, the wire phases can be removed and resoldered with the phases of the motor reversed.

Users of this detached motor wire fix can use the wire layout from the following photo



LED Fault

This section has not yet been filled in.

Axis Grinding And Binding

If FR4 users experience grinding on an axis while trying to home or perform a move command, they may be experiencing binding. The following is a list of causes and a method for checking. The most common axis which grinding is experienced is the Y axis. The cause of this grinding is usually issue #3.

Cause:

1. Overly tight assembly which does not easily slide on its guide rods.
   To check for overly tight guide rods users must first disconnect the lead screw from the axis motor coupling being tested. Then using the side of a finger apply force to each side of the assembly so it might slide from side to side or front to back. The assembly should require almost no force to move but not slide under its own weight if tipped side to side or front to back.

2. Lead screw which is not concentric or centered with its motor shaft.
   To check a lead screw for concentricity, users should first try to rotate a lead screw by hand while the axis motor is not powered. The lead screw should easily rotate 360 degrees and require a consistent rotational force throughout its rotation. The screw should be tested for the full length of its travel. Should binding occur. It may be necessary to change motor couplings or remove and clean a lead screw.

3. Maximum travel reached due to component misplacement.
   Maximum travel due to misplacement of components is most common with the Z axis hall sensor magnet and Y axis anti backlash nut. Because these components were easily misplaced during the assembly process some assemblies did not function as intended. The Y axis anti backlash nut if improperly placed, keeps the Y axis hall sensor magnet from reaching its hall sensor. To check for this problem users can move the Y axis to its furthest position against back panel or nearest the Y hall sensor. At this point which the Y table binds should be 1mm /.04” or less from the Hall. Should the distance be closer to 12mm/ .5” when the axis binds, the problem is most likely a anti backlash nut located to the wrong

side of an assembly wall. As for the Z axis, should the hall sensor be working properly but not trigger when Z is fully raised, the Z magnet is most likely placed to the right side of the assembly rather than the left and will need to be moved.

4. Motor phase short (in this case motor will not move in any direction when commanded but rather buzz or grind)

5. Debris in lead screw assembly.
   This may be dirt or other grit causing the axis to not rotate smoothly. Using a thinner such as WD-40 or lighter fluid will help to cut oil and remove such debris.

X, Y & Z Limit Switch Fault

The X, Y and Z Limit hall sensors provide a high (3.3volt) or low(0.0volt) signal to corresponding pins 9, 10 and 11 of the Arduino. The hall signals when low, trigger a home switch event. Any of the hall sensors should output a low signal on the output pin when triggered by a magnet and a high signal when no magnet is present. The input of the hall should have a constant supply voltage of 3.3volts when checked against a ground pin of the Arduino. The ground pin of the hall sensor should read 0.0volts against that of a Arduino ground pin. Hall sensors can be checked using a loose magnet but should also be checked by jogging an axis magnet over a hall sensor either by hand or using motors if in working condition. Should an axis not trigger a limit switch throughout its travel but limit switches show proper function, users should see the section on axis grinding and binding.

When testing a hall sensor, it should first be checked for proper input voltage (3.3volts) on the input lead. This voltage should be checked against a ground pin of the Arduino Uno. Without the proper input voltage, the hall sensor will not function as intended. If the input lead does not measure ~3.3volts on the input lead, migrate to the low voltage on 3.3 volt supply

With the input lead of the hall sensor measuring 3.3volts, the output lead of the hall should be checked for a change in voltage as the X axis travels over the hall sensor. The output lead of the hall should measure ~3.3volts with the axis magnet away from the hall and ~0.0volts when the axis magnet is present. If the output lead measures a constant ~0.0volts, migrate to the low voltage on hall output lead now.

Door Alarm Fault

The door alarm function is designed to override machine movement in the event the door is opened. This is to prevent users from getting hurt from moving parts such as the spindle or other components. The following failures are those experienced by other users.

Intermittent door alarms

This section has not yet been filled in.

Constant door alarm

A constant door alarm may be caused by one or more problems with the following components. By checking the components for proper function as described, users should be able to locate and solve the problem

Door hall sensor

The door hall sensor provides a high (3.3volt) or low(0.0volt) signal to the Q1 transistor, indicating the position of the door. This signal when low, is inverted by the Q1 transistor to provide a high signal at the pause pin (A1) of the Arduino. The door hall sensor should output a low signal on the output pin when the door is closed and a high signal on the output pin when open. The input of the door hall should have a constant supply voltage of 3.3volts when checked against a ground pin of the Arduino. The ground pin of the door hall sensor should read 0.0volts against that of a Arduino ground pin.

The Door hall sensor should first be checked for proper input voltage (3.3volts) on the input lead. This voltage should be checked against a ground pin of the

Arduino Uno. Without the proper input voltage, the hall sensor will not function as intended. If the input lead does not measure ~3.3volts on the input lead, migrate to the low voltage on 3.3 volt supply section now.

