Floodgate Power Switch Disconnect Issue

Evaluation and Mitigation Techniques

V1 Floodgate Power Switches discussed in this document have been recalled, and customers who purchased units affected by this issue will receive fixed Floodgate Power Switches.

This document details evaluation and mitigation techniques for teams who choose to continue to use this switch. We believe that this product is still very usable on most robots, but we encourage explicit testing to ensure that your robot does not have just the “wrong” subsystems which can trigger this issue.

These “disconnects” are experienced as a momentary interruption in power that requires the Control Hub to reboot, and can occur under certain circumstances with the Floodgate Power Switch.

This is due to the over-current protections built into the power switch being tripped by brief but high-current draws from motors. The over-current protection built into the Floodgate allows up to 40A of power to flow before it disables the output, waits 1s, and then reenables the output. This can very appropriately stop short-circuit events by detecting very high current draws and disabling the output. Unfortunately, in some events, motors themselves can draw very high amounts of current (even through the built-in 20A fuse on the battery) which can trigger this over-current protection.

A particular momentary, but very high, current spike can happen when motors reverse direction. When you apply voltage to a motor that is already spinning in one direction, the motor is able to pull more than its stall current, and apply more than its stall torque at the given battery voltage for a very short time. When multiple motors all switch direction simultaneously, this large current spike can peak at above 40A from 4 motors, even with voltage sag from the battery.

On motors without load attached, this is not an issue, as the change in direction happens over a much shorter time. We see this issue most consistently with motors that have some load applied. A common source of these issues is teams using 435 RPM (or faster) motors on their drivetrain.

This can be mitigated by asking the control system to add a slight delay between switching the power from full speed in one direction, to full speed in another. This current spike is short enough that we do not need to delay changing the applied power by very much at all. The example we show makes it so it will take approximately 80ms to go from applying full power in one direction to applying full power in another direction.

Step by Step Testing

If you choose to continue using the Floodgate Power Switch, we encourage you to perform this step-by-step test. This is designed to find any issues with your setup before you go to events.

1. Set your robot up “on blocks” so that your drive wheels can spin freely and clear any obstacles which may prevent you from moving any actuation on your robot.

2. Enable your robot, and run the drive motors back and forth, switching from full power forward to full power backwards. For the most in-depth testing, we recommend creating a new program which allows you to set power to these motors using a button press, allowing you to reverse the direction of the motors instantly.

3. Run the drive motors back and forth, while adding in other motors switching directions through the testing. It can sometimes take quite a few tests to find an issue.

Identifying Issues

If you notice that your robot suddenly "disconnects,” but reconnects after a short while: repeat this process without the Floodgate Switch connected, and see if you can recreate this disconnect. In this situation, the light on the Floodgate may remain green. This is not the intended behavior, but is an unfortunate consequence of just how fast these current spikes are.

If your robot turns off, and doesn’t reconnect, check the battery fuse. Repeated high-current-draw events heat up a fuse and can cause it to blow. If the fuse blows, the light on the Floodgate will turn off.

If disconnects persist with or without the Floodgate Switch in the system, please inspect your wiring between your control hub and battery. Loose connections/wires can cause similar intermittent restart issues.

Code Mitigation (Slew Rate Limiter)

Applying a “slew rate limiter” before setting power to a motor limits the change in power applied between one cycle to another. This means that it progressively follows the control signal instead of applying a single change in voltage. This example reduces the change in output to 0.2 (in a -1 to 1 scale) per loop. This should turn into about 80ms on most robots, which is faster than is perceivable in our testing.

We implement this slew rate limiter by creating a function which applies power to a specific motor. We check the motor’s currently applied power, the desired change, and apply either the desired change, or the maximum change allowed—whichever is greater.

Java Code:

First, paste this function into your robot code. This function takes the motor you’d like to make the change in power to, and your target power, as “parameters.” Because we take the entire motor “object” into this function, we can set the power directly within the function.

```
void setSafePower(DcMotor motor, double targetPower){
  final double SLEW_RATE = 0.2;
  double currentPower = motor.getPower();

  double desiredChange = targetPower - currentPower;
  double limitedChange = Math.max(-SLEW_RATE, Math.min(desiredChange, SLEW_RATE));

  motor.setPower(currentPower += limitedChange);
}
```

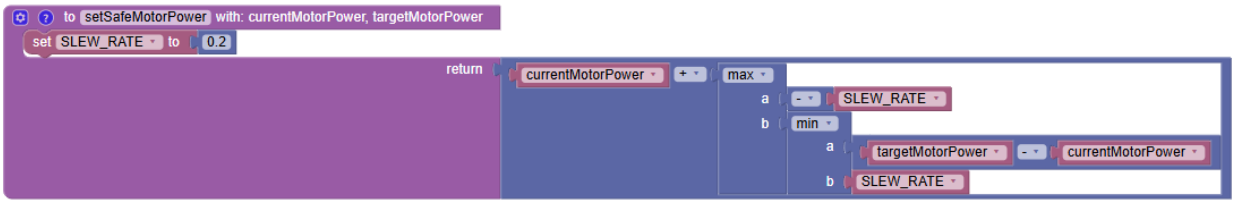
Once you’ve created this function, call it instead of calling motor.setPower() directly.
Here is an example:

```
setSafePower(frontLeftDrive, frontLeftPower);
```

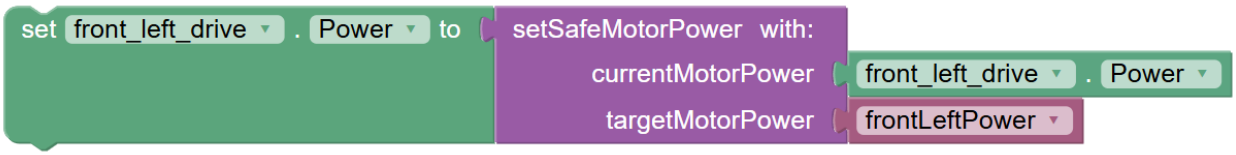
We pass in the motor we’d like to apply this change to (called frontLeftDrive), as well as the power we’d like to apply to that motor (frontLeftPower).

Blocks Code

If your team instead works in Blocks, here is an equivalent function you can create:



Instead of passing in the motor object like we do in Java, in Blocks we pass the current power of our motor into the function. This function “returns” the correct output power, so we use the output of this function to set our motor power.



Contact Information

We understand that this issue with the Floodgate Power Switch is very unfortunate, but we are here to make the experience of using this product as smooth as possible. If you have any questions, please reach out to us at tech@gobilda.com, or by calling (620) 705-5959.