With the input lead of the hall sensor measuring 3.3volts, the output lead of the hall should be checked for a change in voltage as the door opens and closes. The output lead of the door hall should measure ~3.3volts with the door open and ~0.0volts when the door is closed. If the output lead measures a constant ~0.0volts, migrate to the low voltage on hall output lead now.

If both input and output leads of the hall sensor function as intended, begin checking the door transistor Q1

Door transistor

The component Q1 is a SOT23-3 2N7002P transistor. Its function is to invert the door hall sensor output signal. The door hall sensor provides a high (3.3volt) or low(0.0volt) signal to the Q1 transistor, indicating the position of the door. The actual function of the Q1 transistor is to lower the pause pin of the Arduino (A1) to 0.0volts when it's input measures ~3.3volts. The Q1 transistor should trigger a pause event when the door is open, and its output should remain high (3.3volts) when the door is closed. The output of Q1 should be checked against a ground pin of the Arduino when measured.

The transistor output pin should only be checked after the door hall has been confirmed for proper function. With the door hall in proper working order and the door in the closed position, measure the voltage output of Q1 to a ground pin of the arduino. If the output of Q1 measures a constant ~0.0volts, migrate to the low voltage on Q1 output pin now.

If the voltage on the output pin of Q1 measures ~3.3volts while the door is in the closed position and 0.0volts when open, the sensor is in proper working order

Pause Button. The pause button when pressed, lowers the pause voltage from 3.3volts to 0.0volts. It is directly connected to the pause pin (pin A1) of the Arduino.

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Homing Fault

This section has not yet been filled in.

Spindle Fault

This section has not yet been filled in.

Low voltage on hall output lead

This section has not yet been filled in.

Low voltage on 3.3 volt supply

The hall sensors and Swap Drive LEDs are powered by the 3.3volt Arduino supply and will only show a voltage of 3.3 while the arduino is powered via USB. Users can quickly reference the presence of this voltage from the leds located on each swap drive. Without a visible red or green led in can be determined that the 3.3volt supply is not present due to a short to ground or improperly functioning Arduino.

To check that the Arduino Uno is functioning properly, users should remove the Arduino from the FR4 machine shield and check the 3.3volt Arduino pin for the correct voltage. If the Arduino 3.3volt pin shows proper voltage when measured it can be determined that Arduino 3.3volt supply pin is in proper working order. If the proper voltage is not measured, users will need to replace the Arduino unit but should also finish the troubleshooting within this section.

Next, the 3.3volt supply rail of the machine shield should be checked for a short to ground using a multimeter with the continuity setting active. It should first be checked that the power is off and disconnected from Machine Shield.

If continuity is detected between the 3.3volt pin and ground it can be determined that the 3.3volt supply suffers from one or both types of shorts possible and should migrate to the electrical shorts section now.

Low voltage on Q1 output pin

A low voltage on Q1 output pin may be caused by one or more problems. This section should help determine the cause of the low voltage.

With the USB and power disconnected, the output of Q1 should be measured using a multimeter set to the continuity setting. This setting usually provides a beep of sorts when a zero ohm or very low resistance connection has been made. The output of Q1 should be measured to a ground pin of the Arduino. If the measurement shows continuity (beep sound provided) migrate to short to ground on pause pin section now.

If the measurement between the output of Q1 and a ground pin did not show continuity (no beep sound provided) but remained at 0.0volts while the arduino was powered then the pin A1 of the Arduino uno should next be checked for a voltage greater than 3.3volts while the Arduino is removed from the machine. If the measurement of the pin A1 measures a greater voltage than 3.3 while the arduino is removed, the component Q1 may be internally damaged and require replacement. If the measurement of A1 does not provide a voltage greater than 3.3 while disconnected, the function of the Arduino is not as intended and should be reprogrammed or replaced.

Short to ground on pause pin

The Pin A1 should next be measured for resistance to a ground pin of the Arduino. This measurement should provide a resistance in the millions of ohms or an indication that the value is too high to measure. Should it measure less in the 1k - 500k ohms range a dirty solder connection may be causing an intermittent pause event and is most likely the result of a debris type short. For fixing this problem, see the debris shorts section under electrical shorts. A measurement of continuity may be caused by a pause button failure or other electrical shorts. Before removing the pause button to check for failure it is recommended that users first visit the section on electrical shorts as the pause button is the least likely point of failure.

An internal failure of the pause button requires that component be replaced. While the pause button is the least likely point of failure an abundant use of heat has proven to destroy the component. All other forms of shorts should be explored before the removal of the pause button. Removing the pause button will allow users to check the signal A1 of the Arduino for a short to ground. If removing the pause button did in fact remove the short to ground, it can be determined that the pause button was the issue and should be replaced. If removing the component does not fix the issue, the pause button should be left out until the cause of the short can be found.

Electrical shorts

The four types of shorts possible are boardshorts, solder bridges, internal shorts and debris. Internal shorts are that of short within a damaged component and will not be discussed in this section. Solder bridges are the most easy to determine as they are usually visible to some degree. Solder bridges should always be looked for first when troubleshooting a short unless evidence suggests otherwise. When searching for shorts that span between boards or groups of boards such as the back panel and the side panel or main panel and X assembly, it may be best to disconnect connections to help find the location of a short. Separating the back panel from the X assembly is simple as only two ribbon cables connect the two assemblies.

Board Shorts

Board shorts are the product of etching problems during the manufacturing process. These shorts come in several different forms and may or maynot be fixed depending on the severity. Most often a board short consists of an unetched bit of copper between two traces, a trace and a copper plane or a via and copper plane. This bit of unetched copper electrically connects the trace, via or plane to one of the others causing improper function. Board shorts are fairly easy to see on the FR4 machine shield as all traces have a defining surrounding line which appears lighter in color. By inspecting the trace for gap in the white line, users can determine the location of a board short.

Fixing board shorts is usually quick and easy but not always possible. Once the short has been located, a razor blade can be used to separate the two shorted signals. Board shorts between very small signal wires such as those located under the card edge connectors may not be fixable if the distance between wires does not leave working space. A large group of traces shorted together may be impossible to fix and require the replacement of panel.

Solder Bridges

Solder bridges are the product of excess solder electrically connecting two signals that should not have continuity. While solder bridges are often easy to see they can also at times be too small to see without the use of a magnifying glass. Solder bridges may also be under a connector making them visually impossible to see. When looking for solder bridges under a connector, checking continuity of side by side pins will quickly show a bridge.

Fixing a short caused by solder bridges can be difficult as solder without the use of flux is quite difficult to manipulate. Adding flux to a component while reworking the solder is acceptable but the flux must be removed before the machine is to be used. It is not recommended that bulk flux be added to solder connections between boards as flux within joints can be difficult to remove and cause debris type shorts. Remaining wire can be used to soak up solder from bridges but first must be soaked in flux to help draw the excess solder.

Debris shorts

Debris shorts take two basic forms. The first is that of a metal chip from loose or remaining solder beads, or shavings as a byproduct of machining conductive material. The second type of debris is much more deceptive as it may not be visible even with a magnifying lense. This type of debris is flux. Flux that remains from the process of soldering can cause electrical shorts to different degrees. It is most easily measured using a multimeter on the Ohm setting. Any measurement less than that of 1million ohms is most likely the product of flux which remains from soldering. Measurements in the 10k-500k ohm range may cause electrical noise issues between signals while measurements less than 10k will begin to alter the mean voltage of a signal to that of the more powerful signal. For example a 3.3volt signal will flow to ground as the ground signal is the most stable. The 3.3volt signal shorted to the 5volt signal would raise to 5 volts as the 5 volt signal can handle more current than the 3.3volt.

Fixing a short caused by debris is straightforward, once it has been removed the problem should no longer be present or measureable. For removal of larger debris, the use of a vacuum or pick may be more appropriate while the removal of flux may require alcohol and Q-tips or soap and water.

Photos and Diagrams

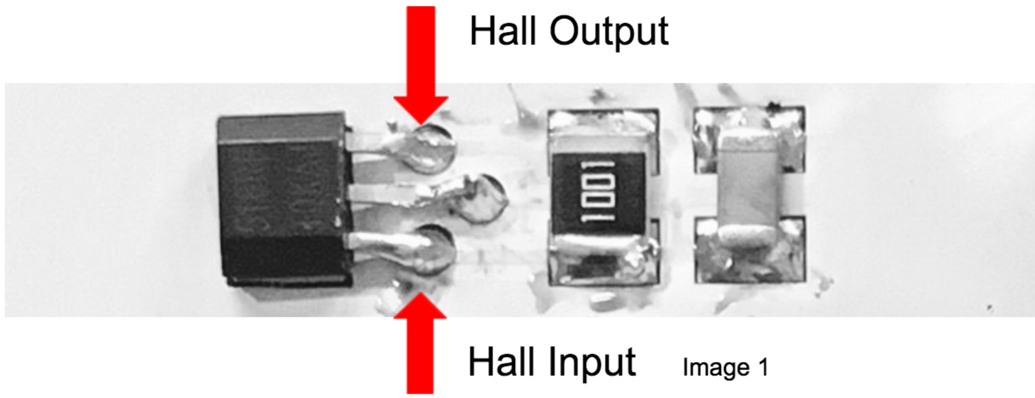

Image 1